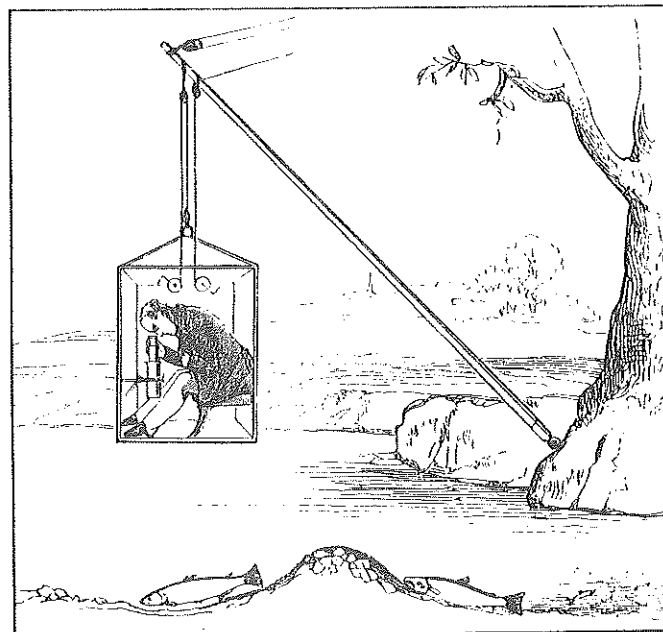


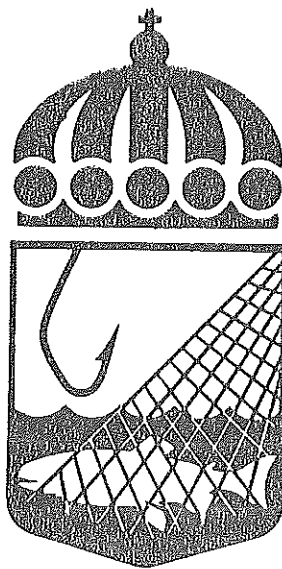
Information from
**THE INSTITUTE OF
FRESHWATER RESEARCH**
Drottningholm



Scope of activities for the period 1986 - 87

Editor:

Lennart Nyman
Institute of Freshwater Research
S-170 11 DROTTHINGHOLM
Sweden



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SCOPE OF ACTIVITIES FOR THE PERIOD 1986 - 87

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FÖRORD

Detta är andra gången som laboratoriet på engelska presenterar sin verksamhet. Vi gör detta av två anledningar. För det första sprids "Information från Sötvattenslaboratoriet" till en rad länder utanför Norden. Där kan man normalt bara tillgodogöra sig den korta sammanfattning på engelska som avslutar varje Information. För det andra behöver vi ofta presentera oss och vår verksamhet för utländska besökare eller sådana som skriver till oss från andra länder och vill ha information om vad vi gör och vilka vi är.

Vi hoppas att denna vart annat år uppdaterade publikation skall fylla detta syfte, och vädjar om överseende från våra nordiska läsare att ni tvingas läsa om oss på engelska.

Catherine Hill och undertecknad har ansvarat för språkgranskningen.

Lennart Nyman
Laboratoriechef

INTRODUCTION / BACKGROUND

This report is published once every two years. The main function of the publication is to give a fairly detailed account of the current research projects carried out at the Institute, including publications, but we also feel that our numerous international contacts - (be they personal or neutral) - may benefit from knowing who we are and what our responsibilities are.

The Drottningholm Institute, as it is sometimes called, was erected on state-owned land through a donation from a private foundation (Knut & Alice Wallenberg Foundation) in 1932. Situated on a small island west of Stockholm and less than a mile north of the Royal Castle at Drottningholm it became the focal point of fisheries research in Sweden. The fisheries biology, technology and management of Swedish freshwater ecosystems were investigated by teams of scientists under the directorships of Gunnar Alm, Sven Runnström and Gunnar Svärdson.

When The National Swedish Board of Fisheries was established in 1948 the Drottningholm Institute became one of its central units, and when the Board was re-organized effective July 1, 1985, the Institute was amalgamated with the Fisheries Research Stations at Kälarne and Älvkarleby to form one of the two sub-units of the new Division of Investigations and Development. The other sub-unit consists of the Institute of Marine Research at Lysekil, on the west coast of Sweden.

SCOPE OF ACTIVITIES

The major responsibility of the Institute is to provide basic knowledge about the national resources of freshwater fish, including anadromous and catadromous species and freshwater crayfish.

More specifically, the Institute shall provide basic data for establishing techniques and methods aimed at managing these resources for commercial and recreational purposes with due consideration to conservation issues.

Considering the limited number of staff (a total of around 50 people including the two research stations) the Institute has been forced to concentrate its resources on a few selected project areas, the plans for which are scrutinized and approved annually by the Fishery Board's Research Council. The eight project areas currently dealt with are presented in more detail below.

Responsibility for national research on the subject of freshwater fish also calls for cooperation with the national universities, where the Institute maintains contact with scientists working on aquatic ecology and supervises research students.

Besides cooperation with the official international bodies of EIFAC and ICES the Institute also maintains close ties with similar research institutes in other countries, primarily in Finland, Norway and Canada. The Institute publishes three journals, the Report Series in English with an international distribu-

tion, and Information Series in Swedish (with English summaries) and a mainly Nordic distribution. The third journal is also published in English, once every two years, and reports on international research on Arctic char (ISACF Information Series).

We hope that this publication will inform you about our activities in such a way that future contacts will be simplified and facilitated. If you have suggestions about how our presentation could be even more valuable to you, do not hesitate to let us know.

Drottningholm, December 13, 1988.

Lennart Nyman
Director

EFFECTS OF ACIDIFICATION AND LIMING ON FISH

Lime treatment of acidified lakes and streams has become one of the most far-reaching manipulations of freshwater ecosystems in Sweden. After a trial period of six years, the operational program for liming was started in 1982. All acidified waters with a pH less than 6 and/or an alkalinity of less than 0.05 meq/l are eligible for subsidies, and at present 5,000 lakes have been treated, comprising about 80% of the total acidified lake area in the country.

Since 1983 the Swedish National Board of Fisheries in conjunction with the Swedish National Environmental Protection Board has monitored the fish fauna of about 120 lakes and 20 streams. The objective of this program is to assess the effects of liming on the fish fauna in lakes and streams, emphasizing long-term changes in the fish assemblages in relation to abiotic factors and changes in overall community structure.

Fishery management and studies of the biotic interactions in limed waters are another important fields, as it is clear that far from all limed lakes and streams are recolonized by the fish species or fish food organisms that have been eliminated due to acidification.

Funding: The project is funded entirely by the Swedish National Environmental Protection Board.

Staff: Project manager; Magnus Appelberg, others; Björn Bergquist, Carin Klevbom, Erik Degerman, Arne Johlander and Torolf Lindström.

Sub-projects:

Long-term monitoring of the effects of liming on fish populations in lakes. Approximately 120 limed and acidified reference lakes, mainly located in the southern and central parts of Sweden, are being studied. Sampling of fish, using standardized gill-netting techniques every third year, also involves age determination and growth estimation. Complementary data on water chemistry, phytoplankton and zooplankton are used to assess the impact of both abiotic and biotic changes on fish. A total of 27 fish species have been recorded. They can be assigned to four different types of fish assemblages. In three of them at least one species occurs less frequently due to low pH before liming. The re-establishment of fish species and population development after liming are to a great extent related to the structure of the remaining fish assemblages and thus call for continued lime treatment and active fishery management.

Long-term monitoring of the effects of liming on stream dwelling fish. The program is focused on the assessment of liming effects on trout and involves experimental studies on the impact of acid spates on young stages of this species. Population abundance and age structure of the fish are estimated yearly in about 20 streams in different parts of the country using electrofishing. Beside the brown trout, another 15 species are also being studied within

the program. Although lime treatment favours the development of fish populations in acidified streams, the effect of liming is often counteracted by acid spates during spring and by intermittent liming measures in upstream lakes. It is found that continuous liming favours the re-establishment of stream-dwelling fish populations in acidified streams.

Fishery management in acidified and limed lakes. In addition to lime treatment, fishery management is used to re-establish fish populations and fish food organisms in limed waters. The effects of reintroduction of acid-sensitive species such as roach, salmon, trout, sander and crayfish are studied. Studies of biomanipulation of skewed species assemblages are conducted in whole-lake studies as well as in experimental studies.

Evaluation of biological results from liming projects during the trial period (1977-1982) for the liming of surface waters. Test fishing, and to a lesser extent other biological studies, that were carried out in 105 lakes during the trial period are being evaluated. The investigations were carried out by local organizations and also include liming data and water chemistry data.

Some recent publications:

- Appelberg, M. 1987. Some factors regulating the crayfish Astacus astacus L. in acid and neutralized waters. p. 167-179. In: *Ecophysiology of Acid Stress in Aquatic Organisms*. Eds.: Witters & Vanderborcht. Ann.Soc.R.Zool.Belg., Gent.
- Appelberg, M. 1987. Evaluating water quality criteria for fresh water crayfish: Exemplified by the impact of acid stress. EIFAC Workshop on freshwater crayfish, Trondheim, 1987. (In press.)
- Degerman, E. 1987. Humic lakes - a literature survey with emphasis on fish and acidification. Swedish Environmental Protection Board, Rep. 3415. 72 p. (In Swedish with English summary.)
- Degerman, E. & P. Nyberg. 1987. The composition and abundance of the fish fauna in acidified and limed lakes in Sweden. Inform. Inst.Freshw.Res., Drottningholm (7). 71 p. (In Swedish with English summary.)
- Degerman, E., J.-E. Fogelgren, B. Tengelin & E. Thörnelöf. 1987. Occurrence of sea trout (Salmo trutta), Atlantic salmon (Salmo salar) and European eel (Anquilla anguilla) in small water-courses on the west coast of Sweden. *Water, Air and Soil Pollution* 30:665-672.
- Degerman, E., G. Lindgren, P.-E. Lingdell & P. Nyberg. 1987. An inventory of the benthic fauna and fish in small streams in mountainous regions of northern Sweden affected by acidification. Inform.Inst.Freshw.Res., Drottningholm (2). 64 p. (In Swedish with English summary.)

- Forsberg, G. 1986. The survival and diet of elvers in an acidified lake. Inform.Inst.Freshw.Res., Drottningholm (8). 29 p. (In Swedish with English summary.)
- Lessmark, O. 1987. Ground liming as a method of mitigating acidification of surface waters. Inform.Inst.Freshw.Res., Drottningholm (9). 38 p. (In Swedish with English summary.)
- Lessmark, O., E. Degerman, A. Johlander & E. Sjölander. 1986. Effects of liming on fish immediately downstream of lime dosers. Inform.Inst.Freshw.Res., Drottningholm (5). 31 p. (In Swedish with English summary.)
- Nyberg, P., M. Appelberg & E. Degerman. 1987. Effects of liming on crayfish and fish in Sweden. Water, Air and Soil Pollution 30:669-688.
- Nyberg, P., E. Degerman, C. Ekström & E. Hörnström. 1986. Acid-sensitive Arctic char (Salvelinus alpinus) lakes in southern and central Sweden. Inform.Inst.Freshw.Res., Drottningholm (6). 240 p. (In Swedish with English summary.)
- Nyberg, P. 1987. Reclamation of acidified Arctic char (Salvelinus alpinus (L.)) lakes in Sweden by means of liming. Paper presented at the XXIII SIL Congress, New Zealand. (In press.)

EEL

Eel (Anquilla anquilla) is an important species for the commercial fisheries in Sweden, both in lakes and in the sea. Eels are caught both as growing yellow eels and as migrating silver eels.

During the 1980s the importance of eels in aquaculture has increased and there is a great demand for starting material, i.e. glass eel. Unfortunately the supply of eel has decreased, as the immigration of glass to Northern Europe has diminished.

A project called "The decline of the Baltic eel stock" was commenced in 1977 and the main purpose was to describe and quantify the decrease in immigration of glass eels, elvers and yellow eels to Swedish waters. A second aim was to assess measures taken to strengthen eel stocks, i.e. stocking.

The methods used were age- and sex determination of yellow eels sampled in ten different localities along the Swedish coast and in some rivers.

The main project was later divided into several sub-projects.

Funding: Provided on a yearly basis by the National Swedish Board of Fisheries. The sub-project on sex differentiation of eels is partly founded by the Swedish Council for Forestry and Agricultural Research.

Staff: Project manager: Håkan Wickström. Others: Kerstin Holmgren. Co-operation with regional Fishery consultants and private individuals throughout the country.

Sub-projects:

Stocking of experimental lakes with eels of different size and origin.

Tagging of yellow eels.

Collection of data from fixed traps which catch ascending eels from the experimental lakes.

The significance of water temperature as a factor directing the sex differentiation of eels.

Work is also done within the EIFAC Working Party on eel.

Some recent publications:

Wickström, H. 1986. Growth of cultured eels stocked in two Swedish lakes. *Vie Milieu* 36 (4): 273-277.

Wickström, H. 1986. Studies on the European Eel by the Institute of Freshwater Research 1977-85. *Inform. Inst. Freshw. Res., Drottningholm*. (13) 43 p. (In Swedish with English summary).

Wickström, H. 1987. Natural or cultured eels for stocking: A comparison. ICES CM. 1987/M:12/ Ref.F. 8 p.

Wickström, H. 1987. Growth of elvers stocked in some Swedish lakes. pp. 328-339. In Szabó, A. (Ed) XXIX Georgikon Napok Keszthely: Hal, halászat és természetászvizi környezet. 1987. augusztus 25-26.

CRAYFISH

Crayfish are ecologically important in Swedish waters. Crayfish constitute a large economic resource since they fetch a high price on the domestic market. Stocks of the domestic species Astacus astacus have dwindled by 90% this century due to the lethal crayfish plague.

After careful initial trials since 1960 a large scale introduction of plague resistant Pacifastacus leniusculus began in 1969. At present about 400 Swedish natural waters are stocked with this North American species. So far this has been a success. From a large test-fishing programme data are compiled and used to develop guidelines for promotion of new stocks and management of crayfish stocks in general. Steps are taken to protect the remaining domestic crayfish populations.

Environmental factors such as climate and acidification have a strong adverse effect on crayfish populations. Predation, especially by eel, also has a strong impact. Research on these and other topics is done at the institute and sometimes in cooperation with other institutions.

Crayfish farming in ponds is a rapidly growing business in Sweden and at present 225 licenses have been granted. Information is supplied to the fisheries administration and to the public. Research in this field is done at the institute.

A project aimed at restoration of the Turkish crayfish production is organized in cooperation between FAO, the Turkish Government and the institute.

Funding: Partly financed by the National Swedish Board of Fisheries, partly self-financed.

Staff: Project manager: Magnus Fürst, others: Arne Fjälling.

Some recent publications:

Fjälling, A. & M. Fürst. 1985. The introduction of the crayfish Pacifastacus leniusculus into Swedish waters: 1969-84. Inform. Inst.Freshw.Res., Drottningholm (8). 29 p. (In Swedish with English summary.)

Fürst, M. 1984-01-26. PM on farming of crayfish for stocking in Alby, Ånge. (In Swedish.)

Fürst, M. 1985. The Swedish crayfish. p. 284-294. In Fisheries biology. Ed.: G. Svårdson & N.-A. Nilsson. LT publisher, Stockholm. (In Swedish.)

FISH TAGGING AND POPULATION ESTIMATES

The Institute of Freshwater Research is responsible for coordinating fish tagging in Sweden. The main motives for this activity are (a) to achieve a better understanding of the migratory phase in different species and stocks of fish, (b) to study where and when the fish populations are harvested, and (c) to control the quality of the fish stocked.

In 1987 about 140,000 fish were tagged. The Institute of Freshwater Research was responsible for 30,000 of these and the Salmon Research Institute was responsible for the remainder. All reports of recapture (about 16,000 in 1987) are sent to the former institute for practical reasons. The administrative activities, such as filing the data, correspondence and the payment of rewards for each recapture, are the basic prerequisites for routine studies on the percentage of recapture and economic feasibility, as well as for more detailed studies on the biological consequences of stocking in fisheries management.

In 1982 a computer system was introduced in order to facilitate the handling of incoming data.

Fish tagging is also a tool for population estimates. Another means of assessment is the use of hydro-acoustic surveys. A portable unit (Simrad EY-M) for echocounting of fish was bought in 1985. This equipment is now used in the five largest lakes in Sweden to monitor the pelagic fish stocks. It is also used, in a few other lakes of special interest, to increase our understanding of what standardised gillnet testfishing reveals about the actual pelagic fish stock as shown from the hydro-acoustic survey.

The yearly work schedule is planned by the director of the Institute in cooperation with the personnel of the fish-tagging group and the fish-farming group of the National Swedish Board of Fisheries.

The fish-tagging group works in close cooperation with other units dealing with fish tagging, such as the Salmon Research Institute (LFI) and the Fish Culture stations in Älvkarleby and Kälarne, but also with corresponding institutes abroad.

In connection with hydro-acoustic surveys the group maintains close contact with the Marine Research Institute of the National Swedish Board of Fisheries, The University of Stockholm as well as the Zoological Museum in Oslo, Norway.

Special activities during 1988 include a change of computer system for the fish-tagging work and a hydro-acoustic survey in one of the lakes of special interest, Lake Mien.

Funding: Government budget money is not used to fund the activities of this group. The administrative section is self-sustaining and the statistical evaluation is financed by special funds from the National Swedish Board of Fisheries.

Staff: Project manager: Olof Enderlein. Others: Eivor Meyer and Berit Sers.

Some recent publications:

Enderlein, O. 1986. Cisco (*Coregonus albula* (L.)) in the Bothnian Bay. Inform. Inst. Freshw. Res., Drottningholm (1) 130 p. (In Swedish with English summary.)

Enderlein, O. 1987. Hydro-acoustic surveys 1986. PM in Swedish.

RUNNING WATER

Fishing in running water is very attractive to anglers. Management of streams and rivers is mainly directed towards an increased production of salmonids. Knowledge of which factors govern fish production thus is of crucial importance, and the need for investigations is obvious in several areas:

- 1) What is the effect of the various measures used to increase production?
- 2) What is achieved by stocking fish in running waters?
- 3) What are the effects of various types of environmental changes?
- 4) Which are the most relevant methods to objectively evaluate population parameters?
- 5) Do we have adequate knowledge of inter- and intra-specific interactions among the fish species in these biotopes?

In 1987 a research scientist will be employed at the Kälärne Research Station. Priority areas for this position will be stocking procedures in relation to hatchery operation and stream biotope enhancement.

It is also anticipated that the research station at Älvkarleby will be enlarged and equipped with a stream tank for experimental research on stream-dwelling fish of all species.

These combined resources will hopefully increase the low present-day activity and also encourage university students to become engaged in running water ecology.

Funding: Government budget money pays some salaries, but materials and travel expenses are also provided on an annual basis by the Research Council of the National Board of Fisheries.

Staff: Project manager: Jan Henricson. Others: Lennart Nyman.

Sub-projects:

The brown trout stock of a northern brook. (Longterm monitoring of population density and individual growth of trout in a brook in the county of Norrbotten.)

Effects of artificial channelization and habitat improvement on the fish population of a brook. (Objectives are to study the possible change in biological production of a simple ecosystem subjected to simulated channelization and subsequent habitat improvement for a number of years.)

Bottom fauna and drift fauna downstream of a hydro-electric station employing short-term regulation. (This is part of a ten year project that has recently been terminated.)

Some recent publications:

Gönczi, A., J. Henricson & G. Sjöberg. 1986. Fisheries management in river reservoirs. Final report from FÅK, part 1. Institute of Freshwater Research, Drottningholm, 115 p.

FISH STOCK REGISTRIES

Most activities within this project area are carried out at the Fisheries Experimental Station at Kälärne, in the eastern part of the province of Jämtland in northern Sweden. Research is aimed at fulfilling the national need for protecting the genetic resources of indigenous fish species, as well as providing commercial fishermen and those engaged in aquaculture with data on performance and limitations of the various stocks commercially available.

This line of research calls for interdisciplinary cooperation with a number of research bodies with competence in ethology, ecology, population genetics, physiology, fish breeding etc. The main goal is to provide fish stocks that are well suited to various "tasks", be it the stocking of natural waters, put-and-take fishing, aquaculture or nature conservation. The Institute has two functions in this respect, to engage in direct research and to coordinate the research of other institutions. The National Board of Fisheries has indicated its interest in a firm organization of this activity by advocating a strengthening of the staff at the Kälärne station.

Sub-projects:

(A) Fisheries Experimental Station, Kälärne

The general objective of the biological research activities can be summarized under the heading "Characterization of species and stocks of salmonids". The aim is to produce data which can serve as a basis for an evaluation of the quality of the fish and to raise the quality of the fish cultured for both fisheries management and aquaculture.

The internal research activities are focused on the areas 1) survey of characteristics of different stocks of char, 2) effects of culture on salmonids, 3) evaluation of the usefulness of different proteins, used in gel electrophoresis, to characterize different stocks of salmonids, and 4) stocking experiments with brown trout and salmon of the Gullspång stocks.

Two important external projects are carried out at Kälärne, i.e. breeding programmes for the commercial culture of rainbow trout (The Swedish Agricultural University) and arctic char (University of Umeå) respectively.

Funding: Basic resources such as materials, technical equipment, and work space are provided by the National Swedish Board of Fisheries. Supplementary funding is varied and comes from government sources and Swedish research councils.

Staff: Coordinators: Jan Henricson, Lennart Nyman. Others: Johan Hammar, Maria Hanson, and (at Kälärne) Lars Hanell, Olle Ring and Knut Svensson.

Project 1

"Effects of culture on fish: A genetic and ecological perspective".

A long-term study on 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 combining population genetics (electrophoresis), ecology and ethology.

Project 2

"Genetic and ecological characterization of strains of the arctic char complex".

Use of protein variants (electrophoresis) to construct genetic profiles for specific strains. Comparative growth studies in standardized environments.

Project 3

"Crossbreeding experiments with dwarf and normal char from Lake Stora Rösjön".

The aim of the project is to investigate the heritability and plasticity of life history characteristics of dwarf and normal char, i.e. age and size at sexual maturity, growth rate etc. (Dept. of Limnology, Uppsala University.)

Project 4

"Test rearing of different strains of char in cages"

Different strains of char are reared in net cages in lakes in cooperation with some fish farmers. Growth, mortality, diseases, flesh colour and fat content are monitored.

Project 5

"Breeding experiments with rainbow trout for farming"

A basic breeding programme with rainbow trout for the aquaculture industry. The objective is to explain the genetic variation in growth pattern in different rearing environments and at different life stages. From these data guidelines for effective breeding work are being developed. (The Swedish Agricultural University.)

Project 6

"Selective breeding of arctic char for farming"

Estimation of genetic parameters of char of the "Hornavan" strain. With the genetic analysis as a basis breeding is carried out with the objective to provide quality fish for the market. (Umeå University, Dept. of Genetics.)

Project 7

"Conservation and fishery management work with salmon and brown trout from the Gullspång River"

The purpose is to genetically characterize these two valuable strains and to put farming methods in practice to minimize the negative genetic effects of farming. Stocking experiments are carried out in natural waters and recapture rates, survival and growth are monitored.

(B) Fisheries experimental station, Älvkarleby

At the Fishery Experimental Station at Älvkarleby experiments and investigations concerning fish farming and management of Atlantic salmon and sea trout are carried out. Production of fish for fishery management financed by fishing charge funds for the River Dalälven is another objective. The experimental activities are primarily aimed at running water species, especially different strains of sea trout.

The station is to be rebuilt and extended to provide more facilities for experimental work, including a stream tank. A minimum flow is planned for one of the river channels in the adjacent, regulated River Dalälven. The channel may be used as a full-scale experimental site.

Funding: Funded by the government on a yearly basis by the National Board of Fisheries and by the World Wide Fund for Nature (WWF).

Staff: Coordinator: Nils G. Steffner. Others: Bjarne Ragnarsson and Jan-Eric Nathanson.

Project 8
"Cultivation methods and techniques"

- a) Experiments on the rearing of sea trout in cages along the coast
The aim of the project is to improve the local fishery for sea trout.
- b) Experiments on the rearing of grayling from the River Dalälven
The aim of the project is to improve knowledge about the rearing of grayling.
- c) The giant catfish project

The European catfish Silurus glanis is in danger of extinction in Sweden. The project studies the possible causes and aims at proposing conservation measures. Experiments on the rearing of fish caught in natural waters are in progress.
Project manager: Jan-Eric Nathanson.

Project 9
"Marking techniques"

a) Disc tagging

Experiments are carried out on three kinds of disc tags. Sea trout raised in cages and released along the coast, or raised in tanks and released in the River Dalälven, are tagged.

b) Sport marking of brood-fish with Alcian blue

The aim of the experiment is to test a simple method of date-marking the salmon and sea trout caught in the brood-stock fisheries on the rivers. In cooperation with Henrik Mosegaard, Institute of Limnology, University of Uppsala.

c) Nose tagging

Experiments are in progress in the Lakes Siljan and Vättern, and in the River Dalälven.

Project 10
"Transport and stocking methods"

These experiments are carried out on a routine basis as part of the stocking procedure in the River Dalälven.

"Remaining activities"

a) Experiments on vaccination against ASA (*Aeromonas salmonicida atypica*). In cooperation with Ulf-Peter Wichardt, Swedish Salmon Research Institute.

b) Preparation of ADB programmes for registration of brood-fish. A new new system for registration of catch data on brood-fish is evaluated. In cooperation with Henrik Mosegaard, Institute of Limnology, Uppsala University.

Some recent publications:

Hammar, J. 1984. Ecological characters of different combinations of sympatric populations of Arctic charr in Sweden. p. 35-63. In Biology of the Arctic charr. Eds.: L. Johnson and B.L. Burns. Proceedings of the International Symposium on Arctic charr, Winnipeg, Manitoba, May 1981. Univ. Manitoba Press, Winnipeg.

Hammar, J. 1985. The geographic distribution of the Arctic char (*Salvelinus alpinus* (L.)) species complex in Svalbard. ISACF Information Series No 3:29-37.

Hammar, J. and Filipsson, O. 1985. Biological testfishing with Lundgren's multimesh size gillnets, the Drottningholm technique modified for Newfoundland Arctic char populations. Rep. Inst. Freshw. Res., Drottningholm No 62:12-35.

- Nathanson, J.E. 1987. Distribution of the sheatfish (Silurus glanis). Inform.Inst.Freshw.Res., Drottningholm (1). 70 p. (In Swedish with English summary.)
- Nilsson, N.-A. 1985. The niche concept and the introduction of exotics. Rep.Inst.Freshw.Res., Drottningholm, No 62:128-135.
- Nilsson, N.-A. 1985. Consequences of the rotenone treatment of a subarctic lake on the fish and zooplankton communities. Rep.Inst.Freshw.Res., Drottningholm, No. 62:120-127.
- Nilsson, N.-A., L. Nyman, M. Fürst, N. Johansson and N.G. Steffner. 1987. Stocking of fish and crayfish - recommendations. Inform.Inst.Freshw.Res., Drottningholm (10). 90 p. (In Swedish.)
- Nyman, L. 1986. A breeding methodology for fisheries management. Inform.Inst.Freshw.Res., Drottningholm (2). 20 p. (In Swedish with English summary.)
- Nyman, L. 1986. Genetic effects of fish culture. Nordforsk, Miljövärdsserien 2:179-184. (In Swedish with English summary.)
- Nyman, L. 1987. High, old and small: The dwarfs of chardon. ISACF Information Series No. 4:107-112.
- Nyman, L. and L. Norman. 1987. Genetic aspects on culture of Atlantic salmon and sea trout for stocking: guidelines for breeding methodology and management. Rep.Swedish Salmon Res.Inst. 1987:4. 20 p.
- Ring, O. and L. Hanell. 1987. Genetic background of brood stocks of Gullspång salmon and brown trout at the Fisheries Board's Kälarne hatchery. Inform.Inst.Freshw.Res., Drottningholm (6). 44 p. (In Swedish with English summary.)
- Svärdson, G. and N.-A. Nilsson. 1985. Fisheries biology. LTs förlag, Stockholm. 310 p. (In Swedish.)

MONITORING FISH STOCKS IN VARIOUS TYPES OF LAKES

Originally this project area was focused on large lakes with extensive commercial fisheries. Studies of species interactions and food webs necessitated cooperation with other organizations. Year-class fluctuations and dominance relationships between fish species, as they may be construed from available statistics and test fishing trials, normally form the data base for the stock analyses. The major emphasis is on explaining the interaction between lake trophic level, fishing pressure and the dominant species of fish.

In recent years the activities within this project area have concentrated on monitoring smaller lakes of various types using standardized methods of fishing with so-called survey nets. Normally lakes are visited once every two, three or five years. This enables us to test the various biological models which form the net result of our pooled knowledge.

As an example of "where and why" we fish, the lakes eligible for standardized fishing in 1987 are described below.

Lake Korsvattnet (province of Jämtland): allopatric char, which displays a sigmoid growth curve. Limited net-fishing occurs and the char attain a large size (up to 6 kg) and are cannibalistic. Do small and big char segregate genetically?

Lake Västansjön (province of Lappland): a study of the effects of a net-fishing ban on char and perch (Perca fluviatilis). The reference lake - Lake Bollvattnet - could no longer be used because the net-fishing effort was severely reduced even in this lake as a result of the Chernobyl accident.

Lake Garnsviken (province of Uppland): effects on fish and crayfish (Astacus astacus) populations of a heat-extraction project.

Lake Vallentunasjön (province of Uppland): same as above.

Lake Östra Ringsjön (province of Skåne/Scania): effects of eutrophication on fish and zooplankton communities in a lake dominated by cyprinids. Standard survey net fishing and hydroacoustic equipment will be used to monitor fish populations. Cyprinids will be selectively removed by a trawl fishery.

Lake Ången (province of Södermanland): effects of stocked eel on the natural fish community of the lake. The development of the eel stock is monitored annually by fyke nets in the lake and a trap at the outlet.

Each year a seminar is held in which the results of the annual test fishing investigations are discussed. In this way a continuous flow of new knowledge into all project areas is guaranteed.

In recent years this project area has been enlarged. Fisheries management in reservoirs, a ten-year project, was terminated in 1986 by the publication of two monographs, one pertaining to management of river reservoirs, the other dedicated to management of fish stocks in regulated lakes. A number of important aspects concerning management procedures in the regulated lakes could not be evaluated within the time frame of the project, however, and as a result two sub-projects were formulated in order to pursue some of the most urgent problems even after 1986. These sub-projects are described below.

Another sub-project, addressing the management of a single lake, Lake Ringsjön in the province of Skåne, southernmost Sweden, was started in 1987. This project is referred to as sub-project 3 below.

Funding: Primarily government funding for the basic project, special funds provided on a yearly basis from the National Board of Fisheries, local funds from County Administrations, and special government funds for environmental impact studies after the Chernobyl accident.

Staff: Coordinator: Olof Filipsson, others: Eva Bergstrand, Johan Hammar, Gunnel Hasselrot, Nils-Arvid Nilsson, Lennart Nyman, Gun Odén, Gun Svensson.

Sub-project 1: "Interactions between Pallasea quadrispinosa, benthic fauna and fish"

This project follows up the project "Fisheries management in reservoirs" which ended in 1986. Since 1960, three species of crustaceans have been stocked as fish-food organisms in impounded reservoirs, to replace the littoral fauna that was exterminated by fluctuations in water level. These crustaceans are the opossum shrimp Mysis relicta and the gammarid amphipods Pallasea quadrispinosa and Gammaracanthus relictus. The effects of the introduction of Mysis were presented in a report by Fürst, Hammar and Hill (1986) and in a review article by Lasenby, Northcote and Fürst (1986).

Pallasea is epibenthic and has a two-year life cycle. It was stocked in 25 lakes in the early 1970s and has established populations in at least 16. The amphipod is eaten by fish such as brown trout (Salmo trutta), Arctic char (Salvelinus alpinus) and whitefish (Coregonus sp.), and is particularly important as a food organism during winter. However, introduction of Pallasea seems to have caused a decrease in the mean size of brown trout and Arctic char in some lakes in the River Umeälven. The amphipod is also thought to have spread the nematode Cystidicola sp., a parasite of the swimbladder of fish.

The ecology of Pallasea has been studied in a lake where the species occurs naturally. The effects of the introduction of the amphipod on benthic fauna and fish are being investigated in two small lakes. A comparison has been made of the quality of Arctic char in reservoirs with and without introduced Pallasea. It is

also planned to review the literature on the ecology of smelt (Osmerus eperlanus), as it has been suggested that this fish could be stocked in impounded lakes to provide a link between introduced crustaceans and piscivorous fish.

Project manager: Catherine Hill, others: Magnus Fürst and Johan Hammar, plus Elin Sigvaldadottir and Stefan Lundberg from the Museum of Natural History.

Sub-project 2: "The biology of lake-dwelling salmonids: population ecology, interactions and systematics"

Salmonid fishes dominate the fish fauna of north Swedish lakes from an ecological as well as economic point of view. Many salmonid fish stocks in southern Sweden are also economically important, but also represent valuable resources both from the point of view of conservation and from a historic perspective. Many salmonids are part of complicated species and genus assemblages with more or less well developed genetic barriers between them. Because of their early immigration to Swedish fresh waters from various Ice Age refugia and their subsequent isolation in the lakes, the evolutionary processes have given rise to unique populations with specific ecological and genetic characteristics. Many of those characteristics can be related to traits typical of anadromous populations. This in turn explains why dynamic fluctuations occur in their population structures and in relation to other fish stocks.

In fisheries biology it is common to study the relationships among northern salmonids in lakes with few fish species, to obtain clues to the ecological pathways that should guide contemporary fisheries management. Increased exploitation of natural resources augments the need for a refined understanding of how the adverse effects should be mitigated. This project aims at defining the effects on salmonid fish stocks of various environmental hazards, e.g. water level regulation, "construction" of new food webs and longterm effects of the Chernobyl accident. The final objective is to increase knowledge of the biology of salmonid fishes, and to tailor rational programmes for fisheries management of the lakes in which they live.

The studies are based on natural populations, which are investigated by standardized testfishing methods, analysis of ecological parameters and electrophoresis. To verify the interactive and genetical models used experimental studies will also be performed.

Project manager: Johan Hammar, others: Olof Filipsson, Jan Henricson, Lennart Nyman, plus Georg Neumann and Manuela Notter at the National Swedish Environment Protection Board and Brian Dempson and Eric Verspoor at Science Branch, D.F.O., St. John's, Newfoundland, Canada.

Sub-project 3: "Effects of eutrophication on fish and zooplankton communities of Lake Ringsjön"

The fish fauna of the eutrophic Lake Ringsjön is dominated by cyprinids. In the seventies, the mean size of cyprinids and percids was reduced and the size-selective predation by fish on zooplankton increased. During the same period blooms of blue-green algae became persistent. In 1987 the National Board of Fisheries initiated a project in cooperation with the Institute of Limnology, University of Lund. The aim of the project is to elucidate the effects of a reduction fishery trawling on cyprinids and its consequences for the zooplankton community and the blooms of blue-green algae. The Drottningholm Institute performed a test fishing trial and a hydroacoustic survey in 1987 and will be responsible for the analysis of fish growth and zooplankton in the project.

Project manager: Eva Bergstrand, others: Olof Filipsson, Olof Enderlein.

Some recent publications:

Bergstrand, E. 1987. Effects of eutrophication on the fish and zooplankton communities of Lake Ringsjön, Sweden. p. 173-191. In Eutrophication and lake restoration. Water quality and biological impacts. Actos of the French-Swedish Limnol.Symp. INRA, Thonon-les-Bains, June 1987.

Edelstam, C., J. Hammar, S. Jensen, J. Mowrer & M. Olsson. 1987. Environmental toxicants in the Arctic Ocean. Results of analyses from the Ymer expedition 1980. p. 174-182. In Expedition YMER-80 - en slutrapport. Eds.: G. Hoppe, S. Björn-Rasmussen & M. Wiberg-Roland. Polarforskningskommittén. Kungl.Vet.Akad., Stockholm. (In Swedish.)

Filipsson, O. 1986. What happens in Lake Övre Särvsjön? Fiskerinytt, Drottningholm 1. 6 p.

Filipsson, O. 1987. The effects of banned gillnet fishing on the fish populations of a northern lake. p. 27-30. In Proceedings of the fourth ISACF workshop on Arctic char. ISACF Inf.Ser. (4). Inst.Freshw.Res., Drottningholm.

Fürst, M., J. Hammar & C. Hill. 1986. Introduction of new food-organisms to impounded lakes. Final report from FÅK, part II. Inst.Freshw.Res., Drottningholm. 78 p. (In Swedish.)

Hammar, J. 1987. Down North Labrador. NOS, Föreningen Natur och Samhälle i Norden (1):4-12. (In Swedish.)

Hammar, J. 1987. The char-sensitive inhabitant of Arctic lakes - an indicator and reference fish in modern fish biology. p. 157-165. In Expeditionen YMER-80 - en slutrapport. Eds.: G. Hoppe, S. Björn-Rasmussen & M. Wiberg-Roland. Polarforskningskommittén. Kungl.Vet.Akad., Stockholm. (In Swedish.)

- Hammar, J. 1987. Status of the Arctic char and char research today. p. 1-3. In Proceedings of the fourth ISACF workshop on Arctic char. ISACF Inf.Ser. (4). Inst.Freshw.Res., Drottningholm.
- Hammar, J. 1987. The fourth ISACF workshop in Switzerland, Austria and Germany. p. 4-8. In Proceedings of the fourth ISACF workshop on Arctic char. ISACF Inf.Ser. (4). Inst.Freshw.Res., Drottningholm.
- Hammar, J. 1987. Zoogeographical zonation of fish communities in insular Newfoundland: A preliminary attempt to use the Arctic char population ecology to describe early postglacial colonization interactions. p. 31-38. In Proceedings of the fourth ISACF workshop on Arctic char. ISACF Inf.Ser. (4). Inst. Freshw.Res., Drottningholm.
- Hammar, J., G. Neumann & M. Notter. 1987. Chernobyl-cesium in biota of lakes and reservoirs of northern Sweden: Indications of transport of radionuclides from sediment via introduced Mysis relicta to Arctic char and brown trout; a project description. p. 39-53. In Proceedings of the fourth ISACF workshop on Arctic char. ISACF Inf.Ser. (4). Inst.Freshw.Res., Drottningholm.
- Hill, C. & G. Forsberg. 1986. The diet of fish in lakes with the introduced amphipod Pallasea quadrispinosa. Inform.Inst. Freshw.Res., Drottningholm (10). 35 p. (In Swedish with English summary.)
- Lasenby, D.C., T.G. Northcote & M. Fürst. 1986. Theory, practice and effects of Mysis relicta introductions to North American and Scandinavian lakes. Can.J.Fish.Aquat.Sci. 43:1277-1284.
- Olsén, P., U. Heyman, U. Boström & C. Hill. 1987. Fat content and condition in Arctic char. Inst.Freshw.Res., Drottningholm. PM. 13 p.

COOPERATION WITH DEVELOPING COUNTRIES

The National Swedish Board of Fisheries, of which the Drottningholm Institute is a part, is extensively engaged in development projects within the fisheries sector. The vast majority of these projects are financed by SIDA, but SAREC and FAO also make contributions. Small-scale aquaculture, development of freshwater fisheries and basic ecological studies in lakes and rivers are areas where our staff are involved. In south-east Asia, within the framework of the Bay of Bengal Programme (BOBP) pond, net and pen culture have been developed. These activities mainly took place in India, Bangladesh, Thailand and Sri Lanka. In southern Africa, with the SADCC countries as a target group, there is a regional project aimed at development of aquaculture systems for local communities (ALCOM). A preparatory phase started in 1986. This programme focused attention on aquaculture and various farming systems, aquaculture in small water bodies and on the environmental impact of aquaculture.

Apart from these SIDA-funded projects there is a broad-scale project in Sri Lanka funded by SAREC and operated jointly between the Drottningholm Institute and Ruhuna University, Matara, Sri Lanka.

These projects are aimed at understanding the ecological relationships between the various species - native and introduced - in old and new reservoirs (tanks), at developing technology for standardized stock-taking schemes and at adapting fishery methods for fish and crustaceans. Preliminary investigations have also been conducted on the productivity of salmonids in the highmountain streams of the island.

Funding: SAREC and SIDA provide the entire financial backing.

Staff: Coordinator: Lennart Nyman, others: Olof Enderlein, Arne Fjälling, Magnus Fürst and Håkan Wickström.

Sub-projects:

Standardized stock-taking schemes for reservoir fish resources.

Eel biology and eel management in selected tanks (reservoirs).

Crustacean resources in selected tanks.

Trout production or environmental protection in the Hill Country?

Some recent publications:

Nyman, L., H. Ackefors, A. Andreasson, B.-I. Dybern & B. Holmberg. 1983. Prerequisites for Swedish support to aquaculture in developing countries and proposed guidelines for actions. National Swedish Board of Fisheries, Secretariat of Development Cooperation, Fisheries Development Series 10. 91 p.

Enderlein, O. & H. Wickström. 1986. Report of the third mission of the "fish biology group": Inland Fisheries Project in Sri Lanka. PM. 3 p.

Fürst, M. & A. Fjälling. 1986. Inland Fisheries Project in Sri Lanka: Results and experiences from investigations concerning crustaceans. PM. 7 p.

Nyman, L. 1987. Ecoenvironmental aspects of integrating small-scale aquaculture with rural development programs in southern Africa. MS. 52 p.