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KALANTUTKIMUSOSASTO

MONISTETTUJA JULKAISUJA

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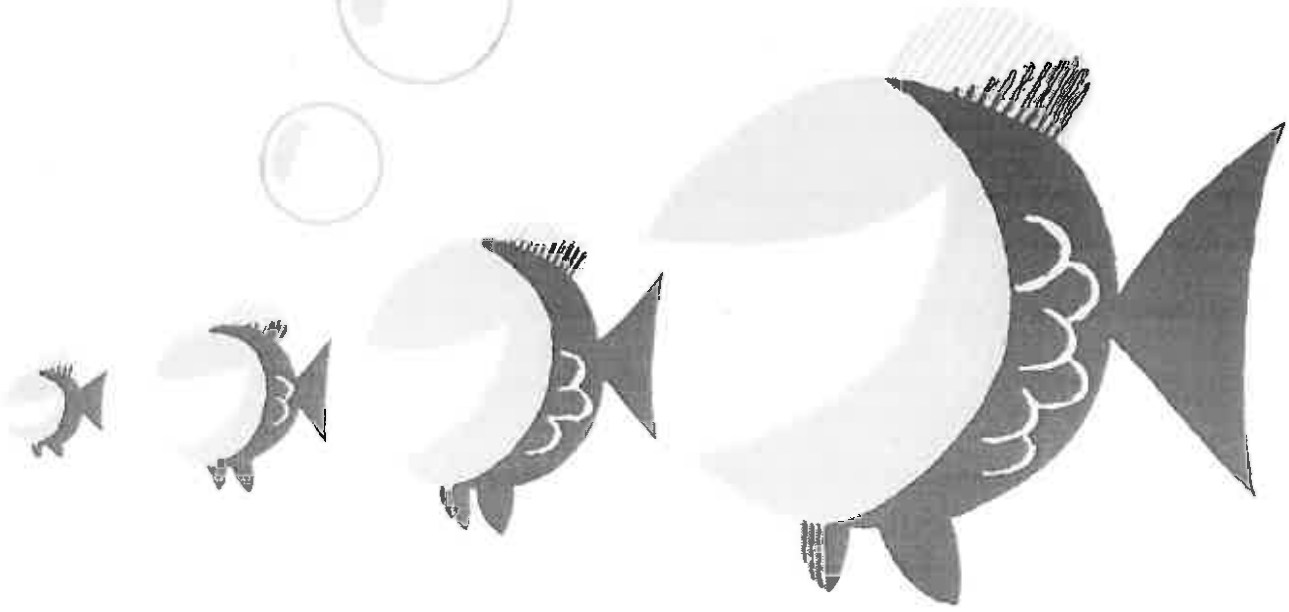

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RIISTA- JA KALATALOUDEN TUTKIMUSLAITOS, KALANTUTKIMUSOSASTO

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No 28 1984

COUNTRY REPORT OF FINLAND FOR THE INTERSESSIONAL PERIOD OF THE EUROPEAN INLAND FISHERIES ADVISORY COMMISSION (EIFAC) 1982 - 1984

Outi Heikinheimo-Schmid, Markku Pursiainen, Kai Westman and Pekka Tuunainen

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OUTI HEIKINHEIMO-SCHMID, MARKKU PURSIAINEN, KAI WESTMAN and PEKKA TUUNAINEN[1)]

Introduction

Finland's inland waters cover 31 000 km^2, which is about 9.4 % of the country's total area. There are over 60 000 lakes, 17 of which have a surface area of more than 200 km^2 each. The lakes are shallow, the average depth being 7 m; their total volume is 220 km^3. Together they have a total shore length of 130 000 km. Nearly one hectare of lake area and about 30 m of shoreline are available per capita of the population (4.8 million in 1981). The total length of the rivers exceeds 20 000 km.

In 1983 a new fishing law came into force. The main principle of the new law is full exploitation of fish resources. The law expanded fisheries administration to include eleven districts, each headed by a fisheries biologist.

The number in brackets ( ) refers to the number in the bibliography.

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1) Finnish Game and Fisheries Research Institute, Fisheries Division, P.O.Box 193, SF-00131 Helsinki 13, Finland

In 1982 some 859 000 people were engaged in fishing in inland waters. About 2 700 were commercial fishermen, and the rest fished for recreation and their own use.

According to calculations made by the Finnish Game and Fisheries Research Institute, the catch from inland waters was about 29 900 tons in 1982 (Appendix 1). This was about 21 % of the total catch for the country. The combined catch of the most important seven species, perch (Perca fluviatilis), pike (Esox lucius), vendace (Coregonus albula), roach (Rutilus rutilus), bream (Abramis brama), whitefish (Coregonus lavaretus s.l.) and burbot (Lota lota) was about 28 000 tons, being about 93 % of the total catch from inland waters. About 18 % (5 500 tons) of that was taken by professional and semiprofessional fishermen.

Damming of rivers and construction of reservoirs for hydroelectric power generation and flood prevention have caused severe damage to many river spawning fish species, and to crayfish. Water level regulation of lakes and reservoirs is also a notable problem in fisheries and its management.

About 700 km^2 of the lake area in Finland, i.e. 2 %, is badly polluted. The most extensively polluted areas are near pulp and paper mills and close to towns. Some 10-15 % of the lake area in Finland is polluted to some extent. About 2 200 km of the rivers is polluted by industry, public sewage, or agriculture.

Water pollution control measures have been directed by a new Ministry of the Environment since October 1983. Revision of water legislation is almost ready to be presented in the Parliament. The national program on water pollution control has been revised and extended up to 1990. This program includes increasing use of biological methods in effluent and watercourse monitoring, and serves as a basis for decisions at all levels of the administration.

Extensive fish stocking programs form the main part of the management of economically important fish stocks. The most important species are Baltic salmon (Salmo salar), sea trout (Salmo trutta m. trutta) and migratory whitefish (Coregonus

lavaretus s. str.) in the rivers and estuaries, and whitefish (mostly C. muksun (Pallas)) and brown trout (Salmo trutta m. lacustris) in lakes and reservoirs. The total number of fish stocked in 1982 was 35 million (excluding newly hatched), the proportion of the above species being c. 90 % (Appendix 2).

The State's fish farms together with private fish farms produce the stocking material. Production is continuously increasing, due to a great extent to the beginning of compensation stockings in the largest dammed salmonid rivers.

Production of rainbow trout (Salmo gairdneri) for human consumption has increased as well, being about 6 300 tons in 1982. The proportion produced in brackish water cage farms has risen rapidly and exceeded that of fresh water farms in 1982.

The EIFAC National Committee for Finland, installed in 1980, is composed of representatives from fisheries research, fish culture, fisheries administration, and advisory boards, and chaired by the EIFAC correspondent for Finland. The committee is responsible for liaison between EIFAC and Finland and works on subjects of current interest to EIFAC.

I FISHERIES BIOLOGY AND MANAGEMENT

1. Economic aspects of sport and commercial fisheries

The value of the total catch from inland waters taken by professional and semiprofessional fishermen (5 500 tons) was 29.4 million FIM (6.1 million USD) in 1982.

Statistics for different fish species and fishing methods on catch, yield, expenses, investments and working time, are annually collected by the Finnish Game and Fisheries Research Institute from some 70 fishing households and fishing enterprises in inland waters to study the profitability of commercial fisheries (**191**). The income level is compared

annually with that of other population groups. A study on the use of fish will be published in 1984, in which the fish flows from the fisherman to the consumer are analyzed.

The Committee for Fisheries Income suggested in the beginning of 1984 annual negotiations and different forms of support for commercial fishery, in order to ensure that the development of the income level of fishermen would correspond to that of other population groups (72).

As the most popular leisure time activity in Finland, recreational fishing is of great economic and social importance. A general fishing licence (17 FIM from 1.1.1984), and the permission of the water owner, are required for fishing, excluding angling with natural bait within the angler's home municipality. The new fishing law provides the possibility for angling with natural bait, and ice fishing with rods, without the permission of the water owner, if one purchases a licence (27.50 FIM), which is valid within one of the eleven administrative districts, the fisherman being allowed to purchase licences for all of the districts.

More than 850 000 people were so-called subsistence and recreational fishermen in 1982. Perch and pike were the most important species in their catch, according to a nationwide study on subsistence and recreational fishing in 1981 (94).

The value of the catch (24 400 tons) was 137.8 million FIM (28.6 million USD) in 1982.

Anglers were the largest group of fishermen, but the number of gill nets in use was much larger than the number of rods, and more than half of the total catch was taken with gill nets.

In northern Lapland, about one third of the people are primarily dependent on natural resources for their livelihood. For this reason, i.a. the growth in tourism, fisheries research has been intensified in the northernmost parts of Finland.

The value of the total annual catch from inland waters (29 900 tons) was about 167 million FIM (35 million USD) in 1982, which was 44 % of the value of the total catch in Finland in the same year.

The annual catch of the native crayfish (Astacus astacus) was estimated at about 3 million specimens in 1983, the value of which was about 15-18 million FIM (2.7-3.2 million USD).

The lamprey catch in 1982 was 2.0-2.2 million individuals, which is about 90 tons. The value of the catch was estimated at 2.75 million FIM (0.6 million USD) (59).

2. Survey and appraisal of inland waters

Fish stock assessment using MSY/R -models and population analyses is nowadays common in fisheries research in Finland. Stock assessments from eight lakes, and the coastal area, have thus far been published, the main species assessed being vendace, whitefish, perch and pike (95,184,133). Studies on population dynamics and causes of year class fluctuations in vendace (Coregonus albula), which is the most important species for commercial fisheries in lakes, were continued in Lakes Pyhäjärvi (Karelia), Lentua, Puruvesi and Pyhäjärvi (Säkylä). A research program on the ecosystem in Lake Pyhäjärvi (Säkylä), which is the most productive vendace lake in Finland (annual catch 20-40 kg/ha), was begun by the University of Turku, supported by the Academy of Finland. A study on the present state of fisheries in Lake Saimaa, East Finland, will be published in 1984.

The echocounting method, developed within EIFAC, has been used in eight lakes in Finland during 1982 and 1983. Finland also participated in the echocounting experiment on Lake Constance, which was a part of the EIFAC program, International Intercalibration Exercise on Fish Sampling Methods in Lakes.

During the intersessional period, extensive research programs for planning regional fisheries management have been in progress. The report of a three-year investigation of the fisheries system in Lake Oulujärvi, drained by the Oulujoki

River, will be published in 1984. A plan for fisheries management in the northern part of the Archipelago Sea was completed in 1983. The new fishing law involves regional fisheries planning in every administrative district.

3. Management of inland waters

Follow-up research programs on natural salmonid smolt production in several rivers have been continued. Some rivers or parts of rivers have also been restored in order to increase the natural salmonid smolt, river-spawning whitefish juvenile, and crayfish production. A research program concerning the natural production of both fish and crayfish in these waters has been underway for several years. Restoration projects have had promising results.

Fish stocking is the most common fisheries management method used in Finland. The following numbers of fish were stocked in Finland in 1981 and 1982, according to the statistics collected by the Finnish Game and Fisheries Research Institute (Appendix 2):

Species		1981 1 000 of ind.	1982 1 000 of ind.
Baltic salmon	fry - 1-year old	260	414
	2-summers old and older	658	1 016
Landlocked	fry - 1-year old	118	92
salmon	2-summers old and older	96	15
Sea trout	fry - 1-year old	282	492
	2-summers old and older	749	785
Brown trout	fry - 1-year old	1 431	1 878
	2-summers old and older	1 414	1 355
Other salmonids	fry - 1-year old	1 633	2 124
	2-summers old and older	149	125

Grayling	fry	556	356
	1-summer old and older	366	317
Whitefish	fry	119 154	151 898
	1-summer old and older	29 353	27 934
Vendace	fry	1 420	3 338
	adult (transfer stocking)	58	5 956
Pike	fry	20 426	19 181
	fingerling	1 237	2 042
Pikeperch	fry	250	-
	1-summer old	117	182
	adult (transfer stocking)	9	1
Bream	1-summer old	40	201
	adult (transfer stocking)	17	25
Id	fry	100	120
	1-summer old and older	10	130
Carp	1-summer old and older	20	3
Tench	1-summer old and older	2	2
Perch	adult (transfer stocking)	1	1
Crayfish	1-summer old	2	7
	adult (transfer stocking)	9	15
Signal crayfish	1-summer old	1	4

Baltic salmon, sea trout, and migratory whitefish stockings have mainly been made in river mouths. In addition, lampreys are annually transferred from the river mouths over the dams to the spawning areas.

The number of fish stocked increased considerably in 1983 due to the fact that stockings were initiated in the Kemijoki watercourse and the Iijoki watercourse to compensate for losses caused by the damming of the rivers. Beginning in 1984, the number of fish stocked in these areas will amount to 925 000 salmon and 118 000 sea trout smolts, 80 000 brown trout and 7.2 million 1-summer old whitefish and grayling annually. In addition, about 160 000 lampreys will be transferred annually from the river mouths over the dams to the rivers.

To evaluate the stocking results, some 38 000 salmon and 19 300 other salmonids were tagged with Carlin tags in 1982: in 1983 the corresponding numbers tagged were 43 200 and 26 300. In addition, about 5 400 other freshwater fish were tagged in 1982 and 4 000 in 1983 either for stocking evaluation or research purposes. To add to this, some 222 000 whitefish fingerlings have been marked with "nose-tags" for research purposes during the above mentioned years.

A report on the results of brown trout stocking, based on taggings made during the 1960s, was published in 1983. Stocking of large, clearwater lakes provided the best results, 200-500 kg/1 000 tagged juveniles. Poor results were obtained in smaller lakes, rivers, and regulated lakes (169).

Results of whitefish stocking in northern Finland, using one-summer old fingerlings reared in natural food ponds, indicate that such operations are profitable. The average catch in the studied lakes has been 137 kg/1000 fingerlings, and the increase in whitefish catch due to stocking was estimated at 2 000 tons altogether during 1960-1981 (145, 258).

4. Development of eel fishery resources

Finland's eel fisheries in inland waters are almost totally dependent on stockings with introduced elvers or young yellow eels because most of the largest rivers are closed by damming, which prevents natural migration into the lakes. Due to rather large introductions of elvers in 1966-1968, the eel catch in inland waters grew from 9 tons in 1976 to 63 tons in 1980; but this declined rapidly to 29 tons by 1982, which clearly shows the importance of stockings.

The eel stocking rate in recent years has been rather low, and no stockings have been made since 1979 to the risk of spreading communicable fish diseases along with the stocking material. In 1983 a working group set up by the Ministry of

Agriculture and Forestry prepared recommendations concerning eel introductions and stocking. Probably in a year or two introductions will be possible after quarantine.

The results and profitability of stockings are controlled by a yearly analysis of the eel catch from several rivers and lakes according to the recommendations of the EIFAC Working Party on Eel. Special attention has been given to catching methods, growth and age determination procedures, and food and behaviour studies.

5. Crayfish

Owing to her large number of water bodies and their long shorelines, Finland has an exceptionally high potential for crayfish production. The disastrous crayfish plague (Aphanomyces astaci) and the various river construction operations (draining, dreding, water regulation, etc.) have been and still are the greatest threat to crayfish stocks and production (70).

Several institutes are conducting research on crayfish and crayfish fisheries in Finland. The Finnish Game and Fisheries Research Institute has paid particular attention to comparative studies on the only native crayfish species (Astacus astacus) and the plague-resistant North American signal crayfish (Pacifastacus leniusculus). Studies have also been made concerning the management of crayfish stocks, crayfish sampling methods, and the cultivation of crayfish and signal crayfish.

Studies concerning the effects of habitat modification on crayfish have continued. It has been shown that Astacus is not able to withstand simultaneous drops in both the oxygen content and the pH value of the water. These observations are of considerable importance, since construction and engineering works in crayfish habitats often result in both hypoxia and acidification of the water.

In connection with the programme of the EIFAC Working Party on Crayfish, statistics on the status of crayfish stocks and fisheries in Finland, and data on the institutes, research workers, and research programmes concerned with crayfish, have been collected.

At the Department of Applied Zoology of Kuopio University restoration programmes for crayfish production and fisheries have been carried out in some rivers and lakes. The biological basis of crayfish production, and interactions between crayfish stocks and land use forms, have been studied. In connection with these fishery studies, the rearing technique and physiology of crayfish juveniles have also been investigated.

Studies of the endocrine system and reproductive physiology of crayfish (Astacus astacus) have continued. Studies on the effects of temperature and diet on sexually active male crayfish subjected to bilateral eyestalk ablation are also current. Studies on the feeding biology of crayfish have concentrated on the effects of different feeding regimes and diets on the free amino acid pool in crayfish (Astacus) haemolymph.

At the Department of Biology, in the University of Turku, the research programme on the mechanisms of adaptive responses in the physiology of the crayfish (Astacus astacus) has continued. In particular, the effect of temperature and temperature acclimation on the behavioural and neural responses in the crayfish has been studied. Recent crayfish studies focus on the effect of temperature on the neural membrane.

6. Cooperative research programs with other countries

Cooperative research programs have been continued between Finland and her neighbouring countries. In the Tenojoki (Tana) River on the Finnsh-Norwegian border, yearly studies of the Atlantic salmon (Salmo salar) stock include catch statistics, catch samples, and assessments of parr densities. Cooperative

studies on salmon will be extended to the Näätämöjoki (Neiden) River in 1984.

The Finnish-Soviet Boundary Water Commission has continued its work on questions concerning fisheries in the border region, the main subjects being Lake Inari and Lake Pyhäjärvi (Karelia). In Lake Pyhäjärvi, comparisons were made between fish stocks on the Finnish side, which are under heavy and constant fishing pressure, and those in the Soviet area, where fishing pressure is insignificant. A report of the results will be given in 1984, and monitoring of the situation will continue. Finnish-Soviet cooperation in investigations on salmonid smolt production began in 1982.

The Finnish-Swedish Boundary River Commission has organized monitoring of fish stocks and fisheries in the Tornionjoki (Torneå) River. In 1983, an investigation of fisheries and catches was carried out, and a plan for fisheries management will be made in 1984.

Liaison has been established with inland fisheries researchers in Poland, the main subjects being fish culture, and whitefish and sea trout research.

7. Other subjects

The Committee for the Conservation of Rapids has completed its work in 1983 . Rivers and rapids which need to be preserved were inventoried and preservation measures suggested.

The fixed term Working Group on Restoration of Migrating Fish Stocks was installed in 1983; its report will be published in 1984.

In 1983 the Committee for Preservation of Salmon Stocks suggested restrictions of off-shore salmon fishing, in order to preserve sufficient natural smolt production in the still existing salmon rivers, the Tornionjoki and Simojoki Rivers (100).

II FISH CULTURE AND DISEASES

1. Fish culture

The production of rainbow trout (Salmo gairdneri) was 6 325 tons in 1982, of which 3 226 tons was produced in brackish water in net cages, according to fish farming statistics in Finland (Appendix 2). The number of private fish farms producing rainbow trout was almost 300.

The Finnish Game and Fisheries Research Institute has 10 fish farms, with one more under construction and four in the planning phase. The main aims of State fish cultivation are to produce eggs and fry for the rearing of stocking material, to preserve threatened valuable fish species and stocks, to control stocking material, and to investigate and develop fish rearing and management methods.

The production of salmonids (excluding newly hatched) for stocking purposes amounted to 4.6 million specimens in 1982. Whitefish, grayling, pike and pikeperch, as well as many other fish, are produced in natural food ponds and stocked as fingerlings, mainly 1-summer old. In 1982 the number of such ponds was c. 600, with a total area of 5 500 hectares, producing over 30 million fingerlings.

Research on fish cultivation has dealt mainly with salmonids, whitefish, pikeperch and crayfish. Special attention has been given to the quality of stocking material, transportation, and stocking methods. Finland has also participated in the COST 46/4 Project from its inception. Fish genetics has also proved to be of great importance in fisheries management based on stockings. Research in this area continues. Projects concerning the selective breeding of rainbow trout have been carried out, and one of the State's planned fish farms is intended primarily for studies in this area of fish culture.

2. Economic evaluation of aquaculture

The Finnish Game and Fisheries Research Institute annually draws up statistics on aquaculture in Finland. Using producer prices, the total value of all aquaculture products was approximately 167.2 million FIM (about 35 million USD) in 1982. The value of fish production for human consumption (rainbow trout) was 128.4 million FIM (27 million USD) and that of stocking material about 38.8 million FIM (8 million USD).

3. Fish nutrition research

In 1983 the total production of dry fish feeds in Finland was 19 000 tons. Almost all fish feeds are produced in Finland, only a small amount of dry feed was imported.

Different types of pelleted and crushed feeds are produced for salmonid production. The greater part of the raw materials, animal and vegetable proteins and fish oil, are imported. Only cereals, mostly wheat, are of domestic origin.

The goals in the development of fish feeds are the improvement of growth and feed conversion and the reduction of the phosphorus content of feed in order to reduce the eutrophication effects of effluents. The development of pellet quality is also important in this respect.

In the future it will still be important to try to create feeds which are as non-polluting as possible, without decreasing the production potential. Feeds are of great importance in the quality of stocking material.

The utilization of low value fish (roach, smelt etc.) and Baltic herring as fish feed has been estimated at 5 000 tons annually.

4. Development in aquaculture technology

Following Recommendation 80/17, large-scale physiological investigations have been run by the Finnish Game and Fisheries Research Institute in cooperation with the University of Helsinki for several years in order to develop quality-control methods for assessing the condition of salmon and trout from fry to smolt. The greater part of the stocked salmon consignments is already tested physiologically from fish samples taken. The quality of the stocking material varies with the technology used in rearing.

Recent research in this field has concentrated on comparing commonly used procedures with eachother, and studying the effects of fish density in basins, different feeds, and feeding technology.

The development of rearing basins is also of great importance. The aim here is to produce the best possible, uniform environmental conditions throughout the basin.

Methodological development in the use of pituitary hormones in the breeding of pikeperch has come to a close. In the present circumstances, this method seems to be of little advantage in practical use.

The program on the determination of the sex of rainbow trout has shown as also found in other countries earlier, that the sex ratio can easily be changed in favour of females, which is clearly useful in rainbow trout farming.

5. Utilization of heated effluents and recirculation systems

In accordance with recommendations 80/11 and 80/13 of the 11th Session of EIFAC, fish cultivation experiments in heated effluents of a nuclear power plant have been continued. Special attention has been paid to the rearing of 1-year-old salmon smolts. Comparative rearing experiments with different salmon strains, including investigations of their smoltifica-

tion and physiological condition, are in progress.

Some of the recently constructed fish farms utilize heated cooling waters from hydroelectric power plants.

Recirculation and heat circulation systems have been constructed in some fish farms.

6. Introduction of exotic species

No introductions of new fish species have been made during the intersessional period. Stocking with fingerlings of the Siberian peled whitefish (Coregonus peled), 2-3 year old North American lake trout (Salvelinus namaycush), and carp (Cyprinus carpio), all produced in fish farms in Finland, has continued. Self-reproducing populations of these species have not been found, but stockings have been economically profitable in a number of lakes.

The North American plague-resistant signal crayfish (Pacifastacus leniusculus) has developed self-reproducing populations in some lakes. Stocking with juveniles cultivated in Finland has continued on an experimental scale.

7. Fish and crayfish diseases

The number of fish farms belonging to the official fish health program maintained by the National Veterinary Institute was 76 at the end of 1983. Economic losses due to fish diseases were mainly caused by vibriosis (Vibrio anquillarum) in rainbow trout farming along the coast in the brackish water areas of Finland, excluding the northern part of the Bay of Bothnia. The manufacturer of a Finnish vibriosis vaccine has begun field trials.

The first Aeromonas salmonicida infections since the sixties were diagnosed in 1982. Bacterial isolations, all of which have

been atypic strains of Aeromonas salmonicida subsp. achromogenes, were taken mainly from farmed trout and salmon, but also from wild fish.

Dangerous viral fish diseases such as VHS and IPN have never been detected in Finland. Prohibitions against transferring salmon and trout from the fish farms at the mouth of Kemijoki River, and from Tornionjoki River to other water systems have been in force during 1982-1983 due to ulcerative dermal necrosis (UDN).

Several new cases of crayfish plague (Aphanomyces astaci) have been observed during the intersessional period. Due to the economic significance of this disease, research on its spread and on means of plague control of the plague has been continued. There is also a program concerning the plague spots in signal crayfish (Pacifastacus leniusculus). The migrosporidian crayfish parasite, Thelohania contejeani (white tail disease), has been recorded in 36 localities in different parts of the country. Research on this subject continues.

The parasite Psorospermium haeckeli was observed in 1975. The disease has been recorded in three localities in the south of Finland. The frequency of infection is from 80 to 100 % in different localities, but no observations of mass mortality have been recorded. Psorospermium (perhaps a fungal disease) has a pathogenic effect on crayfish, especially during moulting periods. The fungal disease, Ramularia astaci (burn spot disease), first observed in 1977, is under study. (252)

Research on the effects of crayfish plague, Thelohania contejeani and Psorospermium haeckeli on the haemolymph values of crayfish has been started.

8. Other subjects

The rapidly increasing amounts of stocking and cultured brood stocks have led on one hand to a situation in which the natural selection is missing, and on the other hand to the possibility to losing genetically pure stocks of wild fish. This can be avoided by rearing brood stocks based on the natural spawn of known stocks from selected areas. Genetic material has also been preserved by freezing milt since Autumn 1983.

In fish culture there exists the problem of long distances between the fish farms and stocking sites. Transportation stress can cause mortality after stocking. Physiological studies on the transportation stress, and methods to avoid it, have been run. Concomitant efforts have been made to develop better transportation techniques and tanks. In order to avoid mortality at stockings, release ponds will be constructed for salmon and sea trout in the most important stocking areas.

III FISH AND POLLUTED WATER

1. Fish farm effluents

The most serious factor limiting the expansion of aquaculture in Finland is the eutrophication caused by the fish farm effluents. The water protection authorities have strenghtened the regulations in this area and limited the production of farms.

Several research programs are going on to eliminate the problem. One of the most important aspects is to reduce the phosphorous content of dry feeds; but the removal of effluent waste solids has also proved to be an effective method. By using so-called self-cleaning rearing basins and whirling separators,

it is possible to remove almost all solid waste from the farm's effluents. This means a c. 50 % reduction in the phosphorous load. The difficulty still remains when a farm has large earthern ponds from which it is difficult to collect waste solids before the phosphorus has dissolved.

2. Biological monitoring

Special attention has been directed towards the effects of effluents from pulp and paper mills on fish stocks, fishing and the physiology of fish. A cooperative project by the Finnish Game and Fisheries Research Institute and the University of Helsinki has continued since 1975. Experiments on this subject are also run by the Finnish Pulp and Paper Research Institute and by the National Board of Waters. The application of toxicological and physiological methods in evaluating the effects of pulp and paper mill effluents on fish, and on the reproduction, growth, survival, behaviour, and sensitivity of different fish species at different stages of their development, have been investigated, with special attention to organochlorines and resin acids. Acute toxicity tests have been carried out, and concentrations of effluent components have been analyzed both in water and in fish tissues.

Fish stock assessments in waste water areas are made using the echocounting method. Long-term physiological effects have also been studied by caging fish in recipients. This research also deals with the avoidance reactions of fish, and organoleptic tests.

Methods for the use of fish in toxicity testing and as an indicator of water quality are being developed, including the effects of effluents from the pulp and paper, metal, and chemical industries.

International cooperation with the Helsinki Commission, ICES and OECD continues in this area.

3. Bioaccumulation of toxic substances in fish

Research concerning bioaccumulation of toxic substances in fish has been carried out in several waters, even covering whole food chains. A national monitoring program on the concentrations of chlorinated hydrocarbons and heavy metals in fish has been underway since 1978. Extensive research has been carried out during the last two years on the occurence of and reasons for high mercury concentrations in fish in waters with no wastewater influence.

4. Acidification of inland waters

The acidification of inland waters in Finland has not thus far caused such drastic alterations in fish stocks as those reported in Sweden and Norway. However, the problem also exists here, and according to recent estimates, there are hundreds of acidified or acidifying small lakes in southern Finland. The physiological basis of pH regulation in fishes has been studied by the University of Helsinki, as has the pH sensitivity of fish at different developmental stages.

On the western coast of Finland, acidification due to sulfid clays in the soil has caused fish and crayfish kills in rivers, estuaries, and fresh water reservoirs.

5. Physical habitat modification

The effects of habitat modification on fish stocks and fisheries have been studied in several rivers and lakes, and the results of the management measures have been followed (Recommendation 82/9). Guidelines for this type of investigation are being prepared, in order to obtain uniform practice and make the results more reliable and comparable. In

this connection, a project was begun in 1983 which aims at developing and applying methods used in fisheries research for evaluating the effects of habitat modifications on fish stocks(46).

A three-year research program, concerning the effects of dredging and land-drainage works in the Kyrönjoki River on fish and crayfish stocks and fisheries in the river estuary and the influenced sea area, was completed in 1983 and a report is published in 1984.

SELECTED LITTERATURE

I FISHERIES BIOLOGY AND MANAGEMENT (SUB-COMMISSION I)

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FISHING IN 1982 (1000 kg)

	SEA FISHERIES				FRESHWATER FISHERIES				TOTAL			
	Professional fishermen	Semiprofessional fishermen	Non-professional fishermen	Total	Professional fishermen	Semiprofessional fishermen	Non-professional fishermen	Total	Professional fishermen	Semiprofessional fishermen	Non-professional fishermen	Total
Fishermen	1 769	2 646	218 599	223 014	320	2 376	856 277	858 973	2 089	5 022	1074 876	1081 987
Baltic herring	74 373	9 551	1 076	85 000	-	-	-	-	74 373	9 551	1 076	85 000
Sprat	4 467	13	70	4 550	-	-	-	-	4 467	13	70	4 550
Cod	5 395	677	2 054	8 126	-	-	-	-	5 395	677	2 054	8 126
Flounder	87	24	310	421	-	-	-	-	87	24	310	421
Atlantic salmon	546	69	66	681	7	6	44	57	553	75	110	738
Brown trout	76	39	180	295	3	16	404	423	79	55	584	718
Whitefish	892	715	803	2 410	77	199	1 281	1 557	969	914	2 084	3 967
Vendace	177	70	43	290	1 405	2 406	2 134	5 945	1 582	2 476	2 177	6 235
Smelt	207	79	31	317	48	58	74	180	255	137	105	497
Common bream	294	224	362	880	9	61	1 592	1 662	303	285	1 954	2 542
Ide	27	33	85	145	9	23	151	183	36	56	236	328
Roach	231	164	727	1 122	48	217	3 462	3 727	279	381	4 189	4 849
Pike	224	287	1 172	1 683	63	197	5 727	5 987	287	484	6 899	7 670
Perch	282	221	1 705	2 208	29	192	7 683	7 904	311	413	9 388	10 112
Pike-perch	160	71	217	448	12	16	242	270	172	87	459	718
Burbot	126	133	235	494	26	107	1 031	1 164	152	240	1 266	1 658
Eel	1	0	8	9	0	1	28	29	1	1	36	38
Others	137	32	93	262	75	169	570	814	212	201	663	1 076
Total	87 702	12 402	9 237	109 341	1 811	3 368	24 423	29 902	89 513	16 070	33 660	139 243

Appendix 2: Fish Culture in 1982

KALANVILJELY VUONNA 1982 — FISKODLING ÅR 1982 — FISH CULTURE IN 1982

KALANVILJELYLAITOSTEN LUKUMÄÄRÄ ANTAL FISKODLINGS-ANSTALTER NUMBER OF FISH FARMS AND HATCHERIES	Merilaitokset[1] Anläggningar i havet Brackish water cage farms	Sisävesilaitokset[1] Anläggningar i sött vatten Fresh water farms and hatcheries	Luonnonravinto-lammikkoyritykset Naturdammsföretag Natural rearing pond breeders	Yhteensä Inalles Total
	98	296	203	597

KALANVILJELYLAITOSTEN TUOTANTOTILAT FISKODLINGSANSTALTER-NAS PRODUKTIONSUTRYMME PRODUCTION CAPACITY OF FARMS AND HATCHERIES	Haudontakapasiteetti Kläckningskapacitet Incubation capacity		Kasvatustilat Uppfödningsutrymme Rearing space						
	Suppilohaudonta Kläckning i glas Glass incubation	Asettihaudonta Backkläckning Tray incubation	Keinoaltaita Konstgjorda bassänger Artificial tanks	Maa-altaita Jorddammar Earth ponds	Verkkoaltaita ja -aitauksia Nätkassar och -inhägnader Net cages and enclosures merialue havsområde sea area	 sisävesi-alue sötvattens-område freshwater area	luonnonravinto-lammikoita naturnäringsdammar natural rearing ponds		
	Mätilitraa Liter rom Egg liters								
	12 892	13 593	kpl 2 319 1 000 m² 25	1 915 959	813 268	173 112	680 ha 5 527		
Laitoksia — Anstalter — Farms and hatcheries	58	62	68	247	98	26	203		

KALANVILJELYLAITOSTEN[2] RUOKAKALANTUOTANTO FISKODLINGSANSTALTERNAS MATFISKPRODUKTION FOOD FISH PRODUCTION OF FISH FARMS	Merilaitokset Anläggningar i havet Brackish water cage farms	Sisävesilaitokset Anläggningar i sött vatten Fresh water farms	Yhteensä Inalles Total	Tuotannon arvo Mmk Produktionens värde M Fmk Value of production M Fmk
	Tuotanto — Produktion — Production 1000 kg[3]			
	3 226	3 099	6 325	128,4
Laitoksia — Anstalter — Farms	98	195	293	

[1] Saman omistajan eri laitokset laskettu omiksi yksiköikseen — Samma Ägares olika anläggningar räknade som olika enheter — Same owner's separate farms counted as separate entities.

[2] Tuotanto kirjolohta paitsi 23 tonnia lohta, taimenta ja puronieriää. — Produktion regnbågsforell utom 23 ton av lax, öring och bäckröding. — The production rainbow trout expect of 23 tons salmon, brown trout and brook trout.

[3] Tuotantoluvut perkaamatonta painoa. — Produktionssiffrorna som orensad fisk. — Productionin kg of ungutted fish.

ISTUTUKSIIN KÄYTETTY TUOTANTO 1982 PRODUKTION FÖR UTSÄTTNING 1982 PRODUCTION TO STOCKING 1982	Vastakuoriutuneet nykläckta newly hatched [4]	1-kesäiset 1-somriga 1 summer old [5]	1-vuotiaat 1-åriga 1 year old	2-kesäiset 2-somriga 2 summers old	2-vuotiaat 2-åriga 2 years old	3-kesäiset 3-somriga 3 summers old	3-vuotiaat 3-åriga 3 years old	vanhemmat äldre older	Yhteensä (ei sis. vastakuoriutuneita) Inalles (nykläckta inte med) Total (excl. newly hatched)
Istutukset 1000 kpl — Utsättningar 1000 st — Stockings 1000 fish									
Pohjasiika — Sik — Whitefish Coregonus pidschian (Gmelin)	1 288	2 601	—	32	—	—	—	—	2 633
Vaellussiika — Sik — Whitefish Coregonus lavaretus (L.) s.str.	113 618	6 386	—	1 440	—	—	—	—	7 826
Järvisiika — Sik — Whitefish Coregonus oxyrhynchus (L.)	19	182	—	—	—	—	—	—	182
Planktonsiika — Sik — Whitefish Coregonus muksun (Pallas)	14 309	11 289	—	3	1	—	1	1	11 295
Peledsiika — Sik — Whitefish Coregonus peled (Gmelin) s. Berg	22 516	4 916	—	9	—	—	—	0	4 925
Siika, laji tuntem. — Sik, art ökand Whitefish, unidentif. — Goregonus sp.	148	1 073	—	—	—	—	—	—	1 073
Muikku — Siklöja — Vendace Coregonus albula (L.)	885	1	—	—		—	—	—	1
Lohi — Lax — Atlantic salmon Salmo salar L.	—	79	335	44	953	—	18	1	1 430
Järvilohi — Insjölax — Landlocked salmon Salmo salar m. sebago Girard	—	92	—	1	13	—	1	—	107
Meritaimen — Havsöring — Sea trout Salmo trutta (m. trutta) L.	144	277	71	242	508	23	12	0	1 133
Järvitaimen — Insjö-öring — Brown trout Salmo trutta m. lacustris L.	1 510	321	47	255	934	101	64	1	1 723
Purotaimen — Bäcköring — Brown trout, non-migratory — Salmo trutta m. fario L.	445	—	—	—	5	—	—	—	5
Kirjolohi — Regnbågsforell — Rainbow trout Salmo gairdneri Richardson	—	14	4	15	38	1	7	—	79
Nieriä — Röding — Char Salvelinus alpinus (L.)	1 240	33	1	1	—	—	—	0	36
Puronieriä — Bäckröding — Brook trout Salvelinus fontinalis (Mitchill)	—	1	—	—	—	—	—	—	1
Harmaanieriä — Kanadaröding — Lake trout Salvelinus namaycush (Walbaum)	386	—	—	—	39	—	19	0	58
Harjus — Harr — Grayling Thymallus thymallus (L.)	356	317	—	—	—	—	—	—	317
Hauki — Gädda — Pike Esox lucius L.	19 181	2 042	—	—	—	—	—	—	2 042
Lahna — Braxen — Bream Abramis brama (L.)	—	201	—	—	—	—	—	10	211
Karppi — Karp — Carp Cyprinus carpio L.	—	1	0	2	1	—	—	—	3
Säyne — Id — Id Leuciscus idus (L.)	120	130	—	—	—	—	—	—	130
Suutari — Sutare — Tench Tinca tinca (L.)	—	—	—	0	—	0	—	—	2
Kuha — Gös — Pike-perch Stizostedion lucioperca (L.)	—	181	—	—	—	0	—	—	182
Rapu — Flodkräfta — Grayfish Astacus astacus L.	—	7	—	—	—	—	—	0	7
Täplärapu — Signalkräfta — American crayfish — Pacifastacus leniusculus (Dana)	—	4	—	—	—	—	—	—	4

[4] Lohi-, taimen- ja nieriälajien osalta syömäänoppineita, vapaasti uivia poikasia — Beträffande lax, öring och röding, yngel som börjat äta och som simmar fritt. — Salmonids free-swimming fries.

[5] Hauen osalta esikesäisiä, muutaman viikon ikäisiä poikasia — Beträffande gäddan nykläckta, några veckor gamla yngel. — Pikes a few weeks old younglings.

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