2012

ENVIRONMENTAL REPORT

Norwegian Seafood Industry

Emphasizing facts and figures from 2012 up to July 2013

FHL

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0305 Oslo

The report can be downloaded from www.fhl.no

Norwegian Seafood Federation

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1 PREFACE

Norwegian Seafood Federation (FHL) members take responsibility for sustainable seafood production. Sustainability is a vital element in all parts of the value chain. This FHL report includes the fisheries industry for the first time and does not focus solely on aquaculture.

The report's primary aim is to provide a concise summary of knowledge, status and challenges concerning major environmental issues. Dialogue and openness are important elements and an essential basis for debate and co-existence between the various interests along Norway's coast.

We in the seafood industry are extremely proud of the fact that we produce 36 million seafood meals for the world, every day, all year round. The industry's potential and market demand are considerably greater, but further growth must naturally occur in a sustainable manner.

The opportunities are there, as revealed in last year's report from The Royal Norwegian Society of Sciences and Letters (DKNVS) and the Norwegian Academy of Technological Sciences (NTVA). The report claims it is possible for a quintupling of sales from our productive marine areas to no less than NOK 550 billion (€68.2 billion/$91.2 billion) by 2050.

All kinds of food production has an impact on the environment. FHL's environmental policy objective is that seafood production shall be sustainable, and environmental pollution shall not limit the opportunities for producing safe seafood. It's all about operating in a manner that is sustainable and maintained within acceptable boundaries set by the authorities.

The FHL is responsible for the publication of the Environmental Report, which is founded on facts and analyses from the FHL and participants in the industry, government bodies and public management, as well as numerous research and expertise circles.

You can also download the report electronically from our website FHL.no.

We hope you will find the report beneficial.

Kind regards

Gunnar Domstein
Chairman FHL

We in the seafood industry are extremely proud of the fact that we produce and supply the world with 36 million seafood meals. Every day.

2 ABOUT FHL

The Norwegian Seafood Federation (FHL) is a nation-wide industrial-political employer organisation that as at 01 July 2013 represented the interests of 485 member enterprises within the entire value chain in the fisheries industry, the aquaculture sector, the feed industry and marine ingredients industry. FHL is affiliated with the Confederation of Norwegian Enterprise (NHO).

The FHL General assembly elects the Board, whitch is the decision-making organ between the general assembly meetings. The Board consists of eight members and also has associate advisory member organs – industry groups, sector groups and work committees in the regional aquaculture associations. The decision-making organs are delegated executive authority by the Board.

The seafood industry is dependent on the environment, and some of its most essential prerequisites are linked directly to nature and the environment. The diagram shows the management structure and administrative structure of the FHL, where the technical aspect concerning environmental issues is anchored in one of the four sections.

Some of FHL's tasks:

* Attends to the members' joint interests in regard to national and international authorities and institutions and the community at large.

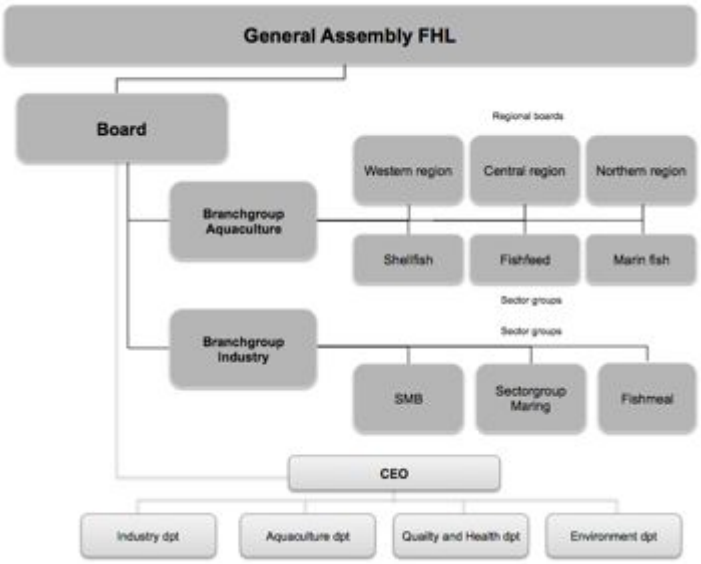
* Works to ensure the companies have framework conditions and development opportunities that strengthen their competitive edge and profitability, and thus provide sound and secure workplaces.

* Works to build up development of the industry's expertise and to maintain good, stable relationships between member companies, the employees and their organisations.

* Contributes towards giving a voice to the fisheries and aquaculture industry through participation in a number of activities, consultations and committees.

* Contributes towards ensuring the sustainability of seafood production.

* Contributes towards promoting the public profile of the industry in a uniform, dynamic and sustainable way in relation to the authorities, management and public opinion.



The FHL is the mouthpiece for almost 500 enterprises throughout Norway and is the country's largest seafood organisation.

3 SUSTAINABLE SEAFOOD PRODUCTION

The growing world population

Increased seafood production is a crucial element of the solution to meeting the global food challenge. Norway manages some of the world's richest fisheries and aquaculture resources and can augment supply significantly. Even today Norway meets the seafood requirements of more than 130 million people.

Rock carvings dating back more than 6000 years reveal that people along the Norwegian coast have fished and hunted throughout the ages. The sea is effectively a food pantry which by its very nature has laid the groundwork for a nation that has become a seafood superpower. Today only China exports more seafood, measured in value. The fisher-farmer has been replaced with professional fishermen, industrial workers, marine farmers and exporters who ensure a supply of food to more than 150 countries. Places like Båtsfjord, Frøya, Måløy and Egersund are directly linked to the rest of the world and are bringing life to a rural industry that is profitable, subsidy-free and based on renewable resources.
Demand for Norwegian seafood products is growing, particularly amongst the middle class in a number of countries.

Potential for increased production of seafood

Globally there is a shortage of seafood and this shortage will only worsen. The World Health Organisation (WHO) has warned against not eating enough fish, as a lack of seafood adversely affects the health of the population. Ideally, one should eat at least two fish meals per week. Increased supply is therefore a part of the solution to the health and food challenges faced by the world. Currently less than two per cent of the world's food production comes from the sea. In this perspective we, as a fisheries and aquaculture nation, have a role to play. With abundant fish stocks, sovereignty over extensive stretches of sea and a coastline that is ideally formed for aquaculture, we know the potential is immense. Through responsible, long-term and sustainable management, Norway is capable of increasing supply.
In the course of 2012 and 2013 the FHL has looked at the possibilities, first and foremost through its own reports:
1. Seafood 2025 – how to create the world's leading aquaculture industry
2. Seafood 2025 – how to create the world's leading wild fisheries industry

In these reports we have studied what is required to increase production, operate more profitably and achieve the vision of being number one in the world. The prerequisite for the whole process is naturally to implement this in a sustainable manner.

The FHL is not the only one looking at stepping up seafood production. In August The Royal Norwegian Society of Sciences and Letters (DKNVS) and the Norwegian Academy of Technological Sciences (NTVA)[1] presented their report entitled "Creation of values based on productive seas in 2050". The potential for improved creation of values in our coastal and sea areas is huge. In its analysis the working group said a turnover of NOK 550 billion (€68.2 billion/$91.2 billion) is feasible by 2050, a quintupling of the current turnover. The working group consisted of recognized researchers, experienced administrators, founders and industrial players. Researchers from the research organisation SINTEF and the Norwegian University of Science and Technology (NTNU) have compiled the work in written form. This report is a follow-up of a report from 1999 where the predictions made proved to be squarely on the mark: at that time it was predicted that the seafood industry would represent a total sales value of around NOK 75 billion in 2010 – the actual value ended up at approximately NOK 80 billion.

On 27 June the cabinet ministers of the Ministry of Trade and Industry (NHD), the Ministry of Fisheries and Coastal Affairs (FKD), the Ministry of Local Government and Regional Development (KRD) and the Ministry of the Environment (MD) presented reports and studies related to the potential for creation of values in the northern regions. Many of the conclusions drawn in the sector analyses[2] linked to the seafood industry coincide with those in the above report.

Thus the seas around us do not serve exclusively as our food pantry, but also supply markets on every continent.

From the industry and rural districts' standpoint, this amounts to a tremendous opportunity to boost value creation and employment. From a political standpoint, this is about responsibility for contributing more in an area where the nation has the best opportunities. A number of countries already have much of their seafood needs covered from Norway. The EU is totally dependent on Norwegian fish. Thus the seas around us do not serve exclusively as our food pantry, but also supply markets on every continent.

Sustainable prerequisite

The Stoltenberg government's political platform declared that: "Norway shall be the world's leading seafood nation". During the FHL's Annual Conference 2013 the Minister of Fisheries and Coastal Affairs Lisbeth Berg-Hansen presented the government's seafood report, *'The world's foremost seafood nation'*. The content of the report focused on being at the forefront of expertise in areas such as sustainable exploitation of resources, marine environment, climate, product development and the market.

The FHL has a clear environmental political objective. This is bilateral and deals with both the industry's own impact on the environment and the environment's impact on the seafood industry: *Seafood production shall be sustainable, and environmental pollution shall not limit opportunities to produce safe seafood.*
Both of these aspects are important and necessary for safe, future-oriented food production. Being able to ensure and document that these prerequisites are in place is thereby decisive for a growing industry whose target is to continue development.

How do we reach our goal?

As previously mentioned, sustainability is the foundation for development. The United Nations (UN) has, through the Declaration of Human Rights, emphasised that sustainability requires taking into consideration respect for the environment, social conditions and financial profitability. It is vital that this perspective is fully comprehended. Without profitability it is impossible to create dynamic industries.

a) Fisheries[3]
The world's foremost seafood nation must therefore have a solid, profitable and innovative fisheries industry. The value chain must become more adept at marketisation, and the companies must – in collaboration with the authorities and research environments – invest in development of seafood clusters on a national level.

Meanwhile, the politicians administer a set of regulations that with the right adaptation can create broader framework conditions for hundreds of companies. This will in turn trigger a willingness to invest, innovation and new workplaces.

In *'Seafood 2025 – how to create the world's foremost wild fisheries industry'*[3], the wild-catch segment of the seafood industry's objective of profitability will enable the industry to contribute to Norwegian society to a greater degree. In itself, increased profitability contributes towards creating secure workplaces and assured tax revenue for society. If there is adequate profitability then we must also expect the possibility of debate on payment for use of natural resources, as has been the case in the hydro power sector, the aquaculture industry and the petroleum industry. Over time, as income from petroleum revenue declines it will be important for the Norwegian community to have other highly profitable industries.

The target is that by 2025 the value creation from the wild fisheries value chain will be around NOK 30 billion (the current level is NOK 20 billion), of which the fisheries industry will contribute with NOK 6 billion (the current level is NOK 3 billion).

Recommendations for achieving the targets
In the report 6 assignments are outlined, as are the various tasks a) the companies, b) the organisations and c) the authorities must fulfil in order to achieve the targets. These are:

1. More seafood! With the growth of the global population, so too increases the need for more food. Understanding for healthy food will also contribute toward improving demand. Norway and the Norwegian seafood industry thus have an ethical commitment to ensuring supply.

Seafood production shall be sustainable, and environmental pollution shall not limit the potential for producing safe seafood.

FHL's environmental policy objective

2. Seafood is the most important! What will we live off in the future? The report's assumption is that the bar will be raised for the level of knowledge, expertise and interest in seafood in Norway.

3. Profitability. A premise for the Norwegian wild fisheries industry in 2025 is new industrial development. If the industry is to be competitive this would supposedly require automation, rationalisation and structuring. Accordingly this would compensate for Norway's high wage and cost levels.

4. Norway first and foremost. Investment and opportunities shall take place in Norway. Innovation, R&D (research and development) and enthusiasm for new thinking takes place here in this country.

5. Environmentally friendly seafood. Few industries can match such low discharge as the seafood industry. Companies, organisations and the authorities shall nonetheless make a greater effort to keep discharges at the lowest possible level.

b) Aquaculture[4]

The potential for growth is greatest in the aquaculture sector. Currently only 5 per thousand of sea acreage is utilised within the base line for aquaculture.

Nonetheless, salmon and trout production is triple that of the entire Norwegian meat production. However, with food production sea and land acreage is managed according to totally different principles. While food production on land is protected, the area employed in seafood production is not given any priority in regard to other industrial activities and recreational interests. If one seriously believes that Norway can and should contribute toward increased seafood supply, areas must also be allocated to food production in the sea.

Further production growth in the aquaculture industry will enable Norway to step up its supply of seafood to the global market whilst strengthening the Norwegian economy, workplaces and local communities. It is possible and realistic to increase production volume from aquaculture on a national level to 2.7 million metric tons by 2025[4]. This would have to occur within the boundaries of environmental, economic and social sustainability.

That necessitates more R&D, while the industry implements appropriate measures at the same time as the national seafood policy and management lay the groundwork for this development to take place. It also requires establishment of long-term political objectives for the development of the seafood industry. In this way the aquaculture industry can, in collaboration with the authorities, management and researchers, provide a supportive contribution to the vision of shaping Norway into the world's foremost seafood nation.

References:

1) Report from a working group appointed by The Royal Norwegian Society of Sciences and Letters (DKNVS) and the Norwegian Academy of Technological Sciences (NTVA) (2012): Value creation based on productive seas by 2050.
2) The Ministry of Trade and Commerce, the Ministry of Local Government and Regional Development, the Ministry of Fisheries and Coastal Affairs and the Ministry of the Environment (2013): Sector analysis for the marine industries in northern Norway, expertise compilation and value creation in the north.
3) FHL (2013): Seafood 2025 – How to create the world's foremost wild fisheries industry
4) FHL (2012): Seafood 2205 aquaculture – How to create the world's foremost aquaculture industry?

4 INDUSTRIAL RIPPLE EFFECTS

Industrial ripple effects

Creating values worth NOK 46.5 billion

Throughout time immemorial Norway has been a fisheries nation and seafood is now one of our principal export industries. Since the 1970s the aquaculture industry has expanded and contributed significantly to growth. Around 150 countries import seafood from the Norwegian fisheries and aquaculture industry. Norway supplies cod, saithe, herring, mackerel, salmon and other species to the market in quantities that equate to 36 million dinner portions a day.

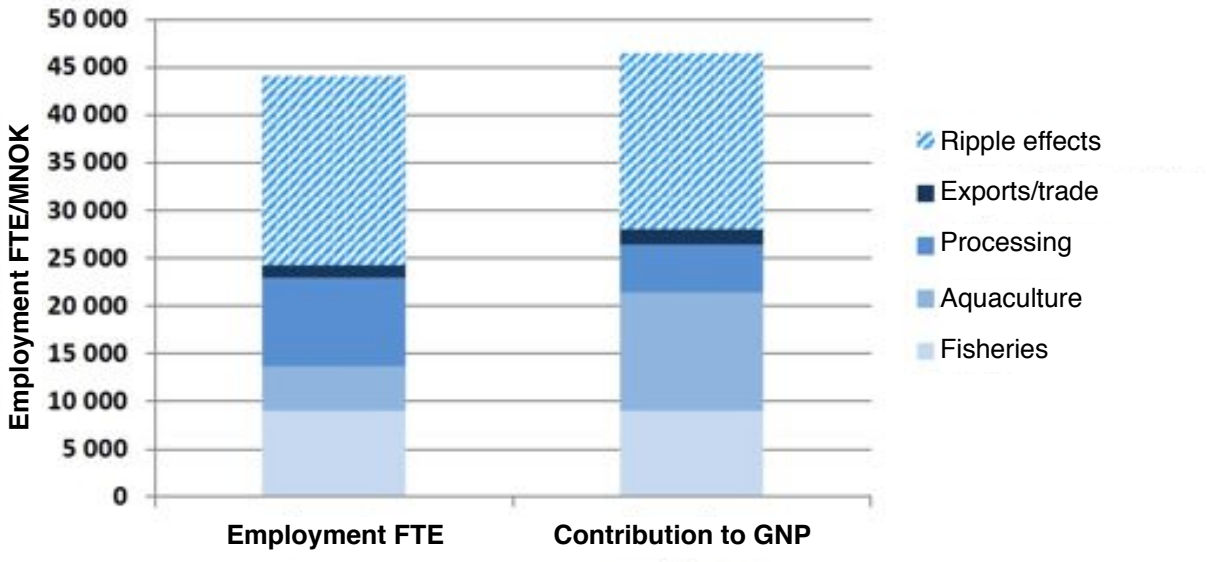
The seafood industry accounts for major activity and value creation along the entire Norwegian coast. Each year, research group Sintef carries out a survey[1] of the industrial ripple effects caused by this activity. The analysis is based on figures from Statistics Norway. The contribution the seafood industry makes annually to Norway's GNP through value creation amounts to NOK 46.6 billion and accounts for employment of around 44,000 FTEs (Full-Time Equivalents).

Fisheries-based value chain

The fisheries-based value chain includes the catch segment, fish processing (based on wild fish /crustaceans/ molluscs) and the export/trade segment, plus suppliers of services and equipment for the various sections of this value chain. Including ripple effects, in 2010 the fisheries-based value chain employed approximately 24,200 FTEs. Total value creation including ripple effects amounted to NOK 20.4 billion.

Aquaculture-based value chain

The aquaculture-based value chain includes broodstock, smolt, edible fish, fish processing (based on farmed fish and crustaceans), cultivation of molluscs and crustaceans and the export/trade segment, plus suppliers of goods and services for the various sections of this value chain. Including ripple effects, in 2010 the aquaculture-based value chain employed approximately 21,100 FTEs. Total value creation including ripple effects from the aquaculture-based value chain totalled around NOK 27.2 billion.



Graph 4.1: FTEs and value creation. *Distribution of employment and value creation (contribution to GNP) in core activities and ripple effects in other industries. Based on figures for 2010. (Source: Sintef 2012)*

The Norwegian seafood industry contributes to value creation through input to GNP of NOK 46.6 billion and provides jobs totalling around 44,000 FTEs.

Averages
Sintef's analyses are based on figures from Statistics Norway and models for calculation of ripple effects, and the report applies these averages to the value chains:

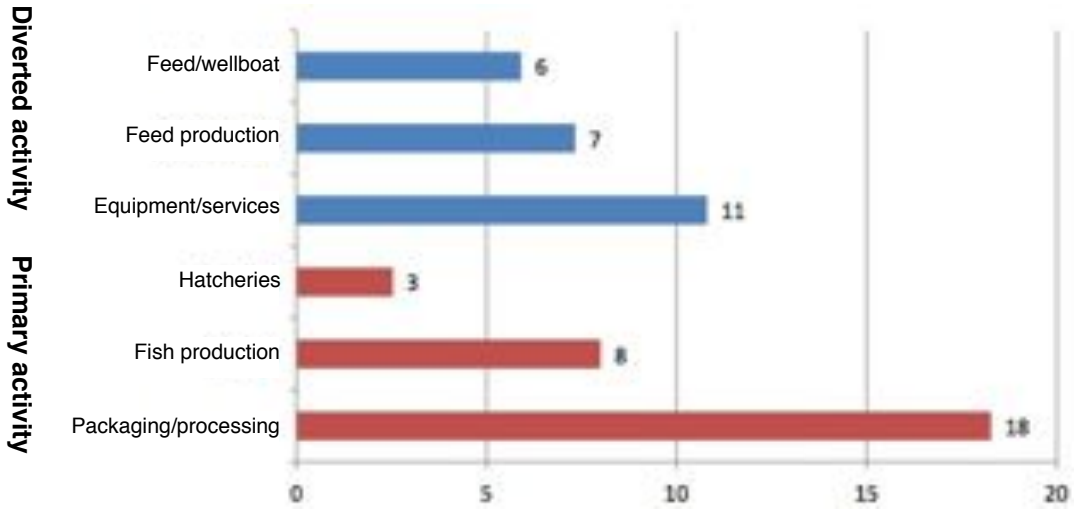
Fisheries:
* Each FTE generates 0.6 FTE in other industries.
* Each krone in value creation generates NOK 0.60 in other industries.
Aquaculture:
* Each FTE generates 1.4 FTEs in other industries.
* Each krone in value creation generates NOK 0.80 in other industries.

In 2012 the research firm Nofima carried out a singular charting and analysis[2] of how the aquaculture industry in Troms County (Northern Norway) purchases goods and services, and how this diverts activity and ripple effects locally and regionally. The study showed that 80% of the purchases were made from suppliers in northern Norway.

Ripple effects from 4 production licences
Starting with the project that was based on figures for 2011, Nofima broke down the numbers to show the average ripple effects for a farm site with 4 production licences. This farm site would have a maximum permitted biomass (MPB) of 3120 metric tons of fish for licences of 780 MPB and 3600 metric tons for licences of 900 MTB (in the counties of Troms and Finnmark).

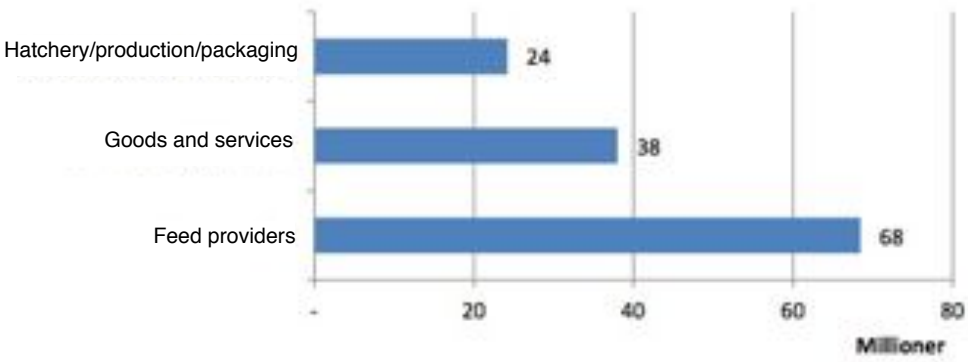
The analysis shows that a site of this size generates considerable ripple effects in other industries:

Employment:
* One farm site with 4 production licences collectively provides employment for 53 FTEs.
* 29 of the FTEs in the core activity are connected to salmon production and slaughtering, while 24 FTEs are created through the suppliers (graph 4.2).
Purchases:
* One farm site with 4 production licences diverts purchases of goods and services for NOK 130 million.
* Feed accounts for the largest share of NOK 68 million, while other goods, equipment and services account for NOK 62 million (graph 4.3)
* The figures are conservative as they do not include transport, which for Troms County alone amounted to 5,476 trailer transporters in 2012 and represented a purchase cost of NOK 197.2 million.



Graph 4.2: Employment at a farm site with 4 production licences. *FTEs in primary and diverted activity. In total 53 FTEs are created in and around the marine farm site. (Source: Nofima)*

A farm site with 4 production licences collectively provides employment for 53 FTEs.



Graph 4.3: Purchases from one site with 4 production licences. *Of purchases totalling NOK 130 million, NOK 68 million was spent on feed and NOK 62 million on other goods and services. The aquaculture industry in Troms County purchased goods and services for NOK 3 billion in 2011, of which NOK 2.5 billion (80%) was from northern Norway. (Source: Nofima)*

Value creation per head

Another perspective on an individual industry's contribution to the national economy is the industry's value creation per FTE. Sintef's analysis shows that value creation per FTE in the three sectors of the seafood industry - fishing and catches, aquaculture and fish processing - vary significantly:

* Fishing and catches NOK 0.99 million per FTE
* Aquaculture NOK 2.68 million per FTE
* Fish processing NOK 0.54 million per FTE (Average value creation (contribution to BNP) per FTE for Mainland Norway was in 2010 approximately NOK 0.98 million.)

References

1) Sintef fisheries and aquaculture (2012): Value creation and employment in the Norwegian seafood industry 2010.
2) Nofima (2012): Nofima report no. 28/2012.

5 FOOD PRODUCTION AND USE OF RESOURCES

5.a Catches – Norwegian fisheries

Norwegian fishing vessels delivered 2.1 million tonnes of fish, shrimp, crustaceans and molluscs in 2012[1]. This is 7% less than in 2011. The downturn is due primarily to reduced quotas for Norwegian spring-spawning herring (nvg), and it is normal for volume to vary in the total catch due to variations in the set quotas. Historically, catch volume from the Norwegian fishing fleet has varied between 2 and 3 million tonnes.

First-hand value declined in 2012 by 12 per cent to NOK 14.1 billion. 84% of the catch was allocated to consumption and 16% to the meal and oil industry[2].

The most important fisheries are now concentrated on North Atlantic saithe, cod and haddock, Norwegian spring-spawning herring, North Sea herring, mackerel, capelin, blue whiting and prawns. Fishing also focuses on a number of groundfish such as golden redfish, halibut, plaice, tusk and ling. Harvesting of seals and whales also are important. Sand eel and Norway pout are mainly fished for use in production of fishmeal and fish oil.

Norwegian vessels also fish for krill in the southern Antarctic Ocean, and in Norwegian waters there is limited fishing for the zooplankton Calanus finmarchicus[3].
In 2012 the export value of the wild fisheries-based seafood industry totalled NOK 20.1 billion[4], with product volume of approximately 2 million tonnes. Most of the value is attributed to the main product, although the value of rest raw materials has increased in recent years[5].

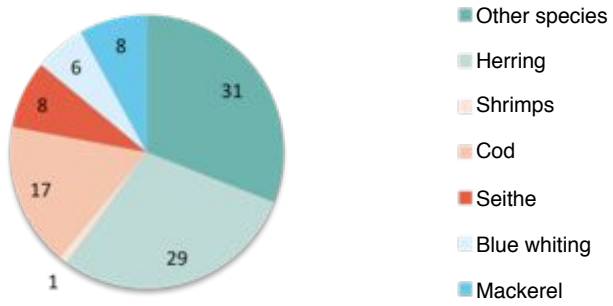
Setting of quotas and regulation

The Directorate of Fisheries is responsible for inspection and management-related tasks, and proposes regulations and quotas for the different fisheries. Final quotas and regulations are set by the Ministry of Fisheries and Coastal Affairs after the proposals have been sent out for comments from within the industry.

Total quotas are set on the basis of stock assessments and environmentally related targets
Quotas are also set for the individual vessels. The majority of quotas for the major stocks are set through international negotiations between coastal states.

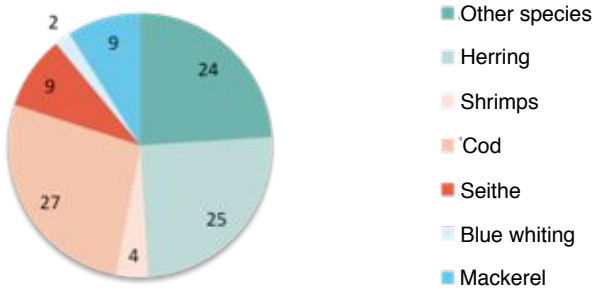
Negotiations concerning stocks in the Barents Sea take place in the integrated Norwegian-Russian fisheries commission, and negotiations concerning stocks in the North Sea take place between Norway and the EU. For the major pelagic stocks negotiations take place between Norway, the EU, the Faroe Islands, Iceland and Russia. The Norwegian Seafood Federation (FHL) is represented in the Norwegian delegations at the various negotiations. Long-term management regulations have been established for most of these stocks and normally these quotas are set in

Catch volumes 2012



Graph 5.a.1: Overview of catch volumes of the various species.
Percentage distribution of catch volume of fish species in 2012, based on provisional figures for 2012. (Source: Statistics Norway)

Catch values 2012



Graph 5.a.2: Overview of catch volues of the various species.
Percentage distribution of catch value of fish species in 2012, based on provisional figures for 2012. (Source: Statistics Norway)

line with recommendations from The International Council for the Exploration of the Seas (ICES).

Stocks in good condition

The situation for the major and commercially most important stocks in Norwegian waters is generally very good. In the Barents Sea, Norwegian-Arctic cod stocks are in record number. Stocks of saithe and haddock have reduced in recent years, but are still well within sustainable levels. Stocks of Greenland halibut and deepwater redfish appear to be recovering in numbers, after many years of stringent regulatory measures.

Of the major pelagic stocks in the Norwegian Sea, mackerel is in extremely good condition despite the failure of coastal states to reach a management agreement. Mackerel has spread far and wide, and is currently found in huge numbers in Northern Norway.

Blue whiting stocks are also enjoying firm growth as a result of solid recruitment in recent years. Stocks of Norwegian spring-spawning herring have reduced in recent years. In the North Sea the trend is positive, after many years of weakened stocks and reduced quotas. For the coastal stocks of common redfish and halibut, the condition of stocks in the south remains weak. For more details see the report to Parliament (Stortinget) no. 40 (2012-2013) on F*isheriesavtalane Noreg har inngått med andre land for 2013 and fisket etter avtalane i 2011 and 2012* (The fisheries agreements Norway has entered into with other countries for 2013 and fishery according to the agreements for 2011 and 2012).

During the last year in particular there has been discussion internally in marine research circles and the industry about the current management strategies. Some point out the need to look at development of the various fish stocks in a wider context than is the case today, including keeping predator fish stocks such as mackerel and cod at a lower level, to provide a basis for more stability amongst stocks, increased total harvest and larger stocks of fish at a lower level. This discussion calls for resources to be made available for marine researchers to extend research on the consequences of diverse management strategies.

International conflicts over quota setting

Over time there has largely been agreement on distribution of shared resources between the coastal states. This has been of positive significance in ensuring that the setting of quotas concurs as far as possible with the recommendations of marine researchers. When conflicts occur over distribution, this often also leads to problems in regard to the setting of total quotas for the individual fisheries.

Mackerel stocks have increased in recent years. This has resulted in mackerel temporarily spreading into Faroese and Icelandic waters. Iceland and the Faroe Islands have on this basis presented demands for changes to distribution of the mackerel quota, and in practice demanded that they should receive around half of the total mackerel quota. Historically the percentage for the two countries has been 5-6 percent.

Norway and the EU have not accepted that Iceland and the Faroe Islands should receive such a large share of the quota, but have offered the two countries higher shares.

Insofar as this has not been accepted the conflict over distribution remains ongoing, and Iceland and the Faroe Islands have accorded themselves quotas in accordance with their own demands and outside international agreements. Norway and the EU have for their part set quotas on the basis of historic distribution of the mackerel quota. Thus the various countries' set quotas are in total larger than that recommended by the marine researchers. The challenge lies in that the country or countries that give in first will in reality lose the rights they maintain they have.

Norway has imposed a unilateral ban on landings of fresh mackerel from Iceland and the Faroe Islands at Norwegian ports. The EU is considering whether to levy sanctions. The Norwegian pelagic consumption industry has been caused considerable costs in regard to the conflict in that we have lost out on raw materials from the Faroe Islands and Iceland, and this raw material contributes to building up improved production capacity in Iceland and the Faroe Islands.

Recently the Faroe Islands also granted itself an increase in quotas for Norwegian spring-spawning herring, and for this reason Faroese vessels have had their MSC environmental certification withdrawn. See chapter on environmental certification.

The FHL has called for international arbitration mechanisms that can step in to prevent national conflicts having a detrimental effect on long-term management of our fish stocks.

Vessels and equipment

At the end of 2012 there were around 6200 vessels in the Norwegian fishing fleet and about 12,000 fishermen[1] registered. Of these, around 10,000 have fishing as their main occupation and around 2000 have this as a secondary income. The number of fishermen has declined radically in the last couple of decades, and in the period from 1985 to 2012 numbers dropped from approximately 30,000 in 1985 to the current 12,000 fishermen.

One of the reasons for the downturn in the number of fishermen is that the fishing fleet has developed increasingly efficient catch equipment and fishing vessels, and the same amount of fish can be caught with fewer fishermen and vessels. Through participant restrictions and structural arrangements, quotas are concentrated on fewer fishing vessels and fewer fishermen. This also contributes to more energy-efficient fishing in that fewer vessels are needed and less fuel used to make the catch. See separate chapter on discharges.

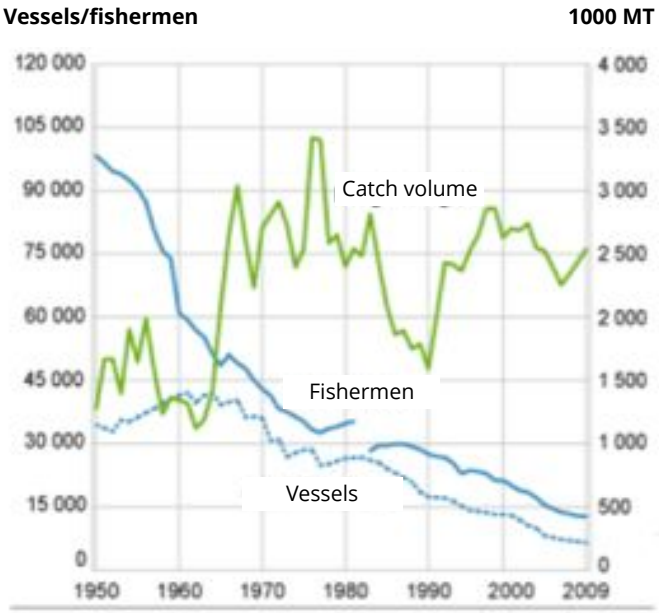
Reduced impact on the environment as a result of targeted efforts

Various types of equipment are used in the Norwegian fishing fleet. The seine is dominant amongst pelagic fishing gear, while groundfishery mainly uses nets, trawl, lines and Danish seines. In recent years the Norwegian authorities and seafood industry have worked towards reducing the environmental impact from fisheries activities in regard to seabed habitat and bycatches.

Measures implemented and new

In order to reduce damage to vulnerable seabed habitat, a general requirement has been introduced to exercise caution when fishing in proximity to known locations of coral reefs. Intentional destruction of reefs is prohibited, and several coral reefs are protected against groundfishing gear. Vessels are also required to assess the amount of sponges and coral in every catch, and if the threshold values are exceeded the fishing must be halted and the vessel must move away from the area. Furthermore, all Norwegian sea areas deeper than 1000 metres are closed to groundfishing unless specific protocols are prepared for execution and documentation.

Through the MAREANO programme, comprehensive mapping is being made of the seabed in Norwegian sea areas. The fisheries regulations have set various levels for



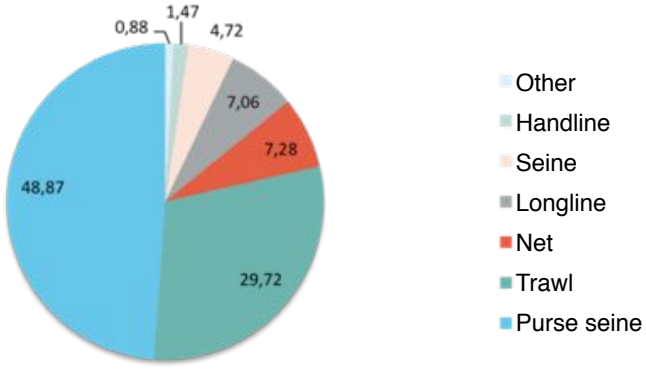
Graph 5.a.3: Raising the level of efficiency in fisheries is leading to fewer fishermen*. The graph shows the trend in number of vessels and trend for combined catch volume 1950-2009, compared with the number of fishermen recorded in the fisherman's register. Catch volume has been relatively stable, while the number of fishermen and fishing vessels has been significantly reduced during this period. This is attributable to rationalisation in the fisheries, participant restrictions and structural arrangements that concentrate quotas among fewer fishermen and vessels. (Source: Nofima)*

The FHL has called for international arbitration that can intervene to prevent national conflicts from adversely affecting the long-term management of our fish stocks.

acceptable quantities of bycatches and several measures have been implemented to reduce bycatches (such as use of sorting grids in trawl fishing). Several research projects are underway to develop more selective and considerate fisheries, and the results from these will over time be phased into the Norwegian fishing fleet.

Where energy consumption is concerned they have diverse types of equipment with various uses, and energy consumption per kg of fish is largely dependent on the rate at which catches are made, availability of the fish and sailing time to and from the fishing grounds.

Catches according to equipment group 2012



Graph 5.a.4: Catches according to equipment group. *The graph shows in percentages the catch portion according to equipment group for Norwegian vessels in 2012. The catch portion is calculated on the basis of quantum round growth. (Source: Nofima)*

Eco-certification of fisheries

The industry is finding that retail chains and others are increasingly demanding various forms of eco-certification that document the seafood's environmental status. For fisheries it is the joint management of the fishing that determines whether or not the fishing is environmentally sustainable, therefore it is logical for fisheries to be certified under the direction of the industry as such.

The FHL has therefore worked to achieve eco-certification of the various fisheries. This means that the companies can then decide themselves if they will implement a certification arrangement for their companies and production in order to make use of the certification arrangement in marketing their products to the consumer.

MSC certification of all major fisheries for food consumption

The Norwegian fisheries are now the most eco-certified fisheries in the world. In the fisheries for food consumption segment, the industry has largely chosen to certify fisheries according to the Marine Stewardship Council (MSC) standard. This is the most recognised eco-label in the commodity trade.

Fishing for Norwegian spring-spawning herring, North Sea herring, mackerel, saithe and North-East Atlantic cod and haddock, prawns north of 62°N and Antarctic krill are MSC certified. Antarctic krill is certified following an initiative taken by Aker Biomarine. The other fisheries are certified jointly with the Norwegian fisheries.

The MSC certificate for mackerel has been temporarily suspended since April 2012. During the last two years mackerel have been harvested in greater quantities than those recommended by marine researchers. This is due to Iceland and the Faroe Islands having unilaterally accorded themselves large quotas of mackerel outside the established quota distribution key. It is therefore a prioritised task for the FHL to find a solution to this issue.

In that the Faroe Islands have also set their own quotas on spring-spawning herring that are not internationally recognised, the MSC certification for spring-spawning herring fished by the Faroese fleet has been rescinded. Measures of this nature have not been taken against other countries' fleets except the Faroe Islands, as it is the Faroe Islands that is breaking away from the international agreement.

Mention should be made that those fisheries not certified under the auspices of the MSC or IFFO RS (IFFO Global Standard for Responsible Supply) may nonetheless meet all the criteria required by these programmes. Other certification arrangements also exist. Deciding whether a fishery should apply for certification is largely influenced

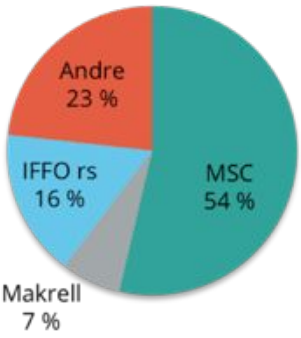
by demands in the trade, the fisheries' size and its value measured against the cost of effecting and recertifying the fisheries. For small fisheries the costs of certification are about the same as for bigger fisheries.

The Norwegian authorities have therefore also established the portal fisheries.no which provides a good overview of environmental conditions and sustainability in diverse fisheries and aquaculture production in Norway.

IFFO RS certification of industrial fisheries

The fisheries whose raw materials are delivered for production of fishmeal and fish oil are often referred to as industrial fisheries. Fishmeal and fish oil are often used in, for example, feed for salmon production. In order for the various aquaculture companies to be able to eco-certify their end-products, demand is increasing to also provide documentation that fishing for raw material designated for fish feed takes place in an environmentally sustainable manner.

The FHL and the Norwegian manufacturers of fishmeal and fish oil have therefore decided to certify the industrial fisheries and companies under the direction of the IFFO RS Global Standard for Responsible Supply. Work on this certification was initiated in 2011 and completed in 2012. All Norwegian fishmeal and fish oil plants are now certified according to the IFFO standard. Subsequently the following fisheries have been eco-certified: Norway pout, blue whiting, capelin and sand eel.



Graph 5.a.5: Overview of eco-certified fish in 2012. *The graph shows the percentages of Norwegian fish caught in 2012 that are MSC certified and IFFO RS certified ('Andre"/Others' are non-certified catches in relation to these schemes). Mackerel is included as a separate post owing to the provisional suspension of mackerel from MSC due to the conflict over international distribution. In regard to krill, only the portion of the catch that is MSC certified is included as MSC certified, while the rest is noted as non-certified. The figures are based on the Directorate of Fisheries' overview of total volume caught of the individual fish species. The summaries were prepared by the FHL. (Source: Directorate of Fisheries and FHL)*

References

1) Directorate of Fisheries (2013): Economic and biological key figures from the Norwegian fisheries - 2012.
2) Statistics Norway (2013): Fisheries 2012 – provisional figures.
3) FHL (2013): Seafood 2025 – How to create the world's foremost wild fisheries industry?
4) Norwegian Seafood Council: National sales and export
5) Rubin: Rubin's value creation analysis, www.rubin.no

All Norwegian fishmeal and fish oil plants are now certified in accordance with the IFFO standard.

5.b Fish landing and packing stations, processing industry

The traditional fish industry, salmon packing stations and new industrial sectors based on marine raw materials are important parts in the value chain and account for an essential and future-oriented section of the Norwegian seafood industry.

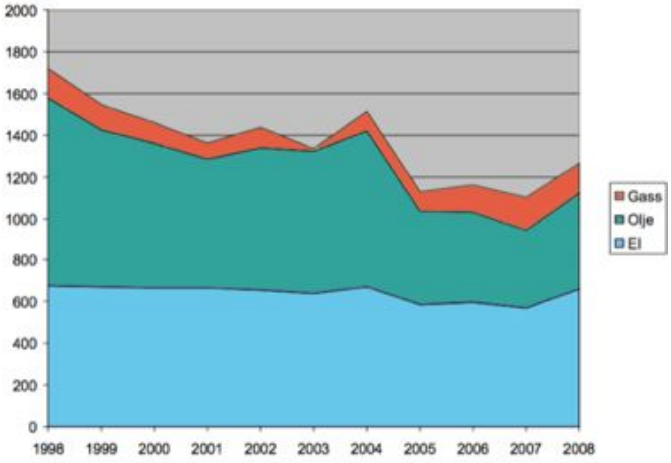
Energy consumption in the fish industry

A general overview has been prepared through the "Creative" project of energy consumption in the Norwegian processing industry, and of distribution of energy requirements per branch of industry within the fish industry. As shown by the graph, the collective energy consumption in the processing segment has been reduced. Energy is a fundamental cost for the companies involved; consequently the companies are firmly focused on economising energy costs.

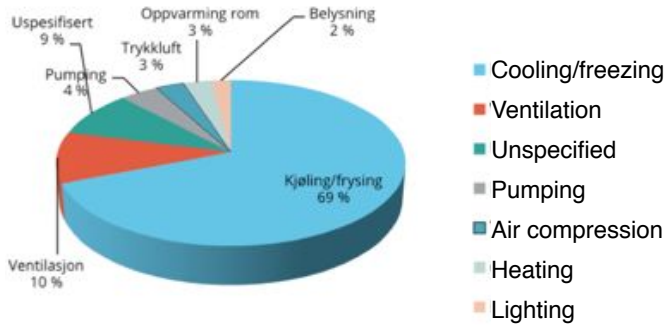
In calculating energy consumption data was utilised from the project *"The future ENØK energy efficiency enterprise in the fisheries industry".* These calculations only include the cooling requirements for processes such as refrigeration/ chilling, storage and production of ice. Other processes and daily operations also utilise some energy. According to Danish consulting group COWI, refrigeration and storage represent 80-85% of the total energy consumption in an average pelagic installation[1].

The pelagic industry has the greatest potential for reduction of energy consumption in refrigeration processes and the lowest specific energy consumption compared with groundfish, aquaculture and packing stations. Refrigeration and storage is the chief energy-demanding process for pelagic, while groundfish and redfish involve several other processes that consume energy. Enova has proposed several possible initiatives to reduce energy consumption in the fisheries industry.

These are covered in greater detail in SINTEF's "Fact sheet on energy consumption in the fish industry", 2010[2].



Graph 5.b.1: Energy consumption in the fish industry. *Development 1998-2008. Total energy consumption and the share of consumption of electricity, oil and gas in the fish industry in the period 1998–2008. In general, energy consumption was reduced in these years, particularly oil consumption. (Source: Sintef Energi AS)*



Graph 5.b.2: Overview of what uses energy has in the fish industry. *Distribution of energy consumption in the fish industry. Energy requirements are clearly most pronounced for chilling and refrigeration of products. (Source: Sintef Energi AS)*

Packaging

Shelf life is an important aspect that must also be considered when selecting the type of packaging

Choice of packaging can be a key factor in regard to shelf life and quality of fish. In the project "Optimal packaging of pelagic fish"[3], the shelf life and quality of herring products wrapped in different packaging materials was assessed. The shelf life of various 20 kg vacuum packs

was tested in pervious and impervious packaging with varying oxygen barriers. The project revealed that the shelf life of herring cuts can be extended from 8 to 12 months by packaging in 20 kg vacuum packs instead of barrels.

The project also examined end-user packaging, where storage trials were carried out and showed that thermoforming equipment intended for 20 kg packaging can be used to manufacture retail packs with adequate shelf life for the fresh fish market.

Assessments made of environmental conditions in regard to packaging

In 2012 a project was initiated to prepare a joint, established methodology for documenting environmental, cost and resource conditions for packaging of fresh seafood for transport. The methodology was tested on actual cases in the Norwegian seafood market involving the participating companies. One objective was to find environmental, cost and resource-effective packaging solutions for Norwegian seafood.

Various analyses show it is vital to take the entire value chain (from packing station to customer) into consideration when evaluating the efficacy of the packaging systems. It is important that data pertaining to the actual packaging systems for the alternative solutions are documented in a credible and comparable manner by, among other things, ensuring fair and equal competition.

Analyses have been made based on methodology for life cycle assessments. The project placed particular emphasis on how the packing system affects the product's environmental impact and cost. The methodology being developed is now formalised as a "PCR" (Product Category Rule). EPD's (environmental product declarations) will be developed on the basis of this methodology. The environmental product declaration is a widespread, internationally recognised ways to document the environmental impact of a product in a Business to Business context. The process is carried out by Østlandsforskning in coordination with Standard Norway, financed by FKD and FHF, for the purpose of developing a PCR for seafood[4].

Transport

Of a total export of 2.3 million tonnes in 2012, more than 1.2 million tonnes were to the EU. Most of this was transported by truck. Pelagic fish, on the other hand, were mainly transported by boat, and the same applies to much of the clipfish.

The European road network has inadequate capacity, which presents a challenge for the companies in transporting their fish. The road network, particularly in Norway, is in bad condition in many places. In winter drivers often have to deal with closed roads and treacherous driving conditions.

In general, national goods transport by road accounts for an increasing portion of the greenhouse gas emissions in Norway. Discharges from heavy vehicles have increased by 62 per cent from 1990 to 2011 and are responsible for almost half of the discharges from the country's vehicle fleet.

The National Transport Plan 2014–2023 (NTP) lays considerable emphasis on limiting the negative impact transport has on the environment. The Government's objective is to have the transport sector contribute toward reducing greenhouse gas emissions in line with Norway's climate targets as stated in the climate policy notification (Note. St. 21 Norwegian climate policy).

Efficient transport systems reduce greenhouse gas emissions

Scattered rural settlements and long distances contribute to Norwegian industry having higher transport and logistics costs than countries we compete against. It is therefore also vital we create an efficient transport system that can reduce distance costs and thus also greenhouse gas emissions and competitive drawbacks for Norwegian industry. This will also be conducive to reducing the level of costs for goods and services in Norway.

Current initiatives

Through the Norwegian Transport Plan (NTP) the Government will lay the groundwork for transferring goods from the roads to rail and sea. This type of transfer is crucial in reducing greenhouse gas emissions

connected to goods transport. Not least, this is important because freight and goods transport is expected to increase by 40 per cent by the year 2030. As climate measures in the transport sector are costly, the NTP intends implementing measures that have positive effects also in regard to the climate effect.

Conversion of goods transport to railways will on its own have greatest effect on climate and energy consumption, to be followed by conversion to transport by ship.

Rail initiatives provide more efficient employment market regions, and goods transport by rail improves transport to towns and cities. The railway's main advantage is that it is area-efficient, transport with high capacity, low noise and no local air pollution. Measures that will ensure this are:

* increasing passage for goods transport on roads by improving the existing transport network and expanding road capacity so that anticipated growth in traffic can be developed in a good way.
* facilitate increased rail transport of goods through improved operational stability, with enhanced punctuality and regularity.

The Government will lay the groundwork for equipping the ports to ensure the switch between different means of transport is simpler and more efficient.

Eco-certification of production plants/ facilities

Several of the major production plants/facilities (fish landing stations, salmon packing stations and various value-added processing (VAP) plants) have comprehensive audit systems to ensure food safety, but many of these also have chosen to certify their operations according to recognised international standards that focus especially on food safety. Several of these standards are also focused on the environment and safety.

References

1) FHF, COWI (May 2013): Evaluation of energy and emission reduction measures in the fishing fleet.
2) Sintef (2010): Fact sheet on energy consumption in the fish industry.
3) Sintef (2008): Optimal packaging of pelagic fish.
4) FKD, FHL, Standard Norway, Østfoldforskning (2013): Documentation of environmental, cost and resource conditions connected to diverse transport packaging solutions for Norwegian seafood.

5.c Utilisation of by-products and rest raw materials from fisheries and aquaculture

Status and challenges

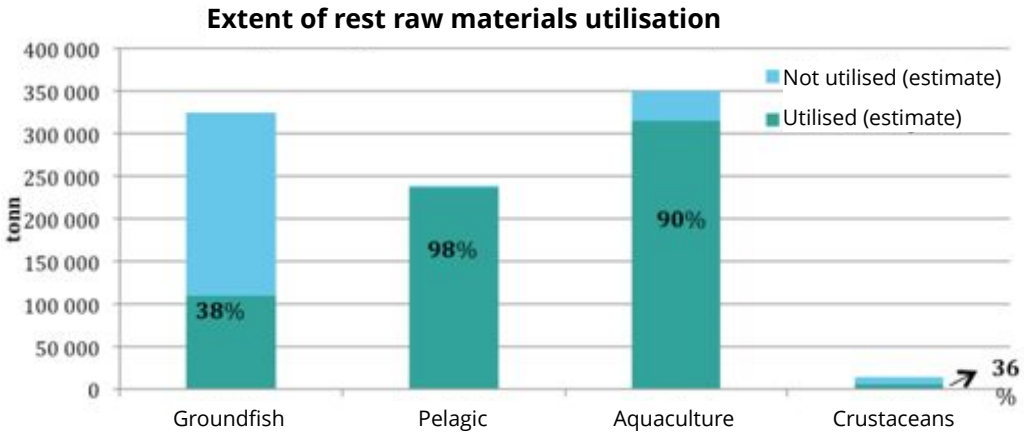
Almost all of the rest marine materials are taken ashore and processed in a worthwhile manner. Even though there is still considerable potential to optimise exploitation of the material, these resources already contribute significantly to value creation in the fisheries and aquaculture industry[1]. This is an important and correct progression toward the target of utilising all the fish/crustaceans from catches and aquaculture in their entirety and in a worthwhile manner. Stable supply and large volumes of raw materials from the aquaculture industry have formed an important basis for building the marine ingredients industry that is based on marine rest raw materials (offcuts, heads, spines, fish offals). The industry has grown steadily and solidly during the past 10 years[1].

Almost all rest raw materials and by-products from the aquaculture sector and pelagic fisheries are utilised. In the cod fishery just under 200,000 tonnes of rest raw materials are still discarded, mainly through offals and offcuts from fish processed at sea goes back into the marine environment. Here the potential is massive for gaining access to raw material and thus an increased supply of fish oil, fishmeal and other marine proteins. This also applies to the shrimp industry (see graph 5.c.1). The unexploited raw materials in the cod sector can readily be dealt with, but to do so we are dependent of adjustment in regulations.

Rest raw materials and by-products in general
All raw materials left over during slaughtering and value-added processing of farmed fish or landing and processing of wild fish can be used in food production. The prerequisite is that at all levels the raw materials are handled in accordance with the hygiene regulations for food products.

Rest raw materials can be further processed for high-grade processed products such as fishmeal, fish oil, fish hydrolysate etc. for use as food, food ingredients or dietary supplements. Currently around 10% of the total volume of rest raw materials and by-products are utilised for these products. Use of fresh offals and offcuts from salmon for extraction of oil and hydrolysated proteins has increased significantly in the last five years.

In all Norwegian seafood production there are also whole fish or parts of fish that cannot be used as food for human consumption. According to legislation these are by-products that cannot be used as food. Depending on the origin, these by-products may be suitable for use in feed for food-producing animals or for technical purposes such as production of bioenergy. The regulations



Graph 5.c.1: Overview of extent of rest raw materials utilisation – by sector. *The overview shows the degree to which rest raw materials from different fisheries, aquaculture and crustaceans are utilised. With the exception of blood, leftovers from aquaculture are utiilised 100%. (Source: Directorate of Fisheries, Statistics Norway, Norwegian Seafood Council, sales associations, Kontali Analyse and SINTEF)*

Almost all rest raw materials and by-products from the aquaculture sector and pelagic fisheries are utilised.

categorise the various by-products in different categories. The overwhelming share of fish by-products, around 90%, is so-called Category 3 material that can be used as feed for food producing animals, including farmed fish.

A limited percentage of 54,000 tonnes of Category 2 fish by-products from aquaculture cannot be used in feed for food producing animals. Category 2 fish by-products are mainly dead fish from fish farms that are menced, ensiled with organic acid to pH <4 and stored before further processing. This category is applied to production of biodiesel, biogas and biochemicals. Other areas of use are as feed ingredients for fur-bearing animals etc.

"The ensilage industry", i.e. receivers of ensilage from Category 2 fish by-products, has played a major role in the establishment of nationwide logistics systems for ensilage and is a vital prerequisite in enabling aquaculture to grow so rapidly and at the same time having the opportunity to deal with these by-products. The edict of a 0-emissions regime for the aquaculture industry appears to have encouraged growth in this industry and turned a possible environmental challenge into useful, valuable products (marine oils and fish protein concentrate) for the European feed industry[2].

In total the result is an efficient, hygienic and quality assured treatment of all by-products from fish farms and packing stations.

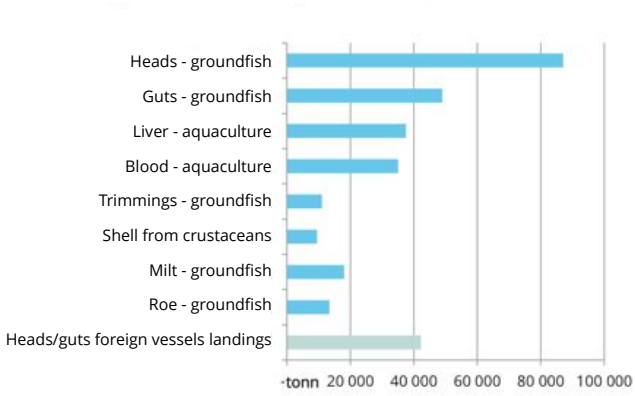
Utilisation

Marine rest raw materials and by-products from fisheries and aquaculture in 2012 totalled around 929,000 tonnes[2]. This is equal to about 29% of all fish caught and produced in fish farms in Norway that year. In 2012 no less than 72% or around 670,000 tonnes of rest raw materials/by-products was utilised. How the various parts were used is shown in graph 5.c.3. Graph 5.c.2 provides an overview of which parts are as yet unutilised.

Of the around 670,000 metric tons of rest raw materials and by-products from the Norwegian fisheries and aquaculture industry that are utilised, approximately 4% is from the aquaculture industry, 36% from pelagic fisheries, 16% from the groundfish sector and 1% from crustaceans.

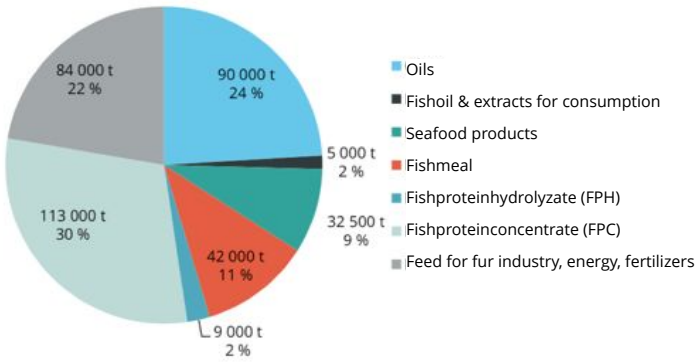
Sales for the industries that utilise rest raw materials and by-products have grown 49% in the last 5 years. The fastest growing section of the marine ingredients industry is fresh extraction of oil and enzymatic hydrolysis of protein from salmon offals/offcuts. Revenue from this type of processing has increased 247% in 5 years. In the pelagic sector most of the rest raw materials are used in

Yet unutilised rest raw materials and by-products



Graph 5.c.2: Overview of as yet unutilised rest raw materials and by-products. *The overview shows which parts of fish raw materials are still not utilised, in tonnes in 2012. (Source: Companies and SINTEF)*

Rest raw materials utilisation 2012



Graph 5.c.3: Overview of the degree of rest raw materials utilisation – by sector. *Use of rest raw materials and by-products in different productions in % and tonnes in 2012. (Source: Companies and SINTEF)*

production of fishmeal and fish oil for feed. In 2012 the fishmeal and fish oil industry received a total of 159,000 tonnes, of which around 88% was fresh herring offcuts. These are MSC certified fish.

Implemented initiatives

The FHL's primary objective is to exploit the value creation potential of marine by-products and rest raw materials to the fullest. There have previously been several projects completed in cooperation with Rubin documenting diverse processing methods in regard to use of aquaculture by-products in feed.

The FHL has a separate sector group for the marine ingredients industry. It covers a diversity of productions based on by-products and rest raw materials from Norwegian fisheries and aquaculture activities.

Future objectives

All raw materials from fisheries should be landed and used as a resource. This can help towards increasing production of marine products for human consumption or feed.

The FHL is working to achieve safe and appropriate utilisation of marine resources. It is important to accomodate the best possible foundation for value creation from the ocean, while at the same time ensuring that human and animal health is attended to. The EU's food hygiene legislation regulates use of marine rest raw materials for human consumption and thus the greatest potential for value creation. The EU's by-product ordinance regulates handling and use of by-products for feed or technical application, and is also an important part of the framework conditions.

A new animal by-product regulation was implemented in EU on 4th March 2011. As Europe's largest seafood nation, Norway has been a supplier of premises and expertise,and has contributed in ensuring that the legislative terms and conditions are proportionate in relation to risk, without placing necessary restrictions on handling of by-products from aquatic animals. Norway also plays a role in improving 'elbow room' in regard to marine ingredients for human consumption.

The FHL will have further work towards ensuring that by the year 2025 the Norwegian seafood industry will optimize the use of all marine resources harvested. Primarily, the resources shall be utilised directly or indirectly (as feed) for food production. Material that is not suitable for food production may be used, for example, in production of energy. In 2025 the goal must be that the products are not divided into main product and and rest raw materials, but that everything is treated as a combined, valuable resource[3].

New measures

It is important to continue the work of documenting and approving new handling methods for the different categories in the regulations. This involves the simplest treatment methods possible so that hygiene requirements are met, but that unnecessary heat treatment is avoided. The methods shall naturally be safe from spreading infection, also when marine by-products are used in fish feed for farmed fish.

Efforts will concentrate on developing new products for human consumption. At present the focus is on making the most of fish by-products for use in feed production. Future projects will focus on landing of fish and utilisation of all marine raw materials and development of essential solutions for logistics and refrigeration/chilling.

References

1) Sintef fisheries and aquaculture (2012): Analysis of marine rest raw materials.
2) Sintef fisheries and aquaculture (April 2013): Norwegian marine ingredients industry.
3) FHL (2013): Seafood 2025 – How to create the world's foremost wild fisheries industry?

FHL will work towards ensuring that by the year 2025 the Norwegian seafood industry will utilise all marine resources harvested from the sea in an even more optimal way than is currently practised.

5.d Feed and feed raw materials

Status and challenges

A major concern of the aquaculture industry is ensuring that feed raw materials used for fish feed are harvested sustainably. This requires that these raw materials originate from regulated fisheries that are managed and approved in accordance with national fisheries authorities and in line with international agreements.

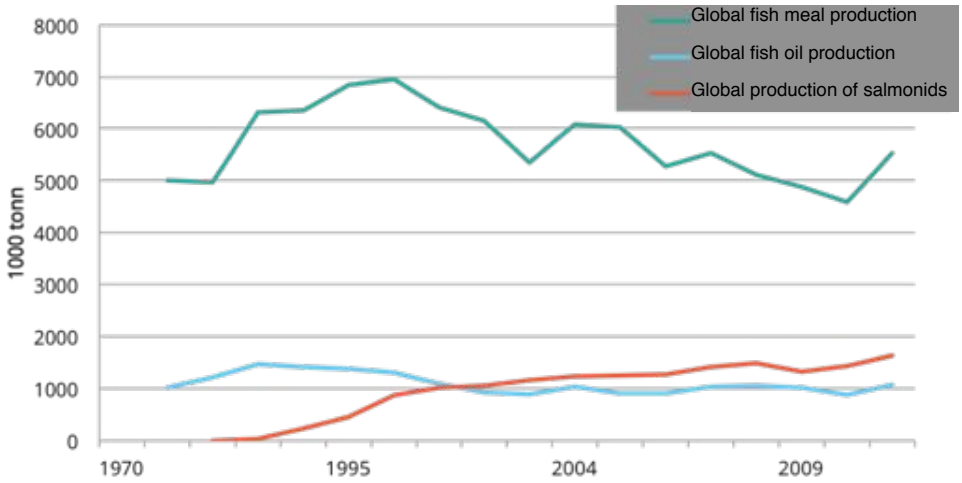
Global supply of marine ingredients is limited. Therefore the feed companies have through several years of research played a role in ensuring that these raw materials are now used far more efficiently and that the percentage of marine raw materials is declining for all feed companies.An increasingly large percentage of marine raw materials are now rest products from fillet production. The pelagic consumption industry has managed to automate fillet production and implement a structure that provides sufficient production to effectively make use of offcuts industrially. All offcuts that are not fillet go directly to production of fishmeal and fish oil. This means that the whole fish is used, which in turn means a greater percentage of feed raw materials for salmon is offcut products from the herring industry.

65% of the feed in Norway in 2012 was comprised of vegetable material, including from soya, sunflowers, rape seed and wheat. Large amounts of rest raw materials are also used that the salmon utilises better than traditional agricultural livestock. Comprehensive research is currently being carried out on use of vegetable material in regard to optimal utilisation, and to find good and new sources for use in feed production. Focus is also on ensuring the source for vegetable raw materials is sustainable, where criteria must be met in regard to production and traceability. There are several certification arrangements for vegetable raw materials, and these certified raw materials are in demand with fish feed producers.

Increased production and use of vegetable material in feed

In 2012 a total of 1.7 million tonnes of feed was produced in Norway for the aquaculture industry. Farmed fish are now fed subject to stringent terms and conditions, the feed is more suitable and is utilised better and therefore the fish need less to grow. While on the whole the aquaculture industry has increased its production both nationally and globally in the last 30 years, production of fishmeal and fish oil has not increased accordingly.

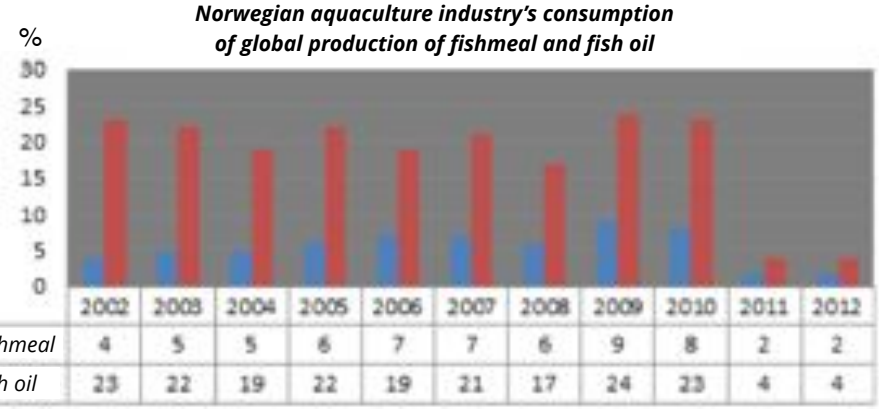
Norway's share of fishmeal and fish oil consumption on a global basis has increased in the same period, at the same time as an increasingly larger percentage of feed now consists of vegetable material. The percentage of fishmeal and fish oil will vary somewhat depending on supply and demand from the global market[1]. At present fishmeal and fish oil is produced from pelagic species,



Graph 5.d.1: production of fishmeal, fish oil and Atlantic salmon. *The graph shows how global production of salmonids has increased compared with global production of fishmeal and fish oil from 1970 up until 2011 (Source: IFFO and FHL)*

All offcuts that are not fillet go directly to production of fishmeal and fish oil. That means an increasing percentage of feed raw materials for salmon are offcut products from the pelagic industry.

Norwegian aquaculture industry's consumption of global production of fishmeal and fish oil



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Fishmeal	4	5	5	6	7	7	6	9	8	2	2
Fish oil	23	22	19	22	19	21	17	24	23	4	4

Graph 5.d.2: Norwegian aquaculture industry's consumption of global production of fishmeal and fish oil in %. *The graph shows the percentage of global production of fish oil and fishmeal used in feed for the Norwegian aquaculture industry.*

also called industrial fish, where almost exclusively species are used that are highly unsuitable for use directly as human food. An increasing percentage is now derived from rest raw materials (skin, bones, guts etc.) from fish caught for human consumption. With few exceptions all fish are nutritionally suitable as human food, but nowadays with the standard of living rising in many major markets, demand is increasing for meat and fish of what is perceived to be higher quality than that offered by industrial fish.

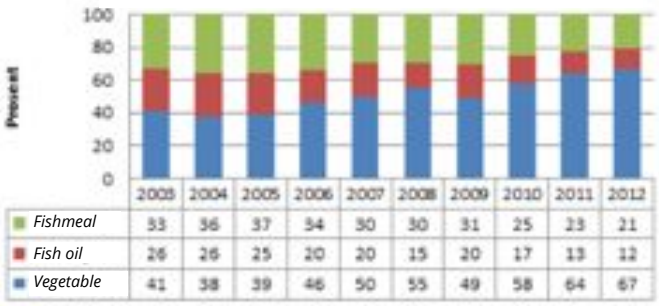
Fish that are directly suitable for food fetch a higher price in the market than what the feed industry is willing to pay, thus regulating use of the resource. We are also seeing an increasing percentage of feed now consists of vegetable material, at the same time as the percentage of fishmeal and fish oil in feed is being reduced year by year.

Figures for 2012 show that the trend of more vegetables in feed is continuing. From 2010 to 2012 the percentage of vegetable material in feed has risen from 58% to 67% (Graph 5.d.3). This means the percentage of marine ingredients in feed is declining and now accounts for 31.9% of the total volume used in 2012 (see Graph 5.d.4).

Increasing use of raw materials from neighbouring sea areas for production of Norwegian fish feed

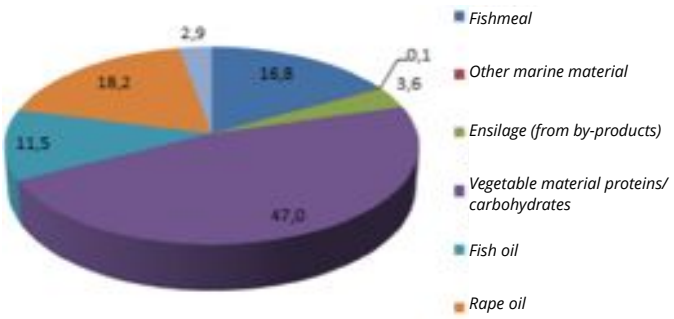
Geographically the Norwegian aquaculture industry is mainly dependent on fisheries in the north-east Atlantic Ocean and the south-east Pacific Ocean (Peru and Chile). Around 30% of Norway's fishmeal now comes from the

Main groups of raw materials in fish feed from 2003–2012



	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Fishmeal	33	36	37	34	30	30	31	25	23	21
Fish oil	26	26	25	20	20	15	20	17	13	12
Vegetable	41	38	39	46	50	55	49	58	64	67

Graph 5.d.3: Distribution between the main groups of raw materials in fish feed from 2003–2012: *The graph shows distribution of meal, oil and vegetable material in percentage, and illustrates clearly how since 2005 there has been a general reduction in the percentage of marine raw material in feed. (Source: FHL)*



Graph 5.d.4: Ingredients in Norwegian fish feed for 2012*. 65-67% of the feed now consists of vegetable material, while marine ingredients account for 31.9%.*

Fiskeart		Fiskemel				Fiskeolje			
Engelsk	Norsk	2009	2010	2011	2012	2009	2010	2011	2012
Anchovy	Ansjoveta	34	26	27	33	27	11	31	41
Blue whiting	Kolmule	9	7	1	2	2	1	<1	<1
Capelin	Lodde	2	6	27	21	<1	2	16	12
Herring	Sild	18	12	4	1	22	15	9	3
Sandeel	Tobis	8	13	14	3	3	11	7	2
Sprat	Brisling	7	7	6	7	11	21	13	12
Mackerell	Makrell	<1	1	<1	<1	<1	2	<1	
Jack mackerel		5	<1	1	<1	1	<1		
Horsemackerel	Hestemakrell		<1	0		<1	<1		
Pilcard	Sardin		<1		<1	8	3	1	1
Menhaden				0	<1	8	10	7	5
Norway pout	Øyepål	<1	5	1	<1	<1	2	<1	<1
Boarfish	Villsvinfisk	<1	3	<1	1				<1
Trimmings	Avskjær	5	17	17	31	5	20	15	24
Herring cuttings	Sildeavskjær	8		0		11			
Pearlside	Laksesild			<1			<1		
Silvercod	Sølvtorsk			0					
Krill	Krill			<1	<1				
Other species	Andre arter	1	2	<1	<1		2		<1
SUM		100	100	100	100	100	100	100	100
Mel (1000 tonn)		412	329	281	280				
Olje (1000 tonn)						267	220	193	193

Table 5.d.5: Fish species used in feed for the Norwegian aquaculture industry. *The table shows a simplified merging of fish species used in fish feed, i.e. an adjusted species distribution based on volume of fishmeal and fish oil, using figures from the three biggest feed companies in Norway. (Source: EWOS, Skretting, Biomar, FHL, Polorfeed 2011 og 2012)*

southern hemisphere, and anchovies are the principal species. In the northern hemisphere the principal species are capelin, sprat, sand eel, blue whiting, Norway pout and herring (only when the consumer market is unable to absorb catches), in addition to offcuts from aquaculture value added production. Some portions of the offcuts comes from fish species that are certified. More details are given in chapter 5.c. Total use of offcuts for meal and oil has increased from 5% in 2009 to 28% in 2012[2].

The salmon is our most efficient domestic animal

Salmon is a highly energy-efficient "domestic animal". If calculated from an average feed pellet, in Norway barely 1.5 kg of marine raw materials are used to produce 1 kg of farmed fish. Vegetable raw materials and raw materials from offcuts and by-products account for an increasing component of Norwegian fish feed[3].

Compared with pork and chicken, salmon is more than twice as efficient at converting feed to meat. This is also reflected in the utilisation of fishmeal and fish oil the last 30 years, where we now see an increase in use for aquaculture at the expense of land animals such as pork and chicken.

Increased use of fishmeal and fish oil for aquaculture and human consumption

The historic development shows a relatively sizeable change in utilisation of fishmeal and fish oil the last 20-30 years from agriculture to aquaculture. From a resource perspective this is particularly encouraging, as we know today's salmon is our most efficient "meat producer".

Fish oil with omega-3 has previously mainly been used for hardening of margarine, but also for paint and biofuel. The hardening process destroys the omega-3 such that it cannot be used by people. At times when fish oil is cheap, as was the situation in the spring of 2009, fish oil is still used in biofuel.

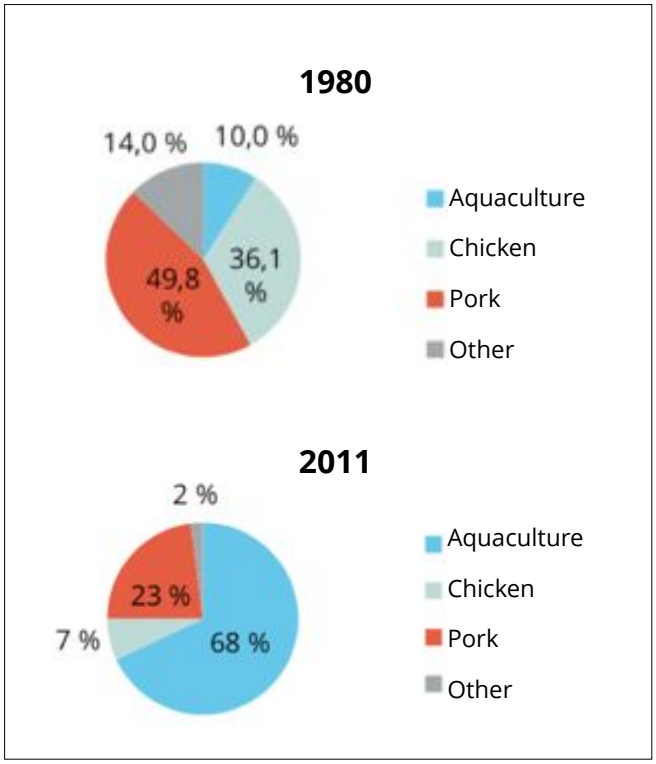
If using an average-sized feed pellet for the calculation, barely 1.5 kg of marine raw materials are used to produce 1 kg of farmed fish.

It is difficult to defend this use as long as this valuable resource could have been used for production of nutritious, health-promoting food for people.

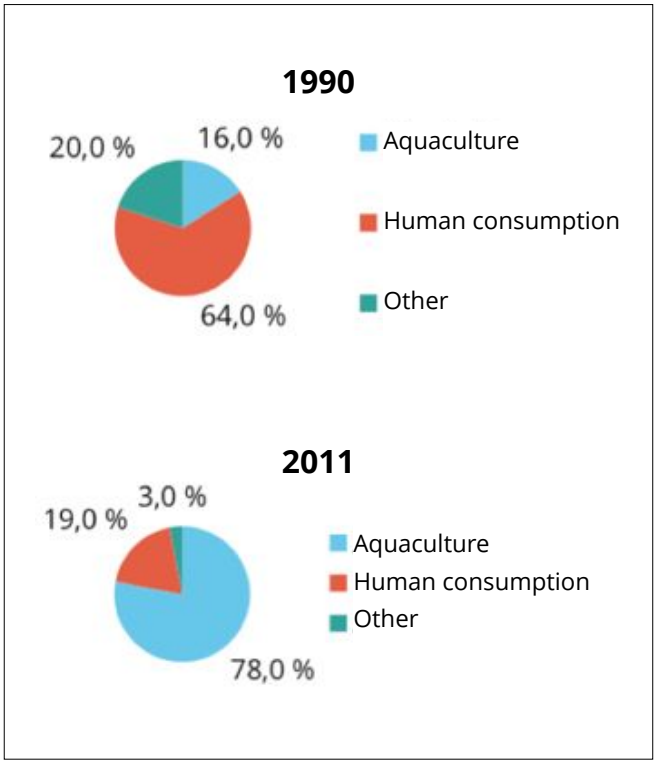
In the last 30 years use of fishmeal for aquaculture has increased from 10% to no less than 68%, and only 2% goes to production other than food (see graph 5.d.7 below). In 1980 only 16% of fish oil was used for aquaculture as opposed to 78% usage in 2011. Only 3% was used for other things than food production in 2011. In 1990 20% went on other usage (see graph 5.d.8).

Dyreart	Laks	Kylling	Svin
Spiselig del av dyret i %	65	50	50
Proteinandel (gram/kg)	190	200	165
Fôrfaktor	1,0	2,5	3,0
Proteinretensjon	31	21	20

Table 5.d.6: Utilisation of protein in the edible parts of pork, chicken and salmon. *The graph shows that the edible part of the salmon is very high, feed factor is low and utilisation of protein (retention) in feed is very good. This means if there is a shortage of a feed resource that can be used by diverse species of animals; it would definitely pay to feed the salmon as it is decidedly the most efficient species. The economic feed factor for salmon was 1.2 in 2012. (Source: FHL)*



Graph 5.d.7: Use of fishmeal from 1980 to 2011. *In 1980 about 86% of the global fishmeal production was used for land animals such as pork and chicken. From using just 10% of the meal production in 1980, aquaculture now uses no less than 68% of the world's production in 2011. (Source: IFFO)*



Graph 5.d.8: Use of the world's production of fish oil from 1990 to 2011. *The graphs show that more and more of the global fish oil production goes to aquaculture and is utilised in a better way than previously, where a large part of the oil was hardened and used elsewhere than in food production. In 2011 fully 78% of fish oil production went to aquaculture and 19% directly to human consumption. (Source: IFFO)*

Initiated measures and targets

Efficient utilisation of available feed raw materials
The feed producers and aquaculture companies are challenged to utilise the available feed raw materials as efficiently as possible. At the same time players in the industry are also looking at possibilities for using alternative raw materials, without this being at the expense of fish health, fish welfare and quality.

This development is well under way due to improved composition and digestion of the feed, as well as through increased use of fish offcuts and vegetable material, but also through improved feeding systems and feeding methods. In total this has resulted in a reduction of the feed factor (the amount of feed needed to produce 1 kg of fish) of at least 15-20% over the last 30 years.

Less dependent on marine raw materials
The feed manufacturers and aquaculture companies are working to find the most efficient ways to utilise available resources, at the same time as alternative raw materials are being brought into use. Dependency on wild fish has been radically reduced. While in 1990 around 4 kg of marine raw material was needed to produce 1 kg of salmon, now only around 1.5 kg of marine raw materials are needed[7]. Dependency on wild fish is thus greatly reduced.

Research is also being carried out to find alternative marine sources for feed. This concerns looking at the potential for exploiting surplus at a lower level in the nutrition pyramid (krill, zooplankton), production of marine fatty acids in plants, use of single cell protein and increased use of fish offcuts. To stop using fishmeal and fish oil is not a goal in itself. The requisite is that raw materials are responsibly managed and produced so that they do not undermine sustainability in the industry. Specific criteria are defined for suppliers and followed up during supplier audits[1].

New global standard and certification arrangement for suppliers of fishmeal and fish oil implemented
Developments in the global fishmeal and fish oil market have created a need to draw attention to sustainable harvesting, and reliable production of ingredients for aquaculture, agriculture and products that go directly to human consumption. The International Fishmeal and Fish Oil Organisation (IFFO) has therefore developed a global standard and certification programme for responsible supply of fishmeal and fish oil (IFFO R/S)[4]. The standard makes demands in regard to responsible selection of raw materials, i.e. it requires that the fisheries live up to the United Nations' (UN) Food and Agriculture Organisation's (FAO) international codex for responsible fisheries. The standard also states that it must be possible to trace the origin of the fishmeal and oil back to these fisheries, and that the meal and oil is produced in a responsible and safe manner. An overview of the percentage of eco-certified fish is provided under the paragraph on eco-certification of fisheries (chapter 5a).

IFFO R/S certification of industry fisheries
Fish supplied for production of fishmeal and fish oil are often referred to as industrial fish. The IFFO R/S certification of these fisheries is covered in more detail in chapter 5.b. By the year 2015 it is expected that 9 million tonnes of raw material will be certified. This would represent 40% of the global production of fishmeal and fish oil[5].

Norwegian feed producers put demands on the suppliers about sustainability
Suppliers of marine raw materials to the Norwegian feed industry must document that fish used in production of fish oil and fishmeal have been caught in a responsible manner, without depleting fish stocks or harming the marine environment.

It is required that these raw materials originate from regulated fisheries that are managed and approved in accordance with the national fisheries authorities' regulations and in line with international agreements. Furthermore, the feed industry is the driving force behind suppliers being able to provide satisfactory, systematic tracking documentation on the species used in fishmeal and fish oil production. The feed companies make regular audit visits to their suppliers to ensure information they have received is correct and in accordance with the set criteria. The feed industry's goal is to ensure the species used in fishmeal and oil production are from sustainable

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Fishmeal	229	264	288	325	325	334	360	412	329	281	280
Fish oil	196	206	212	219	195	225	178	267	220	193	193
Vegetable	331	322	309	344	440	564	649	595	757	945	1094
Slaughtered	528	567	600	680	778	858	863	1025	995	1128	1347
Feed factor	1,21	1,28	1,26	1,24	1,16	1,24	1,32	1,28	1,3	1,3	1,19

Graph 5.d.9: Feed consumption in Norwegian production of salmon and trout. *The graph shows feed consumption in Norwegian production of salmon and trout. One can see how the percentage of marine raw materials has not increased as a consequence of increased production of salmonids. The graph also shows the economic feed factor (amount of feed used per kg of slaughtered fish) in the period. The biological feed factor (amount of feed used to produce 1 kg of meat) is not shown in the graph, but has been reduced by 15-20% the last 30 years. (Source: IFFO and FHL)*

fisheries. Focus is also on sustainable vegetable raw materials in regard to requirements for production and traceability. There are several certification programmes for vegetable raw materials. Certified raw materials are in demand amongst fish feed manufacturers.

New measures

The industry is preparing to contribute towards sustainable utilisation of marine resources

The industry is preparing to cope with continued relative reduction in dependency on fishmeal and fish oil for a growing production and demand for seafood. The Norwegian authorities have been an active motivator in stamping out illegal, unregulated and unreported fishing, (UUU fishing). Massive quantities of marine raw materials are still cast overboard as waste each year and Norway has had its proposal accepted in the FAO, the UN's Food and Agriculture Organisation, for a global agreement on port state inspection, where the FAO is now preparing guidelines for limiting discards and by-catches[3].

The salmon is a net producer of marine protein

It is already known that the salmon is a net producer of marine protein because vegetable proteins in feed are actually converted to fish proteins. Fish oil, on the other hand, presents the biggest challenge.

Given that production is expected to grow to 2.7 million tonnes by 2025, there will be a shortage of fish oil even if all fish oil should go to salmon feed.

Availability of marine raw materials can be improved by laying the groundwork for increased utilisation of by-products in processing of fish for human consumption and that rest raw materials on board the fishing fleet are also landed.

Additionally the introduction of a ban on discards in other countries, including the EU, could play a role to some extent in ensuring raw materials from this type of landing do not go directly to human consumption[6].

Future measures to ensure sustainable access to feed sources

There is still enormous potential in exploiting discards from fisheries (estimated at 20 million tonnes per year) and waste from diverse processing methods (estimated at

maximum 30 million tonnes per year). Utilisation of these resources will contribute towards doubling available marine feed resources and a potential doubling of production.

Developments in the salmon industry in the last ten years are based on a growing use of vegetable material, and the salmon is thus moved one step down the food chain. The future perspective for marine value creation is estimated at NOK 550 billion by 2050. This will require around 6 million tonnes of fish feed and comprehensive research on new and more efficient feed resources[7].

FHL will intensify its efforts to effect a ban on discards (including the EU) and wishes to cooperate with other organisations that have the same goal, such as NGOs. The feed industry will support research for possible exploitation of other sources of omega-3 for salmon. By reducing discards, utilising rest raw materials better and stepping up R&D efforts to develop alternative feed sources, the industry believes it will be capable of increasing access to feed sources parallel to growth in production[6].

References

1) Skretting (2010): Skretting Environmental Report
2) Skretting, Ewos, Biomar, FHL (2012). Polar Feed (2011, 2012).
3) FKD (February 2011): Aquaculture policy statement.
4) IFFO (Sept 2009): Global Standard for Responsible Supply.
5) Shepherd J, Jackson A, IFFO (April 2011).
6) FHL (2012): Seafood 2025 – How to create the world's foremost aquaculture industry
7) The Royal Norwegian Society of Sciences and Letters (DKNVS) and the Norwegian Academy of Technological Sciences (NTVA), (2012): Value creation based on productive seas by the year 2050.

5.e Aquaculture production figures and statistics

Status and progress

The Norwegian aquaculture industry is an industry in a constant state of development. Production of salmonids continued to grow also in 2012, despite no new allocation of production licences after 2009 or more sites activated for farming of salmon and trout in recent years.

From 2011 to 2012 sales of salmon and trout increased by 17% and 20% respectively, according to figures from the Directorate of Fisheries and Statistics Norway in June 2013. The increase is due to a number of circumstances. More suitable farm sites are operative, and comprehensive site surveys have helped towards more optimal location of fish farms in relation to flow and seabed topography. With new knowledge and target-oriented efforts, producers have become more adept at exploiting production potential within existing production licences. In the same period, production of other marine species and crustaceans has continued to decline.

While 97% of the licences at sea production of salmon and trout were operative in 2012, only 32% of the licences for marine fish species were operative. 44% of the licences for crustacean production were operative in 2012[1]. In this sector market-related conditions are mainly to blame for the downturn in production and profitability in recent years. However, gross sales of scallops have shown a positive trend since 2008, even though sales are still a long way off the peak years of 2001 and 2004. In terms of volume of molluscs sold, common mussels are still decidedly number one in Norway, with volume of around 2000 tonnes in 2012.

In general aquaculture is an industry of growing significance, with vital ripple effects for the seafood nation of Norway. Substantial annual contributions to the gross national product (GNP) are important. Another and perhaps equally important aspect of this development is the industry's decisive contribution to maintaining and even promoting growth in settlement in a number of rural municipalities. This applies to many local communities along the entire Norwegian coast where aquaculture and/or related industries play a vital role in providing numerous jobs and activitiy in rural areas.

Eco-certification of aquaculture

There are a number of different certification programmes in the aquaculture industry. Several of these are also linked to the environment and environmental impact of production. A lot of sites have made a tremendous effort and attained GLOBALGAP certification, a certification scheme that in varying degrees covers several elements of sustainability, including traceability and food safety. It covers the entire production chain from feed to retail outlet. Many are also certified according to the international eco-standard ISO 14001.

The ASC standard for salmon production

The FHL decided to become actively involved in development of the standard for sustainable production of salmon through the Salmon Aquaculture Dialogue (SAD). The World Wildlife Fund (WWF) took the initiative to the dialogue and a number of interest groups from across the globe participated in developing the standard. The FHL had one representative in the executive group, and participated in this work in a number of contexts.

Following a comprehensive process, the work carried out in the SAD has resulted in the salmon standard of the Aquaculture Stewardship Council (ASC). The ASC is the organisation that administers the standards for responsible aquaculture production of various fish species that were developed through a total of eight different Aquaculture Dialogues.

The ASC is now completed and an audit manual and checklist have been prepared. Many have shown interest in the standard and a number of aquaculture companies have initiated the process for certification of farm sites.

Even though the FHL – through the executive group – has participated in the development work, this does not imply that the FHL has endorsed the standard or committed its

In 2012 the volume of salmon sales totalled 1,241,482 tonnes and the volume of rainbow trout sales totalled 70,364 tonnes.

members in regard to certification. Nonetheless the FHL has faith in that this standard, which has been developed through such a comprehensive process and with opportunities provided for contributions from all the different participants, will gain significance in the future. The ASC label complements the MSC label (Marine Stewardship Council) that is used on certified, sustainable wild catch fish.

Many of the different certification programmes mentioned above require that the whole production chain is certified. Control over traceability is an important reason for this and as such is a part of this chain certification.

Statistics and development in aquaculture

On this and the next page are overviews of the number of licences per county (2008-2012) for production of salmonids, marine fish species, molluscs and crustaceans , and a county overview of developments in smolt put to sea, salmon and trout given in number of individuals. Additionally, there is an overview of existing salmon biomass in the sea throughout the year.

Fylke/*County*	2012	2011	2010	2009[1)]	2008
Finnmark	25	26	33	35	63
Troms	16	20	21	21	21
Nordland	118	141	179	201	198
Nord-Trøndelag	20	19	16	23	34
Sør-Trøndelag	17	15	16	16	27
Møre og Romsdal	41	60	76	82	98
Sogn og Fjordane	31	51	54	62	67
Hordaland	59	71	62	69	77
Rogaland	48	46	39	64	70
Vest-Agder	5	5	3	3	6
Aust-Agder	6	6	7	7	8
Øvrige fylker	7	7	7	8	9
Totalt/*Total*	393	467	513	591	678

Graph 5.e.2: Overview of number of licences for production of other marine fish species. *The graph shows per county distribution of licences for production of other marine species such as cod, halibut etc.*

Fylke/*County*	2012	2011	2010	2009[1)]	2008
Finnmark	6	7	6	7	16
Troms	8	6	10	10	16
Nordland	39	47	66	100	119
Nord-Trøndelag	28	35	38	41	41
Sør-Trøndelag	23	24	24	32	33
Møre og Romsdal	15	22	22	26	32
Sogn og Fjordane	28	34	46	52	66
Hordaland	61	79	81	87	104
Rogaland	26	26	27	41	47
Vest-Agder	8	8	9	9	13
Aust-Agder	23	24	24	26	26
Øvrige fylker	19	23	24	25	24
Totalt	284	335	377	456	537
Tonn solgt		1926	2001	1727	2053

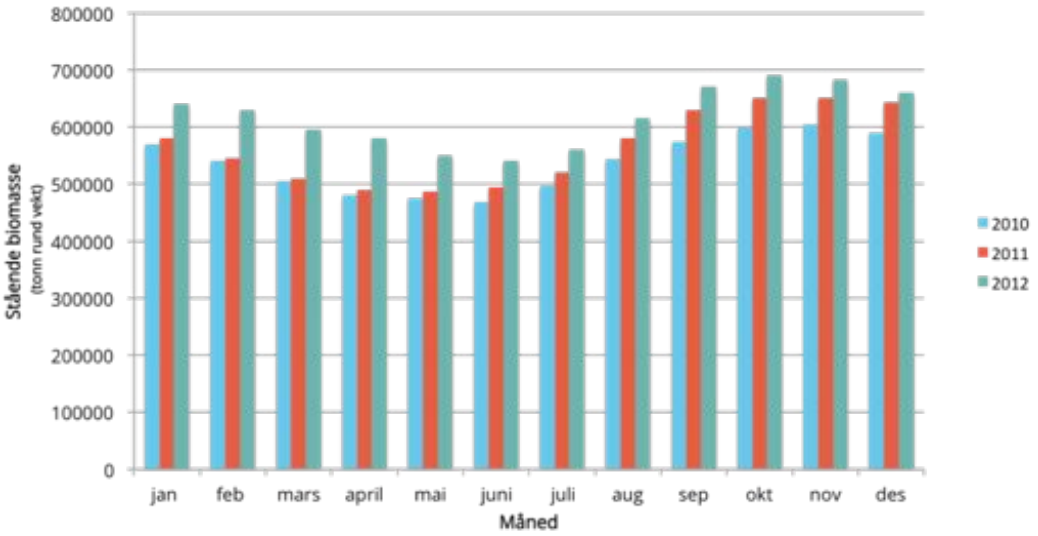
Graph 5.e.3: Overview of number of licences for production of diverse crustaceans per county and total volume sold per year. The overview shows per county distribution of the number of licences *for production of diverse crustaceans such as blue mussels, lobster, scallops, sea urchins and oysters. Most of the licences apply to blue mussels, but far from all licences are operative. The number of tonnes of crustaceans sold per year shows a tiny decline, but has not changed markedly in the period 2008-2011. (Source: Directorate of Fisheries)*

	2012		2011		2010		2009	
	Settefisk	Matfisk	Settefisk	Matfisk	Settefisk	Matfisk	Settefisk	Matfisk
Fylke	Antall	Antall	Antall	Antall	Antall	Antall	Antall	Antall
Finnmark	4	90	3	90	4	90	4	90
Troms	11	95	11	94	11	94	11	93
Nordland	32	161	32	161	31	160	33	156
N-Trøndelag	16	70	16	70	16	70	17	71
Sør-Trøndelag	21	93	20	93	21	93	22	94
Møre og Romsdal	35	110	36	110	35	110	34	108
Sogn og Fjordane	23	88	23	89	23	89	23	90
Hordaland	62	156	61	157	60	157	60	154
Rogaland	18	59	20	61	21	61	21	61
Vest-Agder	3	16	3	16	3	16	3	16
Aust-Agder	1	3	1	2	1	2	1	2
Øvrige fylker	9	22	21	47	23	49	27	53
Totalt	235	963	247	990	249	991	256	988

Graph 5.e.1: Overview of the number of licenses for production of salmon and trout in operation. *The list includes all commercial production of juveniles, ie, onshore production of smolt and fish stocking ready for further production in the sea. Some hatcheries for salmon and trout smolts are commercial, and thus also on the list. Overview of brood fish (33 licenses in 2012) and concessions for R & D (44 licenses in 2012) is not included in the list of licenses for the production of fish in the sea. (Source: Directorate of Fisheries, 2013)*

Graph 5.e.4: Overview of releases of smolt per county (number per 100 pcs). *The graph shows a county overview of the number of smolt/ juveniles of salmon and rainbow trout in the period 2009-2012, given as per 1000 pcs, and is calculated on the basis of the overview of purchased smolt (external suppliers and smolt supplied from companies' own smolt facilities (internal depots). (Source: Directorate of Fisheries, 2013)*

	2009		2010		2011		2012	
Fylke	Laks	R.Ø	Laks	R.Ø	Laks	R.Ø	Laks	R.Ø
Fin. og Troms	16 000	0	18 000	0	21 000	0	25 000	0
Nordland	50 000	0	60 000	1000	64 000	1 000	68 000	1 000
N-Trøndelag	26 000	0	31 000	0	35 000	0	32 000	0
Sør-Trøndelag	26 000	2 000	26 000	2 000	27 000	2 000	24 000	3 000
Møre og Romsda	35 000	2 000	36 000	2 000	41 000	2 000	46 000	2 000
Sogn og Fjordan	19 000	3 000	19 000	5 000	23 000	5 000	17 000	5 000
Hordaland	44 000	7 000	50 000	8 000	58 000	7 000	57 000	8 000
Rogaland	14 000	1 000	15 000	1 000	16 000	3 000	14 000	1 000
Øvrige fylker	4 000	0	4 000	0	4 000	0	4 000	0
Totalt	234 000	16 000	259 000	18 000	288 000	20 000	287 000	19 000



Graph 5.e.5: Existing biomass in the sea 2010-2012*. Existing biomass (i.e. volume of fish in tonnes round weight) in the sea of Atlantic salmon during the year in 2010-2012. (Source: FHL)*

References

1) Directorate of Fisheries (2013): Statistics for aquaculture 2012. Provisional figures per June 2013

5.f Area in use for aquaculture

Status and challenges

Green production in "the blue fields"
Parliamentary report no. 22 (2012-2013) "The world's foremost seafood nation" was published in March 2013. The title is identical with the Government's vision for Norway as a seafood nation.

The basis for such an ambitious vision lies in Norway's unique coastal and sea areas. Norway manages sea areas seven times the size of its land areas, and governs over abundant fish stocks and other marine resources. 276 of the country's 430 municipalities border Norway's 21,000 km long coastline, which becomes 57,000 km long if you include all the islands. Within the base line there is access to 90,000 km^2 of sea area. Here you find clean waters, reliable water circulation and a sheltered coastline.

This is Norway's blue field; a natural resource ideally formed for harvesting and production of healthy seafood. A natural advantage that for more than 40 years has provided a real foundation for exceptionally area-efficient and climate friendly production of good, healthy food through aquaculture. Production, as with all other food production, leaves a footprint, but it still has little impact on the environment and normally does not leave long-lasting, visible traces in the environment when use of the allocated area ceases and the installations/facilities are removed.

The Government report stresses that the world's foremost seafood nation must "have a responsible seafood industry and utilise sea and coastal areas in a sustainable manner. Sustainable use is ensured through sound knowledge, a good management system and good practice[1]. We all agree on that; this has to be the prerequisite, and is what the FHL and Norwegian aquaculture industry strives to achieve every single day.

Area-efficient and sustainable food production
The Norwegian strategy for an environmentally sustainable aquaculture industry states: *"Efficient area usage is use of an area that can provide the basis for best possible production within a limited geographical area and without unacceptable negative impact on the environment"[2].* Aquaculture meets the vast demand for food by producing large amounts within a highly limited geographical area. What is an acceptable level of impact on the environment is a political issue, where evaluations and weighing up the pros and cons must at all times be based on available, objective and documentable knowledge.

When political decisions are made regarding the efficient use of sea area, it is important to base it on the whole concept of sustainability, involving both environmental, social and economic sustainability.

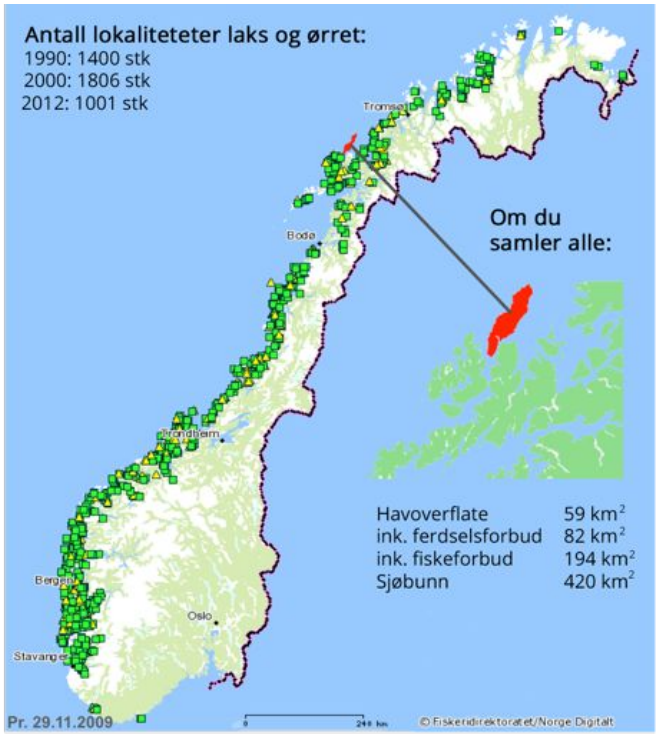
Nofima has used statistics from the Directorate of Fisheries as the basis for calculating and illustrating the area occupied by salmonid production in Norway as at November 2009. As shown by the table in Graph 5.f.1, the

	2012	2011	2010	2009[1)]	2008	2007	2006
Fylke	Antall	Antall	Antall	Antall	Antall	Antall	Antall
Finnmark	69	67	62	62	74	83	88
Troms	117	116	110	107	103	123	106
Nordland	206	203	196	197	192	236	198
Nord-Trøndelag	66	69	69	71	76	78	85
Sør-Trøndelag	91	97	94	80	91	94	110
Møre og Romsdal	90	100	107	105	110	142	126
Sogn og Fjordane	82	81	96	99	106	116	115
Hordaland	196	200	203	197	211	240	230
Rogaland	71	74	73	64	63	74	66
Vest-Agder	11	11	11	11	9	9	9
Aust-Agder	2	2	2	3	3	3	3
Øvrige fylker	0	0	0	0	0	0	0
Totalt	1001	1020	1 023	996	1 038	1 198	1 136

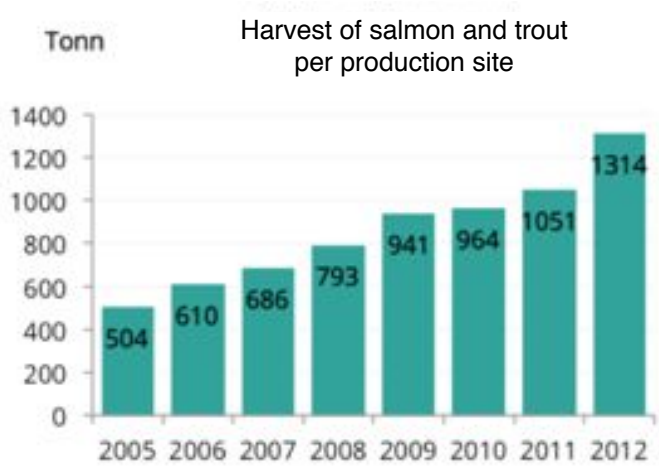
Graph 5.f.1: Number of marine farm sites per county. *Distribution per county of marine farm sites producing Atlantic salmon and rainbow trout updated per 31.1.2013. The graph shows the total number of sites has declined in recent years. This has occurred parallel with an increase in production. Meanwhile, more suitable sites have been brought into use that tolerate a higher level of production. (Source: Directorate of Fisheries)*

number of sites for production of salmon and rainbow trout was reduced to 1001 farm sites in 2012. These sites, which in total cover an area less than the size of Andøya Island and use less than 0.5% of the total sea area within the base line, produced in 2012 around 1,240,000 tonnes of salmon and 75,000 tonnes of trout. This amounts to a total of 1,315,000 tonnes of seafood, or around 14 million meals of salmon and trout that are exported daily throughout the year (see graph 5.f.3).

Even though the number of aquaculture sites (both fish and crustaceans) has been drastically reduced in recent years, on average each site is now bigger than previously and several farms have been moved out to deeper waters and more exposed locations. Each site therefore requires more space, and thus area occupied is on the whole relatively stable. The total area occupied of around 420 km2 includes the area seen on the sea's surface (approx. 59 km2), a ban on traffic 20 m around the farms (approx.



Graph 5.f.2: Overview of area usage. *The overview shows area occupation for marine production of salmon and trout as at November 2009. The number of operative farms has declined since then, but farm sites are larger and area occupation therefore practically the same. (Source: Nofima)*



Graph 5.f.3: Harvest of salmon and trout per operative production site. *The overview shows that area-efficiency continues to improve. In 2012 average production for the entire country was 1,314 tonnes of salmon and trout per farm site. (Source: Nofima)*

82 km2) and no-fishing zones extending 100 m from the farms (approx. 194 km2). About 60% of the farm sites are operative at any given time, so that the actual area occupied is considerably less. In comparison, operative agricultural land in Norway in 2012 occupied no less than 9,892 km2, or around 3.3% of Norway's surface area3.

Highly suitable sites are a prerequisite for area-efficient production

The trend continues of increased production at fewer sites and less space required per produced kilo of seafood. While the number of farm sites today is almost half that of the late 1990s, production in total and per site has increased in the same period. This is shown in Graph 5.f.4 and illustrates that production of salmon and trout in the Norwegian aquaculture industry is increasingly efficient in use of the area it occupies.

A given for this development has been increased knowledge about what characterises a good, suitable site for aquaculture and technological progress that enables production to take place in deeper waters and sites that are more exposed to weather and currents. Important catchwords in this context are good water exchange, thorough knowledge of seabed conditions and optimum

While the number of farm sites today is almost half that of the late 1990s, production in total and per site has increased in the same period.

placement of a farm in relation to currents/flow and topography. These are important factors for ensuring a good production environment for the fish and good animal welfare, and to ensure minimum impact on the environment and area-efficient production. These elements have proven to correlate well.

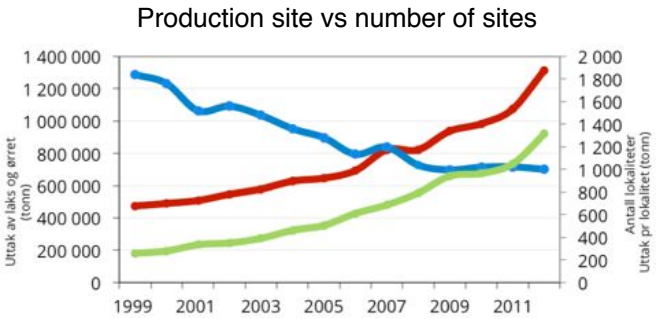
Area that is intended for aquaculture activities is carefully considered according to stringent regulations by several public bodies and administrative authorities. Sites are only approved if operation at the location is deemed to be environmentally responsible[4]. The size of activities that can be permitted at the site, i.e. the site's carrying capacity or maximum permitted biomass (MPB), is of major significance for the evaluation.

If the site is to have an MPB of 3600 tonnes or more, there are particularly stringent criteria for suitability. Graph 5.f.4 clearly indicates how development has in recent years steered more towards farm sites capable of larger production.

Competition for sea areas intensifying

Many different interests are linked to use of the coastal zone. These range from conservation interests and recreation to vital industrial interests such as traditional fisheries, aquaculture, oil and gas extraction, wind turbine parks, transport and tourism. With the Planning and Building Act opening up to combine different categories of use for sea areas, all of these interests must be considered in the area plans. Also, in protected areas coexistence and opportunities for simultaneous use and conservation must always be evaluated. Coexistence increases understanding and support for the conservation aspect while ensuring jobs and continued thriving settlement along the coast.

The competition for acreage in the sea and by the coast has intensified in recent years. Both coastal fishing and aquaculture are industries now facing competition from other activities that want to use the same acreage. In this situation it is vital that the municipality's planning is flexible and solution-oriented in relation to changes and new needs. But thought must be given to whether a municipality can draw up binding area plans



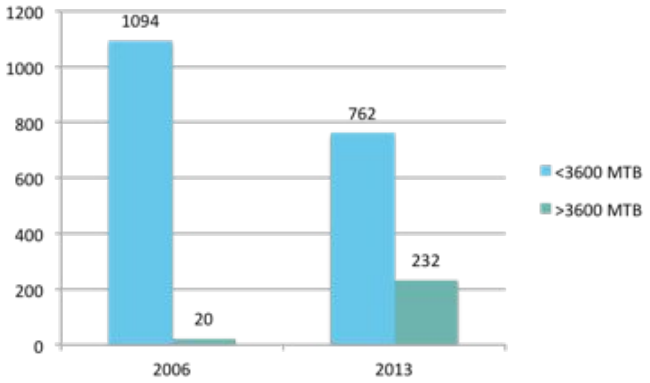
Graph 5.f.4: Overview of production vs. number of farm sites. *The overview shows, per county, development in production of salmon and trout for the period 1999-2012 compared with development in the use of the number of farm sites and development in total tonnes produced per site. (Source: Nofima, Directorate of Fisheries and FHL)*

independently for its district when efficient use of the area and future area requirements for production of seafood are at stake. Development towards more of a zone and area-based location structure in the aquaculture industry, which has accelerated in connection with the industry's voluntary coordinated lice management effort in recent years, indicates the need for inter-municipal or regional planning.

Based on the Planning and Building Act, one should also look at the possibilities of drawing up legally binding area regulations. Evaluation of an area's suitability for aquaculture and what is an acceptable level of impact on the environment in the area must be clarified in the plan process and not as a part of the management's assessment of the basis for individual companies' opportunities to make use of the area.

The ocean for seafood

When recognizing how area-efficient seafood production can be at highly suitable sites, it is crucial to ensure that documented and suitable acreage is in fact allocated to aquaculture. Therefore "soil conversion" should be established in the sea in the same way as for agriculture on land in order to ensure space for food production in the sea. It is highly encouraging that the Government is advocating the same in its seafood report, which states:



Graph 5.f.5: Salmon and trout farm sites. *The diagram shows development in number of farm sites above and below 3600 MPB. (Source: Nofima)*

"With increasing pressure on coastal and sea areas, the time is ripe to prioritise food production ahead of other uses in the areas that are best suited to this"[1].

In practice this means "soil conservation" in the sea similar to the protection given productive land through the Land Act. The provisions of the Land Act stipulate that productive land shall not be redeployed for other purposes, and that local and regional authorities must take this into account in area planning. Sea areas that are highly suitable for food production should have corresponding national guidelines. The aquaculture industry must for its part ensure that these areas are used and operated in a sustainable manner.

Implemented measures

Application of new expertise

The Norwegian aquaculture industry is focused on ensuring that fish farming takes place in the most suitable locations, which means investing more in finding sites that are ideal in regard to flow, wave and depth conditions. Prior to an application for approval of 'acreage' for marine farming, much work is therefore needed to chart seabed topography, waves, flows and weather conditions at the location. Proximity to other aquaculture operations or other activity that could be perceived as having an impact on the environment is also of significance to the evaluations.
Correspondingly, greater consideration is given to the degree of possible impact a marine farm might have on other activity, fauna or vulnerable eco-systems in the neighbouring area. This has influenced producers to move many farms further out on the coast. New expertise and new aids have provided new opportunities to investigate and document suitability before a site is brought into use. This is followed up by mandatory and voluntary environmental studies and monitoring during production. The measures benefit both the industry itself and the environment, and have been a crucial success factor for enhanced area-efficiency in seafood production.

Coordination and smart localisation

Over time the aquaculture industry has developed good models for coordinated use of the coastal zone, ensuring efficient utilisation of 'acreage' and reducing the risk of spreading infection.

At many places along the coast the industry itself has initiated resource and labour- demanding restructuring of marine farming sites. The goal has been to reduce the risk of infection between marine farms and between marine farms and wild fish. This is achieved through adaptation to zonal-coordinated plans for putting fish of the same generation to sea simultaneously, and eventually zonal-coordinated fallowing of farm sites after completed production cycle.

Development has shot ahead in connection with the industry's national lice project, where all aquaculture companies have committed to cooperate and coordinate efforts to thwart the spread of salmon lice. This has been followed up by authoroties through zone regulations in North Trøndelag/Osen and parts of Hordaland.

In cooperation with municipal and county authorities, the industry has implemented flow modelling for several coastal regions. This is carried out as part of an assessment to find the best position for a site in an area and in relation to other sites in the same area. It is expected the models will be developed further, possibly through the establishment of a national flow catalogue as proposed by the Area Committee (Arealutvalget) in its report[8]. Together with mapping instruments and hydrographical observations, this will eventually provide vital knowledge for the further development of a sound,

The photo shows Vorterøy in Skjervøy; an illustrasjon of area-efficient food production: Vorterøy is a marine farm site licensed for 5400 MPB, producing in total more than the combined meat production for the counties of Troms and Finnmark (5121 tonnes in 2009). (Source: Nofima)

sustainable site structure where there is less risk of leaving behind lasting imprints on the environment.

Future objectives

In the Government's strategy for an environmentally sustainable aquaculture industry, the goal for area usage is that *"the Aquaculture industry has a site structure and area usage that reduces the impact on the environment and the risk of infection. New sites shall be placed according to an executive plan for the industry's area usage, and in areas designated for aquaculture in the municipal plan's area segment. Each site that is used and cleared must be highly suitable out of consideration for the environment and fish health and fish welfare"*[1]. The goal coincides with that set by the industry, and the industry has progressed a long way in achieving parts of the goal that it can influence directly. The aquaculture industry is eager to see improved utilisation of good, suitable farm sites. Less suitable sites should be phased out and other sites should be restructured to achieve areas where farmers can coordinate their work of putting smolts to sea and (at the end of production) fallowing of the entire area where this is possible and appropriate. This type of change has in some areas led to considerable relocation of licences and the necessity to alter production volume at other sites.

The industry concurs with the Government that, in arease where a focus on individual issues has prevailed, the current area structure is not ideal bearing in mind further development and growth in the aquaculture industry[3]. In many ways this has presented a challenge when the industry itself has proposed restructuring as outlined above. Restructuring that is intended to address the interests of small, medium-sized and major players in the industry requires not just a higher degree of cooperation from the industry's side, but also that management acts in a predictable, coordinated and uniform manner and facilitates changes that are necessary and the achievement of goals. Participants in the industry must themselves lead the way in this work.

"The ultimate objective for the Government's aquaculture policy is further growth within sustainable boundaries", stated the Government in the section of the parliamentary report dealing with area, issued in March 2013[1]. This objective is also fully in line with the industry's own long-term objective as described in *"Seafood 2025 – how to create the world's foremost aquaculture industry"*[5]. The FHL is eager for the aquaculture industry to develop further in order to exploit the natural advantages afforded by the Norwegian coast, to produce more healthy salmon and trout, create considerably more jobs in a number of coastal communities and subsequently increase export revenue significantly. The increase in production shall occur on sustainable premises. Our aim is to engage in close dialogue with the authorities, research communities and environmental interests in

The aquaculture industry has the potential to increase production in many existing sites, but goals cannot be reached without continued access to more 'acreage'.

order to further discuss how we should realise seafood potential in Norway[5]. An increase in production towards 2.7 million tonnes in 2025[5], or 5 million tonnes in 2050[6], depends on the industry gaining access to more 'acreage' than is in use now. The aquaculture industry has the potential to gear up production in many existing sites, but the goals cannot be reached without continued access to more 'acreage'. We believe this can be achieved through various initiatives[5].

New initiatives, R&D

Development in the direction of bigger farms in good, well-documented fjord sites or more exposed sites on the coast is ongoing. This means that planned continued growth for seafood production in Norway will not be 'guilty' of corresponding increased use of 'acreage' if the authorities facilitate the regulations in order to promote efficient marine farming.

Sound coastal zonal planning is still a decisive factor. Assessment of area suitability for marine farming and deciding which effects of aquaculture activities are acceptable must be clarified already in the planning process to ensure that consideration of the environment and food production are taken into account in a good, appropriate manner. Any consequence reports must be completed at this level and not in connection with applications for starting marine farming activities at a specific site.

The fisheries and aquaculture industry will continue to make ripple effect analyses of its activities. As long as there is competition among different interests for the same sea areas and the various areas of use must be prioritised, then these analyses will be extremely useful in assessing sustainability and area efficiency. In this connection as well, regional thinking and planning will be important and essential. Not least for an industry that is increasingly producing ripple effects beyond the municipality where the primary production takes place.

Given modern vessel and navigation technology, consideration must be given to whether areas currently used for shipping lanes can possibly be released for production of food. Similarly, consideration should be given to permitting aquaculture activities in preserved areas provided this would not adversely impact the original purpose in preserving such areas.

Increased access to 'acreage' is a prioritised task for the FHL. In cooperation with the Norwegian Seafood Research Fund (FHF) and others, documentation requirements for area access should be reappraised to determine how the documentation can be improved. The focus will also be on mapping actual available areas based on natural conditions and to obtain an overview of possible hindrances to sea acreage being allocated to marine farming. This would provide a summary of existing knowledge and contribute towards new and vital expertise of significance for participants and decision-makers in planning and operation to ensure continued area-efficient and sustainable development of the aquaculture industry[7].

Work is under way to determine how municipalities that facilitate allocation of suitable sea areas for marine farming can profit from this. In principle, the FHL is of the opinion that this should not lead to any increase in the industry's overall tax liabilities; rather that state more of the tax revenues from aquaculture should be allocated back to the minicipalities. Availability of areas well suited to aquaculture is a prerequisite for increased seafood production.

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2) FKD (2009): Strategy for an environmentally sustainable aquaculture industry.
3) Statistics Norway (2013): Only covers the agricultural area that is operative and for which production grants have been applied.
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5.g Inspection and monitoring of the fisheries and aquaculture industry

Status and challenges

A regulated industry

The Government states in its seafood report[1] that a prerequisite of succeeding with the vision of Norway as the world's foremost seafood nation is that we can maintain pure, thriving and productive eco-systems where biodiversity is preserved. The FHL agrees with the Government, and this makes demands on the fisheries and aquaculture industry that harvests from the sea and produces in the sea, but also on all other interests that make use of the sea and sea areas for industrial and recreational purposes.

Consideration for the environment and sustainability permeates a highly comprehensive legislation that regulates the fisheries and aquaculture industry. The goal of an eco-system based approach and focus on environmental premises affetcs both licences to engage in fishing and aquaculture, and a comprehensive development of technology in the industry. These considerations also define to a great extent where fishing and production can take place and in what quantity for the various species in terms of defined time and space. Concern for the environment is an important consideration in an industry governed by licences, quotas and regulation of production.

Fishing and aquaculture is a biological production of food, and consideration given to ensuring food safety is reflected in a comprehensive, stringent set of hygiene regulations at all levels of the production chains. This applies to catches and feed production, to fish landing stations, packing stations, value-added processing plants and the transport sector. The production environment, fishing and production equipment, raw materials and products are monitored in accordance with a defined national, risk-based monitoring programme and through the companies' own internal control systems.

The ensuring good fish health, sound fish welfare and god infection hygiene is accordingly embodied in animal health and animal welfare regulations, as well as in extensive mandatory and voluntary fish health checks, infection-reducing measures and medicine residual control of farmed fish.

On the whole, it is crucial that the fisheries and aquaculture industry can be characterised as a highly regulated industry with the regulatory focus firmly on the environment, animal health and food safety. The same areas of focus also form the basis for a number of voluntary standards used in certifying the industry.

Monitoring resources and the environment

Monitoring of natural resources, pollution and other environmental conditions in our sea and coastal areas is well-established. There is extensive cooperation between researchers and management to regulate fisheries and a comprehensive, well-documented system has been established for calculation of stock numbers and quotas for economically important stocks. Content of environmental toxins and foreign substances are also monitored in raw materials and finished products.

Resource control

Inspections in regard to harvests and sales in the wild fisheries sector are essential in ensuring that harvesting of the resource is in compliance with set quotas and that equal terms and conditions of competition prevail. The frequency with which inspections are made of fish landed in Norway, however, is relatively low; a factor that must be seen in the light of that several hundred thousand landings of fish are made in Norway annually. In the pelagic sector and where landings of frozen fish are concerned, the frequency of inspections is far higher than for landings of fresh cod.

The cod quota for 2013 is historically high, at the same time as market conditions are extremely difficult with reduced purchasing power and price reductions. This has pressed prices and profitability down for the entire Norwegian groundfish sector, and unfortunately probably contributed to illegal activities in first-hand sales. The FHL takes a serious view of this and has engaged in close dialogue with authorities on the situation and possible

Inspections in regard to harvest and sales in the fisheries industry are essential in ensuring that harvesting of the resource is in compliance with set quotas and that equal terms and conditions of competition prevail.

measures to expose regulation breaches. Meanwhile, the winter of 2013 has been alive with rumours and it cannot be ruled out that discussions related to quality of raw materials and application of calculation factors have added fuel to the rumours. Insofar as capacity for inspections is limited, it is decisive that thorough risk assessments are made and in this area it is possible for cooperation between the industry and the authorities to be developed further. An important prerequisite for resource control is a distinct, accountable set of regulations that are practical and able to be put into practice.

The landings and contract note regulation is a key element in this area, and the FHL has therefore involved itself in the revision of this regulation. A new regulation is expected to come into force as from 2014. Furthermore, equal terms and conditions are needed for sales of round fish (Whole Fish Equivalents) between sales associations so that varying practices among sales associations do not lead to undesirable adjustments and breaches of regulations. In this context the issue of use of the calculation factor and gutting onshore is important, and the FHL has therefore concentrated on initiating a thorough examination of how the regulations are modelled and how they are practised in the different sales associations' districts.

Environmental related monitoring
In the aquaculture industry, conditions on the seabed below the fish farm are monitored before commencing operations and during periods of maximum production (MOM B inspections). The inspections and results from these are described in more detail in the chapter about nutrients and organic material from aquaculture.

Additionally, oxygen conditions are monitored to ensure good environmental conditions for the fish. The fish are checked by fish health personnel at least 6 times a year to assess health, welfare and risk of infection, and salmon lice are counted and reported on a weekly basis to ensure and document low lice levels in the marine farming industry.

At production facilities on land, which cover everything from feed production and hatcheries/smolt raising facilities to fish landing stations, salmon packing stations and various types of value-added processing plants, monitoring covers intake and discharge of production water, production hygiene, products and relevant environmental parameters. Requirements for cleansing measures ensure both production hygiene and minimal environmental effects from emissions.

Safe, healthy seafood
Monitoring of seafood has been carried out since 1994, with around 200- 500 samples taken per year to obtain data about possible content of undesirable chemical residues in seafood. The industry and in recent years the authorities have financed a more comprehensive charting of cod, saithe, mackerel, North Sea herring, spring-spawning herring and Greenland halibut, taking 850-2200 samples from each species annually. The results reveal that Norwegian seafood generally has a low content of foreign substances, but environmental toxins for certain species and in certain areas may represent a challenge to food safety.

Feed cleansed as required
To ensure that the farmed fish are safe, there are also strict limit values for environmental pollution in feed. Fish oil from wild catch industrial fish or offcuts from fish processing are feed raw materials that in some cases have to be cleansed before use in order to meet the limit values. There are established systems and capacity to carry out this cleansing at fish oil production plants in order to meet the requisite volumes.

Most of the fish oils used are of such quality that they are well within the limit values set by the authorities and therefore do not need cleansing. The feed manufacturers comply with regulations and limit values as set by the authorities. Both Norwegian salmon feed and the finished product are well below the limit values set for safe food with today's cleansing routines[2].

Extensive sampling
Each year around 12,000 samples are taken from fish in aquaculture production. The samples are analysed for foreign substances and selected feed additives. The results show that the levels of foreign substances in fillet are low compared with the upper limit values set in the

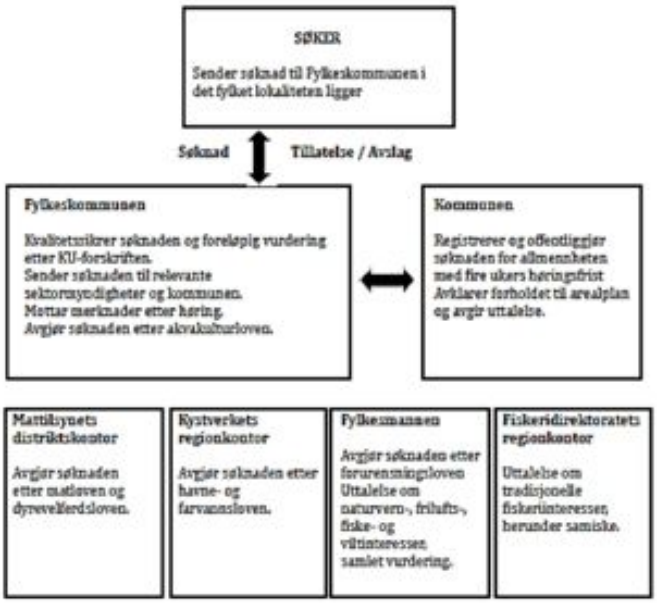
Around 12,000 samples are taken from farmed fish annually. The samples are analysed for foreign substances and selected feed additives.

regulations. No evidence has been found of residues of legally used medicines over internationally set limit values[1].

The Norwegian Food Safety Authority (NFSA) monitors the presence of algae toxins and biological and chemical contaminants in the production and harvesting of live mussels. Data from this monitoring also forms the basis for weekly updated information to consumers who harvest molluscs for their own use.

Many public bodies monitoring the fisheries and aquaculture industry

There are many administrative bodies in the picture when a decision is to be made on an application for a new marine farm site. Graph 5.g.1 provides an overview of which public bodies are involved in considering the applications. Graph 5.g.2 illustrates that there is a highly comprehensive inspectorate established for this purpose. Most of the inspectorate bodies also have a role in regard to the fisheries industry. It is vital that management is also aware of this demanding situation and contributes to coordinating its inspection activity. This will save the industry and management resources and add to ensuring uniform management.



Graph 5.g.1: Overview of case procedure when applying for a marine farm site: *The graph shows case procedure and which administrative body and relevant legislation apply each time an application is made for a new marine farm site. The regulations state the maximum deadlines for case handling by the administration bodies, but unfortunately we see several examples where the case procedure (deadline) in some of the departments is often grossly exceeded, resulting in untenably lengthy procedures for industry participants that should be planning and securing production. (Source: Norwegian Food Safety Authority)*

References

1) FKD (2013): Meld. St.22 (2012-2013). The world's foremost seafood nation.
2) Skretting: Cleansing to meet limit values (Interview on Kyst.no 13.6.13)

Graph 5.g.2: Overview of some inspectorate tasks and roles in the aquaculture industry. *The overview shows some of the inspectorate tasks and roles that Norwegian management has in regard to the aquaculture industry. Also illustrates how the industry itself is very fragmented and demanding on resources, thus challenging for the authorities and industry participants. The FHL calls for more coordination and rationalisation of the inspectorate, and welcomes input regarding improvements. (Source: Directorate of Fisheries)*

5.h Foreign species

Foreign species are spread with the aid of human activity to areas they would not have managed to reach on their own. The spread of foreign marine species is primarily monitored by the Institute of Marine Research (IMR). It is extremely difficult to remove foreign marine species, but it may be possible to control dispersal.

The king crab is the most well-known foreign species in Norwegian waters. The crab has its natural habitat in the Bering Sea and the northern stretches of the Pacific Ocean, but was released into the Murmansk fjord by Russian marine biologists in the 1960s. During the 1990s a substantial increase in stocks was registered on the Norwegian side of the border and in 2002 commercial catches of king crab commenced.

The current management of king crab is based on Parliamentary report no. 40 (2006–2007) "Management of king crab"[1]. The species has a two-part management regime. Within a quota-regulated area east of the North Cape, where the king crab is already well-established, stocks are managed in a way that provides the basis for industrial activity and employment. At the same time, the aim is to limit their further spread. Unrestricted free catches are permitted outside the quota-regulated area and there is a ban on discards. State-financed fishing to eradicate this species has been carried out in the west. Companies have also developed new products based on commercial use of smaller crabs from the free fishing in the west. Mapping carried out by the IMR shows that the spread westwards has almost halted and thus stocks are being kept in check within the quota-regulated area. King crab management will be assessed during 2013.

Some research has been conducted into the effects of the king crab on other species and on the eco-system. The king crab feeds on molluscs, sea urchins, king ragworm, capelin eggs and lumpfish eggs. In 2008 and 2009 the IMR carried out studies[2] on seabed fauna in areas with king crab. These studies concluded that the seabed fauna in areas with a large and dense spread of king crab had been affected. The king crab feeds on seabed animals such as king ragworm and there are distinct differences between areas with or without dense stocks of king crab. The studies were made during a period of growth for king crab stocks when they were dispersed far and wide. These stocks are now declining, and therefore research is needed on the outcome for seabed fauna when the density of king crab stocks declines. The king crab eats fish eggs, but research shows the crab is not having a negative effect on commercial fish stocks. For instance, capelin and cod stocks have set record numbers during the period where king crab stocks have been at their most prolific. There has also been an increase in halibut stocks in eastern Finnmark. Lumpfish have not seen a comparable increase, but neither has there been any negative association with the king crab. Insufficient research has been carried out in this area. It is also of interest to research other effects. It could be asked, for example, whether the king crabs feeding on sea urchins has a positive effect on the kelp forest. Reports from Russian marine biologists have not provided any grounds for concluding that the king crab has any particular negative impact on the eco-system.

The snow crab was first observed in the Barents Sea in 1996 and so far is mostly concentrated on the Russian side of the border. No large stocks have been detected in Norwegian waters, although fishing and landings have been made in Vardø waters during 2013. The snow crab may be freely caught in Norwegian waters. No documentation has been made on whether the species was introduced or migrated to the Barents Sea naturally.

In its report "Foreign species in Norway – with Norwegian blacklist 2012"[3] the Norwegian Biodiversity Information Centre provides a detailed overview of foreign species in Norway, plus ecological risk assessments of foreign species that reproduce in Norwegian areas.

References

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Foto: Marine Harvest

6 EMISSIONS

6.a Emissions from the wild fisheries sector

Status and challenges

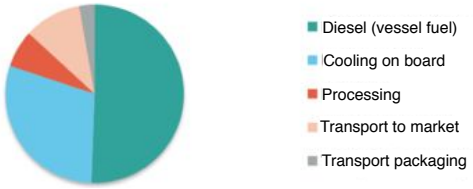
Distribution of energy consumption/greenhouse emissions in the wild fisheries sector

Compared with other food production, the level of carbon footprints from seafood is low. This does not reduce the focus on how we can further reduce the greenhouse effect so that seafood increases its standing as climate-positive food production. See separate chapter on carbon footprint.

The Parliamentary report no. 34 on Norwegian Climate Policy (2006-2007) states that "within the fisheries and aquaculture sector it is mainly the fishing fleet that contributes to Norwegian greenhouse gas emissions"[3]. This also illustrates how greenhouse emissions are distributed in the various segments of the wild fisheries sector. If we apply Sintef's calculations of carbon footprints from the seafood sector, we can quantify distribution between the different segments of the value chain[2]. Sintef 's calculations of greenhouse gas emissions include emissions of diverse gases with greenhouse effects, where CO_2 is the most significant, but also where gases such as nitrous oxide, methane and KFK gases are included. All of the different emissions are converted to CO_2 equivalents.

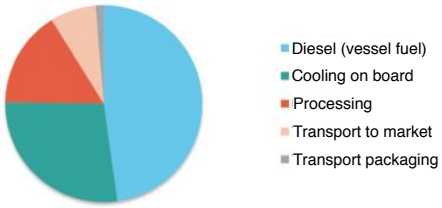
In the graphs below we have selected individual product groups and distribution between the various segments up to delivery to market to illustrate this. SINTEFS's findings confirm it is the catch segment that accounts for the largest amounts of greenhouse gas emissions in the cod fisheries sector, with transport a secondary factor. In pelagic fisheries, however, transport is the primary factor followed by the catch. The difference between the two sectors has to do with the fact that pelagic fishing is intensely concentrated within a certain time period, where the fish are in schools and thus catches are executed in a highly efficient manner, and due to this section of the fleet being more structured. The processing segment has less significance in the overall picture. Therefore in this environmental report we have also focused on measures initiated in the fleet segment to reduce greenhouse gas emissions and looked at initiatives that can further contribute towards reducing emissions from the fleet.

Frozen cod fillet to Paris



Graph 6.a.1: Emission of greenhouse gases calculated in CO_2 equivalents for frozen cod fillet delivered to Paris. *The graph shows the percentage of greenhouse gas emissions for the different sections of the production and transport chain for cod caught and further processed in Norway before transportation to wholesale warehouses in Paris. The graph shows that the largest emissions of greenhouse gases occur through diesel consumption and chilling in the catch segment. (Source: Sintef fisheries and aquaculture[2])*

Clipfish exported to Lisbon



Graph 6.a.2: Emission of greenhouse gases calculated in CO_2 equivalents for clipfish exported to Lisbon. *The graph shows the percentage of greenhouse gas emissions for different sections of the production and transport chain for clipfish exported to Lisbon. The graph shows that the largest emissions come from the catch segment. (Source: Sintef fisheries and aquaculture[2])*

Emission of greenhouse gases from the fleet

Emission of greenhouse gases from the fishing fleet can be divided into two components: consumption of fuel during fishing and emissions from chilling of the fish. The latter is expected to be reduced in the years ahead due to phasing out use of the cooling medium with the biggest emissions. Future measures should therefore be directed at reducing actual consumption of fuel during fishing. This can be achieved through technological initiatives such as cleansing of discharges, new and more energy-efficient engines etc., although in fisheries political frame

factors have great significance. Nowadays fishing rights are linked directly to the individual vessels. A fisheries company with several vessels is thus prevented from transferring quotas from one vessel to another, despite this resulting in more energy-efficient fishing.

Therefore there is also a need to review regulation of the fishing and the structural measures for the fishing fleet with the objective of reducing greenhouse gas emissions.

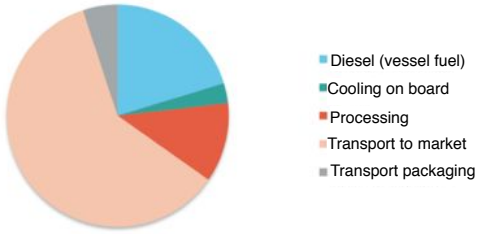
Increased focus on emissions of fuel and NOx

In recent years there has been an increasing focus on emission and energy reductions in the Norwegian fishing fleet. The NOx Fund was established in 2008 for the purpose of stimulating reduction of NOx emissions from combustion gases. The NOx Fund was initiated and is run via the Confederation of Norwegian Enterprise (NHO) fellowship, although the NHO has also actively involved other key organisations such as the Norwegian Fishermen's Association (NFA) in the fund and its establishment. Establishment of the NOx Fund is a valuable incentive to individual companies/fishing boat owners to invest in technology that reduces emissions of NOx. As an alternative to paying a fee to the State, the fishing fleet and others can instead pay a smaller subscription (one-quarter of the fee) to a fund and the next time around receive money from this fund to implement measures that can reduce NOx emissions.

More details on measures and effects

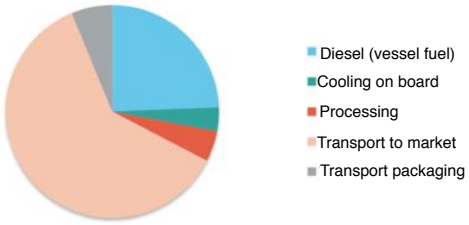
The follow-up programme Fishing Fleet Energy Network is an R&D project carried out for the Norwegian Fishermen's Association on behalf of the FHF (Norwegian Seafood Research Fund) in collaboration with COWI AS. 62 vessels from 5 vessel groups are participating in the project, which is aimed at establishing industry standards for the various vessel groups based on a ratio between catches and oil consumption. The project aims to summarise the last few years' new developments and experiences in energy conservation and emissions reductions for the entire Norwegian fishing fleet. The project follows on from a previous project and is intended to contribute to lowering energy consumption and the level of emissions for the entire Norwegian fishing fleet. This will be achieved by establishing the basis on which to initiate emission and energy reducing measures in vessels, and

Frozen herring fillet to Moscow



Graph 6.a.3: Emission of greenhouse gases calculated in CO_2 equivalents for frozen herring fillet transported to Moscow. *The graph shows the percentage of greenhouse gas emissions for various segments of the production and transport chain for herring caught and further processed in Norway before transport to wholesale warehouses in Moscow. The graph shows the largest proportion of greenhouse gas emissions occur in the transport segments. (Source: Sintef fisheries and aquaculture[2])*

Round-frozen mackerel to Moscow



Graph 6.a.4: Emission of greenhouse gases calculated in CO_2 equivalents for round-frozen mackerel exported to Moscow. *The graph shows the percentage of greenhouse gas emissions for various segments of the production and transport chain for mackerel caught and round-frozen in Norway before transport to wholesale warehouses in Moscow. The graph shows that the greatest percentage of greenhouse gas emissions occurs in the transport segment. (Source: Sintef fisheries and aquaculture[2])*

making energy data and analyses available for further R&D activities and spreading of information[1, 4]. The report provides accurate, detailed information about which measures have been initiated in regard to the fleet that are most effective in reducing emissions and oil.

References

1) Norwegian Seafood Research Fund
2) Winter, Ulf (2009): Carbon footprint and energy consumption of Norwegian seafood products.
3) Parliamentary report no. 34 (2006-2007) Norwegian Greenhouse gas policy
4) FHF, Cowi, (May 2013): Evaluation of energy and emission reduction measures in the fishing fleet.

Establishment of the NOx Fund is a valuable incentive to individual companies/fishing boat owners to invest in technology that reduces emissions

6.b Emissions from the fish industry

Status and challenges

Emission of greenhouse gases from the fish industry
As indicated at the start of the chapter about emissions from the fishing fleet, the total processing segment does not account for an significant portion of greenhouse gas emissions in the wild fisheries sector. This applies also to the aquaculture industry.

Just as important as total emissions is that processing in Norway prevents unnecessary transport. This is possible through our transporting the principal/end products directly from Norway instead of transporting whole fish. Not to mention that transport to, say, China for processing, then transportation back to Europe for sale increases emissions. According to Sintef's calculations, Frozen cod fillet transported to Paris via China results in a quintupling of greenhouse gas emissions measured against transportation of frozen cod fillet from Norway directly to Paris.

In addition, processing in Norway helps towards reducing the total transport in that it is the principal/end product that is transported. In contrast, fish is often transported in whole fish equivalents (WFE) from Norway, which adds to the total volume transported. Thus more processing in Norway will contribute towards reducing greenhouse gas emissions from transport, while a corresponding downscaling of the Norwegian processing industry will lead to increased greenhouse gas emissions through increased transport volume.

Other emissions from the fish industry
At production plants on land, which cover everything from fish landing stations, salmon packing stations and varying types of value added processing plants, there is monitoring of actual intake and discharge of production water, production hygiene, products and relevant environmental parameters. Requirements for cleansing measures ensure minimum impact on the environment from discharges.

New criteria and measures in small and medium-sized enterprises
Regulations concerning pollution from fish processing companies came into force on1st January 2010. A new chapter 26 in the Pollution Regulations regulates pollution in the form of discharges into the sea from small and medium-sized fish processing companies. The regulation applies to companies that utilise from 50 tonnes of raw materials annually to those that produce up to 75 tonnes per full day of finished products. The criteria apply to purification ofprocess effluent, discharge pipes, measuring and log entries and a general requirement to prevent odours[1].

The log entries criteria require these companies to have continuous control of and log received quantities of raw materials, quantities produced, water usage, composition, handling and delivery of rest raw materials/by-products and any fish waste. They must maintain an overview of the quantity and type of chemical consumption (for cleaning etc.), and they must log information on strained goods, quantity and disposal of skimmed fat in grease traps and similar, and results from sampling that document compliance with the criteria. This is important as part of the companys internal contorl system and as documentation for the authority which in the autumn of 2012 carried out inspections of these companies. Any non-compliance that is pointed out is followed up on and the companies subsequently benefit from the improvements.

Requirements for larger production companies
Fish processing companies with production capacity for finished products of more than 75 tonnes per full day, and factory ships and activities that produce fish oil, fishmeal or fish feed must obtain a separate permit from the County Governor according to the Pollution Act, which also includes the Industry Emissions Directive (IED)[1].

The Industry Emissions Directive (IED), formerly IPPC, came into force on 6th January 2011 and is now implemented in Norwegian legislation. The IED is seven directives merged into one; a framework directive that requires the regulating of all pollutant discharges into the air, water and earth from one and the same activity gathered in one permit, granted by one authority. The aim

Fish industry. *The majority of fish processing plants now discharge to appropriate recipients, where there are no major challenges in regard to over-euthrophication and pollution. Illustration photo: Norwegian Seafood Council*

is to achieve a more uniform assessment and regulation of the total pollution impact caused by one activity, and subsequently better protection of the environment. The directive aims for regulation to take place preferentially through individual discharge permits, but also opens for application of general regulations where this is appropriate. To achieve a common practice, the directive includes certain criteria in regard to content of the licence application, administrative procedure, and terms and conditions of the licence. The scope of the directive is specified in a list of categories of industrial activities over a certain size[2].

The new directive tightens up the principle on use of best available techniques (BAT), in that binding industry-specific discharge limit levels are adopted in so-called BAT conclusions. Demand is also made for greater frequency of inspections, and to update terms and conditions in existing licences when new and revised BAT conclusions become available and at the latest four years after publication of a new or revised BAT conclusion[3].

The companies that are covered by the IED regulations report emissions of nitrogen, phosphorous, suspended dried solids, biological oxygen consumption (BOC), chemical oxygen consumption (COC), fat and water quantity. Reports are uploaded to the website of the Norwegian Environment Agency. No collective overview or statistics have been made of emissions from fish processing companies in Norway. One of the reasons for this is because there is currently only a measurement requirement and not a quantitative requirement for each parameter.

The majority of fish processing plants now discharge to appropriate recipients, where there are no major challenges in regard to over-fertilisation and pollution. The inspection action that KLIF (now the Norwegian Environment Agency) carried out in 2012 nonetheless exposed certain deviations from the applicable regulations, particularly in emission control, purification plant, waste disposal and environmental risk assessment. The companies will strive continuously to improve and put an end to these deviations.

References

1) MD: the Pollution Regulations chapter 26.
2) Ministry of the Environment 2013.
3) Norwegian Environment Agency 2013.

The majority of fish processing plants now discharge to appropriate recipients, where there are no major challenges in regard to over-fertilisation and pollution.

6.c. Emissions from aquaculture

Escaped fish

Status and challenges

Official statistics tell us that marine farm escape figures have declined significantly in recent years. 2012 is the year with the lowest number of salmon escapes since the Directorate of Fisheries' official farm escape statistics were first published in 1993. Also in the first half of 2013 there have been very few instances registered of fish escaping (graph 6.c.1). The trend is similar for escaped salmon in rivers[1]. This is a gratifying and important development for the aquaculture industry, which strives to achieve this every day of the year and has a clearly expressed zero vision for fish escapes.

This does not mean we are approaching or will get to a point where we can rule out that accidents will happen, but we will continue to work vigilantly at reducing the risk of accidents happening through own negligence, others' failure or extreme weather conditions. This means the number of escapes and extent of escapes shall be further reduced to a minimum. Fish escapes are undesirable for several reasons, so the aquaculture industry has therefore stepped up its efforts substantially in recent years to guard against and prevent escapes. Even though broodstock material for the farmed salmon is collected from Norwegian rivers, consideration towards local stock welfare and preventing any negative impact must be maintained. This is also the reason for the industry's drive to prevent salmon farm escapes. Escapes of cod and rainbow trout are also undesirable. For the aquaculture companies' part, escapes are extremely costly. Every escaped fish has a negative impact on the aquaculture company's profitability. Thus this is also a powerful motivator in the work of preventing escapes.

The aquaculture industry is focused on ensuring sustainable operation and growth, and companies naturally do whatever possible to maintain the positive trend in escape statistics of recent years. The industry is therefore determined to continue stepping up its efforts against escapes and is about to implement several new

Escapee: *Fewer salmon are escaping from Norwegian marine farms. Photo: Norwegian Seafood Federation*

initiatives to ensure that escaped farmed salmon do not have a negative impact on wild salmonids[2].

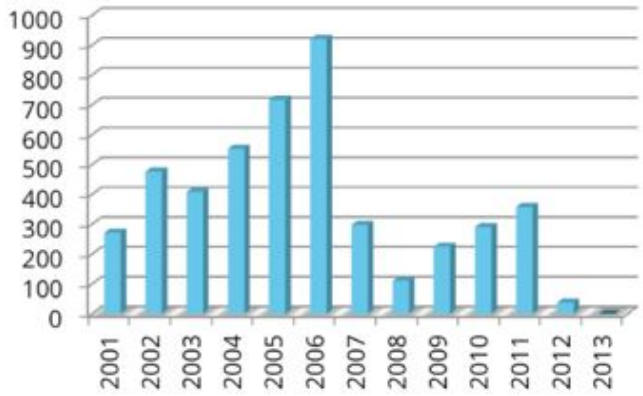
How many fish are escaping?

For the FHL's part, it is a prerequisite that companies comply with the regulations and report all escaped fish. However, figures vary widely over how many fish escape from Norwegian marine farms. The common denominator for many of these is that they are based on guesses and more or less feasible calculations. If we are to work seriously and purposefully to reduce escape numbers, we are dependent on being able to rely on actual reported figures. These figures are now available through the Directorate of Fisheries' escape statistics[3]. Reports of escaped farmed salmon in sports fishing and sample fishing / broodstock fishing in several Norwegian rivers just before spawning in autumn is also taken into consideration. Even though there is evidence of weaknesses in methods of reporting, they are our reference points and we must strive to ensure they are as accurate as possible to ensure we achieve our goals.

All statistics are published

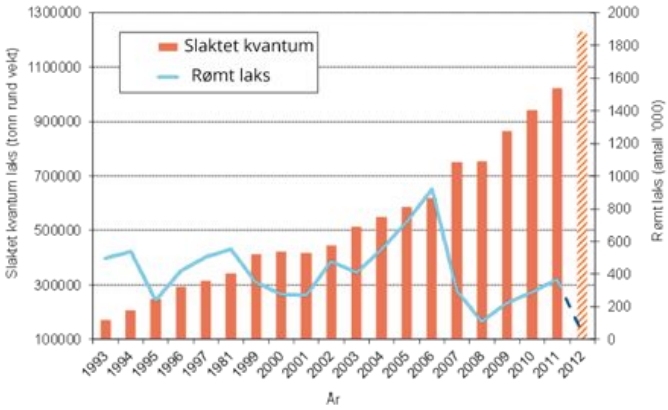
Escape statistics are official and readily available on the Directorate of Fisheries' website[3]. Official escape statistics are recorded by the Directorate of Fisheries on the basis of reported escapes from aquaculture companies. The statistics are updated in relation to recapture and checks

Escaped salmon (figures in 1000)



Graph 6.c.1: Overview of escaped salmon 2001-April 2013. *Number of escaped salmon in the period 2001–April 2013. Since spring 2006 the trend has turned and the number of escaped fish is lower than in the period before 2006. Implemented initiatives have worked. (Source: Directorate of Fisheries)*

Escape figures and production figures



Graph 6.c.2: Overview of escaped salmon and production of salmon. *Blue line (right axis) shows number of escaped salmon in the period 1993–2012. The columns (left axis) show growth in production (slaughtered volume) in same period. (Source: Directorate of Fisheries and FHL)*

of fish still remaining in the farm cages, and are therefore subject to change until all fish from the cage where the escape occurred have been slaughtered.

Escape can occur due to a critical incident, but is often due to a combination of several incidents. Regardless, it is vital that all escapes are scrutinised so that contributory causes can be exposed and result in a lesson learned with subsequent introduction of preventive measures.

In the aquaculture industry all escapes or suspicions of same must be immediately reported to the Directorate of Fisheries. As soon as is practicable, the Directorate of Fisheries will examine what has occurred at the aquaculture site concerned, including clarifying the extent and possible cause of the accident. All cases shall also be considered by the recently established Aquaculture Escape Commission, which is a part of the Directorate of Fisheries. The plan is that the new commission, like the old, will be tasked with finding possible causes and make recommendations to administration and participants in the industry. In contrast to the old, broadly composite and government appointed commission, this will be more technically focused and a part of the public administration. The new commission was still not quite in place in June 2013. This is highly regrettable, as the old commission was wound up in the summer of 2011. It is to be hoped the new commission will soon be up and running and that it will be as important in efforts to prevent escapes as the previous commission was in the years 2006-2011.

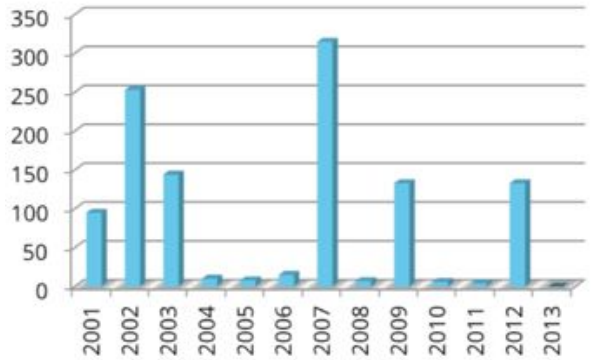
Escape figures for 2012 show we are on the right track

In 2012 around 38,200 salmon were registered as having escaped during 10 episodes. 2012 was thus the year with fewest reported salmon escapes, both in number of fish and episodes, since the early 1990s (see graph 6.c.1). After spring 2006, when the cyclone Narve was a contributory cause of several major escapes, there has been a marked decline in the number of escaped salmon. Sweeping measures were implemented during this period to achieve this result. Therefore it is extremely pleasing to see that the measures have worked. Salmon production has more than doubled in the period 2004–2012 (graph 6.c.2).

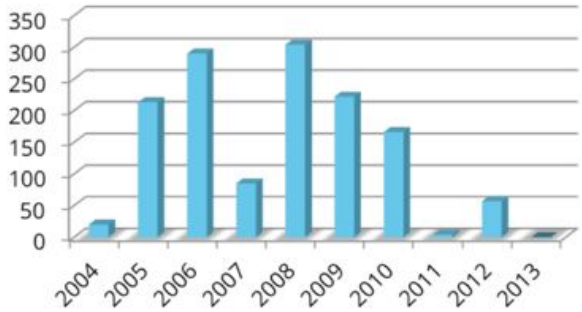
Two instances of escapes of rainbow trout were reported in 2012, as opposed to four in 2011. One of these two concerned close to 123,000 fish, and thus contributed to raising the number considerably compared with 2011 when the total number of escaped rainbow trout was just 3,000[3].

In 2012 around 38,200 salmon were registered as having escaped during 10 episodes. 2012 was thus the year with fewest reported salmon escapes, both in number of fish and episodes, since the early 1990s.

Escaped rainbow trout (figures in 1000s)



Escaped cod (figures in 1000s)



Graph 6.c.3 and 6.c.4: Overview of escaped rainbow trout and cod. *The overview shows numbers of escaped rainbow trout (left) and cod (right) in the period 2001–April 2013. (Source: Directorate of Fisheries)*

In 2012 approximately 56,600 cod were reported as having escaped in three episodes. Even though the number of escaped fish has been significantly reduced in recent years, the number of escaped cod is still relatively high in relation to cod biomass in marine farms.

Reasons for escapes are changing

In the knowledge platform SECURE, which is part of the Research Council's focus on sustainable aquaculture, researchers have reviewed all reported escapes from Norwegian marine farms in the period 2006-2009 and examined the reasons for fish escaping. Sintef Fisheries and aquaculture summarised this part of the project as follows:

"The review of the escape reports shows that suppliers and producers have succeeded in fixing some of the equipment problems that previously caused the massive escape figures. Escapes due to defects with floating collars and anchoring are occurring less and less. For salmon and trout farming the biggest challenge now is friction between the net and chains."[4]

Holes resulting from friction between the net and chain holding the bottom collar accounted in the period 2008-2010 for more than 50% of escapes. Researchers, equipment suppliers and the aquaculture industry have gone to work with a vengeance on this challenge. In 2012 and 2013 considerable resources have been applied to find the best way to resolve this factor.

The second factor rating special mention by the knowledge platform is human error in connection with operations. Work is proceeding on gaining control over these factors, which can probably be prevented through improved product design and improved procedures[4,5].

More knowledge needed

Given the wishes of the Government, administration and the aquaculture industry for sustainable development of the aquaculture industry, and because the industry must adapt its production accordingly to this, it is extremely important and totally necessary that the focus is firmly on knowledge. For more details on needs and implemented initiatives in this area, see the chapter on R&D.

All the parties concerned are eager for good indicators to be found that reveal the real impact the industry has on wild salmon stocks. But if the industry is to be measured by these indicators, then it is of vital importance that these are developed based on knowledge and that standardised measuring methods are part of the foundation. At present these are missing from the picture.

Implemented initiatives

The aquaculture industry, authorities and various bodies of expertise have collectively and individually contributed towards reducing escape figures in recent years.
Many different measures have been implemented to prevent fish from escaping, ensure a lesson is learned

from unfortunate episodes that occur, ensure proper readiness in case of an emergency and have the capacity to reduce the consequences as much as possible if an accident should nonetheless happen.

Further tightening of technical requirements
The technical standard for marine fish farms (NS 9415) was first published in autumn 2003. It was revised in autumn 2009 and involves standardised requirements for site surveys, the equipment and that all equipment is adapted to other items of equipment and to the site. The NYTEK regulation (Regulation on requirements in regard to the technical standard for installations employed in the marine farming industry) was revised to reflect the standard, and the revised regulation came into force on 1st January 2012. The revised regulation is comprehensive and includes further tightening of the requirements made of the marine farming company, certification bodies, scope of certification, equipment and equipment suppliers. Figures from the supplier industry show that on an annual basis the aquaculture industry has invested more than NOK 1 billion in new and more robust equipment since 2006[6]. This is most likely a significant contributory cause of the decline in the escape figures.

Closed containments (for aquaculture) do not automatically lead to a lesser risk of escapes
There are those who believe the aquaculture industry currently faces challenges on the environmental side that could be resolved by employing closed containments in the sea or on land. The industry maintains that the answer is not so simple, and is supported by the Norwegian Board of Technology's report which states that closed containment solutions present a number of new challenges[11].

Nonetheless, marine farming companies are now participating in the development of different concepts involving closed containments. Constructions are being tested that wholly or partially close the fish inside for periods of time as protection against lice or to ensure effective treatment. But experiences with permanent closed test facilities show that also these systems can be subject to accidents, escapes, production breakdowns and challenges associated with fish health.

Sintef[12] has looked at closed containment solutions and concluded that
* closed facilities cannot automatically be considered escape-free
* that area usage will be increased by 5-15 times compared to current area usage if the same quantity of fish is to be produced
* that closed solutions require considerable energy to pump water;
* that the cost of investment is extremely high compared with current technology
* that closed solutions are currently not commercially available
* and that there a number of challenges that must be resolved first.

In its report the Norwegian Board of Technology recommends more research and development including further development of existing technology (feed development, biological solutions, enhancement of operational routines, vaccines etc.) At the same time, there should be systematic examination of the potential inherent in closed technology and any other interesting technological solutions.

Aquaculture companies are focused on these issues now, although the Norwegian coast is exceptionally well suited to marine farming in open systems. The natural conditions, with deep fjords and massive water exchange, by and large account for the industry's biggest competitive advantage. Therefore it is not realistic to imagine the whole of Norway's aquaculture production converting to closed solutions, even if eventually constructions are developed that can be used in certain areas or in parts of production.

Maximum number of fish per cage
In December 2011 the authorities determined new regulations on the maximum number of fish permitted per cage. A provision in the aquaculture operation regulation states that after 1.1.2013 it is not permitted to have more than 200,000 fish per production unit. The provision thereby results in more production units and more operational activities at the sites. It remains to be seen whether the new provision will work as intended.

Reduced risk of escapes from land-based aquaculture sites

Since 2008 the industry has been required to have drains doubly safeguarded at smolt facilities. The "smolt offensive" project in 2007 renewed focus on escape security, also from land-based aquaculture facilities, with extra efforts resulting in a considerably lowered risk of escape. NS 9416 came into force on 1st January 2013. This is a technical standard for new land-based aquaculture facilities for fish, the purpose of which is to prevent escapes. The FHL, the previous Aquaculture Escape Commission and the Directorate of Fisheries have been the driving forces and contributors to creating the standard, which has been av ongoing process since December 2009 and has prompted discussions, involvement, strengthened focus, knowledge and further initiatives to avoid fish escaping. One important principle in the final standard is that escape security shall be attended to throughout the entire aquaculture site's, from projection and laying the foundation of the facility to delivery of the fish.

Human factors and fish farm escapes

The first work package has been completed in a project financed by the Norwegian Seafood Research Fund (FHF) that looks closer at the human factors in connection fish escapes. Even though the report from the first part of the project summarises by saying "The impression is that participants in the industry are very focused on reducing escape figures and making a tremendous effort to achieve this", and that "This is reflected at all levels in the companies, from management level to the individual farm worker in his daily routine", it also highlights the interaction between people and technology and the surroundings as contributing roles to escapes. Together with the remaining work packages in the project, the study will be able to form the basis for reducing the human factor as a cause of escapes[5].

Deviations dealt with and knowledge shared

The internal control, the NYTEK regime and the new technical standard for land-based aquaculture facilities all require that aquaculture facilities must have their operations risk-assessed and deal on an ongoing basis with any deviations as they arise in connection with operation or equipment. This is the actual foundation for continual improvement in the industry. In connection with this work, the Directorate of Fisheries' databases of gained experience provide a good, relevant support.

Also helpful are the preparedness guidelines with templates, completed and made available on the Directorate of Fisheries and FHL's websites in spring 2010. This was drawn up in collaboration between the Directorate of Fisheries and the FHL, assisted by Safetec AS. All the aforementioned measures are included and form the basis for learning from mistakes and improvement of routines and procedures. Safeguarding the spread of experiences and new knowledge to all is important. Therefore in recent years the FHL has held a number of courses on escape prevention along the entire coast, for both marine-based and land-based aquaculture. Demand and participation has been substantial, and many people in all regions have participated every year since the courses commenced in 2008.

In 2012 around 160 people attended two courses in escape prevention. During the first half of 2013 there have been four new courses, with around 300 participants from all company levels. A new course is also planned for autumn 2013. Keynote Speakers will attend from the Directorate of Fisheries, Aquaculture Escape Commission, research and equipment suppliers, and from various aquaculture companies.

The Miljøløftet ('Environmental Promise') represents a concerted effort to combat escapes

In April 2011 the FHL publicised its "Environmental Promise" as part of its increased efforts to ensure sustainable development of the aquaculture industry. Initiatives taken under the aegis of the E"nvironmental Promise" clearly go a lot further than the formal demands made on the industry by the authorities, and involve in the first instance six concrete measures to avoid escapes threatening stocks of wild Atlantic salmon. These have been initiated, are in the process of being initiated or are under preparation. The measures can be viewed at www.fhl.no/miljoloftet. Meanwhile the FHL has requested the Norwegian Food Safety Authority (NFSA) and the Directorate of Fisheries to tighten up inspections of companies and enforce the regulations in a uniform manner.

The 'Environmental Promise' initiatives clearly go a lot further than the formal demands made on the industry by the authorities.

The FHL's own committee working to avoid escapes appointed new members in 2012, and has got to grips with and initiated research and further follow-up to ensure the equipment used in marine farming works as a unit and does not cause wear and tear to the nets.

A pilot project has also been initiated that provides learning from incidents and near-incidents. Further initiatives to improve preparedness are also under preparation.

The need for knowledge

The FHL has requested and initiated extra research to clarify to which degree and at which levels escaped salmon impact on wild salmon. This is to enable the establishment of appropriate and measurable sustainability criteria with relevant limit values. In 2012 and 2013 the need was pointed out for knowledge in important hearing processes that concern sustainability indicators and quality norms for wild salmon.

As Institute of Marine Research and the Veterinary Institute state in their report "Proposal for first generation gauging method for environmental impact (impact indicators) with regard to genetic influence from farmed salmon to wild salmon, and influence of sea lice from marine farming on wild salmonid stocks", there is no documented scientific knowledge on the actual significance of escapes and sea lice in wild stocks of salmon and sea trout. Research reports and ongoing studies in many rivers underline extreme uncertainty in both the sampling methods intended to indicate the percentage of escaped salmon in the rivers, in measurements of spawning stocks intended to help form a basis for estimating the significance of escaped salmon in rivers, and not least in the connection between escaped salmon in rivers and any genuine negative genetic impact on stocks.

Studies of genetic change in 21 rivers have revealed changes in a minority of these, and these studies have so far not shown any relationship between the incidence of escaped salmon and change. Or what a proven change means. This illustrates some of the knowledge basis that must be in place before relevant indicators can be developed and brought into use. That the authorities have an integral perspective on challenges facing wild salmon is decisive for both the wild salmon and for the further development of the aquaculture industry.

Tagging and tracking of salmon

The aquaculture industry is looking for a system that differentiates escaped farmed salmon from wild salmon in rivers, and that tracks escaped fish back to the company responsible. Several tagging/tracking systems are being considered parallel in projects initiated by the FHL. Several research communities are working on tagging and tracking projects for the salmon industry. Seven projects are currently underway under the auspices of the FHF (Norwegian Seafood Research Fund), which has allocated NOK 17 million for this purpose. A main criteria is that the method shall be the standard method employed by everyone and not involve any risk to the environment, animal welfare, food safety or working environment. The system shall provide definite identification and must not be copied or misused. One or more methods can in total meet the requirements. Estimates for tagging costs and possible added value in the markets is also included in the evaluations.

Wild salmon projects. *From monitoring of fish in the Varpa watercourse in Nordland, one of many projects that the aquaculture industry's Environmental Fund has wholly or partially financed. The projects have so far provided valuable data on 26,000 salmon in 62 vwatercourses. Photo: FHL*

Årstall	Total antall undersøkte elver	Totalt antall undersøkte laks	Antall rømt laks	% innslag	Median	Elver < 5 % innslag	Elver 5-10 % innslag	Elver > 10 % innslag
2011	12	7.424	336	4,5 %	3,4 %	8 (67%)	2 (17%)	2 (17 %)
2012	62	18.909	476	2,5 %	1,6 %	48 (77 %)	7 (11%)	7 (11%)

Graph 6.c.5: Incidence of escaped salmon in 62 river studies. *The overview shows results from studies of more than 26,000 salmon in 62 watercourses across the entire country. Different methods are used such as catches using fishing lines, fish traps, diving and video monitoring. To differentiate between wild fish and farmed fish, fish scales have been analysed in 82% of the watercourses and visual assessment carried out of the remaining 18%. All fish, both assumed farmed salmon and wild salmon, were examined in order to provide the most accurate details of the situation in the individual rivers. In most of the projects the main focus has been on studies carried out in the sports fishing season. (Source: Norwegian Seafood Federation FHL)*

The Environmental Fund; initiatives in more than 60 rivers

The aquaculture industry's environmental fund is a part of the Environmental Promise (Miljøløftet). The aquaculture companies have contributed with NOK 10,000 per production licence each year for three years, and the fund is intended to be an immediate initiative to reduce the number of escaped fish in rivers until the industry and research communities have found a more robust system to separate farmed fish from wild fish, and to track fish back to the aquaculture company concerned. The fund is managed by appointed national and regional executive groups that consider applications in two annual distribution rounds. In 2012 funds were granted to 18 regional projects. These include both test fishing initiatives and monitoring projects in a total of 62 rivers.

Around 30% of the funds are designated to national projects. The national projects have focused especially on researching various tracking solutions, but also on finding out more about how fishing methods, fishing locations and timing of the studies can affect the result of the studies of incidences of escaped salmon in rivers. As at May 2013 more than NOK 17 million had been granted to national and regional projects. Representatives from wild salmon interests are invited to add input to regional and national projects.

Few escaped salmon in the rivers

Studies of more than 26,000 salmon in 62 watercourses across the country in 2011 and 2012 show that the incidence of escaped salmon in rivers is lower than expected compared with previously presented figures. Summarised on a national basis the incidence of escaped salmon was 4.5% in 2011 and 2.5% in 2012. (graph 6.c.5). The bulk of the studies were carried out during the sports fishing season in summer, in addition to some watercourses studied later in the autumn.

If one looks at the median values for incidence of escaped salmon, in 2011 this was 3.4% and in 2012 it was 1.6%. In the main study in 2012, half of the rivers had a 1.5% or lower incidence of escaped salmon in 2012. In this connection it is worth mentioning that researchers estimate a natural mismigration amongst salmon on average around 4%[7].

Reduced incidence of escaped salmon in rivers

The Norwegian Institute for Nature Research (NINA) has for several years carried out studies on interference by farmed salmon in test fishing/brood fishing just before spawning in autumn. The study is partly commissioned by the Directorate of Fisheries and partly by the Norwegian Environment Agency (DN). In 2010 the unweighed percentage of estimated escaped salmon was 13.1% for the 41 rivers where more than 20 samples of scales from salmon were analysed[1]. While the unweighed average for incidences of escaped salmon in rivers every year from 1989 up to and including 1998 was over 20% in the autumn fishing, since then this has declined and settled between 11% and 18%[13]. The overview of the rivers that are included in the study from NINA shows variations

from year to year as to which rivers are included in the study, how great the incidence of farmed fish is (0–60.3% in 2010) and how many samples were taken from the different rivers (20 – 378 salmon in 2010)[14]. If we look at the individual rivers, we can also see that the result can vary considerably between different test locations in the river[15]. It is extremely important that work on standardising the sampling and selection of rivers is intensified. In this way the figures will provide the most correct picture possible.

In that there is so much uncertainty surrounding the figures and such a big variation in the incidence of escaped salmon between the rivers, then use of the median value rather than the average value provides on the whole a more accurate picture of the situation in the rivers. The median value in this context will show the percentage share that half of the rivers are on or under. In using this value, extreme values are excluded These can move the average significantly up or down. Since 2006 the median value has been under 10%. In 2010 the median value was 9.3%.

It must also be pointed out that in the period 1983-2010 the influx of salmon into Norway has shown a negative trend and thus the migration of wild salmon into the watercourses has been reduced[13], and consequently the total number of escaped farmed salmon has in fact fallen more than the percentage decline indicates.

Goals for the work on escape prevention
Farmed fish escapes are unwelcome. In 2007 the FHL's Annual General Meeting adopted a 0-vision for farmed fish escapes. This means the number of escapes and scope of single escapes shall be reduced to a minimum. The vision and target therefore tally well with the target in the previous Government's "Strategy for an environmentally sustainable aquaculture industry"[8].

Trends in official statistics for escape figures and incidences of escaped fish in rivers have on the whole shown a positive trend over several years. This strengthens the belief that the efforts made and measures implemented are working. But the target and vision have still not been achieved, so new initiatives will therefore be implemented.

New initiatives and R&D

Intensified effort to combat escapes
Marine farming companies have, in keeping with the Environmental Promise's intentions, appointed a committee to study the possibilities of strengthening preparedness and to a greater extent contribute towards involving fishing vessels, salmon fishermen and other pertinent cooperating partners so that recapture of escaped salmon is improved.

The industry also intends to fund intensified research to clarify to what extent and at which levels escaped salmon impact wild salmon, so that measurable and relevant sustainability criteria can be established. A pilot project has been initiated for voluntary reporting and exchange of knowledge regarding observations of potential dangers of escapes. A summary and evaluation after completion of the pilot project will decide whether this will be extended to become a national system.

There is still significant demand for courses in escape prevention. New courses are planned on topics including escape prevention, contingency, regulations, technical standards, exchange of experiences and focus on human factors.

Knowledge about causes of escapes is an extremely important basis for further development of equipment that will reduce the risk of escapes. Since gnawing from chains on nets have been identified as a crucial factor, several projects have been initiated under the auspices of the industry itself, equipment suppliers and a larger project under the aegis of the FHF involving testing under a range of controlled current and wave conditions in the test facility at Marinek in Trondheim. The project was initiated by FHL's escape commission and test results are on the verge of providing important answers in relation to how natural forces affect the equipment under normal operating conditions and under "extreme weather". Practical, usable results are expected from these trials in the autumn of 2013. The hope is – and the intention is there - that the results will contribute toward standardising of nets and cage systems to a greater degree than is the case today.

Trends in official statistics for escape and the incidences of escaped fish in rivers have on the whole shown a positive trend over several years.

There remain several work packages in the three-year project linked to human factors and escapes from aquaculture. The intention of the project is to arrive at systems that address what is popularly called "human error" and to prevent this leading to escapes. The project is a follow-up of a prioritised area of investment for FHF. Other prioritised areas of research include finding acceptable methods for tagging and tracking of escaped salmon, and clarification of whether sterile salmon is an alternative for the Norwegian aquaculture industry[10].

New areas of focus for FHF that commenced in 2013 aim to clarify how escaped salmon affect wild stocks of salmonids, seen in relation to how other factors influence stock development. They will look closer at an evaluation of how knowledge can contribute towards ensuring reliable catch statistics for escaped salmon in rivers. This is research that in total will contribute follow-up the Environmental Promotion's goal of "intensified research input to establish to what extent and at which levels escaped salmon affect wild salmon so that measurable sustainability criteria can be established".

Various projects are under way that will form the basis for better decisions on investments in – and the need for research on – production of salmon in closed containments. At the same time, it can be expected that the summation of knowledge from these projects will contribute towards a more nuanced and fact-based debate about this type of installations.

In January 2013 the Directorate of Fisheries gave a promise of 6 new research licences for farming of sterile salmon for commercial production. The Institute of Marine Research (IMR) and AquaGen will lead the research project in cooperation with 5 different aquaculture companies. The goal is to reduce the risk of possible genetic impact in the event of escapes, but more knowledge is still needed. This will not reduce the industry's focus on preventing fish from escaping.

There are also a number of projects in which research institutions such as SINTEF fisheries and aquaculture, the Institute of Marine Research, NINA, NTNU, Nofima and others contribute collectively or individually and often in cooperation with aquaculture companies and/or equipment manufacturers. The goals can be to improve or develop new and more escape-proof equipment, develop monitoring equipment or lay the groundwork for gaining more knowledge concerning escapes and interaction with wild salmon.

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Sea lice

In the course of 2012 and 2013 the aquaculture industry has made considerable progress in combating the problem of lice. Although alternatives to medicines and cleaner fish have not achieved commercial extent of any significance, the aquaculture industry has managed to reverse the negative trend we saw around 2009 and 2010.

Status and challenges

Spring 2013: Few sea lice on farmed and wild salmon
One of the main objectives for the aquaculture industry is to ensure lasting low lice levels in marine farming. Figures from the industry's weekly counts of sea lice through 2012 and the first half of 2013 indicate we are heading in the right direction and that this goal is within reach. But the low lice levels have not just appeared by themselves. They are mainly the result of hard work, innovation, coordination of initiatives and good cooperation in the aquaculture industry. Meanwhile, it is pleasing that the authorities' counts of lice on wild salmonids during the spring of 2013 also show low numbers of lice on emigrating smolt of salmon and sea trout[1, 2].

Challenges are met by goal-oriented effort
In order to reverse the trend of rising lice levels in marine farms during the autumn of 2009, during the last 3-4 years the industry has employed many resources in the campaign against sea lice along the coast. Much of the focus was has been on documentation and transparency, research and development, exchange of knowledge and communication in and between the various areas.

To achieve lasting low levels of lice in marine farming, one must have extensive knowledge of the louse's biology and about optimum use and effect of the various control initiatives. In this connection, two in particular of the four primary goals for the aquaculture industry's lice campaign are central; control of the lice shall occur through minimal use of medicines, and at the same time effective medicines against salmon lice must always be available if needed. We have not quite achieved that yet, but we have registered that work is now progressing with more than 20 different non-medicinal control measures[4]. This is promising, and results so far provide ample grounds for optimism.

A parasite found naturally in all sea areas in the northern hemisphere
The sea lice (Lepeophtheirus salmonis) is a member of the copepod species. The salmon louse is host-specific and has existed together with salmonids for a long time. It is first mentioned in the 17th century[6]. As with most parasites, stocks are subject to natural fluctuation and there have been reports of very high lice counts on wild salmonids several decades ago, including from Canada in 1939[7].

A higher number of farmed fish in the sea results in a higher number of hosts for the sea lice. At the same time, it is also the case that wild salmon naturally carry lice with them from the sea when in spring they swim into the coast to spawn in the rivers. This happens at the same time as smolts migrate from the rivers to feeding grounds in the sea. Even though studies have shown that the smolt pass through fjord systems at a high tempo on their way out to sea, nature has shown that smolt can be infected by lice larvae in the sea during this migration[8]. This occurs regardless of whether these originate from wild salmonids or marine farms. Therefore it is vital that the lice level in marine farms is extremely low throughout spring.

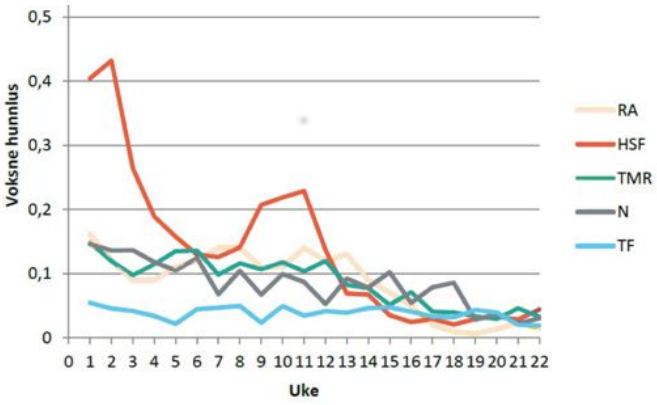
Temperature determines how fast a sea louse develops, and experience shows the number of lice in the sea increases naturally when temperatures rise during summer and autumn. Therefore since 2010 strategies have been laid as part of the national lice project with the aim of keeping lice levels low in marine farms also during summer and autumn, not just in spring. In autumn 2012 the salmon lice regulations were revised again and one of the new regulations applicable from 1.1.2013 stipulates a maximum of 0.5 adult female lice per fish throughout the year, also in autumn. In the period 2009–2012 the sction level was one adult female louse per fish between 1 September and 31 December, and 0.5 the rest of the year.

Reduced numbers of lice in marine farms in winter and spring 2013
A fourth main objective for the aquaculture industry in

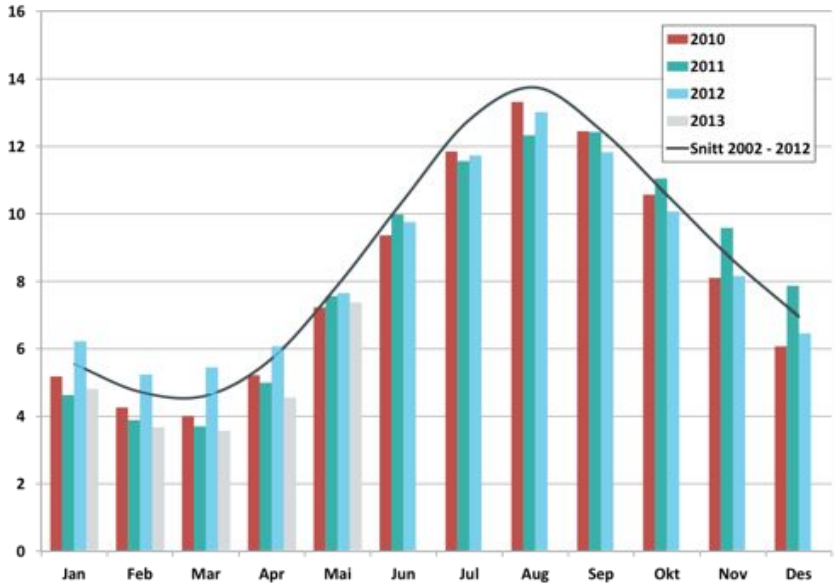
The low lice levels have not just appeared by themselves. They are mainly the result of hard work, innovation, coordination of measures and good cooperation in the aquaculture industry.

relation to salmon lice is to minimise damage impact on fish in marine farms and on wild stocks. As a consequence of this objective and efforts made based on applicable regulations, lice levels on fish in marine farms in recent years have been very low in the period when the majority of wild salmon smolt make their way to the sea. To achieve this, in line with regulations the aquaculture industry has carried out coordinated delousing with extremely low action limits (max. 0.1 mobile lice per fish)[3]. Since spring 2013 the counties of Troms and Finnmark have also participated in the coordinated spring delousing, but despite the low action limits there were very few farms in these counties that needed to take action. Many farms in the other counties did not have to act either. This is very encouraging, especially considering that such intense handling at such low sea temperatures is not without risk to the health and welfare of the salmon.

The lice counts for the marine farms are publicised at lusedata.no. These show reduced numbers of sea lice during winter and spring 2013 period and the beneficial effect of coordinated spring delousing. The Norwegian Food Safety Authority (NFSA) inspectors, who have also been out and counted lice in many farms, confirm the industry's lice figures[1]. In its report for winter and spring 2013 under the title "Objective of spring delousing achieved", the NFSA summarised: "Levels nation-wide averaged under 0.1 adult female lice per fish in the period for the coordinated spring delousing. This has contributed to reduced incidence of lice larvae in the sea during the time when wild salmon smolt are migrating".
Later in the same report they wrote that "the NFSA's



Graph 6.c.6: Progress of salmon lice levels in regions 2013. *Salmon lice levels in NFSA's different regions in Norway. The maximum limit under the lice regulations permits 0.5 adult female lice on each fish in a marine farm, but in connection with the spring delousing it was as low as 0.1. Similarly, on lusedata.no you can follow the progress of the smaller lice concentrations on the fish. The industry can use this to plan coordinated treatments at an early stage to reduce the development of adult female lice with eggs. (Source: Norwegian Food Safety Authority)*



Graph 6.c.7: Overview of temperatures in the last three years. *Registered sea temperatures throughout the year in the years 2010–2013, together with average temperatures for the last 10 years in Norway (2002–2012). The curves show that sea temperatures (on a national basis) were considerably higher in the spring of 2012 than in 2013, but that the difference was not as pronounced between sea temperatures in the spring of 2010/2011and 2013. In May and June, when most of the smolts migrate, temperatures have been relatively stable in recent years. The low amount of lice in marine farms are largely due to an excellent sustained effort by the entire industry, and not just low sea temperatures in the winter and spring of 2013. (Source: Aquaculture data based on reports received from Altinn)*

Lice counts in marine farms are publicised at lusedata.no. These show reduced incidence of lice for the whole post-Christmas winter and spring 2013 period and the beneficial effect of coordinated spring delousing.

overview of sea lice levels in marine farms in the period January to June noted that levels were lower than in recent years. On a national basis the average level was under 0.5 adult female lice, which is the maximum limit for the number of lice permissible on each fish in a marine farm."[7]

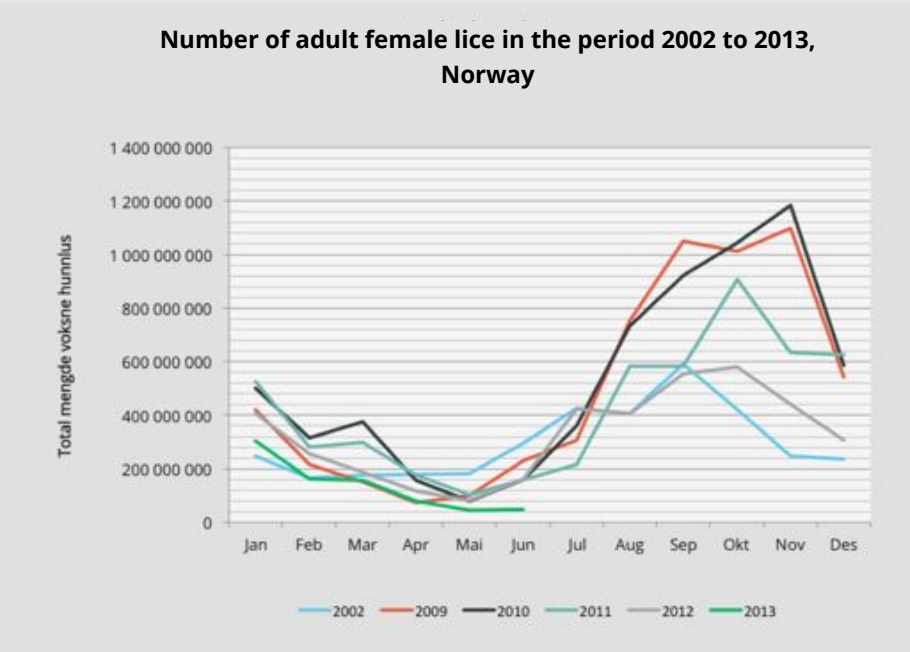
The NFSA claims in its summary that the low sea lice levels are due first and foremost to low sea temperatures[1]. But if we look at the temperatures for the last four years and the average temperature from 2002, it is obvious the situation for lice in marine farming is not only due to this, but also largely to an excellent effort by the entire aquaculture industry over a long period of time (see diagram 6.c.8 and 6.c.9).

Extremely low infection press in the sea

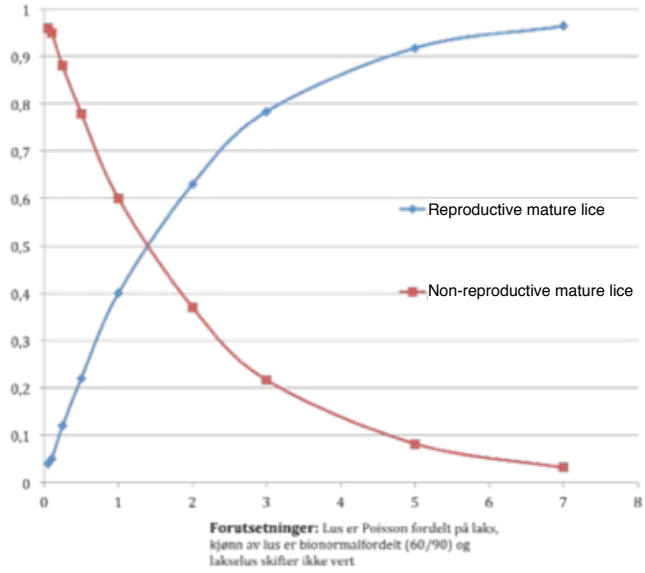
The Institute of Marine Research has been commissioned by the NFSA and Ministry of Fisheries and Coastal Affairs to take charge of coordinating monitoring, research and consultancy in regard to numbers of sea lice on wild salmonids along the Norwegian coast[2]. In their risk assessment of Norwegian aquaculture for 2012 they still consider numbers of sea lice as one of the most problematic risk factors[5].

It is nonetheless heartening that in their progress report to the NFSA concerning sea lice on wild salmonids in May and the beginning of June 2013, they concluded that "So far the results indicate that 2013 is a year where stress from infection has been extremely low in parts of western and central Norway in spring and early summer, and that both sea trout smolt and salmon smolt have had low levels of infection during smolt migration. This could be due to measures taken by management and the industry, but can also be due to low temperatures and plentiful fresh water in spring and early summer" [2]. Results from northern Norway were not included in this earlier report. Wild salmonids thus appear to have got off to a better start in 2013 than in 2012.

It isn't easy to say which of the proposed explanation models they describe has been of greatest significance for this situation. It is nonetheless important to note that lice levels in the sea and migration routes for wild salmonids are dependent on, and are affected by, a number of factors. Most of these are linked to natural variations in precipitation levels and other weather conditions, temperatures in rivers and the sea, flow conditions in different sea layers etc. Regardless, the aquaculture industry will continue to play its part in contributing



Graph 6.c.8 Lowest lice numbers in 10 years. *The graph shows average number of adult female lice per fish multiplied by total number of fish in the sea in the period 2002 to 2013. As the graph shows, lice levels are the lowest for the past 10 years. The low figures are largely due to a conscientious effort by the entire industry over a long period of time, and not just natural variations in weather conditions and sea temperatures. Production doubled in the same period (2002–2012). (Source: Lusedata.no and FHL)*



Graph 6.c.9: Percentage of reproductive mature lice. *Lice are reproductive, but female lice that are not fertilised also produce strings of eggs. The adult louse is not particularly mobile, and with low lice numbers the adult female louse "does not find" a partner and is then not fertilised. The percentage of adult female lice with fertilised egg strings is therefore in principle very low when lice levels are low. This means it is important to have a low number of adult, sexually mature female lice in the marine farms. (Source: Arnfinn Aunsmo, SalMar. Lecture during veterinary science days conference 2011)*

towards reducing pressure from infection in the sea by ensuring long-lasting low sea lice levels.

Salmon lice in the aquaculture industry in 2012. Reduced lice levels.

A review of the weekly reports of lice numbers in the aquaculture industry in 2012 reveals that the total number of adult female lice (average number of lice multiplied by number of fish in the sea at any given time) in the first half of the year was about the same level as in 2009, but considerably lower than in 2010 and 2011. In July the level was somewhat higher, while the rest of the summer and all of the autumn were significantly under the levels for 2009-2011 (see graph 6.c.8). We see clear contours of a new and positive trend.

The cause in this instance is also complex, but bearing in mind that this has occurred at the same time as production has increased, we are convinced that the three-year lice project the FHL initiated in autumn 2009 has produced good results. The initial objective was to reduce numbers of lice in order to minimise damage impact on fish in the aquaculture industry and in wild salmon stocks, at the same time combating development of resistance in salmon lice. This would be achieved by establishing a control regime in the aquaculture industry that would facilitate maintaining lasting low levels of lice on salmonids in the aquaculture industry. Results show that the strategy and initiative are successful. Work carried out during the three-year project period forms the basis for the necessary long-term maintenance of low lice levels by the aquaculture industry. Measures other than medication and heightened focus on monitoring of the early lice stages will contribute toward ensuring necessary measures can be coordinated better and implemented early to evade numbers of lice with fertilised egg strings.

Lumpfish and wrasse (mainly goldsinny wrasse, ballan wrasse and corkwing wrasse) function as "cleaner fish" and are nature's own, highly efficient method of sea lice removal in farm cages. Cleaner fish prefer to eat adult female lice with egg strings. Increased use of cleaner fish is therefore a crucial part of the strategy to maintain low levels of adult, reproductive female lice in farm cages. So far, cleaner fish have made a significant positive difference and are often put into the cages at the same time as the smolt.

Use of medicines is regulated and monitored

Non-medical control measures are not just an important part of the strategy to achieve the main objective of lice combat, but also to achieve another main objective; limiting the use of medicines. An important reason for limiting use of medicines is that with prolonged use sensitivity to the preparations can become dulled. In their report for winter and spring 2013 the NFSA wrote there was no indication that the resistance situation had changed during spring. The aquaculture companies coordinate treatments and rotate the medicines that are available to avoid diminished sensitivity and resistance. Hydrogen peroxide, an extremely environmentally friendly

Work carried out during the three-year project period forms the basis for the necessary long-term maintenance of low lice levels.

Cleaner fish. *So far, experience shows cleaner fish have had an excellent effect and are often put to sea simultaneously with the smolt. (Photo: Norwegian Seafood Federation FHL)*

alternative, has been used by many, particularly in the Trøndelag region, as a way to cut down on other medicines[1].

All delousing means used are prescribed by authorised fish health personnel and are approved for use on farmed fish. In accordance with the regulations, the effect of all the treatments must be assessed through counting of lice before and after treatment. Diminished effect or suspicion of diminished sensitivity towards a preparation must be reported to the NFSA. Contributing causes must be explained and lice sensitivity tested before new treatment is commenced with another active substance.

Initiated measures

A united aquaculture industry will continue to coordinate efforts

In the late summer and autumn of 2009 the industry's own weekly sea lice counts indicated rising lice numbers. On this basis and in acknowledgement of the fact that combat and control of sea lice cannot succeed unless all companies participate in the task, the FHL took the initiative in autumn 2009 of a joint organisational and action plan for combating lice. Norwegian Seafood Association (NSL) members and non-organised aquaculture producers were invited to participate. This was initially a 3-year project that finished at the end of 2012. Cooperation within the industry in keeping lice numbers down has proven to be tremendously important and useful, and has produced good results. Therefore, with some minor organisational alterations the aquaculture companies have opted to continue this cooperation in accordance with the strategy and with the main objectives that were developed during the project period.

This way of organising the work gives everyone in the industry a chance to participate. Transparency regarding lice figures, treatments and sensitivity to medicines facilitate efficient coordination of the job of prevention and combat of lice. This ensures the planning, academic foundation and assessment of new measures, also that the means available, and which are efficient, are employed. Subsequently, knowledge is consolidated and provides the motivation for completing the lice strategy. The results of these efforts and initatives, and the status of work carried out locally, are distributed weekly internally within the aquaculture industry. The three regional coordinators and the national coordinator still all have important roles in combating the lice problem, particularly in regard to communication to management at all levels and to the public in general.

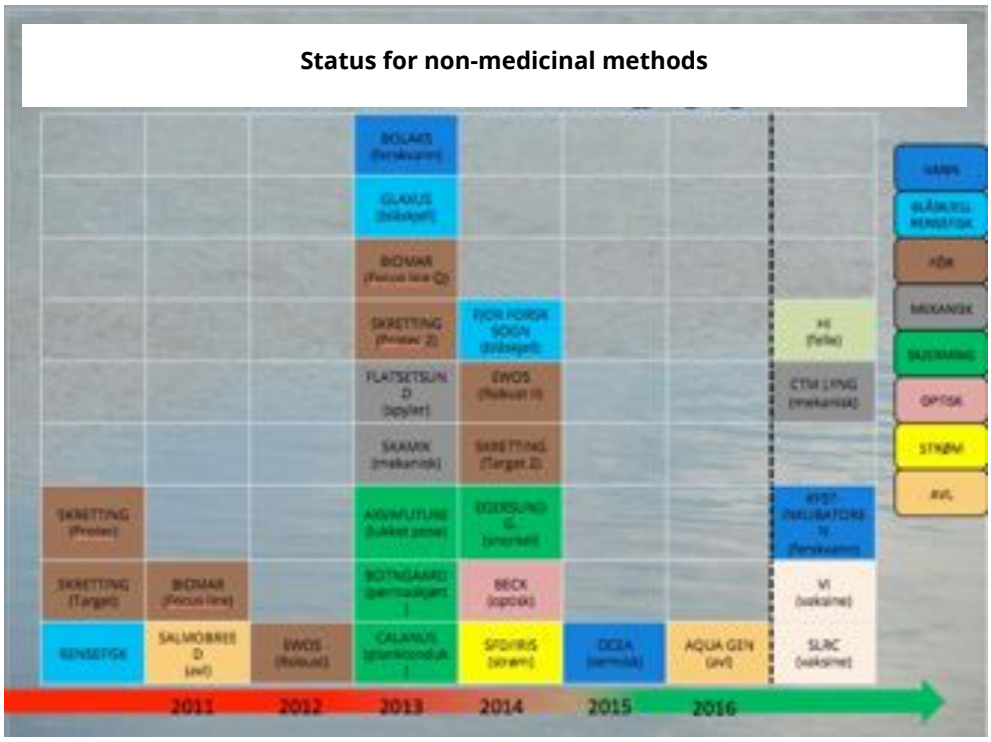
Dialogue with the authorities to bolster practicable regulations

Close dialogue with the authorities has been prioritised to establish the most appropriate regulations possible on a national basis. While aquaculture companies have put in place cooperation, the government has further developed regulations. Increasing emphasis is aimed at collaborating with the measures implemented within the framework of the lice project. Demands are stricter in regard to numbers of salmon lice on fish in marine farms and for coordinated delousing. The last revised issue of the lice regulations came into force on 1st January 2013 and includes requirements for a lower lice limit and weekly salmon lice counts [3, 9].

The aquaculture companies have for their part followed up the lice project's plan of action with 12 secondary targets and more than 40 concrete initiatives, as well as the Environmental Promise (April 2011) where FHL's member companies committed to further initiatives included measures to combat salmon lice[9].

Some important measures that have been initiated:

* Interaction in areas/zones that have mostly been defined by the industry on a voluntary basis. To a large degree these also form the basis for implementing national regulations, including coordinated plans for release and harvesting of fish, for coordinated laying fallow of sites in relevant areas and for coordinated lice treatments.
* More frequent (weekly) and more detailed reporting of results from monitoring of the lice situation, treatment etc. in marine farms.
* Revision of the website Lusedata.no offers even better and easier access to data for the public in general, aquaculture producers and lice control coordinators, thereby providing greater opportunity to plan coordinated treatments etc. on a much improved basis and at an earlier stage. Data is also used as the basis for the FHL member companies' weekly overviews.
* Updated overviews of relevant R&D projects and other pertinent information on Lusedata.no. These also mirror the extensive research that is ongoing and has taken place with substantial support from the Norwegian Seafood Research Fund (FHF).
* More cooperation and exchange of knowledge concerning catches and use of cleaner fish. This is one of the most important initiatives to achieve control of lice numbers with no or much reduced use of medicines in marine farming.
* National guidelines have also been prepared and were under revision in spring 2013.
* Focus on ensuring development of non-medicinal control measures against lice, including farming of cleaner fish. Many industry participants and research communities are involved in more than 20 different initiatives (graph 6.c.10).
* Development of therapy guidelines with important principles for planning and rotation of relevant medicines to ensure access to and preserve sensitivity for as long as possible of the means at one's disposal.
* Development of national guidelines for optimum monitoring and treatment against lice. These are readily available on lusedata.no.
* Lice filters have been introduced or are in the process of being introduced at packing stations. Measures have been initiated or are under consideration and tested in several well-boats.



Graph 6.c.10: Overview and status for non-medicinal methods for lice control. *The overview shows a summary prepared after a FHF/FHL/NSL seminar in March 2013, where different research communities and industry participants presented important non–medicinal measures against lice that are under development, on trial or already in use. The time axis shows when industry participants believed the different measures would become commercially available. The overview lends support to the belief that challenges concerning lice can be resolved within a few years. (Source: Lusedata.no)*

Counting salmon lice. *Marine biologists at work, an important cooperating partner for aquaculture companies along the coast. Photo: Norwegian Aquaculture Centre.*

Breeding technology companies and researchers have in recent years accomplished much in regard to breeding salmon that are more resistant to salmon lice, and eggs from parent fish selected for enhanced resistance to sea lice are now offered on the market.

Work is also continuing on development of vaccines. In the long term vaccines may also be a worthwhile supplement in preventive work. Definite progress has been made here, with provisional research results indicating this work is on the right track. However, it is a complicated process requiring long-term research.

Knowledge must be the basis for any sustainability indicator for aquaculture

In 2012 the FKD, as a follow-up of its sustainability strategy from 2009, presented a proposal for sustainability indicators and limits for sea lice. The proposal was based on a report from the Institute of Marine Research and the Norwegian Veterinary Institute. In autumn 2012 the FHL added input to the proposals and pointed out that for the time being insufficient scientific material was available to establish indicators and limits as proposed. Among other things, we pointed out that there has not been sufficient verification of the level at which sea lice cause mortalities or have a regulative effect on wild salmon stocks. At present no one knows enough about the significance of lice on the various stocks. It is therefore positive that FKD in its parliamentary report in March 2013[11] has realised the need for more knowledge and written: "Salmon lice are mainly a problem for wild fish. Salmon lice are monitored continually in the marine farming industry. Research is continuing on the relationship between salmon lice numbers in marine farming and their impact on wild salmon". This is much needed.

The authorities' work to acquire knowledge to ascertain what is acceptable to avoid a regulative effect on stocks is crucial in ensuring predictable framworks for seafood production. As shown by the overall results already achieved and ongoing, target-oriented efforts, we have here a united aquaculture industry that is well on the way to achieving its objective of lasting low lice levels in marine farming. It is vital to have expertise in place that can form the basis for assessing what is environmentally acceptable.

The seafood producers are confident that initiatives aleady started or due to start will also contribute to keeping lice levels low even as salmon production increases, as outlined in *"Seafood 2025 – how to create the world's foremost aquaculture industry"*[9] and that this can be accomplished in a sustainable manner.

Targets and strategies for combating the lice problem

The main objectives for the aquaculture industry's work with sea lice mirrors the intention of the lice regulations, but is also formulated as concrete targets.

The main objectives are:

1) Ensure that numbers of salmon lice in the aquaculture industry are kept at a permanently low level.
2) Minimal use of medicines.
3) Minimise damage impact on fish in marine farms and wild stocks.
4) Effective medicines against salmon lice shall be available.

In 2012 more than 70 different projects focused on resolving challenges presented by salmon lice.

The strategy for achieving the main objectives is:
1) Responsible geographical placement of farm sites.
2) Coordinated laying areas fallow in appropriate zones.
3) Non-medicinal control of lice numbers in farm cages.
4) Coordinated reduction of lice numbers with the aid of biological, mechanical and when needed medical treatment in an optimal combination of agreed criteria.

New initiatives, R&D

Considerable strides have been made in research and development to combat the sea lice challenge. In 2012 over 70 different projects focused on resolving challenges presented by salmon lice[9]. The Research Council granted in total NOK 40 million to new sea lice projects that were started in 2010. Of this amount, the FHF contributed around NOK 15 million. The FHF extended this investment in 2011, and since 2002 has invested almost NOK 100 million in research into effective prevention and control of sea lice, the main objective of which is: Effective control of sea lice with least possible use of medicines[10].

Priorities for FHF are those associated with measures to succeed with marine farming and use of cleaner fish, development of non-medicinal prevention and treatment of lice, finding better methods of measuring and avoiding developing resistance to lice treatments, and projects in support of compiling a knowledge base to develop a vaccine against sea lice[10].

New areas of priority for the FHF in 2013:
* Determine how significant salmon lice are in the development of wild stocks of salmonids, seen in relation to other factors that influence stock development.
* Knowledge for validation of hydrodynamic spread of infection models for sea lice and PD (Pancreas disease).
Building of a knowledge platform (Centre for research-managed innovation, SFI) for prevention and treatment of sea lice is an investment over 4 years headed by the Institute of Marine Research (IMR) with contributions from many research and expertise circles in Norway, as well as from some foreign research circles. The investment will form the basis for possible development of vaccines and new tools for rapid and accurate testing of resistance in sea lice. Funding has been provided for research in increasing the effect of the methods that are currently used in bath treatments of sea lice in well-boats and farm cages. This is a cooperative project where aquaculture companies, pharmaceutical manufacturers and equipment suppliers participate together with researchers from various research communities in Norway and abroad.

Larger-scale cooperative projects are under way between companies in the industry and research institutions in connection with developing production of ballan wrasse and lumpfish. These are cleaner fish that can be used both for big and small salmon. Research is also ongoing into breeding salmon that are less attractive to sea lice; in other words, salmon that attract fewer sea lice. Aquaculture companies are involved in many larger and smaller R&D projects that cover a wide range of topics in the area of sea lice.

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Nutrients and organic material

Status and challenges

Emissions from aquaculture contain substances that are a natural component of the ecosystem in the sea and mainly originate from metabolic products, faeces and excess feed. These are released in loose and bound form. Based on knowledge of water transport and typical nitrogen and phosphorous values measured in coastal currents, nutrient discharge from marine farms along the route from Lista to the Helgeland coast (Leka) are estimated at around 1-1.5% of the natural concentrations in the coastal current. The estimated contribution from the marine farms decreases to 0.4%, 0.02% and <0.1% in the three northernmost regions. Emission of nutrients, including from aquaculture, therefore have insignificant impact on nutrients in coastal waters[4].

Requirements for monitoring

It is mandatory for the aquaculture industry to monitor the environmental area in the form of MOM (Modelling - Ongrowing fish farms - Monitoring) studies of the farm site, both prior to, and at peak production time at the site.

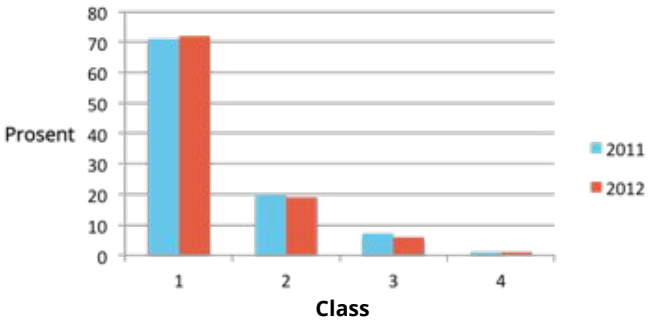
A MOM study is an environmental monitoring of impact on the seabed caused by marine farming, in compliance with Norwegian Standard (NS 9410). The standard describes methods for measurement of seabed impact and provides detailed procedures for monitoring of environmental impact in the immediate vicinity of the plant. This is to ensure that the farm site's carrying capacity is not exceeded and that measures such as laying sites fallow are initiated if unacceptable environmental conditions emerge. Monitoring comprises two studies. MOM B describes how the seabed under and in immediate vicinity of the plant is affected. MOM C provides a picture of impact on the seabed near the plant and some distance out from the recipient. The NS 9410 Standard was introduced for mandatory monitoring of marine farms on 1st January 2005 and from summer 2009 it became mandatory to report results from these studies to the Directorate of Fisheries via the Altinn portal. Over 90% of all the samples reported in the period 2008-2010 were in category 1 and 2, which are regarded as normal condition. The status is available in the chart service of the Directorate of Fisheries (http://kart.fiskeridir.no).

Monitoring results reveal good conditions

There has been professional disagreement in research communities about the extent to which nutrient emissions from the aquaculture industry contribute towards over-euthrophication or not in fjord and coastal areas. The Ministry of Fisheries and Coastal Affairs, in collaboration with the Ministry of the Environment, therefore appointed in January 2011 an expert group to agree on conclusions regarding the degree of eutrophication, dose-response issues and possible effects on the environment in fjords with aquaculture activities.

Hardanger Fjord and Bokna Fjord in western Norway received special mention in the report. Measurements of nutrients in both fjords indicate the values lie within what is characterised as excellent water quality according to the criteria set by the Norwegian Climate and Pollution Agency (KLIF) in the majority of cases. The reason for this is that the natural exchange of water is causing a massive flow of nutrients in and out of the fjord systems. Contributions from edible fish production are too small to cause eutrophication. Norwegian fish farms are now mainly located in areas with good water exchange[1].

Evironmental conditions for reported MOM studies



Graph 6.c.11: Environmental conditions for reported MOM studies in 2011 and 2012. *The percentage of farm sites in each condition class (1-4) is based on reporting to the Directorate of Fisheries on results from MOM B studies of farm sites. Condition class 1 (Excellent) and 2 (Good) are equal to natural conditions and comprised 93% of the reported farm sites in 2012. (Source: Directorate of Fisheries, 2013)*

Nutrient emissions from marine farms on the route from Lista to the Helgeland coast (Leka) are estimated at around 1-1.5% of the natural concentrations in the coastal current.

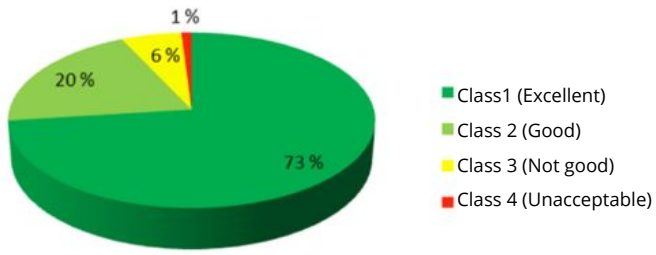
Nonetheless, negative local effects can occur caused by marine farming if the discharge is too large relative to the carrying capacity in an area.

These areas are not suitable for fish production and therefore not used by aquaculture companies. Graph 6.c. 11 shows the results from NS 9410 B studies in 2011 and 2012. 91% of the samples are in condition class 1 and 2 for 2011 and the corresponding figures for 2012 are 93%, which is considered to be normal conditions according to Norwegian standard 9410. With condition 3 a new investigation after 6 months is required. If the study shows unacceptable environmental conditions (condition 4), a larger number of samples are taken from the farm site within 2 months.

With continued unacceptable environmental conditions, the Directorate of Fisheries' regional office can, in consultation with the County Governor's environmental section, come to a decision whether the farm site must be laid fallow. The decision on fallowing the site is not lifted before the survey shows that the environmental conditions are in the highest condition categories, that is condition 1 or 2. The Institute of Marine Research's review of similar seabed studies for the remote zone (MOM C studies) revealed that over 80% in the counties of

Nordland and Hordaland[4] had excellent or good environmental conditions in 2012. For 2012 the breakdown of results is as follows: Condition 1: 73%, condition 2: 20%, condition 3: 6%, and 1% in condition 4

Results from MOM B studies



Graph 6.c.12: Results from MOM B studies reported to Altinn in 2012. *93% of the studies are in condition class 1 and 2, which is considered to be normal conditions in relation to the Norwegian Standard 9410. (Source: Directorate of Fisheries)*

(graph 6.c.12). This is a slight improvement in relation to 2011, where the corresponding figures were: condition class 1: 71%, condition class 2: 20%, condition class 3: 7%, and condition class 4: 1%. The Directorate of Fisheries has now opened for registration of MOM C studies via AltInn. This will help us to gain a better overview of the status of reported MOM C studies on a national basis in the future.

Implemented measures, new initiatives and R&D

Environmental monitoring in Rogaland

Through the "Marine Monitoring Rogaland" project we have gained new knowledge about the water quality of coastal waters. The project is one of the most comprehensive mappings of coastal waters undertaken of any fjord system in Norway. Since 2010 samples have been taken and analyses have been made of long-term series of nutrient concentrations, seabed conditions and the macro algae situation in Rogaland. The project commenced in May 2010 and will continue over a 10-year period, and is being financed by aquaculture companies, the county administration and the Ryfylke Fund. Blue Planet is the project manager and Uni Research is responsible for taking the measurements.

Uni Research concluded in its report that by large there were low values of nutrients in the surface waters of the fjords studied. Concentrations of chlorophyll-a were low, with most of the measurements condition I (Excellent) or II (Good). A registration and comparison of macro algae was conducted at 21 selected stations in 2010 and 2011. The lower growth boundary for sugar kelp (Saccharina latissima) and the group with sugar kelp/sea rod/seaweed was located between 15 and 25 metres for most areas, which is normal. Five depth stations were examined with grab samples in Bokna Fjord, Jøsen Fjord, Hidle Fjord, Finnøy Fjord and Vinda Fjord in 2011. The depth of the sampling stations varied from 183m to 712m. Calculations were made from species diversity, which species were most common at the different stations, number of individuals in each species and a "sensitivity index" for the registered species. All the stations examined had a varied fauna with several animal groups at the stations. Allthe stations ranked class I (Excellent) in the analyses of

seabed fauna. A similar project has now been started in Hordaland.

Environmental documentation Nordmøre
In 2010 the aquaculture industry took the initiative to establish a project for documentation of environmental impact as a result of activity in Nordmøre. An important goal was to develop a method to quantify the environmental impact of marine farming activities in Nordmøre. This task has comprised 5 work packages and the project was organised by FHL's central Norwegian marine farmers' association. Studies of the local impact zone, the intermediate impact zone and regional impact zone around 14 farm sites in the period 2011-2012 showed no sign of euthrophication in the form of ecological changes for the aquatic organisms. The Norwegian standard of MOM C was used. The composition of seabed fauna in the sediment from a marine farm has proved to be a good source for monitoring the farm's impact.

An impact study was also conducted to decide whether or not emissions had negative chemical and ecological effects on the plankton ecosystem in relation to the European water framework directive. The combined conclusion from the studies, based on several methods, was that the concentrations of nutrients, biomass of the phyto plankton, condition assessed from the experiments in Hopavågen and algae-physiological indicators reflected an intact ecosystem. Phase 2 of this documentation effort is ongoing and will be completed during 2013. A similar project will be started in Trøndelag during 2013.

Environmental monitoring in Nordland
In Skjerstadfjord work is progressing on developing the "Fjord Standard", a guideline in environmental monitoring commissioned by Bodø Municipality. Aquaculture companies in the fjord system have contributed with information on environmental studies from and around their farm sites. A comprehensive study of the fjord as a unit is also ongoing. The "Fjord Standard" will convey vital knowledge, particularly on environmental carrying capacity in a limited marine ecosystem such as Skjerstad Fjord, and can undoubtedly be an important instrument for municipalities in their preparation effort, perhaps especially for aquaculture. According to the plan, the standard will be able to be transferred to other counties and fjord systems.

Environmental monitoring in Troms
In connection with consideration of marine farming applications, it was decided to carry out extended environmental monitoring in which residents and fishermen near the farm site outside Harstad (Kjøtta) were invited to participate. The intention of the programme is to conduct environmental monitoring where the parties have the opportunity to have a say in selection of monitoring stations and where instruction is given in scientific rechecking methods for monitoring. The studies are carried out by marine biologists. Samples are taken from the seabed and water measurements taken from 7 different places around the farm site. The first samples were taken in autumn 2011 when the farm became operational, and later these were followed up by new samples to see if there were any changes after a year of operation. For the time being it would appear as if there has been little or no change in the environment around the farm site. This possibly indicates the site is well suited to marine farming. In addition to seabed samples, there was test fishing of wild fish in the area and video recordings made along the site to reveal any changes. Environmental monitoring continued with new samples when production peaked and further samples will be taken in autumn 2013 when the farm operation comes to a close.

The industry is now at a stage where it is moving towards increasingly larger farms. There is also growing focus on monitoring of fjord systems and farm clusters. The projects mentioned here are therefore of major significance for documenting the impact emissions from marine farms have on a fjord system.

Integrated multitrophic aquaculture (IMTA)
Several projects are taking a closer look at utilisation of nutrients from marine farms as a means to cultivate other species. Some of these are:
* In a NTNU and SINTEF project a study was made of emissions of nutrients from marine farms in 2009, environmental impact and the potential for integrated multitrophic aquaculture (IMTA). Due to much dissolved inorganic nitrogen (DIN) from marine farms, the potential

The projects in Rogaland, Nordmøre, Nordland and Troms are crucial for documenting the impact emissions from marine farms have on a fjord system.

for IMTA is greatest in regard to production of seaweed and kelp. Blue mussels are dependent on the right size of particled organic carbon (POC).
* Salmon Group AS and Sulefisk AS started integrated marine farming in 2010 in cooperation with a company in the Netherlands. The salmon are produced together with three types of seaweed. The aim is to find a "formula" for cultivating as much seaweed as possible of good quality in the shortest possible time. The seaweed will go to food production, first and foremost through refining of protein in the seaweed.
* Blue Planet is the project manager for a project entitled Dymalys: Cultivation of macro algae in Lysefjord. The project is a cooperative project between various companies/organisations, Lerøy Seafood Group, Rogaland County Council, Biotec, Sylter Algenfarm, IVAR, Bellona and Ewos Innovation. The intention is to look at possibilities to cultivate seaweed in Lysefjord and test what uses the seaweed may have. The project is intended to establish high-quality seaweed production and the final products will go to human consumption, ingredients and fishfeed raw materials, intake of nutrients and use of CO_2 for bio-energy.
* Val Upper Secondary School, Norway's Vel (Royal Norwegian Society for Development), Bioforsk and Bellona have also teamed up on a pilot project for cultivating algae[2].

Integrated aquaculture in Norway is still in the start-up phase. The many ongoing projects with several aquaculture companies may provide useful knowledge about new sources of food, feed and energy production in the years ahead.

Marine carbon catches and storage in aquaculture
The world's population is steadily increasing and there will be a huge demand for increased food production in the coming decades. At the same time, we are dependent on reducing emissions of CO_2 into the atmosphere. The potential for storage of carbon in Norwegian coastal and fjord areas is, according to the Institute of Marine Research (IMR), 6.4 million tonnes of CO_2 annually.

By comparison, a full-scale purification plant costing NOK 40-50 billion sited at Mongstad captures around 1 million tonnes of CO_2 annually. IMR has estimated that cultivating seaweed and having deepwater disposal can bind and store long-term 30% of the Norwegian CO_2 emissions in 6% of our sea area within the base line[3].

In regard to aquaculture and carbon storage, studies have been made of shellfish farming in China. Calcification of shellfish produces CO_2, but this is bound in the extensive primary production (seaweed and phyto plankton) in the coastal areas where shellfish farming takes place.

Cultivation of blue mussels for industrial purposes has been singled out by several scientific milieus as having huge potential as a source of marine protein and fatty acids, as permanent storage (sequestration) of CO_2 in the shell fraction, as a means of removing nutrient salt discharge from human activity and filtering of undesirable microorganisms from sea water such as salmon lice larvae.

The Institute of Marine Research (IMR) has estimated that a significant percentage of Norway's CO_2 emissions can be stored as chalk/shell from blue mussels. Norway has long traditions for production of fishmeal and oil, a technology that could easily be applied to industrially cultivated mussels. There is still a need for more knowledge concerning carbon, nitrogen and phosphorus flux in the various systems. Furthermore, the groundwork must be laid for external conditions connected to CO_2 capture through reestablishment of kelp forests. More knowledge is needed about industrial exploitation of blue mussels as a feed resource and permanent storage of CO_2 in the (mussel) shell fraction.

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Chemicals – use and emissions

Status and challenges

Aquaculture – an export industry with extremely high standards for the use of chemicals

The Norwegian aquaculture industry is an export industry with the world's largest chain food stores and the processing industry as its biggest and most highly demanding customers. In practice this translates into stringent specifications and standards that are often far in excess of the demands imposed by regulatory bodies with regard to HES, animal welfare, the environment and food safety. The demands imposed by customers relate to use, handling and monitoring of both food safety and the immediate environment. Adherence is often monitored by a third party.

The key chemicals currently used in the Norwegian aquaculture industry are detergents and disinfectants, impregnation compounds for nets, and medicines. Amongst medicines the most common are anti-bacterial treatments and anaesthetics used in connection with vaccination and lice counts.

In addition to the companies' own sampling, which is mainly analysed by laboratories licenced for the required analyses, the Norwegian Food Safety Authority monitors farmed fish for medicines and undisireable substances for many years. The National Institute of Nutrition and Seafood Research (NIFES) carries out analyses and is responsible for reporting[1]. Results from the analyses are published in "Sjømatdata"
(Seafood data)[2].

Safe seafood from aquaculture

A new report published by NIFES for 2011, based on samples taken from 11,765 farmed fish checked for content of legal and illegal medicines, heavy metals and other environmental poisons or other compounds etc. that are banned from use in food production. No residual traces of legal medicines were found. All results proved to be within the permitted detection levels and thresholds for environmental poisons. The results were in accordance with previous low findings in similar checks and inspections[3]. The monitoring programme is implemented in accordance with requirements stipulated by the EU since 1998. The report also reveals a positive trend, with decreasing levels of environmental poisons in farmed fish In comparison, one can mention that in 2012 a total of 3,779 samples were taken from various species/ foodstuff from agriculture and game animals. In 116 of these (3.1 %) finds were made that did not comply with the relevant standards[6].

The use of medicines for fish is strictly regulated, and only medicines are used that have been approved by the Norwegian Medicines Agency after an extensive process during which both food safety and environmental impact are assessed and evaluated. Prescriptions can only be issued by authorised veterinarians and fish health biologists, and there are strict rules in place for retention periods between medication and slaughter. The Norwegian Food Safety Authority monitors and enforces the regulations.

The use of antibiotics in aquaculture remains marginal, even though there was an increase in 2012[4]. Operating responsible animal husbandry does, however, demand that approved medicines are used when a sickness arises – or to prevent the spread of salmon lice to wild salmonids. Sales of salmon lice preparations also increased on 2012, but the aim is to be able to maintain a permanently low level of salmon lice with a minimal use of medicines.

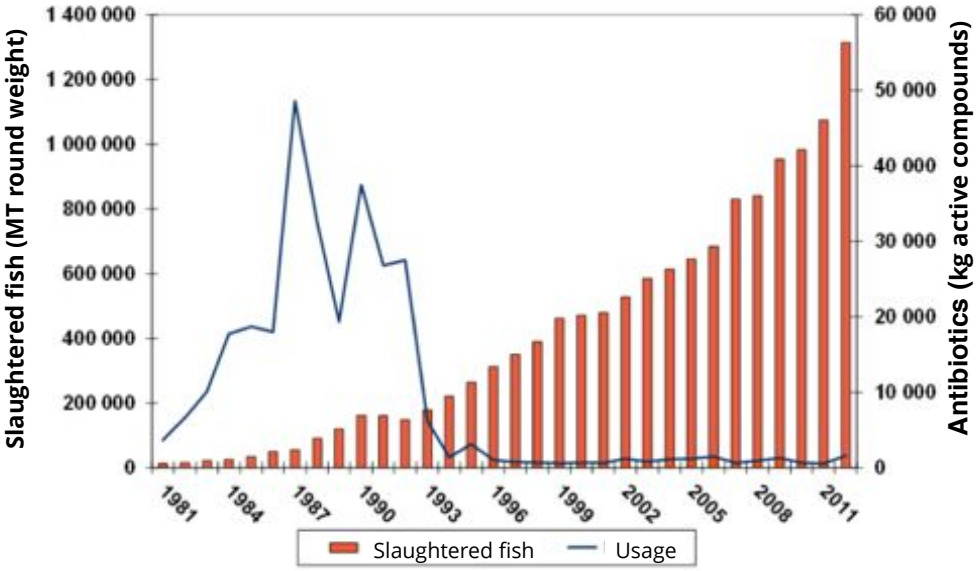
Implemented measures

Good preventive measures continue to ensure marginal use of anti-bacterials

In step with the development of vaccines for known bacterial diseases in farmed fish, the use of anti-bacterials has shown a dramatic reduction in the past 10-15 years. Sales of anti-bacterials were halved from 2009 to 2011 and have not been so low since the logging of usage commenced.

Sales rose again in 2012, but compared to the biomass of farmed fish in production the increase is still marginal. Total usage of anti-bacterials in 2012 in Norwegian

Graph 6.c.13: Developments in the use of anti-bacterials and production of salmonids in Norway 1981-2012.
The use of anti-bacterials (blue line) fell considerably during the first half of the 1990s while at the same time several new important bacterial disease vaccines became available. Usage continues to be very low from 1995 and to date, despite the considerable rise in volume of biomass and slaughtered fish (columns) during the same period. (Source: The Norwegian Institute of Public Health, based on figures from the Norwegian Food Safety Authority's prescription data and FHL)



aquaculture (all species) was 1,591 kg active compounds. This means that only approximately 1% of fish were treated with one antibiotic cure[4].The increase in the use of antibiotics in 2012 was caused by – amongst other factors – several outbreaks of cold water fibrosis. This is a disease that salmon are usually vaccinated against, but despite extensive vaccination we still see an increase in the number of cases in some years.

Of the total usage in Norway of roughly 55 tonnes of antibiotics in 2010, the aquaculture industry used only roughly 1%, while 11% was used for land animals and 88% by the human population. If we break these figures down into distribution amongst the total biomass, i.e. convert to volume of antibiotics per kilo "meat", the total volume of antibiotics equates to 90.5% to human medicines, 9.3% to land animals and 0.2% to aquaculture.

It is thus clear that only very small volumes of anti-bacterials per kg fish "meat" are used compared to each kg of meat produced in agriculture. This very satisfactory trend in relation to the use of anti-bacterials over time is due to preventive measures; the vaccination of fish and increased knowledge about the best choice of facilities are decidedly the most important individual factors. Anti-bacterials are not used in mollusc farming.

Sales of salmon lice medicines increased in 2012. The same applied to sales of anti-intestinal worm medicines, while sales of anaesthetics for fish remained at roughly the same level as in 2011. In particular, it is the aquaculture industry's use of chitin inhibitors (diflubenzuron and teflubenzuron) that have been the subject of debate. After having been taken into use in 2009, usage fell in 2010 and 2011 but increased slightly in 2012. This is not a desirable trend, even though these are approved medicines and recommended doses are adhered to.

It is, however, in part a result of the industry adopting a rotation system for the use of medicines in order to preserve the effects for the longest possible term.
A great deal of effort is being expended on attempts to reduce the use of anti-lice agents and to increase non-medicinal control methods. These are discussed in more detail in the previous chapter on salmon lice.

Many of the methods that are being developed and tested, and that were presented at a dedicated seminar in March 2013, show great promise[5]. Even if it should transpire that not all the non-medical methods under development result in the desired outcome being achieved, it is expected that their introduction will be

Of the total use of medicines in Norway of approximately 55 tonnes of antibiotics in 2010, the aquaculture industry used roughly 1%, while land animals used 11% and 88% was for human consumption.

reflected in a reduction in the use of chemicals and thus also a reduction in chemical emissions as early as autumn 2014.

The use of copper-content impregnation compounds
In December 2010 the NOU 2010:9 report, Norway without environmental pollutants, was sent for hearing. The report dealt with how emissions of environmental pollutants that represent a threat to health or the environment can be halted by 2020. None of the 18 prioritised measures proposed in the report are directly related to the fisheries or aquaculture industry.

The report does, however, ascertain that the aquaculture industry contributes to a large proportion of emissions of copper and that discharges in 2006 totalled 690 tonnes. The report also says that the emission statistics issued by the Norwegian authorities are flawed by a high level of uncertainty, without FHL wishing to make light of or question the discharge of copper by the aquaculture industry.

It is important to note that new knowledge has resulted in copper being removed from the authorities' list of prioritised environmental pollutants. It is also important to be aware that copper is a vital trace element for all organisms and is thus found freely in nature, both on land and in water.

Current emissions of copper from the aquaculture industry are due to the use of approved impregnation compounds for nets in aquaculture plants at sea. At net cleansing plants, where the nets are impregnated and cleansed, requirements are in place for the collection and cleansing of all waste from the processes.

The use of approved impregnation compounds containing copper is an anti-fouling measure that indirectly also contributes to prevent the risk of fish escapes, due in part to the nets being more stable in the water. Fouling also hinders the free flow of fresh, oxygen-rich water and reduces the effect of cleaner fish that will be able to eat the growth on the nets rather than salmon lice. In order to ensure the best possible environment for the fish, it is therefore - until an equally good solution is found - necessary to impregnate a major part of the nets. However, work is ongoing to identify alternative solutions to ensure clean nets.

The use of cleansers and disinfectants
Equipment and vessels in daily use are cleansed and disinfected using approved cleansing agents and disinfectants. This is done with the aim of ensuring a high standard of cleanliness and not least to prevent the spread of any infectious material between facilities. There is an increasing demand that cleansing agents and disinfectants must be both health and environmentally friendly, securely stored, handled and used, and not least easily dispersible and degradable in the natural environment.

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7 WASTE MANAGEMENT

Waste and scrapped equipment

Status and challenges

Collections and waste management

Eco-certifications and different standard and customer requirements linked to order and waste management have played a part in intensifying focus on good, sound management of waste and scrapped equipment in aquaculture, fisheries and the fisheries industry. The types of waste that already have well established waste disposal schemes and return systems are employed by the industry. There are generally good routines connected to all waste found on land, whether it concerns the fisheries industry or land-based marine farms. There are reliable return and recycling systems for large and important waste items such as fish packing cases, feed sacks etc.

Where scrapped marine equipment is concerned (fishing and aquaculture), local businesses are able to receive plastics, fishing equipment, nets, feed hoses, steel and partially also floating collars and bottom rings. A report from a mapping project on recycling of scrapped equipment from aquaculture activities states that most aquaculture companies and mollusc divers keep their sites in order, and that most of the scrapped equipment and waste from the aquaculture industry is disposed of in a good way[1]. Nonetheless there is still potential for improvement for some fractions of fisheries and aquaculture in relation to the degree of recycling. This applies for instance to scrapped nets and fishing equipment, which for various reasons are still dispatched for destruction and incineration.

There are a few recycling companies that specialise in large waste items such as floating collars, bottom rings, feed hoses, larger fishing equipment and nets. Services offered from these in regard to collection and management has improved considerably in the last three years and the degree of recycling is therefore in an upward trend.

In 2009 a project was carried out that contributed to initiating more permanent and robust systems for collections and recycling of scrapped equipment. This was a broad cooperation project where aquaculture companies, the supplier industry and waste management industry were active participants. The final report has been uploaded on www.kystretur.no[2].

Impregnated nets from the aquaculture industry can still present challenges. In accordance with the guidelines prepared by KLIF for cleaning and disinfection of net bags, those containing more than 0.25% copper are defined as hazardous waste. After this led to major challenges and reduced opportunities for recycled goods collections in 2012, recycled goods collections are once again up and running. Some waste collection companies have, after exacting application and documentation processes, received permission to export nets with higher copper content for material recycling to the EU. Others have found methods to cleanse these nets other than material recycling in Norway or abroad. One goal is to find and make use of impregnation substances, coatings and net material that prevents clogging and enables recycling of all nets.

Currently documentation is supplied in vastly varying degree from the different recycling companies on how much is recycled and to what purpose. The fisheries and aquaculture industry is increasingly required to be able to produce this documentation, also for plans to reduce waste items. These are powerful motivators to have these arrangements in place, which the industry is also actively engaged in.

By recycling 1 kg of plastic you have gained an environmental reward of 2 kg of oil. Furthermore, 1 kg of recycled plastic saves close to 2 kg of emissions of CO_2 greenhouse gas[3]. The industry aims to actively contribute to more recycling.

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8 CARBON FOOTPRINT

Carbon footprint of Norwegian seafood

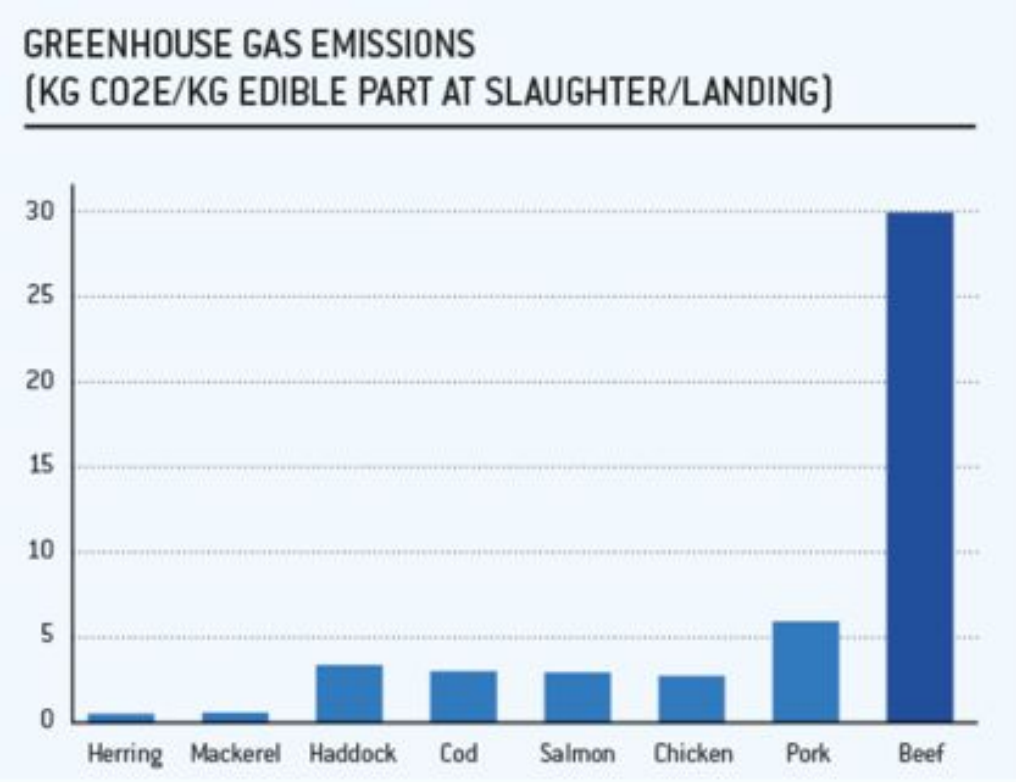
Status and challenges

Norwegian seafood is climate-friendly food
Research shows that Norwegian seafood is some of the most climate-friendly food we can eat[1]. Generally it has a very low level of emission compared with other food production.

On initiative from the FHL and the Norwegian Fishermen's Association, SINTEF Fisheries and Aquaculture AS together with SIK, Institutet för Livsmedel och Bioteknik AB, carried out a study in 2009 on Norwegian seafood, "Carbon footprint and energy use of Norwegian seafood products"[2]. The study was financed by the FHF and covers 22 different Norwegian seafood products including wild catch fish, farmed fish and molluscs. The study was conducted as an ISO standardised LCA analyse ("lifecycle analysis").

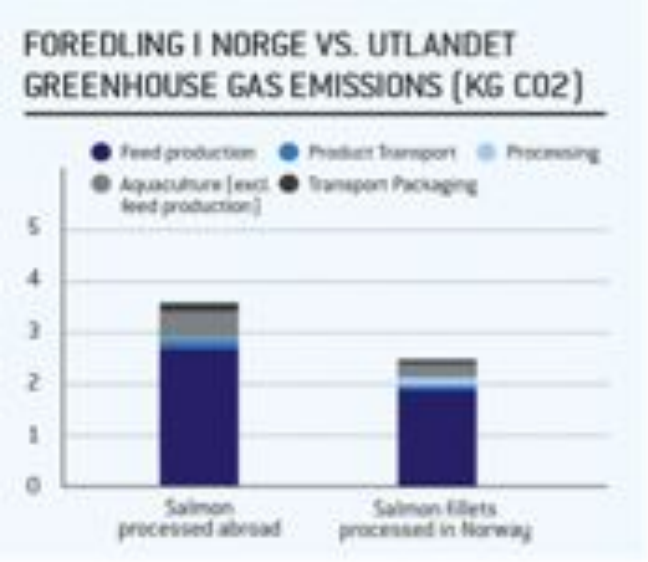
The conclusion was that in terms of the climate, Norwegian seafood is competitive compared with meat produced in agriculture (see graph 8.1). The study also showed that despite extremely low emissions of greenhouse gases there is still potential for improvement. For fisheries this lies especially in better fuel efficiency and more climate-friendly cooling systems on board vessels, while for salmon production it is about optimisation of feeding and feed production.

At the same time, graph 8.2 (next page) also shows there will be less emission of greenhouse gases calculated in CO2 of Norwegian salmon further processed in Norway compared with if this is further processed in another country[2]. Emissions of greenhouse gases are mentioned in greater detail elsewhere in the report under the chapter on emissions from the fishing fleet and fisheries industry.



Graph 8.1: Emissions of greenhouse gases from fisheries and aquaculture compared with meat from agriculture. *Emissions of greenhouse gases converted to kg CO2 equivalents for catches of different fish species, farmed salmon, chicken, pork and beef. Seafood emerges extremely well from this type of comparison with pork and beef. (Source: Sintef [2])*

Research shows that Norwegian seafood is one of the most climate-friendly foods we can eat.



Graph 8.2: Emissions of greenhouse gases when salmon is processed in Norway and abroad*. The graph shows that processing of Norwegian produced salmon in Norway contributes to lower greenhouse gas emissions than if it is processed abroad. (Source: Sintef[2])*

New Norwegian standard for seafood products – competitive edge and improvement tools

In June 2013 a new Norwegian standard for calculation of carbon footprints for seafood was launched. This contains a set of regulations that determine how the carbon footprint for a seafood product shall be calculated. Norway has thus gained an instrument that helps producers and exporters to document that Norwegian seafood is an extremely climate-friendly alternative in the display counter.

But this instrument is also relevant as in-house equipment in seafood companies to highlight how and where they can produce even more efficiently in terms of energy, with even lower emissions of greenhouse gases[1].

Future targets and new initiatives

Vital for the Norwegian seafood industry to have comparable and credible environmental documentation

Several companies in the seafood industry now present annual environmental accounts. In order to compare seafood carbon footprints with other protein sources, it is important to prepare common standards for calculation of carbon footprints for all types of food. It was in this connection that the cooperation with Standard Norway resulted in a new Norwegian standard that is also planned for translation to English.

In 2012 a major international interaction project was initiated for reduced climate impact by the seafood industry. SINTEF Fisheries and aquaculture participated from the Norwegian side, financed by FHF. Representatives from seafood companies, the FHL, the Norwegian Fishermen's Association and FHF sat on the management committee.

The work will play a role in achieving the goal through standardisation, development of a single net-based instrument for calculation of carbon footprints from seafood products, preparation of a manual with information and guidelines for the task of carbon footprint calculation, and participation in meetings for international interaction in the area. The project will be completed in 2013.

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9 CLEAN SEAS

Clean seas

The FHL's environmental policy has two main objectives: Firstly, it is vital to ensure sustainable food production so that the industry's own impact on the environment is kept within acceptable limits. Secondly, the industry is totally dependent on clean sea areas if it is to produce safe and good seafood. It is for these reasons that the FHL is also actively engaged with regard to potential discharge and known environmental polluters, both national and international, who can contribute to reducing the potential for food production in our coastal and adjacent sea areas.

The seafood industry represents the future in Norwegian value creation. The marine environment is under continual pressure from both acute emissions and long-term pollution. In order to ensure that the fisheries and aquaculture sector can exploit its enormous store potential, the FHL has highlighted the following:

** There shall be no harmful emissions from new or current oil activities. Any new petroleum activity in Norwegian waters must be in accordance with the environmental recommendations put forward by research and the industrial authorities.*
** Seismic shooting is a part of petroleum activities and must be prohibited in areas that are not open for petroleum activities. The FHL is concerned about the effect seismic shooting has on fish and the conflicts this causes between the oil industry and the fisheries and aquaculture industry.*
** Safety at sea must be stepped up and contingency planning for acute emissions along the Norwegian coast must be improved.*
** National/international focus to ensure that radioactive marine emissions are reduced significantly.*
** Emissions to sea areas from other activities shall be reduced to a minimum.*
** Previous environment pollution and polluting shipwrecks must be charted and dealt with.*
** The fisheries and aquaculture industry is of major significance in areas where it is located and on a national basis. Consideration towards the industry and its potential for growth should therefore be given more emphasis than it currently receives when the authorities are evaluating industrial activity in coastal and sea areas.*

The FHL continues to closely monitor the government's decision concerning the clean-up plans for the sunken submarine U-864 off Fedje.

The FHL firmly believes that the authorities must adopt the best and safest plan for the clean up, that progress in the work is guaranteed and that economic considerations are not a factor when adopting the solution and plan. The FHL is also engaged in work to ensure that the best interests of the fisheries and aquaculture are afforded priority in connection with oil pollution defence and clean-up actions, and the Norwegian Coastal Administration Authority has expressed its sympathetic understanding for this viewpoint.

The Convention on control and handling of ballast water and sediments from vessels, which was adopted by the UN's maritime organisation (IMO) on 13th February 2004, encompasses stringent demands on shipping traffic. The intention is to prevent the spread of foreign organisms in the marine environment via ballast water and sediments from vessels. The Norwegian authorities adopted the IMO's proposal for new requirements for purification of ballast water from vessels in 2011. This means that existing vessels and new buildings must have technology installed for the cleansing of ballast water by 2016. In order for the Convention to come into force, efficient cleansing technology must be developed. Norwegian research environments are participating in the development of such new technology[1].

The convention takes effect 12 months after 30 states and 35% of the merchant fleet's gross tonnage has been ratified. The number of states has now been met, but 4.68% of gross tonnage remains at July 2013[2]. Norway became a signatory to the Convention in 2006.

"Ett hav" (One ocean)
One ocean is a forum, founded in 2012, with the aim of ensuring construtive dialogue between the petroleum industry and the seafood industry. Contingency resources, fishing vessels in oil conservation preparedness, SAR resources and knowledge status on seismic activities and fish are important issues. In addition, a reality model description of the situation of both industries was prepared. The forum will be in a position to contribute to

ensuring that seismic shooting and other activities that can and do create conflicts are discussed between the involved parties in a manner that serves the best interests of all involved. Work will commence to identify solutions that contribute to increased wealth growth and a reduced level of conflict, and it will look at the potential synergies and areas of cooperation between the industries.
In recent years the seafood industry has also involved itself, particularly in regard to conditions for the environmental criteria of the mining industry in connection with its discharges. There has been an increase in the international market in the demand for minerals.

One consequence of this has been that the commencement of mining activities in both old and new mines is now firmly on the agenda. The mining industry has put forward proposals for the depositing of large volumes of waste mining materials in a number of national salmon fjords, as well as in areas that are vital to the fishing industry as nursery and spawning areas.
The FHL expects the government to ensure that future emissions from the mining industry do not pose a threat to our fjord environments, spawning beds and seafood safety.

FHL's policy in relation to mining activities:
The FHL is positive towards industrial and other activities that exploit our common resources in a responsible and sustainable manner. The FHL is deeply concerned about the effects and impact on our coastal and fjord areas if these are used as dumping grounds for waste matter and environmentally harmful chemicals from the mining industry. The dumping of mining industry waste has been decreasing and continues to do so in other countries. Dumping can easily be a threat to marine life, food safety, the good reputation of seafood and in turn to seafood producers who work in the affected areas.
It is an absolute demand that when dealing with marine emission issues in the future where there can be a risk of harmful emissions, there must be unambiguous and serious assessments carried out at professional level that take sufficient account of the requirements and best interests of the seafood industry prior to discharge being permitted. The seafood industry is extremely important for Norwegian food production, employment and the supplier industry. The FHL maintains therefore that the authorities must to a greater extent prioritise consideration taken towards the seafood industry in matters where coexistence is difficult.
This also entails that:
a) The Institute of Marine Research and National Institute of Nutrition and Seafood Research must extend their advisory function in relation to the impact of pollutant discharge and waste disposal in fjord and coastal areas.
b) Clear routines must be established so that the Directorate of Fisheries, Norwegian Food Safety Authority and seafood organisations are provided with all relevant items for comment.
c) The Directorate of Fisheries and Norwegian Food Safety Authority (NFSA) must receive adequate resources and a clear mandate to enable them to attend appropriately to their management responsibilities in these matters.
d) Statements from expert communities, sector authorities and the organisations in the seafood industry must be weighed extremely carefully when a decision is to be made whether or not an emission permit is to be granted.

The FHL recognises that the seafood industry, after exerting pressure on the authorities over the long term, are now having their best interests dealt with in a better manner in several arenas and connections, but there is still much room for improvement.

The comprehensive management plans for our coastal and other waters are the government's tool for coordinating sustainable use and protection of the marine ecosystems in the Norwegian sea areas the Barents Sea–Lofoten, the Norwegian Sea and the North Sea–Skagerak. The management plans cover the areas in question from the baseline and out to sea and the impact resulting from human activities in these areas. Work on the management plans for Norway's sea areas is now complete. The plans will naturally be subject to revision in the years ahead, and the FHL will closely monitor these and other processes related to the question of clean seas in order to continue to protect and ensure the best interests of the seafood industry.

References

1) Ministry of the Environment 2013.
2) Norwegian Maritime Authority 2013.

The FHL expects the government to ensure that emissions from future mining activities do not represent a threat to our fjord environments, spawning areas and seafood safety.

Own notes