Strategy

Strategy for an Environmentally Sustainable Norwegian Aquaculture Industry

NORWEGIAN MINISTRY OF
FISHERIES AND COASTAL AFFAIRS

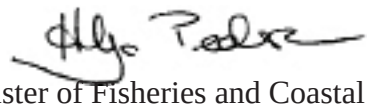
Foreword

The Soria Moria declaration's statements on aquaculture were addressed in the Government's Strategy for a Competitive Norwegian Aquaculture Industry, presented in August 2007. On the subject of protecting the environment, we wrote that the Government "will ensure that the Norwegian aquaculture industry is run on a sustainable basis." Strategy for an Eco-friendly, Sustainable Aquaculture Industry is a follow-up to and extension of the competition strategy, concerning sustainability.

Aquaculture is a vital industry in Norway. It creates jobs and value. Know-how has been acquired which can be used to develop and improve aquaculture production in this country, and to help Norwegian companies break into other markets than the country's traditional ones. Aquaculture also creates spin-off effects for the supply and processing industries. It brings life to the coast and growth to rural districts and towns. Seafood is healthy, and scientists recommend that we eat more fish, which is why the Government wants to develop the industry further. The greatest potential for growth is in the farming of salmon, cod and shellfish. Growth in the aquaculture industry cannot be determined solely by market demand; it must occur within the limits that the environment can tolerate. This entails that a ceiling has to be set for how large the industry can become, and ensuring that production remains within what the environment can cope with is a determinative factor in making this assessment. Eco-friendly, sustainable production is therefore a precondition for long-term development and growth.

A sustainable aquaculture industry is one which is run with consideration for the environment, and adapted to the marine environment and biological diversity. As a food producer, the aquaculture industry depends on good environmental conditions and water quality, which means that in order to protect their own businesses, fish farmers have an obvious interest in maintaining good water quality and avoiding any negative impact on their surroundings. It is important to ensure a clean marine environment and good production locations for aquaculture, with minimum impact from long-distance transport emissions and pollution from more local sources. Similarly, the authorities and industry must cooperate to ensure that aquaculture is run to the benefit of its surroundings, and not to their detriment.

Those involved in the aquaculture industry are invited to collaborate in order to fulfil the goals of this strategy, which is to ensure that the Norwegian aquaculture industry is run in the most sustainable manner possible.



Minister of Fisheries and Coastal Affairs

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1. Introduction

1.1 About the process

During the process of devising the strategy, the Ministry of Fisheries and Coastal Affairs has received input from a wide variety of sources. The Directorate of Fisheries, the Norwegian Food Safety Authority, the Institute of Marine Research and the National Veterinary Institute have helped considerably with identification of the problems, and with quality assurance. The Ministry of the Environment has contributed specialist skills for environmental aspects and a wide range of stakeholders have taken part in hearings, sharing their views on what should comprise an eco-friendly aquaculture industry of the future. These include: The Norwegian Seafood Federation, the Norwegian Seafood Association, Bellona, Greenpeace, WWF Norway, Norwegian Salmon Rivers, The Norwegian Association of Hunters and Anglers, the Norwegian Fishermen's Association and the Norwegian Farmer's Association.

The strategy identifies problems, sets goals and explains what needs to be done to achieve them. It does not include specific effect-indicators for acceptable influence. Further work is therefore necessary on implementing the concept of sustainability in an appropriate manner, which will require further research or investigation. Many of the measures proposed will have to be implemented either by specific regulations, or by changes to existing rules. Such regulations will be subject to hearings and the economic and administrative consequences will be assessed in the usual manner.

1.2. Background

Over the last 40 years, aquaculture has developed into a major industry in Norway, with over 800,000 tons of farmed fish produced in 2007, equivalent to around NOK 17.5 billion in first-hand turnover. Farmed fish represent more than half of total Norwegian seafood exports, and have helped Norway become the world's second biggest exporter of seafood. Around 4,500 people are directly employed in the industry, but very many more work in the supply industry, and in processing and transport companies.

The Norwegian aquaculture industry faces a range of environmental challenges, and scientists and environmental organisations have helped identify some of the major problems. The industry and the authorities have already implemented a range of measures, but there is a lot more work yet to be done. Therefore, a major element of aquaculture policy will be the identification of what elements go to making eco-friendly sustainable production.

The Government's policy for conservation of wild salmon is stated in Report to Storting no. 32 (2006-2007) *On Conservation of Wild Salmon and Completion of National Salmon Watercourses and Salmon Fjords*, and the strategy here will contribute to achieving the goals for wild salmon conservation. This should also be implemented into the strategies of the fish farmers themselves.

This strategy focuses on the environmental aspects of sustainable farming, based on five main areas in which the industry impacts the environment (the impact model). These are:

- genetic interaction and escapes
- pollution and discharges
- disease, including parasites
- zoning
- feed and feed resources

The strategy document discusses details of challenges, status, measures initiated, future goals and the Government's proposals for new measures for each of these five areas. The strategy will identify problems, set goals and explain what needs to be done to achieve them. It does not include specific effect-indicators for acceptable influence. The Directorate of Fisheries and the Norwegian Food Safety Authority will play a central role in implementing the drive for sustainability, and the ongoing process will require more research or investigation. All stakeholders will be invited to contribute to this process.

1.3 Horizontal concern for the environment, and use of the precautionary principle

The Aquaculture Act has a special environmental clause which states that aquaculture must be established, run and wound down in an environmentally responsible manner. When evaluating the concept of environmental responsibility, the precautionary principle comes into play, which entails that, where there is a risk of serious or irreversible damage to nature, ignorance may not be used as an excuse for delaying or avoiding the initiation of proportionate and cost-effective measures. This entails in turn that any possible impact is not to be assessed in isolation, but against a background of the environmental load that has already occurred through other forms of impact.

The principle of total load is also relevant when the environmental impact of aquaculture is being assessed. The principle implies that the impacts of an ecosystem must be assessed based on the total load it is or will be exposed to. This has particular relevance if environmental load is at a critical threshold, at which only a small increase will have a major effect on the ecosystem. These principles form the basis of the Government's bill for the Natural Diversity Act, and lay down guidelines for the implementation of aquaculture legislation.

1.4 Climate, traceability and environmental labelling

Aquaculture has an impact on the climate, and is influenced by the climate. For example, changes in weather and temperature may affect disease levels in fish, and test the tolerance to disease of the aquaculture facilities. Production and the sale of seafood also affect the climate through discharges.

The Ministry of Fisheries and Coastal Affairs has commissioned a report on climate gas emissions from the commerce in seafood to establish the levels of emissions from various types of transport and packaging. This will contribute to broader understanding from which to evaluate the impact that various forms of seafood products have on the environment from a lifetime perspective, and to identify areas where such impact can be minimised.

Consumer demand for labelling and documentation related to the climate and the environment is growing. Such labelling is currently based on a variety of initiatives, and with various levels of official involvement, for example, mandatory schemes such as the forthcoming labelling requirements for production method, type and catch area. Notable private certification schemes applicable to fisheries are KRAV, Friend of the Sea, and the Marine Stewardship Council (MSC). Similar schemes for aquaculture include Krav, Friend of the Sea, Global GAP, and organic labels such as Debio, Naturland and the Soil Association. The WWF has taken the initiative for the Aquaculture Stewardship Council (ASC), equivalent to the MSC, but for aquaculture. The UN's Food and Agriculture Organisation (FAO) is developing guidelines for the certification of sustainable aquaculture.

Clear criteria and chain traceability are important for climate labelling and eco-labelling, so that the information is credible and provides guidance, and does not mislead the consumer. The Norwegian authorities are working via international forums to establish common guidelines for eco-labelling of farmed seafood. The authorities have also launched a project to implement, by 2010, a common electronic infrastructure for exchanging information on food, including farmed fish, throughout the entire value chain.

The climate issue is relevant to the aquaculture industry, but the problems are more complex and general than the five main areas focused on in this strategy. Please refer to Report to Storting no. 34 (2006-2007) on Norwegian Climate Policy.

2. Genetic interaction and escapes

2.1 Status and challenges

2.1.1 Salmon

World stocks of wild Atlantic salmon have been significantly reduced over the last 30 years. Around 1/3rd of the Atlantic salmon have their spawning grounds in Norway and, through international agreements, Norway has committed to take special managerial responsibility for wild Atlantic salmon. Salmon have disappeared from around 45 watercourses in Norway, and around 100 of the remaining 400 Norwegian populations are vulnerable. However, historic catch data from Norway show fluctuations, and trends vary in different regions over time. There are many reasons for the decline in wild salmon stocks over the last 30 years, and these have been examined in more detail in Norwegian Official Report NOU 1999: 9 *Not enough salmon for all? The reasons for the decline in Norwegian wild salmon stocks and suggestions for strategies and measures to improve the situation.* Among the main reasons described in the NOU are natural fluctuations in food availability and water temperature in the Norwegian Sea, pollution, acid rain, watercourse diversion, *Gyrodactylus salaris*, overfishing, the effects of aquaculture etc.

The Government's policy for wild salmon conservation is laid out in Report to Storting no. 32 (2006-2007) *On the conservation of wild salmon and the designation of salmon watercourses and salmon fjords*. In addition to national salmon watercourses and fjords, the proposition states that effective measures are needed with regard to aquaculture, salmon watercourses, combating the salmon parasite *Gyrodactylus salaris*, calcification, gene banks, R&D, salmon monitoring and regulating salmon fishing.

There is a large degree of agreement in research environments that substantial and persistent interbreeding with escaped, migrant, farmed salmon is detrimental to wild salmon.
The causes of most escapes in recent years have been wrecking of installations, inadequate technical state of the installations, human error, predators and predation through nets, collisions, poor inspection and working procedures, lack of control systems and competence among salmon farmers.

Escape figures reported for salmon reduced significantly in 2007 and 2008 compared with previous years. Over the last five-year period from 2004 to 2008, reported escape figures were 553,000, 715,000, 920,000, 290,000 and 100,000 individuals respectively. This positive trend shows that efforts made by the authorities and the industry are paying off. However, there is reason to assume that there are also significant numbers of unreported escapees.

Farmed salmon in Norway differ from most other farmed stocks in the world, in that they do not have any genetic material from stocks outside of the country. Farmed salmon differ from wild salmon in terms of growth, behaviour and amount of genetic variation, characteristics which greatly influence their adaptability to the living conditions in rivers and the sea, and thereby their survival in the wild.

The characteristics of farmed salmon are a result of highly selective breeding over around eight salmon generations, with the aim of improving important production qualities for aquaculture.

Scientific comparisons of wild and farmed salmon, and their cross-breeds, has shown that gene transfer from farmed to wild salmon can reduce the latter's ability to survive. This is why such gene transfer is one of the main problems with escapes. Records of escaped farmed salmon in a number of Norwegian watercourses since the late 1980s document a very high proportion of escapees in many watercourses. Genetic mutation is already demonstrable in some salmon stocks. We have little knowledge of the extent to which cross-breeding can take place without the naturally adapted genes of wild salmon being degraded permanently. Nevertheless, it is known that even relatively low numbers of escaped farmed salmon in the rivers can damage wild stocks. Many of the breeding characteristics of farmed salmon will be diluted and out-competed by the genes of wild salmon if the number of escaped fish in rivers - particularly during the spawning season - is held at a sufficiently low level. Escapees are also known to disturb and confuse spawning grounds, in addition to competing for food and space.

2.1.2. The rainbow trout

Rainbow trout is an introduced species, which is undesirable in the Norwegian fauna. Escaped rainbow trout can migrate up the rivers and spawning has been recorded in several instances. There is an element of uncertainty as to whether the rainbow trout has established stocks, and the risk related to potential genetic effects is therefore not well understood. In addition, escaped rainbow trout could transfer disease and parasites, in particular Gyrodactylus salaris and salmon lice, to wild salmon and sea trout.

Reported escape figures for rainbow trout show a lot of variation over the five years from 2004 to 2008: 10,000, 8,000, 15,000, 315,000 and 600 individuals respectively.

2.1.3. Cod

Farmed cod have proven to be more adept at escaping than salmon and rainbow trout, and relatively more cod escape than the other two species. This is due among other things to cod having different behaviour patterns in the cages, looking for holes, and they have even been observed chewing their way through nets. This is something which is supported by very high - and partly inexplicable - losses during production.

Farmed cod which spawn in the cages represent a challenge to the genetic distinctiveness of wild cod, due to the release of fertilised eggs. Coastal cod have spawning and nursery areas close to where the farms are located, and escapes and spawning in cages will therefore have a detrimental effect on wild stocks. Even though studies have demonstrated significant dispersal of eggs from cages, nothing is known of the spread of eggs from cod farming facilities. The effect of escaped fish and eggs has therefore not been documented on wild cod stocks, but negative effects cannot be ruled out.

Reported escape figures for cod have been relatively high in recent years. For the five year period 2004 to 2008, reported figures were 20,000, 213,000, 85,000, 290,000 and 228,000 individuals respectively.

2.2 Measures implemented

The industry itself bears a major responsibility for preventing escapes, and puts a lot of effort into preventive measures. The fishery authorities also take the escape problem seriously, and have developed a control system, rules, technical requirements, operational requirements and inspections to ensure farming is operated on environmentally-responsible lines. Many of the measures are however recent, and it must therefore be expected to take time before they produce any clear impact, and produce results.

In 2004 Norway became the first country in the world to introduce a scheme laying down requirements and a technical standard for aquaculture (NYTEK).

The Ministry appointed a permanent escape commission for farmed fish in 2006 to examine the causes of escapes, to work systematically to reduce risk, and to propose changes to standards, rules etc. The commission's term has just been extended to 31.12.2010.

The Directorate of Fisheries launched a special initiative in 2006/2007 called "Vision: Zero Escapes" to bring down the number of escapes. This plan has now been extended and includes a number of measures to prevent the escape of farmed fish. Collaboration between Økokrim (the National Authority for Investigation and Prosecution of Economic and Environmental Crime), the Prosecution Service and the Directorate of Fisheries has closened, allowing the Prosecution Service and Økokrim to prioritise breaches of the law within the aquaculture industry.

The final resolution on national salmon watercourses and fjords was taken in the Storting on 15 May 2007 and entails the setting up of a total of 52 national salmon watercourses and 29 national salmon fjords, where stricter regimes for aquaculture will be applied for the sake of the wild salmon.

A series of administrative measures have been introduced to reduce the likelihood of escape, including a requirement for internal control of the facilities, new requirements for mesh width in nets, requirements for double protection on hatchery outlets, new marking rules for reducing the likelihood of collisions with the facilities, and more stringent reactions in the event of a breach of the rules which causes an escape.

Furthermore, methods for marking fish are under development, to allow them to be traced to their origin. DNA identification is now in use to identify where escaped fish come from, and these methods have been shown to be suitable, and escape episodes have been resolved.

Work is being done to develop sterile fish for aquaculture, something which could help reduce the genetic impact escapes have on wild fish. Current techniques of sterilising fish have detrimental effects on fish welfare and production results. A lot of work therefore still remains to be done before such techniques can be used in practical terms in a commercial environment.

2.3 Future goals

Aquaculture will not contribute to permanent changes in the genetic characteristics of wild fish stocks.

The goal of "Vision: Zero Escapes" must be upheld. One escaped farmed fish is one too many, but to adapt the measures to the risk, it will be necessary to define limits which indicate what effects are unacceptable. The different salmon stocks may however have different tolerance levels and robustness, and suitable parameters/indicators are needed to measure the effects.

The number of reported escaped fish is not an optimum metric for escapees and since escaped farmed fish do not have identical behavioural patterns, and escape figures are probably inaccurate, it will be relevant in the future to use the number of farmed fish found in salmon watercourses as a more realistic indicator of potential harmful effect.

Even if we develop techniques for producing sterile farm fish which satisfy the requirements for production results and fish welfare, they will not fully replace the goals for escapes above, as sterile fish will also affect spawning grounds for wild fish, physically and ecologically.

2.4. New measures

The Directorate of Fisheries will expand its "Vision: Zero Escapes" plan. This will involve creating a better escape register, new escape instructions and new experience databases, which can provide the knowledge of practices which reduce the likelihood of escape.

The technical requirements for farming equipment are of major significance for preventing escapes, and more emphasis is needed on preventive technology. Experience gained by the Escape Commission shows that a technical standard such as NYTEK, which will apply to land-based farming facilities (hatcheries), should be developed.

Understanding of the genetic stability of wild salmon stocks needs to be increased. Whether DNA profiles are more stable in salmon stocks within national salmon fjords than those elsewhere needs to be studied, and whether DNA profiles in wild salmon are more stable in areas with few escaped farmed salmon than in areas with many. The occurrence and penetration of escaped fish in the spawning population in the autumn in national salmon watercourses and in reference watercourses needs to be established. The same applies to the extent of hybridisation and gene-transfer in national salmon watercourses and reference watercourses. The aim is to increase understanding of the tolerance limits of salmon stocks with respect to the penetration of escapees in spawning populations.

To be able to improve the strategies for more effective recapture of escaped fish, better understanding of a number of biological conditions is needed, including the behaviour of newly-escaped fish. To fish-out escaped fish in rivers incurs costs for the authorities, and in accordance with the principle in Norwegian environmental policy of the polluter paying, an assessment should be made as to whether such costs should be charged to the aquaculture industry.

In the event of an accident to or wrecking of large cages, greater quantities of fish will escape compared with smaller units, and the consequences of such damage increase. Given that the trend is towards larger units, the setting of an upper limit for an acceptable amount of fish in one cage should be considered.

The Government will:

- improve inspection of aquaculture facilities, along with prosecution of infringements, to ensure that the environmental provisions in the rules are observed
- propose tightening up the rules on technical requirements and standards
- encourage the development of new technological solutions to prevent escape
- prioritise knowledge-building and transfer of escape-related behaviour and escape risk
- prioritise the monitoring programme for national salmon watercourses and fjords, and increase understanding of DNA profiles and genetic stability in major salmon populations
- continue to work towards increasing understanding of the effects escaped farmed fish have on wild populations
- investigate whether fish-farmers should pay for damage-compensation measures implemented by the authorities after an escape
- investigate whether an upper limit on the size of cages and/or the number of fish in a cage ought to be introduced, with regard to the consequences of an escape

2.5 Cod in particular

The Ministry for Fisheries and Coastal Affairs presented the Government's proposals for a sustainable and forward-looking aquaculture industry on 12 February 2009. We want controlled growth, in parallel with the development of technology which ensures environmental sustainability.
We need better understanding in several fields, and will therefore launch investigations to:

- identify environmental risk factors, including on genetic impact and the risk of infection of wild fish
- obtain an overview of areas with vulnerable coastal cod populations and spawning grounds
- assess whether 'cod fjords' will be a suitable administrative measure to protect particularly vulnerable cod populations.

Based on professional understanding and balancing the desired effects of measures in place and their commercial consequences, new administrative measures will be considered within five years. As part of this work, a bill to amend the Aquaculture Act has been debated. This entails us being able to stop allocating new concessions if necessary, while we await the results of the investigations to be made.

In addition to setting requirements, the authorities will invest major resources in research and development measures. This is important to be able to solve the disease problems within cod farming, and thus help reduce production costs. In 2008, the Ministry spent around NOK 100 million through the Research Council and direct grants to research institutes on research into cod farming.

Effective breeding is essential to combat disease, and cod farming of the future is dependent on solving the problems of disease. Even though breeding will change farmed cod in relation to wild fish, national breeding programmes are being carried out. Equally, the escape of eggs and fry must be prevented. Consequently, researchers and industry will be invited to collaborate to develop the necessary technological solutions. Such solutions will be a vital step to ensuring sustainable growth in the cod farming industry. The Government's ambition is to introduce requirements for zero release of eggs and fry by 2015.

In the short-term, it will be proposed that the following operational requirements are tightened up:

- give statutory effect to the current administrative practice of banning cod farming in wild cod spawning grounds
- requirements for cod farmers to be subject to the same rules as salmon farmers for approved operation plans
- requirement for net checks - and in due course to consider whether double nets should be made a requirement
- requirement for control catches in order to spot incipient escapes more quickly, so as to limit their extent.

3. Pollution and discharges

3.1 Status and challenges

In general, discharges of nutrient salts and organic materials from fish farming are a minor environmental problem in Norway. The long coastline and extensive use of farming locations with high levels of water circulation and good water quality are contributory factors. Farming takes place in many regions in relatively deep fjords and inlets with good receiving waters, where the carrying capacity and self-purification properties are relatively good. Production takes place in composite ecosystems, with high biodiversity and tolerance levels.

The discharge of nutrient salts and organic materials from farming can however have negative local effects, depending on the location. In some aquaculture zones, regional effects cannot be excluded. The decomposition of organic materials (spilt feed and faeces) can result in oxygen reduction and a change in species diversity. Discharges of nutrient salts can also cause increased algae growth, and increased biomass production in bodies of water through a fertilisation effect (eutrophication).

Methods for monitoring the effects on the bottom and on benthic fauna under and near farming facilities have been developed. These methods, Matfiskanlegg – Overvåkning – Modellering (MOM) (fish farms - monitoring - modelling) are defined in a standard, NS9410, and mandatory by regulation. The methods describe how effects on the sea bed are to be monitored, and which limit values (environmental standards) are to be applied to assess whether such effects are acceptable.

The B-investigation described in NS 9410 monitors trends in bottom conditions under and near farming facilities in use. The frequency of investigation is increased in line with discharge levels from the facility. It must also be used before starting operations at a new location to benchmark environmental conditions. The C-investigation from NS 9410 also defines bottom conditions from the facility and into the receiving waters, measuring environmental impact in a much larger geographical area than the B-investigation.

The discharge of chemicals and copper-rich preservatives has undesirable effects on the environment. They concentrate in the bottom sediment and in the food chain, and are harmful to sensitive species, such as molluscs. The use of such substances must therefore be reduced, and the authorities must stimulate the use of alternative and more eco-friendly methods.

3.2 Measures implemented

A new system for production limits with a maximum allowable biomass and environmental monitoring was implemented in 2005. The maximum allowable biomass system combined with the introduction of environmental investigations on allocation and environmental monitoring during operation, ensure environmentally suitable production and fish health and welfare.

In the event of applications for new or expansion of existing facilities, environmental investigations of bottom conditions at the location are mandatory before startup, along with hydrographical and topographic surveys. During operation, farmers have to perform regular environmental monitoring of bottom conditions at the site.

Work on integration of the area into the MOM system into a cohesive management system - MOLO (MOm–LOkalisering) (environmental monitoring - location) has been initiated. Localisation will be a central feature of the new system for zoning and environment adaptation, as we want to know where farming facilities ought to be sited, how big they can be and how they should be run.

A special regulation was introduced in 2005 to prevent discharges of environmentally-harmful chemicals from cleaning, washing and impregnation of farming nets. The regulation applies initially to net laundries which are required to purify their waste water.

3.3 Future goals

All fish farming locations in use will maintain an acceptable environmental state, and will not have higher emissions of nutrient salts and organic materials than the receiving waters can tolerate.

Conditions related to operation, biomass, location of farming facilities or facility integrity can have negative effects and lead to eutrophication and overexploitation. It is therefore important to have accurate assessments and criteria as the basis for location sizing. The degree of utilisation of the location in relation to its carrying capacity must be within defined, measurable limits.
In areas with many facilities and high production, the sum of the effects must not cause reduced environmental quality in the receiving waters.

Discharges of organic materials can in some instances affect the bottom near the facilities, or cause over-fertilisation and lack of oxygen. Furthermore, organic material (particularly spilt food) can be eaten by wild fish. It is therefore important to have a management system which ensures that production in each location is geared to carrying capacity, and which views individual locations in relation to a larger geographical area, such as the Hardanger Fjord area.

3.4 New measures

Environmental adaptation is a precondition for long-term growth and development in the aquaculture industry. Better understanding of the ecosystem in coastal waters is needed in general, and of fjord ecology in particular, including Hardanger Fjord.

The fishery and environmental authorities will collaborate on developing a common, upgraded environmental monitoring system to provide the best means of assessing location sizing. Development of such a system will also help simplify monitoring and checks performed by the authorities, and provide a better foundation for initiating measures in areas where tolerance limits have been exceeded.

It is necessary to look at the impact of discharges from fish farms from an area-perspective, and not just measure discharge levels under and near individual facilities. The C-investigations from NS 9410 help measure levels at greater distances from the facility. Overall, the C-investigations from several fish farms - for example in a fjord basin - will give a better picture of total discharge levels from the aquaculture industry in the area.

MOLO needs to be developed into a cohesive system for regulating environmental effects and area adaptation for aquaculture. Part of this will involve a review of the guidelines for using environmental impact assessments in accordance with the Planning and Building Act.

The Government will:

- prioritise research into environmental data, water quality and fjord and coast ecology, and into the environmental effects of aquaculture
- develop location criteria to protect environmental sustainability.
- propose the introduction of mandatory C-investigations from NS 9410, at the time of allocation and during operation
- stimulate development of MOLO as a future cohesive system for the regulation of environmental effects and area adaptation.

4. Disease

4.1 Status and challenges

4.1.1 Disease in general

Disease, including parasites, continues to be a major loss factor in Norwegian aquaculture. The health situation has however been much improved over the last 20 years, thanks to vaccines and other measures launched against the most common diseases towards the end of the 1980s. Figures reported to the Directorate of Fisheries on losses (fatalities, escapes, predators and rejects) show that around 90% (or 36 million fish) of losses in 2007 were due to fatalities. The loss percentage over the last 10 years has been stable, at between 8 and 10%.

Use of antibiotics can be an indicator of the state of health within aquaculture with regard to bacterial disease. Total consumption has been reduced significantly from its peak in the late 1980s and early 1990s. In 2008, a total of 905 kilos of antibiotics were used in aquaculture. Of these, 342 kilos were used for farming salmon and rainbow trout, while the rest, 563 kilos, were used for farming marine species, mainly cod. Tougher requirements for operating procedures, new and better drugs, including vaccines, made a major contribution to reduced problems from bacterial disease in salmon. New farmed species still have some unsolved problems with bacterial diseases. For example, Francisella is a growing problem within cod farming. The bacteria is also found in wild cod, although its effect on the wild population is unknown. An increase in the scope of marine species farming may also lead to new disease and parasite problems.

The biggest losses to disease within Norwegian aquaculture are due to viral diseases such as pancreas disease (PD), heart and skeletal muscle inflammation (HSMI), infectious salmon anaemia (ISA), and infectious pancreatic necrosis (IPN). The relationship between these diseases and mortality among wild fish in Norway has not yet been established.

Diseases and parasites can represent a serious threat to wild populations, while the disease in farming which has the most serious impact on wild fish is primarily salmon lice. Even though salmon lice also occurs in wild salmon and sea trout, it is an example of a parasitic disease which has been intensified by the multitude of hosts in aquaculture facilities. In addition to being passed from fish to fish, it can also be spread over long distances by currents.

Lice are to be found in most locations, and according to the "*decree relative to fighting of lice in aquaculture facilities*" an average of 0.5 adult female lice is permitted per fish. This is well below the level which can harm farmed fish, but where large-scale farming production increases the number of hosts, wild salmon can be exposed to lice, causing damage particularly to young fish.

Salmon lice on wild fish are much more difficult to tackle than in farmed fish. Even though the tolerance limits for lice infection have not yet been determined, there is a general consensus that the wild salmon stocks cannot tolerate a high infection pressure of lice. Although there is a downward trend in lice on farmed fish, data from the Institute of Marine Research, the Norwegian Institute for Nature Research and others show that in some areas there are very high levels of lice on wild fish. For example, figures from the extremities of Hardanger Fjord show that some caught wild salmon and sea trout had 3-5 times more lice than what is considered to be a "fatal dose". In the worst case, this will lead to migrating salmon with such high infestations of lice dying.

4.1.2 Cage size and its significance for disease control

The size of the production units (cages) has increased from a standard cage of 80 metres circumference to 160 metres, while the largest units can house over half a million fish, and have a circumference of 240 metres. The physical size of the cages gives rise to problems in the execution of routine operations such as daily inspection, lice counts, anti-lice treatment and the recovery of dead fish. The problem of performing good delousing gives rise to particular concern as suboptimal conditions will lead to poor delousing, and are a major factor in the development of resistance in salmon lice.

A large number of individuals in the cages also means problems with recovering dead fish in the event of mass deaths and sanitary culls. This can lead to an increase in the spread of infection and a delay in slaughter.

4.1.3 Infection risk when moving fish

All relocation of fish entails a risk of the spread of disease and the loading and unloading process involves a risk of escape. It is prohibited to move sick fish (except for slaughter) and fish from facilities where infectious disease is suspected.

Smolt must be transported from hatcheries to fish farms. The supply of young fish in the vicinity of fish farms determines the number and length of transport runs. If the availability of smolt is evenly spread in relation to the fish farms, fewer and shorter trips are needed. The current industry structure means there is a shortage of smolt in several regions with high levels of production. Groups with integrated operations use their own hatchery fish regardless of the distance between the smolt facility and fish farm, which contributes to increased transport.

Fish which have already been released are moved for operational reasons. Some farms are better suited to smolt release or for large fish than others. Fish can also be moved to ensure that the ceiling for maximum permitted biomass at that site is not exceeded.

The trend is towards fewer and larger slaughterhouses where fish are slaughtered all year round, and often using several shifts. There are also concerns about this aspect of the production chain with fish farms spread over large geographic areas, who want to use their own slaughterhouses - which increases the need for transport.

4.1.4. Hardanger Fjord

Hardanger Fjord has separate and multiple problems, in particular the critical condition of wild stocks of salmon and sea trout, and the disease and salmon lice situation. There is also uncertainty related to the general environmental condition of the fjord, including water quality and increased algae growth. Closer investigation is needed to discover if there are any real changes occurring in the fjord's ecosystem, which could be the reason for such changes and whether they are man-made or natural.

4.2 Measures implemented

The Norwegian Food Safety Authority has the operational responsibility for implementing official measures against fish diseases, including salmon lice, and was granted fresh funds in 2009 for increased inspections within the field of fish health.

Winter and spring delousings are now performed in Western Norway, and a similar campaign is being planned for implementation at Troms in the autumn. In these campaigns, the Authority prioritises inspection of the treatments and identification of resistance status. It is vitally important that delousing is performed in accordance with the treatment recommendations.

Changes have been proposed in the rules for combating salmon lice, including measures which will reduce the risk of resistance developing. Among these measures are a duty to notify and report suspicion of resistance, a requirement for following up on treatments against lice, a requirement for treatment methodology and the ability of the Authority to set up zones for combating resistant salmon lice in the same way as for infectious diseases.

The Ministry of Fisheries and Coastal Affairs has asked the Institute of Marine Research and the Norwegian Research Council to prioritise salmon lice research over the next few years.

It is important to ensure that the environment and fjord ecology in Hardanger Fjord are protected as the industry continues to develop. That is why the situation in the fjord was frozen on 8 April 2008, in expectation of the setting up of the area's own administrative regime. A draft regulation for the regime will be sent for debate in the spring of 2009, with the aim of becoming effective from 1 January 2010.

4.3 Future goals

Disease in fish farming will not have a regulating effect on stocks of wild fish, and as many farmed fish as possible will grow to slaughter age with minimal use of medicines.

Even though current losses as a result of mortality are relatively low in percentage terms, the figure of 36 million fish in 2007 is unacceptably high. What is therefore needed is a level of understanding, an industry structure and operating practices which minimise future losses in aquaculture.

Neither should aquaculture activities be run in such a way that can lead to unacceptable sickness levels in wild stocks. The industry must therefore have a structure which reduces the danger of disease in farming having a regulatory effect on wild fish stocks. Synchronised withdrawal from service of facilities in a large area is one example of a form of operation which would be highly beneficial in reducing salmon lice on wild fish.

Within current rules, the level of lice in fish farms is not a problem for the farmed fish. However, salmon lice are a serious problem in some areas for wild stocks of salmon. In addition to an acceptable lice level in farming facilities which can satisfactorily protect farmed fish, we must work towards a lice level in wild salmon stocks which does not lead to unacceptable effects.

It will take time to develop new delousing agents, and particularly a vaccine. The existing salmon lice agents will have to be used for many years yet which is why it is essential that delousing is properly performed, and experience indicates use of closed treatment centres gives the best outcome. Biological delousing using wrasse appears to be the most eco-friendly alternative which can beneficially be used more extensively in Norwegian aquaculture.

4.4 New measures

The Norwegian Food Authority will revise its "Action Plan Against Salmon Lice" to include measures against resistance development. A separate plan will also be devised against the development of resistance to salmon lice agents.

Limits have been introduced on salmon lice in fish farms although experience shows that this does not necessarily give the desired effect against lice in wild salmon stocks. Therefore, the lice figures for wild salmon must be included when implementing new measures for aquaculture. If delousing in fish farming fails to yield the desired effect on lice figures for wild fish, it may be necessary to consider a reduction in the biomass of the farming facilities (reduce the number of hosts) in the worst-affected areas.

The industry and the authorities ought to collaborate on measures to achieve a better operating structure which can reduce salmon lice infection and other diseases. There are many positive elements in the industry's own "General Plan for PD" which ought to form the basis for such measures, including safe smolt transport, avoiding released fish being moved other than for slaughter, better utilisation of good locations (fewer but bigger), and coordinated operation/withdrawal from service. The industry ought to take the initiative to develop a code of best practice which incorporates such elements, including well boats, which can also go further than official minimum requirements.

Increased use of larger cages will make treating salmon lice harder and suboptimal delousing will accelerate resistance development. Current rules permit larger cages, providing the farmer can treat the fish satisfactorily. Such requirements need to be applied much more rigorously by the Authority, and if necessary, the rules on cage size need to be revised.

Moving fish involves the risk of the spread of infection and increases the likelihood of escape. A review of current requirements for well boats and transport will therefore be performed and new requirements may range from stricter requirements for boat design, to dedicated boats for smolt transport, and transport of fish for slaughter.

The Government will:

- introduce stricter rules for controlling salmon lice in farming
- propose that lice figures in wild stocks should also be metrics for measures in farming facilities
- consider reductions of biomass in a given geographical area if no other options give the desired effect on the levels of lice on wild fish
- consider introducing a ceiling on the physical size of production units and/or the number of fish in one cage
- propose stricter requirements for well boats and transport,
- encourage the industry to develop a code of best practice
- consult with the industry to devise measures to achieve a better operating structure, with a positive effect on salmon lice infection and other diseases
- initiate a separate administrative regime in Hardanger fjord.

5. Zoning

5.1 Status and challenges

Effective zoning facilitates maximum production within a limited geographical area and without unacceptable impact on the environment. To ensure this, we are dependent on a good zonal structure and the suitability of the location. The latter is relevant to infection spread, pollution, biological diversity etc. and for the growth, welfare and health of farmed fish. The location structure will also be relevant to migrating salmon being able to reach their spawning grounds safely.

The current zonal structure is influenced strongly by the massive growth of the industry over many years. This is particularly true of traditional salmon farming, but also for new species such as cod and mussels. The industry structure is built up around new locations being prepared in the order in which their applications have been granted, with no overall plan.

There are grounds to believe that the current location structure is a contributory factor to the fish health problems the industry has experienced in recent years, particularly concerning pancreas disease (PD) in Western Norway, where the density of farming facilities is greatest. The shortage of new, suitable locations also makes it difficult to relocate for better production conditions. Consequently, production continues in less-suitable locations. Nor do salmon and trout farmers have the opportunity to relocate permits between the Directorate of Fisheries' regions, and the possibility of dispensation is low. Consequently, for example, farmers in Western Norway are prevented from relocating production further north.

Further growth in the aquaculture industry may therefore mean that the current structure needs to be changed, so that allocated zones can be used more effectively. This is particularly true in Western Norway, but also in other parts of the country. This could make the industry better equipped to face its existing and future problems such as lack of space, pollution and the spread of disease.

The options available to the authorities to change the existing structure are limited. A location permit can be withdrawn if the location is no longer deemed to be environmentally appropriate, in accordance with section 9 of the Aquaculture Act, e.g. where a subsequent survey of biological diversity shows that vital natural values have been adversely affected by farming facilities. The statute is a form of safety valve to ensure that the environmental norm in section 10 of the Act is observed, and checked at location level. However, the statute is not suitable as a tool for changing the zonal structure.

The Norwegian Food Authority can change or withdraw permits for establishment under certain circumstances, and the Directorate of Fisheries can also withdraw a sector permit under the Aquaculture Act. This can be done if it transpires that disease levels or awareness of disease or welfare conditions have changed significantly since the permit was granted. The Authority cannot however enforce relocation unilaterally. Neither can it perform an overall assessment of what will be an appropriate zonal structure in a larger area, apart from assessing infection risk between individual farming facilities.

The authorities lack essential tools to counter inappropriate structures, including legislative authority to enforce relocation of facilities when necessary on environmental or social welfare grounds.

On its own initiative, the industry has formed a steering group to tackle PD, which has drafted a "General plan for PD". This proposes extensive structural changes linked to zoning by the industry. The proposal entails organising aquaculture into geographically distinct areas to limit infection, separated by fire doors to prevent or reduce the risk of infection between neighbouring zones, closure of "poor" locations and structural operation of transport of fish in well boats. There must be "viable, synchronised production plans" within the infection-limitation zones which will be dependent everyone within the area implementing and supporting the plan, but individual operators, this can be difficult. Small farmers in particular may have special problems related to the change process. The industry has developed and implemented a model in Møre og Romsdal, which goes a long way to matching the PD steering group's proposal.

Setting up a fish farm must comply with plans in accordance with the Planning and Building Act, where relevant with the consent of the appropriate planning authority. When establishing a major facility or hatchery with more than 5 million fry, the Directorate of Fisheries must decide whether it is necessary to perform an environmental impact assessment (EIA) in accordance with the Planning and Building Act. An EIA must be performed if the Directorate finds that establishment might have a major impact on the environment, natural resources or a local community after assessing the criteria. An EIA must include documentation on the facility's impact on the environment, natural resources or local community and form the basis of more in-depth and specific treatment and setting of conditions for the application.

5.2 Measures implemented

The Aquaculture Act came into force on 1 January 2006. The reason for maintaining a requirement for a permit to operate a fish farm is that the administration needs to safeguard certain social aspects, which can be difficult for individual farmers to do. Regard for the environment and optimised use of the coastal zone are aspects which have to be taken into account when establishing, operating and closing down fish farms. Prior approval of the facility with regard to environmental and zoning issues are therefore central concerns behind the requirement for a permit.

During 2009, 65 new permits will be issued for farming salmon. The new permits can only be issued to applicants planning to establish them in local authorities which have a coastal zone plan, in accordance with the Planning and Building Act. The aim is to stimulate the local authorities to draft and update local development plans. Within the PD zones, a prioritisation criterion will apply in addition to other criteria, for using the allocation of new permits for salmon to change the location structure in order to make combating PD easier. The local authorities were given powers to levy a property tax on farming facilities in seawater in 2009, something which will stimulate them to plan for fish farming.

The Ministry of Fisheries and Coastal Affairs issued new regulations on the establishment of aquaculture facilities, pet shops etc. in 2008. The regulation implemented the EU's new Fish Health Directive and the European Commission's recommendation on keeping farm fish. The new provisions tighten requirements for new locations.

Approving new locations often happens without full awareness of the environmental consequences, as understanding of life underwater is often incomplete. A programme for a national survey of maritime biological diversity has been launched, which covers spawning and nursery areas in coastal zones. The survey will influence where fish farming ought to be established.

5.3 Future goals

The aquaculture industry will have a location structure and zoning which reduces impact on the environment and the risk of infection.

New locations must be placed according to a general plan for the zoning of the industry, and in areas designated for aquaculture by the local authorities. Each locality used and permitted must be well suited with regard to the environment, fish health and fish welfare.

5.4 New measures

The Ministry of Fisheries and Coastal Affairs and the Ministry of the Environment will collaborate on cohesive guidelines and location criteria before the next concession round, to support sustainability and protect wild salmon.

It is important that areas of special value for marine resources are protected, such as spawning grounds, important nursery grounds for wild fish, coral reefs and major kelp forests. A means to be used by the authorities for this purpose is to grant such areas special protection under the Sector Acts, in this instance, the Aquaculture Act. This has to be seen in relation to the need for a report on the use of cod fjords, following the model for national salmon fjords, as a suitable means of protecting particularly important coastal cod stocks.

During the spring of 2009, the Government will submit a proposal for an amendment to the Aquaculture Act which will include a new statute giving the authorities the opportunity to enforce relocation of aquaculture facilities based on a general regard for community and industrial needs.

The new Planning and Building Act comes into force on 1 July 2009, providing wider powers for local authorities to enable the planning of areas for farming specific species or groups of species. However, this will require good understanding of local conditions and suitability.

Local authority development plans are a vital tool for planning the use of coastal zones as a good plan will avoid conflict between various users, such as aquaculture and fishing, and balance their interests against major community needs, such as outdoor pursuits, marine and conservation. Such plans will therefore be a vital part of an overall plan for the placing of aquaculture locations. The Act also facilitates planning across local authority boundaries through new provisions on regional planning and inter-authority joint planning.

According to the Aquaculture Act, the industry must always act responsibly towards the environment, and at no time cause significant impact on the environment. Where the permit-issuing authorities believe there is a risk of such impact, sufficient investigations must be made to establish whether permission can be granted on environmental grounds. Such investigations can include an environmental impact assessment (EIA) in accordance with the Planning and Building Act, although such assessments are rarely required for fish farm establishment. The Ministry of Fisheries and Coastal Affairs will review the guidelines for EIAs in close collaboration with the Ministry of the Environment, and if need be will adjust them to encourage increased use of EIAs.

In its "Strategy for a Competitive Norwegian Aquaculture Industry" the Ministry proposed setting up a committee to examine options for more efficient zoning in the industry which will now be given a much wider mandate. The committee will examine options for more efficient zoning, including how the surrounding environment and fish health and welfare can be protected better than at this time. Its work should result in a general plan for the industry's zoning, including the use of a new clause in the Aquaculture Act to relocate farm facilities and ecosystem-based location criteria.

The Government will:

- initiate the process of defining better location criteria
- consider introducing specially-protected areas for aquaculture administration
- propose changes to the Act to give the authorities options to enforce relocation of farming facilities on general environmental and commercial grounds
- encourage all coastal local authorities to have updated coastal zone plans
- consider guidelines for initiating environmental impact assessments in accordance with the Planning and Building Act
- set up a commission to examine options for more efficient zoning in the aquaculture industry.

6. Feed and feed resources

6.1 Status and challenges

The Norwegian aquaculture industry has had an enormous growth in output for some years, which naturally includes growth in feed consumption. However, the growth in feed consumption has not kept pace with the growth in output over the last 30 years. 1.2 million tons of feed were sold in 2008 of which 1.182 million tons were produced in Norway, while 18,000 tons were imported. Traditionally, fishmeal and fish oil have been the main components in fish feed, but in recent years, the proportion of vegetable oils has grown.

On a global basis, the average production of fishmeal and fish oil is generated from around 33 millions tons of fish annually. Of this figure, around 5.5 million tons are by-products from fish caught for human consumption, while the rest are industrial fish. This gives around 6.3 million tons of fishmeal and 1 million tons of fish oil, and about 50% of global fishmeal production goes to aquaculture. The rest of the fishmeal is used for agricultural feed, in particular for pigs, chickens and pets. Of total global production of fish oil, 85% goes to aquaculture production, 10% to human food and the rest for technical use.

Norway produces around 200,000 tons of fishmeal, and imports about the same amount annually. The major suppliers of fishmeal for Norwegian feed production are Peru, Iceland and Denmark. When it comes to fish oil, Norway produces around 55,000 tons annually and imports around 170,000 tons. Denmark is the largest supplier of fish oil, followed by Peru and Iceland. The countries which export fishmeal and oil to Norway have active fishing management, including regulation of fishing for industrial fish. Management of the actual fish species in these countries follows the same principles as in Norway.

Approximately 20% of the fishmeal used for farmed fish feed is used for the production of salmon feed and the rest is used for marine prawns (23%), marine fish (20%), carp (15%) and other species. The salmon feed industry uses around half of the fish oil used for the production of fish feed.

The term ‘industrial fish’ is used as a generic description of species which are small, bony and have a short generation cycle, and which are used for production of fishmeal and fish oil, such as anchovies, blue whiting, sand eels, Norway pout and horse mackerel. Industrial fish play a vital role in the marine ecosystem, as food for other sea creatures and birds. Harvesting industrial fish therefore contributes to reducing food resources for other wild species, including commercially important species such as cod and tuna. Seabirds are also dependent on prey fish of the right size, which means proper management of industrial fish is important, and has to be taken into account when calculating quotas.

The cornerstone of Norwegian fishery is sustainable management and harvesting. The former is based on best available understanding and scientific advice from ICES (International Council for the Exploration of the Sea) and our own Institute of Marine Research.

Norway has also committed to international agreements on sustainable management for all fish stocks under its management. We will do this using a precautionary principle approach, entailing defined exploitation rates and minimum limit for spawning stocks which must not be exceeded.

All fish (with a few exceptions) are nutritionally suitable as human food. The market, and willingness to pay in the various markets, decide what can be sold as food and what goes for fishmeal for feed production. In the current situation with an increase in wealth in many major markets, the demand for meat and fish of better quality than that which can be met by industrial fish is growing. For industrial fish to end up on the dining table, demand has got to grow to the extent that it is not worth selling it for feed production. One result of this is that there are times when a lot of mackerel, herring and capelin are ground up when prices are higher on the meal and oil market than on the consumer market, and in some instances the fish are landed in countries which do not have the facilities to process them into human food. In the large seasonal fisheries which fish for anchovies off the coast of South America, the production of meal and oil help conserve the catch and spread earnings over a longer period, giving the fishermen better prices.

The overall by-product volume from fish and shellfish in Norway was estimated at 650,000 tons in 2007. Of this, 75% (485,000 tons) was used, mainly for meal and silage production. An increase in the value-creation of by-products from fisheries and aquaculture is a target, to contribute to a sustainable industry. Part of the campaign to this end is the establishment of the Resirkulering og Utnyttelse av organiske Bioprodukter i Norge (RUBIN) (recirculation and utilisation of organic bioproducts in Norway).

How much raw material (fish) is used to produce one kilo of Norwegian farmed salmon has been one of the themes in the sustainability debate on Norwegian aquaculture. The proportion of vegetable raw materials in feed has grown considerably in recent years, and it is not unusual for up to 1/3rd of the oil content in salmon feed to be vegetable oil and 2/3rds fish oil. Given current feed composition and factors, an average of around 2.6 kg fish raw material is used to produce the fish feed needed to produce 1 kg of salmon.

6.2 Measures implemented

The Norwegian management of current fish stocks is deemed to be sustainable. Management of stocks we share with neighbouring countries is regulated by negotiations and international agreements. These are also deemed to be sustainable. In an international context, Norway is one of the driving forces for sustainable fisheries management, which is also reflected in the new Marine Resources Act.

Norway is working internationally to reduce illegal fishing, which is one of the greatest threats to sustainable fisheries management. Effective coastal management, better port state control and tougher requirements for shipping flag states are key to this process. Market-oriented measures, such as tougher requirements for traceability, have been introduced against illegal fish. The Marine Resources Act gives the Ministry of Fisheries and Coastal Affairs authority to require traceability for fish and fish products, with the intention of preventing illegally-caught fish coming onto the market.

Norway has a discard ban which means that fish taken from the sea have to be landed, and is working internationally to influence other countries to do the same.

6.3 Future goals

The aquaculture industry's needs for raw materials for feed will be met without over-exploitation of wild marine resources.

To maintain sustainable production of farmed fish, it is vital that fishmeal and fish oil used in the production of fish feed come from sustainably-managed stocks. In time, other sources of marine fats and proteins should also be utilised, and the utilisation of by-products for fish feed production should also be increased significantly.

In expectation of the development of alternative sources, it is important that the management of fish stocks is prioritised, and that all fish caught are utilised in the best possible way. Combating illegal fishing, reducing discards and ensuring better utilisation of by-products are also vital to sustainable management of the sea's resources.

The feed industry must continue to work to replace marine ingredients with other sources. For example, single cell protein based on natural gas could be considered in this context. The use of non-marine ingredients must however be balanced against fish health and welfare, product quality and the reputation of the industry.

It is also necessary to optimise utilisation of fish feed in terms of feed technology, to ensure that as much of the feed as possible distributed in the cages is eaten by the farmed fish or collected again, and in terms of digestion of feed to ensure that as much as possible of the energy in the feed goes to growth.

6.4 New measures

To ensure that further growth of the aquaculture industry is sustainable at all levels, all the feed used in production of Norwegian farmed fish must have full environmental traceability for all its raw materials, and documentation must be publicly available. This will provide consumers with the information they need to make eco-friendly choices when buying sustainably-produced foods.

The use of offal and marine by-products in feed production must be increased. Given current demand for raw materials for feed, it ought to be commercially viable to invest in know-how and technology to enable the use of more by-products from the fisheries to be used in the production of fish feed.

More work also needs to be done on the development of other marine raw materials for feed production. This might include both the harvesting of lower levels of the marine food pyramid, and the development of new sources of marine feed ingredients.

It is also important that farmed fish, cages, feed and feed technology are adapted to optimise utilisation of feed resources.

The Government will:

- work internationally to reduce the scope of IUU fishing, and reduce discards to a minimum,
- work internationally to ensure countries exploiting industrial fish have sustainable fisheries
- stimulate increased use of marine by-products for feed
- prioritise research into alternative marine sources
- consider means for production, import and marking feed and feed ingredients to ensure that fish feed used in Norwegian fish farming only contains fish meal and fish oil produced from sustainably-managed stocks
- stimulate the development of feed technology and feed which boost growth and reduce environmental impacts around the facilities.

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7. Summary of goals and measures

Chapter 2 Genetic interaction/escape

Aquaculture will not contribute to long-term changes in the genetic characteristics of wild fish stocks.

The Government will:

- improve inspection of aquaculture facilities, along with prosecution of infringements, to ensure that the environmental provisions in the rules are observed
- propose tightening up the rules on technical requirements and standards
- encourage the development of new technological solutions to prevent escape
- prioritise knowledge-building and transfer of escape-related behaviour and escape risk
- prioritise the monitoring programme for national salmon watercourses and fjords, and increase understanding of DNA profiles and genetic stability in major salmon populations
- continue to work towards increasing understanding of the effects escaped farmed fish have on wild populations
- investigate whether farmers should pay for damage-compensation measures implemented by the authorities after an escape
- investigate whether an upper limit on the size of cages and/or the number of fish in a cage ought to be introduced, with regard to the consequences of an escape

Chapter 3 Pollution and emissions

All fish farming locations in use will maintain an acceptable environmental state, and will not have higher emissions of nutrient salts and organic materials than the receiving waters can tolerate.

The Government will:

- prioritise research into environmental data, water quality and fjord and coast ecology, and into the environmental effects of aquaculture
- develop location criteria to protect environmental sustainability.
- propose the introduction of mandatory C-investigations from NS 9410, at the time of allocation and during operation
- stimulate development of MOLO as a future cohesive system for the regulation of environmental effects and area adaptation.

Chapter 4 Disease

Disease in fish farming will not have a regulating effect on stocks of wild fish, and as many farmed fish as possible will grow to slaughter age with minimal use of medicines.

The Government will:

- introduce stricter rules for controlling salmon lice in farming
- propose that lice figures in wild stocks should also be metrics for measures in farming facilities

- consider reductions of biomass in a given geographical area if no other options give the desired effect on the levels of lice on wild fish
- consider introducing a ceiling on the physical size of production units and/or the number of fish in one cage
- propose stricter requirements for well boats and transport,
- encourage the industry to develop a code of best practice
- consult with the industry to devise measures to achieve a better operating structure, with a positive effect on salmon lice infection and other diseases
- initiate a separate administrative regime in Hardanger Fjord.

Chapter 5 Zoning

The aquaculture industry will have a location structure and zoning which reduces impact on the environment and the risk of infection.

The Government will:

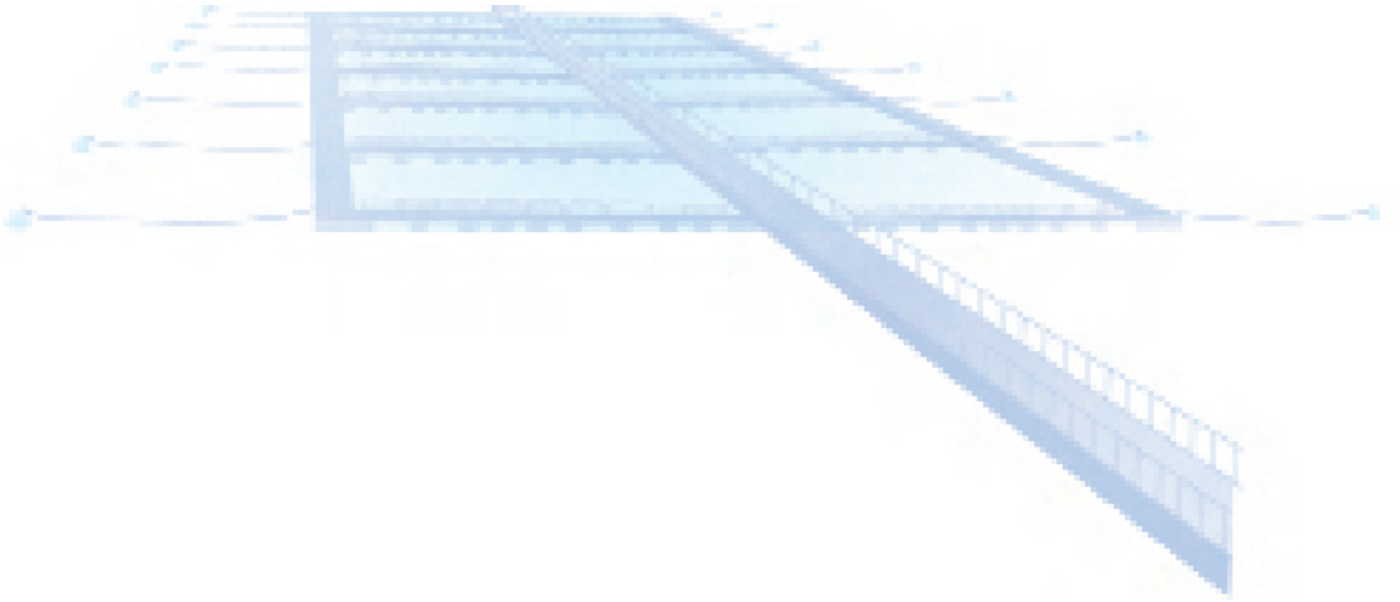
- initiate the process of defining better location criteria
- consider introducing specially-protected areas for aquaculture administration
- propose changes to the Act to give the authorities options to enforce relocation of farming facilities on general environmental and commercial grounds
- encourage all coastal local authorities to have updated coastal zone plans
- consider guidelines for initiating environmental impact assessments in accordance with the Planning and Building Act
- set up a commission to examine options for more efficient zoning in the aquaculture industry.

Chapter 6 Feed and feed resources

The aquaculture industry's needs for raw materials for feed will be met without over-exploitation of wild marine resources.

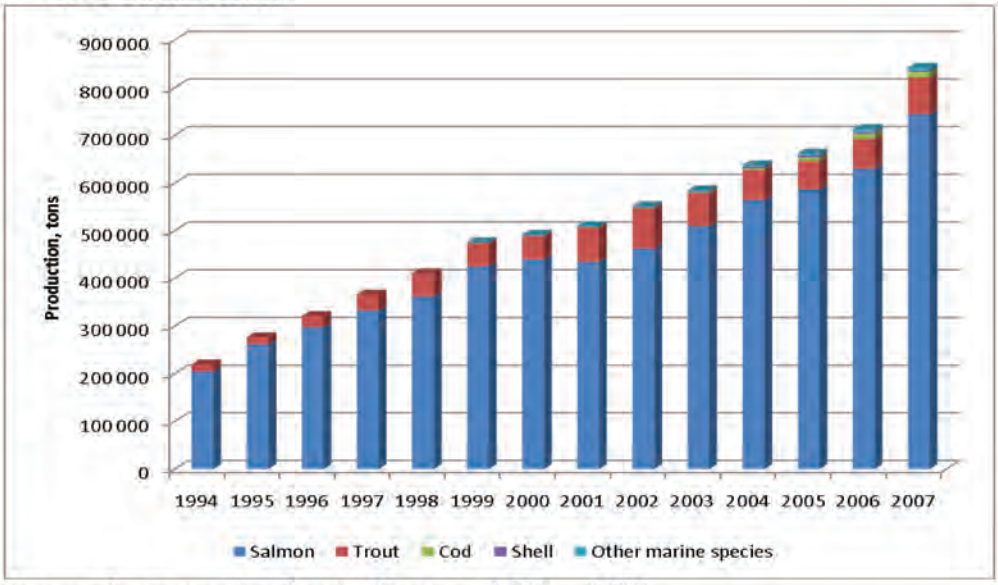
The Government will:

- work internationally to reduce the scope of IUU fish, and reduce discards to a minimum
- work internationally to ensure countries exploiting industrial fish have sustainable fisheries
- stimulate increased use of marine by-products for feed
- prioritise research into alternative marine sources
- consider means for production, import and marking feed and feed ingredients to ensure that fish feed used in Norwegian fish farming only contains fish meal and fish oil produced from sustainably-managed stocks
- stimulate the development of feed technology and feed which boost growth and reduce environmental impacts around the facilities.



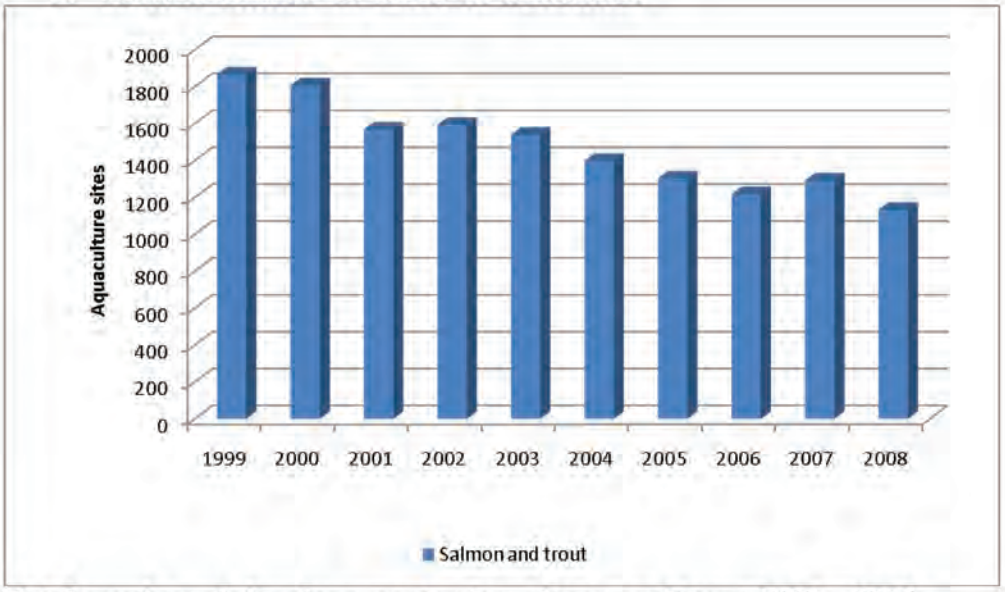
8. Numbers and statistics

1. Production



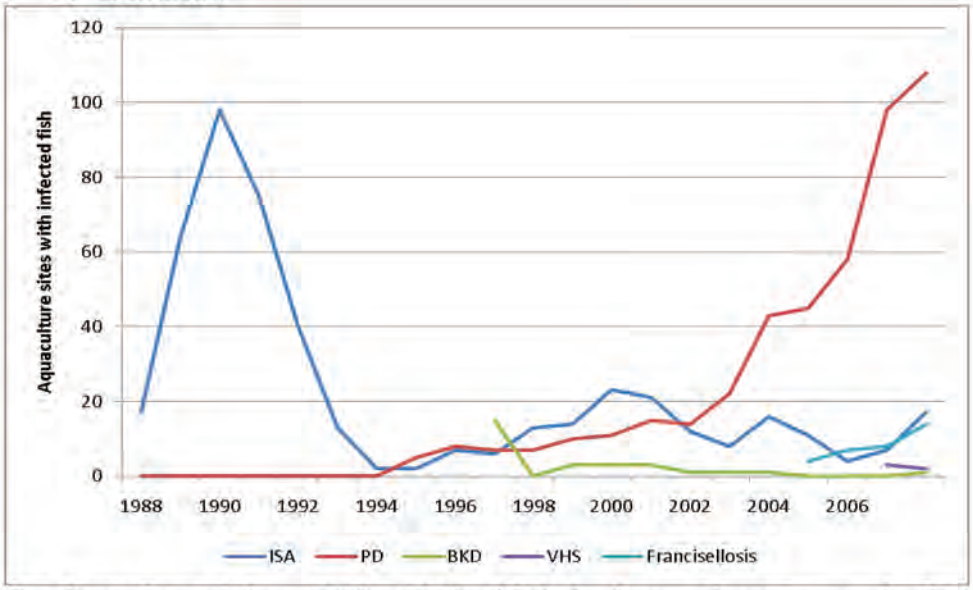
Aquaculture production in Norway 1994 – 2007.
Source: The Norwegian Directorate of Fisheries.

2. Total number of sites in seawater



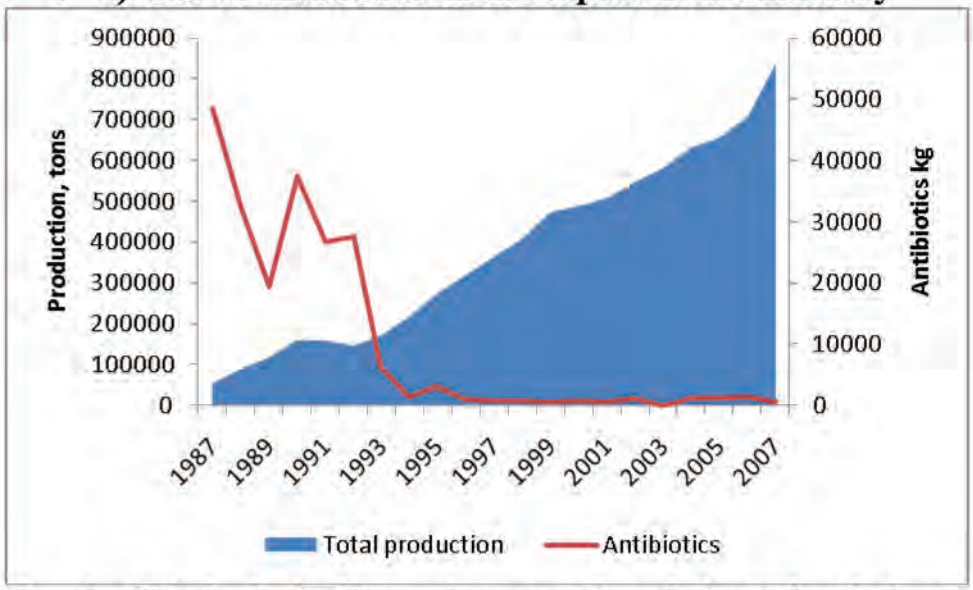
Total number of sites in seawater for salmon and trout 1999 – 2008.
Surveys were performed at different times of the year.
Source: The Norwegian Directorate of Fisheries.

3. Disease



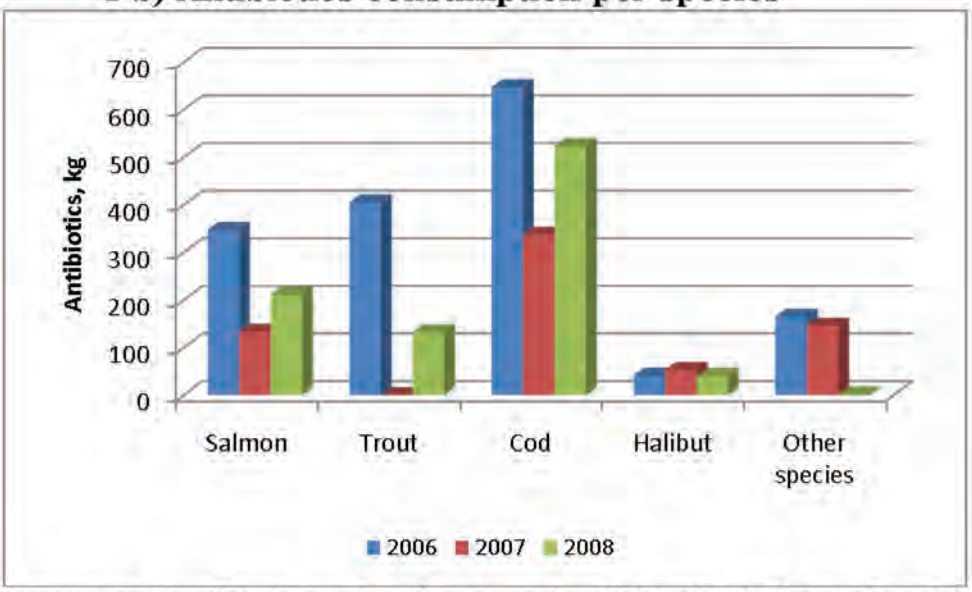
Total number of sites 1988 – 2008 with infectious salmon anaemia (ISA), pancreas disease (PD), bacterial kidney disease (BKD), viral haemorrhagic septicaemia (VHS) and francisella. Source: National Veterinary Institute.

4 a) Use of antibiotics in the aquaculture industry



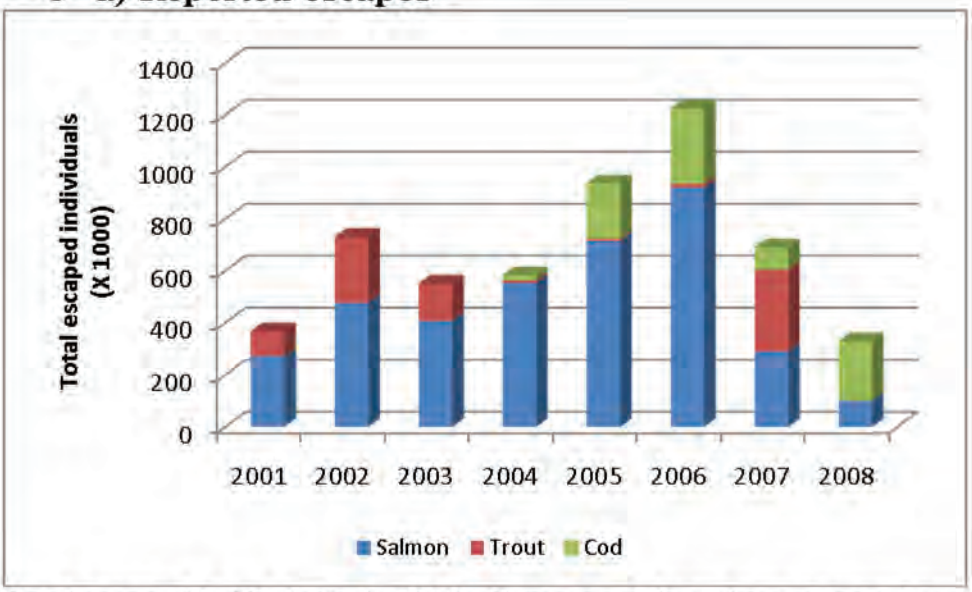
Use of antibiotics in the Norwegian aquaculture industry in relation to total production of farmed fish. Source: The Norwegian Directorate of Fisheries and the National Health Institute.

4 b) Antibiotics consumption per species



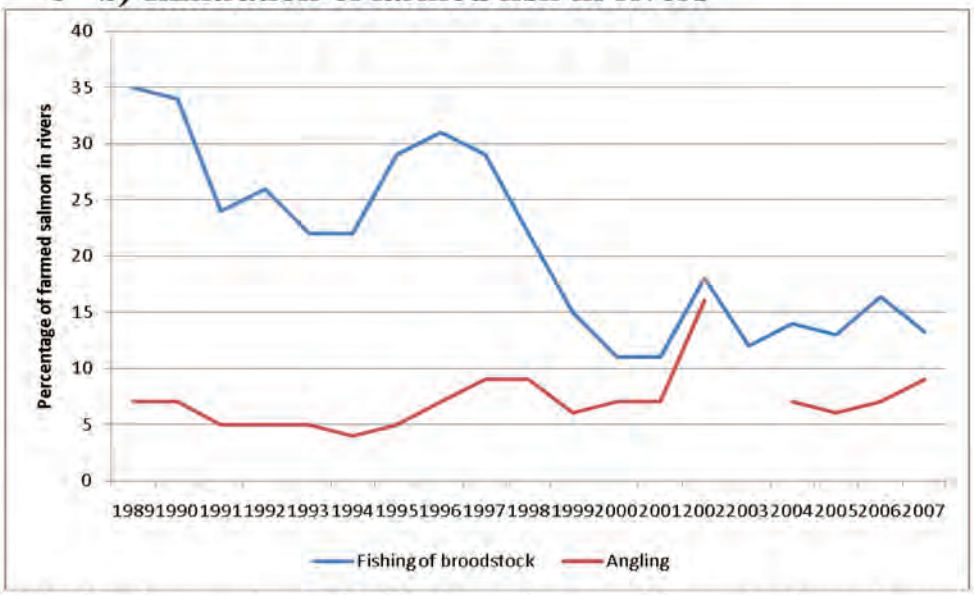
Amounts of antibiotics ordered per species 2006 - 2008. Data taken from the Norwegian Food Authority's prescription database, based on prescriptions reported by the requester and supplier, and registered nationally by the Norwegian Food Authority.
Source: Norwegian Food Authority.

5 a) Reported escapes



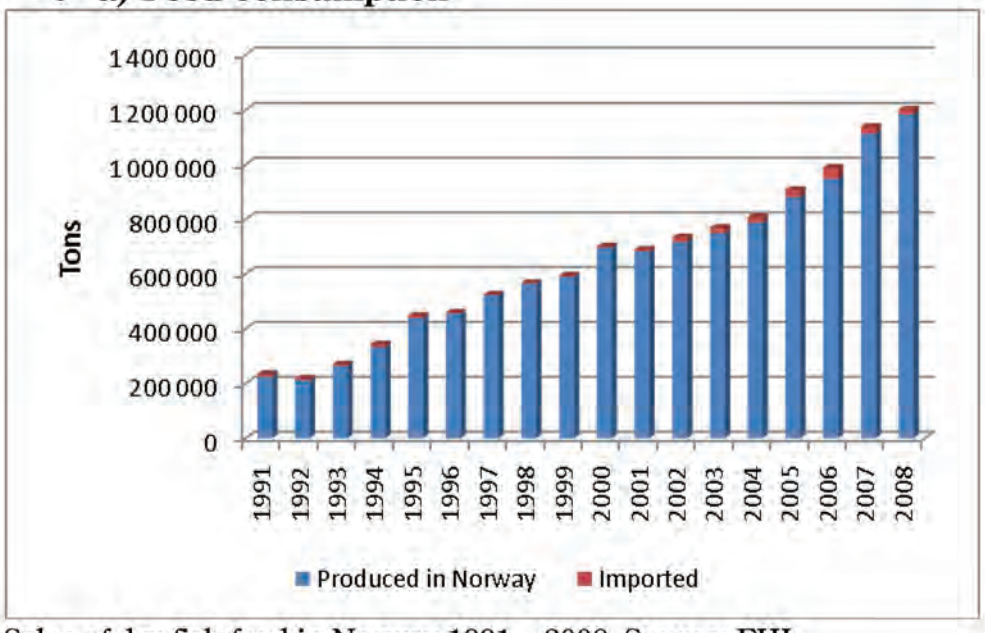
Total escaped individuals (x 1000). Figures are based on reports from fish farmers. Collection of data on escaped farmed fish started in 2004.
Source: The Norwegian Directorate of Fisheries.

5 b) Infiltration of farmed fish in rivers



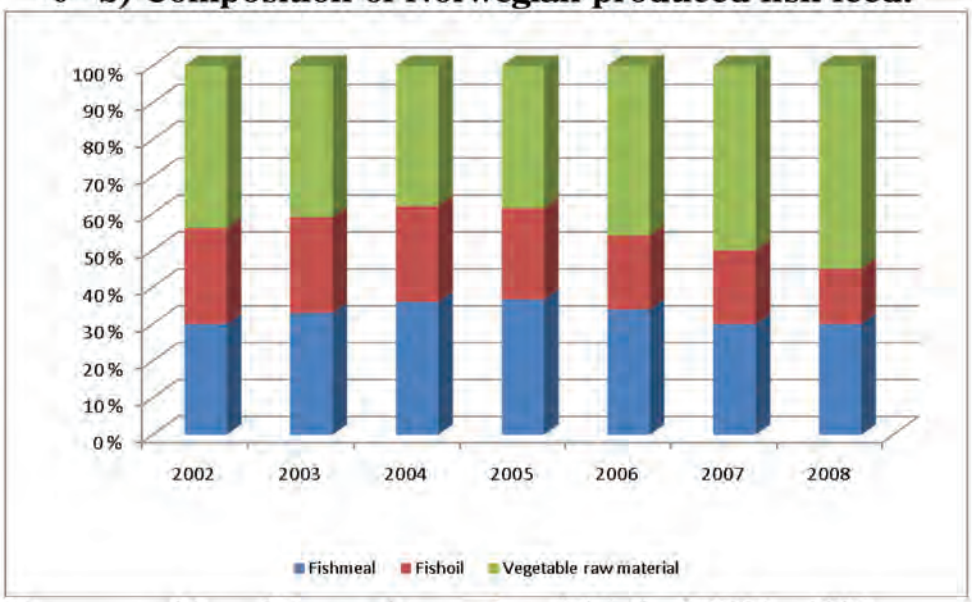
Calculated percentage of infiltration of escaped farmed salmon in sports fish, sample fish/brood stock fish just before spawning between 1989-2007. The proportion of escaped farmed salmon in sports fish was not calculated in 2003. Source: Directorate for Nature Management.

6 a) Feed consumption



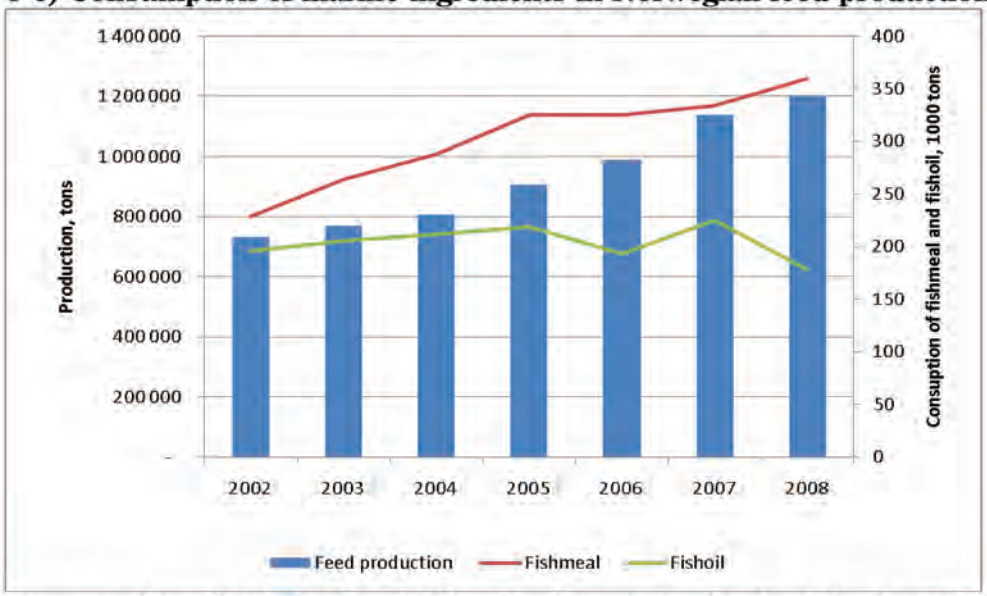
Sales of dry fish feed in Norway 1991 – 2008. Source: FHL.

6 b) Composition of Norwegian-produced fish feed.



The composition of Norwegian-produced fish feed, 2002 – 2008. Figures are based on reports from Norwegian manufacturers. Source: FHL.

6 c) Consumption of marine ingredients in Norwegian feed production



Consumption of fish feed and fish oil in Norwegian feed production in relation to total feed production. Source: FHL.

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