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Report of Activities

ANADROMOUS AND CATADROMOUS FISH COMMITTEE

by

Á. Ísaksson

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BELGIUM

(I.R. De Clerck)

No research was carried out.

CANADA

(D. G. Reddin)

ALEWIFE AND BLUEBACK HERRING (Alosa pseudoharengus) and (A. aestivalis)

The Fisheries

In the Atlantic coastal and Bay of Fundy areas (Scotia-Fundy Region), commercial alewife and blueback herring fisheries using traps, gill-nets, or dip-nets are conducted on medium and large rivers. Recent annual catches have fluctuated near historic lows; 1991 catches increased over those of 1990 but catches declined in 1992 and 1993. There is concern about possible effects of environmental conditions on marine survival since 1990. Much, if not all, of the 1991 increase might be attributable to a new logbook reporting system which has enforceable reporting provision, because fishermen from several major fisheries alleged that catches were actually lower in 1991 than in 1990. Landings from 1988 to 1993 were 3,657, 5,255, 1,388, 2,810, 2,117 t, and 1,939 t, respectively. No new commercial licenses have been issued for several years; many licences are not being actively fished.

The gaspereau fishery on the Miramichi River exploits mixed stocks of both alewife and blueback herring using trap nets fishing six days per week. Recent harvests have declined to an average of about 1,700 tonnes from a peak of 11,000 tonnes in 1952; although that may have included harvest from other rivers. Stock assessments using sequential population analysis with known age structure since 1981 indicate that exploitation has been high. The 1993 harvest was similar to previous years, just under 2,000 t. The catches are generally composed of 65% alewife by weight in most years. Data on catch at age and catch rate were collected in 1993 and assessments of the fisheries based on catch-at-age and annual trends in catch rates one prepared every two years (next 1994).

The Margaree gaspereau fishery harvests almost exclusively alewives. However, the product is of higher quality because fish are salted immediately upon removal from the tip traps. Stock assessments have indicated high exploitation rate and a

reduction in fishing effort was implemented through a one-day-a-week closure beginning in 1984.

Investigations

Stock assessments

1. Studies continue on the return, escapement and future harvest of alewives and blueback herring at Mactaquac Dam, Saint John River, and to the St. Croix River, New Brunswick. **(A)**

2. The logbook system for collection of river herring commercial fishery catch statistics became enforceable in 1991 as a result of changes to the Fishery Regulations. Logbook submissions have been substantially higher since 1992, reaching 100% compliance in some Fishery Statistical Districts. An appropriate method for comparison of pre- and post-regulation catch statistics, particularly for the years since 1984 when neither logbook nor sales slip collection systems were fully implemented, has yet to be determined. **(A)**

3. Assessment data were collected in 1993 for Miramichi and Margaree river stocks. **(G)**

AMERICAN EEL (Anguilla rostrata)

The Fisheries

American eel commercial fisheries using traps, pots, and weirs are conducted on many of the larger rivers in the Atlantic coastal and Bay of Fundy regions of Atlantic Canada. Catches in the early 1980s were near historic lows (17, 20, and 11 t in 1982 to 1984). Recent catches have fluctuated at higher levels: 66 t in 1990, 118 t in 1991, 121 t in 1992, and 146 t in 1993.

The experimental elver fisheries in the Bay of Fundy areas of New Brunswick and Nova Scotia which began in 1990, caught 224.5 kg in 1992 and 732 kg in 1993 (179 kg in Nova Scotia; 553 kg in New Brunswick, mostly (85%) in southwest New Brunswick).

In the Gulf Region, eels (Anguilla rostrata) are harvested in commercial and recreational fisheries. Traps, pots and spears are used to harvest the fish, but the continued use of spears outside the recreational fishery is being questioned because this leads to poor product quality. The fishery is regulated by seasons and size limits, but at this time there is no comprehensive management plan and no catch quota. There is currently no eel research or assessments. There appears to be an increasing demand for eels, and requests from industry for experimental elver fishery were received in 1993. Logbooks were issued to two eel fishers on the Miramichi River to assess the viability of a logbook program to measure catch and effort.

Investigations

Adult studies

1. The study of the timing and relative abundance of elvers migrating to a river on the Atlantic coast of Nova Scotia was extended to 1993. An outbreak of Ichthyophthirius multifilis in the elver run was investigated and a report prepared. **(A)**

AMERICAN SHAD (Alosa sapidissima)

The Fisheries

The American shad fishery is of relatively low economic value and is not closely managed. The important shad fishery in the Saint John River system has declined since the construction of the Mactaquac hydroelectric dam in 1968. Annual shad landings in New Brunswick exceeded 150 t prior to construction of the dam, but now are less than 75 t.

The logbook system for collection of commercial catch statistics introduced in 1991 is expected to provide more accurate estimates of catch than the previous system based on sales slips and reports by field staff. Landings were 87 t in 1991, 69 t in 1992, and 71 t in 1993 for Scotia-Fundy Region.

Investigations

Adult studies

1. Ovary samples from American shad were collected for the second and final year from the Shubenacadie River, Nova Scotia and Saint John River, New Brunswick for MtDNA analysis as part of an Atlantic coast-wide study conducted out of Virginia Commonwealth University, U.S.A. **(A)**

ARCTIC CHARR (Salvelinus alpinus)

The Fisheries

The nominal catch of anadromous Arctic charr in northern Labrador during 1993 was estimated to be 38 t, 48% less than 1992 landings. Total allowable catches were not obtained in any of the stock units. Effort directed toward the fishery was the lowest since 1974.

Investigations

Sex ratios

1. Information on the sex ratio distribution of commercially caught Arctic charr

in 1993 was obtained from a sample of 2,951 fish from seven different subareas within the Nain Fishing Region. Ratio of female to male charr was 47:53. In past years, female charr tended to represent 60% of the catch. (E)

Stock assessment

2. Biological information obtained from sampling commercial catches of Arctic charr in the 1992 northern Labrador fishery was used to advise on allocating total allowable catches for two stock complexes representing eight fishing subareas for 1993. Stock size was estimated using a formulation of the ADAPT framework calibrated with commercial catch rate information. Age, length and weight data were obtained in 1993 from 1,774 commercial specimens, while length information was collected on 13,571 fish. (E)

Tagging and marking

3. Tagging studies were rather limited again during 1993. Only 391 fish were tagged and released. Over 10,000 Arctic charr have now been tagged and released in various northern Labrador areas since 1974 with over 2,700 recaptures. (E)

Genetics

4. Collaborative investigations, with scientists at Memorial University of Newfoundland, have been carried out examining mitochondrial DNA variation among anadromous and and nonadadromous populations of Arctic charr. (E)

ATLANTIC SALMON (Salmo salar)

The Fisheries

In 1993, the nominal catch of Atlantic salmon in Canada in all fisheries was 367 t, a decrease of 155 t or 30% from 1992 landings. For large salmon, the 1993 catch of 209 t; a decrease of 114 t or 35% below that of 1992; while for small salmon the 1993 catch of 158 t was 41 t or 21% below the 1992 landings. Much of the decrease in landings can be attributed to the moratorium on commercial salmon fishing in Newfoundland and reductions in fishing effort due to licence buy-outs.

Recreational catch estimates for 1993 in the Scotia-Fundy Region indicate a retained one-seawinter harvest of 4,303 fish. This number is only 60 percent of the 1992 regional harvest and similar to the 1991 harvest of 4,355 fish. The estimated number of released multi-sea-winter salmon (>63 cm) in 1993 in the Scotia-Fundy portion of Nova Scotia was 1,383 fish. This is a 32 percent decrease from 1992 catch of 1,800 fish, and together the reductions reflect the trend in the region of lower returns of salmon to Scotia-Fundy Region rivers. Some local closures of rivers occurred for the third year in a row as a result of poor returns to those rivers.

In Gulf Shore areas of New Brunswick, returns of 1SW and MSW salmon in 1993 were below the 1992 and the previous five-year means. Total MSW returns to the Miramichi River were 6% below the previous five-year mean return while 1SW salmon returns were 31% above the 1988-1992 mean. Egg depositions were 171% of requirement in the Miramichi River. MSW salmon returns to the Restigouche were 49% below previous five-year mean and 1SW salmon returns were 25% below the previous mean. Total egg depositions were 28-52% of requirements in the Restigouche River.

In Gulf Shore areas of Nova Scotia, angling catches of MSW salmon were down 30% while 1SW salmon catches were similar to previous five-year mean values. Egg depositions in the Margaree River were about three times the requirement.

New Management Measures

A comprehensive five-year Atlantic salmon management plan, instituted in Canada in 1984, was re-implemented for 1990-1994. The original version prohibited commercial salmon fishing in the Maritime Provinces, and quotas (1990-1991) and closure (1992) were subsequently brought to insular Newfoundland. Recreational landings were restricted to one-seawinter (<63 cm) Atlantic salmon (grilse) and regional seasonal creel limits which were further restricted in 1992 were maintained in 1993.

The management plan for Atlantic salmon in the Gulf Region in 1993 was unchanged from the management plan in 1992. The management plan for Atlantic salmon in the Gulf Region in 1992 included major additional restrictions on harvest including: the closure of all commercial fisheries in Gulf Region Newfoundland except for the Southern Labrador portion of SFA 14 (this fishery was regulated by a quota of 13 t) accompanied by a voluntary buy-back program; the reduction of the recreational bag limit from 10 to 8 grilse throughout Gulf Region except for Prince Edward Island (SFA 17) where season and daily bag limits were 7 and 1 grilse; mandatory release of MSW salmon by anglers in all areas except southern Labrador and Restigouche, Québec. Furthermore, landing salmon caught in non-salmon fishing gear (by-catch) was prohibited.

The most significant change to date in the management of Atlantic salmon in the Newfoundland Region occurred in 1992. A five-year moratorium was placed on the commercial fishery in the insular Newfoundland portion of the region while in Labrador, fishing continued under quota or allowance catch. In addition, a commercial license retirement program went into effect in both insular Newfoundland and Labrador. Recreational fishery quotas where in place in SFAs1-14B in Newfoundland and Labrador.

Quotas were introduced for the first time in the recreational fishery in each Salmon Fishing Area (SFA) in Newfoundland in 1992 and continued in 1993. The quotas were assigned for each SFA as a whole and were not administered on an individual river basis. The season bag limit was reduced from ten to eight fish. After the quota was caught in each SFA, hook and release fishing only was permitted.

Investigations

Acid rain

1. DFO is monitoring the water chemistry and invertebrate and fish communities in acidified and acid threatened lakes and rivers in Nova Scotia. Recent analyses of twelve years (1980-91) of water chemistry and physical data indicate that acidification conditions may have improved slightly. However, this improvement appears to be the result of an increase in water temperatures (which would favour production of ANC) that occurred over the same period, rather than to any change in acid deposition. **(A)**

2. The headwater lake liming of a small drainage basin (50 km^2) was continued in 1993-94. This was the eighth year of liming. The native salmon population is being allowed to recover naturally (without stocking). High fry and parr densities have persisted in the limed tributary, and total numbers are increasing as re-colonization proceeds. No juvenile salmon have been found in the un-limed (control) tributary. **(A)**

3. An Atlantic salmon regional acidification computer model is being developed to assist in the management of stocks in acid impacted rivers. The model is being constructed in three modules: marine survival, freshwater production, and water chemistry and toxicity. The first two modules are complete and the third is now being tested. **(A & B)**

4. Continued monitoring of water chemistry, fish densities, and salmon spawning in limed and untreated sections of Fifteen Mile Brook, Nova Scotia. Remarkably, streambed liming continues to be effective 6 years after initial application and is helping to assess the potential for recovery of Atlantic salmon in acidified rivers under present international agreements. **(B)**

5. Laboratory experiments on the effect of silicon on Al-L-gill dynamics have yielded new findings which challenge those previously proposed. **(B)**

6. The quality of the water and benthic communities of five salmon; rivers on the north shore of the Gulf of St. Lawrence was monitored. The objective is to monitor the quality of the salmon habitats in this region,which are knownto be vulnerable to acidification. This is part of the Longe Range Transport of Air Pollutants program (LRTP) of the Canadian government. **(II)**

7. The results of bioassays, made in salmon rivers on the north shore of the Gulf of St. Lawrence, have shown that smolts are stressed during the smowmelt period. The stress is caused by the acid pulse and the increase of inorganic aluminum level. However, direct mortality due to this stress seems to be minimal in rivers of this region. **(II)**

8. The third year of a lake fertilization experiment, in collaboration with Memorial University of Newfoundland, was completed. This project is intended to evaluate the addition of nitrogen/phosphorus for (a) the generation of alkalinity as a means of ameliorating the effects of acidic deposition in brown water lakes and (b) the enhancement of lake productivity and fish production. **(E)**

Aquaculture support

9. Thirty thousand 1+ salmon smolts produced at the Mactaquac and Saint John hatcheries were supplied to the Salmon Demonstration and Development Farm operated by the New Brunswick Salmon Growers Association for research purposes. **(A)**

10. Thirty-seven thousand 1+ smolts produced at the Mactaquac and Saint John hatcheries were provided to the St. Mary's First Nation for their aquaculture project. **(A)**

11. Fourteen thousand River Philip 1+ smolts produced at the Mersey Hatchery were supplied to one cage operator in Nova Scotia as part of a DFO/Industry broodstock development program. The performance of smolts supplied to the Nova Scotia industry during 1992 was assessed in the fall of 1993. **(A)**

12. The study of aquaculture impacts on wild Atlantic salmon in a Bay of Fundy river, initiated in 1992, was continued. **(B & D)**

Artificial propagation

13. Twenty-three discrete stocks of anadromous Atlantic salmon were reared at Scotia-Fundy hatcheries for stock enhancement purposes. The 310,000 fry, 1,260,000 parr and 772,000 smolts distributed in 34 rivers during 1993 satisfied production targets. **(A)**

14. Modernization and upgrading of the Mactaquac and Saint John hatcheries continued during 1993; seven swedish-type ponds at Mactaquac were modified to operate with a 1 m depth of water rather than 0.5 m of water. Predator protection was provided for the Mactaquac ponds and the automatic feeding system at the Accelerated Rearing Facility was refurbished. Visitor facilities have been completed at Mactaquac Hatchery. In addition to providing a positive experience for the visitors, the fish benefit from reduced stress because the visitors are no longer permitted in the main production area. An electrical upgrade of the Saint John Hatchery was completed and automatic feeders installed on an additional eight swedish-type ponds. A system to enable the recirculation of water at the Saint John Hatchery was designed and constructed. **(A)**

15. During 1993, 84% of the 1+ smolts and 85% of the 2+ smolts produced at Scotia-Fundy hatcheries were considered to be of good quality. Salmon produced at the hatcheries were inspected by the Regional Fish Health Unit on

a regular basis and found to be free of diseases or disease agents listed in schedule II of the Fish Health Protection Regulations. **(A & C)**

Disease

16. A research program is underway to determine the potential use of alive, avirulent vaccine to protect fish from bacterial kidney disease. **(C)**

17. Many salmon farms in the Bay of Fundy were affected by Hitra Disease in 1993. Work has begun to see if a new serotype of the disease agent is present there which could help in improving vaccine response. **(C)**

Ecosystems

18. The first year of a research project to address the environmental impacts of salmonid aquaculture in Newfoundland was initiated. This research agenda has included: (a) initiation of development of empirical models from literature data and (b) first year of data collection from a field program to test models and determine range of variables encountered in Newfoundland. **(E)**

19. A geo-referenced database for insular Newfoundland in SPANS MAP, using 1:250,000 digital topographic maps and other sources, was completed to provide a source of basemaps for regional activities/programs. **(E)**

20. A field program on the dynamics of Arctic microzooplankton at the DFO station at Resolute Bay, NWT, funded by the National Science Foundation of the US Division of Polar Programs, was completed. **(E)**

21. The DFO Green Plan Sustainable Fisheries funded a collaborative project (with Scotia Fundy) in relation to aquaculture impacts/modelling for testing expansion and validation of models predicting evironmental effects of aquaculture. **(E)**

Fish Passage

22. Department of Fisheries and Oceans through the Green Plan/ Sustainable Fisheries funded a swimming speed/velocity barrier study in relation to investigating the swimming ability of salmon and trout (1994/95 in Newfoundland) and walleye (1995/96 in Ontario/Manitoba) to develop a database for design criteria in relation to possible velocity barriers. Matching funding from the Canadian Electrical Association (CEA) was approved for the 2 year period in the form of a 'joint undertaking agreement'. **(E)**

Habitat

23. Post-construction habitat and biological assessment (4th year) was conducted at the Seal Cove River, Newfoundland a project where habitat compensation was

required to offset habitat losses arising from highway construction. The Department of Fisheries and Oceans is evaluating the success of creation of artificial habitat, including the use of improvement devices, in compensating for habitat loss associated with the project. A poster paper on the project will be presented at the Habitat Hydraulics Symposium, Trondheim, Norway, August 1994. **(E)**

24. The Department of Fisheries and Oceans initiated a multi-agency, multi-disciplinary research program into buffer zones required for protection of fish habitats in relation to forest harvesting. This was conducted within the Newfoundland Model Forest, a Green Plan initiative. **(E)**

25. A user friendly database software program was developed as an adjunct to a small stream survey manual, for public use in support of delivery of the regional habitat improvement program. **(E)**

26. A review of the literature in relation to habitat use and suitability criteria of Newfoundland salmonids was completed and will be published. **(E)**

27. The proceedings of a symposium concerning the ecology of juvenile salmon, held in St.John's 1991, was published, as a Special Publication of Fisheries and Aquatic Sciences. **(E)**

28. The detailed engineering design for a major fishway on the Saint John River has been completed. If constructed the project will allow Atlantic salmon to surmount Grand Falls and colonize large areas of habitat in northern New Brunswick. The existing barrier to salmon migration consists of a 21.6m falls and a 6.7m high dam just upstream of the falls that is part of New Brunswick Power's hydroelectric development at the site. It is expected that about 13,000 additional salmon and grilse could return to the river as a result of this project. This compares with estimated average river return of 12,500 wild fish. The development of this $3.5 million fishway is contingent on funding from a local public interest group. **(A)**

Juvenile studies

29. The research of the Salmonid Research Group (SRG) of Memorial University focuses on the juvenile stages of salmonids, in particular those of Atlantic salmon (Salmo salar) and Brook trout (Salvelinus fontinalis). In order to get a better understanding of the relationships between the riverine habitat and salmonid populations the SRG investigates habitat selection and movement. The research related to habitat selection is done using both field observations as well as controlled experiments. The research related to salmonid movement is done using electrofishing techniques, mark recapture experiments, and traps. Most of the research takes place in Northeast Brook (Trepassey) and North Harbour River, Newfoundland. **(F)**

30. Densities of juvenile Atlantic salmon and other freshwater species were estimated by electrofishing surveys at the following rivers:

Restigouche River, NB	15 sites
Miramichi River, NB	67 sites
Margaree River, NS	5 sites
Gulf Nova Scotia	18 sites

Juvenile densities were used to evaluate recent spawning success. **(G)**

31. Smolt migrations were enumerated to estimate recruitment at 3 rivers: Black River, NB; Catamaran Brook (Miramichi), NB; and O'Law Brook (Margaree), NS. **(G)**

32. Comparative analysis of salmon scale characteristics of parr from fluvial and lacustrine habitats have continued and may suggest an alternate technique to quantify relative production of smolts from these respective habitats. Proximate analyses have been carried out and preliminary analyses suggest differences among parr utilizing fluvial versus lacustrine habitat, for rearing. **(E)**

33. In Newfoundland, optimum spawning requirements are being determined to maximize smolt output as it relates to carrying capacity of different habitats with varying environmental conditions.

The research is conducted on three river systems. A systematic approach has been taken to study the entire freshwater ecosystem in two of these systems. An inventory of biological, physical, and chemical parameters has been undertaken. Emigrating and immigrating salmon are monitored near the outlet of two streams. Egg deposition undergoes natural variation in one stream in excess of 6.0 eggs/m^2 and is fixed at 2.4 eggs/m^2 in another. Smolt and adult production from these depositions are being monitored. Smolt-to-adult survival in the river stocked at the high density ranged from 2.6 to 8.2% in the past 7 years.

Egg-to-smolt survival for four year classes, which resulted from egg depositions over 6.0 eggs/m^2 were 0.50, 0.35, 0.45, and 0.46. Investigations relating densities and production of juvenile salmon to egg deposition and habitat variables continued. Growth rates, survival, and smolt yield are measures relative to densities and physical, chemical, biotic, and climatic factors.

(E)

34. The pond habitat project is designed to evaluate the Atlantic salmon nursery potential of five insular Newfoundland lakes, and to develop a cost effective juvenile salmon stocking strategy. Evaluation of controlled releases of swim-up fry, relative to releases of 100-day fed parr, continue as the focus of this lacustrine research. The lake-cage strategy for fall-fingerling production continues to result in swim-up fry to fall-fingerling survival of about 80%. As of 1993, 22 of the 40 juvenile releases required by this experimental design have been completed. Favourable research results have resulted in a new

project orientation towards pilot demonstration and evaluation of a recreational fishery development strategy wherein incremental salmon production, that has developed as a result of the enhancement project, and is surplus to enhancement spawning requirements, can be harvested by anglers. This project has been taken over by a public group that wishes to develop economic opportunities based on salmon fishing and eco-tourism. **(E)**

Migratory patterns

35. During 1993, Carlin tags were applied to 1,443 1SW and 532 large (2SW and previous spawners) salmon entering the Miramichi. Recaptures from anglers and in aboriginal food fisheries provided information on migration timing, exploitation rates and escapements. 155 bright salmon tags were returned by anglers and from aboriginal food fisheries during the 1993 season. **(G)**

36. Carlin tags were applied to salmon captured at trapnets in the Restigouche River (390 small and large salmon), 119 predominantly large salmon were Carlin tagged on the Upsalquitch River as part of a catch and release study, and at trapnets in the Richibucto River (23 in total), Buctouche River (66 in total), the Tabusintac River (268 in total). **(G)**

37. Carlin tags were applied to 601 salmon captured in two estuarine trapnets on the Margaree River, NS. Recaptures were used to estimate population size and exploitation rate. **(G)**

38. The Department of Fisheries and Oceans Green Plan/Sustainable Fisheries funded a radio telemetry project (in 1993/94) involving the use of fixed location monitors and aerial tracking of ouananiche to determine movements/migrations and habitat use as related to hydroelectric development. **(E)**

Nutrition

39. Experiments were performed to determine the effect of vitamin C supplemented diets on growth, survival, feed efficiency, pathology and immunity to furunculosis and vibriosis. Vitamin C levels increased gradually in liver and kidney tissues. Magadose levels in the diet resulted in decreased mortality in fish challenged with the vibriosis agent but not the furunculosis agent. **(C)**

40. High mortality of Atlantic salmon fry reared in DFO hatcheries was found to be related to high levels of biogenic amines, particularly histamine, produced in diets during the extrusion process. Many feed manufacturers had used horse mackerel and other South American species for meals in starter diets. **(C)**

Stock assessment

41. LaHave River, Nova Scotia - Estimated egg deposition above Morgan Falls (upper one-third of the river basin) barely met the 2.4 eggs/m^2 target level, a low deposition not seen since 1977. The wild 1993 adult return was 777

1SW and 121 MSW salmon, the former being a 60% decrease and the latter being a 44% decrease from the counts made in 1992. Data were collected by smolt trapping to record the smolt run during the first two weeks of May; two-year-old smolts averaged 14 cm and three-year-old smolts averaged 15 cm in fork lengths. (A)

42. Saint John River, New Brunswick - Returns of wild 1SW salmon destined for Mactaquac in 1993 numbered about 3,200 fish - the lowest number in 15 years, i.e., since the 1977 smolt class. Wild multi-sea-winter salmon returns numbered about 3,000 fish, the lowest number in 14 years. Hatchery returns numbered only about 1,200 1SW fish and 400 MSW salmon; return rates for hatchery smolts released at Mactaquac in 1992 and 1993, respectively, were 0.00406 and 0.00135 - the lowest of a 19 year data set. The estimated egg deposition above Mactaquac was 51% of the 2.4 eggs/m^2 target. Also in 1993, a partial count at a fence on the Nashwaak River below Mactaquac (equivalent to about 40% of the production area above Mactaquac) suggested that egg deposition on that tributary was <40% of the target 2.4 eggs/m^2. (A)

43. Recruit grilse, the basis of stability in Inner Bay of Fundy Atlantic salmon stocks, showed low numbers and marginal improvement over the numbers seen in 1992. Escapements in both index rivers were about 40% of the target spawning requirements. The smolt run from a tributary of one of the inner Bay of Fundy rivers was less than 50% of previous years. Similarly, juvenile populations were low in comparison to levels recorded in the previous four years. In an attempt to isolate the apparent cause of marine mortality, a five-week effort to locate post-smolt salmon was unsuccessful. (A)

44. A steel and aluminum, 216-foot-long counting fence build on a concrete base was operated during the migration season by people of a First Nation, under a co-operative funding arrangement. A late-fall spate after leaf-fall resulted in a major fence failure that will require substantial repair before operation in 1994. (A)

45. Returns of Atlantic salmon and other diadromous species were monitored at 12 index sites in the Gulf Region during 1993. Sampling provided information on biological characteristics of spawners at many of the sites. Index monitoring sites are operated by Department of Fisheries and Oceans, National Parks, provincial agencies and conservation groups. (G)

46. An assessment was prepared for Atlantic salmon in the Margaree River, NS. Spawning escapements exceeded target requirements in 1993, similar to the last 9 years. (G)

47. An assessment was prepared for Atlantic salmon in Miramichi River, NB, for the whole river and for each branch separately. Total returns were estimated to be about 127,000 salmon (1SW, 2SW and previous spawners). Target egg deposition (132 X 10^6 eggs) was exceeded in 1993 (171% of target).

Forecasted large salmon returns in 1994 have 69% probability of meeting spawning target. (G)

48. An assessment was prepared for Atlantic salmon in Restigouche River, NB. Total returns were estimated to be between 10,000 and 18,000 1SW and 6,000-12,000 MSW salmon. In 1993, above 50% of spawning requirements (71.4 x 10^6 eggs) were met. As in the Miramichi River, electrofishing surveys have indicated above average densities of juvenile salmon in most years since the 1984 management plan was initiated. Electrofishing surveys indicated juvenile densities were similar in 1992 and 1993. (G)

49. An assessment of Atlantic salmon was prepared for the Tabusintac River, NB, for 1993. MSW total returns as estimated from mark-recapture were 799, and 1SW total returns were 559. Egg deposition was 183% of target requirements (1.9 million eggs). (G)

50. An assessment of Atlantic salmon was prepared for the Richibucto River, NB, for 1993. Due to insufficient tag returns, a qualitative comparison with 1992 returns was made based on assumed similar efficiencies of capture methods in both years. It was concluded that spawning requirements were not met in 1993. (G)

51. An assessment of Atlantic salmon was prepared for the Buctouche River, NB, for 1993. MSW total returns as estimated from mark-recapture were 79, and 1SW total returns were 62. Egg deposition was only 14% of target requirements (1.1 million eggs). (G)

52. A stock assessment was prepared for the Morell River, P.E.I. Returns to the Leard's Pond fishway were down (31% for small salmon and 76% for large salmon) from 1992 levels. (G)

53. An assessment of the Conne River Atlantic salmon population and native food fishery was conducted in 1993 by monitoring and surveying the downstream migration of smolts by mark-recapture, and enumerating adult upstream migration at a fish counting fence. The estimated number of smolts in 1993 was 55,765, about 18% less than in 1992. Total return of adult salmon to the river in 1993 was 2,703 small salmon and 100 large salmon, about 7% more small salmon than in 1992, but well below values obtained from 1986-89. Only 61% of the target spawning requirement was achieved in 1992. Smolt to adult survival was estimated to be 4.0% (3.6-4.4%), higher than the previous year but still among the lowest values recorded over the past five years. (E)

54. Assessment of the Gander River Atlantic salmon stock continued in 1993. The Gander River watershed (6,398 km^2) is the third largest in Newfoundland. Counts of salmon are obtained with a counting fence installed on the main stem just above head of tide. Target spawning requirement was exceeded in commercial salmon fishery moratorium years 1992 (111%) and 1993 (136%).

The percentage of target requirement achieved during three years prior to the moratorium ranged was 33-36%. **(E)**

55. A general assessment of the status of Atlantic salmon stocks in SFAs 1-11 was conducted based on changes in landings in the commercial and recreational fisheries as well as counts of salmon at fishways and counting fences. Com9^R mercial fishing was only permitted in Labrador where landings remained below average and quotas were not caught for the fourth consecutive year. In contrast to 1992, quotas for retained fish in the recreational fishery were not reached in Labrador in 1993. The number of grilse and large salmon retained in 1993 were below average (1984-89). Recreational catch of grilse, effort, and CPUE were above average in 1993. The overall increase however was due mainly to the contribution of northeast coast rivers (SFAs 3-5); catches and CPUE in the remaining SFAs, particularly along the south coast (SFSs 9-11) were generally below average. There was an overall increase in counts of grilse and large salmon at counting facilities during the two moratorium years compared to pre-moratorium years. Again, the increases were due mainly to the influence of northeast coast rivers (SFAs 3-5). At most counting facilities, counts of grilse similar to or greater than those observed in 1992 and 1993 occurred in pre-moratorium years; the same was noted for large salmon at several counting facilities. For the south coast, there is evidence to suggest that low marine survival coud have contributed to low returns. Low index of smolt condition has also been associated with low smolt-adult survival, suggesting a possible freshwater influence on sea survival. **(E)**

Stock enhancement

56. In Newfoundland and Labrador, a total of seven watersheds were studied by the Public Involvement Unit in relation to enhancement activities as follows; **Exploits River** (Salmon), operation of 4 major fishways, stocking of 1.6 million unfed fry, assessment of stock status; **Rocky River** (Salmon), operation of smolt fence, adult enumeration at fishway, assessment of stock status; **Colinet River** (Salmon), operation of adult counting fence, assessment of stock status; **Little River** (Salmon), operation of smolt counting fence, adult enumeration at counting fence, stocking of 130,000 unfed fry, egg incubation of 160,000 eggs, assessment of status of stock; **Terra Nova River** (Salmon), operation of fishway with adult count, construction of egg incubation building, egg incubation of 161,000 eggs; **Romaines River** (Salmon), adult enumeration with counting fence, habitat survey, assessment of stock status; **Crossing Place River** (Salmon, Brook Trout, Brown Trout), up and downstream counting fences were operated. **(E)**

Tagging and marking

57. The marking program for hatchery-reared juvenile Atlantic salmon released for stock enhancement purposes included the tagging of 40,600 smolts with modified Carlin tags and removing the adipose fin of 495,000 smolts and 510,000 0+ and 1+ parr. **(A)**

Techniques

58. A three day workshop on electrofishing rationale and methodology was held in April 1993 and a two day follow-up workshop was held in April 1994. A proceedings including recommendations related to standardization of techniques will be published in a technical report. **(E)**

59. The Department Fisheries and Oceans through Green Plan/ Sustainable Fisheries funded a project in relation to the development of instream flow criteria for Newfoundland salmonids and the development/testing of a suite of instream flow models for regional application. Co-funding from the the Newfoundland Dept. of Environment and Lands, Water Resources Division has been committed. **(E)**

60. The Department Fisheries and Oceans through Green Plan/ Sustainable Fisheries funded an inter-regional project (with Scotia-Fundy) in relation to experimentally determining the appropriate habitat improvement techniques for use in the Newfoundland Region to assist in technology transfer. **(E)**

Toxicology

61. A Green Plan funded study was undertaken to sample fish and address mercury content in fish tissue in reservoirs and downstream areas of the Churchill Falls hydroelectric development in Labrador. This is the third set in a time series of data from this development and will be presented as a poster paper at the International Conference on Mercury as a Global Pollutant in Whistler, B.C., July 1994. **(E)**

STRIPED BASS (Morone saxatilus)

The Fisheries

Spawning stocks of striped bass presently occur in three large rivers in the Scotia-Fundy Region (the Annapolis and Shubenacadie/Stewiacke rivers of Nova Scotia and the Saint John River in New Brunswick). Striped bass are not commercially fished except as legal bycatch in other fisheries but are angled at various sites throughout the region. Serious concern exists about the status of native striped bass stocks and a new more restrictive management regime was implemented in New Brunswick in 1993. Evidence is mounting that a substantial portion of striped bass caught in the region are migrants from American rivers.

Striped bass spawn in some rivers, but appear in estuaries of many more as they move along the coast to forage. A management plan was drafted in 1992 which will prohibit sale, limit retention by anglers, and restrict bycatch of striped bass in commercial fishing gear. Although there is no directed commercial fishery for striped bass, by-catch in the gaspereau, smelt, and eel fisheries may be substantial.

Investigations

Adult Studies

1. Ovary and liver samples from striped bass were collected for the second and final year from the Shubenacadie/Stewiacke rivers, Nova Scotia and the Saint John River, New Brunswick for MtDNA analyses as part of a larger study in conjunction with a researcher at the Institute of Environmental Medicine, New York University Medical School. **(A)**

2. The presence of young-of-the-year striped bass in the Miramichi, Tabusintac, Kouchibouguac, and Richibucto Rivers confirms that spawning occurs in these rivers. Striped bass at least 2 years old were also seen in other rivers during 1993 such as the Buctouche and Margaree. The New Brunswick management plan for striped bass failed to prevent fishing for or commercial sale of striped bass though some gaspereau and smelt fishers returned small bass bycatch to the water. The New Brunswick Wildlife Federation contracted Dr. R. Bradford to assess the size of the striped bass population spawning in the Northwest Miramichi River and the impact on the population of estuarine commercial fisheries. A final report on this research is expected in summer 1994. **(G)**

Genetics

3. An examination of striped bass from the Gulf, Bay of Fundy, and American rivers for mitochondrial DNA was published in CJFAS in 1993. All three groups are genetically distinct. Age-stratified samples were collected from the Miramichi and Kouchibouguac rivers in 1993 to examine the degree of mixing between adjacent Gulf rivers. Juvenile and adult fish from the Schubenacadie and St. John Rivers were collected to examine the degree of mixing of each stock with American striped bass. The Schubenacadie River appears to be a genetically distinct stock but the St. John adult fish were indistinguishable from the American fish. **(G)**

Life history

4. Samples of striped bass eggs, larvae, and young-of-the-year collected in the Miramichi River in 1992 were examined. Distributions will be correlated with physical parameters and abundance of zooplankton prey (prey identified by analysis of stomach contents). This work will be presented in fall 1994 as an M.Sc. thesis by K. Robichaud from the University of New Brunswick. **(G)**

CONTRIBUTING INSTITUTES

Scotia-Fundy Region:

(A) Department of Fisheries and Oceans
Freshwater and Anadromous Division
Biological Sciences Branch
Halifax, Nova Scotia

(B) Department of Fisheries and Oceans
Benthic Fisheries & Aquaculture Division
Biological Sciences Branch
Halifax, Nova Scotia

(C) Department of Fisheries and Oceans
Aquaculture and Invertebrate Fisheries Division
St. Andrews Biological Station
Biological Sciences Branch
St. Andrews, New Brunswick

(D) Atlantic Salmon Federation Research Centre
St. Andrews, New Brunswick

Newfoundland Region:

(E) Department of Fisheries and Oceans
Science Branch
P.O. Box 5667
St. John's, Newfoundland
A1C 5X1

(F) Salmonid Research Group
Department of Biology
Memorial University of Newfoundland
4 Clark Place, St. John's, Newfoundland
A1C 5S7

Gulf Region:

(G) Department of Fisheries and Oceans
Science Branch
P.O. Box 5030
Moncton, New Brunswick

Quebec Region:

(H) Institut Maurice-Lamontagne
C.P. 1000, 850 route de la Mer,
Mont-Joli (Québec) G5H 3Z4

DENMARK

(O. Christensen)

ATLANTIC SALMON (Salmo salar)

A. The Baltic Sea

The Fisheries

The total nominal catch of salmon in the Eastern Baltic (IIId) in 1993 amounted to 556 tons.

Investigations

Sea ranching

1. The delayed release experiment releasing one year old salmon smolt after three months in a net pen at the eastcoast of Bornholm was proceeded. Of the 20,000 releases 2,000 were Carlin tagged.

   Further 60,000 one year old smolt were released in the River Mörrumsån, Sweden, and 40,000 in the coastal waters of Latvia.

Stock assessment

2. Catch-effort-data on the offshore salmon fishery were compiled from logbooks. About 800 scale samples together with data on length and weight of about 700 specimens were collected for stock analysis.

B. The North Sea and the Kattegat

The Fisheries

The total nominal catch of salmon in Danish waters exclusive the Eastern Baltic (i.e. IVb, IIIa, b and c) in 1993 amounted to 9 tons.

Investigations

Migratory behaviour

The investigation of the mortality and migration of salmon smolt in a lake as part of a salmon river system initiated in 1992 was continued. 500 tagged smolt of different origin entered the experiment.

Stock enhancement

In the former salmon River Gudenå running to the Kattegat (IIIa) re-

establishment of the stock, started in 1990, was followed up by the release of 8,600 one year old parr on former spawning sites. In order to minimize the post smolt fishing mortality the releases of 97,700 one year old and 28,400 two year old smolt were trailed in a net cage through the lower part of the river to be liberated outside the estuary. For comparison 2,400 smolt were released in the river. A total of 6,000 were tagged.

In the River Skjern Å to the North Sea the modest natural stock was supported by the release of 45,000 one year old parr.

In five former salmon rivers to the North Sea establishment of permanent stocks are attempted. About 5,800 fry, 60,800 half year old and 54,000 one year old parr of various origin were released.

EEL (Anguilla anguilla)

The Fisheries

The total nominal catch of yellow and silvery eel in 1993 amounted to 445 t and 471 t respectively.

Abundance

In order to estimate the possible changes of immigration of elvers into Danish rivers and streams, registration of ascending individuals, carried out for years, were continued.

Investigations

Fishery experiments

1. Investigation of the relationship between the size composition of eel and mesh size in the second chamber of fyke nets did not show any correlation.

Stocking experiments

2. To evaluate the efficiency and profitability of eel stocking about 100,000 eels 2-5g were released in the brackish inlet Roskilde Fjord, double marked with tetracyclin in order to be distinguished from the about 200,000 tetracyclin marked individuals released the previous year. Research fishery was carried out to assess the survival and growth.

   The effect of eel stocking in rivers were controlled by electrofishing in several localities.

   Stocking in lakes has been monitored by release of marked eel, and estimates on total eel production was presented.

Stock enhancement

According to a stocking scheme about 4.8 million eels of a size of 2-5 g were released, distributed on rivers and streams (5.7%), lakes (17.3%) and salt and brackish waters (77.0%). The stocking scheme is prepared on basis of distribution of bottom vegetation and local knowledge of the fishermen and is covering the whole country during a period of six years for the lakes and two years for the coastal areas.

SEA TROUT (Salmo trutta)

Investigations

Fisheries studies

1. Experiments with commercial pound nets, aimed at reducing non-catch fishing mortality of smolts, have been successfully completed, and will soon be published.

Genetic studies

2. Genetic studies based on allozyme electrophoresis and mitochondrial DNA were performed, among others to evaluate the genetic variability of stocking materials from commercial pond farms.

Juvenile studies

3. The current investigations in two small streams on reproduction, stock composition, abundance, survival and smoltification monitored by electro-fishing were continued.

Modelling

4. A series of meetings with the aim of creating a simple predictive sea-trout cohort model was completed in a joint cooperation between different Danish fish biologists. The model is aimed at evaluation of supplementary stockings and stream and coastal management, and intends to create a practical platform for more elaborate studies on sea trout biology. A comparative study of relations between smolt output and resulting return of spawners in different Danish streams is presently being planned.

Nutrition

5. The effect of extensive sea ranching with trout on the local fauna was carried out by comparing food items of the releases with the species, abundance and size composition of other marine species.

Predation on smolt

6. Predation by sea birds, especially by cormorants, of smolt captured in pound nets and fyke nets were investigated in three inlets. A preliminary report suggests that cormorants may be extremely detrimental to smolt trapped in netgear.

Investigation of predation on smolt while downstream migrating a river and a lake forming part of the river system was carried through.

Smoltification

7. A tagging experiment started in 1991 to evaluate the effect of stocking with trout reared in recycled water and consequently smoltified half a year old compared to normal smoltified one year old specimens was continued by the release of 1000 Carlin tagged trout.

Stock enhancement

According to trout stocking schemes, prepared on basis of habitat evaluation and stock analysis by means of electrofishing, trout were released in rivers and streams as follows:

1,716,300	fed fry
410,500	half-yearlings
343,100	one year old parr
139,100	two years old parr
507,900	one and two years old smolt

Further 33,600 one year old parr were released into lakes and 298,200 smolt into coastal waters.

A number of stocking schemes older than 5 years were revised.

In order to evaluate the effect of the stocking programmes and with the final objective to improve the stocking procedures in fresh water as well as in the sea, stocking experiments with tagged hatchery reared trout is performed.

WHITE FISH (Coregonus lavaretus)

The fisheries

The total nominal catch in 1992 amounted to 27 t.

Stock enhancement

About 696,000 fry were released in a number of inlets.

FAROE ISLANDS

(J.A. Jacobsen)

ATLANTIC SALMON (Salmo salar)

Investigations

The fishery in the 1992/93 season was entirely a research fishery as the salmon quota was bought out until the end of 1993 and was sold again for 1994. Fiskirannsóknarstovan has continued the scientific research on salmon in the North Atlantic by chartering one commercial salmon longliner to operate in the area north of the Faroes during the fishing seasons. In 1992 the Norwegian Institute of Nature and Research (NINA) and Fiskirannsóknarstovan initiated a cooperative research on salmon in the Faroese area. As a result a programme to tag salmon in the open sea started in November 1992, founded by the Faroese Government and the Norwegian Government (MD). In 1993 the project was widened to also include Iceland (Veiðimálastofnun), Sweden (Laxforskningsinstituttet), Finland (Finish Game and Fish. Res. Institute) and in Norway the Marine Research Institute also joined the project. At the same time the project also got financial support from the Nordic Minister Council (Nordisk Ministerråd).

The main goal is to estimate the distribution and proportion of salmon from different countries that uses the Faroese area during its growth phase in the sea.

The total catch in the Faroese area in the 1992/93 season was 21 tonnes. In addition approx. 9 tonnes or 3.050 salmon were tagged and subsequently released into the sea. As in the previous three seasons it was impossible to fish in January due to bad weather. All salmon was measured and over 4.000 scale samples were collected in order to estimate the proportion of fish-farm escapees and sea-ranched fish in the open sea.

A total of 1.300 stomachs were collected during the 1992/93 season to investigate the diet of salmon in quantitative ways.

The catch in number per 1.000 hooks (CPUE) was high in November 1992 and dropped in December, but increased again in March 1993. The overall CPUE for the 1992/93 season was 84 salmon per 1.000 hooks, this is the highest on record ever inside the Faroese EEZ.

FINLAND

(E. Ikonen)

ATLANTIC SALMON (Salmo salar L.)

The Fisheries

1. In the Baltic Sea the nominal catch of Atlantic salmon by professional fishermen in 1992 was 1522 tons from the Main Basin and Gulf of Bothnia (ICES sub-divisions 26-31) and 362 tons from the Gulf of Finland (ICES sub-division 32). The total commercial catch in the Baltic Sea was 1884 tons in 1992. The non-commercial catch was 288 tons in 1992 according to the latest data available.

   The salmon catch from the Finnish side of the Teno River flowing into the Arctic Ocean was 73 tons in 1992 and 68 tons in 1993. In the Näätämöjoki River the catch was two tons in 1992 and one ton in 1993 in the Finnish part of the river.

   On the Finnish side of the Tornionjoki River the salmon catch was about 15 tons in 1993 and in the Simojoki River just 100-200 kg in a year.

   In the Kymijoki River the catch was about 2,3 tons in 1993.

Investigations

Artificial Propagation

2. The numbers of the artificially reared salmon smolts released into the Baltic Sea in 1993 were: ICES sub-division 29: 155.774, ICES 30: 200.900, ICES 31: 1.220.225 and ICES 32: 398.667. The total number of smolts released was 2 million.

Migratory Behaviour

3. The studies of the timing of the seasonal return migration of wild and sea-ranched salmon (Salmo salar) were continued in the Gulf of Bothnia. The pattern of the return migration was analysed using the samples collected in the Archipelago Sea, Bothnian Sea and Bothnian Bay.

Physiology

4. The research programme to improve the rearing technique for the production of high quality salmon and brown trout smolt for stocking has been continued. Besides the general smolt characteristics of minimum size, body silvering and condition factor, several physiological properties, including the oxygen carrying

and osmoregulatory capacities and energy stores of the fish, were recorded. Attention has also been given to the hormonal control of smoltification and to the ways of regulating it. By connecting the physiological studies with the tagging experiments, a clear correlation between the physiological status of the smolt and the tag return rates of adults has been shown. Activities to manipulate the time of smoltification to fit the most favourable releasing time are in progress.

The research programme concerning the control of brood stocks and egg quality has been continued. It includes experimental work on the effects of annual and artificial light rhythms on, for example, egg quality and hormonal control of reproduction.

Stock Augmentation

5. There were 510.600 salmon eyed-egg roe, 265.000 alevins, 124.728 fry, 401.197 one-year-old parr and 200 angling size released into the rapids of the rivers flowing into ICES sub-division 31. And there were 447.700 eyed-egg roe, 19.000 alevins, 100.000 fry, 3.710 one-summer-old fingerlings and 109.722 one-year-old parr released into the rivers flowing into ICES sub-division 32.

Stock Assessment

6. The assessments of the Atlantic salmon stocks in the Baltic Sea have been done in connection with the work of the Baltic Salmon and Trout Assessment Working Group. The Gulf of Bothnia and Gulf of Finland stocks have been assessed separately.In every assessment area the total salmon catch would be higher if fishing could be restricted or the recruiting-age could be increased.

Stock Identification

7. The investigations to distinguish between wild or hatchery-reared salmon were continued. The principal method used was visual examination of the freshwater zone of the scale according to the criteria presented by Antere & Ikonen (1983). A study discussing the possible origin of wild salmon caught in the costal fishery of the Gulf of Finland was concluded (Ikonen et al. 1993, ICES C.M. 1993/M:31). The results indicate that the fish have migrated to the Gulf of Finland from the Bothnian Bay. In the autumn of 1992 a scale reading test was carried out to intercalibrate Baltic salmon scale reading. During 1993 the test scales have been read by Swedish, Polish, Estonian, Latvian and Finnish scale readers and the results have been tabulated and partially treated statistically. The results indicate rather large variation between readers.

Fish farm escapees in Teno River catches have been detacted based on the scale pattern analyses.

Stock Investigations

8. In the Rivers Tornionjoki, Kiiminkijoki, Pyhäjoki and Kalajoki (flowing into

ICES sub-division 31) and in the Rivers Kymijoki and Vantaanjoki (flowing into ICES sub-division 32), the population densites of salmon parr were investigated by electrofishing. In the Simojoki River the population density of salmon fry was very low, less than 0.1 individuals per 100 m^2. The density of salmon parr was 2.0 individuals per 100 m^2 in the lower part (0-52 km from the sea) and 0.3 parr per 100 m^2 in the upper part of the river (53-110 km from the sea). In excess of low numbers of ascending spawners, the reason for the dramatic decrease of salmon fry densites may be M-74 phenomenon. If no improvement in spawning success will happen, natural reproduction will stop within few years in this river.In the Tornionjoki River the population densities of salmon fry were about 0.7 individuals per 100 m^2 and the corresponding densites of salmon parr were about 2.2 parr per 100 m^2. The number of offspring has stayed at the same level during the last years except in 1991, when an exceptionally strong year class was hatched.

In the Simojoki River a total smolt run was estimated at 25.000 individuals of which about 10.000 had originated from natural spawning. In the Tornionjoki River the total smolt run has been estimated at the level of 75.000-125.000 smolt of which 80 percent had originated from natural spawning. The situation still indicates a serious decrease in the spawning stock of the Tornionjoki River due to overfishing in the sea. Fry and parr originating from natural spawning were not observed in the Vantaanjoki River and in the Kymijoki River the densites were lower than before.

9. Ongoing salmon parr density investigations were conducted by successive-removal electrofishing on 57 permanent study sites in the Teno, Inarijoki and Utsjoki Rivers during 1993.

10. The parr growth studies monitored changes in the length and weight of individual age groups throughout the year. Samples were collected twice a month through the open-water season in two stations along the Teno River and five on the Utsjoki. The analysis of these collections will be used to evaluate habitat-selective growth and the influence of the annual climatic variation on the population of a given site.

In the Vantaanjoki and Kymijoki Rivers, the population densities of salmon parr originating from the natural spawning were investigated by electrofishing. In the Vantaanjoki River no parr was found and in the Kymijoki River the densites were under 10 parr (0+ - old) per 100m^2 in the best areas of the river. The parr densities in the Kymijoki River depend strongly on the discharge regulation of the river.

11. Efforts have also been intensified in a study of the spread of sculpin in the Utsjoki River since its first finding there in 1979. The aim of this study was to monitor the rate of colonization of new habitat. The effects of an increase in the sculpin population on juvenile salmon densities is of primary concern. In 1993 sculpin was found in Utsjoki River only 1 km apart from Teno River. These observations suggest that sculpin is passing through the last riffle section of Utsjoki River to Teno within a couple of years.

12. In the Baltic Sea area a total of 4.732 scale samples were collected using drift nets, long lines, trap nets and in the river fisheries by various gears. The aim of sampling was to monitor the exploited salmon stocks. The number of scale samples in different ICES sub-divisions were: ICES 29: 470; ICES 30: 429; ICES 31: 2 011; ICES 32: 1 758.

13. A total of 4 000 scale samples from adult salmon were collected in the Teno River watercourse by local fishermen in 1993. In addition, 50 scale samples were contributed from the Näätämöjoki River. The major current research projects involving these collections include the timing of runs, annual variations in escapement, back-calculated growth studies, adult and smolt age composition and the number of repeat spawners in a run. In addition, since the net-pen rearing of salmon has recently been started in the Teno Fjord, adult scale samples provide a means for monitoring the effects of pen reared escapees on catches and the natural salmon populations in the Teno drainage.

Tagging and Marking

14. Salmon smolt have been tagged with Carlin tags in order to study the profitability of smolt releases and to get information on the migration pattern and growth of different salmon stocks. The numbers for tagged smolt in 1993 were: ICES sub-division 29: 4 091; ICES 30: 10 901; ICES 31: 14 566; ICES 32: 8 483; total: 38 041.

In the Tornionjoki River, 248.240 hatchery-produced salmon parr and 27.672 two-year-old smolt were marked by cutting the adipose fin and 3.000 smolt were also tagged with Carlin tags.

In the Simojoki River, 37.370 hatchery-produced parr were marked by cutting the adipose fin and with left pelvic fin clipped. There were also 5.087 two-year-old smolt of which all were adipose fin clipped and 1.770 were tagged with Carlin tags. In excess, 1.000 smolt originating from natural spawning were tagged with carlin tags.

In the Kymijoki River 6.500 two-year-old smolts were tagged with Carlin tags. As well, 13.000 one-year-old parr were also marked with coded wire tags and auxiliary fin clips.

The last recoveries of auxiliary fin-clipped and coded wire tagged salmon released in the Kymijoki River in 1987-89 were analysed. Total amount of recoveries was about 3.5% of tagged and released smolt. The coded wire tags was found in 60% of the adipose fin-clipped salmon sample. Analysing of the research material is still continuing. The aim of this marking was to discover differences between the stocking results of one- and two-year-old smolt.

In the mouth of of Teno River 93 adult salmon were tagged with radiotransmitters in June-July. Fish were tracked through the summer with manual receivers and permanent stations. 23 specimens were still left in the

river at spawning time in October. The fish were tracked until the batteries of the transmitters ran out.

SEA TROUT (Salmo trutta m. trutta L.)

The Fisheries

15. The sea trout catch from professional fisheries in the Baltic Sea was 234 tons in 1992. The non-commercial catch was 1.036 tons in 1992. On the Finnish side of the Teno River in 1992, the sea trout catch was 1.700 kg and in 1993, 1.100 kg. In the Näätämöjoki River the sea trout catch was 200 kg in 1992. In the Tornionjoki River the sea trout catch was in 1993, about three tons. In the Kymijoki River, the sea trout catch was about 1.600 kg in 1993 but about half of them were put and take-size fish.

Investigations

Artificial Propagation

16. The total number of sea trout smolt released into the Baltic Sea in 1993 was 1.120.850 (ICES 29: 211.941; ICES 30: 195.863; ICES 31: 365.697; ICES 32; 347.349).

Stock Augmentation

17. There were 17.221 sea trout alevins, 255.000 fry and 110.554 one-year-old parr released into the rivers flowing into ICES sub-division 31. Released into the rivers flowing into ICES sub-division 30 were 10.820 fry and 15.280 one-year-old parr. There were 4.149 one-year-old parr and 1.649 angling size parr released into the rivers flowing into ICES sub-division 32.

Stock Investigations

18. In the Rivers Tornionjoki, Viantienjoki, Kiiminkijoki, Siikajoki, Pyhäjoki, Kalajoki, Lestijoki, Isojoki, Aurajoki, Vantaanjoki and Kymijoki sea trout parr densities were studied by electrofishing. The parr densites in the River Tornionjoki have been at a higher level during the 90's than during the 80's.

19. A total of 307 scale samples were collected from the sea trout fisheries in the Baltic Sea. The number of samples from the different sub-divisions were: ICES 29: 106; ICES 30: 0; ICES 31: 43; ICES 32: 158. The aim of this sampling was to get information on the age and size structure of sea trout caught by different gear.

    In the Teno and Näätämöjoki Rivers, about 100 scale samples from adult sea trout were collected by local fishers in 1993.

20. Hatchery-reared sea trout smolt were tagged with Carlin tags, altogether 27.100: ICES 29: 4.399; ICES 30: 4.297; ICES 31: 9.212; ICES 32: 9.192.

In the River Tornionjoki, 79.266 hatchery-reared parr and 31.253 two-year-old sea trout smolt were marked by cutting the adipose fin and 2.000 smolt were also tagged with a Carlin tag.

MIGRATORY WHITEFISH (Coregonus lavaretus L. s.str.)

The Fisheries

21. Professional fishermen caught in total 1.304 tons of whitefish in 1992 from the Baltic Sea. The catch consisted of anadromous migratory whitefish (Coregonus lavaretus L. s.str.) and sea-spawning whitefish (Coregonus widegreni Malmberg). The catch of anadromous whitefish has been estimated to be about 60 % of the total catch (781 tons).

Artificial Propagation

22. The artificial propagation of whitefish has mainly been done by stocking with one-summer-old fingerlings or fry. The numbers of released fingerlings were: ICES sub-division 29: 252.388; ICES 30: 930.471; ICES 31: 8.296.541; and ICES 32: 1.216.526. The total number of fingerlings released was 10.695.926 and total number of fry was 38.4 million.

Fisheries studies

23. Migratory whitefish were tagged with ultrasound tags. The behaviour of the fish near trap net fishing gears was observed with an automated hydrophone system placed in a vessel. The movements of the tagged fish was estimated on the basis of one hydrophone only. The system will be completed with a second hydrophone. The whitefish followed the leader arm of a trap net swimming back and forth. The results of the primary experiments proved that the movements of whitefish near standing gear on open coast can be monitored with ultrasound tagging.

Stock Investigations

24. Scale samples of anadromous migratory whitefish have been collected in the river mouths of the rivers flowing to the Baltic Sea. The numbers of scale samples in different sub-divisions were: ICES 30: 163; ICES 31: 1 316; and ICES 32: 269; for a total of 1.748.

CONTRIBUTING INSTITUTE

Finnish Game and Fisheries Research Institute
Fisheries Division
P.O. Box 202
SF-00151 Helsinki
Finland

FRANCE

(P. Prouzet & G. Euzenat)

ATLANTIC SALMON (Salmo salar)

The Fisheries

The rod and line catches during the 1993 fishing season were estimated to be 2000 in number and 7 tons in weight. The number of fish caught is similar to 1992 and near the average of the last 10 years. On the Adour-Gaves Basin, less than 200 salmon were caught by rod anglers. **(A2)**

The main commercial fishery using drift net is located in the Adour River. Around 9 tons were landed in 1993. The fishery has been studied by IFREMER since 1985. During the 1985-1993 period, the catches fluctuated from 550 to 5500 salmon. The number of grilse in the landings was variable and ranged between 22 and 97%. **(B0)**

Investigations

Artificial propagation

2.14 million fish were released during 1993 and 1.3 million in 1992. The distribution by stage of development was : 23% eggs ; 27% fed fry ; 35% 0+ parr and 15% 1 year old pre-smolt. Only 8% of the fish released were marked, 2.5% with nasal micro-tags. 43% of the total production was released on several Brittany and Lower-Normandy rivers, 21% on the Loire Basin (Allier and Gartempe Rivers), 26% on Garonne and Dordogne Rivers, 11% on the Adour-Gaves Rivers and 6% on the Rhine. **(A2)**

From 1981 to 1989, on the Garonne and Dordogne Rivers, the stocking effort was below 100.000 fish per year, 75% of which were of foreign origin. For 4 years, the stocking level has been around 300.000 fish per year almost all of local strain (Loire-Allier Basin). Until 1991, less than 25 adult salmon returned each year but in 1993, respectively 95 and 45 salmon returned in the Garonne and Dordogne Rivers. **(A5)**

Stock enhancement

On the Nivelle River, comparisons between artificial propagation and natural production are in progress. Tagging with Pit tags were made in order to compare the growth and the rate of return of the juveniles produced in hatchery and in natural conditions (D). The abundance of the salmon run on the Douffine River, a tributary of the Aulne River (Brittany), was 460 fish originating from 30 750 smolts reared at the Favot Hatchery located on that river. The minimal catch rate was 1.5%. **(A2)**

Juveniles studies

On the Oir River (Lower-Normandy), the salmon population has been studied since 1985. The fluctuation of the number of smolts and the number of spawner is described and the stock-recruitment relationship of the salmon population of the Oir River is defined. **(C1)**

Different studies have been undertaken on the Scorff River:

1. Application of a new stock assessment methodology.

   The application of a new method of assessment with electro-fishing by the determination of the number of individuals caught in 5 minutes on suitable areas allowed to double the number of areas sampled in 1993 (25 to 50). Such a method allows in a short period to have a clear idea of the spawning success on a catchment area such as the Scorff one. A comparison between the results obtained by this method and those of De Lury is in progress. **(C1)**

2. Analysis of the embryo survival.

   In a tributary, the estimate of the rate of survival from the green egg up to the unfed fry has been estimated to 10%. This value is in agreement with those found in the literature for this kind of environment with a lot of sand and silt.

   In the main river, just downstream from a hatchery, the fry had emerged very early and before the complete resorption of the yolk-sac. A high proportion was infested with a parasite of the genus Ichtyophterius commonly found in hatcheries. **(C1)**

   Comparison of the behaviour of salmon juveniles reared in hatchery and in the spawning channel showed that the latter had a similar behaviour as the wild juveniles whereas the former showed a different swimming behaviour (more gregarious). **(C2)**

   On the Adour River, routine surveys on juvenile salmon populations are carried out since 6 years to control the spawning success and the results of the 0+ salmon summer restocking. A positive correlation between the number of summer parr and the number of 2SW female spawners in the previous year led us to think that the spawning success was better with 2SW salmon than grilse. **(A6)**

Migratory patterns

On the Adour River, observations, using external and radio telemetry tags, on the movements of reared salmon smolts through a bypass located on the hydroelectric

dam of Soueix, indicated that smolt migration was strongly dependent on the increase of the discharge. 70% of the population migrates downstream during the night. The diversion of the smolts was mainly efficient during the night and its efficiency was dependent of the fluctuation of the light. **(A8)**

On the Dordogne River, no clear relationship was evident between the variation of the rate of flow and the migration and spawning behaviour. **(A4 & A6)**

Reproduction

The reproductive success of precocious male salmon parr in different conditions of density wass observed in cooperation with the University of Leicester for paternity analysis using DNA minisatellite probes. The male selection in Atlantic salmon is examined by monitoring changes in female spawning behaviour in different male and female size ratio group.The studies concerning the hybridization between salmon and trout in natural conditions and controlled artificial channel are in progress in the framework of a cooperation with the University of Oviedo. **(C2)**

Physiology

The results concerning the comparison between the lipidic characteristic of the plasmic membrane of the spermatozoïd of reared and wild Atlantic salmon showed a significant difference between the lipid composition of the plasmatic membrane of the two groups. **(C3)**

Interspecific comparisons

Different studies on the comparison of the biological characteristics of the life cycle of Atlantic salmon and brown trout have been undertaken:

1. On a tributary of the Scorff river where the two species cohabit from the spawning period to the beginning of the third year of growth.

2. On a tributary of the Oir river where the distribution of the two species according the characteristics of the natural environment was observed.

3. On the eco-physiological characteristics of the migrants of the two species. From the observations, a greater heterogeneity of the migratory trout population from a morphological, biometric and demographic point of view was evident. The mean age of brown trout and the salmon is similar and lower than those of the sea trout. The downstrean migration period of the salmon from the tributary to the main course happens later than those of the brown trout but sooner than the one of the sea trout. **(C1)**

Stock assessment

On the Bresle River, only 52 grilse were caught in a trap in 1993. This low abundance of adults correspond to a low production of smolts in 1992: 700 smolts. The return rate was estimated to be 7.5%. **(A1)**

On the Oir River, a tributary of the Selune River (Lower Normandy), 10 adult salmon were recaptured. They originated from a batch of 580 wild smolts released in 1992. This corresponds to a recapture rate of 1.7%. **(A2 & C1)**

On the Nivelle River the rate of return of the 1989 cohort was estimated at 1.8% whereas the 1990 and 1991 cohorts were evaluated respectiveley at 9.1 and 7.2% respectively.

In 1993, 92.4% of the run was constituted of grilse which returned in the river mainly in June-July up to mid autumn. Around 86% of the adults had migrated downstream as 1 year old smolts. 58.6% of grilse and 95.2% of the multi sea winter fish were females.

In this river, the mean egg density was 52 and 18 per m^2 on the lower and upper course respectively. **(C2)**

Adult characteristics

With the exception of the Loire River, where all the salmon caught by rod and line were multi sea winter fish, 55 % of the salmon caught by the sport fishery are grilse. **(A2)**

On the Adour estuary, the control of salmon landings showed that 90% of the fish were grilse. 39.2% of the grilse, 95% of the 2 sea winter fish and 100% of the 3 sea winter fish are females. The potentiel number of eggs per spawner was estimated at 3050, one of the lowest recorded during the period 1985-1993. **(B0)**

On the Loire River, 90% of the salmon caught by commercial fishermen are multi sea winter fish. **(A2 & A6)**

Management

A five year program for the restoration of migratory species is in progress. The cost of a new management plan is estimated to be 390 million FF. **(A0 & A2)**

SEA TROUT (Salmo trutta)

The Fisheries

The number of fish caught by the drift net fishery in the Adour estuary was estimated to be 400 fish. The landings remain very low since 1988. Around 10% of the fish were infested by a parasite which causes muscle liquefaction. **(B0)**

On the Bresle River, 400 fish were caught with nets whereas 150 fish were angled. On the coast (north-western part of France), 1000 sea trout (2.5 tons) were caught with fixed nets by amateur and commercial fishermen in 1993. The closure of some areas allowed to reduce the exploitation by nets by 12%. In 1993, rod and

line and coast nets caught respectively 10% and 28% of the total stock. The rate of exploitation by rod was slightly higher than the 10 year average: 9%. **(A2)**

Investigations

Ecophysiology and genetics

Studies on the ecophysiology of juveniles has been carried out in the natural environment. The results show that there exists a true smolt stage as in the Atlantic salmon with a high level of NA-K-ATPase. The smoltification was not necessarily an adaptation to sea water since all the individuals above 14 cm were able to survive at a 30 $\%_0$ of salinity.

There exist 4 phenotypes of trout with an intermediate one which is difficult to connect, according to the morphological characteristics alone, to the sedentary or migratory group. **(C1, C3, A2 & D)**

Adult characteristics

On the Bresle, Touques and Orne Rivers in Normandy, the main characteristics of the population are: 56 cm, 2.2 kg on average, a maximum of 83 cm and 7 kg; 3 or 4 years (1+ smolt/1SW adult); 2 females for 1 male and 10 to 30% of previous spawners. **(A1 & A2)**

On the Adour estuary, very large sea trout were caught each year. In 1993, the mean weight of the catches was estimated to be 2490 g for a total length of 580mm. 92% of the catches were females. This observation confirms those made the previous years. Most of the fish caught (80%) had spawned one time before being caught.

(B0)

Stock assessment

On the Bresle River (Upper Normandy), estimation of stock abundance is continuing to provide data for forecasts and advice for fisheries managers. The rate of survival in river is low (less than 1%) but the rate of return of adults is high: 18% in 1993. **(A2)**

Management

In the north-western part of France, Normandy and Artois-Picardy Regions, a system based on voluntary declaration has been set since 2 years. The rate of catch report is 15%. **(A1 & A2)**

SHAD (Alosa alosa and Alosa fallax)

The Fisheries

Between 7 and 8 tonnes of allis shad were caught, in the Adour estuary, off the river by marine commercial fishermen in 1993. **(B0)**

Investigations

Stock investigations

20.000 and 35.000 fish were caught in 1993 in counting facilities on the Garonne and Dordogne Rivers. The catch increased by a factor 3 to 4.5 over the 5 last years. **(A5)**

Hybridization

In the framework of the French-Portugese cooperation, discrimination studies have been undertaken to separate allis shad from the twaite shad and to distinguish the hybrids. The main results showed that:

- in the Lima River, we could distinguished from 5 meristic variables the allis, twaite shad and hybrids;
- the utilisation of meristics and morphometrics together allowed to classify the shad populations on the different basins studied;
- the hybrids were clearly identified as produce of the first generation. **(C1)**

Exploitation

Studies on the catch fluctuation of allis shad in the Adour river showed the influence of the rate of flow and tidal coefficients on catch per unit effort (kg per trip) variations. Analysis performed either with Correspondence Analysis or with Generalized Linear Model indicated that an increase of catch per unit effort (CPUE) is associated with the increase in the tidal coefficient. The rate of flow was considered to be a secondary factor of variation. **(B0)**

EEL (Anguilla anguilla)

The Fisheries

For the Adour River the catch of the marine commercial fishermen remained low in 1993: between 5 and 6 tonnes. the mean catch per trip was 2.3 kg similar to those estimated in 1985 and 1992. **(B0)**

On the Somme River, between 2 and 3 tons of glass eels were caught in 1993 by 13 commercial fishermen in the estuary. 10 to 20 tons of siver eels were caught by 20 commercial fishermen in river. On the Seine River, between 0.5 and 1.5 tons of glass eels and between 8 to 15 tons were caught by 16 commercial fishermen. **(A1)**

Investigations

Ageing

Studies concerning the ageing of glass eel fished in different French estuaries allowed to improve the knowledge on the larval phase of the biological cycle of Anguilla anguilla and on the meaning of the recruitment mechanisms. Some new hypotheses on the oceanic migration from the Sargasses sea and the French coast have been formulated. **(B1, D & E)**

Stock assessment

Studies concerning the estimates of the catch per age groups were undertaken on the Loire and Vilaine Rivers. The results allow a better understanding of these fisheries. Estimations are obtained by the combination of several estimated variables (catches, size classes, age groups). The objective of this study is the management of this stock on a watershed scale with modelling the stock dynamics by a structural approach. **(D)**

SEA LAMPREY (Petromyzon marinus)

The Fisheries

Landings in the Adour River were estimated to be 16 tonnes. The mean weight of the catches was approximately 1 kg (1120g). **(B0)**

Stock investigations

Respectively, 2.200 and 6.500 sea lamprey were counted in trapping facilities on the Garonne and Dordogne Rivers in 1993. The catch increased by a factor of 4 and 6.5 respectively during these 5 last years. **(A5)**

CONTRIBUTING INSTITUTES

(A0) Conseil Superieur de la Peche
Direction Technique et Scientifique
134, avenue de Malakoff
75016 Paris

(A1) Conseil Superieur de la Peche
Délégation Haute-Normandie et Artois-Picardie
Station salmonicole
Rue des Fontaines
76260 Eu

(A2) Conseil Superieur de la Peche
Délégation Bretagne et Basse Normandie
84 rue de Rennes
35510 Cesson Sevigne

(A3) Conseil Superieur de la Peche
Délégation Pays de Loire et Centre
112 Faubourg de la Cueille
86000 Poitiers

(A4) Conseil Superieur de la Peche
Délégation Auvergne-Limousin
RN 89 - Marmilhat
63370 Lempdes

(A5) Conseil Superieur de la Peche
Délégation Midi-Pyrénées et Aquitaine
34 Boulevard Riquet
31000 Toulouse

(A6) Conseil Superieur de la Peche
Délégation Midi-Pyrénées et Aquitaine
Antenne de Pau
Building des Pyrénées 2D
64000 Pau

(A7) Conseil Superieur de la Peche
Délégation Champagne-Ardenne, Alsace et Lorraine
18 rue de Nomeny
57000 Montigny les Metz

(A8) GHAPPEe (CSP - CEMAGREF - IMF)
Avenue du Professeur Camille Soula
31400 Toulouse

(B0) IFREMER
Station d'Hydrobiologie
BP 3
64310 St Pee sur Nivelle

(B1) IFREMER
Laboratoire Ecohal
BP 1049
44037 Nantes cedex 01

(C1) INRA
Laboratoire d'Ecologie Hydrobiologique
65 rue de St Brieuc
35042 Rennes Cedex

(C2) INRA
Laboratoire d'Ecologie des Poissons
BP 3
64310 St Pee sur Nivelle

(C3) INRA
Laboratoire de Physiologie des Poissons
Avenue du Général Leclerc
Campus de Beaulieu
35042 Rennes Cedex

(D) ENSAR
Unité Halieutique
65 rue de Saint-Brieuc
F 35042 Rennes cedex

(E) Université de Perpignan
Laboratoire de Biologie Marine
52, avenue de Villeneuve
66860 Perpignan cedex

FEDERAL REPUBLIC OF GERMANY

(Prof. Dr. W. Nellen)

ATLANTIC SALMON (Salmo Salar)

The Fisheries

The total landings along the German Baltic coast was 30,7 mt. Origin: up to 95 per cent Central Baltic. There are no indigenous stocks at the German Baltic coast. **(H)**

17 specimens were caught in the River Elbe within an ongoing fishery science programme at Hamburg University performing experimental fishing in the tidal influenced part of the river on a monthly bases. **(D)**

Artificial propagation

Stocking of fry to North Sea tributaries:

River Elbe system below the city of Hamburg: 40.000 specimens. **(A & B)**

River Rhein system: 350.000 specimens of which 15.000 were tagged and released at an age of 150 days. **(K)**

River Weser system: 45.000 specimens. **(C)**

A larger programme aimed at the rehabilitation of salmon and sea trout stocks in the River Rhein system is co-financed by the E.U. for a 4 year period (1993 - 1996). Most of the released fry originated from Irish and Norwegian stocks.

To improve the access to the spawning grounds for salmon in the River Sieg about half a million DM has been invested respectively in constructions of and improvements to fish passes. **(K)**

SEA TROUT (S. trutte trutta)

The Fisheries

River Ems: 75 kg (commercial). **(B)**

Baltic coast: 14 mt (commercial). **(H)**

River Elbe below Hamburg: 88 specimens (research).

Sieg (River Rhein tributary): 34 spawners (experimental fishing for stock enhancement through breeding of eggs in hatcheries). **(K)**

Kiel Kanal: 20 kg per year on average during the last twenty years by commercial fishing and 150 kg per year respectively by sport fishing. **(L)**

Artificial propagation

Schleswig-Holstein: more than 20 of the smaller rivers which have been known as indigenous sea trout spawning grounds were stocked with fry at an amount of 10.000 to 80.000 per riverlet in March 1993. In one of the rivers (Eider) 10.000 fingerlings were released in June 1993, altogether about 1,4 Mio specimens; in addition 320.000 specimens of fry were stocked into two larger Elbe tributaries on the West coast. The eggs are bred in two larger and several small breeding stations which seem to collect eggs unselectively from all over the area where spawning fish emerge. **(K)**

Nordrhein Westfalen: 17.000 fry stocked in the River Sieg.

Investigations

As rainbow trout have been stocked for years in spawning rivers of S. trutta, without success as far as establishment of self-sustaining stocks is concerned, a thesis has been completed on this question at Hamburg University. The results of this thesis suggests that the more aggressive behaviour of the rainbow trout causes a steady recruitment overfishing as the rivers are all heavily frequented by sport fishermen. **(D)**

Spawning sea trouts from the river systems Rhein, Stör and Oste (W and N Germany) are under investigation for their genetic variability. There is also concern about the percentage of hybrids between salmon and sea traut which are suggested to be imported in connection with the salmon stocks-rehabilitation programmes. **(J)**

EEL (Anguilla anguilla)

The Fisheries

River Ems 16,5 mt, River Weser 9,9 mt. **(C)**

River Elbe below Hamburg: 2,9 mt (commercial) plus 2.611 specimens equivalent 325 kg (research fishery). **(D)**

Baltic coast: 200 mt (commercial). **(H)**

Kiel Kanal: 8,3 mt per year on average over the last ten years without trend (commercial and sport fishing, each nearly 50% of the total. **(L)**

Investigations

Analyses of the catch composition of an eel fishery off the East German Baltic coast showed that non target species (perch, pike perch, flounder) made up between

65% to 99% of the total catch concerning specimen numbers, and about 70% concerning weight. **(H)**

Gas bladders of 1.240 eels from coastal areas of the Baltic and 180 eels from lakes in Mecklenburg have been investigated for Anguillicola crassus. Eels from coastal regions were infected from 30% to 70%. In eels from the lakes the infection rate was up to 97%. The condition of specimens bearing the parasitic nematod was not obviously altered. **(H)**

These findings are in agreement with the results of a Ph.D. thesis on A. crassus completed at Hamburg University in 1993 by F. Hartmann. As the anatomy of the eel's swim-bladder suggests that it keeps or even improves its function during the oceanic spawning migration there is much concern about the fate of the European eel stock as the parasite has meanwhile spread over the whole of Europe and North Africa. **(D)**

Other migrating fish species

Non specific information can be added to the report of the previous year except that the numbers of sea and river lampry registered has increased and that a large specimen of Acipenser sturio of unknown origin has been caught in the outer estuary of the River Elbe in the fall of 1993. **(B)**

Artificial propagation and experiments on the enhancement of the more or less vanished stocks of migrating Coregonus lavaretus ssp. ("Nordsee- and Ostsee-Schnäpel") at the West and East coast of Schleswig-Holstein were continued. **(A & B)**

The studies on fishery ecology in the upper estuary of the Elbe went on. In this project population dynamics, food resources, propagation, and migration patterns of smelt, flounder, eel, twaite shad and some other migrating species of minor importance are investigated. Of the eight anadromous catadromous species caught by the research fishery 96% of the 6,3 Mio specimens were smelt. On a weight base smelt dominated by 86% followed by eel and flounder with about 4% each of the total weight of fish caught. **(D)**

CONTRIBUTING INSTITUTES

(A) Landwirtschaftskammer Schleswig-Holstein
Holstenstr. 108
24103 Kiel

(B) Landes-Sportfischerverband Schleswig-Holstein
Hamburger Chaussee 102
24113 Kiel

(C) Niedersächsisches Landesamt für Ökologie
Postfach 10 10 62
31110 Hildesheim

(D) Institut für Hydrobiologie und
Fischereiwissenschaft der Universität Hamburg
Olbersweg 24
22767 Hamburg
z. H. Dr. R. Thiel

(E) Aalversandstelle des Deutschen Fischerei-Verbands
Gärtnerstr. 81 a
25469 Halstenbek

(F) Staatliches Fischereiamt
Fischkai 2 a
25572 Bremerhaven

(G) Biologische Anstalt Helgoland
Notkestr. 31
22607 Hamburg

(H) Bundesforschungsanstalt für Fischerei
Institut für Ostseefischerei
An der Jägerbäk 2
18069 Rostock

(J) Zoologisches Institut 1
Universität Heidelberg
Im Neuenheimer Feld 230
09120 Heidelberg

(K) Ministerium für Umwelt
Raumordnung und Landwirtschaft
Fischereiverwaltung
Schwannstr. 3
40476 Düsseldorf

(L) Verwaltung des Nord-Ostseekanals
Wasser und Schiffahrtsamt
2410 Kiel Holtenau

ICELAND

(Á. Ísaksson)

ARCTIC CHARR (Salvelinus alpinus)

The Fisheries

Arctic charr catches increased markedly in Lake Mývatn after many years of low catches. No clear reasons have been found for the drastic fluctuations in the abundance and condition of charr in Lake Mývatn, which is one of the most productive charr lakes in Iceland. Catches in other lakes seemed to be close to average although documentation of lake catches is poor. A total of 18.000 sea charr were recorded in riverine rod catches.

Investigations

1. Charr continued to be monitored in Lake Mývatn but recently a study has been started on char in Lake Þingvallavatn, where catches have been low in recent years, especially in the pelagic char component. Catches of pelagic char in gill nets on the spawning migration used to be close to 50 tonnes and were canned for export. In recent years there has been a collapse in catches, probably due to reduction in the maturation size. Studies in 1993 indicated some improvement in the size of pelagic charr.

2. In 1992 a study was initiated between several research institutions to document biological and physical charatceristics of Icelandic lakes. This database should facilitate classification of lakes based on these characteristics and be useful in formulating fisheries advice.

3. Studies of sea-char were continued in Vesturdalsá and Nýpslón lagoon and new studies initiated in other east coast rivers with the aim of increasing utilization of this species.

Aquaculture

In 1993 the total production of reared arctic charr was 340 tonnes, which is a modest increase from previous year. Much of the production is from relatively small farms.

ATLANTIC SALMON (Salmo salar)

The Fisheries

The total catch of salmon in 1993 was 217.600 salmon, which is close to 640 tonnes. Of this 168.000 salmon were harvested in ranching stations, which amounts to 77% of the total catch. The total rod catch was 39.000 salmon but about 10.000

were caught in riverine and coastal gill nets. The sports fishery decreased somewhat from the previous year, but was still 7% higher than the 1974-93 mean catch. Both grilse and 2SW salmon were down from the previous year, especially in western Iceland.

Tagging and marking

A total of 311.000 hatchery smolts and 2800 wild smolts were microtagged in Iceland in 1993. Most of the hatchery smolts were released in ranching stations but the wild smolts were tagged in Elliðaá river on the west coast and Miðfjarðará and Vesturdalsá rivers on the north and east coasts, where long term marine survival studies are being carried out. Parr were also microtagged in some west coast rivers as a part of a wild/ranched salmon interaction study. A total of 1345 adult salmon were tagged with Floy spaghetty tags.

Investigations

River assessments

1. Salmon stocks in the river Blanda, a stream of mixed run-off and glacial origin, have been continuously monitored since 1982 to document the situation prior to hydroelectric development. The power plant started operation in 1992 and post-hydroelectric conditions are now being monitored. Preliminary information indicates that glacial component has been reduced, facilitating salmon migration over obstacles and improving conditions for fishing in upstream tributaries.

Ranched/wild salmon interactions

2. Straying of ranched salmon into salmon rivers seems to be more confined than anticipated, when large scale ranching started in Iceland. Considerable straying was observed both into rivers and between ranching stations in the 1990-91 period and it has been theorized that this could be related to poor smoltification in the smolts used. This is supported by the fact, that higher straying rates seem to be associated with low total return rates. As expected straying is highly dependent on the distance between rivers and ranching stations and is greatest in small rivers flowing directly into the sea. Straying proportion in 1993 was similar to 1992 and considerably lower than in the 1990-91 period.

3. Estuarine traps in some ranching stations are instrumental in reducing strays but are criticised by nearby river owners for their harvest methods under the assumption that the traps also to catch wild salmon. These claims are partially supported by scale readings but tagging information for wild salmon is very limited. A major research effort is directed towards the solution of this problem.

Selective breeding

4. The program for selective breeding in ranching is close to completion. Results indicate that both freshwater and marine survival, as well as growth rate can be improved through family selection. A final report is being prepared. Selective breeding experiments for salmon farming in land-based units has been initiated using Icelandic and Norwegian rearing stocks.

Stock assessment

5. Wild smolt survival studies were continued on the Elliðaár river in southern Iceland, the Miðfjarðará river in northern Iceland and Vesturdalsá river in northeastern Iceland. Returns of wild smolts of the 1992 smolt class as grilse into Elliðaár river were 9.6%, comparable to the previous year, but returns of grilse from the 1992 smolt class into Vesturdalsá river in 1993 were only 1.2%, considerably lower than in 1992. Returns of 2SW salmon were also down from the previous year.

6. Juvenile electrofishing studies continue to be an important tool in evaluating production potential of salmon rivers. Productivity of Icelandic salmon rivers is highly variable between years and between areas in the same year, but neighbouring rivers tend to fluctuate together. Although freshwater productivity is highly important, a good smolt class sometimes performs far below expectations as a result of poor survival and adverse conditions in the ocean, especially in the northernmost areas of Iceland.

Aquaculture production

The aquaculture production of salmonids according to Institute of Freshwater Fisheries statistics are shown in the following table:

Species	Quantity Tonnes	Export value US dollars
Salmon	2.844	13.622.000*
Rainbow trout	221	840.000
Artic charr	340	1.927.000
Brown trout	5	24.000
Total	3.410	16,4 million

* Includes 496 tonnes of ranched salmon

Salmon smolt production in 1993 was about 5,9 million smolts, with over 3,6 million smolts released in ocean ranching operation. Smolt production of other salmonids was about 1,2 million smolts in 1993. The above figures assume an approximate export value of US dollars 4,8 per kilogram of ungutted salmon.

SEA TROUT and BROWN TROUT (Salmo trutta)

The Fisheries

Sea trout catches on the south coast of Iceland improved further in 1993 after a drastic decline in 1990. Small sea trout seem to have increased in abundance probably due to increased recruitment. Brown trout catches in the Veiðivötn lake complex are still good as a result of fry plants in the late 1980s. Natural recruitment has been a serious problem in some of the lakes due to limited spawning areas. Arctic charr have invaded the area in recent years and are overtaking some of the brown trout lakes.

Investigations

1. Brown trout populations in the Veiðivötn lake have been monitored since 1985. In 1992-92 period hatchery broodfish were found to be over 50% infected with the BKD bakterium as indicated by Enzyme-Linked Immunisorbent Assays (ELISA) and eggs had to be partially destroyed. In 1993 these assays showed no infection and all eggs could be used for enhancement purposes. These findings indicate a highly variable infection rate in the lakes, possibly related to yearclasses.**

2. Sea trout populations in southern Iceland continued to be monitored by tagging and ageing of adults and electrofishing of fry and parr. Scale analysis of sea trout inicates that smoltification first occurs at an age of 2-5 years at an average size of 25,3 cm. Most of the fish mature after 3-4 summers in the sea at a size of 50-65cm. Tagging results indicate that mature sea trout invariably spawn in its home river.

3. Genetic studies of brown trout using electrophoresis of tissue were initiated in 1993. results are being analyzed.

CONTRIBUTING INSTITUTES

Institute of Freshwater Fisheries
Vagnhöfði 7
112 Reykjavík
Iceland

**University Pathological Laboratory
Keldur, 112 Reykjavík
Iceland

IRELAND

(J. Browne)

ATLANTIC SALMON (Salmo salar)

The Fisheries

The salmon catch in 1993 was approximately 600 t, slightly lower than that for the previous year, but still well above the very poor catches of 1990 and 1991. Estuarine draft net catches generally showed an increase over 1992, while drift net catches were down. It was believed that numbers of returning fish were good and that the low catch could be attributed to some extent to low fishing effort, particularly in the case of the inshore drift nets.

Investigations

National Microtagging programme

1. A total of 365,000 hatchery-reared and 4,570 wild salmon smolts were released in spring from rearing stations on the west coast. Recoveries indicated that the influence of the Faroese longline fishery on Irish stocks was small and that closure of the fishery would result in an increase in Irish homewaters catch of between 1,000 and 2,000 fish. The impact of the Greenland fishery was shown to be more serious as it intercepts potential 2 SW fish which are already scarce. **(A, B, C & D)**

Telemetry

2. Work has continued in the Rivers Erne and Moy as outlined in the report for 1992, confirming the failure of hatchery-reared salmon to travel upstream beyond the point of release as smolt in the Erne. Of 35 Moy salmon caught in draft nets and released in the estuary between June and September, 8 did not proceed upstream and a further 6 entered fresh water and returned to the estuary. In the River Lee, the behaviour of hatchery-reared salmon transported upstream at spawning time is being studied. **(A, C & D)**

Physiology of salmonid smoltification

3. Salmon, sea trout and brown trout from streams on the west coast of Ireland are being studied. Ability to osmoregulate has been shown to vary with size, small smolts being more susceptible to mortality in sea water challenge tests. The results in 1993 confirmed the previous observation that ability to osmoregulate did not vary according to place of origin.

Sea surface temperature and salmon catch

4. Remote sensing studies have indicated associations between seasonal warm water fronts and the catches of salmon in the high seas fisheries.

Antibiotics in fish farms

5. Oxytetracycline, shown to be associated with particulate matter in fresh water, can be removed by using a rotating drum filter. In a typical Irish marine farm, oxytetracycline can be found under cages in an area equivalent to twice the cage area. Peak values are less than those reported in Norwegian cage farms by a factor of 10. **(G)**

Population genetics

6. Relative fitness of wild, farm and hybrid families are being examined in a simulated escape situation. DNA profiling, a combination of 6 minisatellite probes and mitochondrial typing with two enzymes enable 97% of the offspring obtained from a population sample in August to be identified to a single family. An examination, begun in 1988, of genetic changes in rivers in Co. Donegal, where juvenile and adult escapee farm salmon are likely to occur, has continued. **(B)**

Environmental studies

7. Equipment to monitor pH, discharge, sediment load and ionic budgets has been installed in the Burrishoole catchment. Data sets so far obtained, from streams in afforested and open moorland, suggest that coniferous forest-mediated acidification and overgrazing of peatlands by sheep are having a detrimental effect on salmonid productivity.

SEA TROUT (Salmo trutta)

The Fisheries

Catches in two key fisheries in the mid-western region affected by stock collapse in recent years, had increased and minor increases were noted in five other fisheries. This may be associated to some degree with increased effort. Some rivers in the southwest of the country performed extremely poorly, but his was not a consistent feature in all rivers in the region. In general, the sea trout fishing season was described as satisfactory in most regions.

Investigations

Decline on west coast

1. Extensive studies have continued and a report of the Sea Trout Working Group was published early in 1994. The sampling programme was extended and located other rivers in which infestation by juvenile sea lice occurred. A correlation between infestation by juvenile sea lice and proximity to salmon cage farms was demonstrated, though it was noted that this explained only 50% of the variance. For the first time, free-living juvenile lice were located. **(A, B, C, D, E, F, G, & I)**

Monitoring in Burrishoole River System

2. Survival of wild smolt to finnock had increased in 1993 over the previous year. However, total survival to first return had fallen. The number of wild smolts leaving the system and the total number of returning adult sea trout had both fallen in 1993. **(B)**

Enhancement

3. A substantial broodstock of wild and F1 wild sea trout has been established following the collapse of many stocks in the west of Ireland. This stock has yielded sea trout ova since 1991 and maximum production is expected between 1994 and 1997. A progrmme of enhancement, stocking and rehabilitation has been put in place for the western fisheries.

Parasites

4. The completion of a study of the helminth parasites of trout showed that the faunas of different stages of the trout life-cycle differ, and this may in part be explained by migratory patterns and access to potential intermediate hosts. **(B & F)**

EEL (Anguilla anguilla)

The Fisheries

Catches of silver eels at the two regular monitoring stations were very low. It has been suggested that unusually low summer water temperatures may have had an effect on the numbers of eel reaching migration stage. Catches of newly arrived elvers have been low at all monitoring stations.

Investigations

Migratory patterns

1. Data on silver eel in the Burrishoole system collected over a period of 35 years has been analysed, indicating a trend towards lower numbers, increased size and predominance of females. New elver trapping techniques have been developed in the Shannon estuary. Successive waves of different sizes of immigrating glass eels have been identified. Studies of ascending and descending eel on the River Shannon continue. A country-wide assessment of potential elver supply was begun. **(A, B, D, F & G)**

Stock assessment

2. Sampling in the River Shannon and its lakes was conducted for its second season and regular monitoring in Lough Derg, begun in 1981, has continued. **(A & G)**

CONTRIBUTING INSTITUTES

(A) Fisheries Research Centre
Abbotstown
Dublin 15

(B) Salmon Research Agency
Newport
Co. Mayo

(C) Central Fisheries Board and
Regional Fisheries Boards
Mobhi Boreen
Dublin 9

(D) Electricity Supply Board
Fitzwilliam Street
Dublin 2

(E) Zoology Department
University College
Cork

(F) Zoology Department
Trinity College
Dublin

(G) Zoology Department
Microbiology Department
University College
Galway

(H) EOLAS
Glasnevin
Dublin 9

(I) Zoology Department
University College
Dublin

LATVIA

(A. Mitans)

ATLANTIC SALMON (Salmo salar)

The Fisheries

The total nominal landings of Baltic salmon amounted to 280 t in 1993; of these 220 t were caught by sea fisheries in the Main Basin (ICES Subdivisions 26 and 28) and 60 t by coastal fisheries in the Gulf of Riga. There are no commercial and sport fisheries of salmon in the Latvian rivers.

Investigations

Artificial propagation

1. A total of 720.000 one year and two year old smolts were released into the Gulf of Riga and Baltic coastal rivers.

Juvenile studies

2. In the River Salaca wild salmon parr density investigations were conducted by electrofishing. Five sites were sampled and all of them hold salmon. The average parr density is calculated to be 18 per 100m^2 in 1993.

Stock investigations

3. A total of 1.000 scale samples from drift-net salmon and 700 from coastal fisheries were collected. The study includes determination of hatchery or wild origin, back-calculated growth studies, age composition and the number of repeat spawners. The correlation analysis of salmon growth in the sea and some environmental factors was carried out. The significant multiple correlation between the salmon growth rate, water temperature, sprat biomass and sunspot activity were revealed.

Tagging and marking

4. A total of 3.000 hatchery reared salmon smolts were tagged with modified Carlin type tags and 90.000 were adipose clipped.

SEA TROUT (Salmo trutta m. trutta)

The Fisheries

The official commercial landings of sea trout amounted to some 17 t in 1993

and were recognized in the coastal fisheries. Most catches of sea trout were not reported.

Investigations

Artificial propagation

1. In 1993 a total of 28.000 sea trout smolts and 404.850 alevins were released into the Latvian rivers.

Juvenile studies

2. Electrofishing surveys were carried out in some rivers in the Gulf of Riga to determine the parr densities, especially in the localities where hatchery sea trout alevins had been released. The rate of survival of the alevins were calculated.

Stock investigations

3. Size-weight and age composition of sea trout spawning stocks in the Rivers Salaca and Gauja were investigated (in total 750 samples).

RIVER LAMPREY (Lampetra fluviatilis)

The Fisheries

The commercial fishery of river lamprey was reported in 7 Latvian rivers. The Total landing was 96 t.

Investigations

Artificial propagation

1. In 1993 a total of 7.781.000 river lamprey alevins were stocked into Gulf of Riga rivers.

Stock investigations

2. Sampling of lamprey (total 1.689 samples) was carried out from commercial landings.

CONTRIBUTING INSTITUTE

Latvian Fisheries Research Institute
Daugavgrivas 6
Riga LV-1007
Latvia

NETHERLANDS

(W. Dekker)

ATLANTIC SALMON (Salmo salar)

The Fisheries

A special Dutch fishery on salmon does not exist. A few (about twenty per year ?) are caught by fyke net and stake net fishermen, fishing for eel, sea-trout and pike perch mainly.

Abundance

Salmon is still very rare in Holland, but the numbers which are reported, are slowly rising to about a dozen last year.

Management measures

Within the frame of the Rhine Action Program a number of measures have been planned to enhance the possibilities for migration of the anadromous salmonids salmon and sea-trout. Rebuilding of fishpasses near weirs and adaptation of the management scheme of drainage sluices are the main activities in The Netherlands. These are linked to measures taken in Germany, France and Belgium, to rehabilitate former spawning tributaries, in the drainage area of the Rivers Rhine and Meuse. Moreover young salmonids are released in these riverstretches.

Investigations

No special investigations have been done on the biology or migration of Atlantic salmon in The Netherlands because the number is too small.

SEA TROUT (Salmo trutta)

The Fisheries

The fisheries in the rivers Rhine and Meus, in the coastal zone and in the IJsselmeer yielded about 2.000 kg of trout.

Abundance

The amount of trout captured every year by Dutch fisheries is not known exactly, however there are no signs of significant changes in the populations.

Management measures

See Atlantic salmon.

Investigations

Tagging programs, carried out during the last few years have revealed that the sea-trout in the Dutch coastal zone originates from the rivers Rhine and Meuse and from rivers in the North Western part of France. The function of new fishpassages for the migration of salmonids have been studied in the river Meuse. The new built pool and weir type pass appeared to be a suitable facility for these fishes to pass weirs with locks and power plant in upstream direction.

EUROPEAN EEL (Anguilla anguilla)

The Fisheries

The fisheries for eel in the Netherlands are split over coastal waters, lake IJsselmeer and many smaller polders and lakes. Only the fisheries on lake IJsselmeer are monitored. Catches declined drastically from over 500 tonnes in the previous years to 373 ton in 1993. It has been shown that this reduction in catch is caused by the recruitment failure since 1982.

Recruitment

Recruitment of glasseels in 1993 was once again very low, averaging 1.03 glasseels per dipnet haul in front of the sluices at Den Oever (dyke between Waddensea and lake IJsselmeer), compared to an average of 3.3 glasseels for the past 50 years.

Management measures

The stock of eels in lake IJsselmeer is heavily overfished. Management actions were restricted to avoidance of further increase of fishing effort, by means of technical measures, without an actual reduction of the current fishing pressure. Apart from the installation of several fish passes for coarse fish, no special action is undertaken to facilitate the immigration of glasseels.

Investigations

In a paper to the EIFAC eel working party in May 1993, a first version of an assessment model was presented, based on length frequency data and a retrospective application of the length projection matrix. The model was applied to data on the IJsselmeer eel fisheries. It was shown that - in the absence of accurate age readings - knowledge of the growth rate of the eel does allow for a true assessment of the fisheries. The fisheries on lake IJsselmeer show a fishery mortality of ≈ 0.6 (size range 28 thru 32 cm, peak at ± 34 cm of > 1.0), making the assessment almost worthless: nearly all animals above the minimal legal size of 28 cm are caught within one summer.

NORWAY

(M. Holm and B. Jonsson)

ATLANTIC SALMON (Atlantic salmon)

The Fisheries

The nominal catch in 1992 was 867 tonnes, of which 441 tonnes were taken in rivers and 426 tonnes were taken in the sea.

Aquaculture production

Based on preliminary statistics (by Febr. 1994) the *gross* production of farmed salmon is estimated by The Salmon Growers Association to lie between 170-175,000 metric tonnes in 1993.

Investigations

Environment

1. Water chemistry of 24 Norwegian rivers are monitored. **(A)**

Escapement from fish farms

2. The proportion of escaped farmed Atlantic salmon at the feeding grounds in the north-east Atlantic was estimated at between 25 and 48%. **(A)**

3. Most of Norways 500 salmon rivers are characterized by a small number of fish. The proportion of cultured salmon in these rivers has increased with the growth of the Norwegian salmon farming industry. In several rivers, the number of cultured fish exceeds that of wild conspecifics. The most serious effect of hatcheries so far has been the introduction to wild populations of lethal parasites and infectious diseases. More than 30 populations have been completely wiped out by the monogean parasite Gyrodactylus salaris. High mortality of adult salmon has also been observed as a result of furunculosis in some streams. **(A)**

Fish trap

4. A portable trap for salmon and sea trout spawners was designed and tested in the River Øyreselv. The trap consists of a leading fence and a trap chamber of a steel frame-work covered with a plastic coated steel netting (garden fence). Both 40 and 50 mm mesh sizes were tested. The steel frame-work consists of standard scaffolding elements (pipe diam. 48 mm). The supporting legs of the leading fence are "A" shaped, with a vertical height of 1.80 m. and a 90° top angle. The total length of the leading fence below the trap is about 27 m, constructed of sections reinforced by 3 m horizontal steel pipes connected to

each other with "snap on" locks and joined to the legs by Kee clamps. The lower 0.6 m of the fencing was bent upstream and secured tightly to the river bed with stones and steel chains to prevent spawners to sneak under the fence. The width of the trap entrance is 15 cm. The pressure per area of the leading fence is reduced because the "A" shaped legs tilt the fence downstream, thereby increasing the contact area with the water. By setting the fence at a narrow angle to the river flow direction the pressure is further reduced. Altogether 67 sea trout and 20 wild Atlantic salmon spawners, representing a considerable part of the spawning population, were trapped and tagged in the river in 1993. **(C)**

Genetic markers

5. A number of farmed and wild Atlantic salmon spawners were screened for genetic variability in isoenzymes expressed in low risk tissues. Samples of muscle and fin tissues were taken by biopsy shortly before spawning. A male, heterozygous for *GPI-3*105*, was crossed with four females homozygous for the same allele. Another male, heterozygous for a *GPI-1,2*160* allele, was crossed with a female homozygous for that allele. Mortality in all sib groups was recorded during the egg and juvenile stages. The groups were sampled and individuals were genotyped. Length and weight of the various genotypes were recorded and compared. In all families the observed genotypic distributions were in close agreement with the expected Mendelian ratios, even in the one family where the mortality was over 95%. There were no differences in performance between the two genotypes in any of the families. The inheritance of the observed variability was verified, and we conclude that the detected alleles have potential as genetic markers in experimental studies of gene flow and adaptation. **(C)**

Juvenile studies

6. When rearing of juvenile salmonids in water flowing with currents equivalent to swimming speeds of ca. 0.75-1.5 body lengths per second, the fish tend to grow faster and make more efficient use of the food than conspecifics held in standing water. **(B)**

7. Catchability of different size-classes of Atlantic salmon and brown trout parr by electric fishing was estimated in a low conductivity stream in western Norway. The catchability of both species increased with increasing fish length. **(G & C)**

Migration

8. Migratory behaviour of adult and farmed Atlantic salmon during the last phase of the marine migration was analysed by radiotelemetry outside the large north Norwegian River Alta. The results show precise homing to the river in wild salmon, whereas released farmed salmon showed more random distribution to rivers in the area. Large rivers attracted more fish than small ones. **(A)**

9. Survival of released hatchery-reared smolts increased when released in large shoals of migrating wild smolts relative to releases into lesser shoals. **(A)**

10. Water discharge influences the start of the run and the shoal formation of smolts in the River Orkla. **(A)**

11. Salmon homing at sea consists of two phases: (1) crude navigation from the feeding areas in the north Atlantic towards the Norwegian coast, (2) more precise navigation in coastal and estuarine waters towards the home river. Experience gained as outward migrating smolts was required for salmon to navigate during the second phase. **(A)**

12. Estimated mean migratory speed of released hatchery-reared post-smolts along the west coast of Norway was 7.45 km day^{-1}. In the fjords it was 1.63 km day^{-1}. **(A)**

Mortality

13. Gooseanders (*Mergus merganser*) feed on smolts. The birds aggregate in the estuary of the River Halselva in June when the fish migrate to sea. Ca. 15% of the dives resulted in birds' bringing prey to the surface, and ca. 25% of the prey were salmonids. Birds selected relatively small wild smolts. It was estimated that this duck harvested ca. 2% of the wild and 1% of the hatchery smolts migrating through the river estuary. **(A)**

Parasites

14. Smolts infested with more than 70 sea lice larvae per fish, were moribund with a 95% probability, after the larvae reached their preadult stage. These results are based on a measured survival rate of the lice of 0.82 from the 1. chalimus stage to their 2. preadult stage. The mortality of the salmon smolt is due to the feeding activity of the preadult and adult lice. The infestation resulted in significantly lower values of serum protein and haematocrites of the smolts. Moreover the infested smolts showed significantly higher values of serum chloride than uninfected ones. The chloride was also significantly correlated with infestation intensity. **(E)**

Population studies

15. In biochemically detectable loci, small but statistically significant differences in allele frequences exist between populations within and between Norwegian rivers. **(A)**

Sea ranching

16. Many post-smolts ascended rivers the same year as released, most of them the river of release. **(A)**

17. A total of 43000 one-year-old smolts descending from wild parent fish originating from the rivers Lone, Dale and Vosso were released in four releases starting May 12th and terminating June 3d in the Selstø Bay, Sotra Island, SW-Norway. The fish had been reared at standard smolt farm conditions. 11200 smolts were Carlin tagged and the rest were micro-tagged. The fish were graded into 4 groups of "small" and 4 groups of "large" smolts (10 -13 cm and 13 - 17 cm), ca. 5000 fish in each group. A modified oil barrier was used to accumulate a bracckish water layer in the inner part of the release site. A group of "large" and a group of "small" fish were released on the same dates. Two release "pairs" had been given 3 days of sea water acclimation in net pens in the Selstø bay, and two "pairs" had had 7 days acclimation before relese. The fish were observed by under- water video cameras, divers and with hydroacoustics at release. **(C)**

18. Reported recaptures of sea ranched fish, released in 1991 and 1992 from the "coastal ranching" project in Selstø Bay, SW- Norway, were 0.54 percent for the 1991 year-class and 1.7 percent for the grilse of the 1992 year-class. Based on reports by cooperating trap-net fishermen, the rates of sea ranched fish in the commercial catches within a radius of 60 km from the release site varied between 4 and 25 percent, with the highest percentage in the vicinity of the release site. 50 percent of the total catches of sea ranched grilse were made at the site of release, while the majority of the reported captures of sea ranched salmon were taken by the comercial fisheries. Carlin tagged Selstø fish recorded in other rivers, predominantly in rivers iS and SE- Norway, is around 25 percent. No carlin tagged fish were recorded in the brood stock fishery in the nearby rivers, but some fin clipped fish were observed. **(C)**

19. A total of 121000 smolts were released in June in a large scale sea ranching experiment from the Ferset river estuary, Vega Island, mid-Norway. All smolts were adipose clipped, and 11000 were Carlin tagged while 30000 were micro tagged. During 3 months prior to release the fish had been "trained" in the rearing tanks by water velocities corresponding to approximately 2 bls^{-1}. The fish were released from a large closed tarpaulin pen ("Giga-pen") where they had been kept 2-4 days for acclimation to full stength salt water by substituting the fresh water in the pen by pumping in sea water. The fish were released from the bottom of the 6 m deep pen, thereby avoiding bird predation which had been problematic in releases in 1991-92. The migrating smolts were sampled by pair trawling at a distance of up to 2 km from the release point. **(D & C)**

20. In a large scale sea ranching R&D project at Vega, Mid-Norway, 0.3 percent grilse were recaptured of the 1992 release. 108 of totally 252 reported recaptures were made at the release site, the Ferset river estuary, or in the river itself. The other recaptures were made by local fishermen around the Vega Island. Based on Carlin tag reports the straying rate to other rivers was less than 10 percent. **(C)**

ARCTIC CHARR (Salvelinus alpinus)

Feeding

21. Alternating periods of food deprivation with those of unlimited provision of food depressed the growth in Arctic charr below that of controls. However, both immature and maturing fish displayed a compensatory growth reponse on return to adequate feeding.

    Food intake of Arctic charr was greatest in the fish with reduced lipid depots. **(B)**

22. Feeding in darkness eliminates density-dependent growth suppression in Arctic charr. **(B)**

Physiological studies

23. Arctic charr can rapidly adapt to salinities up to 35 ppt in April. **(H & B)**

24. Hatchery-reared Arctic charr smolts released in the estuary of the River Halselva grew more slowly than wild conspecifics the first summer in the sea but not during later years. **(A)**

Population studies

25. Anadromous Arctic charr stay in fjords and coastal water during summer. Mean length of the sea residence was 46 days for females and 49 days for males of fish spawning in the River Vardnes, northern Norway. Fish descending to sea early in spring tended to stay longer at sea than those descending later. There was positive correlation between the duration of the residence at sea and water temperature in the river in May and negative correlation with water temperature in the river in September. **(F)**

26. Arctic charr underwent phenological and ontogenetic habitat shifts between the epibenthic and pelagic zones in five lakes studied. Pelagic charr had larger age-specific lengths than their epibenthic counterparts. Results indicate that habitat chice of charr is a trade-off between food demand and presence of predators. **(A & F)**

BROWN TROUT (Salmo trutta)

Environment

27. Resource use of brown trout in four deep hydroelectric reservoirs was studied. The fish were spatially segregated according to size. Trout smaller than 22 cm

lived epibenthicly whereas larger fish also exploited near-surface waters of the pelagic zone. **(A)**

Population studies

28. Populations of brown trout and Arctic charr are subdivided into freshwater resident and migratory individuals. Migrants usually grow larger and have higher reproductive potential but lower survival than resident conspecifics. The 'decision' about migration versus residence probably depends partly on early growth rate, or a physiological process like metabolic rate which is correlated with growth rate. Females often dominate among migrants and males among residents. **(A)**

RAINBOW TROUT (Oncorhynchus mykiss)

Marine studies

29. Experimantal sea ranching of rainbow trout has been performed in two south Norwegian fjords. Recaptures by numbers were ca. 5 times and by weight 3-4 times higher in the Oslofjord than in the Boknafjord. Most fish were recaptured during the year of release. Fish were recaptured in rivers and at sea along the coast, most of them near the sites of release. The proportion of fish recaptured increased with mean fish weight at release. For fish between 50 and 400 g at release, yield decreased with increasing fish size at release. **(A & I)**

CONTRIBUTING INSTITUTES

(A) Norwegian Institute for Nature Research
Tungasletta 2
N-7005 Trondheim
Norway

(B) Norwegian College of Fisheries Science
University of Tromsø
9037 Tromsø
Norway

(C) Institute of Marine Research
Department of Aquaculture
P.O. Box 1870-Nordnes
N-5024 Bergen
Norway

(D) Sør-Helgeland havbeite A/S
P O Box 196
N- 8980 Vega
Norway

(E) Institute of Zoology
Dept. of Ecology
University of Bergen
Muséplass 3
N- 5007 Bergen
Norway

(F) Department of Zoology
University of Trondheim
N-7055 Dragvoll
Norway

(G) Department of Biology and Nature Conservation
P O Box 5014
N-1432 Ås
Norway

(H) Norwegian Institute of Fisheries and Aquaculture
Tromsø
Norway

(I) Zoological Museum
University of Oslo
Sarsgt. 1
N-0562 Oslo
Norway

POLAND

(R. Bartel)

ATLANTIC SALMON (Salmo salar)

The Fisheries

The nominal catch in 1993 in the Baltic Sea (ICES Subdivision 24, 25 and 26) was 191t (42.530 salmon).

Investigations

1. Rearing of Daugava spawners was continued in cages in the Gulf of Gdansk. There were 606 spawners. **(B)**

2. In the autumn of 1993 there were collected 1.430.000 salmon eggs from spawners reared in cages in the Gulf og Gdansk. **(B)**

3. Salmon alevins of different stages of development were released into some small tributaries of Pomeranian rivers to compare their survival and growth rates. **(C)**

Ageing

4. In total 68 scale samples were collected from commercial catches in the Baltic Sea (ICES Subdivision 26).

BROWN TROUT (Salmo trutta m. lacustris)

Investigations

Ageing

1. Scale samples from 129 fishes were collected. **(A)**

Artificial propagation

2. 100.000 alevins were released into tributaries of the Wdzydze Lake.

Tagging experiments

3. A quantity of parr were released into the Szurpity Lake (North East part of Poland). **(A)**

EEL (Anguilla anguilla)

The Fisheries

500 t of eel were caught, but this figure is not yet complete.

Investigations

1. 709 fish were measured. **(B)**

Tagging experiment

2. In total 217 silver eels were tagged with Carlin tags and released into Pomeranian coastal waters near Ustka. **(A & B)**

LAMPREY (Lampetra fluviatilis)

The Fisheries

In 1993, the nominal catch of lamprey was ca 35 t, but this figure is incomplete.

Investigations

1. In the Vistula Firth 709 eels were measured and the sex ratio was distinguished in 100 eels.

RAINBOW TROUT (Oncorhynchus mykiss)

The Fisheries

In 1993, the nominal catch of rainbow trout was ca 10 t.

Investigations

Ageing

1. Scale samples from 60 rainbow trout caught in the Gulf of Gdansk were collected.

SEA TROUT (Salmo trutta)

The Fisheries

In 1993 the nominal catch of sea trout was 272 t.

Investigations

Ageing

1. In total 200 sea trout scale samples were collected from commercial catches in the Baltic Sea (ICES Subdivision 26).

2. Scale samples were collected from 92 and 172 fish caught in the Vistula mouth and the Slupia River respectively. **(A)**

3. Scale samples were collected from 100 sea trout caught in the Wieprza River. **(D)**

4. Egg-samples to measure size of eggs were collected from 92, 172 and 100 fish caught in the Vistula River, the Slupia River and the Wieprza River respectively. **(A & D)**

Artificial propagation

5. In 1993, a total of 711.460 sea trout smolts were released into the following rivers: the Vistula River - 409.110; the Drweca River - 178.000; the Leba River - 66.900; the Slupia River - 22.850 and the Wieprza River - 34.580.

6. In 1993 a total of 4.500.000 alevins were stocked into tributaries of the Leba River, the Slupia River, the Wieprza River, the Parseta River and the Rega River.

Stock identification

7. Scale samples from 10 sea trout caught in the spring and 157 anes caught in the summer in the Drweca River were used to evaluate the share of summer and winter sea trout in a spawning migrating population. **(A)**

Tagging experiments

8. In total 16.528 one year and two year old tagged smolts were released into the Vistula River (7.000), the Drweca River (3.000), the Slupia river (2.000), the Wieprza River (2.000), the Leba River (1.000) and the Gnilna River (a tributary of the Slupia River 998 reared smolts and 630 wild ones). **(A)**

9. Delayed released experiments with sea trout smolts were carried out in the Gulf of Gdansk, 2.752 tagged sea trout smolts were released. **(B)**

10. A tagging experiment using sonic tags was carried out in cooperation with the Freshwater Institute at Borok (Russia) to follow the movement of sea trout spawners below a dam and in a fishpass in the Vistula River near Wloclawek.

11. Experiments with fish passing through turbines of hydroelectric plants situated on the Wieprza River were carried out. **(A)**

CONTRIBUTING INSTITUTES

(A) Inland Fisheries Institute
10-957 Olsztyn Kortowo 5

River Fisheries Department
Zabieniec, 05-500 Piaseczno

River Fisheries Laboratory
Reduta Zbik 5, 80-761 Gdansk

Salmon Research Station
Rutki, 83-330 Zukowo

(B) Sea Fisheries Institute
Kollataja 1, 81-332 Gdynia

(C) Szczecin University
Department of Histology and Embryology
Lukasinskiego 43
71-215 Szczecin

(D) Engineering College
Raclawicka 15-17
75-620 Koszalin

RUSSIA

(V. Shleinik)

Pinro, Murmansk

The main directions of the Pinro research activities in 1993 were the following:

- the monitoring of the status of Atlantic salmon stocks in the main salmon rivers;
- studying of biological peculiarities of young fish and spawners on the index rivers the Varzuga, Ponoy, Kola and Tuloma;
- determination of reproduction potential of the salmon rivers;
- preparation of biological substantiation for licenced recreational fishery for Atlantic salmon;
- development of measures of protection and reasonable exploitation of Atlantic salmon stocks.

The investigations proved that salmon abundance in the Kola Peninsula rivers in 1993 was nearly 10% lower than the mean level for the latest 10 years.

In 1993 in all the Barents and White Seas rivers levels and discharges of water exceeded the mean long-term values. Mean yearly water temperature in feeding areas was by 0.6 C higher than the norm (3.9 C). Combination of these factors resulted in delaying of salmon run nearly by two weeks and in shifting of term of its completion. Unfavourable meteorological and hydrological conditions (frazil. stong winds, low level of water) in the period from mid-October to mid-November caused delay in Autumn run of salmon in the Varzuga River. Besides, early formation of frazil and storm appeared to be a cause fo mortality of large numbers of salmon in coastal zone near the river mouth.

Evidently, Atlantic salmon stocks in the rivers of Western and Eastern Murman - the Kola, Zapadnaya Litsa, Ura, Pechenga, Verzina, Iokanga Rivers and in the Ponoi and Varzuga Rivers, related to the White Sea basin are satisfactory for successful commercial and recreational fishery.

Investigations showed that a decrease of salmon abundance in the Kola Peninsula rivers is expected in 1994-1995, because progeny of 1988-1989 yearclasses of mean abundance come into spawning.

Studies also indicated that in recent years the level of illegal catch has considerably increased and reached to 50% of abundance of brood fish running to spawn in such rivers as Tuloma and Kola.

In 1993 reproductive potentials of the Varzina, Iokanga, Kharlovka and Rynda Rivers flowing into the Barents Sea and of the Umba River flowing into the White Sea was defined more exactly.

Data on density of young salmon in the Kola, Tuloma, Varzina, Iokanga Rivers (the barents Sea basin) were obtained. Prediction of possible salmon catch in 1995 was prepared and catch limits were determined for all commercial rivers in 1994.

Total amount of material obtained on spawners of Atlantic salmon constituted 8.7 thous. individuals and on young fish - 3.24 thous. individuals.

Northern Pinro, Arkhangelsk

The White Sea Atlantic salmon. Biological data were collected from fishery sites of the Nothern Dvina River. Salmon fishing in the Northern Dvina river started later than usually, in the end of July, because of the high water level in the river. In 1993 the first migrants to the White Sea coast were observed in the beginning of July, in the usual term when salmon appear from feeding grounds. Subsidence of spawning migration was observed in the end of September, a little earlier than by mean long-term data and resulted from a sharp cold snap and decreasing of water temperature in the river. In 1993 the mean water temperature in the Dvina river constituted 7.6 C which is lower by a factor of 1.5 compared with the two previous years (in 1991 and 1992 - 11.2 C).

Since 1993 biological samples did not include salmon migrants which began spawning run of the stock, a number of fish of younger age (3+ and 4+) in the samples was less and a number of fish of older age (5+, 6+) was respectively larger. In 1993 fish at age 3+ and 4+ constituted totally 10% in the samples and 5+ and 6+ age groups - 90% to compare with mean long-term values of 15.8% and 84.2% respectively (1989-1992).

The status of the White Sea salmon population has considerably deteriorated in the recent 2-3 years because of an illegal fishing.

Studies of natural reproduction and the estimation of the relative abundance of young salmon in 1993 was carried out in the Northern Dvina and Mezen Rivers tributaries which were under control. Estimation of smolts were carried out in the Megra River (Winter shore of the White Sea); the total abundance of smolts migrating from the Megra River was 6000 fish. Data obtained from controlled rivers of the Northern Dvina and Mezen basins, small coastal rivers, indicated an extremely low abundance of brood fish participating in spawning. An extremely scattered distribution of young salmon was observed over spawning and nursery areas compared to that in previous years (1989-1990).

The Pechora River Atlantic salmon. As in previous years, monitoring of the anadromous part of the population is impeded by a lack of fishing. Unfortunately, scientifically controlled fishing does not cover all the period of migration because of some limitations of services of nature protection: migration has been followed from 6 August to 27 September. As a result, biological data obtained did not completely reflect structure of spawning stock as well as reliable data on abundance of the stock entering the Pechora River were not obtained.

Salmon migrated from sea areas of feeding to the Pechora River mouth in the usual period, i.e. in the second part of July (according to observations on vendace fishery). Peak of migration was reached in August.

Total number of biological samples accounted for 745 specimens. data from biostatistical analysis of samples obtained showed length of anadromous salmon to vary from 59.0 to 120.0 cm and weight - from 2.3 to 20.5 kg, constituting in average 81.9 cm and 7.1 kg respectively. For the whole stock, mean values of length and weight must be a little lower compared to those obtained in the period of observations, because small fish usually entering the river among first migrants were not included in the sample.

Age composition of stock in 1993 was found to be similar to that for mean longterm period. As for absolute age (river and sea period of life) two age groups 5+ (37.6%) and 6+ (56.0%) were traditionally predominant. Age composition by number of sea winters was also observed to be at the usual level, i.e. at age 2.15 - in average.

Sex composition was dominated by females. In the total sample they appeared to be 2.2 times as many as males.

SPAIN

(J.A. Sánchez)

ATLANTIC SALMON (Salmo salar)

The Fisheries

The total catches (only by rod and line) in the most important Spanish rivers were the following:

River							
Bidasoa	**Cares**	**Sella**	**Narcea**	**Esva**	**Navia**	**Porcia**	**Eo**
61	495	423	917	331	16	21	16

Stock enhancement

On average, 10,000 artificially reared salmon (juveniles or smolt) were released in 1993 in each river. All eggs were originated from local stocks. All hatchery-reared juveniles were marked removing the adipose fin.

In Eo river and in other rivers of Galicia 163.000 salmon parrs were released in 1992-93. These fish were marked using coded wire tags and by cutting the adipose fin. In these rivers most of the parrs were of Scottish origin.

Investigations

1. In the Bidasoa river the survival from egg up to the juvenile or smolt stage of a stock of Iceland origin is less than the survival of a local stock.

2. Scale samples were collected for fish caught in all rivers. In all rivers an increace of grilse was found.

3. Tracking studies were started in the Eo river in 1992. Preliminary results indicate that there are differences between individuals and that the adult salmon can remain in the estuary or lower river for long periods.

4. Genetic variability, by means of enzyme electrophoresis, in the adult population has been monitored since 1986. These studies indicated that the use of foreign stock to repopulate the rivers did not change the gene frequencies at 6 segregating loci.

EEL (Anguilla anguilla)

The Fisheries and Abundance

In the Nalon estuary an inventory of catches of glass-eel has been made since 1952. The main feature of evolution of catches is maybe that opposite to the strong increase in catches among 1972 and 1979, catches showed a very quick decrease in 1980, and a record low was reached in 1990. It seems that catches are now stable at a low level. Similar decreases have been reported in other parts of Europe.

Investigations

A sampling programme of yellow-eel (using electro-fishing) was started in 1992 in different areas of the Nalon and Narcea rivers. This programme allows us to obtain biological information of population structure, age (determined by analysis of otoliths), growth, demographic structure and levels of infestation of the parasite Anguillicolla sp.

CONTRIBUTING INSTITUTES

Universidad de Oviedo
Departamento de Biología Funcional
Area de Genética
33071 Oviedo

Gobierno de Navarra
Departamento de Ordenación del Territoria
y Medio Ambiente
C/Alhóndiga 1,1
31002 Pamplona

Gobierno del Principacio de Asturias
Consejería de Ordenación del Territorio
y Medio Ambiente
Dirección Regional de Recursos Naturales
C/Coronel Aranda
33005 Oviedo

Centro de Experimentación Presquera
Consejería de Medio Rural y Presca
Av. Principe de Asturias
33212 Gijón

SWEDEN

(L. Karlsson)

ATLANTIC SALMON (Salmo salar)

The Fisheries

The catch along the west coast amounted to 56 t which was the highest on record. This reflects good coastal fishing conditions and increased releases of reared smolts as part of a compensatory programme. The river catches were also the highest on record.

The Swedish catch in the Baltic amounted to 222,337 salmon or 1,126 tonnes. The coastal catch in the Gulf of Bothnia was 48,577 salmon or 267 tonnes. This means that the coastal catch this year decreased compared to earlier years in the beginning of the 90s, while the sea catch remained at the same level as earlier. The total river catch was about the same as in the preceeding 3 years or 19,939 salmon (88 tonnes). These figures suggest that the recent change in catch from the offshore fishery towards the coast seems to have stopped. In earlier years this change was mainly due to declining effort in the offshore fishery in the Main Basin.

Investigations

Artificial propagation

1. In support of the Swedish salmon conservation program 2,253,000 smolts, 173,000 1+ parr and 60,000 fry and 0+ parr were released into Baltic rivers. 133,000 smolts were released in rivers on the west coast. **(A)**

2. In seven rivers with hatchery-reared stocks of Baltic salmon, fixed gear operated during the entire season were used to catch spawners of hatchery-reared Baltic salmon for use as broodstock. In 1993, the number of female spawners caught in most rivers decreased considerably compared to levels in earlier years in the beginning of the 90s, but the level was in most cases still above the longterm average. In river Ume, which has a wild salmon stock, the number of wild spawners increased to its highest level since the late 70s. **(A)**

Diseases

3. The practical application of commercial vaccines against Aeromonas salmonicida is being evaluated in large scale field experiments. Different methods of adminstering the vaccine and the importance of water temperature and booster vaccination are being tested. **(A)**

4. The occurrence of Gyrodactulus salaris and other Gyrodactulus species were examined in a number of wild and hatchery-reared salmon stocks. It was found

on a number of parr in the River Högvadsån, one of the major salmon rivers at the west coast. There was no evidence that Gyrodactulus s. had caused any parr mortality in the river, though many Norwegian stocks have been wiped about by this disease. **(G)**

5. In 1992-93 a mysterious alevin syndrome, M74, caused mortalities of 50-80% in reared Baltic stocks. A prognose based on early hatching eggs suggests the mortality may be high also in 1994. Electrofishing surveys in 1992 and 1993 indicated that wild salmon stocks in the Gulf of Bothnia are experiencing mortalities of similar magnitude as reared stocks. The severity of this syndrome have caused the formation of a group that will propose a research programme about the causes of this syndrome. Because of some evidence that other Baltic fish species may be affected in a similar way, it was decided to broaden the scope and put a special program called FIRE (Fish Reproduction). Many researchers believe that environmental poisons in the Baltic are to blame for the outbreak of the syndrome. Present investigations concentrate on a description of the syndrome and possibilities of linking it to any kind of enviromental poision. **(A)**

Environment

6. Major parts of Sweden are acidied due to acid precipitation and especially in the southern areas this caused a decline almon stocks declined considerably until the beginning of the 1980s. At that time large scale liming porgrams have been running. The effects of acidification and liming on Atlantic salmon are assessed particularly in River Högvadsån, on the west coast of Sweden. **(E)**

Genetics

7. The genetic variation among natural and reared populations of salmon in Sweden is being examined by electrophoresis. A study is being conducted on the relationship among stocks on the west coast of Sweden. **(A)**

Juvenile studies

8. Early sexual maturation and smolting in salmon is studied. The project aims at studying: (1) The effects of growth conditions on early sexual maturation, and the physiological mechanisms involved in the control of sexual maturation. (2) The effects of parr maturation on smoltification and the physiological mechanisms controlling smoltification in previously mature males. **(B)**

9. Environmental control of seaward migration is studied. The project aims at studying; (1) Social interactions and swimming behaviour in freshwater among individually tagged juveniles during the preparation for a seawater life, and (2) The rate of survival from river releases of salmon juveniles depending on time of release, size at release and sex (early mature males vs. immatures). **(B)**

10. A national four-year survey of the proportion of mature males among hatchery-reared salmon stocks is underway. **(A, B & C)**

11. About 1000 electrofishing stations, through out Sweden, are registered each year. The data from these electrofishings are analyzed with regard to each individual site, drainage area, type of stream, type of bottom substrate, temperature regime and other environmental variables. **(E)**

Migratory pattern

12. A project aiming at evaluating the differences in spawning run between a wild and a hatchery stock in relation to the riverine condition. **(B)**

13. Telemetry studies are performed both on emigrating sea trout and salmon smolts and adult salmon and sea trout in River Dalalven. The behaviour of spawners is studied in order to examine the effects that rebuilding of a power plant have on the migration of ascending salmon. **(A)**

Physiology

14. The nutritional status of fish, the formation of muscle proteins and maturation of oocytes is being examined. Protein metabolism in muscle is modulated by changing the composition of the feed. **(F)**

Stock enhancement

15. A program to enhance natural salmon populations in rivers situated at the Bothnian Bay started in 1980. Salmon parr or fry are being stocked in several of the rivers. The effects of stocking on the salmon populations is measured by electrofishing, use of smolt traps and through fishery statistics. The program has now been expanded to most of the rivers in the Bothnian Bay still having wild salmon populations. In 1993 stocking of fish decreased because of M74 and also that a major part of the program is finished. **(D)**

Tagging and marking

16. 50,555 smolts were tagged with Carlin tags and 315,720 parr or smolts had their adipose fin cut before release into the Baltic. Totally 6,956 smolts were Carlin tagged but no smolts were adipose fin cut before release at the west coast of Sweden. **(A)**

BROWN TROUT (Salmo trutta)

Investigations

Artificial propagation

1. In total, 559,000 1+ and 2+ smolts, 1437,000 1+ parr and 728,000 fry

and 0+ parr were released to Baltic rivers and 21,000 smolts were released at the west coast. **(A)**

Environment

2. See text concerning salmon. The effects of acid precipitation on the Swedish sea trout populations have generally been more adverse than those on salmon. The reason is mainly that sea trout occur in smaller rivers and the upper reaches of major rivers which are more susceptible to acidification. **(E)**

Juvenile studies

3. Physiological and behavioural differences between reared and wild smolts are examined by experimental releases and catch in a smolt trap and physiological parameters such as salt water tolerance and levels of growth hormone. **(C)**

4. Olfatory mediated sib-recognition in sea trout fry is studied. The aim is to reveal the mechanism and ecological and ethological function of the phenomenon. **(E & H)**

Life history

5. Life history and population dynamics is studied in a small west coast river. Parr are tagged with passive integrated transponders with the main objective to relate state at tagging for juveniles to life-history traits (age and size at maturation, movements, growth). **(C)**

6. Factors which are dimensioning the population structure of sea trout, including strategies for migration and reproduction, are studied in a Gotlandian chalkstream drainage to the Baltic. Data are collected on survival, growth, foraging behaviour, age at smoltification, predation and other relevant factors. **(E)**

7. Optimal growth under size-dependent risk. Optimal control theory is used to model optimal growth in seasonal environments, with the main objective to study causes and effects of sexual maturation of male parr and body-size bimodality. **(C)**

8. Is foraging in salmonids a compromise between growth and survival? This question is being studied by adminstration of growth hormone, which has been shown to increase appetite and dominance status of domesticated rainbow trout. The method is now used to study risk taking an agonism also in wild brown trout. **(C)**

Tagging and marking

9. In support of the sea trout monitoring program 16,243 smolts were Carlin tagged and 143,449 had their adipose fin cut before release into Baltic rivers.

Totally 1,495 were tagged and none had thery marked their adipose fin cut at the west coast. **(A)**

Wild-reared studies

10. Under an experimental situation a group is studying effects of domestication on sea trout spawning behaviour, migratory behaviour, foraging behaviour and anti-predator behaviour, primary and secondary sexual characteristics and general morphology. **(E)**

CONTRIBUTING INSTITUTES

(A) Swedish Salmon Research Institute
Forskarstigen
S-810 70 ÄLVKARLEBY

(B) Department of Aquaculture
Swedish University of Agricultural Sciences
S-901 87 UMEÅ

(C) Department of Zoology
University of Gothenburg
Box 25059
S-400 31 GOTHENBURG

(D) National Board of Fisheries
Regional Investigation Office in Luleå
Segelvägen 15
S-951 56 LULEÅ

(E) National Board of Fisheries
Institute of Freshwater Research
S-170 11 DROTTNINGHOLM

(F) Wenner Gren Institute for Experimental Biology
University of Stockholm
S-106 91 STOCKHOLM

(G) Department of Zoology
University of Stockholm
S-106 91 STOCKHOLM

(H) Department of Zoophysiology
Uppsala University
S-751 22 UPPSALA

UNITED KINGDOM (ENGLAND AND WALES)

(E.C.E. Potter)

The National Rivers Authority (NRA) have a national R&D programme for fisheries which includes all projects of national significance. Individual NRA regions continue to carry out regional operational investigations which address specific local operational needs. (These investigations may not all be listed in this report.) The NRA collect and compile migratory salmonid, eel and freshwater fish catch statistics. The use of these data for the management of stocks in England and Wales is being evaluated, and the manner in which they can best be used to estimate stock size will be determined. The NRA also undertake routine stock monitoring programmes on rivers in England and Wales, and studies are being carried out to examine statistical approaches to survey design and fish stock assessment in river fisheries. Methods of classifying river fisheries, including juvenile salmonid stocks, are also being examined.

(NRA:HQ, WRc)

ARCTIC CHARR (Salvelinus alpinus L.)

The Fisheries

A small net fishery for charr operates in the north-west of England. No data are available for landings in 1993. The declared catch in 1992 was 2.7 t, which was similar to those in previous years.

Investigations

Stock assessment

1. The management and ecology of Arctic charr populations in Lake Windermere are being studied to compare spring and autumn spawning stocks in the North and South Basins of the lake and to survey their spawning sites. The sensitivity of the juvenile stages of the various stocks to reduced oxygen concentrations and to elevated temperatures is also being investigated.

(IFE)

ATLANTIC SALMON (Salmo salar) AND SEA TROUT (S. trutta)

Fisheries

The nominal catch of salmon for England and Wales in 1993 is provisionally estimated to have been 274 t, which is considerably higher than the confirmed total for 1992 of 186 t. The provisional net catch of 56,512 salmon was about 67% greater than in 1992 and close to the average for the previous five years (1988-92). The estimated rod catch of 20,441 fish was 43% higher than in 1992 and was the best figure since 1988. The introduction of a national rod licence in 1992 is

likely to have affected the comparability of the catch returns with earlier years, and the data must therefore be treated with caution.

Only limited data are available for catches of sea trout in 1993, but provisional figures appear to be similar to 1992. The nominal catch of sea trout in 1992 was 106 t. The declared catches by net (41,903) and rod (14,742) were only 61% and 44% of the averages for the previous 5 years (1987-91) respectively.

Investigations

Acid rain

1. The effects of liming as a means to restore water quality and natural fish production are being studied at Llyn Gamallt, North Wales. **(NRA:HQ)**

Diseases and Parasites

2. Examination of 154 wild salmon and sea trout broodstock, taken from 19 English and Welsh rivers for stripping as part of stock enhancement programmes, failed to show evidence of BK, IHN, VHS or *Gyrodactylus salaris*. However, IPN-TV serotype (birnavirus B_1) was confirmed in one salmon broodstock from a Welsh river. **(MAFF:FDL)**

Fishery studies

3. A detailed survey is being made of salmon fishing methods and their operation in England and Wales. **(MAFF:DFR)**

Genetics

4. Genetic studies of salmon stocks are being carried out using traditional electrophoretic techniques and restriction endonuclease analysis of mitochondrial DNA. The aims of the studies are to investigate the genetic integrity of salmon stocks from different areas of England and Wales and to identify some of the changes which may result from stock transfers and introductions. **(MAFF:DFR)**

5. Information on the genetic characteristics of early running, multi sea winter salmon has been reviewed. Fishing pressure as a selective agent has been examined and environmental factors that may combine with genetic composition to determine run timing and sea age at maturity have been considered. **(NRA:HQ)**

7. The degree of genetic differentiation between salmon populations in the Windermere catchment is being investigated to ascertain whether juvenile salmon in the lower and upper parts of the catchment are derived from a common genetic stock. **(IFE)**

8. The NRA has appointed a genetics fellowship for a two year investigation of

the genetics of sea trout in England and Wales. Studies will include spatial variation in mtDNA and allozyme characteristics between and within river systems and investigations of variation within adult and juvenile (smolt) migrant groups. **2. (NRA:HQ)**

Habitat studies

9. Habitat assessment techniques for juvenile salmonids are being reviewed. One such methodology, the HABSCORE technique, developed for rivers in Wales, is being assessed on the basis of more than 600 sites nationally in England and Wales. **(NRA:HQ, WRc)**

10. The effects of siltation on the survival of salmon ova and alevins are being investigated in both spate rivers and chalk streams. Survival rates for salmon eggs and alevins on the River Itchen have been shown to be significantly improved by manual gravel cleaning. The longevity of the beneficial changes are being assessed along with the impacts of gravel cleaning on the macro-invertebrate fauna. Incubators have been used successfully in stream-side situations to supplement production. Weed cutting has been shown to result in increased production of juvenile salmon. **(MAFF:DFR, IFE)**

11. The effects of land use change on river quality and fisheries has been examined through a case study of the River Torridge catchment (south-west England). The apparent decline of salmonids (principally salmon) has been investigated by means of water quality studies, juvenile surveys and bioassays. **(WRc, NRA:HQ, MAFF:DFR)**

Juvenile studies

12. Populations of salmonid fishes in upland waters are being studied to describe and quantify year to year fluctuations in the numbers of young salmonids and the abiotic factors which appear to influence them. The effects of a impoundment in northern England (Cow Green) and afforestation in mid-Wales (Llanbrynmair Moor) on salmonid stocks are also being studied. **(IFE)**

Migratory patterns (freshwater and estuaries)

13. The effects of environmental factors, such as natural and artificial flow regimes and water quality, on patterns of movement of migratory salmonids are being investigated in a number of areas using various techniques, including radio and acoustic tracking and fish counters. **(MAFF:DFR, NRA:HQ, IFE)**

14. A two year study of the estuarine behaviour of Atlantic salmon and sea trout smolts in the Afon Conwy (north Wales) has been completed. Smolts were trapped and tracked through the estuary using miniature 300 kHz acoustic transmitters and acoustic sonar buoys. Migration was largely nocturnal within the river and estuary, and movement seaward was initiated on an ebb tide. The same methodology, is now being used to study the behaviour of smolts in the River Tawe estuary (south Wales), which has a tidal barrage. A high

resolution tracking system is being used to study smolt movements close to the barrage. **(MAFF:DFR, NRA:HQ)**

15. The behaviour of returning adult salmonids is also being studied on the Tawe estuary, with the high resolution tracking system being deployed downstream of the barrage to investigate the movements of upstream migrants as they approach the obstruction and the fish pass. **MAFF:DFR, NRA:Wh)**

16. A three year study of adult salmon movements has been carried out on the River Dee (north Wales). The study has included an investigation of movements in the estuary in relation to water quality and tidal effects and the effects of a partial barrier at the head of tide. Movements in freshwater have also been investigated. **(NRA:HQ)**

Physiology

17. The ability of salmon parr to discriminate the urine of sibling and non-sibling groups has been studied by electrophysiological and behavioural techniques. Urine from both siblings and non-siblings is a potent odorant, but responses were significantly greater in Atlantic salmon that were stimulated with sibling urine. Urine from siblings and non-siblings also elicited behavioural responses, generally of an aggressive nature. Parr also tended to move towards the source of sibling urine but away from the source of non-sibling urine.
(MAFF:DFR)

18. Electrophysiological studies have shown a significant reduction in the ability of mature salmon parr to detect testosterone and the urine from mature female salmon after perfusion of the olfactory epithelia with water of pH <6.5. At reduced pH, the concentrations of odorants required to produce a similar olfactory response to the controls were at least two orders of magnitude greater. After perfusion with water below pH 3.5 no olfactory responses could be detected to either odorant. An SEM and TEM study of the anatomy and development of the olfactory rosette has also been undertaken.
(MAFF:DFR)

19. Techniques are being developed for characterising and quantifying steroid pheromone receptors in trout and salmon. The appearance and disappearance of specific steroid binding sites is being monitored during the development of the fish to assess the physiological significance and behavioural role of these compounds. The extent to which environmental factors may also disrupt receptors is also being investigated. **(IFE)**

20. The ionic contents of pavement epithelial cells and mitochondrial rich cells in sea trout gills, adapted to sea water and freshwater, are being measured by X-Ray emission analysis on a scanning electron microscope. The aim is to determine the part these kinds of cells play in ionic and osmotic regulation.
(Lancaster)

Stock and fishery investigations

21. Fish counters are being installed and run on a variety of rivers in England and Wales with the aim of assessing adult salmonid stocks and estimating exploitation rates in rod and net fisheries. Salmon spawning stock targets are being derived for several Welsh rivers and used to assess current levels of spawning in preparation for a review of the number of net fishing licences. **(MAFF:DFR, NRA:HQ, IFE, NRA:Wh)**

22. Juvenile salmon are being microtagged in a number of rivers in England and Wales and wild smolts have been tagged on the Rivers Wear, Coquet and Esk in the north-east and the River Test in the south as part of a national programme to compare patterns and levels of exploitation in various home water and distant water fisheries on stocks from different regions. **(MAFF:DFR)**

23. A long-term stock assessment programme on Welsh Dee is continuing to collect data on rod and net exploitation rates, run size, year class strength, run-timing and biological characteristics, juvenile abundance, stocking effectiveness, behaviour and habitat usage. **(NRA:Wh)**

24. A full evaluation of the current state of knowledge of sea trout stocks in England and Wales has been undertaken in order to establish an appropriate programme of investigations to allow effective management of sea trout stocks as a sustainable resource. **(NRA:HQ)**

25. Studies are being undertaken of the population dynamics, feeding and growth of resident and migratory brown trout and other fish species in salmonid streams. The objectives are to assess the numbers, biomass, growth, mortality, production, movements and feeding of trout in Lake District streams; to identify the factors affecting these variables; and to develop models that can be used to predict changes in them. **(IFE)**

26. Sea trout catches have been sampled in the east coast fishery. Analysis has included examination of the size and age composition of the catch, changes in the diet of the fish at different times of year and diseases and parasites. In some areas, the fishery is fairly selective for post-smolts which appear in the fishery within about two months of leaving rivers in the north east of England. Elsewhere the catch comprised mainly older fish (1-2 sea winters) that were maturing to spawn during the following winter. **(MAFF:DFR)**

Stock enhancement

27. The most cost effective stocking strategies for migratory salmonids are being investigated in order to maximise returns of adult fish to fisheries and to supplement natural spawning populations. **(NRA:HQ)**

28. The effects of stocked trout (brown and rainbow) on the survival of wild fish is being assessed in a variety of rivers, particularly with respect to predation on juveniles, in order to produce recommendations on future stocking practices. **(WRc, NRA:HQ)**

EELS (Anguilla anguilla)

The Fisheries

Catch returns are not generally required from eel fishermen in England and Wales and no data are available for 1993. Although the recorded catch for 1992 was 5 t elvers and 36 t eels, the actual landings are thought to be higher. The annual catch in England and Wales has been estimated to be about 50 t elvers and 550 t adult eels, which included about 50 t silver eels. Of the adult eel catch about half is taken in freshwater and half in estuaries and the sea.

Investigations

Diseases and Parasites

1. Since the first identification of eel parasite *Anguillicola crassus* in UK eels in 1986, it has been found in eels in five catchments in eastern England which flow into the North Sea but never in west coast rivers. Tests on elvers from the Bristol channel continue to show no evidence of serious disease, and examination of eels from the River Wye and its tributaries in Wales did not detect *Anguillicola crassus* in the stocks. **(MAFF:FDL)**

2. Parasites of eels are being investigated with studies of: the population and community dynamics of helminth parasites of eels; the life cycles, modes of transmission and seasonal dynamics of the common helminths of eels in freshwater and estuaries; the colonisation and spread of *Anguillicola crassus* in Britain; the role of inter-specific competition in determining the distribution and abundance of eel parasites and their community structure; and long term studies on eel parasites in Ireland. **(Exeter)**

Stock assessment

3. Information currently available on eel populations in UK waters is being collated and assessed and will be compared with data on other European eel stocks. **(MAFF:DFR, IFE)**

4. The effects of commercial elver fishing on riverine eel stocks in the Severn estuary have been investigated. Elver catches have declined throughout Europe in the last 15 years, possibly partly due to changes in ocean currents affecting the migration of larval eel. Within the catchment, the number of immigrating juvenile eel and elver decreases with distance upstream, and migration upstream is affected by barriers. Various elver pass designs have been evaluated and effective designs have been recommended. Artificial stocking of the Severn

catchment has been proposed. A Europe-wide management strategy has been recommended to prevent further decline in this species.
(Westminster, NRA:HQ)

RAINBOW TROUT (Oncorhynchus mykiss)

Investigations

Parasites

1. The population and transmission dynamics of selected species of parasites in trout and the role of fish stocking in the transmission of helminth parasites are being investigated. Further studies are focusing on the possibility of predicting the parasite fauna of rainbow trout. **(Exeter)**

Physiology

2. Studies are being carried out to elucidate the basic physiological and endochrinological changes that occur when fish are subjected to acute and chronic environmental stress, with special emphasis on survival, disease resistance, growth and reproduction. The studies are also investigating methods for controlling the stress response by modifying the fish's environment or by selecting, for breeding purposes, fish with low sensitivities to environmental stress. The aim is also to use the results of these studies for the scientific management and conservation of stocks of freshwater fish and their environment, especially in relation to human perturbations such as eutrophication, acidification, and changes in land use or climate. **(IFE)**

WHITEFISH (Coregonus spp.)

Investigations

1. The vendace (*Coregonus albula*) and shelly/gwyniad/powan (*Coregonus lavaretus*) populations of England and Wales are being investigated in a three-year project to gather information on the ecology and the genetic variation of these fish which is necessary to safeguard their populations. **(IFE)**

CONTRIBUTING INSTITUTES

Exeter
University of Exeter,
Department of Biological Sciences,
Prince of Wales Road,
Exeter, EX4 4PS.

IFE
Institute of Freshwater Ecology,
Ferry House,
Ambleside,
Cumbria.

Lancaster
Lancaster University,
Division of Biological Sciences,
Lancaster LA1 4YQ.

MAFF:DFR
Ministry of Agriculture Fisheries and Food,
Directorate of Fisheries Research,
Pakefield Road, Lowestoft,
Suffolk NR33 0HT.

MAFF:FDL
Ministry of Agriculture Fisheries and Food,
Fish Diseases Laboratory,
14 Albany Road, Weymouth,
Dorset DT4 9TH.

NRA:HQ
National Rivers Authority,
Rivers House, Waterside Drive,
Aztec West, Almondsbury,
Bristol BS12 4UD.

NRA:Wh
NRA, Welsh Region,
Rivers House,
St Mellons Business Park,
St Mellons,
Cardiff CF3 0EG.

Westminster
University of Westminster,
School of Biological and Health Sciences,
115 New Cavendish St,
London W1M 8JS.

WRc
Water Research Centre,
Henley Rd, Medmenham,
PO Box 16, Marlow,
Bucks, SL7 2HD.

UNITED KINGDOM (NORTHERN IRELAND)

(W.W. Crozier)

EELS (Anquilla anquilla)

The Fisheries

The nominal catch of eels in Northern Ireland in 1993 has not yet been collated. Lough Neagh remains the most important commercial eel fishery in N Ireland.

Investigations

Stock assessment

1. Information continues to be gathered on abundance, distribution and size of eels in Lough Neagh, as part of a general monitoring programme. **(C)**

ATLANTIC SALMON (Salmo salar)

The Fisheries

The number of fishing licences issued in 1993 (211) was lower than the 1992 figure (232). The difference is mainly accounted for by a reduction in draft net licences in the Foyle Fisheries Commmission area. In this area, the new season adopted in 1992 (20 June to last day of July) continued in 1993, while in the remainder of the Northern Irish fishery, historical fishing seasons were unchanged. Regulations governing type of material and mesh sizes of nets remained unchanged.

The final declared catch in N Irish commercial salmon fisheries in 1992 was 89t, a downward revision of the provisional value available at that time, due to errors in catch reporting. The provisional catch for 1993 (83t) shows a small reduction relative to 1992, and remains below the previous 5 and 10 year average values.

Investigations

Acid rain

1. Routine monitoring was maintained at the Northern Ireland stations throughout 1992/93. Analysis of the data for the calendar year 1992 is complete and, for the first time since monitoring began in 1985, the mean annual pH at all sites in Northern Ireland were above 5.0 (ie non-acid rain). The paucity of acid events in 1992 is reflected in the continuing downward trend in SO4 (upward trend in pH) reported at the Silent Valley in last years report. The non-acid rain would appear to be a direct result of the significant reductions made in SO2 emissions in recent years in the UK and Europe.

2. DANI Forest Service report that current K Deposition levels of around 1-3 kg K ha-1 yr-1 in rainfall are insufficient to supply the needs (10-15 kg K ha-1 yr-1) of largely coniferous forests on peaty soils around the Province. As a result, many of these plantations are suffering from K deficiency and require fertilising. ASRD are involved in monitoring changes in water chemistry, including pH, within Glenderg Forest, Co Tyrone, following K applications made by helicopter in March/April 1994.

3. ASRD are working closely with the NI Soil Survey team (ACRD) in the production of a Critical Loads map for the acidification of soils in Northern Ireland on a 1km x 1km grid, using a GIS. The map is based on the Skokloster classification scheme used to produce preliminary critical loads maps in Great Britian and elsewhere. The inclusion of Northern Ireland (and subsequently the Republic of Ireland) will complete the picture for the UK (and later, the British Isles). Modifications to the map to take into account the effects of land use are planned for the near future.

Fisheries studies

4. Patterns of exploitation of salmon stocks in homewater and distant-water fisheries are being investigated through microtagging studies. Hatchery-reared and wild smolts are tagged on the R Bush and a large scale tag recovery programme is operated in the coastal fisheries. **(A)**

Genetics

5. Investigations continued into the population genetics of wild and hatchery stocks of Atlantic salmon in N Ireland, including temporal stability of gene frequencies in wild populations, experimental stocking with genetically-marked salmon fry and genetic interactions between escaped farmed salmon and a local wild population. **(A)**

6. An investigation on the spatial and temporal genetic differentiation of sea trout and Atlantic salmon stocks in relation to the processes of gene flow (straying), natural selection and genetic drift is continuing. The impact of stocking and farm escapees on the genetic structure and fitness of natural populations is also being examined. **(B)**

7. Multi-locus and single-locus hypervariable DNA probes are being developed for use in stock discrimination and in studies of fitness characteristics in wild and farm stocks of Atlantic salmon and brown trout. **(B)**

Population dynamics

8. Traps are operated on the R Bush to count the total runs of adult salmon and smolts. Figures for marine survival and the freshwater stock/recruitment relationship are being assessed annually. Timing of runs, sex ratios, fecundity, length/weight relationships and age structure of the wild and hatchery stocks are also monitored. **(A)**

Predation

9. Predation by cormorants, Phalacrocorax carbo L., on juvenile salmon and trout stocks on the R Bush continues to be studied, with counts of numbers of birds feeding in freshwater, counts of nests and egg clutches on a nearby colony, together with analysis of stomach contents of feeding birds being carried out. **(A & C)**

Stock assessment

10. Electrofishing surveys are carried out annually on the R Bush to assess and compare survivals from natural spawning in different areas. The results have been used to help pinpoint pollution problems, and follow-up water quality surveys have been initiated. A single anode semi-quantitative electrofishing technique has been calibrated against standard estimation methods and is now used as a standard survey method in N Ireland. The potential of such survey techniques for providing an index of recruitment from rivers where smolt counts are unavailable is being assessed. Results are encouraging, with a significant relationship between fry numbers and subsequent counts of migrating smolts at the Bushmills trap. **(A)**

The Fisheries Conservancy Board for N Ireland include details, in their Annual Reports, of salmon redd counts in all the main catchments of N Ireland, excluding the Foyle area.

Foyle Fisheries Commission include details, in their Annual Reports, of adult numbers through counters, redd counts and the results of electrofishing surveys for juveniles.

Stock enhancement

11. Work aimed at relating survival of juvenile salmon to stocking densities under high and low levels of intra-specific competition, was completed in 1993 and is being prepared for publication. **(A)**

12. The potential for reintroducing salmon to the R Lagan has been assessed by means of surveys of the available spawning and nursery habitats, in conjunction with studies of water quality in the freshwater and estuarine reaches. Weirs have been surveyed with a view to determining the need for and feasibility of installing fish passes. Experimental stocking with salmon fry has been carried out from 1991 to 1993. Initial returns of 1SW salmon from the 1991 stocking were observed in 1993, in excess of 250 fish being enumerated from rod catches and observation at weirs. **(A)**

Sea ranching

13. The effectiveness of 'sea ranching' of hatchery reared salmon has been assessed

and this is being continued at a low level as part of the microtagging programme. **(A)**

14. Investigations continued into the feasibility of further improving the economics of sea ranching carried out on the R Bush, by reconditioning hatchery origin kelts and by varying method and timing of releases of hatchery-reared smolts. **(A)**

SEA TROUT (Salmo trutta)

The Fisheries

There are no commercial fisheries specifically targeting sea trout, but they are present as a by-catch in the salmon fisheries. The commercial catch for 1993 is still being collated, but annual catches of the order of 2t are declared.

Investigations

Fishery studies

1. A collation and verification of N Ireland commercial catch statistics of sea trout is being carried out, in order to examine historical catch trends. **(A)**

Genetics

See under Atlantic salmon.

Stock investigations

2. A small scale study into biological characteristics of sea trout in several N Irish rivers continued in 1993, in co-operation with local angling clubs. **(A)**

CONTRIBUTING INSTITUTES

(A) Department of Agriculture for Northern Ireland
Aquatic Sciences Research Division
Newforge Lane
Belfast BT9 5PX

(B) The Queen's University of Belfast
School of Biology and Biochemistry
Belfast BT7 1NN

(C) University of Ulster Freshwater Lab.
Traad Point
Ballyronan
Co Londonderry
BT45 6LR

UNITED KINGDOM (SCOTLAND)

(D. A. Dunkley)

ATLANTIC SALMON (Salmo salar)

The Fisheries

The combined catches of salmon and grilse (salmon which have spent only one winter at sea) reported caught in 1992 by rod-and-line, net-and-coble, and fixed-engine were 82,897, 44,947, and 56,673 fish respectively giving a combined total catch of 184,517. The total number of fish caught was 33% more than in 1991.

The rod-and-line, net-and-coble, and fixed-engine catches were all higher than in 1991 (by 33%, 46% and 24% respectively). The total catch of salmon and grilse by rod-and-line was the third highest since records began in 1952, only 1988 and 1989 showing higher catches. However, the catch of spring salmon by angling was the lowest on record. In the net fisheries, the net-and-coble catch of salmon and grilse was the second lowest on record, 1991 being the only year when a smaller catch was reported. The fixed-engine catch of salmon and grilse was the third lowest since records began in 1952, only catches in 1990 and 1991 being lower.

The total weight of salmon and grilse caught was 599.5 t, 30% more than in 1991. The mean weight of fish reported as salmon (4.35 kg) was the same as in 1991 but the mean weight of fish reported as grilse was slightly lower at 2.36 kg compared with 2.40 kg in 1991. The mean weight of fish reported as salmon caught by rod-and-line was 4.13 kg, while the mean weight of fish reported as grilse was 2.40 kg. In the net-and-coble fishery, the mean weight of fish reported as salmon was 4.76 kg and the mean weight of fish reported as grilse was 2.22 kg. The mean weight of fish reported as salmon caught by fixed engines was 4.90 kg while the mean weight of grilse was 2.40 kg.

Compared with 1991, the all-method catch in terms of both numbers and weight increased in all Regions with the exception of the West Coast Region which remained at practically the same level. Compared with the 1987-1991 five year average, catches in terms of both numbers and weight decreased in most Regions, the exceptions being the North and Outer Hebrides where catches were slightly greater.

The distribution of the catch was similar to that reported in previous years with 64% of the catch being divided between the three east coast Regions, East, North East and Moray Firth. **(A)**

Abundance

The total net upstream count recorded at Logie on the North Esk during 1993 was 10887, the third highest since records began in 1981. The net upstream count recorded during 1993 at the fish counter on the West Water, a major tributary of the North Esk, was 2699, an increase of 160 on the 1992 figure.

Work continued on the installation of the automatic fish counter on the River Dee (Aberdeenshire).

Construction work began on counting installations on the River Helmsdale (Caithness), River Grimersta (Lewis) and River Laggan (Islay). **(A)**

New Management Measures

Regulations prohibiting the use of prawns and shrimps as baits or lures for angling were introduced for a number of rivers in 1993. Regulations defining lawful netting methods and construction of nets came into force in 1993. Regulations prohibiting the keeping or the release of Pikeperch (Stizostedion lucioperca) were introduced in 1993.

Investigations

Acid rain

Investigations into the effects of acid rain continue in several areas of Scotland.

1. A research study to address acidification in terms of "Critical Loads" methodology was started in the River Halladale catchment in Caithness in 1993. Five streams and three precipitation sampling sites were selected. Critical Load values were calculated for each sample at all sites. **(A)**

2. Investigations into the effects of acid precipitation in rivers in south-west Scotland have continued. The effects on juvenile salmon have been investigated using salmon ova planted out in egg box experiments. Continuous chemical monitoring stations have been established to monitor pH, temperature and water height, and in some cases aluminium, sulphate and calcium levels. **(B)**

Aquaculture broodstock

The following research and monitoring activities and have been reported.

1. Broodstock maintenance and improvement. **(D)**

2. Photoperiod and egg production. **(D)**

3. Melatonin secretion and developmental change. **(D)**

4. Egg quality determinants. **(D)**

5. Control of fecundity and egg size. **(D)**

Aquaculture production

The following research and monitoring activities have been reported.

1. Investigation of possible causes of failed smolt condition of farmed salmon. **(C)**

2. Waste production from land-based freshwater fish farms. **(D)**

3. Evaluation of offshore farming. **(D)**

4. Evaluation of the use of remote sensing devices in aquaculture. **(D)**

Artificial propagation

1. Many District Salmon Fishery Boards throughout Scotland operate hatcheries. In most cases, eyed ova or unfed fry are planted out above impassable falls to increase juvenile salmon production.

Behaviour

The following study has been reported.

1. Observations on the winter behaviour of juvenile salmon continued. The proportion of time spent in free water became increasingly nocturnal as the temperature fell from 10° C. This response was found to be independent of photoperiod or season. **(A)**

Diseases

The following research and monitoring activities have been reported.

1. Investigation into the causes of morbidity and mortality in wild and farmed salmon. **(C)**

2. Testing for notifiable diseases under the Diseases of Fish Act, 1937 & 1938. **(C)**

3. Inspection and testing of farmed salmon for diseases listed under Directive 91/67/EEC. **(C)**

4. Investigations into furunculosis:

   (i) virulence of Aeromonas salmonicida,
   (ii) vaccine development,
   (iii) genetics of A salmonicida. **(C)**

5. Investigations into Infectious Pancreatic Necrosis (IPN):

   (i) diagnostic methods,
   (ii) genetics of IPNV,
   (iii) methods of disposal of dead fish. **(C)**

6. Investigations into Bacterial Kidney Disease (BKD):
   (i) diagnostic methods,
   (ii) molecular genetics of Renibacterium salmoninarum. **(C)**

7. Investigations into Pancreas Disease (PD):
   (i) transmission of disease,
   (ii) nature of acquired resistance,
   (iii) diagnostic methods,
   (iv) factors affecting development and recovery from disease. **(C)**

8. Behavioural contributions to dorsal fin rot and its prevention. **(D)**

9. Epidemiology of erythrocytic inclusion body syndrome (EIBS) and its effects on immune systems. **(D)**

10. Investigating alternative anti-microbial agents for treatment of fungal furunculosis. **(D)**

11. Mechanisms of anti-microbial resistance in bacterial pathogens. **(D)**

12. Enhancement of non-specific defences to bacterial infection. **(D)**

13. Research on furunculosis vaccine; immunosuppressive aspects and thymus dependency of the protective antigens. **(D)**

Escapement from fish farms

1. Salmon farming in Scotland is concentrated in the west, north west, Hebrides and Northern Isles. Salmon and grilse catches were sampled at fisheries throughout Scotland in 1993. At all locations, catches included some fish which were of cultured origin. Fish had escaped at all life stages. The incidence of escaped farm fish in catches was highest in the west and north west of Scotland where about 20% of the fish taken in catches at the fixed engine fisheries located there were considered to be of cultured origin. This figure is likely to be an underestimate as it is not possible to identify all fish of cultured origin. Levels were much lower in catches taken in fisheries in the east and south east of Scotland. **(A)**

Feeding behaviour

The following studies have been reported.

1. Investigations into feeding behaviour in salmon in cages and tanks have shown that circadian feeding rhythms are very flexible and can be modified by training. However, circannual feeding rhythms are probably genetically fixed and not amenable to adjustment in culture. **(A)**

2. An evaluation of the effects of social hierarchies on food intake is being undertaken. **(A)**

3. Investigations are being undertaken into digestibility of food and nutrient uptake in seawater. **(D)**

Fisheries studies

The following studies have been reported.

1. Sampling of salmon catches taken at fixed engine stations around the Scottish coast and at net-and-coble and rod-and-line fisheries in Scottish rivers continued. Details of length, weight, age and sex ratio were collected. Sex was determined using the vitellogenesis technique. Scales were collected at a number of fisheries for ageing purposes while at others, the relationship between length and sea age previously determined was used to separate catches into sea-age classes. Analysis of these data allows reported catches to be corrected for "grilse error", the misreporting of large grilse as multi-sea winter salmon. In some years, this error can be very large. It has been found that in those years when grilse catches were large, the grilse were themselves large and the "grilse error" large. **(A)**

2. Studies into fisheries enhancement methods are being carried out. **(D)**

3. Catch and effort data were collected from a number of angling fisheries in the River Spey to improve analysis of angling catch returns. **(E)**

4. Catches at a number of angling fisheries along the River Tweed were sampled. Scale samples were taken to give information on the geographical and temporal variation in type of salmon present in the river throughout the fishing season. **(F)**

Genetics

1. Investigations into the genetics of salmon populations in different river systems and different parts of river systems continues. **(A)**

Habitat

The following studies have been reported.

1. Juvenile salmonid habitat categorisation studies have continued in streams throughout Scotland. **(A)**

2. Investigations into the effectiveness of habitat manipulation in small streams in the south-west of Scotland. Landowners and riparian owners are being encouraged to fence of watercourses to prevent overgrazing, reduce bank erosion and encourage better bankside vegetation for cover. An experiment to improve in-river parr habitat is being undertaken on the River Stinchar. **(B)**

3. A land use database system is being established for catchment areas in the south west of Scotland. **(B)**

4. A survey and assessment of riparian vegetation levels and implementation of improvements, where possible, is being carried out on the River Spey. **(E)**

5. Surveys of juvenile salmonid habitat quality are being undertaken throughout the River Tweed district. Normal survey data are augmented with information from aerial photographs. **(F)**

Juvenile studies

The following studies have been reported.

1. Annual salmon smolt production estimation of the North Esk has continued since the mid-1960s. Each year, a proportion of the emigrating smolts is trapped and a stratified mark-recapture experiment is used to determine smolt production. The mean annual smolt production of the North Esk is 175,000 smolts. **(A)**

2. Extensive electro-fishing surveys of juvenile salmonid populations throughout Scotland have been undertaken to assess the impacts of the low returns from the 1989 and 1990 smolt runs. Preliminary results indicate that juvenile salmon population densities are similar to the levels observed in the mid-1980s, when extensive surveys were last undertaken. **(A)**

3. A study of juvenile salmon population structure in the Girnock Burn, a tributary of the River Dee (Aberdeenshire) demonstrated that interactions among year classes lent robustness to annual smolt production in a nursery stream where two main age-classes were represented among migrants. The effect of sub-optimal spawning on later smolt production was mitigated by the accelerated development of the following year-class. **(A)**

4. Comprehensive electro-fishing surveys have been carried out in the Rivers Stinchar, Doon, Luce, Bladnoch, Cree, Nith and Water of Fleet, all in south-west Scotland. Areas with no salmon have been identified and investigations started to determine the reasons for their absence. **(B)**

5. Investigation of feeding rhythms and environmental effects in early development. **(D)**

6. Investigations into temperature, light and stocking density effects on early development. **(D)**

7. Investigations into temperature, light and stocking density effects on early development. **(D)**

8. Electro-fishing surveys of juvenile salmon populations in the River Spey catchment area have been undertaken. **(E)**

9. Electro-fishing surveys of juvenile salmon populations in the River Tweed catchment area have been undertaken. **(F)**

Migratory behaviour

1. In a preliminary investigation into salmon smolt behaviour on first transfer to the marine environment, observations were conducted with separate groups of cultivated and wild-caught smolts in a sea-water aquarium. On first transfer to sea water, the hatchery-reared smolts formed more widely-spaced schools than the wild smolts. After 24 to 48 hours, however, the swimming behaviour of the wild smolts was similar to that of the hatchery fish. **(A)**

2. Investigation of photoperiod and smoltification. **(D)**

3. Tracking passage of smolts through Scottish loch systems. **(D)**

Nutrition

The following studies have been reported.

1. Oral delivery methods for protein growth enhancements. **(D)**

Parasites

The following studies have been reported.

1. Investigations on the sea louse (Lepeophtheirus salmonis): vaccine development using recombinant DNA. **(C)**

2. Investigations on Gyrodactylus salaris:
   (i) susceptibility of Scottish salmon stocks,
   (ii) diagnostic methods,
   (iii) genetics of G. salaris. **(C)**

3. A number of investigations into the biology of the sea louse (L. salmonis) and treatment of infestations are being undertaken. **(D)**

4. Investigations into the development, life cycle and population dynamics of Sphaerospora species. **(D)**

5. A study into the systematics of trichodinids of salmon. **(D)**

6. A study into the systematics of gyrodactylid monogeneans of salmonids using novel taxonomic techniques. **(D)**

7. A study into the taxonomy and life cycles of the strigend digeneans of salmonids. **(D)**

Physiology

The following studies have been reported.

1. A study into the patterns of food intake and growth in salmon in their first year in the sea was continued. Differences in efficiency of utilisation of food delivered under different feeding regimes have been examined. The effects of intermittent periods of starvation on compensatory growth and on control of maturation are being examined. **(A)**

2. An investigation into the starting time of gonadal development in salmon parr has been undertaken. A parr population was sampled on a monthly basis from October and gonad growth was found to start in November, implying a developmental switch relating to maturity which operates in the autumn. **(A)**

3. Studies into the how the muscle tissues of young salmon grow by hyperplasia and hypertrophy have been undertaken in collaboration with the Royal Veterinary Hospital, London. It is suggested that as there may be survival value in reaching the largest possible size before emergence, hypertrophy would be a more energy-efficient method of increasing body size rapidly than hyperplasia. **(A)**

4. The most reliable source of information about season for fish is the length of the day and its rate of change. An investigation into the seasonal and daily patterns of melatonin production in juvenile salmon has indicated the presence of a system responsive directly to changes in light intensity but not itself governed by a clear yearly rhythm. However, this system could still act as a neurohormonal transmitter of information about season. **(A)**

Predation

1. Studies continue on the feeding behaviour and potential impact on salmonid populations of piscivorous birds such as the goosander (Mergus merganser merganser), red-breasted merganser (Mergus serrator serrator) and cormorant (Phalacrocorax carbo) in Scottish rivers and estuaries and freshwater bodies. **(A & G)**

RAINBOW TROUT (Oncorhynchus mykiss)

Sea run rainbow trout occasionally turn up in salmon fisheries in Scotland but there is no directed commercial fishery for this species. Those fish which appear in catches at salmon fisheries are rare and are assumed to be fish which have escaped from fish farms or put-and-take sport fisheries and which have subsequently migrated to sea. Most research activities are therefore directed at aquaculture interests.

The following research activities have been reported.

Aquaculture broodstock

1. Photoperiod and egg production. **(D)**

2. Egg quality determinants. **(D)**

3. Control of fecundity and egg size. **(D)**

Aquaculture production

1. Environmental effects of waste output from cage culture. **(D)**

2. Waste production from land-based freshwater fish farms. **(D)**

3. All year round egg production. **(D)**

4. Evaluation of the use of remote sensing devices in aquaculture. **(D)**

5. Effects of formalin, malachite green and suspended solids on some respiratory parameters. **(D)**

6. A comparison of haemoglobin and haematocrit values at sea level and high altitude. **(D)**

Diseases

1. Research on lymphocyte heterogeneity using cryopreservation. **(D)**

2. Epidemiology of erythrocytic inclusion body syndrome (EIBS) and its effects on immune systems. **(D)**

3. Monoclonal antibody research for proliferative kidney disease. **(D)**

4. Epidemiology and control of rainbow trout fry anaemia syndrome. **(D)**

5. Development of a vaccine for Bacterial Kidney Disease caused by R. salmoninarum. **(D)**

Nutrition

1. Energy intake, food intake and performance. **(D)**

2. Digestible crude protein to digestible energy ratios, nutrient dense diets and performance. **(D)**

3. The use of non-conventional foodstuffs. **(D)**

SEA TROUT & BROWN TROUT (Salmo trutta)

The Fisheries

During 1992, the numbers of sea trout reported caught by rod-and-line, net-and-coble and fixed engine were 34315, 19921 and 10258 respectively, giving a total reported catch of 64494 weighing 72.0 tonnes. The fixed engine catch, in numbers, represented a 57% increase on the 1991 figure (58% increase by weight). The numbers of sea trout reported caught by rod-and-line increased by 25% on the 1991 figure (34% increase by weight), and the net-and-coble catch was up by 24% by numbers and 27% by weight on the 1991 figure. Concern has been expressed over the decrease in catches of sea trout in recent years, especially in parts of north-west Scotland. (A)

There is no commercial fishery for brown trout (resident trout) in Scotland. There is a widespread and important recreational fishery for brown trout in lochs and rivers throughout Scotland.

New Management Measures

In Scotland, regulations which apply to salmon also apply to sea trout but not to resident "brown" trout, fisheries for this species being regulated separately.

Investigations

In many of the research activities described for Atlantic salmon, data on trout are collected as a matter of course. Thus, investigations into the effects of acid precipitation and juvenile salmonid population surveys provide information relevant to both salmon and trout. When surveys of juvenile trout populations are undertaken, it is not possible to partition the catches into anadromous and resident components. In many river systems, both resident brown trout and sea trout may contribute to the spawning populations.

A number of investigations into the biology of sea trout have been reported.

Diseases

1. As a result of widespread concern about the poor catches and low perceived abundance of sea trout in west and north-west Scotland, a number of investigations are underway into the incidence of disease in sea trout. Samples of post-smolt sea trout have been collected in sea lochs and estuaries. (A & C)

2. Tank and sea cage experiments are being undertaken to examine the pathology of sea trout exposed to known levels of disease and parasites. (A & C)

Fisheries studies

1. Surveys of sea trout caught by rod-and-line in the River Ewe, where catches have declined, and in the River Hope, where no decline has been recorded, have continued. Both of these rivers are located in north-west Scotland. **(A)**

2. Studies into fisheries enhancement methods are being undertaken. **(D)**

Genetics

1. The genetic make-ups of trout populations isolated since the end of the last glacial period above waterfalls have been compared with those of trout populations in streams with open access to the sea. Two techniques were used, allozyme electrophoresis and "fingerprinting" of minisatellite DNA. In the allozyme electrophoresis analysis, there was no evidence of extensive genetic structuring of populations in streams with open access to each other but major differences were observed above and below impassable falls. The populations above falls showed less genetic variation due to the apparent tendency of one variant gene type to become dominant. Similar results were obtained with the "minisatellite DNA fingerprinting". In streams with open access to the sea, there were high levels of variation but populations above impassable falls displayed high levels of dominance of variants rare elsewhere. These studies have been undertaken in collaboration with The Queen's University, Belfast. **(A)**

Juvenile studies

As described above, studies on trout population tend to run concurrently with studies on salmon populations. A number of specific research activities was reported.

1. A study into the effects of feeding regime on the development of sea trout progeny has shown that improved feeding of juvenile trout leads to maturation in freshwater and reduced smolt migration. This leads to an increase in the number of sea trout progeny which remain in freshwater as resident brown trout. **(A)**

2. Juvenile surveys have been undertaken in a number of rivers in north-west Scotland where varying degrees of decline in sea trout catches have been noted. These rivers include the Hope, Ewe, Gruinard, Shiel, Shieldaig, Echaig, Ailort and rivers in the Fyne District. **(A)**

3. Investigations have been carried out into feed levels and early development. **(D)**

4. Investigations into environmental effects on smolting rates. **(D)**

CONTRIBUTING INSTITUTES

(A) The Scottish Office Agriculture
and Fisheries Department (SOAFD)
Freshwater Fisheries Laboratory
Faskally, Pitlochry,
Perthshire PH16 5LB

(B) The West Galloway Fisheries Trust
The White House
18 Main Street
Kirkcowan, Newton Stewart
Wigtownshire DG8 0HG

(C) SOAFD, Marine Laboratory
PO Box 101
Victoria Road
Aberdeen, AB9 8DB

(D) Institute of Aquaculture
University of Stirling
Stirling FK9 4LA

(E) Spey District Fishery Board
Fishery Biologist
5 Mannachie Rise
Forres
Moray IV36 0UG

(F) The Tweed Foundation
The Fish Conservancy Centre
Drygrange by Melrose
Roxburghshire TD6 9DJ

(G) Institute of Terrestrial Ecology
Banchory Research Station
Hill of Brathens
Glassel, Banchory,
Kincardineshire AB3 4BY

UNITED STATES OF AMERICA

(J.L. Ludke)

ATLANTIC SALMON (Salmo salar)

The Fisheries

Harvest

There is no directed commercial harvest in U.S. waters, and no sport harvest permitted except on rivers within the state of Maine. The documented sport catch of Atlantic salmon in Maine during 1993 was 654 fish (147 killed, 507 released). The catch represents an increase of 9 percent from the 1992 catch, but a 54 percent decline from the 1990 catch. A reduction in the limit to one salmon per season and changing attitudes among anglers has accounted for an annual increase in released fish. The released portion of the catch increased this year to 78 percent, compared to 68 percent last year.

Exploitation rates in Maine rivers continue to be quite variable (0-11 percent), but over all continue to decline. The exploitation rate this year for the Penobscot River was 7 percent for both wild and hatchery fish, based upon the documented rod and trap catches.

Abundance

Known Atlantic salmon returns to U.S. rivers in 1993, based on rod and trap catches, totaled only 2602 fish. This figure is roughly 29 percent less than recorded in 1992. Major decreases in returns from those recorded in 1992 occurred in the Merrimack and Connecticut Rivers. Overall, adult returns to most other rivers declined or remained relatively unchanged when compared to 1992. Runs in Maine's seven wild rivers were very low. Redd counts conducted on these rivers were the lowest ever recorded.

Artificial Propagation

This year approximately 9.3 million juvenile Atlantic salmon were released into 10 rivers in New England. This total exceeds the number of juveniles released last year by 27 percent. Of the various life stages released, fry comprised 80 percent, compared to 68 percent in 1992, and 50 percent in 1990. Smolt numbers released were similar to recent years at approximately 1.1 million.

The total egg take in New England for 1993 was nearly 21 million. This was approximately 6 million greater than the previous high of 15 million taken in 1991. This was a direct result of an expanded domestic broodstock program. The sources of this year's eggs included 3.3 million from sea-run stock, 15.8 million from hatchery-reared broodstock, and 1.8 million from rejuvenated kelts.

Tags for 1993

Nearly 60 percent of all smolts (616,500) and 5 percent of the 1 parr (3,300) released were marked with microtags (Table 1). Fish were tagged to address the contribution of salmon of U.S. origin to the ocean commercial fisheries and to carry out various research/management studies. In addition, 60,200 smolts were fin-clipped to conduct program specific studies.

A total of 366 two sea-winter salmon with microtags returned to New England rivers. The rates of return (number of two sea-winter salmon with microtags per 1,000 released with microtags two years earlier) varied among the three programs. The rate of return for fish entering the Penobscot River (1.6) was greater than the rate observed for salmon entering the Merrimack (0.23) and Connecticut (0.06) Rivers.

Aquaculture Production

The Atlantic salmon farming industry in Maine has tripled production since 1990 to 5.85 metric tons. Additionally, the industry harvested 270 metric tons of trout. The industry expects to continue expansion.

Investigations

Artificial Propagation

1. Kincaid, Harold
EVALUATE MONOSEX ATLANTIC SALMON POPULATION PRODUCED BY COMBINED GYNOGENESIS AND SEX REVERSAL.

A series of 19 gynogen families were produced from Penobscot sea-run salmon at the Craig Brook National Fish Hatchery in November 1992 and transported to the NBS Laboratory - Wellsboro for rearing. Pseudo-fertilization used lake trout milt denatured by 15 second exposure to UV-irradiation. Using a 28° C heat shock for 20 minutes starting 20 minutes post-fertilization, gynogen yield at hatch ranged from 0 to 30% (mean 6.3%). Isozyme analysis indicated that all surviving Atlantic salmon were gynogenetic diploid females. Families were divided into three groups at the sac-fry stage, with two groups treated with methyltestosterone to effect sex-reversal; one as a dip treatment at the sac-fry stage and the second as a feed treatment for 60 days started at first feeding. At 10 months, survival rate was similar among the gynogen and gynogen/sex-reversed groups. Attained weight of the gynogen/sex-reversed groups were 25% higher than the gynogen group. Efficiency of sex-reversal will be determined when the fish reach 15 months of age. **(B)**

Behavior

1. Hockett, Karen
RETENTION OF THE BIRD PREDATOR AVOIDANCE RESPONSE BY SALMON FRY.

Using a unique experimental design, hatchery fish were reared in environments containing cover, free of cover, and free of human distraction, then tested in a video-taped test chamber. Those fish that had access to some type of cover during hatchery rearing readily sought cover when confronted with bird predators. Those hatchery fish reared without cover did not have an avoidance response in the presence of a predator. This study has implications for the "training" of hatchery fish to utilize cover and reduce mortality when stocked in the wild. **(E)**

2. Seandel, Marco and Carol Folt
BEHAVIORAL TIME BUDGETS FOR 0+ SALMON IN THE WHITE RIVER, VERMONT.

Young-of-the-year salmon were located and observed for 20 minute periods, in the early morning (0800-1000), late morning (1000-1200) and the early afternoon (1200-1400). Behaviors such as benthic or drift feeding, resting, fighting etc. were noted throughout the observation period. Fish were monitored from two separate sites on the White river in late June, late July and late August. Samples of benthic and drift invertebrates together with data on the territory size, and other microhabitat descriptors (e.g. temp, cover, flow, depth) were collected for each individual fish or sampling date. The data are presently being analyzed. **(G)**

Genetics

1. Kincaid, Harold
GENETIC ANALYSIS OF ATLANTIC SALMON FROM MAINE RIVERS.

Isozyme analysis was completed on the 1992 samples from the Dennys, Machias, Narraguagus, Sheepscot, and Penobscot river stocks. Eleven of 55 loci screened were polymorphic using established starch gel procedures. Mean heterozygosity per locus was h = 0.016. The level of differentiation was Fst = 0.026. Significant differents were found between the Dennys stock and all others examined in the test. Evaluation of meristic and morphometric characteristics found small but significant differences among the five stocks. Results from both the isozyme and morphometric data indicated statistically significant differences among these stocks, but additional genetic and life history data is needed to determine if these differences are biologically significant. DNA analysis of the same 1992 samples being performed by University of Maine has not been completed. A new cooperative framework was established in 1993 for continuation of this work in 1994 by USFWS Region 5, Maine Sea-Run Salmon Commission, NBS Laboratory -Wellsboro, NBS Fish Health Research Laboratory, and NBS Ecology Laboratory-Leetown. **(B)**

Habitat

1. Moreau, D.A. and John Moring
REFINEMENT AND TESTING OF THE HABITAT SUITABILITY MODEL FOR ATLANTIC SALMON.

A study was completed that examined the selection of holding pools by adult salmon on their upstream migration. From extensive measurements made with salmon and pools in rivers of Maine and New Brunswick, a modification to the Habitat Suitability Index Model was developed and tested that identifies the key characteristics of holding pools. **(E)**

2. Nislow, Keith and Carol Folt
INFLUENCE OF HABITAT REMEDIATION ON MACROINVERTEBRATE HABITATS AND COMMUNITIES IN STREAMS OF THE GREEN MOUNTAIN NATIONAL FOREST.

The primary objective of the cooperative research effort with the US Forest Service is to evaluate the effect of stream habitat remediation on physical habitats and invertebrate communities, and the potential implication of these changes for ecosystem processes and fish habitat suitability during the May-October season. Two summer field seasons of data collection have been completed. **(G)**

Juvenile Studies

1. Folt, Carol and Donna Parrish
ANALYSIS OF FOOD AVAILABILITY FOR ATLANTIC SALMON FRY.

The primary objective of this research project is to evaluate food availability for and feeding preferences of age-0 Atlantic salmon introduced into the West and White rivers, VT., during the period from May through August. Sites include both high and low survival sites as identified in conjunction with State and Federal fisheries biologists. Anticipated completion date: February 1994. **(G & F)**

2. Parrish, Donna and Carol Folt
AN EVALUATION OF HABITAT QUALITY FOR AGE-0 ATLANTIC SALMON IN THE WHITE AND WEST RIVERS, VERMONT.

This research program is designed to evaluate habitat quality for age-0 Atlantic salmon, and to relate those data to patterns of salmon survival. It is a companion project to (#1 above) and uses habitat data collected at the same sites and times and the data on food availability and fish gut contents. In Addition, microhabitat data for each individual fish are recorded and related to variables such as body size and gut content weight. **(F & G)**

3. Parrish, Donna and Carol Folt
PREY SELECTION OF AGE-0 ATLANTIC SALMON IN THE WHITE AND WEST RIVERS, VERMONT.

In Spring 1992, age-0 Atlantic salmon were collected (N=195) from six sites on the West and White rivers. Prey selectivities were determined by using the invertebrate data collected in (#1 above). Stomachs of salmon from West

River sites generally contained as much or more food than stomachs from the White river. In general, fish were highly selective, foraging on a small subset of invertebrates. Low diversity of taxonomic groups in the diet emphasized the selectivity of the salmon. But, diets of fish in the West river appeared more diverse than diets of fish from the White river and the density of invertebrate groups found most often in fish stomachs was significantly greater in the West than in the White river. The results indicate that types and amounts of food available may influence age-0 salmon survival. **(F & G)**

Nutrition

1. Fynn - Aikins, K.
ATLANTIC SALMON CARBOHYDRATE STUDIES.

Analysis of the carbohydrate study done last year has been completed. The results suggest that digestible carbohydrates can be utilized well by salmon. In addition, results show that the dietary protein level (53%) in the commercial feed that is routinely used in Federal fish hatcheries may be too high. Salmon fed the digestible carbohydrate diets, with 42% dietary protein grew as well as those fed ASD2-30. **(C)**

2. Ketola, George
REQUIREMENTS OF ATLANTIC SALMON FOR DIETARY PHOSPHORUS.

Two experiments were conducted using small and large Atlantic salmon *Salmo salar* (initial mean weights 8.4 and 46 g) fed a common basal diet with and without graded levels of supplemental phosphorus (P) as defluorinated rock phosphate. Feeding salmon the basal diet containing 0.22% non-phytin P, significantly reduced their growth rate, feed efficiency, and bone ash content. The requirement of non-phytin P by Atlantic salmon for maximum growth and feed efficiency was no more than 0.42% and 0.52% for small and large fish respectively. The minimum requirement for maximum bone ash development was no more than about 0.52% non-phytin P for both small and large salmon. These results show that the minimum requirement of salmon for non-phytin phosphorus is about 0.52% of diet. **(C)**

Physiology

1. McCormick, S.D., B. Th. Bjornsson, M. Sheridan, J.B. Carey, and M. O'Dea
INCREASED DAYLENGTH ADVANCES SMOLTING: STIMULATION OF PLASMA GROWTH HORMONE AND GILL Na^+, K^+ - ATPase IN ATLANTIC SALMON.

Atlantic salmon juveniles reared at constant temperature (9-10 °C) were exposed to 4 photoperiod treatments and sampled every two weeks from January through May. Fish reared under normal photoperiod (LDN) exhibited 6- and 3-fold increases in plasma growth hormone and gill Na^+, K^+ -ATPase activity, respectively, between January and April. Fish exposed to abrupt increases in

daylength (LD 15:9) in February or March responded with earlier increases in plasma growth hormone and gill Na^+, K^+ ATPase activity, and earlier decreases in condition factor relative to fish in the LDN group. Fish maintained under short daylength (LD 9:15) from January to May exhibited delayed and muted increases in plasma growth hormone and gill Na^+, K^+ -ATPase activity. The results indicate that plasma growth hormone is responsive to increased daylength and may be causal to increased gill Na^+, K^+ -ATPase. Increased daylength in spring may be used to advance gill Na^+, K^+ -ATPase activity and salinity tolerance during the parr-smolt transformation of Atlantic salmon. **(D)**

2. McCormick, S.D., J.B. Carey and M. O'Dea)
EFFECT OF INCREASED DAYLENGTH ON THE PARR-SMOLT TRANSFORMATION AT WHITE RIVER NATIONAL FISH HATCHERY.

Three hatchery ponds (22,500 fish) were subjected to an hourly increase in daylength per week beginning Feb. 5 and reaching maximum daylength (15:9) on March 3. Photoperiod-treated and control fish were released on March 22, and the effect of photoperiod on subsequent returns will be examined. No significant effect of photoperiod on gill Na^+, K^+ -ATPase activity throughout the spring, or on salinity tolerance in March, was detected. A similar photoperiod treatment at Kensington Hatchery, CT, which uses warmer rearing temperatures, resulted in significant advances in gill Na^+, K^+ -ATPase activity. These results suggest that low temperatures may limit the ability of photoperiod to advance the parr-smolt transformation. Studies this year will 1) use controlled laboratory conditions to test the hypothesis that low temperture limits photoperiod treatments, and 2) use greater light intensities and earlier onset of long days at the hatchery to increase the efficacy of photoperiod treatment. **(D)**

3. McCormick, S.D.
PHYSIOLOGICAL STUDIES OF ATLANTIC SALMON RELEASED INTO SEA CAGE AT THE MOUTH OF THE CONNECTICUT RIVER.

Atlantic salmon smolts (22,500) reared at White River National Fish Hatchery were released into a sea cage moored 1 km from the mouth of the Connecticut River on March 23, and released 9 days later. Return rates from these fish will be compared to control groups released at the same time upstream in the Connecticut River. Salinity was high for the first 4 days (5-28 ppt), but decreased thereafter (0-4 ppt), coincident with increasing rainfall. Temperatures remained between 5 and 8 °C. Fish were highly stressed (elevated plasma cortisol and glucose) immediately after stocking, but returned to basal levels within 5 days and remained low thereafter. Salinity tolerance, measured by survival in a 40 ppt seawater challenge, was initially low and increased throughout the 9 days of sea cage residence. Increased salinity tolerance may have resulted from a combination of recovery from transport stress and exposure to seawater. **(D)**

4. McCormick, S.D.
LOSS OF SMOLT CHARACTERISTICS IN LABORATORY AND STREAM-REARED ATLANTIC SALMON.

One of the strategies for restoration of Atlantic salmon to the Connecticut River involves hatchery spawning of returning adults and planting of progeny into tributaries as recently-hatched fry. These stream-reared fish were examined for changes in smolt characteristics during their normal downstream migration 2-3 years after release. Gill Na^+, K^+ -ATPase activity and salinity tolerance were high at the beginning of migration in early May. Decreases in salinity tolerance were observed by May 14, and decreases in gill Na^+, K^+ -ATPase activity were observed by May 21. Fish reared in the laboratory in river water (with temperatures up to 16 °C in mid-May) had more rapid decreases in gill Na^+ K^+ -AtPase activity and salinity tolerance than fish maintained at a constant 10 °C. Loss of smolt characteristics in stream-reared fish may relate to the exceptionally warm spring and/or the impact of delays imposed by dams. **(D)**

Predation

1. Blackwell, Brad
PREDATION ON ATLANTIC SALMON SMOLTS IN THE PENOBSCOT RIVER BY DOUBLE-CRESTED CORMORANTS.

This was the second of a three-year study which addresses the extent of predation on Atlantic salmon hatchery smolts by cormorants in the Penobscot River and estuary. One objective is to estimate the number of smolts consumed each year by cormorants within the river. Other objectives include movements of cormorants, feeding, and flight behavior. Anticipated completion date: December 1994. **(E)**

2. van den Ende, Oliver
PREDATION ON ATLANTIC SALMON SMOLTS BY SMALLMOUTH BASS AND CHAIN PICKEREL IN THE PENOBSCOT RIVER, MAINE.

This study examined the role of fish predators in the mortality of downstream-migrating salmon smolts in the Penobscot River. Mr. van den Ende completed a Master of Science thesis using field data (stomach analyses), laboratory studies of the food consumption at various water temperatures, and a bioenergetics model to estimate potential impacts of predation by smallmouth bass and chain pickerel. Although the estimates have broad confidence ranges, this was the first attempt at estimating total mortality from freshwater fishes. **(E)**

3. Schulze, M.
ESTIMATING THE IMPACT OF STRIPED BASS ON THE SURVIVAL AND DISTRIBUTION OF JUVENILE ANADROMOUS FISH IN THE LOWER CONNECTICUT RIVER.

The first field season of this two year study has been completed. Striped bass were collected using gillnets, angling and electroshocking. Stomach contents are presently being analyzed. The objectives of this study are: 1) use field surveys to quantify abundance and size distribution of striped bass in the lower Connecticut river; 2) evaluate diet of large striped bass (>300mm); 3) evaluate how striped bass distribution, behavior, and diet changes through time (March-November); 4) evaluate diel pattern of striped bass distribution and foraging behavior in spring, summer, and fall; 5) determine if overlap exists in microhabitat use by (a) striped bass and salmon smolts in the spring and (b) striped bass and juvenile clupeids in the fall; 6) and adapt the generalized bioenergetics model of fish growth for striped bass in the lower Connecticut river and use this model to estimate striped bass consumption of juvenile salmon and clupeids. **(D)**

Stock Assessment

1. Friedland, Kevin
RUN RECONSTRUCTION MODEL FOR THE NORTH AMERICAN MULTI-SEAWINTER STOCK.

A run reconstruction model for the North American multi-seawinter stock component was developed. The model estimates fishery area fishing mortality in commercial gill-net fisheries in Canada and Greenland and provides estimates of total salmon stock abundance in the region. **(A)**

2. Friedland, Kevin
RISK ASSESSMENT OF CATCH ADVICE FOR THE WEST GREENLAND SALMON FISHERY.

A risk assessment of catch advice for the West Greenland salmon fishery was investigated. Post-smolt survival and salmon abundance was estimated using exponential smoothing and regression forecasts. The statistical properties of these forecasts were evaluated using Monte Carlo simulation. **(A)**

Stock Identification

1. Friedland, Kevin
STOCK IDENTIFICATION MODEL TO SEPARATE WILD AND HUSBANDRY ORIGIN SALMON.

A stock identification model to separate wild and husbandry origin salmon in mixed stock catches was developed. The model uses input data derived from scale morphology. Using image processing techniques, circuli spacing patterns and Fourier descriptors of scale texture are determined for each scale.

(A)

2. Friedland, Kevin
STOCK IDENTIFICATION MODEL TO IDENTIFY NORTH AMERICAN AND EUROPEAN ORIGIN SALMON.

A stock identification model to identify North American and European origin salmon in mixed stock fisheries was developed. The model uses Fourier shape descriptors of otolith outline shape to identify samples to their respective stock complexes. **(A)**

Survival

1. Friedland, Kevin
POST-SMOLT SURVIVAL OF NORTH AMERICAN AND EUROPEAN ATLANTIC SALMON.

Post-smolt survival of North American and European Atlantic salmon was investigated. Survival of North American stocks is affected by the areal extent of over-wintering habitat in the northwest Atlantic Ocean. A related mechanism was observed for European stocks; however, the effect appears to occur during the spring period. **(A)**

Tagging and Marking

1. Friedland, Kevin
CODED WIRE TAG RECOVERY IN THE 1993 DISTANT WATER FISHERIES.

The commercial salmon fishery in Canada was scanned for coded wire microtags of U.S. and Canadian origin. Approximately 10,000 salmon were examined in four locations in Labrador, and a total of 9 tags were recovered. Of these tags, seven were from the Connecticut River, U.S., and two were from the St. John River, Canada. There was no commercial fishery in Greenland during 1993, and none of the local catches were scanned. It is interesting to note the occurrence of Connecticut River origin salmon in the Canadian fishing zone. In previous years, it was observed that Connecticut River salmon tended to occur in higher frequency in Canada than in Greenland. This suggests different migration patterns for discreet U.S. salmon stocks. The statistical significance of these tag return patterns have not been tested. **(A)**

ATLANTIC SALMON MARKING DATABASE FOR NEW ENGLAND – 1993.

MARKING AGENCY	AGE	LIFE STAG	H/W	STOCK ORIGIN	TAG TYPE	NUMBER MARKED	CODE OR SERIAL	AUX CLIP	REL DATE	PLACE OF RELEASE	COMMENT
USFWS	1	smolt	H	Connecticut	CWT	22000	7/18/63	AD	3/93	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	22000	7/19/01	AD	3/93	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	22200	7/19/26	AD	3/93	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	22400	7/19/27	AD	4/93	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	22200	7/19/28	AD	4/93	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	21900	7/19/29	AD	4/93	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	21900	7/19/30	AD	3/93	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	22000	7/19/31	AD	3/93	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	21800	7/19/32	AD	3/93	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	21900	7/19/33	AD	4/93	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	22700	7/19/34	AD	4/93	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	11000	7/19/36	AD	3/93	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	9500	7/19/37	AD	3/93	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	19800	7/19/41	AD	4/93	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	12400	7/19/43	AD	4/93	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	16900	7/19/44	AD	4/93	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	21600	7/19/53	AD	4/93	Connecticut R.	
USFWS	1	smolt	H	Connecticut	CWT	23200	7/19/54	AD	4/93	Connecticut R.	
SUBTOTAL (SMOLT)						357400					
USFWS	1	parr	H	Connecticut	CWT	100	7/18/63	AD	3/93	Connecticut R.	
USFWS	1	parr	H	Connecticut	CWT	200	7/19/26	AD	3/93	Connecticut R.	
USFWS	1	parr	H	Connecticut	CWT	100	7/18/63	AD	3/93	Connecticut R.	
USFWS	1	parr	H	Connecticut	CWT	400	7/18/43	AD	4/93	Connecticut R.	
USFWS	1	parr	H	Connecticut	CWT	100	7/19/29	AD	4/93	Connecticut R.	
USFWS	1	parr	H	Connecticut	CWT	2200	7/19/41	AD	4/93	Connecticut R.	
SUBTOTAL (PARR)						3100					
TOTAL – CWT, CONNECTICUT RIVER						360500	99.0% (356,900) of smolts and parr retained CWT				
USFWS	1	smolt	H	Merrimack	CWT	10854	7/19/45	AD	4/93	Merrimack R.	
USFWS	1	smolt	H	Merrimack	CWT	18299	7/19/45	AD	4/93	Merrimack R.	
							7/19/46				
USFWS	1	smolt	H	Merrimack	CWT	8345	7/19/45	AD	4/93	Merrimack R.	
							7/19/46				
							7/19/47				
USFWS	1	smolt	H	Merrimack	CWT	8208	7/19/14	AD	4/93	Merrimack R.	
							7/19/45				
							7/19/46				
USFWS	1	smolt	H	Merrimack	CWT	2119	7/19/38	AD	4/93	Merrimack R.	
USFWS	1	smolt	H	Merrimack	CWT	5995	7/19/38	AD	5/93	Merrimack R.	
USFWS	1	smolt	H	Merrimack	CWT	5166	7/19/38	AD	5/93	Merrimack R.	
TOTAL – CWT, MERRIMACK RIVER						58986	92.6% (54,621) of smolts retained CWT				

ATLANTIC SALMON MARKING DATABASE FOR NEW ENGLAND – 1993.

MARKING AGENCY	AGE	LIFE STAG	H/W	STOCK ORIGIN	TAG TYPE	NUMBER MARKED	CODE OR SERIAL	AUX CLIP	REL DATE	PLACE OF RELEASE	COMMENT
USFWS	1	smolt	H	Penobscot	CWT	20666	7/18/30	AD	4/93	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	27502	7/18/42	AD	4-5/93	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	16978	7/18/43	AD	5/93	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	26217	7/18/44	AD	5/93	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	8901	7/18/62	AD	5/93	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	22378	7/19/49	AD	5/93	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	26471	7/19/50	AD	5/93	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	24738	7/19/51	AD	4/93	Penobscot R.	
USFWS	1	smolt	H	Penobscot	CWT	25993	7/19/52	AD	4/93	Penobscot R.	
TOTAL – CWT, PENOBSCOT RIVER						199844	98.3% (196,444) of smolts retained CWT				
ASRSC	0	parr	W	Narraguagus	CWT		Sequential	AD		Narraguagus R.	
ASRSC	1	parr	W	Narraguagus	CWT		498 – 5034	AD		Narraguagus R.	
TOTAL – CWT, NARRAGUAGUS RIVER						1840					
GNP	1	smolt	H	Penobscot	CARLIN	186	900000		5/93	Penobscot R.	Green
							900200				
TOTAL – CARLIN TAGS PENOBSCOT RIVER						186					
GNP	4+	kelt	W	Penobscot	FLOY	69	9286-9399		5/93	Penobscot R.	Orange
GNP	4+	kelt	W	Penobscot	FLOY	13	9401-9435		9/93	Penobscot R.	Orange
TOTAL – FLOY & STREAMERS						82					
USFWS	1	smolt	H	Penobscot		20032		AD	4/93	St. Croix R.	Not Coded-Wire-Tagged
USFWS	1	smolt	H	Penobscot		10039		LV	5/93	St. Croix R.	
USFWS	1	smolt	H	Penobscot		10034		RV	5/93	St. Croix R.	
USFWS	1	smolt	H	Penobscot		20053		LV	4/93	Saco R.	
TOTAL – FIN CLIPS						60158					

CONTRIBUTING INSTITUTES

(A) National Marine Fisheries Service
Northeast Fisheries Science Center
166 Water Street
Woods Hole, MA 02543-1097
Phone: 508-548-5123

(B) National Biological Survey
National Fishery Research & Develop. Lab.
R.D. # 4, Box 63
Wellsboro, PA 16901
Phone: 717-724-3322
Fax: 717-724-2525

(C) National Biological Survey
Tunison Laboratory of Fish Nutrition
3075 Gracie Road
Cortland, New York 13045-9357
Phone: 607-753-9391
Fax: 607-753-0259

(D) National Biological Survey
S.O. Conte Anadromous Fish Research Center
P.O. Box 796
One Migratory Way
Turners Falls, MA 01376
Phone: 413-863-9475
Fax: 413-863-9810

(E) University of Maine
Maine Cooperative Fish & Wildlife Research Unit
240 Nutting Hall
Orono, Maine 04469
Phone: 207-581-2582

(F) University of Vermont
Vermont Cooperative Fish & Wildlife Research Unit
School of Natural Resources
Aikens Center
Burlington, VT 05405
Phone: 802-656-4280

(G) Dartmouth College
Department of Biological Sciences
Gilman Hall
Hanover, New Hampshire 03755
Phone: 603-646-2378
Fax: 603-646-1347