On the run
- Escaped farmed fish in Norwegian waters

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Foreword

WWF's global mission is to conserve nature and ecological processes while ensuring the sustainable use of renewable resources. Two-thirds of the earth's surface is covered by oceans, and WWF's global marine program is working to reduce overfishing and protect marine ecosystems from threats such as destructive fishing and pollution. Introduced species, or alien species is recognised as one major threat to marine and freshwater biodiversity. Aquaculture is a major factor in the spread of such aliens species. WWF recognises the value of fish farming to society, as it provides a source of income and food. However, fish farming can be detrimental to the environment as well as socially and economically unsustainable in both the short-term and long-term.

This report looks into the general, global problem of introduced species before assessing the more local problems caused by farmed fish escaping into Norwegian waters. Wild Atlantic salmon is used to illustrate the impacts of an introduced species on nature.

The wild Atlantic salmon has a fascinating migratory lifecycle, which takes it from its river of birth to thousands of kilometres out at sea, and back again to the exact same river to spawn. It is an example of a species adapted to its environment through thousands of years of evolution, where each river holds a unique and local salmon stock.

However, these strong survival genes are now threatened. Farmed fish are bred to grow quickly, taste good and be more nutritious for humans – none of which are useful survival traits in the wild. As the fish farming industry has been present in Norwegian waters for more than 20 years, we are now able to see the consequences of these fish escaping into the wild. In areas with dense fish farming, the negative impacts on wild salmon populations are indisputable.

Knowing that stocks of coastal cod are at their lowest level ever, and that cod farming is quickly growing as an industry, WWF fears that we risk repeating history and that escaped farmed cod in a few years will pose a threat to our already dwindling coastal cod stocks.

This report also describes some of the actions taken by the fish farming industry and the Norwegian Government to reduce the amount of escaped farmed fish and concludes with some recommendations for further improvements in management.

It is WWF's sincere hope that by addressing this issue, we will see a steep decline in the number of farmed fish escaping in the coming years. This report should serve as a wakeup call for governments to better manage their fish farming industries, and indicates to the fish farming industry that changes in its attitudes and practices are needed.

Oslo May 9th 2005
Rasmus Hansson
CEO
WWF-Norway

Summary

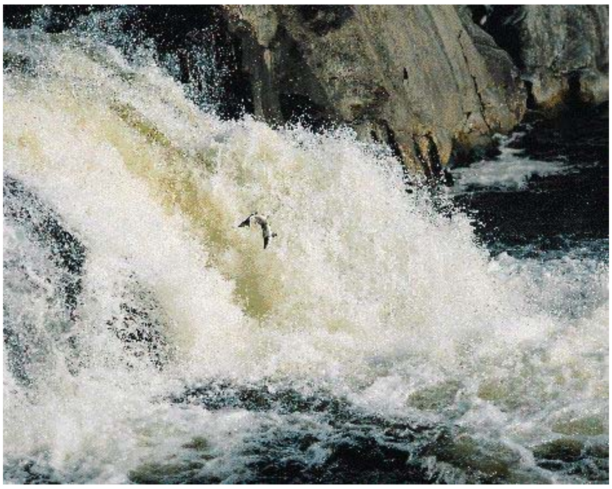
Every fourth salmon in Norwegian seas is of farmed origin. In the great salmon river Namsen, almost 50% of the salmon caught in 2002 were escaped farmed fish. On the western coast of Norway, in the Hardanger fjord, nine out of ten salmon were of farmed origin. In this report, these dramatic numbers are used to illustrate how farmed fish are invading seas and rivers along the Norwegian coast. The report shows that more than half of the Norwegian wild salmon stocks are in some way impacted by escaped farmed fish.

Introduced species, also called alien or exotic species, are today considered a serious environmental problem. They can cause significant disturbances of natural ecosystems, competing for food and habitat and displacing indigenous species. Exotic species can carry diseases or parasites that can be lethal to others. Species that are able to breed with the wild stock can lead to a dilution of the natural gene pool thereby reducing a population's or species ability to survive.

The 1982 UN Law of the Sea highlights the risks from introduction of exotic species into marine ecosystems. This is further emphasised by the UN Convention on Biodiversity (CBD) from 1995, and most recently at the UN World Summit on Sustainable Development in 2002. Introducing exotic species to new areas are a violation of the UN Law of the Sea and the CBD, as both have paragraphs specifically designed to reduce the negative impact from introduced species. Aquaculture is one of the main routes of introduction of marine organisms. This can be both in the form of exotic species or as a domestic form of a natural species.

The wild Atlantic salmon

The Atlantic Salmon (*Salmo salar*) is among the most revered species on the planet. Its ability to navigate the ocean, to return to its childhood stream, to leap over seemingly impassable obstacles, and to detect through its olfactory senses the very gravel of its origin, has amazed and inspired humans for thousands of years. Through millennia, this amazing animal has chosen only the most pristine river systems as its habitat and is therefore a good indicator of a healthy ecosystem. However, over the past two centuries stocks have shown a slow and steady decline, coinciding with human industrial development. Wild Atlantic salmon populations have plummeted precipitously over the past three decades and salmon catches in the entire North Atlantic have fallen by more than 80% between 1970 and the end of the 20th century. Today they stand at the lowest levels in known history, with wild Atlantic salmon lost from much of its original range, and hanging on by a thread in many other locations.



Jumping Wild Atlantic Salmon in Norwegian river – Photo by Jon Arne Sæter.

Norway holds the lion's share of the world's wild Atlantic salmon, around 50% of the total population spawns in Norwegian rivers. Still – many of these stocks are already heavily affected by hydropower dams, pollution, and other human activities. In addition to these pressures comes the constant impact of escaped farmed fish, invading the sea and rivers where the wild salmon is struggling to survive.

Fish farming in Norway

The Norwegian fish farming industry is now a cornerstone of local economies and provides employment all along the coast. It has developed to become one of the country's most valuable export industries, producing around 500 000 tons of salmon and trout each year. The industry has an annual value estimated to be around 12 billion NOK (1.5 billion Euro).

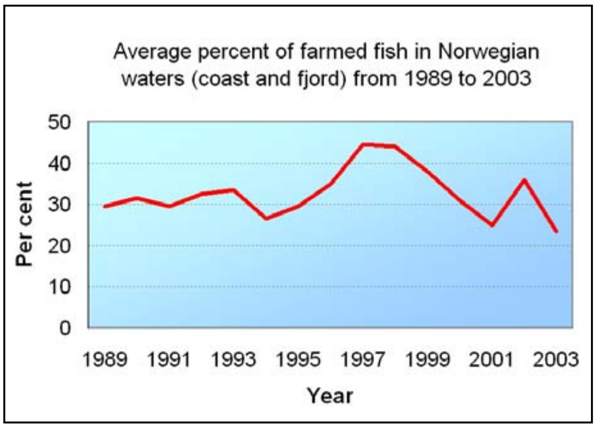
Atlantic salmon (*Salmo salar*) and rainbow trout (*Oncorhynchus mykiss*) are farmed in open sea cages. The first is naturally occurring in Norwegian waters while the latter is non-indigenous, coming from the Pacific. Farmed Atlantic salmon differs significantly from its wild counterpart and is a domestic form of the wild salmon spawning in Norwegian rivers.

Every forth salmon in the sea is an escapee

Around half a million farmed fish, both salmon and trout, escape from fish farms in Norway annually. The escapees are introduced into the sea where some swim up in the rivers, some stay in the fjords and coastal areas, while others can migrate long distances.

Since 1989, the Norwegian Directorate of Nature Management has provided statistics on the presence of escaped farmed fish in coastal areas and salmon rivers. Every autumn after the ordinary salmon fishery has closed, a national survey is organised covering 30 Norwegian rivers, monitoring how much of the spawning stock of Wild Atlantic Salmon is escaped farmed fish. In addition, thirteen sea areas are monitored, to estimate the percentage of the catch that is of escaped origin.

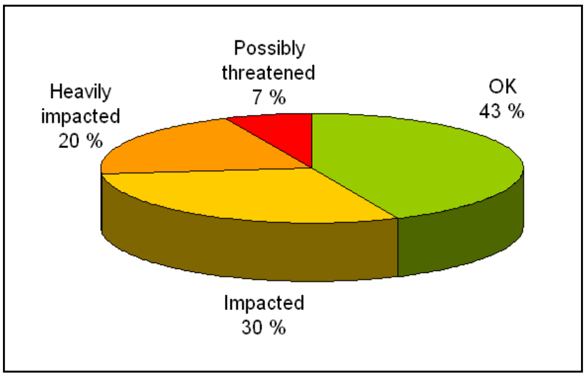
The data from the 2003 survey shows that there is an average of as much as 24% escaped farmed salmon and trout present in Norwegian coastal waters. As seen on the graph below, this is the lowest level since the survey began.



When looking into the individual areas, there are some dramatic numbers. In the outer Hardanger fjord on the west coast of Norway, 86% of the fish caught during 2003 were escaped farmed fish. This actually signifies an improvement over the previous year, as it in 2002 where 94% escapees.

For the salmon rivers, the average percentage of escaped fish in 2003 was 13%. However, over half of the monitored rivers were impacted with farmed fish, and some rivers had up to 48% farmed fish in the spawning stock. Based on recent scientific reports, it can be assumed that when more than 20% of the spawning stock consists of escaped farmed salmonids, it can have an impact on the wild stock. When almost half the salmon in the river is of farmed origin, this is likely to have a considerable negative impact.

The pie chart below shows that 7% of the rivers can be classified as directly threatened by the large amount of farmed fish in the spawning stock, meaning that more than 45 per cent of the fish is of farmed origin. Heavily impacted is from 21 – 45%, impacted is 6 – 20% and less than 6 % is considered not impacted.



Percentage of Norwegian rivers impacted by escaped farmed fish.

Threats from farmed escaped fish

Disruption of habitat

Ecological impacts from escaped farmed fish include the effects of the introduced species on the local fauna and flora and the subsequent alteration of the habitat. Several scientists have now shown that farmed fish migrating up rivers late in the spawning season, and rainbow trout spawning later than wild salmon, can actually displace eggs laid by wild salmon. This is now considered to be the most serious ecological impact of escaped farmed fish. In addition, farmed females often produce eggs which, while numerous, are relatively small. Smaller eggs result in smaller fry that have a reduced ability to survive. And as the farmed salmon is much more aggressive and grows very quickly, it has both a higher competing level and a higher mortality rate. This means that the offspring of farmed fish might out-compete its wild relatives while it is still young, but that its overall survival rate is low. Over time, a high number of farmed fish can have a significant impact on the survival of the wild fish.

Dilution of the gene pool

The escape of cultured animals from farms is a severe form of biological pollution of the environment. Farmed fish are bred to grow quickly, taste good and to be a healthy source of food. None of these parameters are useful when released into the wild. The maintenance of genetic variation, both within and between populations, is essential for their long-term survival and to maintain the evolutionary potential of the wild stock. It is important to protect populations in their natural habitat because they carry gene complexes capable of continually responding to evolutionary forces. Both for salmon and other cultured organisms, there is much documentation showing that during years of captive breeding, genetic variation is lost. Escaped farmed salmon interbreeds with wild relatives, and hybrids between wild salmon and farmed salmon will in the long term change the natural gene pool into less variation. This is defined as loss of genetic resources. Several research projects in the past years have shown that offspring from farmed fish and hybrids have a significant lower survival success than wild salmon. Seen together, the studies indicate that farmed fish can displace wild salmon in the river, and then reduce the overall production of wild salmon. Normally, nature, with its survival of the fittest, would handle this. But the conditions are not natural anymore. Every year there are more escaped farmed fish coming up the rivers, causing a constant pressure on the wild stocks.

Diseases and parasites

Dense aggregations of farmed fish are ideal breeding grounds for diseases and parasites. Additionally, stress on fish resulting from high density and intensive cultivation is often sufficient to allow pathogens to take hold and form disease reservoirs. Wild fish may move in and out of floating cage systems, escaped fish that enter natural habitats and wastewater may carry pathogens capable of infecting other culture stocks or the surrounding environment. Transmission of diseases and parasites from farmed organisms to natural communities can be a major threat to local species and endemic races of the culture species. In areas of Northern Europe, salmon-lice (*Lepeotheirus salmonis)* numbers are now significantly higher as a result of the millions of cultured fish in the sea. Salmon lice, or sea lice is a marine parasite that can be lethal to salmon and trout. The lice are now considered to be a major threat to wild stocks of salmon and sea trout, and there is now little doubt that salmon lice can cause increased mortality on migrating wild smolts.

Escaped farmed fish can spread sealice, and is also a potential host for the sealice in coastal areas in the winter when the natural wild salmon is not present.

Sealice is a saltwater parasite that can be lethal to salmon and trout. Photo Arnold Hamstad, Skogeierforeninga Nord

Causes for escape

The Norwegian Directorate of Fisheries collects the official escape numbers in Norway every year. For 2004, the total amount of escaped fish is estimated to be 450 000. The table lists the various causes to which the escapes were attributed in 2003, with a total of 435.000 escapes.

Causes	**Percent of total causes**
Predators	0.0
Handling	0.1
Collision	42.7
Hauling	0.6
Construction failure	50.3
Propeller injury, seine	0.5
Flotsam	0.3
Other	5.5
Total number of escaped fish	435 000

Causes for escapes of farmed fish in 2003 in percent of total escaped fish.

Can cod farming be a threat to already depleted cod stocks?

The world's cod stocks are in dramatic decline and global catch of cod has declined by more than 70% in 30 years. In 1970, the total global catch was around 3.1 million tons, while in 2002 the total catch was down to 890 000 tons. In Norway, one type of cod is commonly referred to as the coastal cod. This species is stationary and spawns and lives close to the shore and in the Norwegian fjords. Despite the fact that the oceanic cod stock in the Barents Sea is in good shape and supports a large and relatively sustainable fishery, the coastal cod stocks are plummeting.

At the same time, the cod farming industry is growing rapidly in Norway. There are already over 600 licences for cod farming issued in Norway, and WWF has determined that sufficient environmental regulations are not in place. Already, there have been escapes of farmed cod to the sea. Farmed cod has not been bred in captivity as long as salmon, and the differences between the farmed cod and the wild cod are not yet significant. However, cod used for farming can come from other areas and stocks far from the farming site. WWF fears the possible impacts of escaped farmed cod on already depleted stocks of wild coastal cod. A growing cod farming industry will bring problems such as disease transfer and could lead to displacement of wild fish from important spawning grounds or genetic interbreeding with escaped farmed fish.

Preventing escapes

In Norway, several methods have been introduced by the government, as well as by the industry itself, to reduce the amount of escapes. Among the most significant are:

- Exclusion zones for fish farming in areas with important and vulnerable wild salmon stocks
- A new government regulation requiring certification of fish farms based on technical standard aimed at reducing escapes
- Mandatory training of personnel and staff on fish farms.
- All escapes are reported to the government with information about where and when it happened, the extent and the cause of the escape.
- Detailed monitoring of the amount of escaped fish in rivers and fjords

Both USA and Iceland have requirements for individual tagging of farmed fish. This is a tool WWF actively promotes in Norway, though it has not yet been adopted.

Conclusions and recommendations

Escaped farmed fish should be considered an introduced species, as they disturb the integrity of coastal and river ecosystems. Introducing new species, or a domestic form of a natural species, is a violation of international conventions. Countries with an aquaculture industry must ensure that any farm operates with the aim of preventing escapes of farmed organisms into the wild. Natural populations are the ultimate gene bank for future aquaculture applications and should be vigorously protected.

The last few years, new science has come, underlining that escaped farmed fish are causing irreversible, negative impacts on wild salmon stocks. The annual monitoring of the amount of escaped fish in sea areas and rivers is an important means of measuring the impact of escaped fish as well as the effectiveness of industry methods in preventing such escapes. WWF strongly recommends that these are maintained and strengthened.

There is now an increasing fear that the growing fish farming industry, considering the farming of other fish species, can cause more harm to the marine environment. A changing of attitudes is needed. Fish farmers and governments must recognise that escapes are a constant threat to vulnerable ecosystems and species – and do everything possible to prevent escapes. WWF urges that further steps be taken to reduce this problem, including:

<u>Better management at fish farms</u>

Insufficient management at farms is still the major cause of escapes. There is great potential for reductions if routines and training of staff is improved. Systems for sufficient training and good management schemes should be mandatory.

<u>Individual tagging of farmed fish</u>

Many fish escape without ever being reported or the source of the escape found. Individual marking or tagging of fish is one method of reducing this problem. WWF strongly supports the ongoing Norwegian project looking for the most efficient way to introduce a system for tagging of farmed fish in Norway.

<u>Fish farm free zones in vulnerable areas</u>

There is always a risk of accidents, caused by humans, bad weather or other factors. Therefore, areas with particularly vulnerable stocks of wild salmon or coastal cod should be permanently closed to open cage fish farming. This includes areas with important spawning grounds or migratory routes.

Risk assessments when farming new species
The aquaculture industry is growing rapidly, and there is an urgent need to adopt a more precautionary approach to the introduction of new species for aquaculture. WWF urge for Governments to perform detailed environmental impact assessments before new operations are established.

Consumers should ask for eco-labelled fish
Consumers should only buy eco-labelled farmed fish, as these farms have stricter management and with less escapes. Also retailers and supermarkets have a responsibility to ensure that they only buy farmed salmon from the most responsible fish farmers.

1 Introduced species – a global problem

Alien species are referred to by several names which are often used interchangeably: foreign, exotic, introduced, non-natives and non-indigenous species. Those harmful to biodiversity are often called noxious species, aggressive species, invasive species, pests and harmful species. The term alien species is used for all species outside their native distribution range, and also refers to exotic underspecies, races and other exotic organisms within the same species, as outlined by the definition of "biological diversity" (Schei, A. 2003)

The major threats posed by alien species on ecosystem, habitats and species are a consequence of the fact that introduced alien species can establish, invade and change the new habitats to the detriment of native species. According to the United Nations Environment Program (UNEP) alien species are second only to habitat loss as the major threat to global biodiversity.

> Biological diversity - the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.
>
> Sustainable use - the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations.
>
> (United Nations Conference on Environment and Development, Rio de Janeiro 1992).

The term biological diversity was first used in 1980 (Lovejoy 1980). Evolution; migration, isolation and natural selection has shaped the world's biodiversity with different species appearing in different parts of the world. The spread of organisms occurs naturally and is important to a species' natural evolution. However, through human activity the range of species has greatly been expanded. Such artificial spreading differs from naturally occurring migration in three ways:

- The distance species can be spread - many species would never reach so far without our help.
- The frequency of the spreading – worldwide travel and business acts as a gateway for introduced species.
- The ecosystems and habitats where introduced species arrive are already greatly altered by human activities and are more vulnerable to impact from alien species.

Thus, introduction has to do with ecological boundaries, not state borders.

There are two main routes through which animals move to new sea areas: one is when they are moved for aquaculture or display purposes, the so-called intentional species introduction, and the other is when they are accidentally moved (e.g. in ships' ballast water) (ICES 2003a). Exotic species are widely used in aquaculture operations, as in agriculture, and aquaculture is one of the main ways in which exotic aquatic species are spread around the world.

International conventions regulating alien species

The issue of introduced is specifically covered in the UN Convention on Biological Diversity (CBD 1992) and the UN Convention on the Law of the Sea (UNCLOS 1982) The threat from introduced species was also emphasized at the World Summit on Sustainable Development in Johannesburg (United Nations 2002) and is covered in the UN FAO Code of Conduct for Responsible Fisheries (FAO 1995).

<u>The United Nations Convention on the Law of the Seas</u> came into force in 1994. Article 196 on the use of technologies or introduction of alien or new species requires states to take all measures necessary to prevent, reduce and control the intentional or accidental introduction of alien or new species which may cause significant and harmful changes.

<u>The convention on biodiversity (CBD)</u> from 1992 reads: "Each Contracting Party shall, as far as possible and as appropriate - prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species". The term "alien species" refers also to exotic under-species, races and other exotic organisms within the same species, as outlined by the definition of "biological diversity" in the convention's first paragraph (Schei, A. 2003).

<u>The FAO Code of Conduct for responsible fisheries</u> was adopted in 1995, and is a volunteer set of guidelines for fisheries and aquaculture development. The code

reads: “States should conserve genetic diversity and maintain integrity of aquatic communities and ecosystems by appropriate management. In particular, efforts should be undertaken to minimize the harmful effects of introducing non-native species or genetically altered stocks used for aquaculture including culture-based fisheries into waters, especially where there is a significant potential for the spread of such non-native species or genetically altered stocks into waters under the jurisdiction of other States as well as waters under the jurisdiction of the State of origin. States should, whenever possible, promote steps to minimize adverse genetic, disease and other effects of escaped farmed fish on wild stocks”.

General threats from introduced species

The establishment of alien species in new regions is not enrichment for the region, but “uniformity” of the biodiversity of the world and loss of endemic, unique and native species and ecosystems. Introductions of alien species, whether done intentionally or unintentionally, are often of high risk to the ecology and economy of an area, region or country. The main impacts can disturb the natural ecosystem through:

- Competition for food and habitat
- Carried diseases
- Dilution of natural gene pool

All organisms are formed to fit in their home environment. If they are moved, predicting the consequences is impossible. Most organisms introduced into a new environment will fail to settle. One rule of thumb states that approximately 10% of introduced organisms will survive and succeed in reproducing. Of those, only 10% might cause significant ecological changes. However, even if just one percent of introduced species will cause negative changes, knowledge is lacking as to the details of what has been altered. Any species without a major role in its natural ecosystem can suddenly become a plague in another. The other species present (or not present), and the climatic conditions are among factors deciding. For instance, the introduced Iberia forest snail (*Arion lusitanicus*) has no predators in Norway, and seems to fit perfectly into our moist climate. The Iberia forest snail both competes with and feeds on the native black forest snail (*Arion ater*). The true fate of an introduced species can take ages to detect, from 10 to 100 years – a delay that can be caused by the time needed for the organisms to adapt to the new area. During this period, the organism might develop useful ”skills” that makes it very successful in its new environment.

Introduced species can impact the ecosystem in all possible ways, and through any level of the food web. Some will come in with a new function to the established ecosystem, while others might be so successful that they can displace other organisms. The result is instability and reduced diversity. When an introduced species is first established, it will normally affect several levels of the food web.

Threats from introduced species:

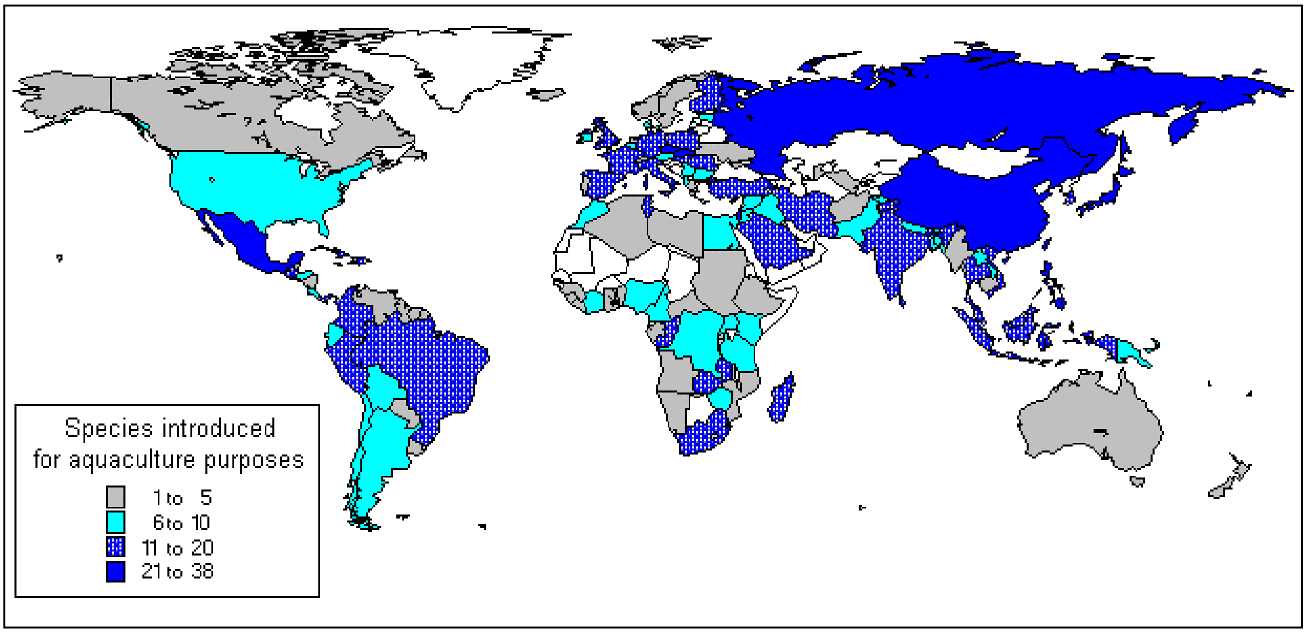
- Will play a role in the local food web with a new function as primary producer, plant eater, predator, parasite, pathogen or terminator
- Compete with other organisms on the same niche in the food web
- Be a resource that will attract new species
- Be a spreader or a reservoir for new parasites or pathogens
- Be toxic to local species
- Breed with a close relative, species or local strain and by that dilute the locally selected gene pool
- Compete with other organisms for habitat

Aquaculture – A long history of growing exotic species

Aquaculture means the farming of aquatic organisms, normally requiring some form of human involvement in the rearing process in order to improve production. From 1970 to 2000, the aquaculture's contribution to global seafood increased from 3.9 to 27% of the total (FAO SOFIA 2002).

The recorded history of aquaculture is more than 3,000 years old, starting in freshwater in China. Aquaculture is diverse and consists of a broad spectrum of systems, practices and operations ranging from simple backyard, small household pond systems to large-scale, highly intensive, commercially oriented practices. A large proportion of aquaculture production comes from small-scale producers in developing countries. This sector contributes to food security, poverty alleviation and social well being in many countries.

Aquaculture is the reason of introduction in 38.7% of the records in the FAO Database on the Introductions of



Number of species introduced for aquaculture purposes. (FAO DIAS 2004b)

Aquatic Species (FAO DIASa). Introduced species form a very large part of aquaculture production: 97.1% of crustacean production in Europe, 96,2% and 84,7% of fish production in South America and Oceania, respectively. Globally, 9.7% of aquaculture production comes from introduced species (Garibaldi 1996) In addition, many of the species in aquaculture are cultivated varieties of their native counterparts, having genes and traits quite different from its native siblings. Atlantic salmon and Tilapia are species where breeding programs have changed the genetics of farmed fish significantly from its native counterparts. However, natural populations are the ultimate gene bank for future aquaculture applications and should be vigorously protected (Dunham 2004).

Some examples of introduced species

Tilapia

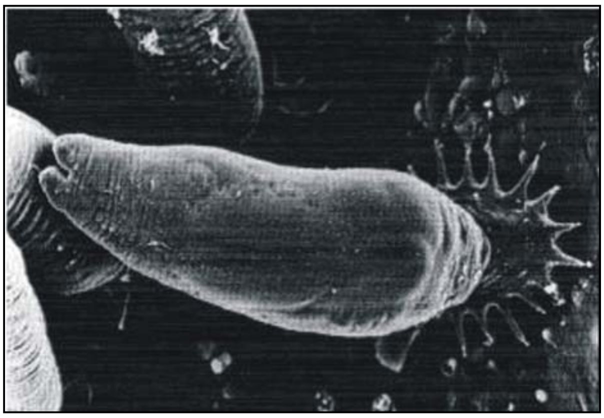
The tilapia *(Oreochromis sp.)* is a freshwater fish species that aqua culturists have long known to be easily adaptable to many different environments and culture systems. Tilapia is also becoming increasingly well known to fish consumers. Different tilapia species and their hybrids are cultivated in many countries around the world. This fish can be raised in a wide range of production systems from small-scale, low-input rural ponds to large-scale, intensive commercial operations. By 2010, the global production value of tilapia is expected to top $4 billion (Cutland 2003). Once native to Africa and the Middle East, the tilapias are now established in the wild in virtually every tropical and subtropical country. Where common, such as in the estuarine waters of Florida, they lower local biodiversity through competition for food resources and direct predation. In their native countries hybrids or non-native tilapias also dilute the gene pool of the native tilapias. Many of these introductions - not just tilapia, but also bass, carp, trout, the famous Nile Perch and other types of fish - are implicated in the decline of native species.

Rainbow trout

The rainbow trout *(Onchyrkuss mykiss)* is a fish species native to the eastern Pacific Ocean of North America, but is also widely farmed in many countries outside its natural distribution range. The species now thrives in countries on every continent except Antarctica due to its introduction for sport fishing (Macrimmon 1971) or aquaculture purposes. This resulted in the rainbow trout replacing and decimating native fish stocks all over the world. Rainbow trout was intentionally introduced to Norwegian rivers since 1902 by fishermen hoping to establish a new species for sports fishing. Luckily, the introductions have not been very successful, and there are less than ten places where rainbow trout definitely have established a reproducing stock. (Hindar et al 1996). However, escaped farmed rainbow trout are now present many places, and it is feared that it can have more success in the coming years (Hindar et al 1996).

Gyrodactylus salaris

Gyrodactylus salaris is a freshwater parasite which does not occur naturally in Norway. It was probably introduced in Norwegian rivers in the 1970s by infected hatchery-reared salmon. The entire lifecycle of the parasite is in fresh water, the majority of it spent on young fish. It is less than 0,5 mm in length and attaches by hooklets to the scales and fins of the fish. The *G.salaris* has a significant negative influence on the Atlantic salmon. Most often it will kill more than 90% of the young salmon in the river after being introduced. In just a few years the number of adult salmon will be dramatically reduced, threatening the native stock by extinction.



Gyrodactylus salaris Photo: Tor Atle Mo, Norwegian Veterinary Institute

Furunculosis

Furunculosis is a skin disease caused by the bacteria *Aeromonas salmonicida salmonicida* and leads to furuncles and eventually ulcerative lesions. It was introduced to Norwegian fish farms by infected smolts from Scotland in 1985, and spread rapidly from those first few infected farms to reach 550 fish farms (70% of the total) by the end of 1992. Wild salmon was also infected. The disease was found among spawning salmon in the autumn of 1989, first among farmed escapees and later among wild fish. By 1992, furunculosis had been detected in 74 Norwegian rivers (Johnsen and Jensen, 1994).

King crab

The red king crab *(Paralithodes camtschaticus)* is another introduced species which has attracted much attention. This species was implanted at the mouth of the Murmansk Fjord on the Kola Peninsula in the 1960s. Since then the stock has grown and spread to Norwegian waters. Since it was first seen in the Varanger Fjord in 1976, the king crab has spread westwards. Little is known about the king crab's effects on the ecosystem, but the species seems to feed off mussels, sea urchins and other benthic species. (Allaby 2004). It is feared that this can cause significant changes in the ecosystems and that the crab might compete with benthic fish (Norwegian Ministry of the Environment, 2004).

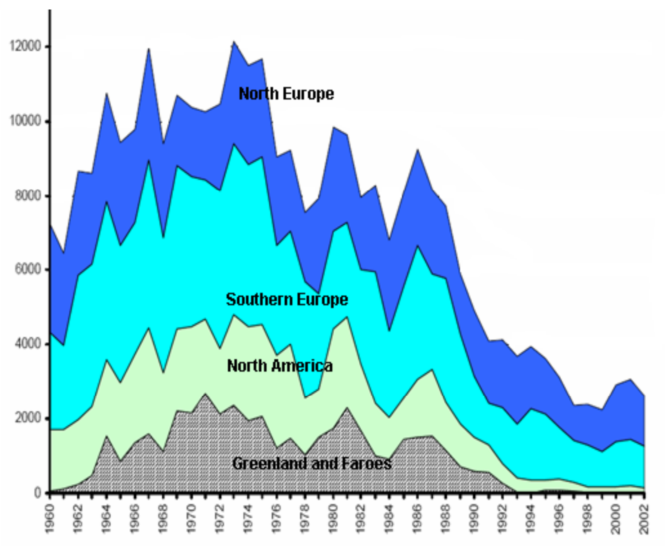
Catch of King crab, Photo: Norwegian Institute of Marine Research

2 Atlantic salmon

The anadromous Atlantic Salmon (*Salmo salar*) is among the most revered species on the planet. Its ability to navigate the ocean, to return to its natal stream, to leap over seemingly impassable obstacles, and to detect through its olfactory senses the very gravel of its origin, has amazed and inspired humans for thousands of years. Dubbed the "King of Fish", the wild Atlantic salmon is today at risk of disappearing altogether. Through millennia, this amazing animal has chosen only the most pristine river systems as its habitat and is a centrepiece for thriving ecosystems.

Wild Atlantic salmon in decline

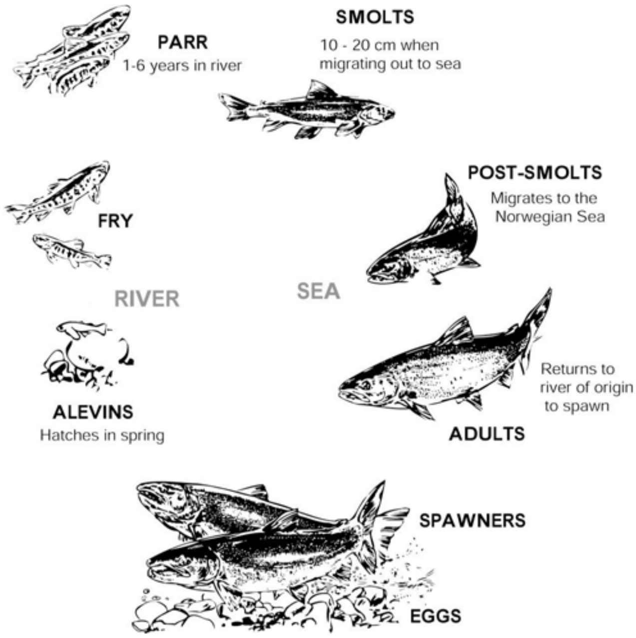
The Atlantic salmon form a large number of spawning stocks connected to a wide variety of watercourses draining into the Atlantic Ocean in Europe and North America. After two centuries of slow and steady decline that coincided, both geographically and chronologically, with human industrial development, wild Atlantic salmon populations have plummeted precipitously over the past three decades. Salmon catches in the entire North Atlantic fell by more than 80 percent between 1970 and the end of the 20th century. Today they stand at the lowest levels in known history, with wild Atlantic salmon completely extirpated from much of their original range, and hanging by a thread in many other locations. The depletion of the salmon stocks in Norway and the rest of the North Atlantic are alarming. In many Western European countries and the United States, a great number of stocks are extinct.



Nominal catches of wild Atlantic salmon in the four North Atlantic regions, 1960-2002 (ICES 2004)

The biology of Atlantic salmon

The salmon spends its years in streams and rivers before smoltifying and migrating from the river to the sea to find further sustenance. After 1–4 years it returns to the same river or stream it hatched to spawn. The salmon's homing ability is the basis for the classification of the stocks. Over the generations these stocks have developed different inherited characteristics and have thus become adapted to their watercourse through natural selection.



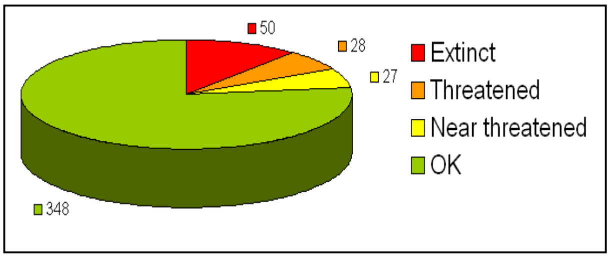
The life cycle of wild Atlantic salmon
Figure Norwegian Institute of Nature Research/Knut Kringstad).

Norway has half of the global Atlantic salmon stocks

Norway has the lion's share of the wild Atlantic salmon stocks with more than 43% of the overall 2003 catch. The wild salmon has historically been, and still is, important to Norwegian and Sami culture. Originally as a source of meat and spiritual value for the first inhabitants of the country, the Norwegian wild salmon stocks caught the attention of British anglers in the mid-1800s. Since then the biggest revenue from wild salmon is derived from selling fishing permits and providing food, accommodation, guiding etc. to foreign as well as Norwegian sport-anglers. Approximately 150-200.000 anglers fish for salmon and sea trout every year. Most salmon rivers are located away from the major towns/cities of Norway, thus wild salmon is of significant economical value to the rural countryside.

The socio-economic value of the 50 most important wild salmon stocks is estimated to be around 20 billion NOK (2,5 billion €) (Naverud 2001).

As a result of the salmon's economic importance in Norway, the status of different stocks are carefully monitored. The assessment from 2003 showed that 50 of 453 wild stocks are recognized as extinct, 28 threatened and 27 near threatened (Hansen et al. 2003), as displayed in the figure below.



Out of 453 Norwegian wild Atlantic salmon stocks, 105 are near threatened, threatened or extinct (Hansen et al. 2003)

Norwegian salmon and trout farming

Norway's fish farming industry has developed astronomically since its modest beginnings with salmon farms in the 1970s. Today, farmed fish is one of Norway's most important export products and the industry is vital to rural revenue. In the space of 30 years, salmon and trout farming has grown into an export industry worth over 12 billion NOK (1,5 billion €).

Around 500.000 tons of salmon and trout are produced annually. Salmon and trout farming constitute the very foundations of the Norwegian fish farming industry and represent the major share of the production potential for many years to come. Work is also ongoing in developing other forms of aquaculture. In 2003, 427 tons of halibut were produced, 2 180 tons of cod and 269 tons of charr.

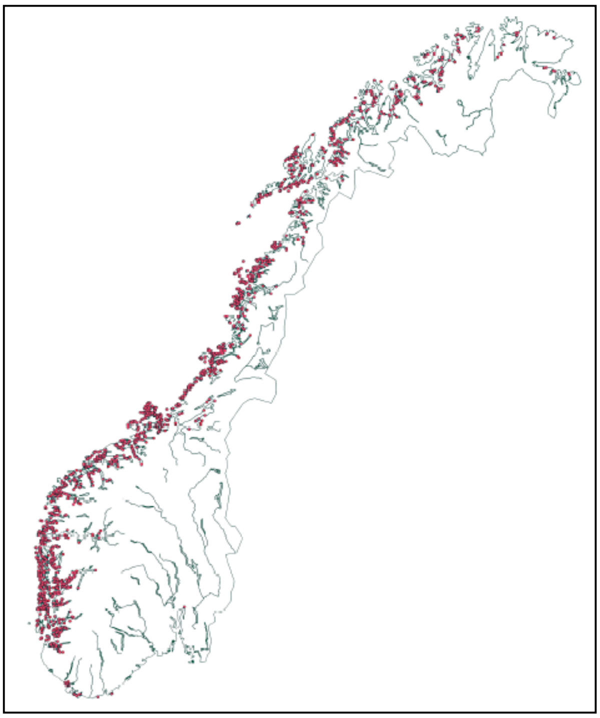
Pursuant to the law on fish farming, the Ministry of Fisheries has the overall responsibility for the management and coordination of the fish farming industry. A number of other authorities and pieces of legislation are also crucial to the management effort; the law on fish diseases, the Pollution Control Act, the law on Ports and Shipping routes and the Planning and Building Act are of central importance in this regard (Norwegian Directorate of Fisheries 2004).

Production of farmed Atlantic salmon

The provisional estimate of farmed Atlantic salmon production in the North Atlantic area for 2003 is around 762.000 tons, representing a 5% increase from 2002 (ICES 2004). Most of the North Atlantic production took place in Norway (61%) and UK (Scotland) (23%), while the rest is produced on the east coast of Canada and USA. In 2002, worldwide production of farmed Atlantic salmon topped one million tonnes for the first time. Total production increased further in 2003 and is provisionally estimated at over 1.1 million tonnes. However, the largest increase in production comes from outside the North Atlantic, where Chile is the major producer.

Country	2000	2001
Norway	419 000	415 000
Britain	124 000	149 000
Canada (east coast)	77 000	86 000
Total	**856 000**	**975 000**

The table shows total production in tons of what farmed Atlantic salmon in the North Atlantic area and part production in the producing countries in 2000 and 2001. Ref ICES 2004

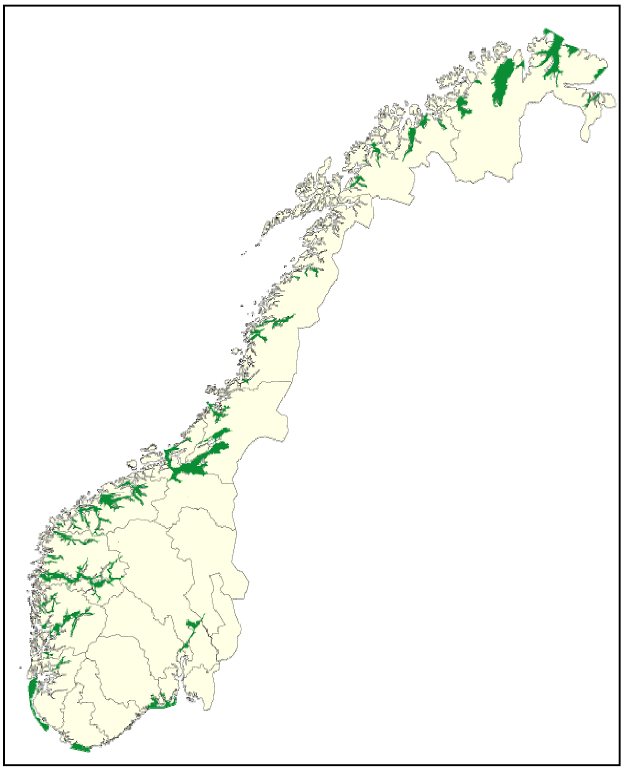


The map shows spatial distribution of salmon and trout fish farms in Norway. The number of licenses is around 850 (Directorate for Natural Management)

3 Escaped farmed fish threaten wild fish

Identifying fish farming as a threat to wild salmon

The Norwegian government, already concerned about the impact of salmon farming on the wild salmon stocks, established in 1989 52 temporary exclusion zones for fish farming. The fjords were adjacent to 125 of the most important salmon rivers in Norway. No new licences for salmonid fish farming has been given in these areas since a evaluation of the zones was done in 1996 (Fiskeridirektøren 1996) and the working group recommended that the zones should be retained, and that some should be expanded in order to give a better protection.



Map showing areas temporary closed for new salmonid fish farms in 1989 (Norwegian Ministry of Fisheries, 1989.)

Responding to the concern over the decreasing wild salmon stocks, the Norwegian Government appointed the Wild Salmon Committee in 1997 (also referred to as the Rieber-Mohn Committee). The working group was a panel with representatives from research and science, governmental agencies and non-governmental organisations such as the fish farming association, salmon angler associations, fishing right owners, farmer organisations and conservation organisations.

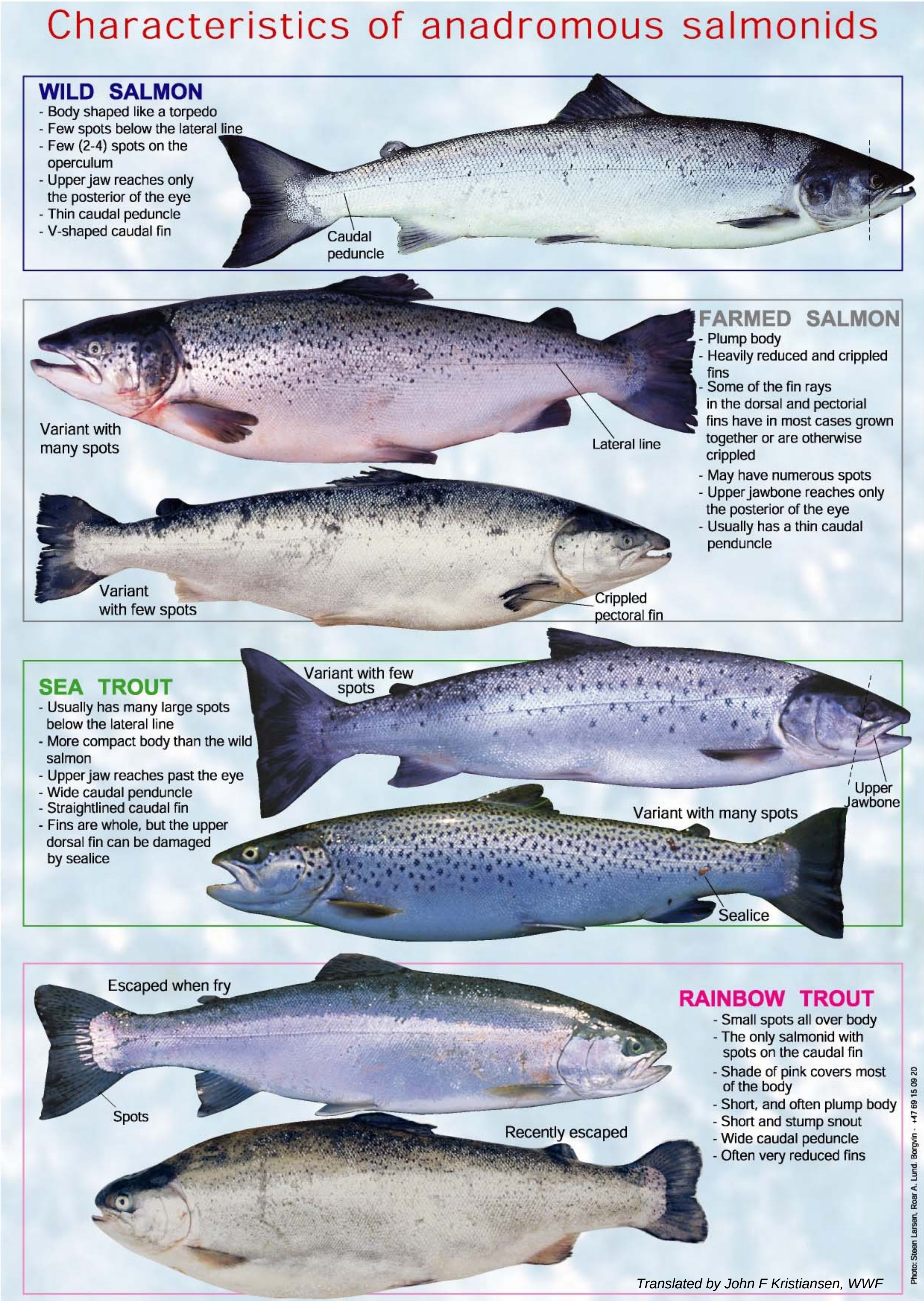
The committee's task was to assess and analyse all possible causes for the decline in the wild Atlantic salmon stocks and to propose measures for implementation. The report (Norwegian Ministry of Environment, NOU 9:1999,) was presented to the Government in 1999. In addition to the already known threats to wild salmon, like dams, pollution, acid rain, *gyrodactylus salaris* and overfishing – the committee also identified impacts from the farming of salmon and rainbow trout as a significant threat. The report concluded that the transfer of diseases and parasites from farmed fish to wild fish could cause high mortality on wild salmon and that escaped farmed fish could negatively impact the species' long term sustainability.

Monitoring escaped farmed fish in Norwegian rivers and coasts

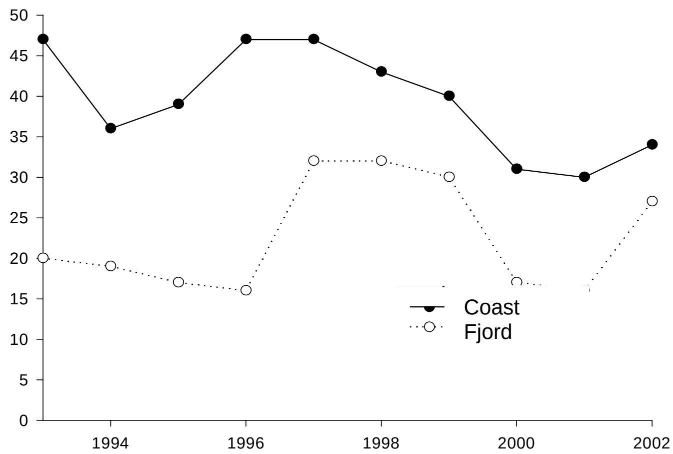
The amount of escaped farmed salmon and trout caught in Norwegian waters has been systematically studied in Norway since 1989 (Fiske et al. 2001). The research is based on identification of escaped farmed salmon by exterior morphology and character of scales. (Lund et al. 1989). The farmed salmon differs from the wild salmon in its body curves, fins, growth zones in scales and because of vaccination the peritoneum is grown together (Borgstrøm, R., Hansen, L. P 2000). The figure on the following page displays the typical differences between farmed salmon and trout and wild fish.

The amount of escaped farmed fish has generally been lowest among in-river fisheries, higher in the spawning stock in the fall, and highest in sea-fishing (ICES 2004). The surveillance fishing of the spawning stock in the rivers is accomplished late in the fall, just after the ordinary fishing season is closed.

From 1986, adult salmon caught at 23 Norwegian coastal fisheries stations have been examined to monitor the occurrence of farmed salmon. In 2003 the amount of farmed salmon in different sample areas in sea varied from 3 - 86%. To study the trends, the same sample areas are investigated for a chain of years. The trend shows that there is a lower amount of escaped farmed salmon in the fjords compared to the coastal areas.


Characteristics of anadromous salmonids
WILD SALMON
- Body shaped like a torpedo
- Few spots below the lateral line
- Few (2-4) spots on the operculum
- Upper jaw reaches only the posterior of the eye
- Thin caudal peduncle
- V-shaped caudal fin
Caudal peduncle
FARMED SALMON
- Plump body
- Heavily reduced and crippled fins
- Some of the fin rays in the dorsal and pectorial fins have in most cases grown together or are otherwise crippled
- May have numerous spots
- Upper jawbone reaches only the posterior of the eye
- Usually has a thin caudal penduncle
Variant with many spots
Lateral line
Variant with few spots
Crippled pectoral fin
SEA TROUT
- Usually has many large spots below the lateral line
- More compact body than the wild salmon
- Upper jaw reaches past the eye
- Wide caudal penduncle
- Straightlined caudal fin
- Fins are whole, but the upper dorsal fin can be damaged by sealice
Variant with few spots
Upper Jawbone
Variant with many spots
Sealice
RAINBOW TROUT
- Small spots all over body
- The only salmonid with spots on the caudal fin
- Shade of pink covers most of the body
- Short, and often plump body
- Short and stump snout
- Wide caudal peduncle
- Often very reduced fins
Escaped when fry
Spots
Recently escaped
Translated by John F Kristiansen, WWF
Photo: Steen Larsen, Roar A. Lund. Borgvin - +47 69 15 09 20

In 2003, the mean value for seven localities in the fjord areas was 21% and for the four coastal localities the mean was 13%. Both areas show a decrease from 2002, and both values are the lowest ever since the monitoring started. However, the situation is drastic in some areas. In the Hardanger fjord, on the Western coast of Norway, 86% of the catch was of farmed origin in 2003. High concentration of fish farms in outer Hardanger fjord, and small stocks of wild salmon cause this phenomenon. In this area the amount of farmed salmon in catches has been 55-94% since monitoring started in 1997. The figure on the next page shows percentage of farmed fish in the 2003 catch.



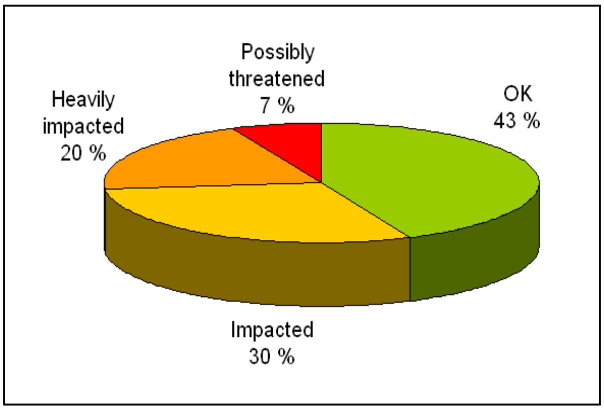
Average per cent escaped farmed fish in salmon catch from 1994 to 2002. ICES 2004

The annual return of salmon from sea to Norwegian rivers is estimated every year. For the last 20 years the average has been between 1 million and 500 000, and in 2003 it was around 650 000 (DN 2004, ICES 2004).

83% of rivers are impacted by escaped fish

Thirty rivers are monitored annually, and the results from 2003, show that eight of these have more than 20% farmed fish. The table over total escaped fish in individual rivers is included in the appendix

WWF has divided the rivers in to four categories in order to find an average of how many rivers are impacted by escaped farmed fish, as well as how many are directly threatened. Levels of up to 5% farmed fish signifies a “green river”. From 6 to 20% is a river that is impacted from escaped fish shown in yellow. Rivers with 21 up to 45% are coloured orange, indicating that there are major reasons for concern. Red represents rivers with 45% or more farmed fish. This is where the stock is likely to be heavily impacted by such large amounts of farmed fish that it can possibly be threatened.

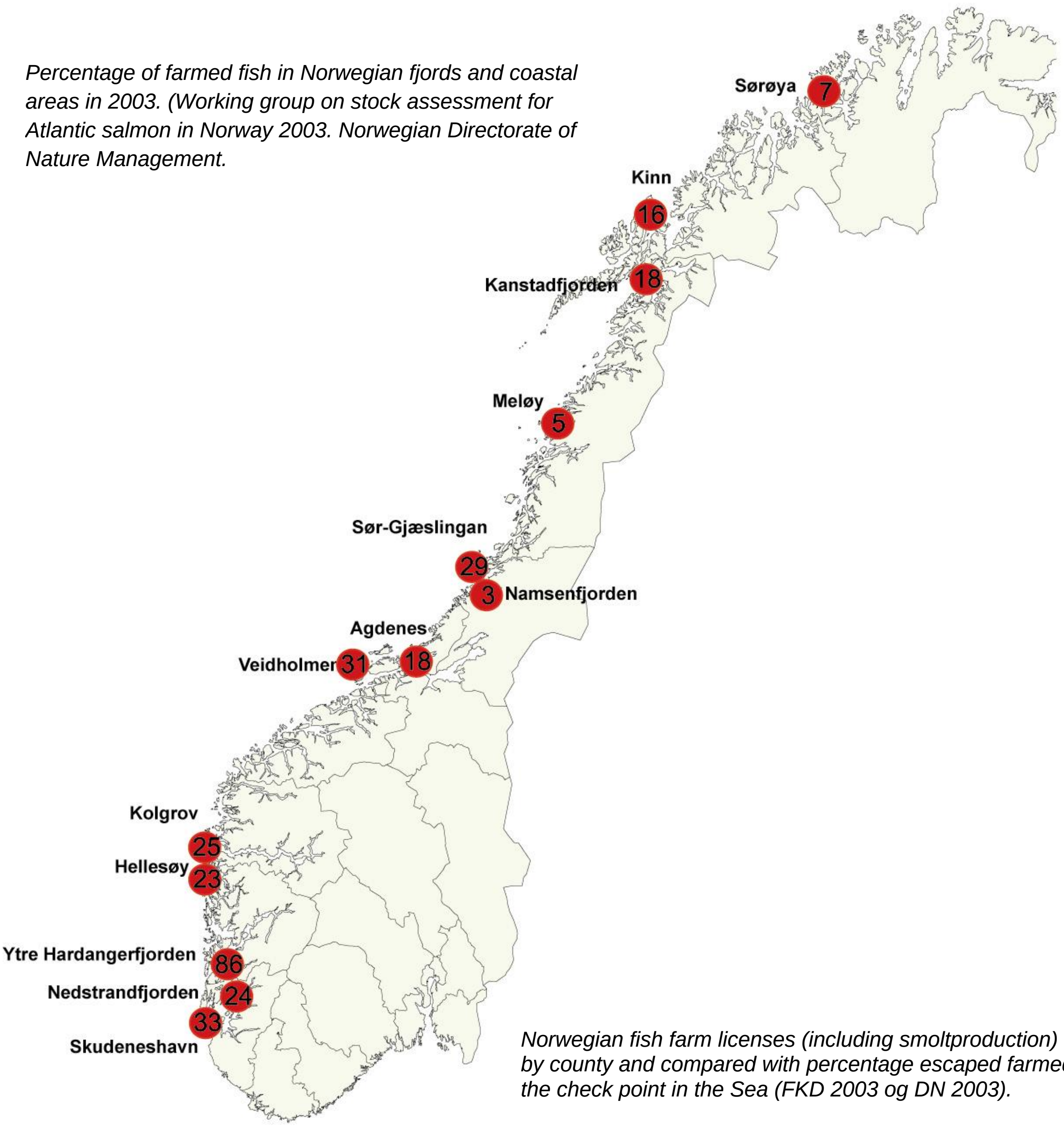


Percentage of Norwegian salmon rivers impacted from escaped farmed fish, based on results from 2003.

Areas with dense fish farming is most impacted

The worst impacted coastal areas are the outer parts of the Hardanger fjord. Here 86% of the wild salmon is of farmed origin. The escape percentages give a good indication of how much the stocks in the area are impacted by fish farming. By comparing these with a table showing areas of dense fish farming in Norway, a correlation can be seen between counties with dense fish farming, and coastal areas with very high percentage of farmed fish. The Hardanger fjord is by far the sea area with the most escaped fish – and it located in Hordaland, the county in Norway with the highest production of farmed salmon.

Percentage of farmed fish in Norwegian fjords and coastal areas in 2003. (Working group on stock assessment for Atlantic salmon in Norway 2003. Norwegian Directorate of Nature Management.



Norwegian fish farm licenses (including smoltproduction) divided by county and compared with percentage escaped farmed fish at the check point in the Sea (FKD 2003 og DN 2003).

County	Number of salmon and trout licences	Check point in sea	Average percent escaped fish
Hordaland	216	Ytre Hardangerfjord	86%
Nordland	172	Kanstadfjoren Meløy Sør-Gjæslingan	17%
Moere og Romsdal	146	Veidholmen	31%
Sogn og Fjordane	110	Kolgrov Hellesøy	24%
Soer-Troendelag	105	Agdenes	18%
Troms	100	Kinn	16%
Rogaland	83	Nedstrandfjorden Skudeneshavn	29%
Finnmark	77	Sørøya	7 %
Nord-Troendelag	77	Namsenfjorden	3%

The escape of cultured animals from farms is a severe form of biological pollution of the environment It constitutes a constant threat of parasite and disease transfer to wild species and escaped farmed species can interbreed with wild relatives. The maintenance of genetic variation, both within and between populations, is essential for their long-term survival and to maintain the evolutionary potential of the wild stock. It is important to protect populations in their natural habitat as they carry gene complexes capable of continually responding to evolutionary forces. Aquaculture itself depends on genetic diversity to sustain productivity, prevent inbreeding and to conserve the potential for new products and increased yields. Ecological impacts include the effects of the interaction of the introduced species on the local fauna and flora, transmission of hitherto unknown diseases and alteration of habitats.

In an international symposium held by NASCO (North Atlantic Salmon Conservation Organisation) and ICES (International Council for the Exploration of the Seas) in 1997, the impact of salmon aquaculture on wild salmon stocks were emphasised and divided into three categories (NASCO & ICES 1997):

- Alteration of habitats and other ecological impacts
- Transfer of diseases and parasites
- Genetic interactions

There are areas in Norway where the wild salmon stocks are directly threatened by fish farming. In a report from 2002, the Norwegian Directorate of Nature Management warned that the situation for the wild salmon on the western coast of Norway was serious, and that escaped fish and sea lice were two important factors (Skurdal et al, 2004). In 2004, the Institute of Marine Research published a report concluding that sea lice coming from fish farms was the direct threat to several of the salmon rivers running into the Hardanger fjord – and that the problem with sea lice was multiplied because of the high number of escaped fish (IMR 2004).

There are of course major differences in how much impact escaped farmed fish have on wild stocks, and factors such as age, time of year, water temperature, currents, and local conditions will greatly affect the survival rate of the escaped fish. However, this chapter is a brief summary of the documented effects that escaped farmed fish can have in the wild.

Competition in the river

The ecological impact of escaped farmed fish, both salmon and rainbow trout in the river can be:

- Competition for spawning habitat
- Destroying the redds of wild fish
- Competition for food and habitat among offspring of wild and farmed fish.

<u>Destroys redds and eggs</u>

The spawning of farmed fish in the wild is to some degree not very successful. However, farmed fish can still significantly affect the wild stocks as it often destroys redds and eggs of wild fish since farmed fish commonly spawns after wild fish. This is thought to be one of the most serious effects of escaped farm fish, though few studies have yet quantified this. (Fleming et al.2000). Both escaped salmon and escaped rainbow trout are known to dig up wild salmon spawning redds. Although Rainbow trout (*Onchorhynchus mykiss*) is not a native species in the Northeast Atlantic, escaped farmed rainbow trout are established in several Norwegian rivers (Hindar et al 1996). Rainbow trout are also potential predators for migrating wild salmon smolt.

<u>Displaces wild parr</u>

The Burrishole study (McGinnity *et al.* 2003) found that larger farmed fish and hybrids dominated and displaced wild salmon parr forcing them to migrate downstream looking for suitable unoccupied habitat. In one year class, 57 % of the wild parr was displaced.

<u>Less homing instinct</u>

The time of year when farmed fish escape determines their behaviour and migration pattern, and thus the probability of farmed salmon entering rivers. Adult fish escaping in winter can stay in coastal areas and fjords for a long period of time, while smolt escaping at sea take up the migration pattern of wild salmon. Even though these fish grow up in the Norwegian Sea, they lack the homing instinct for a specific river, and will spread to a large number of rivers in the North Atlantic to spawn (Skilbrei & Holm 1998).

<u>Late return to the river</u>

Farmed salmon have a later return to the rivers than wild salmon, both in term of age at return and time of year. (Lura and Sægrov 1991, Fiske et al. 2001).The cause is partially environmental and partially genetic. Selection for late maturity will make the farmed salmon return later, and on average larger, than wild fish coming to spawn. The fact that the farmed fish lack a homing instinct also delays their arrival in the river.

Such late returns give an unintended protection from in-river fishing as this fishing is closed due to spawning. It also exacerbates the consequences of destroying redds, as it is likely to dig up the eggs of the wild salmon that have already spawned.

Transfer of diseases and parasites

Dense aggregations of farmed fish are ideal breeding grounds for diseases and parasites. In addition, stress on fish resulting from high density and intensive cultivation is often sufficient to allow pathogens to take hold and form disease reservoirs. Wild fish may move in and out of floating cage systems, escaped fish may enter natural habitats and wastewater may carry pathogens capable of infecting other culture stocks or the surrounding environment. Transmission of diseases and parasites from farmed organisms to natural communities can be a major threat to local species and endemic races of the culture species. In areas of Northern Europe, sea-lice numbers are now significantly higher as a result of the millions of cultured fish in the sea (IMR 2004, Heuch et al 2002)

Salmon lice (*Lepeotheirus salmonis*):
Salmon lice is a marine copeopod which lives as an ecto-parasite on salmonids and naturally exists in Norwegian fjord and coastal areas. Salmon lice feeds on the host's mucus, skin and blood. This directly weakens the host and the bite injuries make the fish more vulnerable to pathogens.

An adult female louse can produce around 800 eggs, and the life cycle of the sealice is app. 50 days. The larvae's planktonic phase lasts for app. 14 days and it then attaches to its host- preferably a migrating smolt or a salmon returning from sea.

Natural conditions are interrupted as the salmon farms provide a large number of hosts for the sealice, presentin fjords and coastal areas throughout the winter season. Naturally, this would be the time of year where most of the hosts (wild salmon) are at sea and the salmon lice population would be low. Heavy salmon lice infestation increases mortality of migrating salmon (Finstad et al. 2000), and in vulnerable areas it is a serious threat to wild salmon stocks (IMR 2004).

Escaped farmed fish is a potential vector for spreading parasites and diseases to wild fish. This can be the introduction of alien parasites and diseases such as *Gyrodactylus salaris* and furunculosis, or the spread of naturally occurring parasites like salmon lice. Escaped rainbow trout seems to be more stationary than escaped farmed salmon, and stay put in the fjords to a much larger extent (Skilbrei 2003). It is thought that escaped farmed fish contributes significantly to the problem of sealice infesting migrating wild salmon smolts (IMR 2004, Heuch et al 2002)

Sealice is a saltwater parasite that can be lethal to salmon and trout. Photo Arnold Hamstad, Skogeierforeninga Nord

At the fish farms, the problem with sea lice can be managed by de-lousing. But even with a low number of adult female lice, a great number of larvae are produced and according to the short time of life cycle (52 days for females at 10°C, (Bjørn et Finstad 1998) the potential growth rate is exponential. A "wall" of salmon lice larvae then meets the wild smolt migrating to the sea, and the balance between parasite and host is disrupted.

The Norwegian Institute of Marine Research is annually performing trawling for migrating postsmolts, assessing salmon lice infestation rates in some fjord systems. In 2001 – the annual survey showed a dramatic result as it was estimated that 95% of the migrating postsmolts that year would die due to lice infestation (IMR 2001). Estimates shows that 10 –15 adult lice on a smolt can be lethal to young salmon (Asplin *et al.* 2002) – and the average in 2001 was 80 sea lice per salmon! However, over the past three years this has improved and the conditions have changed considerably. In the spring 2004, only 3% of the migrating smolt in the Sogne fjord were estimated to have lethal amounts of sea lice. The improvement is credited to better management at the farms in this area, together with environmental conditions less favourable for louse.

Genetic interactions between wild and farmed salmon

Genetic diversity in wild Atlantic salmon has been documented between stocks in different rivers as well within different stocks in the same river throughout the species' distribution range (Møller 1970, Ståhl 1987, Mjølnerød 1999).

Norway has had a breeding programme for farmed salmon for over 30 years. Originally the strains for this program were collected from 40 Norwegian rivers (Gjøen & Bentsen 1997). Nowadays most salmon producing countries use these Norwegian strains to some extent. The selection has reduced the original number of strains and families drastically, and it is estimated that today the lineage of 80% of the salmon produced by the dominating source can traced back to just ten or less salmon from the Namsen River (Mjølnerød, 1999).

Given the short lifetime of salmon farming as a major industry and the complex lifecycle of the wild salmon, the estimated total impact of interbreeding over several generations has not been quantified until recently.

<u>Reduced local adaptation</u>

The introduction of non-native stocks has the potential to change the local populations or stocks genetically. The wild Atlantic salmon is divided into unique stocks, where there are significant differences between rivers. When farmed fish interbreed with the local salmon stock, it can reduce local adaptation and have an impact on the viability and character of the stock (Hindar *et al.* 1991, Bourke *et al.* 1997, Verspoor *et al.* 1997, Fleming *et al.* 2000, McGinnity *et al.* 2003, Weir et al. 2004). By breeding, the natural selection is disrupted, and other traits such as early growth in body mass are favoured. Farmed salmon also show more aggressive behaviour than wild salmon.

<u>Less survival of farmed or hybrid offspring</u>

Mature farmed salmon spawning in a river usually result in interbreeding between wild and farmed salmon, although some pure farmed offspring may be produced. This means that parts of the potential wild juvenile production is lost and converted to hybrids, which show reduced survival and return.

<u>Less genetic variability</u>

With respect to the actual impact on wild salmon gene frequencies and genetic variability, the effect can be a matter of total dose; small doses over many generations equal a massive dose in one generation in an approximately linear way. The ultimate result of a continued impact from farmed salmon is that the wild populations lose their population characteristic traits and eventually resemble the farmed salmon for all genetic traits, including a reduced genetic variability which is an inevitable result of all ongoing artificial selection programmes.

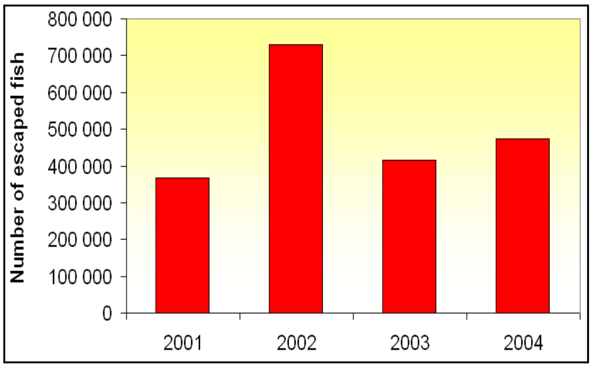
4 Escape prevention

The last two decades, Norway has built up the world's largest salmon farming industry. The fish farming industry now constitutes a major employer, generating wealth along the coast and representing one of the country's largest export industries. In 2002 the production of farmed salmon was 460.000 tons and approximately 144 million young fish were planted in sea cages. In comparison, the amount of wild fish harvested in 2002 was 770 tons, about 200.000 fish. The estimated Three sea cages of farmed salmon can contain more fish than the total annual return of wild salmon to Norwegian rivers.

A leaking industry

Farmed fish escape, and according to the official escape statistics from the Norwegian Directorate of Fisheries, (See figure below), around 4 – 500.000 farmed salmon and trout escapes annually.

The Norwegian Ministry of Fisheries established environmental goals for the fish farming industry in its environmental plan of action for 2000-2004. An important step in this regard was an initiative taken by the Association of Norwegian Fish Farmers in collaboration with the relevant authorities to draw up a national action plan to prevent escapes. The plan was completed in 2000 and contained a proposal to change legislation and to improve training of fish farm staff.(FHL 2000). Unfortunately, as seen on the graph, the amount of fish escaping in subsequent years has not been significantly reduced.



Annual escapes of fish from Norwegian farms 2001-2004, Directorate of Fisheries, 2004

Causes for escape

The Norwegian Directorate of fisheries collects the official escape numbers every year. When a fish farmer suspects that an escape has occurred, the farmer is obliged to report this to the regional Fisheries Directorate, using a standardized form. The form requires details of estimated number escaped, age, health condition and whether the fish had been recently medicated. The cause of the escape must also be reported and all information is available to the public. If there are indications that the farm has violated any of the regulations to prevent escapes or does not comply with the technical standards required, the Directorate can prosecute the farmer.

Several fish farm companies have been fined for escape accidents, either for late reporting, insufficient routines or violation of the operation and disease act. Fjord Seafood got 80.000 NOK, (10.000€) Salmar Farming 200.000 NOK and Grieg Seafood 750.000 NOK (100.000€) but they were later acquittal. Dåfjord Salmon in Troms was in March 2003 sentenced to pay 1.5 million NOK (190.000€) for two incidents of escapes and illegal dumping of dead fish (Hålogaland lagmannsrett 2003) Based on the information given in the form, the Directorate produces statistics showing the main causes of escape. In addition to the official numbers and explanations, an analysis was conducted by a company called Aqua Management in 2004. The results were based on in-depth interviews with fish farmers. They found that the majority of escapes come as a result of inadequate operation procedures and lack of appropriate training (Aqua Management 2004). This is bad news as it points directly to insufficient management on fish farms as the main cause of escapes. However, the results also give hope for significant improvements in the future, as it should be possible to avoid escapes caused by bad routines.

For 2004, the official escape number was 450.000. For 2003, it was 435.000 and the escapes were then attributed to these official causes:

The table shows causes for escapes of farmed fish in 2003 in number and per cent of total escaped fish. (Norwegian Directorate of Fisheries 2004.)

Causes	**No of escaped fish**	**Per cent of total causes**
Predators	0	0,0
Handling	300	0,1
Collision	186 000	42,7
Hauling	2 751	0,6
Construction failure	219 334	50,3
Propeller injury, seine	2 213	0,5
Flotsam	1 317	0,3
Other	24 007	5,5
Total number of escaped fish	**435 922**	

Preventing escapes - laws and regulations in the Norwegian aquaculture industry

The Norwegian Aquaculture Act is the key piece of legislation in fish farming operations. Environmental concerns is concretised in the Operation and Disease-regulation (Norwegian Ministry of Fisheries and Agriculture 1998) where it is stated that aquaculture operations should be established and operated according to requirements in permits and regulations, and in a ”biologically responsible manner”. The regulation was updated in 2004 and becomes legally binding in January 2005. A new and updated aquaculture Act will probably be adopted in May 2005.

To establish or operate an aquaculture operation one need to have a license issued by the Ministry of Fisheries, according to the Aquaculture Law. A license shall not be given if the operation “could lead to occurrence of disease on finfish and shellfish”, “risk of pollution” or “has a clearly negative location affecting the surrounding environment”. The latter is also a legal framework for the designation of the temporary exclusion zones established by the Ministry of Fisheries in 1989 for protecting wild salmon stocks against impacts from salmon farming. Around 100 fish farms were already present in these fjords at that time and were allowed to remain without any particular restrictions. The exclusion was therefore applicable only to new establishments.

Technical standard to prevent escapes

As early as 1991, the Aquaculture Act was amended to allow for a new system of obligatory standards for technical equipment used by the aquaculture industry. In 1988, a certification standard for fish farms was announced by a governmental working group, but the proposal was not accepted by the fish farmers. In 1997, TYGUT (Technical Standards Working group) was initiated by the Ministry of Fisheries. A draft proposal for new technical standards and regulations was sent to all stakeholders, and applauded by industry, NGO’s, technical system suppliers, insurance companies and regulation authorities. The standard included measures such as:

- Documentation of technical requirements
- Authorised audit scheme/body certifier to approve total systems and main components
- Central register with all approved systems
- Directorate of Fisheries will have full control and management responsibilities
- Costs will be covered by registration fees
- A system manager will control sea launch in accordance to standard

In August 2002, a new working group was initiated to complete and finish the standard and update it.

The standard, referred to as NYTEK, introduces new requirements for the technical standard of floating fish farming installations and the main components of such installations. NYTEK makes requirements regarding pre-classification of the localities which are to be used for fish farming activities as well as a requirement that only product-certified floating fish farm installations can be used. Product certification shall be undertaken by an accredited certifying agency in accordance with NS 9415 Floating fish farming installations – requirements for design, dimensioning, performance, installation and operation (NS 9415), or equivalent international standard (FID 2003b).

After more than a decade, the new technical standard, entered into force in April 2004 for all new floating equipment. It will then be another four years before existing equipment must be converted to the new standard (FID 2003b).

The Operation and Disease-regulation

The Operation and Disease-regulation also have quite a few other requirements aimed at reducing and preventing escapes. Floating equipment must be marked with lights to avoid boats running into the facility, and as far as possible have daily supervision. After hurricanes or other harsh weather, immediate supervision must take place. The Operation and Disease regulation requires each farm to have an up-to-date site-specific contingency plan for limiting the size of escapes and recovering escaped fish, and that they report any escapes immediately. (This gives the official escape numbers). The regulation further requires that the plan include safety precautions for the towing of sea cages and for the handling of fish during loading and unloading.

Every farming operation is obligated to have a contingency plan for escapes and the new operation and diseases regulation requires sufficient training for all staff.

Exclusion zones for aquaculture

As recognised by Norwegian Fishing and Environmental Authorities already in 1989, there is always a risk of fish escaping from any farming operation. In order to reduce the possible impacts of fish farming, it was decided to protect many of the most important wild salmon stocks by establishing fish farm exclusion zones.

In 1997, the Wild Salmon Committee was appointed by the government to look into the causes of the decline of Atlantic salmon and propose actions for implementation. The report was presented to the government in 1999 by a uniform committee containing a set of minimum actions that should be implemented together in order to maintain viable populations of wild salmon.

One central proposal was the permanent designation of 50 national salmon rivers and nine national salmon fjords, areas where salmonid aquaculture would be banned (exclusion zones) and activities with potential for harming the wild salmon generally would not be permitted (Norwegian Ministry of Environment 1999). Despite the committee's recommendation, the Government hesitated. And only in February 2003 did the Parliament finally designate a system of national salmon rivers and salmon fjords. A reduced version of the proposal from four years earlier was adopted. After much pressure from the aquaculture interests, a system was negotiated which designated 37 salmon rivers and 21 fjords. Even though the numbers of fjords seems high, these fjords were significantly smaller than what the WSC proposed. In addition, in eight of the fjords salmon farming would still be allowed. New concessions would not be given out for these areas, but existing farms would be allowed to expand their production within their quotas. All in all, less than five farms have to move.

A proposal for supplement and amendments, to a total of about 50 stocks, is to be presented to the parliament in spring 2006, together with a proposal for supplement to the Protection Plan for Water resources and revision of the national Master Plan for hydropower development. With the final designation of national Salmon fjords the temporary exclusion zones that are not being transformed to national salmon fjords will be opened to salmon farming.

The management regime that will apply in the fjords are not yet completed, however a draft was published in March 2004 (Fiskeridirektoratet 2004), suggesting that farms operating in national salmon fjords and near national salmon rivers must comply with stricter regulations for escapes prevention, along with more frequent inspections and coordinated disease treatment.

According to the Ministry of Environment, the 50 stocks protected will account for three-quarters of the wild salmon biomass/resource in Norway. (NASCO 2003). The designation of national salmon fjords and rivers is looked upon as a keystone in the management of the Norwegian wild salmon stocks

Individual tagging of farmed fish

In 2001 – the Norwegian Council for the management of anadromous fish adopted the following statement:

"The council refers to the fact that escaped farmed fish constitute between 30-40 per cent of the spawning individuals in our salmon holding rivers. This is an unacceptably large amount of the broodstock. The council therefore asks the Government to induct mandatory tagging of farmed and cultivated salmon to be able to document where the escapes are occurring. The council thinks this will show an considerable preventative effect" (Samarbeidsrådet for anadrom laksefisk 2001).

Benefits of individual tagging of farmed fish:

- Farmed and cultivated salmon can be identified with near 100% confidence.
- Better knowledge of migrations and occurrence in time and space will help managing escapes and be a guide for location new farming sites.
- Dispersion of hatchery fish can be monitored better.
- Sources of farmed escapees and localities with particularly high percentages of escapees can be identified. A quick identification will in many cases prevent larger escapes.
- Allocation of tags can be used to control the production on each farm and by each country.
- The origin of farmed fish can be documented and used in the different periods of the production, processing and distribution.

Several analysis have been conducted looking into the costs and benefits of a tagging system for farmed fish (Heggberget 1999, Fiskeridirektøren 2004).

Several methods have been evaluated:

- Anchor tags or visible implants for fish are used in small scale for reserach, but are not usefull for massmarking of large quantities of farmed fish as they are expensive, visible and diffucult to use.
- Internal marking, like snoute-tags, are promoted by the Norwegian Institute for Nature Research and also the Passive Integrated Transponder, so called PIT-tags. They are small, invisible and cheap.
- Genetic marking will divide the different fish groups between them and requires a genetic scanning of the fish. Cheap and no physical marking is needed.
- Chemical marking is what the industry are most interested in. This could be a natural marker or introduced to the fisk

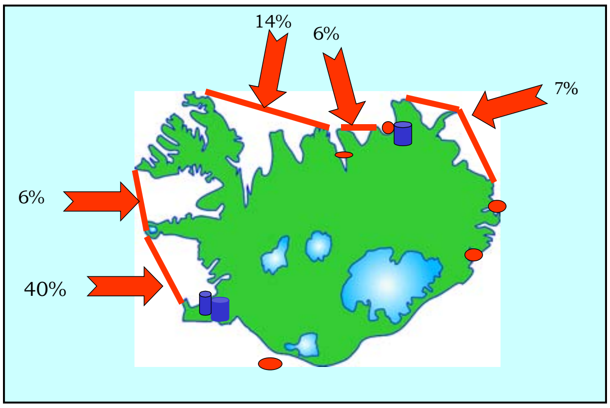
In 2003, the Norwegian Directorate of Fisheries and the Norwegian Institute of Marine Research were given the mandate to assess all options related to the individual tagging of farmed fish. This was based on the text in the White paper to the Parliament (St.meld. nr. 12 2001-2002) and associated comments from the Parliament about the establishing of national salmon fjords and salmon rivers. (Norwegian Parliament, 2003)

The report from the working group came in June 2004, and concluded that tagging could reduce the number of escapes, but that it would be costly for fish farmers. The report recommended no physical tagging of all farmed fish based on present knowledge. Also, it recommended more research into other types of tagging, such as genetic or chemical. So far, no follow-up of this report has occurred (Fiskeridirektøren 2004).

Fish farm free zones and individual tagging in Iceland and USA

<u>Iceland</u>

This map of Iceland shows areas where salmon cage farming using fertile salmon is banned. The proportion of the total average catch within each are is shown. Blue columns show land-based salmon farms, red circles salmon cage rearing stations (NASCO 2004).



Wild salmon protection areas in Iceland. Established in 2001 (Regulation No. 226/2001).

In addition to this zoning system, all marine cage farms must physically microtag 10% of smolts planted into cages according to provisions in the operational licence. Coded wire tags are being applied to about 10% of sea-cage farm production.

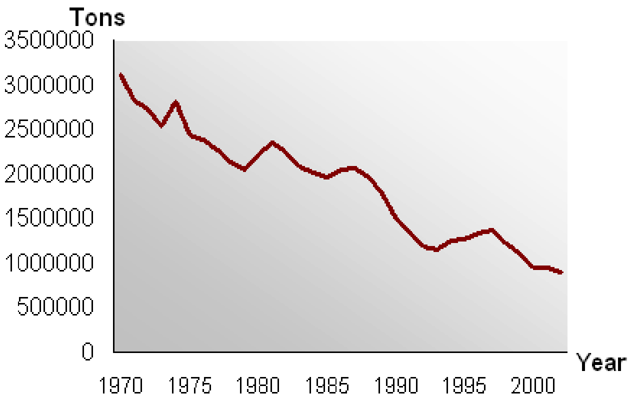
<u>United States</u>

In May, 1987, the Alaska legislature passed a bill placing a moratorium on issuing permits for salmon farming in open waters. In 1990, the Alaska legislature specifically prohibited finfish farming in the *Fish and Game Act* by providing that "a person may not grow or cultivate finfish in captivity or under positive control for commercial purposes." (Alaska Statutes 1990)

In Maine, some firms have opted for a genetic “marking” procedure. The broodstock of these firms has been screened with molecular genetic techniques, which makes it feasible to trace an escaped farmed salmon back to its hatchery of origin through analysis of its DNA. One company has applied a left ventral fin clip, but has not reported numbers for reasons of commercial confidentiality (NASCO 2004).

5 Farming cod

The world's cod stocks are in dramatic decline and global catch of cod has decreased by more than 70% in 30 years. In 1970, the total global catch was around 3.1 million tons, while in 2002 the total catch was down to 890 000 tons (FAO, Fishstats 2004) If such a trend continues, the world will have no more cod on the market in less than fifteen years. This estimate is based on the assumption that cod stocks will continue to decline with the same intensity in coming years.



Total global catch of Atlantic cod was in 1970 around 3.1 million tons. In 2002, total catch was down to 890 000 tons, a reduction of more than 70 %. (FAO Fishstats 2004)

The Atlantic cod, *Gadus morhua*, lives in the North Atlantic Ocean, and separate stocks are found in the waters of North America, Greenland, Iceland, the Faeroe Islands, in the Irish Sea, to the west of Scotland, and in the North Sea, the Barents Sea, the Skagerrak and the Baltic. Atlantic cod is thus separated in a number of different stocks with little or no interbreeding between them.

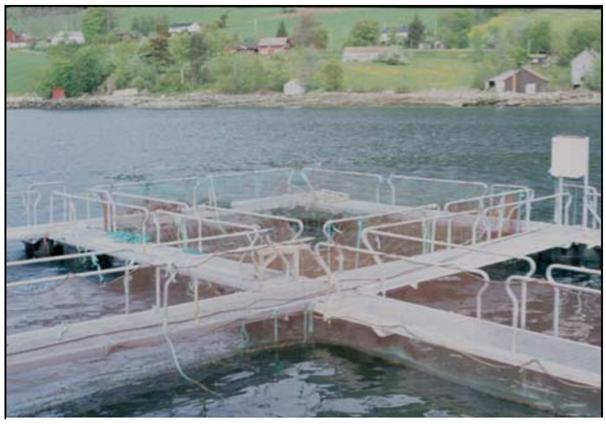
Norwegian coastal cod is the joint name of different coastal and fjord stocks of cod north of 62° latitude from Stad to Varanger. Most of these stocks have individual and defined spawning fields and can be separated genetically from Northeast Arctic cod. Coastal cod are similar to the cod found in the Barents Sea, but have adapted to the various local habitats along the coast.

Results show significant differences between cod, and indicates that the coastal cod is divided in separate, local stocks where genetic interactions are very limited (IMR 2002). In June 2003, ICES recommended a complete cessation of the fishery for coastal cod in Northern Norway. The stock is now declared to be outside safe biological limits as the spawning stock is dramatically low and fishing pressure is too high.

Can cod farming impact wild cod stocks?

In contrary with salmonid farming, cod farming has its whole lifecycle in marine water. This will in most cases increase the environmental effects of cod farming compared to that of salmon and trout farming. Potential environmental effects come especially from diseases and parasites and possible transfer to wild fish, and from genetic and ecological interactions between farmed cod and wild stocks.

There have also been some conflicts between fishermen and fish farmers relating to whether or not a fish farm can have an impact on local fish stocks such as coastal cod. Theoretically, there are several ways in which this can happen. Physical limitations to habitats, release of nutrients and chemicals and use of artificial light could have a potential impact on local stocks such as cod. Experiments conducted in 2003 indicate that cod actually avoids seawater that has been "used" by farmed fish. At present, a research program is on going in Tromsø (IMR 2003 and Fiskeriforskning 2003) to look at potential impacts of fish farming on marine fish, focusing on cod.



Cod farm – Norway Photo: WWF-Norway

Escaped farmed cod

Experience from cod farming in Norway shows that cod have a different behavior in the cage, and are much more adaptive to escaping than salmon or trout (Fiskeriforskning 2004). Research reveals that the chances of a caged cod escaping are ten times higher than that of salmon. This is because cod stays close to the net where it will quickly see any hole that forms and escape. In addition, cod has been shown to chew on the net, and can actually make holes through which to escape.

Large scale production of gadoids in culture may have significant genetic and ecological effects on wild populations. In salmonids, both selection for specific traits and the inadvertent effects of hatchery rearing leading to domestication selection have been shown to alter the genetic composition of individuals compared to that of wild fish. Several recent studies have documented genetic and ecological effects of farmed fish introduced into local wild populations. Escapes or releases of reared fish are also associated with increased straying behavior, and farmed fish may therefore have an effect on wild populations not just locally, but also regionally.

Recently, studies have shown that gadoids are subdivided into genetically differentiated populations and that reproductive isolation may occur over geographically small scales. Such patterns are likely to also reflect adaptations to local conditions, exacerbating the concern that fitness and recruitment in local populations may be adversely affected by introgression from reared individuals (Bekkevold, D, in ICES 2004, Gadoid mariculture symposium).

6 Conclusion

Escaped farmed fish should be considered as an introduced species, as it disturbs the integrity of coastal and river ecosystems. Introducing new species, or a domestic form of a natural species, is a violation of international conventions. UNCLOS, CBD and the FAO Code of Conduct are all international agreements that Norway has signed. These agreements urge states to prevent the spreading of alien species.

New scientific studies released in the past few years have emphasized that escaped farmed fish are causing irreversible, negative impacts on wild salmon stocks. The combined effect of competition and hybridisation on wild stocks means that when a large number of farmed salmon spawn in a river, the potential juvenile production number and the number of adult spawners returning the next generation are reduced. The magnitude of the impact will depend on several factors such as relative numbers of farmed and wild salmon and habitat available for juveniles. As larger escapes now seem to happen quite frequently in some areas, a cumulative effect is taking place on generation after generation. This, together with the threat of diseases and parasites, could ultimately lead to the extinction of endangered and vulnerable wild salmon stocks.

Stricter regulations for cod farming

Cod stocks in many places are severely depleted, and any negative impact from future cod farming could pose a serious threat to already vulnerable stocks, calling for states to use the precautionary approach from day one in developing cod farming. This should be possible if the wealth of knowledge gained from salmon farming is applied to cod farming.

There are already over 600 licences for cod farming issued in Norway, and WWF has determined that sufficient environmental regulations are not in place. For the question of siting, WWF asks for:

- Stricter technical standards for cages for cod farming
- Stricter regulations for operations and disease prevention, such as fallowing and year classes separation
- Areas free of fish farming where there are vulnerable stocks of coastal cod

Further steps are needed to prevent escapes

It is unacceptable that certain areas around the coast have had, over a period of several years, ratios of farmed fish hovering around 80%. A higher number of fish farms in an area leads to a higher risk of escaped farmed fish entering fjords and rivers. In areas with fewer fish farms, there is also less escaped fish in the fjords. WWF sees this as a highly relevant argument for why fish farm free zones are a good management tool that should be used widely, also in other countries.

The annual monitoring of the amount of escaped fish in sea areas and rivers is an important means of measuring the impact of escaped fish as well as the effectiveness of industry methods in preventing such escapes. WWF strongly recommends that these are maintained and strengthened.

There is a need for a changing of attitudes. Fish farmers and governments must recognise that escapes are a constant threat to vulnerable ecosystems and species – and do everything possible to prevent escapes. WWF urges further steps be taken to reduce this problem:

<u>Better management at fish farms</u>
Insufficient management at farms is still the major cause of escapes. There is great potential for reductions if routines and training of staff is improved. Systems for sufficient training and good management schemes should be mandatory.

<u>Individual tagging of farmed fish</u>
Many fish escape without ever being reported or the source of the escape found. Individual marking or tagging of fish is one method of reducing this problem. WWF strongly supports the ongoing Norwegian project examining the most efficient ways to introduce a system for tagging of farmed fish in Norway.

<u>Fish farm free zones in vulnerable areas</u>
There is always a risk of accidents caused by humans, bad weather or other factors. Therefore, areas with particularly vulnerable stocks of wild salmon or coastal cod should be permanently closed to open cage fish farming. This includes areas with important spawning grounds or migratory routes.

Risk assessments when farming new species

The aquaculture industry is growing rapidly, and there is an urgent need to adopt a more precautionary approach to the introduction of new species for aquaculture. WWF urges governments to perform detailed environmental impact assessments before new operations are established.

Consumers should ask for eco-labelled fish

Consumers should only buy eco-labelled farmed fish, as these farms have stricter management and fewer escapes. Also retailers and supermarkets have a responsibility to ensure that they only buy farmed salmon from the most responsible fish farmers.

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Attachment I – Percent escaped fish in rivers and sea areas in 2003

Percentage farmed fish in Norwegian riverine systems: NINA=Norwegian Institute of Nature Research VESO=Centre of Veterinary Contract Research and Commercial Services Ltd

Water system	Percentage farmed fish	Number	Data collected by
Norddalselva (Sør-Trøndelag)	0	25	VESO
Reisavassdraget	8	25	NINA
Stordalselva ST	0	25	VESO
Vikedalselva	4	25	NINA
Kongsfjordvassdraget	7	27	NINA
Numedalslågen	0	28	VESO
Ørstavassdraget	23	31	NINA
Årøyelva	6	31	VESO
Loneelva	15	33	NINA
Salsvatnvassdraget	48	33	NINA
Nordelva	21	39	NINA
Stjørdalselva	7	41	VESO
Altavassdraget	17	42	NINA
Forsåvassdraget	2	42	NINA
Suldalslågen	5	42	VESO
Sylteelva	2	51	NINA
Verdalsvassdraget	2	52	NINA & VESO
Håelva	4	57	VESO
Skiensvassdraget	32	60	NINA
Jørpelandselva	6	70	VESO
Repparfjordvassdraget	27	71	NINA
Åelva	1	86	NINA
Vestre Jakobselv	37	92	NINA
Vikja	40	97	VESO
Varpavassdraget	9	106	NINA
Gaula	3	119	NINA & VESO
Orkla	5	139	NINA & VESO
Bjerkreimselva	1	147	VESO
Namsen	10	168	NINA
OsenSF	45	42	Rådgivende Biologer

Percentage farmed fish in coastal areas and fjord areas

Seastation	Percentage farmed fish	Number	Coast/ Fjord
Agdenes	5	76	F
Kanstadfjorden	18	88	F
Namsenfjorden	3	70	F
Nedstrandfjorden	24	75	F
Ytre Hardangerfjord	86	102	F
Hellesøy	23	70	C
Kinn	16	79	C
Kolgrov	25	75	C
Sleipnesodden	5	66	C
Skudeneshavn	33	72	C
Sør-Gjæslingan	29	14	C
Sørøya	7	76	C
Veidholmen	31	70	C

Attachment II - Conventions regulating introduced species

UN Law of the Seas - UNCLOS

The United Nations Convention on the Law of the Seas came into force in 1994 (UNCLOS 1982), and is now ratified or acceded by over 100 states. It ´s Article 192 clearly states that States have the obligation to protect and preserve the marine environment. Further, article 196 on the Use of technologies or introduction of alien or new species in UNCLOS says: “States shall take all measures necessary to prevent, reduce and control pollution of the marine environment resulting from the use of technologies under their jurisdiction or control, or the intentional or accidental introduction of species, alien or new, to a particular part of the marine environment, which may cause significant and harmful changes thereto.” Article 196 contains a clearer and wider obligation to be precautionary than CBD.

Convention on biodiversity (CBD)

The Convention on Biological Diversity from 1992 is the main international convention relating protection of biodiversity/wildlife. The convention is ratified by most countries, and therefore legally binding. As, introduction of alien species is considered one of the main threats to global biodiversity, Article 8 In-situ Conservation, letter h, of the Convention states: “Each Contracting Party shall, as far as possible and as appropriate: h) Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species; “

At the 6th Partconference in Hague in 2002 The Conference urged Parties, other Governments and relevant organizations to promote and implement the 15 guiding principles on how to minimize the negative effects of alien species (CBD 2002). These guiding principles are to be used by the states in the implementation of article 8 h) in the Convention, based on the Precautionary Principle. The term ”alien species” refers also to exotic underspecies, rases and other exotic organisms within the same species, as outlined by the definition of ”biological diversity” i the conventions first paragraph (Schei, A. 2003)

FAO - Code of Conduct for responsible fisheries

The Parties to the Food and Agriculture Organization (FAO) of the United Nations has adopted the FAO “Code of Conduct for responsible fisheries” (FAO 1995). The code was adopted by FAO members in November 1995, and is a volunteer set of guidelines for fisheries, trade in fish and aquaculture development. The Code provides principles and standards applicable to the conservation, management and development of all fisheries, including aquaculture. FAO Code of Conduct for Responsible Fisheries (FAO 1995) The FAO code of conduct prescribes a precautionary approach to all human activities concerning living resources in all aquatic systems. Point 7.5.1 in the code reads: “States should apply the precautionary approach widely to conservation, management and exploitation of living aquatic resources in order to protect them and preserve the aquatic environment. The absence of adequate scientific information should not be used as a reason for postponing or failing to take conservation and management measures“.

Under Article 9.Aquaculture Development, regarding the introductions and transfers of alien organisms it is stated specifically (article 9.3.1) *“States should conserve genetic diversity and maintain integrity of aquatic communities and ecosystems by appropriate management. In particular, efforts should be undertaken to minimize the harmful effects of introducing non-native species or genetically altered stocks used for aquaculture including culture-based fisheries into waters, especially where there is a significant potential for the spread of such non-native species or genetically altered stocks into waters under the jurisdiction of other States as well as waters under the jurisdiction of the State of origin- States should, whenever possible, promote steps to minimize adverse genetic, disease and other effects of escapes farmed fish on wild stocks.*

NASCO

The North Atlantic Salmon Conservation Organization (NASCO) is an international organization established under the Convention for the Conservation of Salmon in the North Atlantic Ocean, which entered into force on 1 October 1983. All governments throughout the Atlantic salmon’s native range are NASCO Member Countries. In 1994 the parties agreed on the Oslo Resolution on minimizing impacts from salmon aquaculture on wild salmon stocks (NASCO 1994). The Resolution has a lot of recommendations for the parties, but these are only guidelines and not legally binding. In 1997 the North-East Atlantic Commission adopted a Resolution to protect Wild Salmon Stocks from Introductions and transfers (NASCO 1997a) and the Council adopted Guidelines for Action on Transgenic Salmon (NASCO 1997b).

Relevant programs regulating introduced species

GISP

Under GISP (Global Invasive Species Program) an international team of biologists, natural resource mangers, economists, lawyers and policy makers are developing a global strategy to address the invasive species program. The work is coordinated by scientific Committee on Problems of the Environment, in collaboration with the World conservation union (IUCN) ad the United Nations Environment Programme (UNEP) among others. The team's goal is to enable local, national and multinational communities to draw on the best available tools to immediately improve pest prevention and control systems, and to identify priorities for the development of new tolls needed to achieve longer-term success. Further, the program will contribute to the capacity of nations to fulfil Article 8h of the Convention on Biological Diversity.

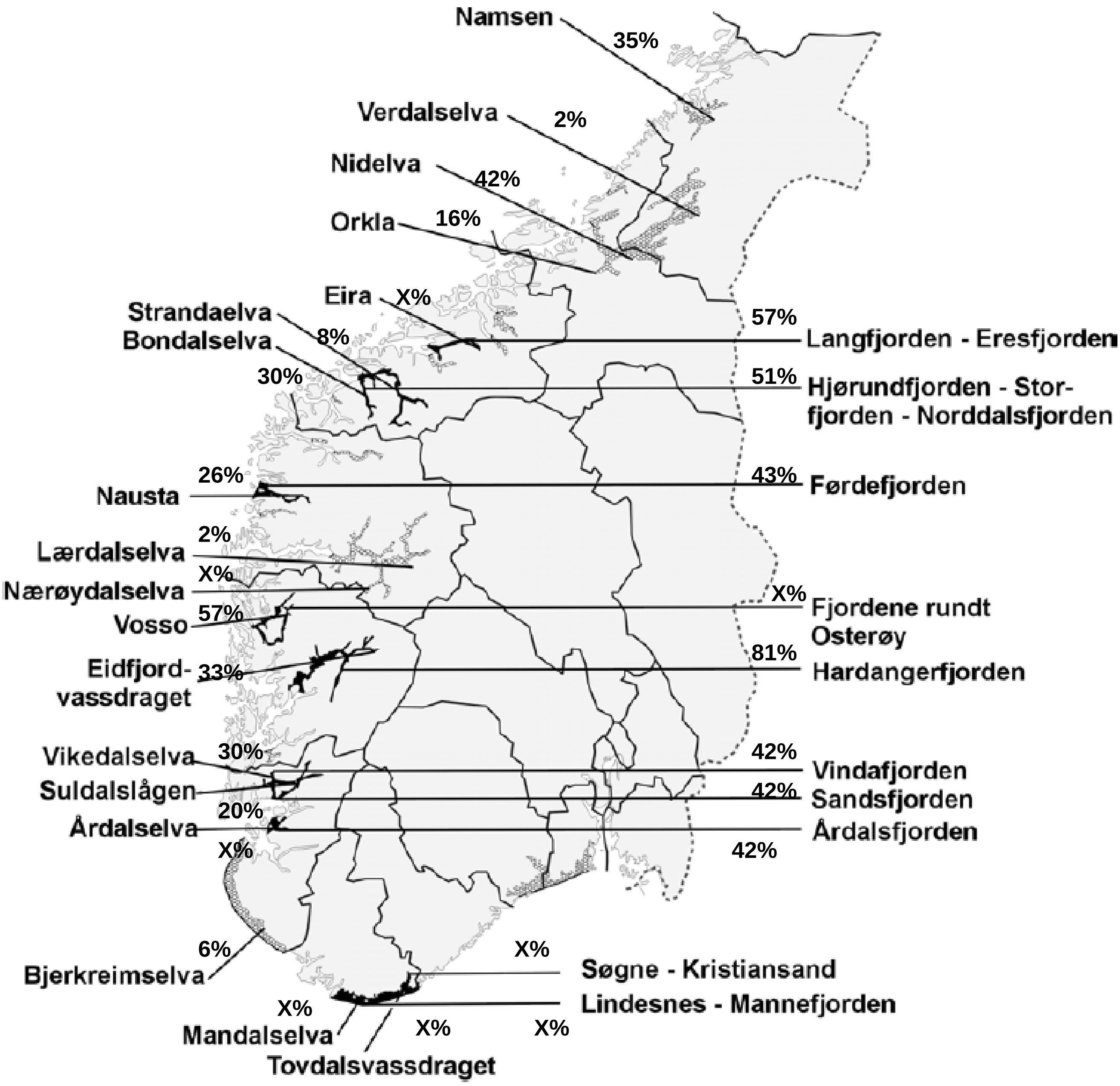
ICES code of conduct

The International Council for the Exploration of the Sea (ICES) has developed a code of practice on the use of introduced species. It generally applies to the purposeful movement of aquatic species, for example, in fisheries, biological control, aquaculture, and for research. The Code is general and can be adapted to specific circumstances and resource availability

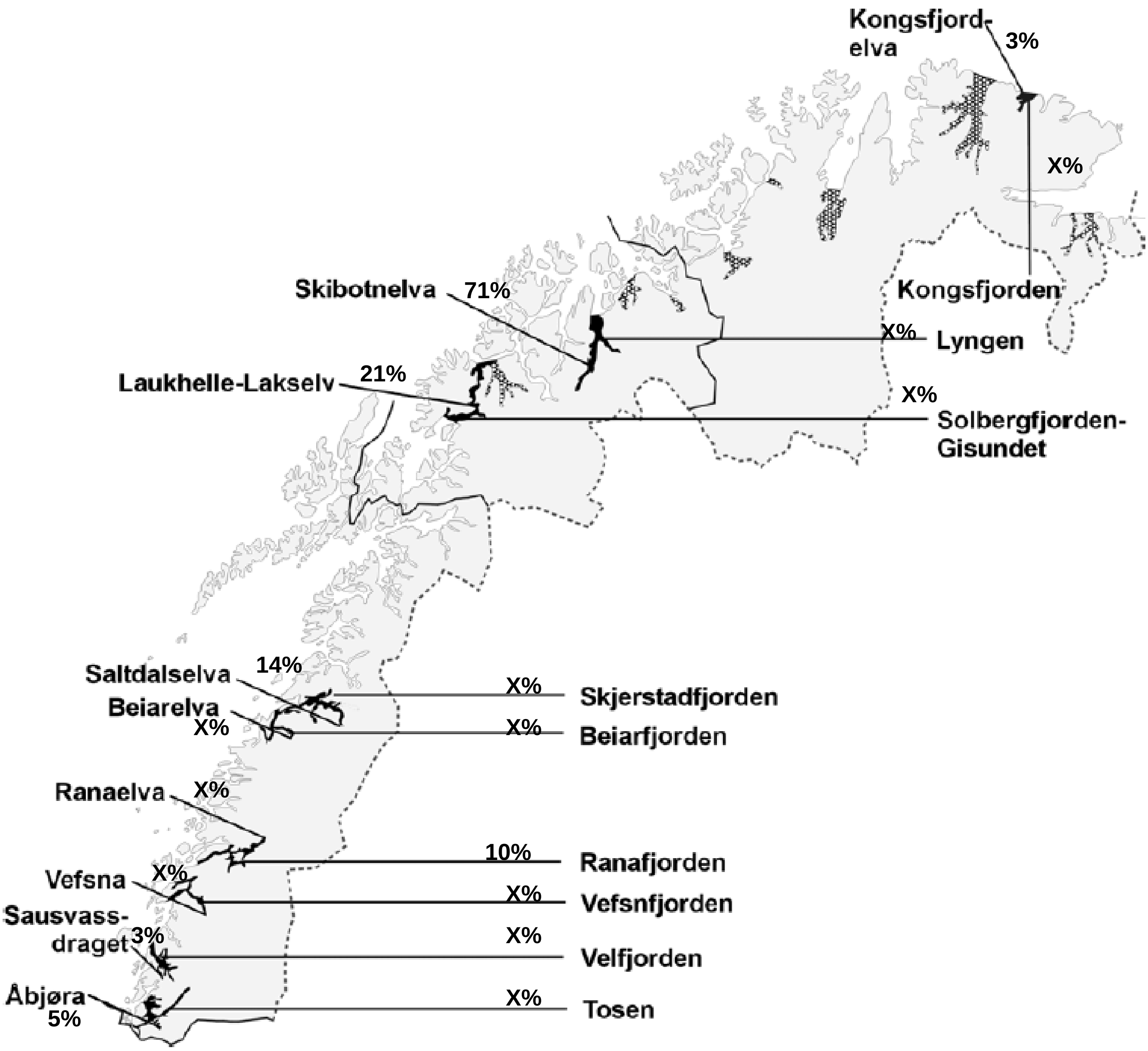
The basic requirements are

- Proposals including location, planned use, source of the exotic species etc.
- An independent review evaluating impacts and risk/benefits of the proposed introduction
- if approval to introduce a species is granted quarantine, containment, monitoring, and reporting programmes are implemented

Attachment III – Percent escaped fish in selected rivers



Per cent escaped farmed fish in salmon rivers (left side names) and coastal areas (right side names) observed by in different years in the period from 1993 to 2001. The fjords drawn in black are already protected as national salmon fjords with restrictions on salmon farming, and the fjords drawn in grey are proposed new salmon fjords. All the fjords and the rivers listed are proposed as national salmon rivers and fjords by the Norwegian Directorate of Nature Management. The proposal is up for a vote in the Parliament in 2006. (Directorate of Nature Management 2004)


Kongsfjord-
elva
3%
X%
Kongsfjorden
Skibotnelva
71%
X%
Lyngen
Laukhelle-Lakselv
21%
X%
Solbergfjorden-
Gisundet
Saltdalselva
14%
X%
Skjerstadfjorden
Beiarelva
X%
X%
Beiarfjorden
Ranaelva
X%
10%
Ranafjorden
Vefsna
X%
X%
Vefsnfjorden
Sausvass-
draget
3%
X%
Velfjorden
Åbjøra
5%
X%
Tosen

Earlier WWF publications in Norway:

2005
On the run – escpaed farmed fish in Norwegian waters

2004
WWFs verneplan – for å bevare Norges fantastiske skognatur
The Barents Sea cod – The last of the large cod stocks
Vanndirektivet – et miljøløft med startvansker
Gaupejakta – forvaltningen bommer igjen
Biologisk mangfold – det levende grunnlaget for fattigdomsbekjempelse

2003
Defensiv norsk miljøpolitikk – i og utenfor EØS
The Barents Sea Ecoregion – A biodiversity assessment
En framtid for villreinen – en framtid for fjellet
Food for Thought: the Use of Marine Resources in fish Feed
Barentshavet – et hav av muligheter…. og trusler
Levende skoger - naturarv for framtida
Gaupa – færre og færre

2002
Clean conscience consumption of seafood – Ecolabels and environmental management systems for fisheries and aquculture
Miljømerker for sjømat - en oppsummering av miljømerker og miljøstyringssystemer for fiskerier- og havbruksprodukter
Particularly Sensitive Sea Areas (PSSA) i Barentshavet
EUs habitatdirektiv
Statsskog bygger "miljøhyttetun" som mangler miljøinnhold ved Lemonsjøen

2001
The Status of Wild Atlantic Salmon: A River by River Assessment

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans lie in harmony with nature, by:

- conserving the world's biological diversity
- ensuring that the use of renewable natural resources is sustainable
- promoting the reduction of pollution and wasteful consumption

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