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Report of Activities

ANADROMOUS AND CATADROMOUS FISH COMMITTEE

by

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1990

BELGIUM

(Ir. Rudy De Clerck)

No research was carried out.

CANADA

(D. G. Reddin)

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

The Fisheries

Commercial alewife and blueback herring fisheries using traps, gill-nets, or dip-nets are conducted on medium and large rivers in the Atlantic coastal and Bay of Fundy areas. Recent annual catches have fluctuated near historic lows; 1989 showed a substantial increase, but 1990 catches declined. Landings from 1985 to 1990 were 2,261, 1,198, 2,753, 3,657, 5,255, and 1,388 t, respectively. No new commercial licenses have been issued for several years and many existing licenses 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 t from a peak of 11,000 t in 1952; although the landings recorded in 1952 may have included harvests from other rivers. Stock assessments using sequential population analysis with known age structure since 1981 indicate that exploitation has been high and produced a 1990 catch of 1,789 t.

The Margaree gaspereau fishery harvests almost exclusively alewives. However, the product is of high quality because fish are salted immediately upon removal from the tip traps. Stock assessments again indicated high exploitation rates and a reduction in fishing effort was implemented through a one-day-a-week closure beginning in 1984. The 1987 year class contributed about 68% (by number) of the 1990 harvest of 1,016 t.

Investigations

Juvenile studies

1. In 1982, a continuing program was begun to relate an index of alewife and blueback herring juvenile abundance to adult escapements into the headpond of the Mactaquac Dam, Saint John River, New Brunswick. The index program ceased in 1989; the time series is short but it does have considerable contrast in the range of adult escapements. Preliminary results suggest no relationship. Resources have been reallocated to examine the timing of downstream migration. **(A)**

Stock assessments

2. Studies have continued on the relation between escapement and future returns of alewives and blueback herring at Mactaquac Dam, Saint John River, where biological parameter data are being collected on both species. A stock-recruitment relation has been developed and a report published. Participation began in a continuing study of the size and biological composition of the alewife run to the St. Croix River. **(A)**

3. The logbook system, expanded to the commercial alewife fisheries in the Scotia-Fundy Region in 1984, received only partial cooperation from fishermen in 1990, as in other years. Methods to ensure compliance in 1991 are being put in place. **(A)**

ATLANTIC SALMON (*Salmo salar*)

The Fisheries

In 1990, the nominal catch of Atlantic salmon in Canada in all fisheries was 870 t, a decrease of 269 t or 24% from 1989 landings and a decrease of 515 t or 37% from the average of the previous five years. For large salmon, the 1990 catch of 465 t was 234 t or 33% below the 5-year average; while for small salmon the 1990 catch of 505 t was 181 t or 26% below the 5-year average.

New Management Measures

A Canadian comprehensive five-year Atlantic salmon management plan was instituted in 1984, tentatively renewed for 1989, and re-implemented for 1990-1994. All versions of the plan prohibited commercial salmon fishing in the Maritime Provinces. Recreational landings were restricted to 1SW (<63 cm) Atlantic salmon (grilse), and regional seasonal creel limits remained at ten (10) fish for the sixth consecutive year.

The management plan for Atlantic salmon in the Gulf Region in 1990 was similar to the five year plan to conserve stocks which was initiated in 1984. Major restrictions on harvest included: the closure of commercial fisheries in New Brunswick, Nova Scotia, Prince Edward Island, and area J2 in southeast Newfoundland; imposition of quotas in SFA's 13 and 14; mandatory release of MSW salmon by anglers in all areas; and landing of salmon from non-salmon fishing (by-catch) was prohibited.

In the Newfoundland Region, a major change was introduced in the management of the commercial fishery in 1990. Quotas were introduced for the first time in all salmon fishing areas except northern Labrador. The overall quota was 662 t including an allowance of 80 t for SFA 1 in northern Labrador. Also commercial fishing in certain estuaries was moved further seaward to increase spawning escapement in specific rivers. The numbers of commercial fishermen and gear units in 1990 decreased from 1989 in both insular Newfoundland and Labrador. Recreational fishing regulations remained unchanged in 1990.

Abundance

Preliminary recreational catch estimates for 1990 in the Scotia Fundy Region indicate a retained grilse harvest of 10,500 fish. This number is less than the regional harvest of 11,600 grilse in 1989, but is close to the six-year (1984-89) mean catch of grilse (10,800 fish). Additionally, anglers in Scotia-Fundy hooked and released for spawning an estimated 5,200 multi-sea winter salmon and grilse.

In Gulf shore areas of New Brunswick, returns of 1SW and MSW salmon were average or below average in 1990. In the Restigouche River, returns of MSW and 1SW salmon were below the previous five-year average. In contrast, in Miramichi River returns of MSW and 1SW salmon were average. Landing of 1SW by anglers were below average in both rivers.

In Gulf shore Prince Edward Island and Nova Scotia, 1SW salmon returns were below, but MSW salmon returns were above average. In western Newfoundland adult salmon escapements in 1990 at Western Arm were below average, but Torrent River was average. Recreational landings of 1SW and MSW salmon in 1990 were average, while commercial landings of small salmon and large salmon were below average mostly because of quota restrictions.

In Labrador, the commercial fishery lasted the entire season without the quotas having been taken. The catch of small salmon was among the lowest on record, while that of large salmon was the lowest. In insular Newfoundland, the fishery lasted the entire season in 3 areas without the quota being taken. Cumulative catches of small and large salmon to closing dates in 1990 were below the average for 1984-89 in nearly all areas.

Recreational catches of grilse and large salmon in Labrador in 1990 were below 1989 and the long-term and short-term means. In insular Newfoundland, the catch of grilse increased over 1989 but was below the 1974-83 and 1984-89 means. In 1989, grilse catch was approximately one-half of average catch.

Investigations

Aquaculture broodstock

1. Present support to the aquaculture industry is for broodstock development and research purposes. Smolts (30,000) which are progeny of wild adult salmon that return to the River Philip and LaHave River in Nova Scotia and the Saint John River in New Brunswick are produced at the Mersey Fish

Culture Station (FCS) and supplied to four marine salmon farms in Nova Scotia for broodstock development purposes each year during a four year program. (A)

2. Thirty thousand Saint John River smolts are presently being produced at the Saint John FCS for broodstock development purposes within the New Brunswick industry. Performance of these smolts while in marine cages will be assessed as part of the Atlantic Salmon Federation's Salmon Genetics Research Program. The Saint John FCS also produces from 15,000 to 25,000 smolts per year for research at the Atlantic Salmon Demonstration and Development Farm, which is operated by the New Brunswick Salmon Growers Association. (A & E)

Artificial propagation

3. Atlantic salmon production and distribution from the Scotia-Fundy Region's six hatcheries during 1990 was 1,647,000 fry and parr and 835,000 one and two-year-old smolts. Most of the production was released into rivers in support of the public fisheries management plan, but 56,000 salmon smolts were sold to the aquaculture industry. The 20 different salmon stocks which were cultured in the Region's hatcheries were distributed to 28 different river systems. (A)

Ecosystems

4. The data collected in the experimental rivers in Newfoundland on production of salmonids related to types of habitat have proved to be very valuable for describing productive capacity of salmon habitat. The most important variables controlling juvenile salmon production have been identified and preliminary models have been devised. The major variables were found to be: mean stream width, type of substrate, total phosphates, total nitrates, total pool length, alkalinity and range of discharge. (F)

Environment

5. In insular Newfoundland and Labrador, the general aims of environmental studies are to determine the susceptibility of fresh waters and associated fisheries resources to the Long Range Transport of Atmospheric Pollutants (LRTAP) and the impact of acid rain on these resources. A long-term monitoring program on lakes and rivers in insular Newfoundland, including sampling of chemistry, benthos, plankton, and fish is used to focus on seasonal dynamics and episodic problems. Selected systems are monitored during peaks in the hydrological cycle to document timing, extent and duration of episodic acidification. (F)

6. In Newfoundland, biomonitoring is conducted on three river systems: the Experimental Ponds Area on the Northwest Gander River, Stevenson's Pond on Grandy Brook, and Harding Pond on the Upper Humber River, Gros Morne National Park. The monitoring program includes on-site inspections and detailed documentation of methods. (F)

7. In Nova Scotia, invertebrate and fish communities are being monitored and toxicity bioassays conducted in acidified and threatened rivers and lakes to detect long-term trends relating to anticipated changes in acid

deposition. Macrobenthos samples are collected three times (spring, summer and fall) at five river sites and two times (spring and fall) at three lake sites. Fish samples are collected from three lakes (trap nets) and nine rivers (electrofishing). The 1990 caged fish bioassay was centered on southwestern Nova Scotia. Hatchery-reared parr (<1 yr. old) are exposed in cages for 60 days during the fall pH decline (Nov.-Dec). This year, bioassays were conducted on 8 rivers. The mean ambient pH's and LT50's were:

River	pH	LT50 (days)
Jordan	4.3	6
Clyde	4.5	8
Roseway	4.5	9
Quinan	4.5	15
Tusket	4.4	17
Canaan	4.7	50
Carleton	5.9	No Mortality
East	6.2	No Mortality

(A)

8. A small (500 km²) drainage acid (pH 5.1) Nova Scotian Atlantic salmon river is being treated with limestone applied to four headwater lakes. The primary objective is to assess the feasibility of maintaining a deacidified refuge for the preservation of an Atlantic salmon strain threatened with extinction by the acidification of its habitat. 1990 was the fifth consecutive year of liming. The deacidified refuge and its controls are biologically and chemically monitored. Refuge pH's remained stable at near neutrality and parr numbers increased at all stations within the limed portion of the river, indicating colonization of empty deacidified habitat by one-year-old parr. Fry numbers are high only at the one site where remnant fish were known to spawn. Only the target species is showing a significant response to liming, e.g. brook trout are present in low numbers, but have shown no response to the liming. (A)

9. A project was begun to assess the potential of cryopreserving sperm of Atlantic salmon from populations threatened with extinction by the acidification of their native rivers. The use of cryopreserving technology would allow for the establishment of gene banks of these valuable genetic resources. After international agreements on emissions achieve a reversal of the acidifying process, the cryogenically preserved unique genetic resources of those waters currently impacted would be used to re-establish their native salmon populations. The objective of this year's study is to assess the degree to which freezability of sperm varied with genetic strain. The study will examine known genetic stocks (pedigreed) from the Atlantic Salmon Federation's Research Centre in St. Andrews, N. B. Frozen sperm from precocious parr will be assessed (in February/March) for motility, viability and fertility, to establish relationships. (A & E)

10. A new project is underway to develop a GIS based model of Atlantic salmon production relative to acid levels. This project will concentrate on the 60 Atlantic salmon rivers of the Nova Scotian Southern Upland, which are considered acidified. The level of acidification varies from river to

river and tributary to tributary. The project will model the distribution of habitat and water quality within each river system, and provide a river-specific Atlantic salmon production model. It will thus be possible to specify the proportion of the run available for harvest, and also to compute the pre-acidification productive potential. (A)

11. The development of a general stress test for juvenile Atlantic salmon based on corticosteroid hormone metabolism and in vitro techniques, similar to that used by DFO for adult salmon, was initiated in 1990 both in the field and in the laboratory. Stress hormone profiles and their variabilities and similarities in hatchery-reared, wild and caged (such as used in acid rain biomonitoring studies) parr and smolt from various river stocks in Nova Scotia are being investigated. (B)

12. A comprehensive study of the ecological and physiological responses of salmonids and other fish to toxic factors in acidic rivers of Scotia-Fundy and to temporal changes in chemistry is ongoing. Most recent findings include: the relationships among plasma electrolytes, gill Al content, and gill morphology in salmonids from acidic streams, an assessment of the long-term effectiveness of applying limestone gravel to the streambed in an acutely acidic stream to mitigate pH and enhance fish populations; determination that ambient concentrations of organic anions are important in moderating the rate and extent of Al uptake; and that Si has the potential to reduce or eliminate the toxicity of Al to fish in some acidified salmon rivers at times of low concentrations of organic anions. (C)

Fisheries studies

13. Canadian, Danish, and USA fishery personnel sampled 4,897 salmon for fork lengths and gutted weights at fish plants in Maniitsoq, Nuuk, and Paamiut, Greenland. Scale samples were taken from 1,208 of these salmon. Microtags were detected in 54 of the 6,394 salmon examined and several Carlin tags were recovered by the sampling crews. The proportion of the samples that were North American in origin was 75% in 1990; this is the highest proportion of North American salmon ever recorded at Greenland. The low proportion of European origin salmon of 25% corresponds well with the low returns of 1SW salmon in Ireland and Scotland from the same smolt class. (F)

Genetics

14. Smolt releases have been made from the Salmon Research Centre in St. Andrews, (Chamcook Harbour, Bay of Fundy) since 1976. Return rates in 1981 and 1982 were about 0.5 to 0.6%. Progeny from returning fish returned at rates of 0.06 and 0.13% in 1985 and 1986. Progeny from random matings of contemporaries of these fish, reared in sea cages, were made in 1985 and 1986. Return rates were 0.41 and 1.08. The results show a recovery in return rate after a generation of random mating. (E)

Habitat

15. The application of a dichotomous key, initially developed for lake trout in the Great Lakes, as a tool for assessing Atlantic salmon habitat production capability was determined. (D)

16. Functional drawings were completed for proposed improved fish collection facilities at the New Brunswick Electric Power Commission, Beechwood Hydroelectric Station on the Saint John River, N. B. The improvement consists of increasing the attraction water by pumping 126 CFS above the current 42 CFS. It is also proposed to replace orifices at the fish entrances with overflow slide gates which adjust automatically with varying tailwater elevations. (A)

17. A fishway was constructed to overcome the 14 foot high waterfall on the Sackville River, N. S., near Hefler's sawmill. It is a pool and weir fishway with 14 inch drops between pools. The fishway will be utilized by alewives, Atlantic salmon and brook trout. (A)

18. The detailed design of downstream migrant facilities and pumped attraction water to the fishways at the Woodland and Grand Falls Hydroelectric Stations on the St. Croix River, New Brunswick were completed. It is proposed to increase the attraction water of each fishway from 20 CFS to 60 CFS. The downstream migrant facility at each site will use 60 CFS with 40 CFS being pumped back to the headpond. The consultant, Klein Schmidt Associated who was retained by the owner, Georgia Pacific, completed their work under the direction of the St. Croix Steering Committee. (A)

19. A fishway was constructed to permit fish passage at the town of Amherst dam on the Nappan River. The fishway is of the pool and weir type with 12 inch drops between pools. The total head is 22 feet. (A)

20. The New Brunswick Electric Power Commission completed another phase of improvements to the Tobique River, New Brunswick fishway. This included the installation of an overflow slide gate which adjusts automatically with varying tailwater elevations and extended baffles to improve velocities in the lower end of the fishway. (A)

Juvenile studies

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

Restigouche River, New Brunswick	15 sites
Miramichi River, New Brunswick	15 sites
Western Arm Brook, Newfoundland	3 sites

Juvenile densities were used to identify spawning success and to identify potential enhancement areas (see enhancement). (G)

22. Smolt migrations were enumerated to estimate recruitment at 5 rivers: Black, New Brunswick; Hughes, Bound, Western Arm, and Western Brook, Newfoundland. (G)

23. A paper was presented at Canadian Conference for Fisheries Research on annual variation in scale characteristics of Atlantic salmon. (G)

24. 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. This involves increasing egg deposition until carrying capacity is reached. From these data a stock-recruitment relationship will be developed.

    The research is conducted on four river systems. A systematic approach has been taken to study the entire freshwater ecosystem in two of these streams. In a third river, adult salmon stocks are monitored and brood stock are removed for experimental stocking. A fourth river provides control stations for interaction studies with brook trout. An inventory of the 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 on one stream at approximately 600 eggs/100 m^2 and is fixed at 240 eggs/100 m^2 on another stream. Smolt and adult production from these depositions are being monitored.

    Salmon enumerated in Northeast Brook were 1,902 smolts, 21 kelts, and 80 adults; 1,657 adults were counted in Biscay Bay River. The egg-to-smolt survival for two year-classes, which resulted from egg deposition of about 6.0 eggs/m^2, were 0.6% and 0.5%. Emigrating salmonids were enumerated and measured at a counting fence on Freshwater River. This will be the first smolt output from an egg deposition of 2.4 eggs m^2. In total, 2,135 smolts, 316 parr, 49 kelt, and 8 brook trout were enumerated. Survival from eggs to smolts for one year with an egg deposition of about 5.6 eggs/m^2 was 0.7%, whereas, the survival from another year-class with an egg deposition of 2.4 eggs/m^2 was 1.0%. (F)

Migration patterns

25. About 1,031 adult 1SW salmon entering the Miramichi River were tagged (Carlin) in 1990. Recaptures from anglers and Native fishermen provided information on migration timing, exploitation rates and escapements. About 107 tags were returned by anglers during the 1990 season. (G)

26. About 1,000 smolts from Western Arm Brook, Newfoundland were tagged to determine sea migration routes. (G)

27. Carlin tags were applied to adult salmon captures in two estuarine trap nets on the Margaree River, Nova Scotia. Recaptures were used to estimate population size and exploitation rate. (G)

Physiology

28. Further research towards production of underyearling (0+) smolts resulted in smolt size fish by September. Exposure to winter photoperiod in summer followed by increasing day length resulted in smolt-like salinity tolerance and elevated gill Na^+-K^+ ATPase activity during October-November. Although smolt-like fish survived transfer to seawater, many

died when temperature fell to winter levels. Efforts will be made to accelerate early growth to smolt size before photoperiod manipulation begins. (C)

Stock assessment

29. Assessments of the status of stocks and evaluations of fisheries are conducted annually in Canada to provide scientific advice for effective and rational management of the salmon fisheries on a zone or river system basis. Assessments are conducted through analysis of trends in indicators of stock abundance, estimates of juvenile salmon population sizes, enumerating smolts and monitoring of spawning escapement at fish counting facilities in relation to required spawner biomass. Research is conducted on the biology and population dynamics of Atlantic salmon to improve the assessment models. (A to G)

30. An assessment of the Conne River, Newfoundland Atlantic salmon population and native food fishery was conducted in 1990 by monitoring downstream migration of smolts by a mark-recapture study, and enumerating adult migration at the counting fence on Conne River. Preliminary estimates of about 60,000 smolt have been calculated and are approximately 20% less than in 1989. Adult migrations were monitored from May 23 to August 6. A total of 4,321 small salmon and 361 large salmon were counted. While fence counts were down from 1989, total estimated returns were about 8% higher than the previous year. (F)

31. A general assessment of the status of Atlantic salmon stocks in Newfoundland was conducted based on changes in landings in the commercial and recreational fisheries as well as counts of salmon at fishways and counting fences. Commercial landings of large and small salmon in 1989 were similar to 1988; however, catches in both years were among the lowest on record. While commercial catches in some individual Salmon Fishing Areas increased over 1988, they still remained below long-term means in most cases. In the recreational fishery, the catch of grilse in insular Newfoundland was the lowest in the 1974-89 period. Recreational catches of large salmon and grilse in Labrador were lower than in 1988 but exceeded the means. There is some evidence that low marine survival could have contributed to low returns of small salmon in 1989. Also, it is hypothesized that drought conditions in 1987 could have been a factor in low returns in 1989 and could impact negatively in the next few years. (F)

32. A complete count of adults (8,021) was obtained from a fence on the Gander River, Newfoundland. An estimated 220 salmon were angled below the counting fence giving a total escapement of 8,241 adults. In 1990, a total of 19,792 smolts was counted at a release trap installed in the adult counting fence. This compares to 12,763 smolts in 1989. (F)

33. The 1990 Atlantic salmon management plan continued in the Saint John River, New Brunswick with existing harvest provisions since 1984, i.e., the commercial fishery remained closed and anglers faced mandatory release of all fish greater than 62.9 cm. Returns of wild and hatchery-return 1SW salmon in 1990 numbered about 8,800 fish (19% below the 1989 return and 16% below the 1975-1989 long-term average return). Multi-seawinter salmon

returns were 47% below the forecast value, resulting in a spawning run providing less than two-thirds the egg deposition target requirement. (A)

34. In the LaHave River, Nova Scotia removal restrictions in the management plan contributed to the 1990 returns to Morgan Falls (upper one-third of the river drainage) of 2,480 1SW and 510 MSW salmon. Hatchery stocks made up about 24% of the 1SW returns and about 22% of the MSW returns. Compared to the total 1989 returns, the 1990 1SW returns were decreased by 3%, while the 1990 salmon also decreased 25% from the prior year. Nevertheless, the spawning run was adequate to provide an egg deposition in excess of the target requirement. (A)

35. Salmon stocks of the inner Bay of Fundy are unique in that they are characterized by: maturing almost totally after the first winter at sea, restricting their marine migrations to the Bay of Fundy and Gulf of Maine, and normally having a significant number of annual repeat spawners in the river escapement. This life history pattern would seem to make these stocks vulnerable to stock depression when 1SW fish show poor recruitment in consecutive or clustered years, such as experienced in the last five years. Since juvenile salmon populations have not shown fluctuations comparable to those by the adults, it appears that abnormally high marine mortality is responsible for the depressed state of these unique stocks. (A)

36. Returns of Atlantic Salmon and other diadromous species were monitored at 21 index sites in the Gulf Region during 1990. 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)

37. An assessment was prepared for Atlantic Salmon in the Margaree River, Nova Scotia. Spawning escapements were exceeded in 1990, as for the last four years. (G)

38. An assessment was prepared for Atlantic salmon in Miramichi River, New Brunswick. In 1990, total returns were estimated to be about 119,000 salmon (132×10^6 eggs) which exceeded the target by 152%. The proportion of salmon that returned to Miramichi River late in the season was substantially greater than in recent years. Electrofishing surveys have indicated greater than average densities of juvenile Atlantic salmon since the inception of the 1984 management plan. Returns of 1SW salmon in 1990 suggest returns of MSW salmon in 1991 will be at least average. (G)

39. An assessment was prepared for Atlantic salmon in Restigouche River, New Brunswick. Total returns were estimated to be between 11,000 and 17,000 MSW and 10,000-16,000 1SW salmon. In 1990, between 55% and 100% of spawning requirements (71.6×10^6 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. (G)

Stock enhancement

40. A lacustrine rearing project is designed to evaluate the Atlantic salmon nursery potential of five insular Newfoundland lakes. As of 1990, 17 of the 40 juvenile releases required by the experimental design have been completed. Fall-fingerlings in support of these experiments were produced in floating lake cages. Swim-up fry were placed in these cages in June. Rearing performance in 1990 was acceptable. Smolts were counted as they emigrated from their lacustrine habitats in 1990. (F)

41. The Exploits River, located in the central Newfoundland area, is the largest river on the island with a drainage area of about 12,000 km² and an axial length of 237 km. Historically, anadromous Atlantic salmon penetrated the system only as far as Grand Falls. Since 1957, anadromous salmon were successfully introduced into Great Rattling Brook (a tributary of the lower Exploits) and into the tributaries of the middle Exploits between Grand Falls and Red Indian Lake dam. Prior to enhancement, the annual total production (before exploitation) was 2,500-3,000 adults; present annual total production is approximately 35,000 adults. The remaining inaccessible tributaries flowing into Red Indian Lake have the potential to produce an additional 65,000 adults annually. The goal of the Exploits River Project is to develop a self-sustaining run of Atlantic salmon in the Exploits River system of about 100,000 adults. (F)

Stock identification

42. The annual variation in scale characteristics of three Atlantic salmon stocks is being investigated. Stocks investigated include Western Arm Brook, Newfoundland and Restigouche and Miramichi Rivers, New Brunswick. (F)

Tagging and marking

43. The marking program for hatchery-reared juvenile Atlantic salmon included the tagging of 58,000 smolts with modified Carlin tags and removal of the adipose fin of 480,000 smolts and 402,000 0+ and 1+ parr. Fifty-five thousand of the clipped smolts were also marked with coded-wire-nose tags. (A)

Techniques

44. The Scotia-Fundy Region utilizes a Hewlett-Packard minicomputer and numerous microcomputers for data entry, storage and analysis. The microcomputers currently house four large data bases integral to operations: fish culture production and distribution, Atlantic salmon tag recoveries, Atlantic salmon and alewife harvests and a data base related to eastern North American fish species introductions and transfers. Two mainframe computers, a DEC-VAX and CDC-Cyber, receive limited use for various applications. (A)

45. The Scotia-Fundy Region's Salmon Assessment Unit is striving to improve methodologies for determining optimum freshwater production of salmon stocks through the use of remote-sensed habitat survey information and

juvenile indexing techniques. A model has been developed which utilizes standing populations of age 1+ parr over large areas, ortho-gradient-weighted areas of the rivers, and distance from tide head. Refinement of the model is continuing. (A)

46. A closed-circuit television fish counting system is being developed for use on Biscay Bay River, Newfoundland. An electronic motion detector was modified so that fish passing through the tunnel automatically switched a VHS recorder from standby to normal recording mode; this greatly reduced time required to examine the tapes. A new imaging system which creates silhouettes of fish passing through a tunnel is being developed to automatically count and size all migrating fish. (F)

EEL (Anguilla rostrata)

The Fisheries

Eels 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 are currently no assessments done on eel stocks. There appears to be an increasing demand for eels.

In the Scotia-Fundy Region, catches of eels in the early 1980s were near historic lows (17, 20 and 11 t in 1982 to 1984) but recently rose from 32 t in 1987 to 149 t in 1988 and 122 t in 1989 before declining to 66 t in 1990. The estuarial fishery developed in the mid-1980s in northeastern Nova Scotia has declined sharply in the past two years due to over harvesting.

An experimental fishery for elvers that operated in the Annapolis River, Nova Scotia area in 1989 continued in 1990 but with little success (less than 45 kg elvers caught). An experimental fishery in 1990 for elvers in several streams of the New Brunswick side of the lower Bay of Fundy was less successful than hoped, with less than 70 kg of elvers caught.

Investigations

Juvenile Studies

1. A three year study was begun in 1989 on the timing and relative abundance of elvers migrating to a river on the Atlantic coast of Nova Scotia. In an associated study, a second release of elvers was made into a fishless lake and a preliminary release made into a second lake with the objective of examining the otoliths of known-age recaptures to validate ageing procedures. No recaptures were made from the 1989 release; the possibility of poor over-winter survival is being examined. (A)

Competition

2. In Newfoundland, the effects of the eel fishery on mortality of salmon parr were investigated. Commercial eel traps were checked by the project

investigator, in September, in several rivers in Bonavista Bay and Notre Dame Bay. (F)

LAMPREY (Petromyzon marinus)

Investigations

Stock investigations

1. A survey of Terra Nova River, Newfoundland was conducted to establish the extent of the sea lamprey population. Lamprey ammocoetes were found along a several kilometer stretch of the Terra Nova River. Concentrations were highest in the area of Birchy Point, where adult spawning grounds were confirmed in 1989. Preliminary evaluation of data suggests that spawning was successful in 1990 and several year classes were present. Recently, metamorphosed sea lamprey were also caught. (F)

SMELT (Osmerus mordax)

The Fisheries

The smelt fishery in the southern Gulf of St. Lawrence is conducted during fall and winter. There were approximately 1,500 license holders in 1986, spread throughout the region, fishing smelt with gillnets, boxnets, bagnets and with spears. Recorded landings for the last ten years have averaged 1,600 tonnes. The fishery is currently regulated by season.

Investigations

Fisheries studies

1. A voluntary logbook program was continued in 1990 to provide data regarding the timing and catch in the smelt fishery of the Gulf Region. Concurrently, samples from fishing districts throughout the Gulf Region are being collected for analysis of biological characteristics (age, length, sex, etc.). By-catches of other species in smelt gear, especially juvenile herring, are also being noted, to provide an indication of juvenile distribution in inshore waters during fall and winter. (G)

STRIPED BASS (Morone saxatilus)

The Fisheries

Striped bass spawn in some rivers, but appear in estuaries of many more as they move along the coast to forage. Since they are not classified as sport fish in most areas, they are not protected by catch, possession, season or size limits. Although there is no directed commercial fishery for striped bass, by-catch in the gaspereau and other fisheries may be substantial. In addition, some people have learned that they can catch in excess of 100 kg per night using hook and line. These fish are easily sold for food.

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ARCTIC CHARR (Salvelinus alpinus)

Investigation

Artificial propogation

1. A research programme was started that over the next two years will investigate the possibility of Arctic charr farming in West Greenland.

ATLANTIC SALMON (Salmo salar)

A. Baltic Sea

The Fisheries

The total nominal catch of Baltic salmon amounted to 728 t, 67% taken by drift nets, the remainder by long lines. The catch rates averaged 17 salmon per 100 nets and 54 per 1000 long line hooks.

Investigations

Sea ranching

1. The tagging programmes of previous years in connection with the annual stocking of smolt in the River Mörrumsan and in the estuary at the river mouth were continued.

   A delayed release experiment was started at the island Bornholm. 8000 one year old smolt were stocked and fed in a net pen, and 3 months later released into the sea with an average increase in weight from 38 g to 292 g. Samples of fish were tagged before as well as after the stay in the pen.

Stock assessments

2. Catch-effort data on the salmon fishery were compiled from logbooks and from fish industry statistics. Data on length and weight together with scale samples were collected for stock analyses.

Stock identification

3. In order to determine the proportion of hatchery reared and wild salmon in Sub. div. 24 and 25 scale samples were collected from commercial landings.

Area	Season	Measured	Aged
IIId	September	172	137
	December		70

B. The Kattegat and the North Sea

Stock enhancements

In a river running to the Kattegat a programme for re-establishment of the salmon stock has been initiated. 44,000 half year old and 40,000 one year old salmon were released on former spawning sites. Besides 25,000 smolt were floated through the estuary to prevent capture in the fishing gear and liberated into the sea.

In 5 former salmon rivers to the North Sea, one of them with a small spawning stock left and the remainder with sporadic run of what are probably escapees, were stocked with 20,000 half year old and 100,000 one year old hatchery reared salmon.

C. West Greenland

The Fisheries

The total nominal catch at West Greenland amounted to 226 t, about 700 t less than the set TAC. The cold winter 1989/90 may have been the cause of the catch deficit as was the case in 1983 and 1984, when the landings were of the same order of magnitude.

Investigations

Stock identification

1. Samples from landings in NAFO Divs. 1B, 1C, 1D and 1E were collected by a Canadian-Greenland team in order to determine continent and if possible country of origin, and age and size composition of the catches.

EEL (Anguilla anguilla)

Abundance

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

Investigations

Artificial propagation

1. Rearing experiments with elvers in net cages in a lake in 1987 and 1988 for later stocking purpose proved not to be practicable.

   Rearing experiments with the slow growing assortments of a batch of elvers showed that a certain part attained the same growth rate as the fast growing assortment of the batch. The result has practical consequences for selection of stocking material.

Maturation experiments

2. The ongoing experiments to obtain maturation by means of injections with hormones were continued in cooperation with Scandinavian Silver Eels, Sweden. A series of experiments failed as a consequence of ignorance of the silvering of farmed eels. Another series included yellow and silver eel separated by means of low temperature and deprivation of food. The hormone treatment gave the expected development of the gonads of the silver eels, but further treatment did not result in the spontaneous maturation aimed at.

Parasites

3. The distribution of the infestation of eel with the air bladder parasite Anguillicola has been monitored in a number of lakes and marine localities. The infestation is spreading and the infestation rate in eels is increasing and is now close to 100% in some of the lakes investigated. A report will be published in 1991.

Stock enhancement

4. In cooperation with fisheries organizations and owners of fishing rights 3.5 million eels imported and reared as elvers were stocked in fresh as well as in salt water.

   In order to know the effect of the stocking and to gain experience with the stocking material and stocking procedure about 100,000 eels were marked and released in various localities in 1987 and 1988. Recaptures are continuously reported, and a preliminary report has been published in 1990.

TROUT (Salmo trutta)

Fisheries

In the salmon fisheries in the Baltic Sea 48 t of sea trout were taken as bycatches. In the other Danish seas and coastal areas official recorded commercial catches amounted to 17 t. The total catches are significantly higher, as sea trout is a main object for the recreational fishery with fixed gear as well as rod and line.

Investigations

Fisheries studies

1. In three of the largest fjord systems in Jutland extensive research programmes on bycatches of emigrating smolt and spent salmonids as well as catches of immigrating spawners have been initiated. The programmes include registration of operating gear (sort, dimensions, number, etc.), inspection of gear for catches of salmon and trout, and market investigations of landings with the same purpose. Final reports shall be prepared in 1992.

Fish passage

2. An investigation of the possibility for smolt to passover dams, where special arrangements (smolt passages) are made to facilitate downward migration was started in 1990 and shall be continued in 1991.

Genetics

3. In cooperation with Aarhus University genetic variability in wild stocks of salmon and trout was investigated by means of enzyme electrophoresis. The preliminary results were published in 1990. Further research is planned for 1991.

Juvenile studies

4. The reproduction of trout in streams by registration of captures in smolt traps was investigated.

Stock enhancement

5. According to the stocking schemes trout were released in streams and rivers to the number of:

   1,525,000 fed fry
   578,000 half-yearlings
   537,000 one year old parr
   477,000 smolt (one and two years old)

   Further 147,000 smolt were released in coastal waters.

   With a view to revising the stocking schemes that are 5 years or older; habitat evaluations and stock analyses by electrofishing were carried out in a great number of localities in streams and river systems.

   Stocking experiments with tagged hatchery reared trout smolts in order to estimate the effect of the stocking programs and to improve the stocking procedures were accomplished in fresh water as in the sea.

FAROE ISLAND

(I. Fjallstein and J. A. Jacobsen)

ATLANTIC SALMON (Salmo salar)

Investigations

Fishery studies

1. The monitoring program in the longline fishery continued and included collection of scale samples, measurements, and tag recording. The total catch in the fishery for the 1989/90 season was 56,606 salmon. More than 85% of the catch was recorded in the monitoring program.

Salmon ranching

2. In 1990, 11,820 salmon smolt were released in River Leynar. The capture of released salmon, wild salmon and trout in River Leynar was recorded in 1990. In total, 500 (2%) released salmon, 587 wild salmon and 66 trout were captured in the 1990 fishery.

FINLAND

(E. Ikonen)

ATLANTIC SALMON (Salmo salar)

The Fisheries

In the Baltic Sea, the nominal catch of Atlantic salmon in the Main Basin and in the Gulf of Bothnia (ICES sub-divisions 26-31) was 832 t and in the Gulf of Finland (ICES sub-division 32) it was 328 t. The total catch in the Baltic Sea was 1,160 t in 1989.

Salmon catch for Teno River which flows into the Arctic Sea was 48 t in 1988 and 56 t in 1990. In the Näätämö River, the catch was 3 t in both 1989 and 1990.

In the Finnish side of the Tornionjoki River, salmon catches were 2 t in 1987 and 1988; and in the Simojoki River salmon catches were only 100-200 kg/year.

In Kymijoki River, the catch was 6 t in 1990.

Investigations

Artificial propagation

1. In 1990, the following numbers of artificially reared salmon smolts were released into the Baltic Sea: ICES sub-division 29 - 167,478, ICES 30 - 290,721, ICES 31 - 1,102,531 and ICES 32 - 434,871. The total number of smolts released was 1.99 million.

Physiology

2. The research program to improve rearing techniques for production of high quality salmon and brown trout smolts for stocking has been continued. Besides the general smolt characteristics - minimum size, body silvering and condition factor - several physiological properties including the oxygen carrying and osmoregulatory capacities and energy stores of fish were recorded. Attention has also been paid to the hormonal control of smoltification and to the ways to regulate it. By connecting the physiological studies with tagging experiments a clear correlation between the physiological smolt status and the tag return rates of adults was shown.

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

Stock augmentation

4. In the Rivers Tornionjoki, Simojoki, Kiiminkijoki, Pyhäjoki and Kalajoki (flowing to ICES sub-division 31) 2.9 million salmon fry and 421,509 one-year-old fingerlings were released into the rapids. In the Rivers Aurajoki and Mynäjoki (flowing to ICES sub-division 29) 7,200 salmon fry were released into the rapids. In the Rivers Vantaanjoki and Kymijoki (flowing to ICES sub-division 32), 115,500 fry and 103,000 one-year-old salmon fingerlings and 221,000 eyed-egg-stage roe were released into the rapids.

Stock assessment

5. Stock assessments of Atlantic salmon stocks in the Baltic Sea have been done in connection with the work of the Baltic Salmon and Trout Assessment Working Group. Gulf of Bothnia and Gulf of Finland stocks have been assessed separately. The Neva River stock salmon released into the Sub-division 30 has also been assessed separately. In every assessment area, the total salmon catch would be higher if fishing effort could be restricted or if age-at-recruit could be increased.

Stock identification

6. 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). Also, in connection with the Baltic Salmon Scale Reading Workshop held in Utsjoki on 15-17 January, 1991 attempts were made to use discriminant analysis in stock identification. Although some of the results seem promising, no definite conclusions can be made until further research has been completed.

Stock investigations

7. The population densities of salmon parr were investigated by electrofishing in the Rivers Tornionjoki, Simojoki, Pyhäjoki and Kalajoki (flowing to ICES sub-division 31) and in the River Kymijoki (flowing to ICES sub-division 32). The densities of parr in Simojoki River were very low, about 5 parr in 100 m^2 in the lower half of the river. In the upper half, 3 parr/100 m^2 parr were found. In Tornionjoki River the population densities of salmon parr were about 1-2 parr per 100 m^2.

   In Simojoki River, a total smolt run was estimated at 58,000 individuals of which at least about 10,000 originated from natural spawning. In Tornionjoki River, the total smolt run has been estimated at 150,000 smolts/year in the beginning of the 1980s, but it is now under 100,000 smolts per year. The situation still indicates a serious decrease of spawning stock in Tornionjoki River due to overfishing in the sea. Fry and parr originating from natural spawning were observed in Kiiminkijoki, Pyhäjoki, Vantaanjoki and Kymijoki Rivers.

8. Ongoing salmon parr density investigations were conducted by successive removal electrofishing on 57 permanent study sites in the Tenojoki, Inarijoki and Utsjoki rivers during 1990. A total of 2,603 salmon parr

were sampled from the three rivers. Goals of this study are to monitor annual density changes, parr age group structure, back-calculated growth in weight and length, and comparative habitat specific density estimates. Stria counts from scale samples will be used in conjunction with current electrophoretic research in an attempt to provide a non-destructive discriminant function for Tenojoki stock management. In 1990, the mean parr density in Utsjoki River was 78 fish per 100 m^2, in Tenojoki River 35 and in Inarijoki River 52 fish per 100 m^2. In some rivers (the Kevojoki, Kalddasjoki, Tsarsjoki, Ylä-Pulmankijoki, Akujoki and Karigasjoki Rivers) of the Teno drainage smolt catches were continued. A total of 12,400 samples from smolts were collected. The aim of this study is to evaluate timing of smolt runs and the effects influencing it, total numbers, age composition and growth studies of smolts.

9. Parr growth studies were continued to monitor changes in length and weight of individual age groups throughout the year. Samples were collected twice a month through the open-water season in one station on Tenojoki and five on Utsjoki. Analysis of these collections will be used to evaluate habitat selective growth and influence of annual climatic variation on the population at a given site.

   In Vantaanjoki River, samples for growth studies were collected in spring, summer and autumn. In Kymijoki River sampling has been carried out in summer. The best growth period is July-August. In Vantaanjoki River the growth was not dependent on parr density. However, in Kymijoki River growth seemed to be density dependent.

10. Efforts have also been intensified in a study of the spread of sculpin in Utsjoki River since the first finding in 1979. The aim of this study is to monitor the rate of colonization of new habitat. The effects of sculpin population increase on juvenile salmon densities is of primary concern.

11. In the Baltic Sea area, a total of 13,340 scale samples were collected using drift net, long line, trap net and river fishery. The aim of sampling is to monitor the exploited salmon stocks. Number of scale samples in different ICES sub-divisions were: ICES 29 - 124, ICES 30 - 472, ICES 31 - 9,312, ICES 32 - 3,432.

12. A total of 3,713 scale samples from adult salmon were collected in the Tenojoki River watercourse by local fishermen. Additionally, 197 scale samples were contributed from Näätämönjoki River. Major research involving these collections include timing of runs, annual variations in escapement, back-calculated growth studies, adult and smolt age composition and numbers of repeat spawners in the run. In addition, since net pen rearing of salmon has recently been started in Tenojoki River, adult scale samples provide means for monitoring the effects of pen-reared escapees on catches and the natural salmon populations in the Teno drainage.

Tagging and marking

13. Salmon smolts 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. Numbers of tagged smolts were: ICES sub-division 29 - 3,887, ICES 30 - 998, ICES 31 - 17,794, ICES 32 - 10,535, for a total of 33,214.

In Tornionjoki River, 275,095 hatchery-produced salmon parr and 85,545 two-year-old smolt were marked by cutting the adipose fin and also 3,000 smolts were tagged with Carlin tags.

In Simojoki River, 67,614 hatchery-produced parr and 26,135 two-year-old smolts were marked by cutting the adipose fin. Additionally, 37,794 parr and 18,038 two-year smolt were marked with coded-wire tags and auxiliary fin clips in Simojoki River. A total of 1,495 two-year-old smolts were tagged with Carlin tags and 1,000 smolts using burn-tagging methods.

In Kiiminkijoki River, 11,600 hatchery-produced parr were marked by cutting the adipose fin. Additionally, 1,000 two-year-old smolts and 998 three-year-old smolts were tagged with Carlin tags and 1,550 two-year-old smolts using burn-tagging methods.

In Kymijoki River mouth, a total of 84 salmon were tagged with Carlin tags during their spawning run. Additionally, 6,060 two-year-old smolts were tagged with Carlin tags.

At the end of 1990, the number of recoveries of auxiliary finclipped and with coded wire tag marked salmon released in the Kymijoki River in 1987-89 were about 2,000. All recoveries were analyzed. Coded wire tags were found in 70% of adipose finclipped salmon. The aim of this marking is to find out possible differences in stocking results between one-year- and two-year-old smolts.

SEA TROUT (Salmo trutta m. trutta)

The Fisheries

Sea trout catch of the professional fishermen was 251 t in the Baltic Sea in 1989. Non-commercial catch was 389 t in 1988. In Teno River, sea trout catch was 460 kg and in Näätämönjoki River 130 kg and in Tornionjoki River some hundreds of kg in 1990.

Investigations

Artificial propagation

1. In the Rivers Tornionjoki, Viantienjoki, Kiiminkijoki, Siikajoki, Kalajoki and Lestijoki (flowing to ICES sub-division 31) 286,060 sea trout fry or fingerlings were released. In the River Merikarvianjoki (flowing to ICES sub-division 29), 6,000 sea trout fry were released. In the Vantaanjoki and Espoonjoki Rivers (flowing to ICES sub-division 32), sea trout fry or fingerlings were released into the rapids of these rivers, in total 8,300 individuals and 112,000 eyed-egg-stage roe. Number of sea trout smolts released into the Baltic Sea was 992,000 (ICES 29 - 270,000, ICES 30 - 168,000, ICES 31 - 322,000, ICES 32 - 232,000).

Stock investigations

2. In the Rivers Tornionjoki, Viantienjoki, Kiiminkijoki, Temmesjoki, Siikajoki, Kalajoki, Lestijoki, Isojoki, Aurajoki, Ingarskilanjoki and Vantaanjoki sea trout parr densities were studied by electrofishing. In most sites of Tornionjoki River no sea trout parr were found.

3. A total of 656 scale samples from the sea trout fishery in the Baltic Sea. Number of samples from different sub-divisions were ICES 29 - 29, ICES 30 -66, ICES 31 - 301, ICES 32 - 260. The aim of this sampling programme was to get information on the age and size structure of sea trout caught by different gear.

   In the Tenojoki and Näätämönjoki rivers, about 50 scale samples from adult sea trout were collected by local fishermen in 1990.

4. Hatchery-reared sea trout smolts have been tagged with Carlin tags. A total of 26,332 smolts were tagged (ICES 29 - 6,078, ICES 30 - 4,975, ICES 31 -6,899, ICES 32 - 8,380).

   In Tornionjoki River, 11,090 hatchery-reared sea trout parr and 1,600 three-year-old smolts were marked by cutting adipose fins.

   In the River Kiiminkijoki, 500 hatchery-reared sea parr were marked by cutting adipose fins. Additionally 500 two-year-old smolts were marked with Carlin tags and 1,000 smolts with a burn-tagging method.

WHITEFISH (Coregonus)

The Fisheries

In 1989, professional fishermen caught a total 1,137 t of whitefish in 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 of 680 t.

Investigations

Artificial propagation

1. Artificial propagation of whitefish has mainly been done by stocking with one-summer-old fingerlings or fry. The number of released fingerlings were: ICES sub-division 29 - 130,043, ICES 30 - 133,630, ICES 31 - 4,884,092, ICES 32 - 662,518. The total number of fingerlings released was 5,919,318 and total number of fry was 44.9 million.

Stock investigations

2. Scale samples of anadromous migratory whitefish have been collected in the river mouths of the rivers flowing to the Baltic Sea. Number of scale samples in different sub-divisions was: ICES 30 - 202, ICES 31 - 2,296, ICES 32 - 692, in total 3,190.

3. A total of 1,068 migratory whitefish were tagged with Carlin tags during their spawning run in Vantaanjoki River mouth (490) and in Kymijoki River mouth (578) (ICES sub-division 32).

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(Dr. W. Nellen)

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

The Fisheries

A total of 50 t of sea trout and salmon were landed in 1990; almost all from the Baltic Sea. The statistics do not separate landings of sea trout and salmon.

Abundance

Data are available only for the River Elbe. In 1990, an experimental fishery using a 9 m² stake net fished between Hamburg and the river estuary yielded sea trout in 26% of the 214 net hauls and salmon in 1% of hauls (one in each of three hauls).

Investigations

Artificial propagation

1. Artificial production of sea trout and their subsequent stocking into tributaries of the River Elbe and Baltic Sea are underway in two coastal states, Schleswig-Holstein and Niedersachsen. About 650,000 eggs were incubated in Schleswig-Holstein hatcheries and the fry were released into 15 rivers. In Niedersachsen, 500,000 eggs were incubated and the fry released. These releases result in stable populations that can be utilized by recreational fishermen. **(B and C)**

EEL (Anguilla)

The Fisheries

Eels are fished in coastal fisheries in the North and Baltic Seas as well as in commercial and recreational fisheries in rivers and lakes. In freshwater, no statistical information is available except for the Lake of Constance which recorded 6 t in 1988 and 14.9 t in 1989; and in Niedersachsen which landed about 15 t in 1989 and 1990.

Recorded landings for Baltic coastal waters west of Lubeck indicate landings of 87.4 t in 1989 and 82.4 t in 1990. East of Lubeck, landings from the new state of Mecklenburg-Vorpommern were 38.6 t in 1989, 20 t less than in 1988. For the North Sea coastal waters, the 1990 eel catch is reported at 67 t in 1989 and 57 t in 1990. In addition, 3.2 t were caught for stocking purposes along the North Sea coast of Scleswig-Holstein.

Abundance

The Institut fur Hochseefischerel in Rostock-Marienehe has investigated the abundance of eels in the shallow brackish water (Bodden) of Mecklenburg-

Vorpommern. Firstly, the landings of all freshwater fish were compared to eel landings from 1974 to 1989. While the landings of freshwater fish were stable at about 3,800 t per year; the landings of eels decreased steadily at about the same rate of decline annually from about 350 t in 1974-75 to about 50 t in 1988-89. Stock assessments have shown stock status to be very bad with a lack of recruits observed in Bodden waters.

Investigations

Parasites

1. One hundred percent of commercially caught eels from the coast of Mecklenburg-Vorpommern checked for Anguillicola crassus show infected air bladders. The number of parasites per fish varied by location. (F)

2. Eels infected with Anguillicola and Pseudoterranova have been reported from the River Elbe. (E)

Stock assessments

3. The Institut fur Hochseefischerel in Rostock-Marienehe has begun investigations on the abundance of eels in the shallow brackish water (Bodden) of Mecklenburg-Vorpommern (see abundance above). (F)

FLOUNDER (Platichthys flesus)

The Fisheries

Flounders are still subject to the in-river fisheries in the Elbe and Weser Rivers and their tributaries. The statistics are not very reliable but indicate landings of 25 t in 1990.

Abundance

Flounder is the second most abundant fish species in the River Elbe next only to smelt. The average biomass between Hamburg and Cuxhaven was about 60 t.

Investigations

General

1. The association between diseases of flounder and environmental conditions in the Elbe estuary, the feeding ecology of flounder in the Elbe, the importance of rivers as nursery grounds for 0- and 1-group flounder in comparison to the Wadden Sea, and on the reaction of these species to oxygen-poor zones in the River Elbe, have been investigated and published. (E)

LAMPREY AND RIVER LAMPREY (Petromyzon marinus and Lampetra fluviatilis)

Investigations

General

1. Both species are protected and cannot be landed any more. Spawning populations have been reported in several rivers and river lamprey seem more abundant than sea lamprey which are restricted to rivers flowing into the North Sea. No further data are available. **(B, C, D, F)**

SMELT (Osmerus mordax)

The Fisheries

Smelt are esteemed for eating by people living in coastal areas. The supply comes from landings of a local fishery in the Rivers Weser and Elbe. The Kiel Canal and the Schlei Fjord (Kieler Bucht) are other places which are fished for smelts. In total, the landings were 10 to 20 t in 1990.

Abundance

Smelt stocks seem to be stable at present; however, precise information is only available for the River Elbe where smelt is the dominant species. A rough estimate based on research fishing with a 9 m^2 commercial stake net, indicates that on average between Hamburg and Cuxhaven, the standing stock of smelt is 140 t.

Investigations

Diseases

1. Studies on diseases, parasites, and skeletal deformities of smelt from the River Elbe have been published. **(E)**

Stock assessment

2. Studies on the population dynamics and ecology of smelt in the River Elbe are underway. **(D)**

STURGEON (Acipenser sturio)

Investigations

General

1. Sturgeon are reported as extinct, but occasionally a specimen is still caught. The last report dates from 22 February 1990 when a sturgeon 67 cm in length was caught and released again off the mouth of the River Oste, a tributary of the Elbe and a former main spawning river of the species in the Elbe system. **(G)**

TWAITE SHAD (Alosa fallax)

Investigations

General

1. A common species in the lower part of the River Elbe during its spawning season in May. The fry and 0-group fish stay there until Fall when the downstream migration into the North Sea begins. Ecological and population dynamic research is underway; although the species is of no commercial interest. **(D)**

WHITEFISH (Coregonus lavaretus)

The Fisheries

Cisco (whitefish) thought to be extinct has been reported in catches from the Baltic coast east of Lubeck. Landings in 1990 and 1989 were 4.2 t and 4.5 t, respectively.

Abundance

Catch per unit effort is highly variable but catch effort with constant effort indicates a maximum of 27 t per unit effort in 1980 to a low of 3.8 t in 1988. In 1990, the effort had to be reduced because of decreasing demand for fish on the local market.

Investigations

Stock assessment

1. In August of 1990, a research program was initiated to study in detail the state of migrating cisco stocks in the Bodden-Waters of Mecklenburg Vorpommern. To date, some 200 specimens have been examined for length at age, weight, sex, fecundity, feed, and condition factor (fat content). **(F)**

Stock enhancement

2. In Schleswig-Holstein, substantial efforts are being made to restore stocks by stocking the river Treene, a River Eider tributary, with 4 cm fingerlings, pregrown in illuminated net cages. The young fish originated from eggs imported from Denmark. In 1990, 35,000 juvenile ciscos were released. In the same year, about 50 adult fish of 35 to 45 cm in length were caught in freshwater for broodstock, indicating that the new stocking measures were successful. **(A and B)**

LIST OF CONTRIBUTORS

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FRANCE

(P. Prouzet)

ATLANTIC SALMON (Salmo salar)

The Fisheries

The total catch by both rods and nets during the 1990 fishing season was estimated to be 4,220 fish and by weight 8 t. Of the total catch, around 50% was caught by rod and line and 50% by nets in estuaries or in rivers by commercial fishermen. The main professional fisheries using drift nets are located in the estuaries of Loire and Adour rivers.

The catches for France by area and sea age are as follows:

	Catches				Age distribution		
	Rod		Nets				
Area (No. of rivers)	No	W(t)	No	W(t)	1SW	2SW	3SW
Normandy (7)	380	1.8			73	27	
Brittany (23)	1086	4.0			65	35	
Loire			196	0.9	8	76	16
Allier	88	0.5			2	44	54
Adour			1450	5.0	68	31	1
Gaves (3)	186	0.9			21	69	10

(Data from A and B)

Investigations

Artificial propagation

1. In 1990, 383,000 juveniles were stocked in the Dordogne and Garonne catchment area. The origin of eggs were from Scottish, Icelandic and French stocks (Allier, Adour and Dordogne). **(B)**

2. In a joint project with IFREMER, INRA and CSP, Loire-Allier and Adour salmon are being raised in sea cages and a freshwater fish farm for use as future broodstock. **(A, B, and C)**

Juveniles studies

3. On the Nivelle River (southwestern part of France) studies were made to evaluate the density of juveniles from natural reproduction. The estimates concerning the rate of return from 0+ juveniles produced naturally in 1985 and 1986 were respectively, 16% and 3%. Comparisons between egg survival in the spawning channel and in the medium and upper courses show that survival was 5 to 18 fold better in the upper course and 10 to 23 fold in the spawning channel than in the lower course. **(C)**

4. In the Oir River, a tributary of the Selune in Lower Normandy, studies are being carried out to improve a model to assess smolt production from electrofishing surveys that takes into account the absence of size bimodality and the influence of precocious sexual maturity. (C)

5. The distribution of young fry have been studied both in an experimental spawning channel and in a nursery stream on a tributary of the Nivelle River. In the nursery stream, a precocious dispersion appeared within the two weeks after the fry emergence. Two months later, juveniles were found down to 2,400 m and up to 400 m from the point of egg immersion. Then a stabilisation of the population was observed. (C)

Spawning behaviour

6. On the Oir River, radio tracking techniques were used to study the behaviour of male salmon before and during the spawning period. The main results show that the smallest individuals were continually in movement while the biggest individuals behaved similar to females. (C)

7. In an experimental spawning channel, studies concerning the impact of spawner density on the spawning behaviour and the success of reproduction are being conducted. An inverse relationship between the number of female spawners and the survival rate of fry was observed. The nocturnal behaviour of spawners have been determined by the means of an infrared camera. (C)

Stock assessments

8. On several rivers (13), salmon were counted at 16 traps and fences. Of these, the data from some of the rivers were used for assessments and showed the following results:

River	Count	Catch	Exploitation
Nivelle	291	1	0.3%
Bresle	120-140	10	0.8%
Elorn	375(*)	145	39.0%

(*) underestimated, 14% for grilse only (B and C)

Tagging

9. Trials were made to define the tag losses from microtagging. The tag loss rate was 5.5%. (A)

EEL (Anguilla anguilla)

The Fisheries

For Adour River, the catch was very low in 1990 (3 t) and the total catch of subadults has continually been decreasing in each of the last five years.

For the Mediterranean coast, the production of subadults is estimated to be between 1500 and 2300 t. In coastal ponds, the yield per 100 m² and per year is ranged between 0.2 and 0.6 kg.

On the Loire, Vilaine and Adour rivers, abundance indices collected from the landings of professional fishermen show a decrease in stock abundance. But it seems that the situation is more complex and a possible influence of environmental conditions on the catchability of glass eel is suspected.

Investigations

Parasites

1. The parasite Anguillicola crassus which was observed for the first time in France at Camargue in 1987 continues to spread. It is very abundant on the Mediterranean coast and it is presently observed on different rivers in all the regions of France (Loire, Dordogne, Garonne, Seine, Adour-Gaves). **(A and E)**

Stock investigations

2. On the Loire estuary, investigations concerning the rhythm of glass eel migration are in progress. **(A)**

3. On the Scorff River (Brittany), electrofishing surveys show that there is the presence of a density gradient and an increase in the mean size of the population from the lower to the upper courses. Also, these distributions are influenced by dams or water quality. **(C)**

4. A model has been designed from the yield per recruit data collected on the Loire and Vilaine rivers. Age interpretations have been validated by utilisation of a fluorochrome pigment to mark the otolith and by analysis of the fine structure of otolith. **(G)**

SEA TROUT (Salmo trutta)

The Fisheries

The coastal catches between the Seine and the Bresle (Upper Normandy and Picardie) were estimated between 2 and 3,000 individuals. On the Bresle River and near its mouth, the number of fish caught was estimated to be 1,200.

On the Adour river, the number of fish caught by the drift net fishery was estimated to be between 310 and 350. The catch in this fishery has continually decreased since 1988 when it was 1,250 individuals.

Investigations

Stock investigations

1. Studies concerning ecophysiology of juveniles have been carried on in the natural environment. These studies showed the existence of a real smolt

stage characterized by strong NA-K-ATPase levels. This study is continuing with experiments in a controlled environment in order to follow the timing of phenomena observed in the natural environment. **(C)**

SHAD (Alosa alosa and Alosa ficta)

The Fisheries

In the Adour, the shad commercial fishery caught about 4,000 fish mainly in April and May. Over the last five years, a drastic decrease in shad catches has been recorded which is mainly due to the degradation of the spawning grounds (gravel extraction) and the erection of dams.

On the Gironde estuary, a strong increase in shad catches was recorded in 1990, more than 1,000 t. It seems that this catch increase is directly related to the stock increases mainly due to the improvement of the quality of the environment and migration of fish up to their spawning grounds.

Investigations

Migratory and spawning behaviour

1. Different studies on the Loire have shown that the migratory behaviour of shad was influenced by the temperature. **(C)**

2. On the Dordogne and Garonne rivers, the migration activity of adults and juveniles were observed by the means of trap and fish ladders. **(B)**

3. On the Garonne, the spawning behaviour of shad was studied. **(B and F)**

Stock investigations

4. On the Adour and Loire rivers, studies are in progress on the characteristics of the different populations. **(A, C and D)**

5. Electrophoretic studies have been undertaken and show the existence of hybrids between the the A. alosa and A. ficta. **(C)**

SEA LAMPREY (Petromyzon marinus)

The Fisheries

Catches in the Adour River were estimated to be between 3,400 and 3,800 individuals.

Investigations

Migratory behaviour

1. On the Dordogne and Garonne rivers, the spawning migration of sea lamprey was studied and the situation of spawning grounds was determined on the Adour River. **(B)**

LIST OF CONTRIBUTING INSTITUTES

(A) IFREMER Laboratoires de Nantes et St. Pée sur Nivelle

(B) CSP Délégations de Bretagne, de Haute Normandie et de Midi-Pyrénées-Aquitaine

(C) INRA, Laboratoires de Rennes et de St. Pée sur Nivelle

(D) CEMAGREF, Divisions de Bordeaux et de Montpellier

(E) Ecole Nationale Vétérinaire de Nantes

(F) E.N.S.A. de Toulouse

(G) E.N.S.A. de Rennesp

ICELAND

(A. Isaksson)

ARCTIC CHARR (Salvelinus alpinus)

The Fisheries

In 1990, some changes for the worse took place in two of the largest charr lakes in Iceland, where commercial net fishing was very poor. There was, however, some minor increase in catches and fishing effort in some of the smaller charr lakes, some of which had not been utilized for many years. The total catches of landlocked charr were thus comparable to previous years.

There is an increased demand for sport fishing licenses for charr in lakes and rivers. The primary interest focuses on sea charr found in many of the colder streams in northern and eastern Iceland. The income from the sale of sport fishing licenses is in most cases of greater value for the landowners than commercial harvests.

Investigations

Stock assessment

1. The population size in two charr lakes in northern Iceland has been estimated using mark-recapture techniques. This was an attempt to improve fisheries management in the lakes. The biomass of fish over 18 cm in size was from 24 to 46 kilograms per hectare and the number of fish over the same size limit was 170 to 190 individuals per hectare. The effects of diatomaceous earth mining in Lake Myvatn on charr populations has been studied for a number of years without explaining in a satisfactory manner the collapse of chironomids and charr populations in recent years. Oxygen deficiencies under ice in the wintertime are a suspected cause. Further studies are planned.

Aquaculture

2. Arctic charr continue being an interesting species in Icelandic aquaculture and selective breeding programs are being planned.

ATLANTIC SALMON (Salmo salar)

The Fisheries

Preliminary statistics indicate that the total catch of salmon in 1990 was 133,000 fish, with 30,000 from sport fisheries, 12,000 from riverine net fisheries and 91,000 from commercial ranching. Total weight was approximately 420 t. Sport and net catches were similar to the previous year, but salmon ranching had increased considerably, as over 4 million smolts were released in 1989. The ranching contribution in 1990 was thus close to 70% of the total number of salmon caught.

Returns of grilse to salmon ranching stations were as in 1989 fair to poor, with the grilse component ranging from 2 to 5%. Similar trends were observed in Icelandic salmon rivers.

Investigations

Aquaculture/wild fish interactions

1. Aquaculture has grown steadily in Iceland from 1986 through 1989, both in sea-cages and land-based operations. Large cage-rearing operations have been carried out in southwest Iceland, suffering major damage during storms and high escapement of salmon. Ocean ranching has also grown immensely. Escapees from fish farms and strays from ranching stations have been found in relatively few streams close to the operations. Since 1988, the salmon rivers in the vicinity of Reykjavík have been investigated to detect escapees, using morphology, scale characters and fin conditions. Incidence of reared salmon in some small streams has exceeded 50%; but in sport catches in larger streams, it ranged from 25% to 43% in 1990. In 1988 and 1989, cage escapees were the majority of reared fish entering rivers, but with most cage operations closing down in 1990, the proportion of salmon of ranched or enhanced origin has increased considerably. Microtagged salmon from various ranching operations have confirmed these observations.

Juvenile studies

2. Juvenile studies are conducted on a routine basis in various Icelandic streams to detect natural fluctuations in fry abundance. These studies continue to be an important tool in the management of the streams with respect to enhancement strategies.

Ranching and rearing

3. Several research projects are being conducted, which have as their main goal the improvement of the economics of salmon ranching and rearing. The main projects are a selective breeding program in ranching, a co-nordic project that is now in its fourth year. There are indications that the size and performance in ranching can be improved through family selection. Other projects are dealing with the optimum size of smolts for release, the early feeding of smolts in the sea and the production of age 0+ smolts for ranching and rearing. A selective breeding program for land-based rearing is in its start-up phase.

Stock assessment

4. Smolt survival studies were continued on the Ellida-river in southwest Iceland, Urrida-river in west Iceland, Midfjarda-river in north Iceland and Vesturdals-river northeast Iceland. Wild smolts were microtagged in those rivers in 1990 and returns monitored for the 1989 tagging. Returns of tagged grilse to Ellida-river in the southwest were 8.1% but 1.1% in Vesturdals-river in the northeast of Iceland, indicating poorer sea survival in the northern area. Both these returns, however, were low and conformed well with returns to Icelandic ranching facilities from 1989 releases.

5. Assessment of the Blanda river system prior to hydroelectric utilization of the river continued in 1990, giving 8 years of continuous surveillance of the salmon runs since 1982. An equally long time series will be monitored after completion of the hydroelectric facilities in 1991.

Tagging and marking

6. Total releases of microtagged salmon smolt in 1990 amounted to 405,600 hatchery smolts and 2,475 wild smolts. Most of the tagged hatchery smolts were released in ranching operations in western Iceland, where a total of 5.6 million smolts were released in 1990. The wild smolts were trapped and tagged in the survival index streams, Ellida-river, Urrida-river, Midfjarda-river and Vesturdals-river, located in various parts of Iceland.

Aquaculture production

7. The total aquaculture production of salmonids in Iceland in 1990 according to Institute of Freshwater Fisheries statistics was as follows:

Species	Quantity Tonnes	Export value US dollars
Salmon	2800	18.4 million*
Rainbow trout	12	80,000
Arctic charr	59	390,000
Brown trout	20	140,000
Total	2891	19 million

*Includes 250 t of ranched salmon.

The above figures assume an approximate export value of US dollars 6.5 per kilogram of ungutted salmon. Smolt production in Iceland is now about 10 million smolts, with over 5.6 million released in ranching operations in 1990.

SEA TROUT (*Salmo trutta*)

The Fisheries

Sea trout are primarily caught in south and southwestern Iceland. They are primarily caught on rod during their seaward migration in April-May and in a Fall fishery in late September through October. The 1990 fishery was relatively poor, compared to previous seasons, probably due to poorer sea survival.

Investigations

Stock investigations

1. Both sea run and landlocked stocks continued to be studied on Iceland's south coast. First returns of sea trout in a ranching project on the south coast were captured in the summer of 1990.

LIST OF CONTRIBUTING INSTITUTION

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IRELAND

(John Browne)

ATLANTIC SALMON (Salmo salar)

The Fisheries

The salmon season in 1990 was poor with catches down by 50% in some regions. West coast fisheries in particular suffered, with the lowest returns for the past six years. Although drift nets continue to take the majority of salmon in home waters, there were indications that the proportion of salmon taken by them has fallen since 1987 and that this trend is continuing. The proportion of the catch by rod and line had remained stable for some years up to 1989 but increased in 1990.

The recorded catch by gear other than drift net and rod ranged from 16% of the total in the Northern Region to 34% in the adjoining Northwestern Region. A significant proportion of the catch in the Southern Region came from "snap nets" (small draft nets). Rod and line returns were an important component of the total catch in several regions: 25% in the Western and 17% in the Northwestern.

Investigations

Juvenile studies

1. The salmon productivity survey in connection with stream maintenance structures installed on the tributaries of the River Boyne by the drainage authority (Office of Public Works) has shown very encouraging population figures and indicates the effectiveness of these structures in relation to river rehabilitation.

Sea ranching

2. From a total of 31,000 reared smolts released in the Burrishoole River in 1989, survival to the coast ranged from 4.3 to 5.5% while survival to the river was 2.5%. The exploitation rate by drift net was relatively low: at 54% it was well below the average for the past ten years. The survival to the river was relatively good.

Stock assessment

3. The index for fishing mortality at sea calculated for wild smolts from the River Corrib was the lowest on record. The index for return to the river was only slightly below average. These observations combined with (2) above suggest that, because fishing was poor, the fishing effort at sea was reduced and that therefore return to the rivers was relatively high. However, the overall survival index was low and the conclusion is that the total stock migrating was small.

Stock restoration

4. A total of 39 adult salmon from a trap at the downstream rearing station were transported to the Sullane, an upper tributary of the River Lee and released after attachment of radio tags. Tracking indicated that the majority traveled upstream and only a small number left the tributary in an attempt to return to the rearing station. The indications are that reared fish may be used successfully to restore breeding populations. The experiment will continue with the installation of a smolt trap so that the progeny of the transported fish may be tagged.

SEA TROUT (Salmo trutta)

The Fisheries

For the second year in succession, 1990 was marked by a collapse of returning sea trout to a group of rivers in the Galway/Mayo (west coast) region. This has followed a decline in numbers observed over a number of years. In other regions sea trout catches were below average but within the recorded extremes. Retention of sea trout by fishermen in the Galway/Mayo region was banned in an effort to preserve breeding stock.

Catch figures for the year are therefore not comparable to those of previous years - but there was no question of the continued scarcity of returning fish. The only constant source of information on sea trout numbers in the region is at the Salmon Research Agency's traps on the Burrishoole River where all migrating salmonids are monitored. The 1989 catch of finnock was the lowest in the 20 years of records but an improvement was observed in 1990. The 1990 run of 1SW sea trout numbered 11 as compared with more than 2,000 in good years in the 1970s.

Investigations

An extensive investigation into the cause of the collapse was initiated in 1989 under the auspices of a Sea Trout Action Group established by fishery owners, conservationists and State agencies. A report was issued at the end of 1990 and some of the principal results are given below:

Climatic factors

1. Marine temperature, fresh water temperature and rainfall were examined. The results were not conclusive because there were few, if any, factors which could be consistently applied to all cases of the collapse and which were confined to the Galway/Mayo region. Sea temperatures in May 1990 were abnormally high, but this was not the case in 1989. Rainfall - and hence river level - in the first ten days of May when the majority of smolts should migrate - was extremely low in both 1989 and 1990 but this factor was equally pronounced in unaffected river systems.

Growth and survival

2. Growth rate at sea was shown to have been below average. A frequently observed factor in sea trout returning to fresh water was an emaciated

condition and there was a general inference that the fish had failed to secure enough food. The returning fish in many cases bore unusually large burdens of sea lice. Observations on other predatory fish species suggested that there was not an actual shortage of prey. The size of smolts appeared to have increased in recent years, but survival at sea was reduced. In other areas some decline in numbers of sea trout was observed, but this was not associated with the emaciated condition or with heavy infestations of sea lice.

Marine surveys

3. Gill nets were used to determine the distribution of trout in the sea and, especially, to investigate the theory that they were attracted to salmon cage farms at which they would become infested with sea lice. The results showed that the preferred habitat was areas of sand butting on to rocky outcrops. One specimen was caught in the vicinity of a sea cage and none were caught underneath the cages. The diet consisted mainly of 0-group sprat with sand eel, adult insects and larval crab.

Sea lice, other parasites and disease

4. A detailed examination of sea lice was made to examine a theory that a major factor in the decline was a superabundance of the parasites resulting from the presence of salmon cage farms in the region combined with the observation that many of the emaciated returning sea trout were heavily infested. The species Sepeophtheirus salmonis was identified on the sea trout and found to be abundant in the sea cages. Sea trout and caged salmon were infested almost entirely by larval rather than adult or preadult lice. The burden of internal parasites appeared to be normal and no bacterial or viral conditions were identified.

Conclusions

No clearly identifiable factor emerged from the investigations which are continuing. Sea-louse infestation was generally considered to be a secondary development associated with fish debilitated by other causes. Failure of the local sea trout population to adapt to the marine environment is receiving serious consideration and a physiological study has been initiated. Environmental aspects, including the possible impact of increased acidity, are also being considered.

EEL (Anguilla anguilla)

The Fisheries

Catches in general were poor. The silver eel run was relatively small in the major fisheries. The supply of elvers was markedly better than in 1989 but well below the high average observed in the 1970s.

Investigations

Stock assessments

1. In Lough Corrib extensive fyke netting took place in July and August, repeating observations made between 1967 and 1969. A serious reduction of stocks had taken place in the south basin of this lake which is inhabited mainly by young (< 10-year) eels. In the north basis of the lake stocks were at the same level as in the 1960s. Poor recruitment throughout the 1980s is believed to be the cause.

NETHERLANDS

(Willem Dekker)

ATLANTIC SALMON (Salmo salar)

The Fisheries

No directed fishery exists on salmon in the Netherlands. However, during commercial fisheries directed for other species, i.e. trout, 5 salmon were caught.

EEL (Anguilla anguilla)

The Fisheries

The fishery for eel on the IJsselmeer yielded 562 t, which is just one t less than the previous year. From a length-based assessment technique, it was concluded that the severe drop in fishing effort in 1989 has stopped most of the overfishing, but the present effort still will not allow for recovery of the depleted stock. Given this situation, the fishermen didn't choose for further cuts in effort, knowing this might necessitate an even more drastic cut in the future.

Investigations

Fisheries studies

1. Because of an anonymous inquiry for fisheries data in 1989; during 1990, voluntary logbooks were introduced on the IJsselmeer. As far as can be judged now, fishermen were quite willing to fill in this logbook, but most of them forgot to do it in practice. During 1991 the available data will be worked up.

SEA TROUT (Salmo trutta)

The Fisheries

In the Netherlands, no directed fishery for trout exists. However, fishermen fishing for other species in rivers can make rather large bycatches. No landings statistics are available.

Investigations

Tagging studies

1. In the summer of 1990, 964 trout were caught in front of the sluices in the Haringvliet (discharge of part of the water of the rivers Rhine and Meuse), and tagged using Carlin tags. Length frequencies ranged from 10

to 65 cm. Before the end of the year, 39 trout were recaptured, some in the rivers and estuaries, but most in the coastal region, up to several hundreds of kilometers from the point of release.

LIST OF CONTRIBUTING INSTITUTES

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NORWAY

(T. Hansen and B. Jonsson)

ARCTIC CHARR (Salvelinus alpinus)

Investigations

Diseases

1. Arctic charr have been challenged with Aeromonas salmonicidae salmonicidae. The gross pathology for charr was similar to salmon although some differences were seen. Histological examination revealed pathology typical of furunculosis. Latent carrier test on surviving charrs resulted in development of furunculosis. **(B)**

Genetics

2. An experiment was set up to study feed digestion and utilization in two strains of Arctic charr which have different trypsin-like isozyme patterns and growth rates. **(B)**

ATLANTIC SALMON (Salmo salar)

The Fisheries

The nominal catch in 1989 was 904 t; of which, 435 t were grilse (whole weight less than 3 kg) and 469 t were salmon (whole weight greater than or equal to 3 kg). Of these, 201 t of the grilse and 216 of the salmon were taken in rivers and 234 t of the grilse and 253 t of the salmon were taken in the sea.

Investigations

Diseases

1. The problem with Gyrodactylus salaris killing Atlantic salmon parr of infected rivers, is still growing. Resistance of Baltic salmon to Gyrodactylosis has now been investigated. Baltic, but not Atlantic, salmon show resistance towards this parasite. **(A)**

2. Infection experiments with Infectious Salmon Anemia (ISA) were started. **(F)**

Environment

3. Acidification of Norwegian rivers is still a major environmental problem. In 1986 and 1987, smolts from several stocks of Atlantic salmon were released in two neighbouring, Norwegian rivers at two locations; one in the estuary and the other 5 km upstream. Both rivers are heavily infected by acid rain and the original stocks of Atlantic salmon have been exterminated. One of the rivers is limed and the other is not. Smolts

released in the limed river survived well, whereas all those released in the acidic river disappeared. Even smolts released in the estuary of the acidic river showed poor survival, probably because the fresh water from the river forms a layer of acidic water on top of the salt sea water. **(A, C, D, E)**

Exploitation

4. Exploitation rates of Atlantic salmon released as individually tagged, hatchery-reared smolts in the Drammen River 1984-86, have been estimated. The exploitation was low at Greenland, moderate at the Faroes and high in Norwegian home waters (although lower than for other Norwegian salmon stocks investigated). The annual exploitation in the Drammen River from 1985 to 1988 varied between 0.33 and 0.53. **(A)**

Fish farming

5. In 1990, food fish farming production increased to 157,944 t of Atlantic salmon and 3,523 of rainbow trout. In total, 60 x 10^6 salmon smolts and 3.3 x 10^6 rainbow trout smolts were produced for aquaculture. **(F)**

Genetics

6. The effect of frequency of trypsin variant TRP-2(92) on growth in 3 different wild strains was studied. Since trypsin-like isozyme studies have revealed a correlation between genetic variation and growth rate in salmon, cDNA of trypsin is being investigated to study the genetic background for this observation. Feed digestion and utilization were studied in 2 groups of Atlantic salmon with and without trypsin variant TRP-2(92). **(F)**

Migration

7. The time of seaward and return migration of Atlantic salmon of different ages, sizes and sexes in the River Imsa have been investigated. Post spawners descended the river during two periods, December through January and March to May. Males descended earlier than females. Age and size groups, on the other hand, did not segregate into different time of descent. The survival of adult males and females in the river were 65 and 85%, respectively. The smolts that migrated to sea during April-June were younger and smaller than those that descended during January-March. The grilse returned later to Norwegian home waters than salmon. However, grilse entered the River Imsa earlier, and at lower water discharges than older and larger fish. The results lend support to the hypothesis that older individuals show annual changes in the life history earlier than younger ones. **(A)**

8. Atlantic salmon released far upstream in the Drammen River descended with a speed of ca. 5 km per day. Fish released downstream from the lakes in the river descended faster. In the fjord area migration speed decreased, but increased again when the smolts reached the coastal current. **(B, A)**

Physiology

9. The effects of photoperiod and temperature regime on seawater performance in 0+ and 1+ smolts were studied. The effects of photoperiod, temperature and food availability on growth rate and incidence of grilse were investigated. The effect of photoperiod and temperature regime on time of ovulation was studied. (F)

Sea ranching

10. Releases of Atlantic and Baltic salmon smolts in the River Akerselva, Oslo have been successful. This river has been empty of salmon for more than 100 years due to heavy pollution. The smolts left the river and the Oslo fjord soon after release to feed in the north Norwegian Sea. They returned to the river as adults one or more years later. Baltic salmon (from the Neva River, USSR), on the other hand, stayed in the fjord area during summer and many returned as adults to the river the same autumn as released. (A)

11. Experiments with sea ranched and wild Atlantic salmon indicated that juvenile experience is essential for early ascent and spawning success as adults in rivers. Adult, sea ranched fish with no juvenile river experience ascended later and descended earlier from the river than wild fish from the same stock. In the river, sea ranched fish moved more up- and downstream during the spawning period than wild fish. Furthermore, sea ranched fish were more frequently injured during spawning competition and many (males in particular) left the river without spawning at all. (A)

12. A large national sea ranching programme on Atlantic salmon was initiated in 1990. Large experimental releases will be done both in the northern and western part of Norway. In 1990, eggs were collected from several salmon stocks and production of smolts were initiated. (F)

BROWN TROUT (Salmo trutta)

Investigations

Reproduction

1. Mean age of mature male parr increases from south to north along the Norwegian coast. Mean age of maturity of male parr was negatively correlated with total length of the parr at age 0 and 1. Populations with poor freshwater growth develop mainly to become sea-run migrants, whereas those which grow well in freshwater become resident. (C)

2. Within populations, there was a positive correlation between fish length, fecundity and egg diameter. Among populations, however, there were significant differences in these variables. When adjusted for fish length, fecundity and egg diameter were negatively correlated among populations. (C)

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F Institute of Marine Research
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POLAND

(R. Bartel)

ATLANTIC SALMON (Salmo salar)

The Fisheries

The nominal catch in 1990 in the Baltic Sea (ICES Subdivision 25 and 26) was 195 t.

Investigations

Artificial propagation

1. Rearing of Daugava spawners from eggs obtained from USSR was continued in cages in the Gulf of Gdansk. **(A and B)**

2. In the autumn of 1990, about one million eggs was obtained from Daugava salmon spawners reared in cages. **(A and B)**

3. In total, 400,000 salmon alevins and 4,992 parr were released into tributaries of the Slupia River. **(A and B)**

Tagging experiments

4. Tagging experiments were carried out together with GosNIIORKh in Leningrad and 1,000 tagged salmon smolts were released into the Neva River.

EEL (Anguilla anguilla)

The Fisheries

In 1989, the nominal catch in the Vistula Firth and Szczecin Firth was 318 t. Data for 1990 are unavailable.

Investigations

Stock assessment

1. An amount of 2,706 eels were measured and material for ageing and feeding was collected from 31 eels in the Szczecin Firth. **(B)**

Stock enhancement

2. An amount of 1,100 kg of alevins was released into the Szczecin Firth.

LAKE TROUT (Salmo trutta m. lacustris)

In 1989, the nominal catch in the Wdzydze Lake and in the Besko reservoir was 105 kg.

Investigations

Artificial propagation

1. In total, 12,640 one year old parr were released into tributaries of the Besko reservoir and 120,000 alevins were released into tributaries of the Wdzydze Lake in 1990.

RAINBOW TROUT (Onchorynchus mykiss)

The Fisheries

In 1990, the nominal catch of sea trout was 488 t; of which, 207 t were caught in rivers and 281 t in the sea.

Investigations

Ageing

1. In total, 136 fish for measuring and ageing were collected from commercial catches in the Baltic Sea (ICES Subdivision 26). **(B)**

2. Scale samples were collected from 78 sea trout in the summer and 178 in the autumn from the Vistula River. Also, scale samples were collected from 356 sea trout from the Slupia River. **(A)**

3. Egg samples to measure size of eggs were collected from 119 and 263 fishes caught in the Vistula River and in the Slupia River, respectively. **(A)**

4. Tissue samples for enzyme gene variation studies were gathered from 131 Vistula sea trouts and 356 Slupia sea trouts. **(C)**

Artificial propagation

5. In 1990, a total of 599,823 smolts, 4,834,900 alevins, and 4,847 parr were stocked. They were released into the following rivers: 314,298 smolts and 470,000 alevins into the Vistula, 258,525 smolts and 4,364,950 alevins and 4,847 parrs into Pomeranian rivers, eg. Leba, Slupia, Wieprza, Grabowa, and Rega.

Stock identification

6. Discrimination methods on the mixed sea trout in the Vistula River were continued. **(A)**

7. Observations on passing of sea trout spawners through a fish pass in the Drweca River, a tributary of the Vistula River were finished. **(A)**

Tagging experiments

8. In total, 5,025 sea trout smolts were tagged and released into the Vistula, Wieprza, and Slupia rivers.

LIST OF CONTRIBUTING INSTITUTES

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SWEDEN

(L. Karlsson)

ATLANTIC SALMON (Salmo salar)

The Fisheries

The preliminary catch amounted to 1,458 t in 1990. The catch in the Baltic area was 1,458 t; of these 949 t were caught in the offshore fishery in the Main Basin and 509 t in the coastal and river fisheries in the Gulf of Bothnia. The catch along the west coast amounted to 33 t. This marked change in distribution from the offshore fishery towards coastal areas is due to the high rate of survival of two year classes of salmon in combination with declining effort in the offshore fishery in the Main Basin.

Investigations

Artificial propagation

1. In support of the Swedish salmon conservation program 2,188,000 1+ and 2+ smolts, 287,000 1+ parr and 1,230,000 fry and 0+ parr were released into Baltic rivers. 219,000 smolts were released in rivers on the west coast. **(A)**

2. In seven rivers, fixed gear operated during the entire season and were used to catch spawners of hatchery-reared Baltic salmon for use as broodstock. In almost all rivers, catches in 1990 were characterized by considerable increases in numbers of spawners. The proportion of grilse was lower than in 1989, but higher than the long-term average. **(A)**

3. Evaluation of the effect and value of the smolt release program on fisheries and salmon conservation is made by a long-term monitoring program that includes the following projects: 1) studies on rearing technique, smoltification physiology and nutrition, and 2) the influence of release technique on survival and homing. **(A)**

Diseases

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

Environment

5. Major parts of Sweden are heavily influenced by acid precipitation; especially in southern areas where salmon stocks declined considerably due to acidification until the beginning of the 1980s. Since then large scale liming programs have been introduced. The effects of acidification and liming on Atlantic salmon are assessed within the central program for monitoring acidified and limed lakes and streams particularly in Hogvadsan, a tributary to River Atran, on the west coast of Sweden. **(E)**

Genetics

6. The genetic variation among natural and reared populations of salmon in Sweden is being examined by electrophoresis. The study deals both with population structure and gene flow. A further goal is to develop guidelines for conservation of populations including breeding programs for reared populations. Until now the work has partly concentrated on both natural and man-made hybridization between sea trout and salmon. (A)

7. Conservation and fishery management work with salmon and brown trout from the Gullspång River is being performed with the purpose of genetic characterization of the stocks. Rearing methods are being developed to minimize the genetic effects of hatcheries. Stocking experiments are carried out in natural waters and recapture rates, survival and growth are monitored. (E)

8. A project is underway to use protein variants (by electrophoresis) to construct genetic profiles of specific stocks. Comparative performance studies (growth, catchability etc.) are being carried out in different environments. (E)

9. Effects of culture on fish are being studied from a genetic and ecological perspective. A long-term study is being performed regarding the possible negative effects of rearing salmonid fish in troughs and ponds. Emphasis is on the problems incurred by a limited number of parental fish and the absence of natural selection. Laboratory and field experiments are performed as a combination of population genetics (electrophoresis, DNA-fingerprinting), ecology and ethology. (E)

Juvenile studies

10. Juveniles can adopt alternative reproductive strategies associated with discrete life histories. Some males mature at a small size in freshwater while others become sexually mature after one or several years in the sea. Proximate factors affecting early sexual maturation are studied as well as the physiological conflicts in this process. The presence of early mature males in salmon populations influences the return rate from river releases and biomass production in aquaculture. (B)

11. Social interactions among immature fish and previously mature males of different sizes are being studied when they compete for dominancy in a stream tank during the smoltification period. The project has a behavioural and ecophysiological approach aimed at evaluating differences in behavioural pattern and optimal time for migration among young salmon. (B)

12. An electrofishing database has been established in order to collect information from electrofishing in streams and rivers throughout Sweden. This database is to support scientists working with problems related to stream ecology. (E)

Migratory patterns

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 to examine the effects that rebuilding of a power plant will have on the migration of ascending salmon. (A)

Physiology

14. Experiments to change sex in juveniles are being performed. Physiological males are produced by testosterone treatment of startfeed. Half of these will be genetic females. Normal females fertilized with such genetic females produce females only. (B)

15. The nutritional status of fish, the formation of muscle proteins and maturation of oocytes is being examined. A close correlation between muscle protein turnover and the maturation process of the fish was demonstrated. Protein metabolism in muscle was modulated without effecting the gonadal development by changing the composition of the feed. Excess proteins in feed had a slight beneficial effect on growth but added unnecessarily to an increased nitrogen excretion into the surrounding water. (F)

16. The smoltification process is being examined by saltwater tests and analysis of ATPase in the gills. The size and age of the fish is of particular interest. (A)

Sea ranching

17. A salmon sea-ranching program by delayed releases is being continued after evaluation in 1990. The results show that returns from delayed releases in the Baltic are 2-4 times higher when compared to normal river releases in the spring. (A, B)

Stock assessment

18. Most watercourses in the Baltic where natural production of salmon still occur are situated in the Bay of Bothnia. In most rivers, production is low, especially in the upper reaches. It has been estimated, based on electrofishing and catch statistics, that the present smolt production is 15-20% of the potential production. In river Torne, special fykenets are used to catch smolts to obtain information about localized production in different parts of the river and the survival of released hatchery-reared parr. (D)

Stock enhancement

19. A program to enhance natural salmon populations in the upper reaches of rivers situated at the Bothnian Bay started in 1980. Salmon parr have been stocked in several of the rivers, especially river Torne. The effects of stocking on the salmon populations have been measured by electrofishing, use of a smolt trap and through fishery statistics. The

program has now been expanded to most of the rivers in the Bothnian Bay that still have natural populations of salmon or rivers with suitable rearing habitats. (D)

Stock identification

20. Investigations are continuing to study the proportions of wild and hatchery-reared salmon in the catches in the Baltic on the basis of scale characteristics. The discrimination method is based on differences in the freshwater zone of the scales. Samples are taken both from the sea fishery in the Main Basin and from different parts of the coast in the Bothnian Sea and Bay. Morphometric analysis is tested as a supplement to scale analysis. Sampling programs have also started at the west coast with the primary aim of studying occurrence of farmed fish, primarily of Norwegian origin, in the catches. (A)

Tagging and marking

21. 73,600 smolts were tagged with Carlin tags before release into the Baltic and 8,800 smolts before release at the west coast of Sweden. (A)

Experimental fishery

22. In the autumn 1990, an experimental fishery with drift nets of different mesh sizes took place in the Baltic. The purpose was to examine the effect a larger mesh size would have on exploitation of salmon in the offshore fishery and number of spawners in the rivers. (A)

SEA TROUT (Salmo trutta)

Investigations

Artificial propagation

1. In total, 586,000 1+ and 2+ smolts, 149,000 1+ parr and 535,000 fry and 0+ parr were released to Baltic rivers and 16,000 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. The reproductive strategies of migrating salmonids are being studied. A comparison has been made of smolting among stocks of wild and hatchery-reared sea trout. The migration pattern and migration tendency of wild and hatchery-reared smolts are also being studied. Effects and causes of early sexual maturation are of special interest. (C)

Tagging and marking

4. In support of the sea trout monitoring program 17,500 smolts were tagged with Carlin tags before release into Baltic rivers and 3,300 at the west coast before release into Atlantic rivers. **(A)**

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UNITED KINGDOM (England and Wales)

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GENERAL INVESTIGATIONS

The National Rivers Authority (NRA) have set up a national research and development programme for fisheries which includes all projects of national significance. Individual NRA regions will 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 also collects catch statistics and undertakes routine stock monitoring programmes on rivers in England and Wales. **(NRA:HQ)**

A study is being carried out to examine methods of river fisheries classification and to recommend and validate methodologies for use in England and Wales. The study is expected to consider all UK freshwater fish including rare species such as lacustrine charr and whitefish. **(WRc, NRA:HQ)**

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 1990. The declared catch in 1989 was 2.27 t, which was similar to those in 1987 (2 t) and 1988 (2 t).

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)

The Fisheries

The nominal catch of salmon for England and Wales in 1990 is provisionally estimated to have been 81,000 fish (297 t) of which about 65% were 1SW and 35% MSW salmon. The net catch was about 250 t, which is approximately 8% below the 5 year average (1985-89), but within the range for the period. Many fisheries were affected by very dry conditions for a second year in succession, the effects being greater in fisheries in the southern half of the country than in the north.

The dry weather conditions had a marked effect on the rod fisheries; the estimated catch of salmon was 46 t, which was 46% below the five year average

and 21% less than the poor catch of 1989. As in the net fisheries the effects were greatest in the southern half of the country, with provisional catches for Wales and the south-west being almost 70% less than the five-year average.

No catch data are available for sea trout for 1990. However, catches in 1989 were much lower than the exceptionally good figures reported in many areas in 1987 and 1988, and there have been reports of further declines in 1990. It is not clear to what extent this reflects the dry conditions experienced in 1989-90 or whether sea trout stocks in England and Wales may be experiencing similar problems to those in parts of Ireland. In Ireland, many of the returning sea trout have been reported to have heavy infestations of sea lice and to be in poor condition, but such problems have not been widely reported in England and Wales.

Investigations

Acid rain

1. Options for restoring water quality in acid lakes are being evaluated and responses to liming are being monitored. Fish and invertebrate populations and water chemistry have also been investigated on river systems where catchment and in-river liming have been employed to treat acid run-off. **(NRA:W, RA:NW)**

Fisheries studies (commercial and sport)

2. Juvenile salmon are being microtagged in a number of rivers in England and Wales as part of a national programme to compare patterns and levels of exploitation in various home water and high seas fisheries on stocks from different regions. **(MAFF, NRA:HQ)**

3. An integrated tracking and Floy tagging programme has been carried out on the River Tywi to assess the levels of exploitation and degree of selectivity of commercial and recreational fisheries. **(NRA:W)**

Gear

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

Genetics

5. 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, NRA:HQ, Bucks)**

Habitat studies

6. A study is being carried out on a stream passing through a newly afforested area. The long-term effects of the forestry development on the

physical characteristics of the river, in particular water quality, quantity and temperature, and its fish population will be studied. (IFE)

7. The effects of reservoir development on water chemistry, sediment transport and salmonid and invertebrate populations are being investigated on the River North Tyne. (NRA:HQ)

8. The effects of siltation on the survival of salmon ova and alevins are being investigated in both spate rivers and chalk streams. (MAFF, IFE, NRA:NW)

9. Habitat indices including physical and biological features are being developed. (IFE)

Juvenile studies

10. The ecology of the young stages of salmonid fish and the implications for practical river management are being investigated. This is part of a continuation of studies of dispersal of salmon fry from a point stocking and channel studies of the relative value of stocking with unfed and five week fed fry. (IFE)

Migratory patterns (freshwater and estuaries)

11. Radio and acoustic tracking techniques and fish counters are being used to investigate the effects of environmental factors, such as natural and artificial flow regimes and water quality, on patterns of movement of migratory salmonids. (MAFF, NRA:W, NRA:Wx, NRA:S, NRA:SW, IFE)

12. Acoustic tracking, using sonar buoys, has been used to study the factors affecting the emigration of salmon smolts from freshwater and their residence time in the estuary. (MAFF)

13. Bubble screens and strobe lights are being tested as means to deflect salmon smolts from a major reservoir intake on the River Thames. (NRA:T)

14. Laboratory investigations are being carried out to assess the risks to migratory fish of passage through turbines in tidal power schemes. Separate experimental facilities are being used to determine critical conditions leading to fish damage arising from: (i) rapid rates of change of hydrostatic pressure; (ii) water shear and turbulence; (iii) cavitation; and (iv) collision with fixed or moving structures. Theoretical modelling studies are being undertaken (by the National Engineering Laboratory) to define ranges of these conditions that are likely to arise in turbine generation. (Nat. Power)

Parasites

15. The immunological interaction between salmon and trout and the sea louse, Lepeophtheirus salmonis, is being investigated. Attempts are being made to identify possible antigens involved in nutrition, metabolism or reproduction of the parasite with a view to manipulating and cloning genes encoding for these antigens. (Plymouth)

Physiology

16. Neurophysiological and behavioural studies are being conducted into the olfactory response of precocious parr to certain sex steroids and other putative pheromones. A SEM and TEM study of the anatomy and development of the olfactory rosette is being undertaken. **(MAFF)**

17. A magnetic study of salmon has been carried out; magnetic particles have been located in the lateral line and characterised. The anatomy of the lateral line and the putative magnetoreceptor have also been investigated. **(MAFF)**

Stock assessment

18. Fish counters are being installed and run on a variety of rivers in Wales, the north-west and in the south with the aim of assessing adult salmonid stocks and estimating exploitation in fisheries. **(MAFF, NRA:W, NRA:NW, NRA:S)**

19. 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)**

Stock enhancement

20. The quality of salmon fry reared in gravel and plastic substrate incubators and conventional troughs has been compared under full production conditions. **(MAFF)**

21. The behaviour and dispersal of newly released hatchery reared unfed and fed fry is being compared with wild fish in an evaluation of various stock enhancement practices. **(MAFF, IFE)**

22. The effectiveness of stocking streams with different life stages of salmon are being investigated in spate rivers (Wales) and chalk streams (south). **(MAFF, NRA: Wales)**

23. A desk study is being carried out to identify possible means of habitat improvement in steep, flashy streams. **(NRA: Wales)**

24. A long-term project is being set up on an experimental stream with a permanent trap site in order to optimise stocking strategies. The effects of stocking density, habitat type and stock parentage on the cost effectiveness of stocking sea trout will be investigated. **(NRA: Wales)**

Stock investigations

25. A trapping facility is being established on the River Dee, Wales to investigate the status and variability of stocks in relation to fisheries. **(NRA:W)**

26. A smolt trap is being operated on the River Pang (a tributary of the River Thames) to establish the timing of smolt migrations and to relate smolt production to juvenile stocking and population surveys. **(NRA:T)**

27. The apparent decline of migratory salmonids in the River Torridge catchment is being investigated by means of land use and water quality studies, juvenile population surveys and bioassays. **(WRc, MAFF, NRA:HQ)**

28. Detailed investigation of the migratory salmonid stocks on the River Tamar have been carried out to assess the impact of a major reservoir scheme and devise the best operational strategies. The programme has included studies of: fish movements in the estuary and freshwater; juvenile production in nursery streams; and the effects of flow on the rod fisheries. **(NRA: South-west)**

29. The brown trout populations of the River Usk are being investigated with specific reference to recruitment variability and the genetic integrity of component population. **(NRA: Wales)**

Techniques

30. Further trials have been conducted with a high resolution tracking system, which is being developed to study the behaviour of smolts and adult salmon around fish passes and obstructions and the territorial behaviour of parr. **(MAFF)**

Activities related to ICES resolutions

Methods for improving the reliability of salmonid catch statistics are being reviewed and tested in several areas. Historical salmonid catch statistics from 1951 to 1988 are being compiled. **(MAFF)**

EELS (Anguilla anguilla)

The Fisheries

Catch returns are not generally required from eel fishermen in England and Wales and no data are available for 1990. Although the recorded catch for 1989 was 21 t elvers and 81 t eels, the actual landings are thought to be higher. The annual catch was estimated in 1982/83 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 was taken in freshwater and half in estuaries and the sea.

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 wild eels from the lower River Severn in 1990 again failed to show evidence of the disease.

Investigations

Competition

1. The age, growth, diet and annual production of eels were examined in a southern chalk stream. Diets of eels, juvenile trout and juvenile Atlantic salmon were compared, and the impact of eel culls on the juvenile salmonid population was assessed. It was concluded that eels do not have a measurable effect on salmonid populations either through direct predation or by competition for the same food source. **(IFE)**

Parasites

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:CRK)**

Stock assessment

3. The effects of the River Severn commercial elver fishery on riverine eel stocks is being studied in order to provide advice on its management. The effects of weirs as barriers to elver migration are being examined to assess the potential value of passes. **(PCL)**

RAINBOW TROUT (Oncorhynchus mykiss)

Investigations

Parasites

1. The routes and methods of colonisation of reservoirs by parasites are being studied with comparison of the importance of anthropogenic activities and natural movements of birds and fish as agents of introduction of parasites to new localities. The investigation includes studies of the population and transmission dynamics of selected species of parasites in trout and the role of fish stocking in the transmission of helminth parasites. **(Exeter:CRK)**

Physiology

2. The role of the renin-angiotensin system in the adaption of rainbow trout to sea water is being investigated. The binding of angiotensin II to various tissues of freshwater and seawater adapted trout has been examined with special emphasis on tissues with an osmoregulatory role. Receptor binding studies using isolated glomeruli have been undertaken to characterise and compare angiotensin receptors in freshwater and seawater adapted trout. **(Exeter:AB)**

3. Studies of the deleterious effects of stress have continued with efforts to improve and widen the range of measurable physiological indices. These now include biliary steroid levels and hepatic conjunctive enzyme activity, in addition to hormonal, haematological and metabolic parameters. Monitoring these factors can provide early warning of potential damage from, for example, sub-lethal pollution. (IFE)

4. Breeding experiments are being carried out on trout which display either consistently high or consistently low responses to stress, as measured by plasma cortisol elevation. The progeny have displayed traits similar to those of the corresponding parental stock. (IFE)

5. Studies are continuing on the effects of stress on reproduction in trout. Results obtained this year indicate that episodes of chronic or acute stress delay ovulation and spermiation can lead to reduced survival of fertilised eggs. (IFE)

6. A project carried out in conjunction with INRA, France has demonstrated that chronic stress suppresses circulatory levels of the key pituitary hormone prolactin. (IFE)

WHITEFISH (Coregonus spp.)

Investigations

Stock studies

1. The vendace (Coregonus albula) and shelly/gwyniad/powan (Coregonus lavaretus) populations of England and Wales are being investigated in a three-year project which will encompass: the current abundance and composition of stocks; their within-lake distributions in relation to oxygen and other factors; their variation; and their potential for captive breeding. (IFE)

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ATLANTIC SALMON (Salmo salar) and SEA TROUT (Salmo trutta)

The Fisheries

The nominal catch of salmon for Northern Ireland in 1990 was 94.1 t, the lowest catch since 1987.

Most north coast netting stations are in the form of fixed bag nets, for which 13 licences were issued in 1990. In addition, 11 draft nets and 4 drift nets were also licensed. Four licences were issued for a commercial freshwater trapping station on the River Bann. Most of the commercial fishing is carried out in the Foyle area, where 110 drift net and 95 draft net licences were issued. The total of 237 licenses issued represents a decrease of 8 from 1989. The commercial fishery operated between 20th June and 31st August 1990 in the Foyle and from 17 March to 15 September elsewhere. (The R. Bann traps operate from 1 March to 19 August.). Regulations governing type of material and mesh sizes of nets remained unchanged.

Investigations

Acid rain

1. Monitoring of precipitation chemistry around the Province continued in 1990. The annual summmary for 1990 will not be available until May 1991, but is expected to show that the mean pH on the eastern side of the Province continues to be about 0.3 pH units lower than that on the western side (the latter's mean annual pH is typically around 5.1). The acid rain database is now extensive enough to permit trends with time to be discerned. Thus, for the Silent Valley site in the south west, the monthly mean rainfall pH values show a significant upward trend with time, of 0.08 pH units p.a. from a pH of 4.5 in January 1985. This matches a significant downward trend of about 0.02 mgl^{-1} p.a. in sulphate concentrations from a starting point of around 4 mgl^{-1} SO_4 in January 1985. It would appear that the recent reductions in SO_2 emissions from UK and Europe have been effective in reducing the acidity of rain falling in N. Ireland. **(B)**

2. Daily monitoring of pH, Al and other relevant ions in the upper reaches of the Annalong River (Mourne mountains) ceased at the end of December 1990, after 1.5 years of data collection. Preliminary observations indicate that the total and labile Al concentrations in the river are very sensitive to the pH of the water. Thus, at pH 6 and above, total Al concentrations are close to 200 ugl^{-1} and are independent of pH (200 ugl^{-1} is the EC limit for drinking water and is also considered to be the level above which salmonid fish find it difficult to survive). However, below pH 6 the total Al levels rise rapidly to 600-700 ugl^{-1} at around pH 5. By comparison, labile Al concentrations are only around 50 ugl^{-1} above pH 6, but rise to around 400 ugl^{-1} at pH 5. The drop in pH in the river is associated with an increase in the river's flow, indicating the influence

of rainfall events. Calcium and magnesium can ameliorate the toxic effects af Al. In the Annalong River, Ca levels were 1.5+/- 0.6 mgl^{-1} while Mg levels were 1.0+/-0.3 mgl^{-1} throughout the study period (over twice the Ca and Mg levels in rainfall).

It is unlikely that the proposed intensive monitoring of the effects of acid rain in the upper River Bush catchment reported last year will now take place. **(B)**

Fisheries studies (commercial and sport)

2. 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. Adults used for broodstock operations on the R. Bush are externally tagged before release as kelts. **(A)**

Genetics

3. Investigations have continued into the population genetics of wild and hatchery stocks of Atlantic salmon in N. Ireland. The genetic basis of observed enzyme variation at several polymorphic loci has been verified by breeding studies. Other research continued the development of a genetically-marked stock of R. Bush hatchery salmon. These were used in a stock enhancement project in a Co. Antrim river in 1990. Genetically-marked fry were stocked in May and follow-up electrofishing and genetic screening were used to assess their survival to the summerling stage. **(A)**

4. 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. **(C)**

5. 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. **(C)**

Population dynamics

6. 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 and 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

7. Predation by cormorants, Phalacrocorax carbo L., on juvenile salmon and trout stocks on the R. Bush continues to be studied at a low level. Although no all-river counts were made in 1990, counts of nests and egg clutches were carried out on a nearby colony, together with analysis of stomach contents of feeding birds. **(A)**

Stock assessment

8. 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 alternative index of recruitment to smolt counts is being assessed. Preliminary results are encouraging, with a significant relationship between fry numbers and subsequent counts of 1+ smolts at the Bushmills trap. (A)

9. 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.

10. An overall assessment of the economic value of juvenile salmonid nursery habitat is being carried out in terms of the replacement value of stocks following fish kills and the potential loss of adult production to commercial fishing, angling and subsequent spawning. This has been submitted for publication. (A)

11. Electrofishing surveys of stretches of the R. Bush that have been subjected to different degrees of land drainage have been used to assess utilisation of these habitat types by naturally spawned salmon. At one site, habitat parameters are being measured biennially to quantify natural recovery of experimental stretches where drainage works were carried out in 1984. Elsewhere on the R. Bush, rehabilitation of drained stretches is being carried out with the addition of groynes, restoning of nursery habitat and installation of spawning beds. This work is to be completed in 1991 and project work will be proposed to further examine stabilisation of rehabilitated habitat. (A)

Stock enhancement

12. Habitat surveys have been carried out throughout the R. Bush system, and the results used to plan a salmon enhancement programme. Since 1983, up to 500,000 swim-up fry annually have been stocked into the system in suitable habitat where there is no natural spawning. Follow up semi-quantitative electrofishing surveys have monitored survival to summer fry stage, with longer term monitoring of descending smolts and returning adults taking place at the Bushmills traps. No stocking has been carried out since 1986, due to improved natural ova depositions in the river. (A)

13. Ongoing work is aimed at relating survival of juvenile salmon to stocking densities under high and low levels of intra-specific competition. Results from the range of densities tested up to 1990 (1 to 20^{m-2}) suggest that

fry stocking densities up to 20 m^{-2} may be applied to good habitat without adverse effects on survival. In best habitat the optimum density may lie above this. (A)

14. The potential of the R. Lagan system as a salmon river 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. Wiers have been surveyed with a view to determining the need for and feasibibity of installing fish passes. Habitat improvement/ rehabilitation measures for the entire river will be based on results from the R. Bush work. (A)

Sea ranching

15. The effectiveness of 'sea ranching' of hatchery reared salmon has been assessed and is being continued at a low level as part of the microtagging programme. (A)

EELS (Anguilla anguilla)

The Fisheries

The nominal catch of eels in Northern Ireland in 1990 was 913 t, similar to the 1989 figure. Most of the catch comes from Lough Neagh, which remains the most important eel fishery in N. Ireland. However, a small component of this may represent eels imported from the Republic of 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. (D)

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UNITED KINGDOM (Scotland)

(R. G. J. Shelton)

ARCTIC CHARR (Salvelinus alpinus L.)

Investigations

Conservation

1. As part of a conservation programme funded by the Nature Conservancy Council, egg hatching rates and mortalities have been studied for Arctic charr from Loch Doon, Ayrshire. Also, the creation of two new populations in reservoirs is being attempted by alevin introduction and direct translocation. Evaluation studies of their success are intended. **(A)**

Ecosystems

2. Investigations of the stomach contents of Arctic charr (Salvelinus alpinus L.) from lochs in the Grampian Highlands have generally indicated that they feed mainly on benthic invertebrates and zooplankton, with organisms such as non-biting midge larvae and pea mussels predominating in spring and early summer and zooplankton assuming greater importance in the autumn. Fish-eating is unusual and much less marked than in brown trout in the same loch. Loch Rannoch charr, however, consist of 2 forms or morphs; one almost entirely planktivorous and the other a benthic feeder which also eats some fish.

   Juvenile salmon which had escaped from cages in Loch Ericht in February 1989 were found in both charr and trout caught in gillnets in June. Salmon juveniles comprised 45% of the stomach contents of the charr by volume, and 77% of the stomach contents of the trout. Zooplankton comprised the main food found in charr in a sample taken at the same site in late August 1985. No trout were caught on that occasion.

   The high representation of fish in the Loch Ericht charr has no analogue in any charr population so far studied in the Grampian Highlands.

   Enhanced growth of charr living on waste food and associated invertebrates near cage-rearing facilities has been observed in a number of Scottish lochs. The recent rapid increase in the rod-caught record to 4 lb 12 oz. (2.15 kg) from a figure of under 2 lbs. (<1 kg), which had lasted for many years, is a remarkable indicator of this phenomenon. Such enhanced growth may have assisted Loch Ericht charr to gain access to the new food resource of juvenile salmon and indicates that the complexity of the ecological impact of cage-rearing units in Highland lochs is not limited to the effects of polluting "waste" food and faecal matter. **(B)**

ATLANTIC SALMON (Salmo salar L.)

The Fisheries

Total Catch

The combined catches of salmon and grilse (salmon which have spent only one winter at sea) reported caught in 1989 by rod and line, net and coble, and fixed engine were 88,007, 93,266, and 97,554 fish respectively giving a combined total catch of 278,827 fish. This total was 7% more than in 1988 but 5% less than average for the period 1984-1988.

The rod and line catch was 9% lower than in 1988 but 17% higher than the average for the period 1984-1988. Both net and coble and fixed engine catches were greater than in 1988 (by 17% and 15% respectively).

The total weight of salmon and grilse caught was 895.4 tonnes, 2% more than in 1988 (Table A). The mean weight of fish reported as salmon was 9.8 lbs (4.5 kg), the same as in 1988, while the mean weight of fish reported as grilse was 5.4 lb (2.5 kg), 0.2 lb (0.1 kg) less than in 1988.

The summer of 1989 included a long period of hot, dry weather during which conditions for fishing were poor. Catches improved markedly in the autumn when wetter weather and increased river flows occurred.

At the time of writing, the 1990 salmon catch returns were incomplete. The indications are, however, that catches will be less than in previous years, especially in the net fisheries. A long period of low flows, especially in the East, North East and Moray Firth regions meant that fishing conditions were poor for most of the season.

Regional Catches

The numbers and weight of salmon caught by Region are summarized in Table B along with the percentage changes from 1988 to 1989. The 1989 catch is compared with that of 1988 and the 1984-1988 5-year average. The all method catch increased in 6 regions, East, North East, North, West, Clyde Coast and Solway and decreased in the Moray Firth, North West and Outer Hebrides Regions.

The 1989 catch in terms of both numbers and weights was above the previous 5-year average in the East, West, Clyde Coast and Solway regions but down in North East, Moray Firth, North, North West and Outer Hebrides (Table B).

The distribution among Regions was similar to that in 1988 with 69% of the catch being divided among the 3 east coast regions, East, North East and Moray Firth (67% in 1988).

The total number of spring fish (those taken before 1 May) was 9,420, 35% down on 1988. The majority of spring fish (77%) was taken by rod and line. The net and coble and fixed engine fisheries took 16% and 6% respectively.

Investigations

Fish Counters

1. The 1989 upstream count recorded by the "Logie 2100A" counter on the North Esk was similar to the 1988 count and the second highest since records began in 1981 (1988 was the highest). However, the distribution of counts throughout the year was quite different from that observed in previous years with nearly two-thirds of the counts being recorded in the period from 1 September to 30 November. Figure 1(a) shows the counts for 1981-1990, and Figure 1(b) the monthly counts for 1990.

   A second "Logie 2100A" counter was installed in the North Esk catchment during 1989/1990 when a Crump weir bearing electrodes was constructed in the West Water, the major tributary of the North Esk, near Edzell.

   During the summer of 1989, a "Logie 1700A" single channel, battery operated counter was tested in Newfoundland, Canada in a collaborative exercise with the Department of Fisheries and Oceans, St John's, Newfoundland. The counter was installed in the opening of a small concrete control dam about 30 m upstream from the end of a fishway in the Northeast River which is located on the western Avalon Peninsula and flows into Placentia Bay. The fishway is located about 9 km above the head of tide. Installation and calibration were undertaken from 24 to 30 June during which time visual surveillance was maintained to determine threshold levels for the counter. The experimental period ran from 1 to 26 July.

   The accuracy and reliability of the fish counts were assessed by comparison with an independent visual count of salmon released from a wooden trap located immediately upstream from and adjacent to the uppermost pool of the fishway. Daily records of the numbers of salmon released from the trap and counts recorded by the counter were maintained. Throughout the experiment, Atlantic salmon were allowed to move unhindered through the counting zone.

   During installation and calibration, 9 salmon, mainly grilse, were released from the trap and 9 were recorded by the "Logie" counter. Salmon were observed to cross the counting zone between 15 minutes and 2 hours after release from the trap. During the experimental period, a total of 517 salmon was released from the trap. In the same period, the counter recorded a total of 549 upstream and 32 downstream fish movements, giving a net upstream count of 517, exactly matching the number of salmon known to have been released from the trap. Trap attendants observed that some salmon remained just upstream of the counting zone for a short time after crossing the Crump weir bearing the counter's electrodes. A few were observed to pass back down through the counting zone. It is not known whether these descents were direct attempts to move back downstream or were simply fish which accidentally dropped back over the weir. Because of the presence of the trap, any fish which fell back over the counter were forced to re-ascend and be counted a second time.

During October 1990, a "Logie 1700A" single channel, battery-operated counter was tested in a fishway in the River Esva, near Oviedo in Asturias in northern Spain. The counter was tested by visual surveillance and, although installed in a temporary structure, performed faultlessly. (B)

Parasites

2. Sea lice (external crustacean fish parasites of the family Caligidae represented predominantly by the genera Lepeophtheirus and Caligus) are often found on fresh-run salmon and sea trout. It is known from experience of the high seas fisheries and from cage culture that salmon are liable to pick up lice throughout their sojourn at sea. Records of sea louse occurrence on wild post smolts are nevertheless infrequent.

   An aggregation of wild smolts was observed off the south east coast of Kintyre, Scotland, in May 1988. The aggregation was within 100 metres of the shore and one of the fish was seen to be behaving lethargically. This fish was caught with a hand net for examination. It was a salmon post smolt (2 years old, female, weight 48.6 g and length 122 mm) and was carrying 12 adult Lepeophtheirus sp. Little fat was evident around the gut and it was in poor condition. The observation of a wild salmon post smolt with a heavy louse burden indicates that infestation by sea lice can occur soon after entry to the sea. It is not known whether the poor condition of the smolt described was as a result of the sea louse burden or if the sea lice were exploiting an otherwise weakened fish. (B)

3. The Kyle of Sutherland catchment in North East Scotland comprises 3 principal rivers, the Shin, Oykel and Carron, which share a common estuary. Genetic variation among the salmon populations of the catchment was assessed by determining the frequencies of genetic variants of enzymatic proteins in juvenile salmon obtained at 5 sampling locations. The frequencies of variant enzymes were compared among sites of origin. Significant genetic differences were detected overall as well as at most of the individual enzyme loci examined, indicating that the fish belonged to different, reproductively-isolated populations.

   Previous study has shown that the frequency of the variant form of one of the enzymes examined (Me-2) may be determined in part by natural selection. Two genes encode for Me-2 in salmon populations and these have been designated as the 100 and 125 forms. The gene encoding for the 100 form is more prevalent among salmon living in the southern part of the species', global range while the 125 form is predominant in northern latitudes. Both forms are common at intermediate latitudes. It has been shown that the frequencies of the alternative forms in populations correlate better with environmental temperature than with latitude. This indicates that Me-2 gene frequencies may be influenced by the effects of selection associated with differences in environmental temperature. This idea was tested among the salmon populations of the Kyle of Sutherland catchment. This catchment is a particularly suitable test site because the thermal regime of one of the component rivers (the River Shin) was modified in 1957 when the river was dammed to increase the capacity of the natural Loch Shin for electricity generation. Water is now delivered to the river via turbines powered by water drawn from below the surface

layers of the loch. As a consequence, the temperature of the River Shin is lower and the range of temperatures among the Kyle sampling sites is greater than might be expected.

The frequency of alternative genetic forms of Me-2 among the Kyle sampling sites was found to be significantly correlated with environmental temperature. The frequency of occurrence of the 100 variant was least at the coldest sampling site and greatest at the warmest one. This supports the idea that natural selection, associated with differences in temperature, is partly responsible for determining Me-2 variant frequencies in salmon populations, even on this local scale. The consequences of this are not fully understood but variation among individual fish possessing different forms of Me-2 is associated with differences in juvenile growth and with the attainment of sexual maturity in adults as grilse or salmon.

With the exception of the Me-2 locus, most of the genetic divergence between the populations of the Kyle rivers appears to be due to the random effects of genetic drift. The divergence among populations, however it has been established, is probably maintained and reinforced by the homing of adults to those reaches of the catchment where they were themselves spawned and where they lived as juveniles. **(B)**

Physiology

4. The nature of the association between growth and age at sexual maturity and the genetic constitution of individuals for the Me-2 genes is not understood. The link may be indirect though the Me-2 gene's linkage on the chromosome with some other more important gene or genes. Alternatively it is possible that the link is direct. That is to say, it may reflect differences in the biochemical properties of the enzymes encoded by the two genes. The frequency with which the alternative genetic forms of Me-2 occur in populations appears to be associated with water temperature. This suggests that the interaction of the effects of the Me-2 enzymes with temperature may underlie differences in performance between fish which carry the different Me-2 genes. In particular, enzymes of different type may function in a manner which depends on temperature, making individuals better adapted to warmer or colder environments.

   The enzyme encoded by the Me-2 genes functions metabolically, to facilitate the biochemical inter-conversion of malate and pyruvate, substances which are important in the interval release of energy. Mitochondria were prepared from fish carrying only the 100 or only the 125 forms of Me-2. Laboratory experiments compared the rates at which these preparations oxidised malate across a range of temperatures. Over the entire range examined, the rate of conversion of malate was higher in preparations from fish carrying the 125 forms of Me-2 than in those from fish carrying the 100 form. This suggests that the differing biochemical properties of the enzymes encoded by the two forms of Me-2 may underlie the differences in performance existing between individuals which carry different Me-2 genes. **(B)**

Fish farm escapees

5. In February, 1989, approximately 184,000 growing salmon escaped from fish-farm sea-cages into Loch Eriboll in northern Scotland as the result of a single accident. By July it had become clear that escaped farmed fish were entering the nearby River Polla with the native run of wild fish. This was inferred from the different appearance of the two groups and particularly from the presence of residual fin damage on putative farmed fish. The accuracy of this classification was confirmed by the results of tissue pigment analyses. Wild fish carried only the pigment astaxanthin. Farmed fish also carried the pigment canthaxanthin which had been an additive to their diet before escape. Salmon of both types were present in the river throughout the summer, autumn and early winter and spawning of wild and farmed fish was documented and compared.

   The movements of radio-tagged wild and escaped fish were monitored in the river until spawning was complete. These data were supported by bankside observations of spawning and by pigment analyses of adult body tissue, of eggs sampled from redds after spawning and of alevins sampled from the river after hatching. The progeny of farmed females differed from those of wild females in carrying the pigment canthaxanthin until the alevin stage.

   All the fish of both types entering the river were sexually mature and farmed and wild fish of both sexes were observed to spawn. All of the females captured towards the end of the year were spent. Wild fish were distributed throughout the river at spawning but the distribution of farmed fish was more restricted. Farmed fish of both sexes tended to spawn mainly in the lower reaches of the river. This tendency was particularly marked among the females. The difference in the distributions of farmed and wild fish at spawning was confirmed, in females by pigment analyses of eggs and alevins sampled from redds located throughout the river's length. Farmed females tended to spawn later than wild ones and sometimes cut redds in areas of spawning gravel where redds had previously been constructed by wild fish. The segregation of farmed and wild fish was incomplete however, and they were observed to interbreed on many occasions.

   Further studies were performed to establish whether escaped farmed females had spawned also in the Rivers Hope and Dionard which flank the Polla to the east and west, respectively. Pigment analyses were made on alevins sampled from 2 sites (lower and upper river sites) in both rivers. In the River Hope, 2 of 104 alevins from the lower river sampling site contained canthaxanthin and had therefore been spawned by farmed female escapes. None of the 51 alevins sampled from the upper site contained canthaxanthin. In the Dionard one of 69 and 3 of 122 alevins sampled from the lower and upper sites respectively, contained canthaxanthin. The progeny of farmed females were present in both the Hope and Dionard at much lower frequencies than in the Polla, suggesting that the return of escaped fish from the accident in Loch Eriboll was largely restricted to the Polla. Indeed, it is possible that the farmed females whose spawning was detected in the Dionard and Hope had escaped from farms elsewhere along the coast.

The incidence of alevins containing canthaxanthin probably underestimates the incidence with which escaped farmed fish participate in spawning for 2 reasons. Firstly, any spawning by males will go undetected because males do not contribute to the pigment load of their progeny. Secondly, some females may not contain detectable levels of canthaxanthin because they have not been fed the pigment in culture or have fed on marine prey items for long periods between their escape from the fish farms and their return to freshwater. **(B)**

Table A. Numbers and Weight of Salmon and Grilse: All Scotland

	Numbers (thousands)				Weight (tonnes)			
	5 year average 1984--1988	1988	1989	Percentage change 1989 on 1988	5 year average 1984--1988	1988	1989	Percentage change 1989 on 1988
Rod and Line	75.5	96.5	88.0	- 9	289.8	356.9	314.3	-12
Net and Coble	93.3	79.8	93.3	+17	326.3	271.2	301.2	+11
Fixed Engine	126.0	85.0	97.6	+15	383.9	253.6	279.9	+10
All Methods	294.8	261.3	278.8	+7	1000.0	881.7	895.4	+2

Table B. Numbers and Weight of Salmon and Grilse: By Regions

	Numbers (thousands)				Weight (tonnes)			
	5 year average 1984--1988	1988	1989	Percentage change 1989 on 1988	5 year average 1984--1988	1988	1989	Percentage change 1989 on 1988
East	71.4	71.4	80.2	+12	284.8	274.1	293.9	+7
North East	66.5	45.8	62.6	+37	219.4	154.8	186.4	+20
Moray Firth	70.40	57.9	49.1	-15	220.3	179.5	146.6	-18
North	39.9	34.6	36.4	+5	124.4	107.4	111.7	+4
North West	15.0	16.2	11.1	-31	46.3	50.6	34.8	-31
West Coast	7.6	8.6	9.1	+6	24.5	26.4	27.8	+5
Clyde Coast	6.8	8.6	10.6	+23	22.5	28.9	31.7	+10
Solway	15.0	15.7	17.3	+10	51.3	52.8	56.4	+7
Orkney	-	0.0	0.0	-	-	0.0	0.0	-
Shetland	-	0.03	0.09	-	-	0.05	0.1	-
Outer Hebrides	2.2	2.5	2.2	-11	6.4	7.1	5.9	-17
All Scotland	294.8	261.3	278.8	= 7	1000.0	881.7	895.4	

Fig. 1a - Net upstream counts at Logie, 1981-89

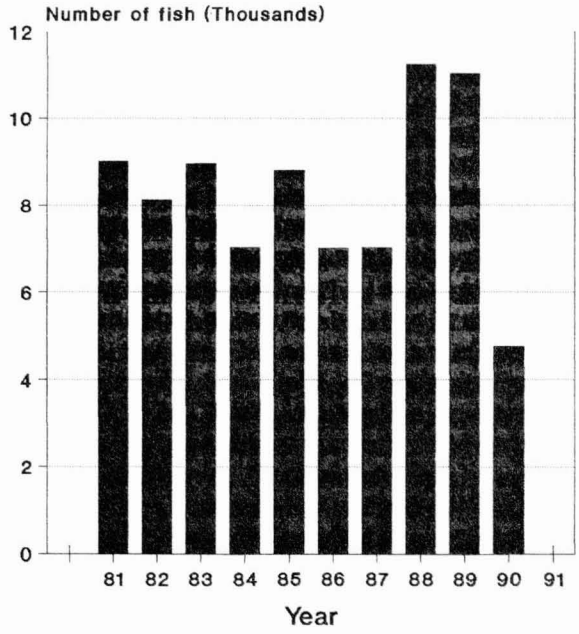
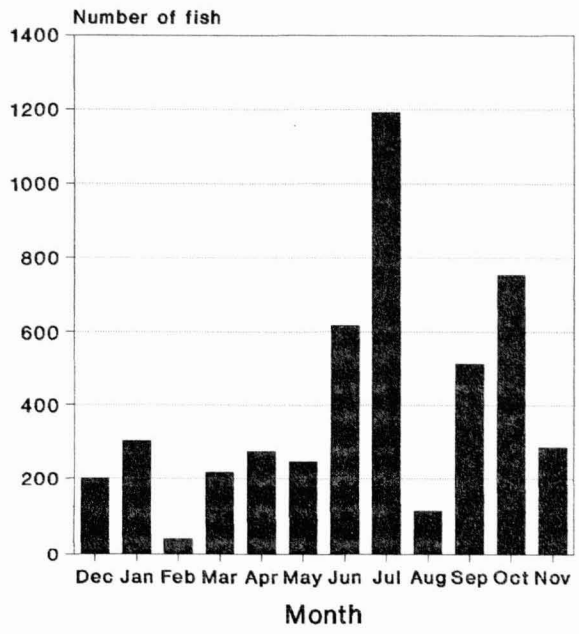


Fig. 1b - Monthly upstream counts at Logie, 1990



EELS (Anguilla anguilla L.)

The Fisheries

Fishing for eels in Scotland has taken place for centuries, silver eel fishery records date back over 800 years. It is difficult to determine the extent of the present eel fishery since there is no statutory provision for collecting information on catches. In 1989, an attempt was made to compile a register of eel fishermen (i.e. people who fish for eels full- or part-time with gear other than rod and line) in Scotland and gather some details of the catches made.

During the 1989 fishing season 17 eel fishermen operating in Scotland were contacted. Numerous other contacts were made with potential fishermen and others who no longer fished due to poor returns in the past.

The most commonly used capture method in still waters and rivers was the Dutch fyke net; a boat with 2 men, one to row the other to set or haul the string of nets) being the norm. Baited eel pots were used to fish deeper water in lochs. Undersized eels (the minimum size kept varied) were returned to the water. Migrating silver eels were also caught, either by fyke nets set at loch outlets or fixed permanent traps on streams and rivers.

Those contacted fished throughout the Scottish mainland, Skye and the Orkney Isles, particularly on lowland rivers and lochs with good access for ascending elvers. Those fishermen who used fyke nets often travelled long distances to fish. Individual catches during 1989 ranged from 0.25 to 10.76 t and the total catch from this group of fishermen totalled 23.44 t. Ninety-three per cent consisted of yellow eels caught in fyke nets and baited pots and 7% migrating silver eels caught mainly in traps. The fishermen generally caught fewer eels (both yellow and silver) in 1989 than they had anticipated on the basis of their past catches. In some areas the expected run of silver eels did not materialise. Two trapping sites which had consistently produced catches in the region of 1 t, caught no silver eels in 1989.

No comprehensive information is available on the catch taken by a number of professional Dutch, Danish and English fishermen who have fished Scottish lochs each summer for the past 10 or more years and who are not included on the register. Their method is intensive fyke netting of yellow eels, generally taking everything possible, and then moving on. Estimates of their past annual catches have varied between 10 and 50 t. It is thought that there are now few such fishermen operating due to reduced catch rates.

A study commissioned by the Highlands and Islands Development Board concluded in 1976 that Highland eels required an average of 17 years to reach 112 g in weight and similar growth rates have been observed elsewhere in Scotland. There may therefore be a long recovery period (perhaps 7 to 12 years) required by a fishery which has been heavily fished for yellow eels. In some areas of Scotland fishermen are now complaining of poorer catches than in past years as a result, perhaps of heavy exploitation and the series of poor elver runs which have been a feature of European eel populations for some

time. A recent cause for concern is that there is now a market for any size of eel down to a minimum of 130 g which may further increase pressure on stocks.

SEA TROUT (Salmo trutta L.)

The Fisheries

The national reported catch of sea trout in 1989 (all methods) was 96,825 fish weighing 105.8 t, slightly higher than the catch reported in 1988 (96,497 for 97.9 t). However, concern was again expressed about the state of sea trout stocks in the north west of Scotland where this year some fisheries experienced their poorest ever angling catches. In Scotland as a whole, rod catches fell in the East, Moray Firth, Shetland, North West, West and Solway regions, with the greatest proportionate decreases in North West and Solway. Many Scottish rivers remained very low over the early summer following an unusually mild winter with little snow and a dry spring. In most parts of the country, catches were probably no worse than might be expected in drought conditions. However, this does not explain the low catches in the north west where there was sufficient rainfall for the summer runs to take place.

Investigations

Environment

1. Over the past 30 years salmon (and sea trout) have returned to several rivers in the Central Belt of Scotland where they had been extinct for the greater part of this century, or even longer.

   The principal cause of the extinctions was the loss of access to (and from) satisfactory spawning and nursery areas mainly caused by pollution of the lower rivers and upper estuaries. The demise of the river populations was often aggravated by the degradation of spawning and nursery areas by urban, domestic and colliery and other industrial wastes. Agricultural practices such as the clearing of extensive raised bogs or "mosses" to provide agricultural land by flushing the peat down watercourses were also destructive. In addition, the river systems were obstructed by weirs with inadequate provision for upstream passage of spawning adults. By the late 18th century the runs of salmon in much of Central Scotland were in decline. The situation in the 19th century became increasingly bad and salmon completely disappeared from many of the rivers.

   Fortunately, over the last 30 years improved treatment of domestic and industrial wastes and reductions in industrial discharges have resulted in such significant improvements in water quality that salmon in this industrial area of Scotland have reappeared in at least 8 rivers from which they had become extinct. **(B)**

2. During the past decade the concentration of sulphate and acidity in precipitation has declined by about 40% in Scotland which corresponds to a similar reduction in UK SO2 emissions. Ammonium and nitrate concentrations have remained relatively stable. Because of the considerable day to day variation in streamwater quality, it is more difficult to detect net changes in these systems than in lochs which tend to "dampen" short term perturbations. In Galloway, there is clear evidence of reversal of acidification in upland lochs draining undisturbed catchments. However, there are differences in the rates of response of pH to changes in acidic inputs. The pH of Loch Enoch, a clear, low base cation (mostly calcium and magnesium) water, has increased faster than that of Round Loch of Glenhead, with its higher organic acid and base cation content. Palaeolimnological evidence indicates that the pH of Loch Enoch would have been about pH 5.5 in pre-industrial times when fish were known to populate the loch. To date the mean pH of Loch Enoch has changed from 4.4 in 1980 to the present day value of 4.8, a change in acidity of 24/ueql-1. A similar change during the next decade would bring the pH back to 5.5, with the possibility of experimental re-introduction of trout when the pH reaches a mean of 5.0. The factors causing these differences in response to reductions in acidic inputs have yet to be quantified but the role of aluminium and its inter-relationship with organic acids is undoubtedly of prime importance.

   Similar studies of the reversal of acidification have continued at stream sites in Loch Ard forest, north of Glasgow. The 2 selected reference streams were initially less acid than the Galloway lochs and each stream held a small resident trout population. Since 1977, around the time when 50% of their catchment areas were planted with conifers, the annual mean pH of one stream has increased from 4.9 to the present day value of 5.24 while that for the other stream has increased from 5.5 to 6.08. These findings have important implications with reference to the role of forests in stream acidification and emphasise the key role of pollutant inputs when compared with other potentially acidifying processes such as base cation uptake via tree roots and litter accumulation. **(B)**

3. In a major clear-felling experiment begun in 1988, a reduction in pollutant input to a stream was obtained by the removal of a large proportion (60%) of forest from the catchment. From previous studies we can predict that sulphate and chloride levels should gradually decline due to the removal of the scavenging influence of the trees. This reduction in major anions should cause an equivalent reduction in total cations of which acidity (H+) and aluminium may be important components. Removal of trees also causes a major disruption of the nutrient cycle especially during the first couple of years after felling and before vegetation has become re-established.

   The trees, which were felled during 1988 and 1989, were part of the 35 year old plantation in the Burn 10 catchment within Loch Ard forest. This stream was acid (pH 4.4) prior to the clearfelling and had no trout population. Preliminary results from this study indicate an immediate response to the nutrient cycle disruption but only a minor change in stream concentrations of sulphate and chloride. **(B)**

Fisheries studies

4. Because of the poor catches in north west Scotland last year, the Laboratory approached proprietors and was given access to private, long-term fishing records at selected fisheries from the Durness area southwards to the Rivers Shiel and Moidart and including the Outer Hebrides and Skye. It was not possible to draw clear conclusions from the catch records up to and including 1988, partly owing to changes in size limits and in fishing effort, but some fisheries appeared to have been in decline for several years. Other records were too variable to show any obvious trend.

A scale sampling study was undertaken in the River Ewe system in Wester Ross, which includes the renowned Loch Maree fishery. The Ewe sea trout are characteristically slow-growing multiple spawners which reach specimen weights by living to old ages. The oldest known sea trout, caught in 1928 by the late Charles McLaren, was 18+ years old and had spawned 11 times. A similar study in 1980 showed that the age distribution and mean lengths at sea ages of the catch were almost identical to those found in an investigation carried out by the Fishery Board for Scotland in 1926-28. The sea trout caught in 1980 ranged up to 14+ years old and had spawned on up to 11 occasions. The poor catches in 1989 limited the numbers of fish which could be examined, and the rod-caught sample had to be supplemented by fish examined at spawning time. The combined sample comprised only 156, compared with over 1,100 in 1980 and over 2,800 in 1926-28. Fewer old fish were represented than in the earlier samples, which could have been due simply to the small number of fish examined, although this observation is consistent with general opinion in the north west that the large sea trout were especially scarce. The 1989 results also show some reduction in calculated mean lengths at individual sea ages, suggesting poorer growth at sea.

At the time of writing, the 1990 reported catches of sea trout are not available, but the indications are that it was another bad year. Both rod and net catches appear to have been poor over much of the country. As in 1989, many rivers remained low during the late spring and summer after another unusually mild winter with very little snow. However, there was reasonable rainfall again in the north west, yet catches there remained low. Some fisheries did slightly better than last year, but many of the fish were small. Research in the west of Ireland, where there has been a similar dearth of sea trout, suggests that an increase in marine mortality rather than decreased juvenile production in fresh water may lie behind the shortage of fish. Many of the young Irish trout are said to have been emaciated and heavily infested with sea lice. During July-October 1990, more than 300 finnock (0 sea year trout) were sampled in the estuaries and lower reaches of several west coast and east coast Scottish rivers. There was no evidence that they were unusually thin and little sign of damage caused by sea lice. Further sampling will be carried out in 1991. **(B)**

WHITEFISH (Coregonus lavaretus)

Conservation

1. As part of a conservation programme funded by the Nature Conservancy Council, egg hatching rates and mortalities have been studied for whitefish (powan) Coregonus lavaretus from Loch Lomond, Scotland. Also, the creation of two new populations in reservoirs is being attempted by egg seeding, alevin introduction and direct translocation. Evaluation studies of their success are intended. (A)

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(J. Weaver)

ATLANTIC SALMON (Salmo salar)

The Fisheries

There is no directed commercial harvest of Atlantic salmon in U.S. waters and no sport harvest permitted in the Connecticut and Pawcatuck Rivers. Regulations on the Merrimack River permit a sport harvest, but there were no known catches by anglers in 1990. All known 1990 sport harvests in the U.S. occurred on rivers within the state of Maine and were higher than reported for the previous three years. The primary reasons for this increase were larger salmon runs and excellent angling conditions throughout the fishing season. As in previous years, the larger percentage of fish caught were released (56% overall). The high grilse component which characterized the past several years on Maine's eastern rivers decreased to normal levels this year. An interesting highlight to the E. Machias River rod catch was the occurrence of aquaculture salmon. It was estimated that 20% of the total catch originated from escapees from the salmon farming industry. The overall statewide exploitation rate for Atlantic salmon in Maine Rivers was estimated at 13%.

Abundance

Known Atlantic salmon returns to U.S. rivers in 1990, based on trap and rod catches, totalled 4,506 fish. This total includes 4,442 to U.S. coastal rivers and 64 salmon that entered the Aroostook River, a tributary to Canada's Saint John River that is located mostly in the United States. Overall, the 1990 returns represented a 17% increase over 1989. Returns to southern New England rivers (Connecticut, Pawcatuck and Merrimack) increased by 160%. Returns to Maine rivers were variable; however, most showed moderate increases.

Investigations

Artificial Propagation

1. During 1990 approximately 3,128,000 fry, 969,200 parr and 1,276,200 smolt were stocked in 15 rivers. This total release of 5.4 million juvenile salmon approximated the previous year's stocking. The Connecticut, Merrimack and Penobscot Rivers received the greatest share of the total; 38%, 21%, and 19%, respectively. The stocking of salmon fry (predominant in the Connecticut and Merrimack releases) constituted over 50% of the total releases. A total of 11 million green eggs were taken in 1990, representing an increase of approximately one million over 1989. The sources of these eggs include 4.1 million eggs from recaptured sea-run stock, 6.2 million from hatchery-reared broodstock, and 600,000 from rejuvenated sea-run kelts. **(G and E)**

2. At the Cronin National Salmon Station, located on the Connecticut River, Atlantic salmon eggs were water hardened in normally soft ambient water enriched to 25, 50, 75, 100, and 125 parts per million calcium to determine if increased calcium levels would improve egg survivability. In

a second experiment, egg survivability was compared between Atlantic salmon eggs fertilized with sperm from precocious parr, domesticated broodstock, and sea-run broodstock. Results of the experiments are pending data analysis. **(F)**

Competition

3. The extent of inter-specific competition for habitat between brook trout and Atlantic salmon was assessed in four streams near Kingsbury, Maine. There was extensive overlap between the habitat use patterns of juvenile Atlantic salmon and brook trout but there was little direct evidence of interspecific competition for habitat. The presence of Atlantic salmon appeared to cause brook trout to move to deeper, slower-flowing holding positions, but these changes did not result in reduced fitness of brook trout. **(B)**

Ecology

4. The Habitat Suitability Index model currently in use for Atlantic salmon is non-functional. Several aspects need to be included in the model to make it predictive and useful for fish managers. The Maine Cooperative Fishery Research Unit is developing a model for adult holding pools. Field work on the Dennys River and on Canadian rivers in summer and fall 1990 has led to the development of a preliminary model that will be tested in summer and fall 1991. **(B)**

5. A study was conducted in waters of the White Mountain and Green Mountain national forests to examine habitat selection by juvenile Atlantic salmon. Densities were manipulated and habitat selection was examined. **(B)**

Environmental studies

6. Atlantic salmon and brook trout fry were exposed to stream water acidified to pH 5.5 and to acidified water with 100 ug/L aluminum added. Brook trout are more acid tolerant than Atlantic salmon and were used as a control species. Exposures were conducted in artificial stream channels located on a tributary stream in the Narraguagus River watershed. Fish swimming and feeding behaviour was recorded on videotape periodically during the three week exposure. There was no significant mortality of either species in either treatment. Brook trout behaviour was similar for all conditions, but Atlantic salmon fry were significantly impaired by exposure to aluminum under acidic conditions. Both swimming and feeding activity were significantly reduced. Salmon exposed to aluminum were typically very sluggish and spent most of the time resting on the bottom of the channel. Even brief exposure to sublethal levels of acidity may impair Atlantic salmon fry behaviour and indirectly result in increased mortality from predation. **(A)**

7. Continuous monitoring of stream pH, temperature, and specific conductance was initiated at selected locations in the Narraguagus River watershed. During spring 1990, monitors were operated in Sinclair Brook and in the Narraguagus River. During fall 1990, monitors were operated at these locations and at two additional sites. Fall data are not yet analyzed. In the spring of 1990, pH declined to 5.0 on three occasions in Sinclair

Brook, and to as low as 5.3 in the main stem of the Narraguagus River in an area where significant salmon spawning occurs. The pH declines were associated with rainstorms and were of relatively short duration. If declines of this severity persisted for more than a few days, increased mortality of early life stages of Atlantic salmon would probably occur. (A)

Fish passage

8. Radio telemetry studies of emigrating smolt on the Penobscot River have shown movement increases dramatically at twilight and remains heavy through the night. Smolt passage at hydroelectric sites appears driven by flow patterns. These studies indicate that a low head hydroelectric project spilling 50% of the spring flow (typical of lower Penobscot River projects) would pass 50% of the smolt via spillage and 50% through the turbines. (G)

9. Cooperative studies on the Merrimack and Connecticut rivers continue to assess upstream and downstream fish passage efficiencies at major hydroelectric facilities. These studies are being conducted by state and federal agencies and the hydroelectric owners.

Genetics

10. Studies into techniques to produce all-female Atlantic salmon are underway at the National Fishery Research and Development Laboratory (Wellsboro, PA). The approach being tested uses a combination of sex-reversal and gyno-genetic techniques. Work during 1990 showed that a 15 second exposure to ultraviolet radiation was adequate to inactivate nuclear DNA in milt. Heat shocks of 29°C for 10 minutes starting 10 minutes post-fertilization yielded 9% genic fish. The combination of producing gynogens followed by sex-reversal yields a higher percentage of XX-genetic females than functional males. These males can be used to produce all female progeny. The procedure being tested is to take eggs directly from wild strains and create functional XX-males to be mated with females from the same wild population in the next generation. This approach provides a method for enhancing reproductive efficiency of the natural population with minimal effect on the gene pool. Reproductive efficiency of sex-reversed males will be evaluated as the fish reach sexual maturity. (C)

11. Research continued toward developing a procedure to preserve Penobscot strain Atlantic salmon sperm through cryo-preservation. This program is being developed to increase the possibilities for genetic diversity. (H)

Nutrition

12. Efforts by the U.S. Fish and Wildlife Service to improve Atlantic salmon diets continued. A number of studies were initiated this year which concentrated on the following topics:

    1. The effect that the level of feed grade lecithin has on performance of early feeding fish.

2. The dietary requirements for choline by swim-up salmon fed two sources of protein.

3. The growth and survival of young salmon fed different forms of vitamin E.

4. The comparative responses of fry and fingerlings to oxidized dietary lipids.

5. The qualitative aspects of lipid oxidation in diets of Atlantic salmon.

6. The effect of excess linoleic acid on Atlantic salmon growth.

7. The reassessment of the W3 fatty acid requirements of Atlantic salmon.

8. The minimum requirement of dietary phosphorus for salmon fingerlings.

9. The enzymatic treatment of feedstuffs to improve the nutritional availability of phytin phosphorus, a poorly digested form of phosphorus found in many plant protein feedstuffs. **(D)**

Physiology

13. A study is currently underway to determine the level of continuous exercise (6 to 12 months) required to increase fitness and improve performance (increased growth rate, level of stamina, tolerance to stress, intensity of smoltification, and survival) of juvenile Atlantic salmon. In this study, fish forced to swim continuously at different fixed velocities in circular tanks are given physiological tests at regular intervals throughout their development from fry to smolt to determine optimum current velocities for rearing. Although available evidence suggests that exercise is beneficial to the growth and survival at every stage of Atlantic salmon development, the optimum levels of activity are unknown. **(C)**

14. Blood and gill samples from migrating salmon trapped in the Merrimack River at the Ayers Island Dam and in various tributaries are being used to measure seasonal changes in smolt status. We want to determine when and where smolting occurs and whether smolt can reach the estuary in time to safely enter seawater. **(C)**

15. Researchers investigated the effect of marine growth on the age of maturity of Penobscot River salmon. There is a consistent pattern of slower growth in the summer and faster growth in the winter for fish returning as grilse. The study results suggest that growth rate during the first summer at sea affects age at maturity. However, the relationship is counter-intuitive in that higher growth for grilse during this period does not increase the grilse: salmon ratio. **(E)**

Tagging and Marking

16. In 1990, coded-wire microtags were applied to 814,200 smolt and 60,300 parr from U.S. and Canadian hatcheries (Upper Saint John and Aroostook rivers) in 1990. Also, Carlin tags were applied to an additional 49,900 smolt released in the Penobscot River. Of the fish tagged with coded-wire microtags, 202,900 smolt were released in the Penobscot River, 17,200 smolt released in the Saint John River, 35,300 parr and 116,900 smolt released into the Merrimack River, and 25,000 parr and 477,200 smolt released into the Connecticut River. Of returning sea-run fish captured in home rivers in 1990, 837 contained coded-wire microtags and 149 carried Carlin tags. All but five of the Carlin-tagged fish were recovered in the Penobscot River.

17. The commercial salmon fisheries in Canada and Greenland were scanned for coded-wire microtags of U.S.A., Canadian and European origin. Preliminary results of the scanning program in Greenland show a return of 36 U.S. origin tags of 1SW fish out of 54 tags recovered (20 Penobscot, 9 Merrimack, and 7 Connecticut Rivers). Preliminary returns from the Canadian fishery totalled 39 coded-wire microtags (24 Penobscot, 4 Merrimack, and 11 Connecticut Rivers) of U.S. origin out of 44 recoveries. Therefore, of the 98 microtags recovered from the commercial fisheries, 75 were of U.S. origin. Results of these studies continue to indicate that the catch of U.S. origin salmon in distant fisheries exceeds home water returns. (E)

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ATLANTIC SALMON (Salmo salar)

A. Atlantic Coast

Investigations

Habitat

1. For the Tuloma River, the long-term research has concentrated on collecting data to assess the importance to the available habitat of the lake which was newly created by the construction of a power station. Possible impacts of the proposed development of a phosphorite deposit on fish resources have also been evaluated. (A)

Juvenile studies

2. In 1990, the numbers of juvenile Atlantic salmon were surveyed in the following systems: Pechora River, Mezen River (upper and middle sections in the Pizhma, Kyma, and Sula tributaries), and Severnaja Dvina (in the upper section of the Vaga and Pinega tributaries). Biological material was collected from a total of 610 fish.

   The data when analyzed indicated extremely low numbers of young. In the Pechora River, the density of young salmon was found to be 3 times as low as the target level, 10 times below the norm in the Mezen River, and at least 5 times lower than normal in the Severnaja Dvina. Presently, the number of salmon returning to the Pechora River are estimated at not less than 60,000 fish, of which, 50,000 spawners are required to maintain optimal production. (B)

Stock assessments

3. In the Jokanga river system, data have been collected to evaluate the possible losses in fish production from the proposed construction of a system of hydroelectric power stations. Measures have been outlined to alleviate any adverse effects on fish stocks. (A)

4. The reproductive capacity of the Varzuga River has been evaluated. (A)

5. A model has been developed to simulate numbers and spatial distribution of salmonids and in particular Atlantic salmon from the Tuloma River. (A)

6. Studies were continued last year to develop techniques for the assessment of stock numbers of fish in inland waters of the Kola Peninsula. Preliminary results have enabled the provision of advice on how to organize the fisheries exploiting these stocks more efficiently. Biological data from a total of 7,000 salmon including 6,900 spawners were collected and 4,600 pre-smolts were tagged. (A)

7. The main goals of the SevPINRO research program are to evaluate the status of Atlantic salmon stocks in the White Sea and Pechora River and estimate TACs. The production of wild salmon in the Pechora, Mezen, and Severnaja Dvina rivers has been studied. In addition, surveys using video and aerial techniques have been conducted on the Pechora River. Biological data collected on 2,051 salmon indicates the 14.4% of the stock consisted of 1SW salmon compared to 4.5% in 1986-89. The age-length and weight characteristics have decreased, i.e. length has decreased from 82.9 -86.2 cm in 1986-89 to 80.0 cm in 1990.

   As previously reported the White Sea salmon stocks are currently depressed. In 1990, the harvest along the White Sea coast and in the Severnaja Dvina was estimated at 51.2 t compared to the TAC of 53 t. **(B)**

ATLANTIC SALMON (Salmo salar)

A. Baltic Sea

Investigations

Artificial propagation

1. Salmon juveniles were reared using pelleted feeds with a variety of compositions. The corresponding hematological and other physiological parameters of the reared salmon were measured. Some new medicinal feeds containing nitrofuran derivatives for treatment of mixobacterious disease in salmon were tested. The ability of salmon to osmoregulate in salt water was investigated according to variations of sodium and magnesium in blood plasma. These tests were carried out to evaluate the quality of released reared smolts of various age and rearing biotechniques. The relationship of thyroid gland activity and smoltification was investigated. Five thousand reared salmon smolts were tagged and released into rivers in the Gulf of Riga. **(C)**

Stock assessment

2. In 1990, a total of 1,086 salmon were sampled from driftnet catches in the Baltic Sea. Measurements included body length (total, fork and scaled length), whole weight, and scales were collected to determine freshwater and sea ages. Wild or reared status was determined visually from the structure of the scales and reared salmon made up 80% of the samples. Growth rates were back-calculated from the scale samples for the first summer and first winter periods of sea life. Details are also available on the Soviet sea fishery in the Baltic including catch per unit effort. A total of 2,532 samples of salmon were obtained from coastal fisheries at the river mouths of the Salatsa, Gauya, and Daugava Rivers in the Gulf of Riga. The proportion of reared salmon in the spawning stock was determined by the presence of adipose finclips.

   Wild salmon smolts migrating downstream and releases of reared smolts were enumerated in the Salatsa River. **(C)**

RAINBOW TROUT (Onchorynchus mykiss)

Investigations

Artificial propagation

1. In total, 370,000 rainbow trout yearlings were released into the river mouths and coastal waters of the Gulf of Riga. (C)

Fisheries studies

2. In total, 70 specimens of rainbow trout from the by-catch in the commercial fishery were analyzed. Their mean whole weight was 2.4 kg. Rainbow trout survival is low and apparently in future the release of rainbow trout for sea ranching will cease. (C)

RIVER LAMPREY (Lampetra fluviatilis)

Investigations

Artificial propagation

1. Experiments to improve river lamprey artificial propagation were carried out using a variety of methods to stimulate sexual maturation in freshwater. Larvae were reared on an artificial substratum of synthetic pellets and after three months the size of the lampreys had reached an average of 17 mm and weight of 10 mg. (C)

Fisheries studies

2. In 1990, lamprey commercial stocks were at a relatively high level, catches in rivers in the Baltic basin being about 250 t. A total of 1,442 lamprey were sampled from commercial catches in Latvian rivers. Mean body size of lamprey from Gulf of Riga rivers was 82-90 cm, and from the rivers of the Baltic coast it was 108-112 cm. (C)

SEA TROUT (Salmo trutta)

Investigations

General

1. The size, weight, and age structure of sea trout spawning stocks in some rivers of the Gulf of Riga was investigated by measuring 660 specimens. During the previous year, cleaning and improvement of freshwater habit was made in two tributaries of the Salatsa River basin. In early May of 1990, 289,000 sea trout fry were released and during the following summer their distribution, feeding, and growth were studied. The improvement of artificial feeds for sea trout juveniles were continued. In total, 2,000 reared sea trout smolts were tagged and released into rivers in the Gulf of Riga. (C)

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