FISKERIVERKET INFORMATION 5:1997

# Action plan on Biological Diversity

*This document is a summary of the main part of a report submitted to the Swedish Government in September 1995*

INGEMAR OLSSON
National Board of Fisheries

FISKERIVERKET

| | |
|---|---|
| Ansvarig utgivare: | Generaldirektör Per Wramner |
| Huvudredaktör: | Informationsassistent Monica Bergman |
| Redaktionskommitté: | Chef U-avdelningen, Ingemar Olsson<br>Chef Havsfiskelaboratoriet, Jan Thulin<br>Chef Kustlaboratoriet, Erik Neuman<br>Chef Sötvattenslaboratoriet, Stellan F Hamrin<br>Informationschef, Lars Swahn |

FISKERIVERKET producerar sedan september 1997 två nya serier;
**Fiskeriverket Information** (ISSN 1402-8719)
**Fiskeriverket Rapport** (ISSN 1104-5906).
Dessa ersätter tidigare serier;
Kustrapport (ISSN 1102-5670)
Information från Havfiskelaboratoriet Lysekil (ISSN 1100-4517)
Information från Sötvattenslaboratoriet Drottningholm (ISSN 0346-7007)
Rapport/Reports från Fiskeriverket (ISSN 1104-5906).

För prenumeration och ytterligare beställning kontakta:
Fiskeriverket, Sötvattenslaboratoriet, Monica Bergman,
178 93 Drottningholm
Telefon: 08-62 00 408, Fax: 08-759 03 38

Tryckt på Storafine miljövänligt papper i 500 ex
November 1997
Göteborgs Länstryckeri AB

ISSN 1402-8719

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**Action plan on Biological Diversity**

*This document is a summary of the main part of a report submitted to the Swedish Government in September 1995*

Ingemar Olsson
National Board of Fisheries, Göteborg

# Action plan on Biological Diversity

*This document is a summary of the main part of a report submitted to the Swedish Government in September 1995*

Ingemar Olsson

National Board of Fisheries
P. O. Box 423, SE-401 26 GÖTEBORG

## Preface

In August 1994 the National Board of Fisheries was commissioned by the Swedish Government to draw up a plan on the environmental aspects of fisheries. The work should be carried out on the basis of the objectives for the fishery and the environment approved by the Swedish Parliament. The plan should indicate measures aiming at a conservation of biological diversity and a sustainable use of the fish resources.

This document is a summary of a main part of the report submitted to the Government in September 1995.

We are indebted to Miss Anja Söderlund for the linguistic revision of the text.

Per Wramner
Director-General

Ingemar Olsson
Assistant Director-General

# Contents

# Introduction

In addition to the Action Plan of the National Board of Fisheries, this summary is based on the document ”Biological Diversity in Sweden. A Country Study” (Swedish Environmental Protection Agency, Monitor 14) and the report ”Fiske och vattenbruk. Ekologiska effekter” (Naturvårdsverket, Rapport 4297). The catch statistics of the Action Plan have been updated to include the figures for 1996.

### The Convention on Biological Diversity

In June 1992, at the United Nations Conference on Environment and Development in Rio de Janeiro, a total of 153 states, together with the European Union, signed the Convention on Biological Diversity. Since then, a number of states have signed or acceded the Convention, making it one of the most widely supported international agreements ever. The Convention came into force on 29 December 1993 and, with its broad approach, has the potential to play a coordinating and leading role in international nature conservation efforts.

The objectives of the Biodiversity Convention are ”the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources”. The last-mentioned of these aims concerns the relationship between countries providing genetic resources and those which use their technology and know-how to develop products from them.

### Terms of reference for the action plan

In the autumn of 1993, the Swedish Government presented a bill intitled *Strategy for Biological Diversity* (Government Bill 1993/94:30). The bill was subsequently approved by the Parliament and thus constitutes a political platform and strategy for the promotion of biodiversity in Sweden. This document sets out broad principles for the conservation of biological diversity and the sustainable use of biological resources.

In August 1994 the Board of Fisheries was commissioned by the Government to draw up a plan on the environmental aspects of fisheries. The work should be carried out on the basis of the objectives for the fishery and the environment approved by the Swedish Parliament. The plan should indicate measures aiming at a conservation of biological diversity and a sustainable use of the fish resources. An important basis for the work was the country study *Biological Diversity in Sweden*. The Board's work with the action plan should be coordinated with corresponding work carried out by the Swedish Environmental Agency. This agency was asked by the Government to undertake ”an overall assessment of the sectorial action plans” of the Swedish Board of Agriculture, the National Board of Forestry, the national Board of Fisheries and the National Board of Housing, Building and Planning.

The work with the action plan has been carried out by a Steering Group headed by Mr K.-E. Berntsson and with Mr I. Olsson (secretary) at the Board of Fisheries. Other members of the group were Mr B. Sjöstrand, Institute of Marine Research, Mr M. Appelberg, Institute of Freshwater Research and Mr J. Andersson, Institute of Coastal Research.

# Objectives

### Overall objectives adopted by the Parliament and the Government

Government Bill 1990/91: A Living Environment

According to the Government Bill 1990/91: "A living Environment" there are the following four overall objectives of Sweden's environmental policy:

- to protect human health
- to conserve biological diversity
- to manage natural resources in order to ensure their sustainable use, and
- to protect natural and cultural landscapes

Guidelines for the work should be:

- Biological diversity and genetic variation should be safeguarded. Plant and animal communities should be manitained in order to enable viable populations of plant and animal species occurring naturally in Sweden to survive in natural surroundings. Viable, balanced populations of species occurring in sea areas and inland waters should be maintained.
- Land and water should be used in ways which enable a rich variety of landscape types, habitats and species to be maintained and viable populations of naturally occurring species to be preserved.
- Renewable resources should be used within the framework defined by ecosystem productivity.
- The introduction of non-native species and genetically modified organisms should only be undertaken with considerable restraints and subject to adequate controls, so it will not jeopardize the conditions required by native flora and fauna.
- Greater sectoral responsibility and greater decentralization should be encouraged, in order to secure broad support for environmental protection and conservation efforts.

Government Bill 1993/94:30 "Strategy for Biological Diversity"

This bill sets out approaches and guiding principles specifically relating to the maintenance of biodiversity in Sweden.

Fisheries

- Viable, balanced populations of species occurring naturally in sea areas and inland waters should be maintained (*Government Bill 1990/91:90: A Living Environment).*
- The objective of nature conservation and environmental protection efforts in the area of fisheries is to maintain viable, naturally occurring populations of fish and shellfish and their food organisms. This includes action to safeguard all fish species in the country. It is essential to preserve within-species variation, since this variation is in many cases considerable (*Government Bill 1993/94:30 Strategy for Biological Diversity*).
- It is important to maintain viable, naturally reproducing populations of fish and shellfish. Special attention must be paid to within-species variation. This is important for Atlantic salmon (*Salmo salar*), for example, which together with the noble crayfish (*Astacus astacus*) and wels (*Silurus glanis*) should be made the subject of measures under the action programme to conserve populations of threatened aquatic species (*Government Bill 1993/94:158: Fisheries Policy Bill*).

### The Instruction of the Board of Fisheries

The Instruction of the Board of Fisheries (SFS 1994:79, March 15 1994) is as follows:

1 §. The Board of Fisheries shall manage the fish resources in a responsible manner with a view to contribute to the Swedish food supp-

ly and general prosperity in a long-term perspective. The Board shall in line with its responsibility for environmental conservation within the fishery sector and in cooperation with the Environmental Protection Agencies work for a biological diversity and with that rich and biodiverse fish stocks.

The Board of Fisheries shall in its work especially

- contribute to the establishment of an efficient fishing industry including aquaculture and pave the way for an adaptation to and a development into a free market,
- take part in international matters related to fishery and in fishery negotiations,
- work towards increased and adequate fishing opportunities for the public,
- strive for a responsible fishery and for a good balance between the interests of the commercial and the recreational fisheries,
- support and undertake research and development.

# Biological diversity with reference to fish and shellfish

### Lakes and rivers

By international standards, Sweden has a very large number of lakes in relation to its area. The country's ancient bedrock, though worn down with the passage of time, is still fractured and uneven. The last ice age left its surface scattered with ridges and mounds of till. These factors combined have created numerous natural depressions and dams, in or behind which precipitation can accumulate. In all, there are some 92 500 lakes in Sweden measuring 1 ha or more, occupying a total of 8.5% of the country's surface area.

In mountain regions, the majority of lakes have largely retained their original character. They are deep, clear and poorly supplied with nutrients - oligotrophic - and have a relatively species-poor flora and fauna. In forest areas, too, lake nutrient levels are low. Some forest lakes also have fairly clear water, but many of them receive a substantial input of humic and other substances from the surrounding land. These substances stain the water brown, and small, relatively shallow forest lakes especially are therefore often transparent to a depth of no more than a metre or so.

A third type of lake is to be found on the plains of southern and central Sweden. These areas were under wate rat the end of the ice age and since then they have been covered by clayish and in some cases calciferous soils. Lakes in such areas, which often are very shallow, receive an abundant supply of nutrients from their catchments. In modern times, agriculture has increased the nutrient input further.

Sweden's lakes, rivers and streams are generally considered to be home to a total of just over 50 fish species, including a few that also occur in salt water. In many mountain waters Arctic char remains the only fish species. In large, deep lakes further south in Sweden whitefishes often achieve dominance. In the southern Swedish highlands there are still a few very oligotrophic lakes with no predominantly predatory fish. Their fish faunas are dominated by non-piscivorous species such as vendace, smelt and sculpins. Even a moderate increase in nutrient availability creates conditions for the presence of predatory fish as well. In northern parts of the country, immediately downstream from waters where Arctic char is the only fish species, brown trout often occupies the highest level of the lake ecosystem food chains. The diet of adult brown trout includes burbot, char and sculpins. In lowland forest lakes, this level is dominated by perch or pike. However, perch, the most widespread of all Swedish fish species, can occur in lakes up to about 1 000 m above sea level. The fish fauna of the often brownish waters of forest lakes is generally dominated by perch and roach. In warm, eutrophic lakes on the plains of southern and central Sweden, pike-perch may also be found, and where it occurs it will be the dominant piscivorous fish species.

The most common fish species of running waters is the brown trout. In larger rivers in the north of Sweden it can be found along with grayling, brook lamprey or sculpins. Higher up the coldest rivers, however, Arctic char is often the only species of fish. In the lowest reaches of less turbulent rivers, species poorly equipped to swim in fast-flowing water will be found. These include perch, pike, orfe (ide) and powan. From time to time Atlantic salmon, sea trout and sea lamprey ascend many rivers from the sea to spawn. Each individual salmon or sea trout has gradually adapted to conditions in its home river.

The principal threats to the diversity of lakes and running waters are regulation of water levels and/or flow, pollution, including acidification and the introduction of non-local species.

Red-listed species of fish

*The following species of fish, lampreys and crayfish have been red-listed by the Swedish Threatened Species Unit:*

| | | |
|---|---|---|
| **0. Extinct** | Sturgeon | *Acipenser sturio* |
| **1.Threatened** | Spring-spawning vendace | *Coregonus trybomi* |
| | Wels | *Silurus glanis* |
| **2. Vulnerable** | Motherless minnow | *Leucaspius deliniatus* |
| | Stone loach | *Barbatula barbatula* |
| | Gudgeon | *Gobio gobio* |
| **3. Rare** | Zope | *Abramis ballerus* |
| | Asp | *Aspius aspius* |
| | Spined loach | *Cobitus taenia* |
| | Russian bullhead | *Cottus koshewnikowi* |
| **4. Special consideration** | Sea lamprey | *Petromyzon marinus* |
| | Atlantic salmon* | *Salmo salar* |
| | Brown trout* | *Salmo trutta* |
| | Arctic char* | *Salvelinus salvelinus* |
| | Grayling* | *Thymallus thymallus* |
| | Four-horned sculpin * | *Triglopsis quadricornis* |
| | Noble crayfish | *Astacus astacus* |

* Regionally different types of threat

### Coastal and offshore waters

The Swedish coast is more than 2 000 km long and goes from the Torne River at the Finnish border in the north to the Ide Fjord at the Norwegian border in the west. This very long coastal area provides very great variations in the marine physical and chemical environment.

In the Bothnian Bay, the northern part of the Gulf of Bothnia, the water has a salinity of no more than 2-3‰ (parts per thousand), owing to the input of fresh water from the major rivers here. Near the coast the salinity may be even lower. To the south, in the Bothnian Sea and on into the "Baltic Proper", i.e. the area south of the Cland Sea, the salinity of the surface water gradually increases. Even more saline and hence heavier water flows in through the Sound and the Belts from the Kattegatt and settles in the deepest parts of the Baltic. This results in the formation, at a depth of around 70-80 m in the Baltic proper, of a halocline. This boundary layer divides the lighter water nearer the surface from the deeper water, which, in the far south at least, can have a salinity of up to 10-15‰, or occasionally even higher.

In the Kattegatt and the Skagerrak a similar halocline arises at a depth of approximately 15 m. As a rule this divides northward-moving surface water, with a salinity varying between 15‰ and 30‰, from the deep water flowing in the opposite direction from the North Sea. Off the west coast of Sweden, this deeper water has a salinity of 32-34‰, not far short of the roughly 35‰ found in the open oceans.

This variation in salinity means that, while the fauna and flora of Sweden's west coast have a good deal in common with those of the neighbouring Atlantic coast, virtually only freshwater species are to be found in the north of the Gulf of Bothnia. Few species are especially adapted to brackish water with the levels of salinity found in the areas in between. These waters mainly support species that have been able to move in from the open sea or from fresh waters as a result of being relatively tolerant of differences in salinity. This category, too is a fairly small one.

In many of the coastal and archipelago waters of the Baltic, the fish fauna consists at least partly of freshwater species. Pike for example, are found as far out as the Sound.

In more open areas of the Baltic, however, certain salt water species that can withstand brackish water predominate. Herring alone are responsible for some 40% of the total fish biomass of the Baltic, with cod and sprat together accounting for another 40%. The Baltic can be classified as a marginal area for several species, which have adapted to a harsh environment and thereby developed special genetic characteristics. Marine species such as cod, herring, flounder and turbot have developed local populations, the reproduction of which have been adapted to lower salinities. It is also probable that many of the fresh water species in the Baltic have adapted to higher salinities. The waters off the west coast of Sweden have a much more varied fish fauna, comprising of 130 species in all. In both the Kattegatt/Skagerrak and the Baltic the distribution of fish is also governed by temperature. Warmth-demanding species such as the carp and perch families chiefly occur in shallow inshore waters, while cold-water fish such as cod and four-horned sculpin remain at a distance from the coast.

Shallow bays and inlets with sandy or muddy substrata are one of the most important marine habitats. Their levels of plant production are comparable to those found on fertilized arable land in the south of Sweden. The benthic vegetation of such sites provides spawning and nursery grounds for many fish species, including flatfish, garfish and herring, as well as pike, perch and eel in the Baltic. As adults, too, most of these species find food here, often alongside sea trout and cod.

Red-listed species of fish

*The following species of fish and lampreys have been red-listed by the Swedish Threatened Species Unit:*

| | | |
|---|---|---|
| **2.Vulnerable** | Fries's goby | *Lesueurigobius friesii* |
| **3. Rare** | Yarrell's blenny<br>Small-mouthed wrasse | *Chirolohpis ascanii*<br>*Centrolabrus exoletus* |
| **4. Special consideration** | Sea lamprey | *Petromyzon marinus* |

# Fishery and aquaculture today

## Commercial fishery

### Offshore fishery

The shallow sea areas around Scandinavia are among the most productive in the world. The annual biological production of commercially important fish species in the Baltic proper amounts to some 49 kg/ha and in the Kattegat and Skagerrak to as much as about 75 kg/ha. Nowadays the quantities of fish caught in most fishing waters are controlled by internationally negotiated quotas. This has reduced the risk of overfishing, although many of the quotas are still higher than is really desireable from a conservation point of view. Most of Sweden's fishing fleet now operates in the Skagerrak, Kattegat or Baltic, within around a hundred kilometers of the Swedish coast. Traditionally, the main focus of Swedish fisheries has been for human consumption. In the last few years, however, Swedish fishermen have also been engaged in large-scale "industrial" fishing with the emphasis on fish suitable for animal feed. Large quantities of herring and sprat are now converted into oil or meal.

Table 1 shows the catch and value of the Swedish commercial fisheries in 1993.

In 1996 the total catch (preliminary figures) amounted to 334 000 tonnes with a value of about 955 million SEK. The quantity of fish for reduction was about 220 000 tonnes. Most of this fishery took place in the Baltic.

### Freshwater fishery

The most important species (by weight) of the Swedish commercial fresh-water fisheries are vendace, pike-perch, perch, whitefish, pike and eel. The main fishery took place in the great lakes.

Table 2 shows the catch and value of the Swedish commercial fresh water fisheries in 1993.

*Table 1. Catch and value per fishing area for some of the most important species in the Swedish commercial fisheries in 1993.*

| Species | North Sea | Skagerrak/ Kattegat | Baltic | Sum[1] (tonnes) | ...share of fish for reduction[2] | Value[3] (SEK x 1000) |
|---|---|---|---|---|---|---|
| Cod | 646 | 5 124 | 12 201 | 17 971 | 13 | 152 196 |
| Herring | 5 782 | 72 879 | 86 497 | 165 158 | 100 675 | 112 646 |
| Northern shrimp | 167 | 2 133 | - | 2 300 | - | 64 268 |
| Norway lobster | 1 | 863 | - | 864 | - | 43 570 |
| Eel | - | 438 | 577 | 1 015 | - | 42 860 |
| Saithe | 1 387 | 3 568 | - | 4 955 | - | 23 418 |
| Salmon | - | 25 | 946 | 971 | - | 18 779 |
| Sprat | 80 | 4 424 | 92 416 | 96 920 | 93 486 | 12 272 |
| Haddock | 908 | 436 | - | 1 344 | - | 11 197 |
| Mackerel | 3 435 | 175 | - | 3 610 | 340 | 9 424 |
| Vendace | - | - | 1 104 | 1 104 | 817 | 2 347 |
| Other species | 862 | 3 721 | 1 559 | 6 142 | 706 | 93 053 |
| Blue whiting | - | 37 265 | - | 37 265 | 37 265 | 153 589[4] |
| Sum | 13 268 | 131 051 | 195 300 | 339 619 | 233 459 | 739 619 |

[1] Sum for fish for consumption and reduction. [2] The species composition of the fish for reduction is uncertain. [3] The value only refers to fish for consumption. [4] Sum of all fish for reduction.

*Table 2. Catch and value of the Swedish commercial fresh water fisheries in 1993.*

| Species | Lake Vänern | Lake Vättern | Lake Mälaren | Lake Hjälmaren | Other waters | Sum (tonnes) | Value SEK x 1000) |
|---|---|---|---|---|---|---|---|
| Pike-perch | 94 | - | 146 | 68 | 48 | 356 | 8 876 |
| Eel | 19 | - | 31 | 28 | 51 | 129 | 6 327 |
| Vendace | 486 | 3 | 27 | - | 12 | 528 | 5 940 |
| (roe) | 23 | - | 2 | - | - | 25 | 5 125 |
| Whitefish | 85 | 48 | - | - | 66 | 199 | 2 997 |
| Salmon and trout | 48 | 33 | 4 | - | 1 | 86 | 2 572 |
| Char | - | 36 | - | - | 21 | 57 | 2 563 |
| Pike | 63 | 4 | 31 | 32 | 38 | 168 | 2 240 |
| Perch | 94 | 12 | 34 | 54 | 26 | 220 | 1 977 |
| Other species | 269 | 9 | 6 | 14 | 220 | 518 | 1 571 |
| Sum | 1 158 | 145 | 279 | 196 | 483 | 2 261 | 35 063 |

In 1996 the total catch amounted to 1 786 tonnes with a value of about 40 million SEK.

### Recreational fishery

The annual catch of the recreational fishery has been estimated to be 10 000-15 000 tonnes. The west coast fishery makes use of just over 40 species, including cod, mackerel, sea trout, whiting, spiny dogfish, wolffish, various flatfish, common lobster and edible crab. The Sound is chiefly famous for its winter fishing for cod. Anglers have here landed specimens weighing over 30 kg. On the southern part of the east coast, pike and perch are caught in the archipelagos and cod in the shallows among the outlying islands. Pike-perch, seatrout and Atlantic salmon are also found among catches. Off northern Sweden, anglers mainly fish for whitefish, perch and pike, but herring and vendace are also caught.

In fresh waters in southern and middle Sweden the catches consist of pike-perch, roach and common bream in nutrient-rich waters and of pike, perch and roach in less nutrient-rich waters. In deeper parts of lakes trout, char and whitefish are caught. In forest lakes in the north the recreational fishermen catch pike, perch, roach, trout, grayling and whitefish, while trout, char and whitefish are caught in the mountain-lakes, which are oligotrophic In rivers and streams the fishermen catch trout, salmon and char.

### Aquaculture

The Swedish aquaculture of today can be divided into the following parts:

- For consumption
- For compensation due to hydroelectric installments
- For the recreational fishery
- Production of crayfish
- Production of mussels
- Production of cod and oysters (experimental production).

The yield of the Swedish aquaculture in 1996 was 5 460 tonnes of fish for consumption, which when converted to round fresh weight is the equivalent of 6 436 tonnes. The dominating species was rainbow trout (6 139 tonnes). Furthermore there were 1 821 tonnes of cultivated blue mussel. The total value of the aquaculture production amounted to 136 million SEK. For compensatory purposes 3.2 million fry of salmon and trout were released, mainly in rivers running to the Baltic.

# Environmental effects of commercial fisheries

The text of the following sections on the environmental effects of commercial fisheries, recreational fishing and aquaculture are quoted from the summary of the report "Fiske och vattenbruk. Ekologiska effekter" (Naturvårdsverket, Rapport 4297).

Commercial fishing activity can affect ecosystems in many different ways in time and space. Commercial fisheries use, however, resources in a variable environment, where many other factors have an effect. The effects of this fishery must therefore be seen as one of many human impacts on a system that is not in equilibrium.

Fishing causes mortality of target species and also by-catches of fish and other animals. Most of the economically valuable stocks of demersal fish in the Baltic, the Kattegat and Skagerrak are today exploited at levels that are too high for a sustainable fishery. The situation is similar for cod in the Baltic, the Kattegat, the Skagerrak and the North Sea and for haddock (*Melanogrammus aeglefinus*), whiting (*Merlangius merlangus*) and saithe (*Pollachius pollachius*) in the Kattegat and the Skagerrrak. It is very likely that other demersal species are also overexploited. Moreover, there are other fish species for which we do not have enough data to make proper assessments of the stocks. Even the economically important stocks of Norway lobster (*Nephrops norvegicus*) on the Swedish west coast shows signs of overexploitation, expressed as a decreasing catch per unit effort. Overexploitation is the result of larger quantities of fish being caught than are recruited yearly from juvenile fish. For many stocks, in particular cod stocks, the recruitment of juvenile fish in recent years has been lower than average. An adjustment of catches to the lower levels that are necessary to maintain the stocks has not occurred.

A too high exploitaton rate will not only decrease the stocks but also reduce the size diversity (lower mean size and mean age). The high exploitation can also cause a genetic selection to for instance smaller individuals, earlier maturing for spawning and decreased genetic diversity.

Naturally spawning salmon in the Baltic are endangered today. Continued heavy fishing on mixed stocks in combination with the reproductive disturbances caused by the M74-syndrome may in the long run cause the extinction of the wild stocks. Heavy fishing on the unique population of Baltic cod is also a threat that must be focused on, especially as their spawning grounds are at present mainly restricted to the Bornholm basin.

Overfishing can also hit economically unimportant species if these occur as by-catches in a fishery aimed at other species. The trawl fishery in the Kattegat and Skagerrak has probably reduced the occurrence of flapper skate (*Raja batis*) and thornback ray (*Raja clavata*).

The industrial fishery is a non-selective fishery which has increased greatly during the last decade. This fishery causes often unknown by-catches of juvenile fish of commercial species which could have been used for human consumption if they had had been allowed to grow up. This fishery can be ecologically hazardous and should be strictly regulated.

In the selective fishery for target species a certain amount and quality of other fish species are caught as by-catch. In the beam-trawl fishery in the North Sea for instance, five kilogrammes of unuseable fish have been caught per kilogramme of marketed sole. Fishing with beam trawls is not allowed in the Swedish fishery. Generally speaking the trend in the development of gear is towards more selective gear.

Fisheries also cause by-catches of birds. The birds can become entangled in most fishing gear but some types of gear are more dangerous. Most of the drowned birds, for instance guillemots (*Uria aalge*) are caught in bottom nets for cod. Guillemots are also caught in the drift gill-nets in the Baltic salmon fishery. Northern Kattegat is classified as a very important wintering ground for seabirds, with 10 species occurring in internationally important concentrations.

Marine animals such as seals and whales are also caught in fishing gear. Our knowledge of these by-catches are however limited and ICES (International Council for the Exploration of the Sea) has therefore initiated investigations to increase our knowledge. In the Baltic and Öresund populations of harbour porpoise have decreased considerably and there are no signs of recovery. By-catch in the fishery, a reduction in the availability of food during the 1970s, an increased number of boats and possibly also effects of toxic pollutants have together caused a continued decline in the populations. Today, by-catches in the fishery are probably the most serious threat to the harbour porpoises in the Baltic as well as in the Skagerrak and Kattegat.

The fishery of a species for consumption can result in discards, either due to regulations (undersized fish or a full quota) or because there is no market for the fish. In the industrial fishery (for production of fishmeal or oil) fish are rarely discarded. In the North Sea it has been established that in the fishery for haddock and whiting, one third of the total catch is discarded. In context this means that considerable amounts of fish and bottom-dwelling animals are discarded. Some of the these survive.

Each year, 400 000-500 000 tonnes of fish, 100 000 tonnes of invertebrates and 70 000-80 000 tonnes of offal are estimated to be returned to the North Sea. In the Swedish fishery for Norway lobster it is estimated that 75% of the number caught are undersized and dumped. This shows that gear need to be constructed to obtain better selectivity. One estimate of the amount of offal dumped shows that about 12% of the landed weight of the fish is dumped. Both discards and offal that are dumped provide a food source for sea birds as fulmars (*Fulmarus glacialis*), gulls and skuas (*Stercorarius* spp.).

A problem that has increased recently in Swedish and North Sea areas is that the statistics for catches, by-catches and the dumping of undersized fish, offal and invertebrates are incomplete. The great uncertainty about actual figures for dumping and by-catches means that we can not make reliable assessments of the sizes of fish stocks and prognoses for future catch levels.

Fishing operations lead not only to catches of fish but also to incidental mortality of fish that escape from the gear. During fishing operations with most trawls and Danish seines the fish are herded in front of the net, and some of these escape before entering the codend, while others voluntarily or involuntarily pass through the codend meshes. Of the fishes retained in the codend some are lost during hauling. Few data exist on the death rates for the the fish that escape the fishing gear.

Mortality rates depend on a number of factors, such as the species of fish (susceptibility to scale loss and to stress), the type of gear (e.g. type of mesh and cordage), how long the gear is towed, the total catch weight and the composition of the catch.

Fishing activity is intensive in the North Sea and large areas of bottom are affected by trawling gear. In theory the whole area of the North Sea could be affected every year. In practice fishing is concentrated to certain areas and therefore some areas are not affected at all. In the most intensively trawled areas the bottom is disturbed up to 7 times a year. A contributing factor is the intensive beam trawl fishery. In the Skagerrak, the Kattegat and the Baltic the area of the seabed affected by trawling is smaller than in the North Sea, as beam trawling is forbidden and midwater trawls are the dominant gear. However, in areas that are trawled intensively, such as the Kiel Bight, tracks from trawling are found in 25% of the area.

Fishing causes an impact on organisms in and on the bottom as the gear are towed. Fishing gear can be divided into 1) gear that penetrates into the sediment in a substantial manner and therefore affects the infauna i.e. organisms that live in the sediment and 2) gear that mostly affects the epifauna i.e. the organisms that live on the sediment surface. The infaunal organisms can for instance be wiped out by due to the damage caused by the chains on beam trawls, the teeth on mussel dredges or the trawling boards. Ropes without a chain on trawling boards probably only affect the epifauna. In the case of shrimp trawls, pair trawls and seines the gear probably does not penetrate the bottom and therefore primarily affects the epifauna. The negative impacts on these organisms can be reduced if the trawl ropes are equipped with bobbins (rubber rolls). Fixed gear and nets have a minimal effect on the bottom dwelling organisms, except for crabs which can become entangled in the nets.

Beam trawls and mussel dredges affect the bottoms most. Beam trawls are designed to tear up the bottom substrate and thereby frighten the flatfishes. Beam trawls are used mostly on sand bottoms and semi-soft bottoms, and are common in the North Sea. The effect on the bottom substrate depends on the chains that are towed on the bottom. There is a clear relationship between the number of chains used and the amount of benthic organisms that are caught. The mortality caused by demersal trawls and their trawl-boards is probably only one tenth of that caused by beam trawls. Investigations of the effect of fishing with mussel dredges have only shown a minor impact.

Fishing activities create garbage through losses of gear and through the dumping of damaged gear. Fishing also creates lots of garbage in the form of plastic articles, which end up on the bottom and on the shores. It is known that ordinary nets, entangling gear and fixed gear continue to fish for a certain time after they are lost or dumped. The term "ghost fishing" is used to describe this phenomenon. The time during which the lost gear continues to fish depends on factors such as current speed, growth of algae etc. on the gear, the amount of fish caught and the appearance of crabs. In time these factors cause the gear to collapse and stop fishing. In areas where fouling by algae etc. is relatively insignificant, the gear can continue to fish for a longer time. When gear reaches the bottom, multifilament nets become entangled but when monofilament nets become free from fish remains and crabs, they can float up and start fishing again. Knowledge of the amount of lost and dumped gears is limited.

Fisheries release exhausts from fishing vessels and toxins from anti-fouling bottom paints. The extent of these inputs of pollutants and their effects on the environment are to a large extent unknown.

The indirect effects of different fishing activities on the environment are mostly caused by an exploitation of fish species that leads to modification of predator-prey relationships in the aquatic ecosystem. One phenomenon which may have been partly caused by the overexploitation of herring was the rich abundance of gadoids in the North Sea during the 1970s. However, hydrographical conditions were probably the most important factor (large scale climate changes). It has also been suggested that the rich abundance of herring and sprat in the Baltic contributes to the poor recruitment of cod, due to predation by these clupeids on cod larvae. The exploitation of predatory fish may certainly decrease the predation pressure on their prey, for instance benthic fauna. These indirect trophic effects may undoubtably be more important than the direct effects of the fishery.

# Environmental effects of recreational fishing

Sport and household fisheries cause various kinds of environmental effects, some that are unique to recreational fishery and others that are more or less common to all recreational activities. The general environmental effects of recreational fisheries include development of land for harbours, erosion, disturbance of fauna and flora and effects related to transport (e.g. release of exhausts and anti-fouling paints from cars, boats, scooters etc.).

Even if recreational fishermen do not have access to the same resources as commercial fishermen, overfishing occurs in some waters. As the fishery is often aimed at large individuals there is a risk of a selective fishery on fast-growing fish. It has been shown that angling in small streams can be a threat to populations of stream dwelling trout (*Salmo trutta*). Recreational fishing in Swedish mountain areas has increased since the war. This fishery has become specialized for fishing trout in running waters and for jig fishing through the ice for Arctic char (*Salvelinus alpinus*). The considerably larger catches of trout in running waters have resulted in a decline in the amount of large trout, which can be interpreted as a sign of overfishing. The use of nylon nets, more intensive household fishing and direct encroachment on lakes, in the form of impoundment, have in principle had similar effects.

Lead from spoon baits, sinkers and loads is probably not a neglible source of lead in the natural environment.

There is no evidence that recreational fishing has seriously affected bird populations. Certain fishing activities can, however, disturb birds during the breeding season. There is a risk that an increase in populations of otter in some areas will lead to an increased catch of this species in gear such as fish traps.

Some lakes in Swedish mountain areas naturally lack fish and often have a unique invertebrate fauna. These lakes should be protected so that they remain fish-free.

The uncontrolled release of fish from small fish farms can cause the genetic depletion of fish populations as inbreeding can occur 100 times faster in trout that are farmed for stocking than in wild, naturally spawning populations of trout. From the genetic point of view, it is often preferable to introduce fishery management measures that promote natural spawning, for instance restoration of spawning sites and clearing streams of obstacles to migration, rather than supportive breeding of fish.

# Environmental effects of aquaculture

Aquaculture can be classified into several types of activity, which have different effects on the environment. The environmental effects of aquaculture are a function of (1) the location of the aquaculture facility, (2) the production level, (3) the feeding technique and (4) the composition of the feed. Aquaculture activities in which food is added to the system normally have negative effects on the environment. Cultivation of organisms that live on naturally available nutritive substances can have a positive effect on the environment.

Cultivation of fish and shellfish, which relies on the addition of food, has negative effect on the environment. Pollutants, mainly phosphorous, nitrogen and organic material, are released by the direct loss of fodder or from organic breakdown-products. The effects of nutrient-rich effluents from fish farms are different in lakes, brackish waters and in marine areas. For instance, fresh waters are normally phosphorous limited while marine areas are normally nitrogen limited. Aquaculture activities that have a cleaning effect include the cultivation of algae and mussels and the extensive farming of fish and crustaceans. The cleaning effect occurs because the organisms feed on a local food source and because the biomass that is produced is removed from the system by the harvest.

The most natural and easiest way to decrease pollution from fish farms is to improve the utilization of fodder. The present trend is towards a better balance between the amounts of phosphorous and nitrogen in the feed and the development of automatic feeding systems, where the fish are allowed to choose when they want to eat. On the basis of existing standards for feeding techniques and fodder quality in modern fish farms, only marginal improvements can be expected in the future. There are some attempts to replace fish meal with substances such as wheat gluten.

The different aquaculture activities use many kinds of chemicals to improve water quality, control vegetation, for impregnation, desinfection, rinsing and anaesthesia. Some of these chemicals, for instance malachite green and other products containing copper, are harmful to the environment.

The compensatory cultivation of fish (supportive breeding) is carried out to compensate for the loss of natural reproduction in wild fish due to the construction of hydroelectric plants on rivers. For instance, Sweden has had an extensive programme for supportive breeding of Baltic salmon since the 1950s. In this type of cultivation the population size of the brood stocks has in many cases been too small and as a result genetic diversity has been lost (e.g. in Swedish salmon stocks). These fish farms discharge nutrients to surrounding waters, as feed is added. The dense stocks in the tanks promote outbreaks of diseases and parasites, which in turn require the use of antibiotics. The cultivation of fish for conservation of genetic resources and the cultivation of fish for put-and-take fishing have similar effects to those of compensatory cultivation.

The cultivation of fish for food, the activity mostly associated with aquaculture, contributes locally to a large extent to inputs of nutrients to the surrounding waters and therefore to eutrophication. In spite of better fodder and modern feeding techniques, local discharges of nutrients can be very large. The dense stocking of fish in the farms often causes diseases and parasites to become a problem. The chemicals and antibiotics that are used to cure the fish may contribute to the development of resistant bacteria. Some of the diseases can be treated by vaccines which are expected to largely decrease the use of antibiotics. There is a risk that runaway fish from the farm will hybridise with natural stocks and even create new stocks of their own. There is also a risk that diseased runaways will spread the disease to natural stocks.

Crayfishes can be cultivated for stocking in natural waters or for consumption. In Sweden, the cultivation of crayfishes, mostly the signal crayfish (*Pacifastacus leniusculus*), has increased markedly during the later part of the 1980s. Signal crayfish are resistant to, but also carrier of the crayfish-plague, so stocking of signal crayfish can spread the plague to the noble crayfish (*Astacus astacus*) that still occur in the stocked areas. As the noble crayfish is Sweden's indigenous crayfish species it should be protected.

Cultivation of mussels (e.g. common mussel *Mytilus edulis*) normally has a small impact on the environment, as no food is added and the plankton in the surrounding waters are used as food. A certain amount of faeces may accumulate under the cultivation site and cause oxygen depletion in the sediment. These cultivations can have a cleaning effect on the environment, due to their uptake of naturally occurring organic matter.

The cultivation of cod and oysters (*Ostrea edulis*) is still at the research stage in Sweden.

A large increase in the aquaculture industry in Swedish waters means that there will be higher pressure on the populations of fish that are used for the preparation of fish meal e.g. sandeels (*Ammodytes* spp.), capelin (*Mallotus villosus*) and sprat (*Sprattus sprattus*).

# Objectives for measures proposed for fresh water and the marine environment

The National Board of Fisheries has established the following environmental objectives for habitats and fish stocks (fish communities, species and populations of fish etc.) with regard to fish(ing) and aquaculture.

## Environment

### Habitats (landscapes/water areas)

All types of representative ecosystems shall be preserved in all Swedish waters.

- Areas which are restored shall reach an ecological level characterized by only a small anthropogenic impact.
- Not effected drainage areas or parts of them and water-courses not used for production of hydroelectricity shall be protected from deteriorating use of land and water.
- Damages caused by fragmentation of water-courses shall be mitigated by measures taken to facilitate a natural migration and by restoring natural migration routes.
- The impact of the regulation of the hydrological regime in water systems shall be reduced by establishing a smallest water flow acceptable to the ecology of fish species.

## Fish stocks

### Communities

The present variation of fish- and shellfish communities and the mechanisms behind the variation shall be preserved.

- Areas of special importance to the surviving and well-being of fish communities, e.g. spawning and nursery areas shall be given the largest possible protection against human environmental impacts.
- The changes of the fish fauna caused by environmental degradation shall be mitigated by a reduction of discharges to a level not effecting the fish stocks, their feed organisms or vegetation belts.
- A natural recolonization shall be facilitated when anthropogenically effected areas are restored.
- Gears and fish conservation measures shall be designed so that the original biological value (integration) is only minimally effected.

### Species

At present nationally and regionally occurring species of fish and shellfish shall be preserved/protected.

- The variation of at present occurring species in Sweden and its natural geographical regions shall be preserved.
- A special protection shall be given to habitats with endangered and vulnerable species indicated in the ”red list”.
- The largest possible restriction shall be exercised when importing exotic species and populations.

### Populations

- The fishing shall be exercised so that impacts on fish populations and by-catch species are not occurring and so that the harvest is not exceeding the natural production (”viable fisheries within sustainable ecosystems”. The fishing shall not either have impacts on the genetical variation.
- Populations at the margin of their area of distribution, ”core” populations and small populations shall have a special protection.
- Areas with concentrations of fish, spawning or migrating for spawning shall be protected where needed.

### Genes

The present genetical variation of species shall be preserved and the dispersal in Sweden of exotic genes shall be prevented.

- The natural, genetical variation and evolution shall be preserved at the present level.
- A special protection shall be procured to those habitats having genetically unique populations.

# Measures proposed for fresh water

## Habitats

**_Measure 1: Inventory of undisturbed water catchment areas or parts of them_**

Background and incentives

The protection of existent undisturbed water catchment areas, or parts of them, to environmental degradation within the areas is the basis for the preservation of the biological diversity in fresh water. Different authorities should aim at a restoration and a changed utilization by information and research elucidating the relationships between the terrestrial and aquatic environment.

Primarily it is of utmost importance that the unexploited rivers are protected against exploitation and that as large parts as possible of catchment areas are protected. The decision on an increased protection of undisturbed water catchment areas, or parts of them, must be preceded by a national inventory.

Time schedule: 1996-1998

**_Mesure 2: Inventory of migration obstacles_**

Background and incentives

The fragmentation of water systems due to regulations of lake levels and water flows and other changes of the habitats have severely damaged the fish stocks. The measure proposed is aiming at a long-term perspective for restoring migration routes for fish and other aquatic animals thereby allowing them to pass non-natural migration obstacles. These can be dams, culverts etc. In a first phase the existing migration obstacles are to be collated in an inventory, whereafter measures to eliminate the obstacles are planned and carried out. In this connection it is important to point out that natural obstacles are not to be eliminated, as these have been and will be of great importance to the biological diversity.

Time schedule: 1996-1998

**_Measure 3: Reviewal of decisions of water courts to guarantee a minimum flow acceptable to the ecology of fish species and improvements of the environment of water flow regulated rivers_**

Background and incentives

Spawning and nursery areas of many species of fish living in rivers and dams with regulated water flows have been heavily affected by the hydrological regime. Therefore it is important to minimize the regulation impacts, above all in order to guarantee a minimum flow of water, which is acceptable from an ecological point of view. The flow varies with regard to time of the year and season, why the models used to calculate the minimum flow shold be based on biological parameters. When reviewing the water court decisions it should be decided that the watercourse is restored so that the biological diversity is secured as long as possible.

Time schedule: 1996-1998 and thereafter

**_Measure 4: Inventory of damaged rivers and lakes which can be restored_**

Background and incentives

Physical disturbances in large and small rivers have seriously damaged many fish populations. Pipe draining and dredging operations have affected the possibilities for fish to reproduce and grow in the agricultural landscape. The dredging of rivers to facilitate timber-flowing has destroyed the spawning and growth possibilities in the forest landscape. Also the lowering of the water level in lakes has in many cases changed the natural fish fauna as eutrophication has. By restoration and habitat measures it should be possible to restore many of the damaged waters giving them a more original function.

In waters where the physical and chemical environment have been restored a natural re-colonization should be facilitated. In eutrophied lakes where the input of nutrients have been reduced the balance of the fish community can be manipulated towards the original fish fauna by selective fishing (biomanipulation).

Time schedule: 1996-1998

### Fish stocks

***Measure 5: National inventory of fish communities, species and populations of fish***

Background and incentives

One goal of the action plan is to preserve the variation of fish communities, species and populations of fish and the mechanisms which have developed those variations, in Sweden and within physical geographical regions. The knowledge of their occurence is, however, to a great extent not sufficient and needs to be be improved by inventories. Certain data have been collected and collated in connection to the implementation of the physical planning in Sweden.

Populations in the margins of their area of distribution can have very valuable genetical characteristics. In several cases the knowledge of these populations are relatively good, e.g. concerning southern populations of Arctic char and these have been classified as having a national interest. In other cases such "border populations" are of a less interest with regard to fishing, e.g. populations of roach and whitefish in lakes far away in the northern parts of Sweden. These populations are of great importance to the biological diversity and besides they are of a large scientific interest.

Time schedule: 1996-1998

***Measure 6: Reduction of discharges to a level not affecting fish and their feed organisms. Liming of anthropogenically acidified waters.***

Background and incentives

Polluting substances transported by air and water have damaged the fish fauna in many parts of Sweden. Especially the acidification and the eutrophication have had severe impacts on the biological diversity, but indirectly increased levels of mercury and cesium have also influenced the diversity. Primarily the impacts on fish should be attended to by a reduction of the discharges to a level not affecting the fish fauna or their feed animals. Secondly measures should be taken to mitigate the negative impacts on the fish and their food.

Time schedule: 1996-1998

***Measure 7: Regulation of the fishery so that fish populations are preserved, the harvest falls within the maximum sustainable yield and genetic variation is not negatively influenced.***

Background and incentives

Both the commercial and the recreational fishery can, if they are carried out by wrong methods or too intensively, imply a depletion of stocks and changes in the entire fish community. A selective fishery may also in the long run cause a genetic depletion of certain characteristics. Also the sport fishery can have negative impacts on the biological diversity, e.g. when there is a too large harvest in oligotrophic lakes of arctic char or of anadromous fish in rivers.

The commercial fresh-water fishery in Sweden is mainly carried out in big lakes Vänern, Vättern, Mälaren and Hjälmaren. In these lakes there is primarily a need for a regulation of the fishery. The possibilities to assess the commercially important species of fish in the lakes are imperfect and thus the knowledge is not sufficient. In order to conduct a responsible fishery it is required that the harvest is related to the size and structure of the fish stocks. The appropriate size of the harvest must be elaborated into a prognosis model, which also takes the sizes of the prey fish stocks into account. After the completion of model it will be possible to regulate the fishery more optimally than it is today.

Time schedule: 1996-1998

***Measure 8: Identification of habitats with "red list species" aiming at a special protection of these habitats***

Background and incentives

Two species of fish have been classified as endangered in Sweden (wels and spring-spawning vendace), three species as vulnerable, four species as rare and seven species as those to which special consideration should be taken. The knowledge on the distribution and occurence of these species are good in certain cases (wels and spring-spawning vendace), while it is not sufficient in other cases. In order to be able to protect the habitats with red-listed species of fish it is necessary to complete earlier performed inventories and collate them. Threatened and vulnerable species should be given the highest priority.

Time schedule: 1996-1998

***Measure 9: Review of regulations in force aiming at a reduction of the risks for the dispersal both nationally and regionally of non-native species and stocks of fish and other organisms. A limitation of releases for compensation and enhancement of reared fish in favour of restauration of natural spawning areas***

Background and incentives

The dispersal in a water system of non-native species and stocks of fish and other organisms as well as diseases constitute one of the biggest threats to the biological diversity. In many cases the dispersal takes place by the release of non-native species and stocks in order to increase the harvest. In other cases the dispersal of new fish species takes place by the fishing itself, e.g. by the fact that non-native species are used as bait or by escapees farmed in net-pens. In order to secure a natural composition of the fish fauna even more restrictive rules are required for the farming and release of non-native species and stocks.

Farmed fish often constitute a threat to the naturally reproducing fish. It is therefore recommended that releases of fish for compensation and enhancement should be restricted as much as possible in favour of measures taken to enhance the naturally reproducing fish. Only in this way the natural, genetic variation and evolution can be preserved, at least on the present level. When releasing fish in sensible and highly protectable areas there must be requirements that the fish released has a known, documented origin and is free from diseases, for which there are a duty to report. Also introduction of plants can have negative impacts on the diversity.

Time schedule: 1996-1997

### Measure 10: Implementation of the action plan for wels

Background and incentives

The wels (*Silurus glanis)*, one of two threatened species of fish in Sweden, is at present living at the borders of its distribution area. The stocks, which are small, are found at three places in Sweden (the Lake Båven area, the lower reaches of the River Emån and in the River Helgeå). In the long run the species has been impacted by the deterioration of the climate, which has occurred since the ice age. The deterioration of the climate is, however, not the primary cause to the small occurrence. The main reason is the lack of suitable habitats in Sweden. The original habitat consists of low-lying river areas. The strong decrease of the stocks during the late century indicates human impacts such as regulations of water levels, pollution and physical impacts on shores and lake/river bottoms. The small stocks are also sensible to harvests of fish. At the river Emån there are three fish plants, which imply risks for the spread of fish diseases to the river.

The needs for measures comprise:

- Inventory of primary habitats for the species
- Protection of habitats, protection against environmental impacts and regulations to protect the fish
- Measures to improve the habitats
- Releases

Time schedule: The implementation programme started in 1995. The first phase of the implementation programme, which comprises a secured survival of the species in the three areas, is considered to be finished in 1999.

### Measure 11: Elaboration of an action plan for the preservation of the spring-spawning vendace

Background and incentives

The spring-spawning vendace (*Coregonus trybomi*) is today probably only to be found in the Lake Fegen. To preserve the species there is a need for a long-term action plan to be elaborated and implemented. The plan should include an inventory of the remaining stock, measures for restauration of earlier habitats and proposals for the protection and management of the habitats. The action plan should also include methods for the introduction of the species in other lakes.

Time schedule: 1996-1997

### Measure 12: Implementation of the action plan for the preservation of the noble crayfish

Background and incentives

The stocks of the Swedish noble crayfish (*Astacus astacus*) have been reduced by about 95% during this century. The main reason for this are the effects of the parasitic mould, but also acidification and other environmental impacts have contributed to the situation. To stop the negative development the National Board of Fisheries was required by the Government in 1993 to investigate the possibilities to increase the crayfish stocks in the lakes and rivers in Sweden. A report was presented in August the same year. It contains 13 items aiming at the preservation and increase of the stocks. Recently measures have been initiated to implement some of the proposed measures e.g.:

- Increased restrictions for releases and farming of the crayfish *Pacifastacus leniusculus*
- A review of the possibilities to classify the noble crayfish as a species of national interest

- New regulations to prevent the spread of the parasitic mould and other diseases
- Increased resources to explore the reason for the outburst of the parasitic mould on a regional level and to combat active plague-spots
- Requirements to boil all imported crayfish, irrespective of species, and prohibition to import crayfish meant to have in aquariums
- Financial support to measures meant to favour the preservation of the noble crayfish
- The highest priority should be given to mitigating liming measures in waters with the noble crayfish
- Increased research on the noble cray and its parasites/diseases and increased information on the total value of the crayfish.

Time schedule: The results of the work should be presented, at the latest in 1996, as a report, which also should indicate possible ways to continue the restauration efforts for the species. The report should include information, which can be distributed to the public and the authorities. The work should be carried out in cooperation with Finland and Norway. After 1996 the work should be carried out in the periods of three years.

***Measure 13: Identification of habitats with genetically unique populations of fish. The habitats should be given a special protection***

Background and incentives

A stock can be described as a group or groups of individuals with defined genetic characteristics. The term stock is therefore used for one or for several closely related populations. Stocks or populations can vary with respect to behaviour, life pattern, resistance to diseases and tolerance and adaptation to the environment and its changes. As to salmon fishes these differences can be identified as morphological characteristics, growth rate, size and reproduction capacity. In 1984 The National Board of Fisheries carried out an inventory of Swedish salmon stocks of high protection values (of national interest) aiming at a preservation of genetically specific populations. Scientific values, nature conservancy values and the value for aquaculture of commercial and recreational fisheries were the factors considered. Especially aboriginal salmon stocks were paid attention to. A revision of the inventory is now carried out.

Time schedule: The revision of the inventory should be finished in 1996. Thereafter there will be a priority of waters with the highest protection values in order to give them a strengthened protection when needed.

***Measure 14: Establishment of a gene bank for genetically and specially valuable species/populations of fish: Cryoconservation and living gene banks***

Background and incentives

Many species of fish, especially salmon fish, occur in genetically distinctive stocks in different water-courses. These stocks have been shaped during a long period of evolution and the genetic composition cannot be reshaped via breeding. Many stocks have already been eradicated due to changed environmental conditions, especially changed water flows. In order to preserve the rests of these unique stocks they have to be identified and protected against further impacts. One possibility to save endangered stocks is to establish gene banks, where living individuals and frozen milt are kept.

Time schedule: Before the year 2002 the species and stocks, which are endangered - at present at a number of about 30 - shall be represented in gene banks.

# Measures proposed for costal waters

## Habitats

**_Measure 15: Inventory of habitats of special importance to fish and shellfish_**

Background and incentives

The knowledge on the occurrence and the extent of key biotopes for different stocks of fish and shellfish and the environmental conditions in these biotopes are a fundamental prerequisite to be able to give priority to measures to be made and to a judgement of the results of these measures. The present knowledge on especially important habitats should be collated and gaps of knowledge should be covered by inventories. Some data are to be found in the earlier carried out physical planning process.

Time schedule: The work should be carried out during the period 1996-1998 and the data should be presented in a national document.

## Fish stocks

**_Measure 16: Development of selective fishing methods_**

Background and incentives

The harvest of fish stocks giving mainly no detrimental effects on the biological diversity requires selective fishing methods. By selectivity means both the catch of target species (size, age) and by-catches of non-target species of fish, shellfish, birds and mammals. The Swedish coastal commercial fishery for eel and *Nephrops* are elucidating examples of a fishery, where to a large extent catches of not desirable sizes of the target species are taken. The fishery is regulated by rules indicating minimum sizes, but the trawl fishery for *Nephrops* implies a high mortality of juveniles. On the other hand juvenile eels exhibit a high survival after release. An investigation on the conditions for a change from the trawl fishery for *Nephrops* to a fishery with traps should be given a high priority in an action plan for biological diversity. Other reasons for this change are lesser physical impacts on the bottoms, on their benthic communities and on sedimentary processes.

The Swedish coastal fishery is to a large extent carried out by pound nets, fyke nets and entangling nets. These types of gears give large by-catches of non-target species of fish and especially the fishery with entangling nets implies a high mortality. A transition to a fishery with gears capturing living fish of a good quality should be given a high priority, as the mortality of the by-catch will be considerably reduced. There are also the problems with by-catches of sea-birds and seals, which should be given due consideration when improving the fishing technique.

Time schedule: The work should be carried out during the period 1996-1998.

**_Measure 17: The development of assessment models_**

Background and incentives

The fishery can if it is carried out in a wrong way lead to a depletion of single populations and often to a change of the age-structure with a predominance of younger individuals. There may also be genetic changes caused by the fishery. Fishes with a high growth-rate and fishes which are sexually mature at a higher age are running the risk of being caught. As a consequence they get deteriorated chances for reproduction. To conclude the fishery may imply a decreased diversity of a population concerning number, age and genetic characteristics. The fishery should be carried out so that these effects are minimized within the framework of an economically sustainable yield.

The knowledge on stock sizes is today incomplete for all of the commercially interesting species of fish. These species are eel, whitefish, vendace, perch, pike, pike-perch, turbot, flounder and cod. The Baltic cod is of great importance to the commercial fishery, but the stock is now over-exploited, mainly by the off-shore fishery. If the stock is restored there will also be stronger coastal populations. A coastal fishery with smaller vessels might be more economically viable than the off-shore fishery with larger vessels. However, there is a strong need for a development of assessment models on how to harvest the coastal cod in an optimal way.

Time schedule: The work should be carried out during the period 1996-1998

**_Measure 18: Inventory of the occurence of species and stocks having high protection values_**

Background and incentives

The species of fish living along the Swedish coasts are separated into a large number of more or less well-defined stocks or populations. The single population is defined by the fact that it has a common spawning area and a comparatively small genetic exchange with adjoining populations of the same species. The spawning area can be a river, for e.g. sea trout, many stocks of whitefish, or a more or less delimited area in an archipelago or at an open coast. The spawning area may have limitations in terms of suitable sediments or of physical-chemical properties. Man can have impacts on the environment by direct discharges of contaminants or nutrients or by impacts on the climate, implying changed temperature and salinity conditions. At an extreme situation the spawning area can be limited to a very small area, where the species or stock can survive deteriorated conditions. When the environmental conditions improve there will a dispersal of individuals to other areas. Such a small area with favourable environmental conditions can be called a "core area". The knowledge on such areas is very limited.

A population living at the outskirts of its area of distribution has most probably been genetically adapted to an environment with harsh environmental conditions. The genetic characteristics evolved in such a border population will most probably be of decisive importance to the survival of the species at long-term changed environmental conditions. The Baltic is characterized by being a border area for a large number of species of fish and shellfish, but an increased knowledge on these species is necessary. There are today large gaps of knowledge on genetic differences between different stocks and populations.

Time schedule: The work should be carried out during the period 1996-1997

# Measures proposed for marine waters outside coastal waters

## Fish stocks

### *Measure 19: Description of changes of the biological diversity*

Background and incentives

The knowledge on which changes in the biological diversity of marine fish and shellfish have occurred are scarce. The extent of possible changes of occurrence, size structure and distribution of most species of fish in the surrounding seas is unknown. One important source of information in order to describe changes of the biodiversity can be found in trawl fishing data files of the Board of Fisheries. Such information but with varying degree of scope, details and applicability are available since the beginning of this century. Swedish research vessels have carried out investigations in as well the Baltic as in the Kattegat-Skagerrak-North Sea areas.

Time schedule: 1996-1998

### *Measure 20: Elaboration of long-term management plans for the commercial fishery*

Background and incentives

As a basis for the definition of appropriate restrictions on the exploitation of fish stocks a European Commission proposal from 1993 can be used (COM 663/93), where the Commission has fixed management objectives and strategies for certain fisheries or groups of fisheries. In addition, CEC has drafted a Regulation permitting, where possible, greater year-to-year flexibility in the management of TACs and associated national qoutas and imposing, where required, penalties for overshooting the qoutas. It is believed that the application of this regulation will lead to reduction in discarding. However, the minimization of discards can only be achieved if gears of improved selectivity are routinely employed by fishermen.

Time schedule: 1996-1998

### *Measure 21: Development of selective fishing methods*

Background and incentives

One important requirement on fishing gears is that they should have good selection properties. This means that the gears should be so constructed that only the target species are caught and that by-catches are minimized. The by-catches include as well fish and shellfish as birds and mammals. Acceptable selection properties mean that no young fish are caught. There are also requirements that the gears shall have small impacts on the sea bottom.

Time schedule: 1996 and onwards

### *Measure 22: Development of methods for stock assessments*

Background and incentives

A necessary, but not sufficient prerequisite for an advantagous management of the living resources are the results of continuous assessments of the sizes of the fish stocks and the effects of the fishery on the stocks (levels of exploitation). To prevent over-exploitation and decreasing stocks the exploitation has to be adapted to the stock sizes in accordance with adopted management plans. Present methods for the assessment of commercially important fish stocks can be improved in several ways. It is of great importance to get ecosystem-based assessment models. Also the catch data can be improved.

Time schedule: 1996 and onwards

**_Measure 23: Removal of lost gears and development of methods to find such gears_**

Background and incentives

Lost gears can be fishing during a long period of time, thereby negatively affecting the biological diversity. At the same time the gears are physically hindering the fishery. When fishing is prohibited, *e.g.* when a quota has been filled, a commercial fishing vessel can be chartered for operations for removal of lost gears.

Time schedule: 1996 and onwards

# Measures proposed for salmon

**Measure 24: Implementation of the plan for the preservation of the naturally reproducing salmon of the Baltic**

Background and incentives

The **short term goal** of the management of the Baltic salmon is to eradicate the acute threat to genetic impoverishment or in certain cases actual elimination, which the majority of wild salmon stocks face today. The **long-term goal** is to utilize the entire natural reproduction in every salmon carrying river or part of a river. An interim goal set by the International Baltic Sea Fishery Commission is that a level of 50% of the reproduction capacity in each salmon carrying river should be achieved before the year 2010. Another goal is that the growth potential in the sea should be made better use of than at present.

The aboriginal Baltic salmon stocks have during the 20th century been heavily reduced due to the constructions of hydroelectric power stations in the water-courses. Of the Baltic Sea area's former about 70 rivers with salmon stocks, there now remain about 45-50. In about 12 of these rivers stocks are maintained through rearing, but in the other 35-40 there is some natural reproduction. In addition there are about 15 watercourses where there has previously been salmon, but which once again could have chances of becoming salmon carrying waters without any greater restoration of the river nursery areas where the fish grow. In Sweden there are natural salmon stocks left in 14 rivers.

a) Measures in the short term

1. Salmon fishing should be suspended in 1994 and 1995 in all rivers in the counties of Norrbotten, Västerbotten and Västernorrland and in the existing closed areas outside these rivers. Such a suspension has been effected.

*Continued measure*
As long as the threat to wild salmon remains, primarily through M74, the measure should be repeated by means of annual decisions.

*Continued measure*
As a consequence of the EU membership, Sweden no longer negotiates on her own on fishery in the Baltic, but is represented by the EC Commission. Within the compass of membership, Sweden should lend support to an adjustment of the extent and form of salmon fishery to what is required for the preservation of natural stocks.
2. Reduction of TAC for salmon

b) Measures in the long term

1. Delayed release of salmon
International cooperation is required to apply the method of delayed release on a larger scale. Experience of the method's application in the Baltic states, Russia and Poland is limited and trials in these countries are needed before a position can be taken on an introduction on a larger scale.

*Continued measure*
Sweden should work for the development and international implementation of the method of delayed release of salmon. This would facilitate a substantial reduction of the offshore fishery for salmon in the salmon feeding areas.

2. Research on M74
A special research programe FiRe (Disturbances in reproduction of Baltic Sea fish) has been drawn up in consultations between national BOard of Fisheries, the National Environmental Protection Agency, WWF and Vattenfall.

*Continued measure*
The research programme drawn up should be implemented.

3. Gene bank
In order to secure a reserve of genetic variation, gene banks should be built up with material from the most important wild salmon stocks.

*Continued measure*
The work initiated under the auspices of the National Board of Fisheries of establishing gene banks for 14 stocks should continue. The gene banks should be maintained until the threats to the wild salmon are averted.

**_Measure 25: Elaboration of an action plan for the preservation of the naturally reproducing salmon stocks at the Swedish west-coast_**

Background and incentives

In the area from the border between Norway and Sweden in the north to the Sound between Denmark and Sweden in the south there are about 15 rivers with salmon stocks. Former threats to these stocks have been the construction of hydroelectric power stations and industrial activites. At present the acidification exhibits the most severe threat. Parasites and diseases can also have impacts on the salmon stocks. An action plan will be elaborated aiming at securing and improving the wild stocks.

Time schedule:1996 and onwards

**_Measure 26: Strengthening of the protection of the naturally reproducing salmon and trout stocks in the lake Vänern_**

Background and incentives

The wild stocks of salmon and trout in the Lake Vänern have been heavily decimated during the 20th century due to the construction of hydroelectric power stations. Today there are only left small, naturally reproducing stocks in the Rivers Gullspångälven and Klarälven. Especially the later stocks represent a very high preservation value and are threatened by a genetic impoverishment and even by eradication. During recent years a number of measures have been taken to increase the protection of these stocks. Closed areas outside the rivers have been enlarged, the net fishery in the Lake Vänern has been restricted, the minimum landing size has been increased and measures have been taken to improve the habitats of the River Gullspångsälven. An increased minimum flow in this river will be required.

Time schedule: 1996-1998

# Other proposed measures

**_Measure 27: Additional rule in the Fishing Act concerning environmental impact assessment_**

Background and incentives

The Fishing Act (1993:878) has been completed by a regulation on environmental impact assessments, which regulation makes it possible to evaluate the impacts on the environment of a fishing method or an introduced fish species. In recent years a fishing for new species have been started along the Swedish west-coast, e.g. for the common whelk (*Buccinum undatum*). It is of great importance that there is a legal basis to require an environmental impact assessment to be carried out before a new target species is exploited.

FISKERIVERKET, som är den centrala statliga myndigheten för fiske, vattenbruk och fiskevård i Sverige, skall verka för en ansvarsfull hushållning med fisktillgångarna så att de långsiktigt kan utnyttjas i ett uthålligt fiske av olika slag.

Verket har också ett miljövårdsansvar och skall verka för en biologisk mångfald och för ett rikt och varierat fiskbestånd. I uppdraget att främja forskning och bedriva utvecklingsverksamhet på fiskets område organiserar Fiskeriverket *Havsfiskelaboratoriet* i Lysekil med *Östersjölaboratoriet* i Karlskrona, *Sötvattenslaboratoriet* i Drottningholm, *Kustlaboratoriet* i Öregrund, två *Fiskeriförsöksstationer* (Älvkarleby och Kälarne) och tre *Utredningskontor* (Jönköping, Härnösand och Luleå).

FISKERIVERKET

Ekelundsgatan 1, Box 423, 401 26 GÖTEBORG
Telefon 031-743 03 00, Fax 031-743 04 44