

A decorative graphic consisting of two thin blue lines that intersect to form a V-shape. A small blue circle with a gradient is positioned at the intersection. A larger, similar blue circle with a gradient is partially visible at the bottom right corner of the page.

**Report of the Icelandic
Fisheries Minister
committee on the status and
possibilities of Blue Mussel
farming in Iceland.**

June 2nd 2008

Summary and Suggestions

Result

- The committee concludes that an Icelandic Blue Mussel farming industry can be developed in a similar way as was done in Canada.

Direction

- The committee suggests that authorities support the growth of the industry with general actions supporting infrastructure, research and increased services for the Mussel industry. The objective should be to increase knowledge, improve organisation and reduce risk in order to make the mussel industry attractive to investors.

Prerequisites

Market

- Total production in Europe is around 700.000 tonnes per year and demand is rising.
- Price of fresh live mussel has risen in the last years and will probably stay high due to limited culture capacity in traditional culture areas of Europe.
- Price on processed mussel is relatively stable as processed mussel meets competition from imported mussel from other continents.
- Harvest time in Iceland complements the seasonal demand and offer changes in other culture regions.

Production

- Iceland offers abundant space for extensive mussel farming.
- The quality of the Icelandic blue mussel is good and constant through seasons compared to other regions.
- The Icelandic mussel farm developers are about to master the culture techniques and the adapting of technology for Icelandic conditions.

Environment, health and safety

- Mussel culture sites in Iceland are found in a very pure environment. Partly because of strict hygiene regulation, partly because of scarce population and partly because of the currents constantly renewing the waters. Nevertheless one issue has come up, in several of the sites the level of Cadmium (Cd) has been measured above the strict EU level of allowed Cd in bivalve flesh.
- Monitoring of toxic algae is already established.
- Monitoring of algae toxins in bivalve flesh is being developed.
- Mussel farming is environment friendly.

Financing and economical feasibility

- The distance to market is reflected in relatively high transport cost per kilo shorter shelf life compared to producers closer to market.
- The committee concludes that mussel farming in Iceland will rely on mass production, high technology level and high quality of product.
- The development of infrastructure and service with the industry attracts capital and reduces investor risk.

Other

- Mussel farming has a positive economic impact on the rural areas.
- Mussel production fits well to other Icelandic seafood production and marketing.
- Development of infrastructure and service for mussel farming is a part of development for the Icelandic aquaculture industry.

Suggestions to the Minister of Fisheries on the methods to support development of mussel farming in Iceland.

Government institutes

Suggestion 1: Consultation workgroup

- The committee suggests that a workgroup is established with representatives from the food and marine research institutes, the mussel industry association and a chairman from the ministry of fisheries.
- The role of the workgroup should be to integrate the work of organisations involved in the development of the industry and bring forward suggestions for culture areas where necessary research will be done and financed from state fund as per suggestions 2 and 3.

Suggestion 2: Culture areas

- As a part of health and safety survey a research on toxic algae should be done in each area.
- A committee on organisation of coast areas should finish work.

Suggestion 3: Product health and safety

- Committee suggests algae toxins and Cadmium testing should be financed from state funds during first years of operation.
- Committee suggests a research on the origin and level changes of Cadmium in coastal seawater.

Research and Development

Suggestion 4: Culture techniques and transport

- The culture technique needs to be adapted to each culture area. For this it is important that the companies developing mussel farming have access to development funds.
- Committee suggests that the fisheries ministry investigates the optimum transport way for fresh live to market in Europe.

The appointment and operation of the committee

On December 7th 2007 the Icelandic Minister of Fisheries appointed a committee to evaluate the status and potential of mussel farming in Iceland. The appointment letter states the following:

„The minister of fisheries has decided to appoint a committee to evaluate the status and potential of mussel farming in Iceland with regards to biological and economical prerequisites as well as environment factors. The committee shall return a report to Minister and make suggestions for the actions authorities can take to strengthen the industry’s premises for growth”

To the committee are appointed: Haukur Oddsson CEO of Borgun hf (Chairman), Ásta Ásmundsdóttir project manager at Icelandic Food Research, Guðrún Þórarinsdóttir Expert at the Marine Research Institute, Jón Páll Baldvinsson from Skelrækt the Association of Mussel Farmers, Kristinn Hugason administrator at the Ministry of Fisheries.

The committee has met 12 times in the last 5 months and covered all relevant subjects. On the 4th meeting the committee met Magnus Gehringer, Hafskel ehf. The February 27th the committee visited Nordurskel ehf in Hrísey and the facilities of the company. Following the visit a meeting was held with Bjarni Jónasson chairman of Norduskel ehf. Gary Rogers the Canadian shareholder, Víðir Björnsson manager and Björn Gíslason from Tækifæri the largest shareholder.

Two delegates of the committee Valdimar Ingi Gunnarsson og Jón Páll Baldvinsson attended the 2008 conference of NAIA the Newfoundland Aquaculture Industry Association. Valdimar Ingi Gunnarsson worked for the committee as a consultant. The committee wishes to thank everyone their contribution.

Reykjavík, June 2nd 2008

Haukur Oddsson, chairman

Ásta M. Ásmundsdóttir, Food Research Inst.

Guðrún G. Þórarinsdóttir, Marine Research Inst.

Kristinn Hugason, Ministry of Fisheries

Jón P. Baldvinsson, Shellfarmers Association

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1. Introduction

The Icelandic Parliament agreed on March 10 1999 a proposal for government support with “mussel farming and other shore farming”.

Following the agreement the government granted a 5 years project (2000 to 2005) to prepare for the growing mussel industry at the Institute of Freshwater Fisheries in cooperation with the Marine research institute and mussel farmers.

From the year 2000 the number of mussel farmers grew and 12 sites around Iceland were tested. The government supported project held annual meetings and mediated advice to new candidates as well as a website for the project.

In the last two years the interest of new mussel farm candidates is growing along with higher unit prices on the EU market.



Image 1. The mussel committee and board members of Nordurskel ehf in Hrisey island February 2008. From left: Kristinn Hugason, Ministry of Fisheries and Agriculture; Guðrún G. Þórarinsdóttir, Marine Research Institute; Haukur Oddsson, chairman of committee; Ásta Margrét Ásmundsdóttir, Iceland Food Research; Bjarni Jónasson chairman of Nordurskel ehf; Jón Páll Baldvinsson, Shellfarmers Association; Gary Rogers, Canadian investor in Nordurskel ehf; Víðir Björnsson, manager of Nordurskel ehf; Björn Gíslason, Tækifæri, investors.

In the last years the Icelandic mussel farmers have asked for increased government support for the mussel farming development in Iceland. This report gives an overview of where the industry development stands (ch. 2), the potential from a biological and technical perspective (ch.3), from a business point of view (ch. 4), the organisation and elements of

the industry (ch. 5) and at last a summary of subjects and suggestions of the committee. (ch. 6).

2. Development status

2.1 How far has the mussel industry been developed?

To give a simple view the production process can be described in 4 steps: Step 1) Culture, Step 2) harvest, Step 3) packing Step 4) sales and marketing on a domestic or international market.

In recent years the growers have gained a lot of knowledge on the mussel culture in the Icelandic natural environment. Still the industrial production that could harness the potential of the farm sites is not established. Until now the production has counted for a few tons per year and mostly sold on domestic market. The development of the mussel industry is going through the same steps as in other countries but taking more time than expected.

It appears that growers are mastering the culture techniques and production is expected to start in the next years. Most of the development effort has gone into the culture itself. Much less work has been spent on mastering of the harvesting and processing techniques. On the other hand it is expected that processing needs less adapting for Iceland and can be used as applied in other countries as soon as production reaches the right level.

2.2 The growers

Today there are around 10 culture sites around Iceland and the growers have limited capital to work with, except for Nordurskel ehf. (image 2). Nordurskel is financed by professional investors in addition to a experienced Canadian grower who recently joined the company. Nordurskel is the only company that has the potential for development work and has actively shared its results. Other companies have results from spat collection, mussel growth and some technical experience. In general the spat collection is

reliable and growth to smaller market size of mussel is two years.

In new culture sites the grower has to map the environment factors along with culture trials to evaluate his sites in the first years.

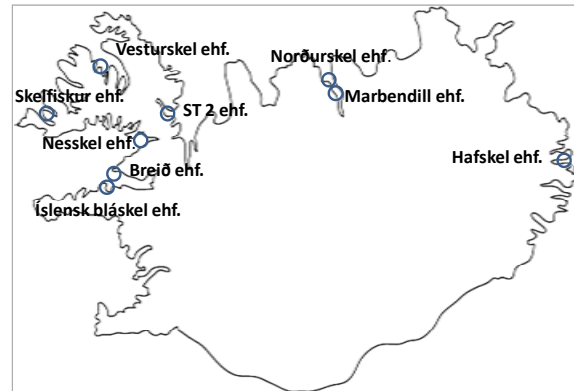


Image 2. The location of the mussel farm sites.

In 2002 the Icelandic mussel farmers founded an industry association named SKELRÆKT. The aim of the association is among other to collect and disseminate practical information to growers. The website of the association is www.skelraekt.is.

2.3 Government support

Icelandic authorities supported the development of mussel farming from 2000 to 2005 in a government supported project at the Freshwater Fisheries institute in cooperation with the Marine Research Institute was conducted in order to collect and distribute information on the ongoing culture and site evaluation. The overall support to the project was 20 million ISK.

In 2002 the Shellfarmers Association was granted 5 MISK from government funds. Thereof 1,5 MISK directly through the Ministry of Fisheries and 3,5 MISK through the Marine Research fund. The fund has also supported seminars and conferences by 1,5 MISK. In 2008 The Shellfarmers Association was granted 2 MISK.

Growers have got several small grants for specific development work. Government funds have also supported surveillance of toxic algae in three areas. Government funds have covered cost of health inspections on culture sites.

3. Biological and Technical prerequisites

3.1 Environment and Culture technique

Access to culture sites

The strength of the Icelandic Mussel farming is among other reflected in abundance of culture areas. (appendix 2). In many other regions the culture space has become limited. Space may become a limited source in Iceland as well resulting in conflict between stakeholders. A committee on coastal area planning should finish work as soon as possible.

Health surveys

Before mussel farming is established a health survey should be carried out. After farming is established the culture area should be regular testing should be followed through. A health survey for shellfarming has already been done in three areas: Hvalfjörður, Eyjafjörður and Mjóafjörður-eystri. A survey is ongoing in Patreksfjörður, Tálknafjörður and Breiðafjörður.

Health and safety of culture areas

In general the Icelandic fjords are not polluted providing good conditions for mussel farming. The only health issue that has appeared is the level of Cadmium that has been measured above EU minimum (1 mg/kg) in several sites. The Cadmium is from natural sources but not pollutin from human activities. Work is in progress for raising of the Cadmium minimum EU level as per suggestin of CODEX. (annex 1).

Algae toxins

Relatively few tests have been done on the algae toxin content of mussel in Iceland. On the other hand the toxic algae blooming are systematically monitored in Hvalfjörður, Breiðafjörður and Eyjafjörður. The results of the monitoring are presented on the website of the Marine Research inst. (www.hafro.is/voktun). The results indicate that toxic algae exceed security limits every year. In other countries the toxic algae have caused damage on the industry and inhibit harvest up to several months lengri tíma. More

testing is necessary to evaluate the pattern of algae toxin periods.

An environment friendly industry

A considerable difference is between mussel farming and fish farming in Iceland. In the fish farming a high number of fish is held in a limited space (intensive culture) while in mussel farming the density is the same as in natural conditions. The mussel feeds on natural plankton and is not fed like fish in culture. Therefore the environmental impact is much less than is the case with fish farming

Culture technique

From the year 2000 the mussel farmers have tried various types of culture and equipment. In the beginning failure could most often be traced to wrong equipment or implementation. In the recent years farmers have suffered from late summer drop-off from lines Farmers have tried to locate culture lines in more sheltered sites and submerge lines to avoid the late summer shake-off and eider duck predators. Due to those problems the Icelandic production capacity is not yet harvested. Mussel farming gear for different conditions can be found on the market. It can be concluded that the aim of the developing Icelandic mussel farms is not to develop new farming technique but to try the existing technique and adjust to the conditions at the culture sites. Despite the fact that mussel export has not started the farmers have made significant progress and export is expected to start soon.

3.2 The biology of the Blue Mussel

Spat collection

In general the spat collection has been easy and not a bottleneck factor. Spat collection is unreliable in many other regions and some companies have to run spat collection sites at two or more locations to ensure annual collection of larvae.

Mussel growth

From the collection of mussel spat it takes 2 to 3 years to grow the mussel to market size. That is if the mussel is grown only on rope and without

socking. In most of the competition countries it takes 1 to 2 years.

With socking the culture time can be reduced but it is still not clear how much.

Quality

Meat yield is one of the main criteria for quality. So far the monitoring indicates very good meat yield most of the year. Typically the mussel spawns around mid June and the spawning time stretches over a month period. Spawning in competition countries is usually two times, spring and fall which is a downside for the farmer. Just after spawning the mussel is low in meat yield. The difference in spawning time possibly gives the Icelandic mussel growers the opportunity to enter market with good quality mussel at times when the European producers can not supply.

3.3 Predators and epifauna

Predators

The eider duck is the most effective predator on mussel and the duck has repeatedly caused damage on most of the mussel culturer sites. Usually the eider causes trouble on the later half of the culture time when the mussel has grown to the suitable size for the ducks. (image 4). No legal method exists to eliminate the predatory effect completely. Various types of scarecrows are available but are not a durable solution as the birds learn not to fear them. Possibly the submerging of culture lines will be a permanent solution and possibly the predatory effect will be negligible in larger culture. Starfish is another predator and but methods to fight starfish are known. The cost of defence against predators is estimated to be the same as in Canada and Scotland

Fouling

Until now the onset of plants and barnacles has not caused problems. In Icelandic mussel farming. When mussel falls off collector ropes plants and barnacles can quickly fill into the gap. In other countries fouling seems to be a greater problem and sometimes demanding costly work to eliminate. Many species of epifauna-

and flora causing problems in other countries are not found in Icelandic mussel culture.

4. Prerequisites for business

4.1 Transport

Transport of live mussel with ship cargo

Iceland mussel industry has to transport across the Atlantic to enter market. Transport cost is thus higher than for producers in Europe.

Transport cost for fresh products from Norway and Scotland to France is around 20 -30 Eurocents per Kg. For producers in center of Europe the transport cost is presumably lower. Transport cost from Iceland is around 40 Eurocents per Kg, if trucked to ship and from ship to buyer. Transport time is also longer compared to producers located near market. 4 to 5 days are needed to get product to buyers in central Europe. Only 1,5 to 2 days are needed to get product from Norway to market.

Long transport time cuts short the shelflife

Long transport distance from Iceland is reflected in loss of product. Usually the shelflife is about 7 days in traditional packings as well as MAP packs. Taking time for shipping will significantly reduce remaining shelflife.

Air cargo, shorter transport time

Transporting mussel with flight cargo cuts the transport time significantly and increases the quality of delivered product compared to ship cargo. The air transport cost difference can be as much as 100 Eurocents/Kg compared to sea freight. On the other hand Icelandic mussel can be competitive to Canadian mussel sold live into Europe, as long as production cost is similar.

Transport of unprocessed mussel into Europe

It is possible to transport live mussel into Europe where it is put into seawater again and refreshed for market. In processing the mussel is sorted in order to pick out any possible dead mussel and optimize quality of product. This method has been used with mussel from Ireland and Norway for transport into Holland and Denmark where it is packed. Very little experience is to date with shipping live dry mussel and therefore

difficult to conclude if it is a feasible way of export from Iceland.

Life-hold stations with running seawater can keep mussel in good conditions on land for several weeks. Compared to dry-live shipping, shipping with life-hold equipment would probably reduce product loss during shipping. This would again increase shipping cost significantly.

Transport cost reduced with processing

Processing the mussel in Iceland can reduce transport cost. If the weight of the product is reduced (f.ex. deshelled mussel) the transport cost should be a smaller part of the product weight. Also the shelf life can be increased by freezing. Processing reduces significantly the negative factor caused by the distance from market. Countries like Chile and New Zealand export only processed mussel to Europe.

4.2 Market

Diversity of market

Icelandic mussel farmers have aimed at the EU market. It is a large market with consumption around 800.000 tonnes/year. The European market is diverse. The mussel products are of variable origin, quality, size etc. Icelandic mussel producers should aim at high quality mussel products and the parts of the market that give the best price

World production

World production of mussel has increased from 1,3 Million tonnes in 1990 to near 2 Million tonnes 2005. China is the largest production country, 800.000 tonnes and Thailand comes second with 250.000 tonnes/year (image 3). In Spain the production has risen up to 250.000 tonnes/year and Spain is the largest production country in Europe. From 1996 to 2004 the world production steadily increased. The annual increase is mostly originating from China and Thailand but also from Chile. Spanish companies have invested in Chilean mussel farming. Chile has increased mussel production from 25.000 tonnes in year 2000 to 125.000

tonnes in 2006. During same period the increase in Thailand has been from 90.000 tonnes to 270.000 tonn.

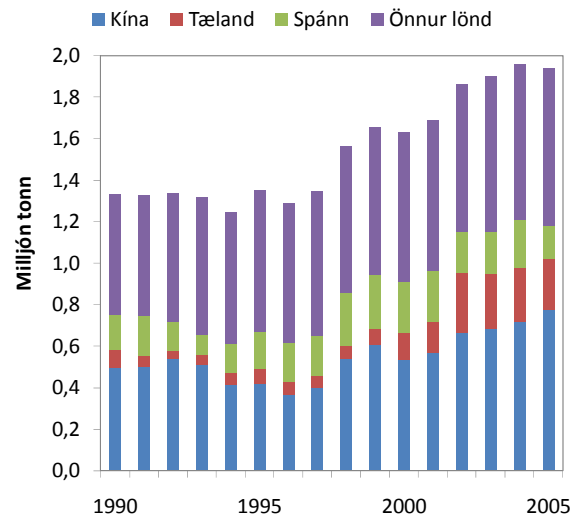


Image 3. World production of mussel, culture and wild 1995-2005 Millions of tonnes: China, Thailand, Spain Other countries. (source: Fishstat Plus, FAO).

Less production in Europe

Production of mussel in Europe from 1990 has been steady around 600-750.000 tonnes/year. In recent years the European production has shrunk. (image 7).

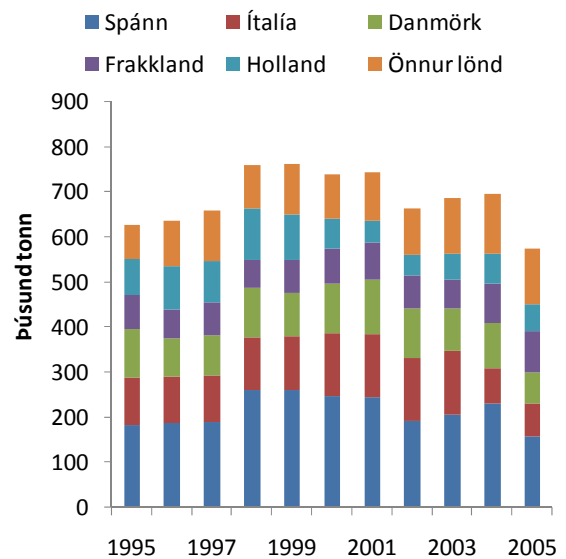
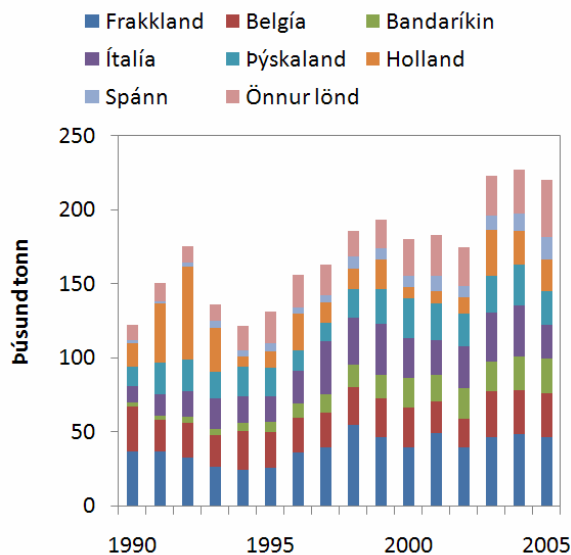


Image 4. European production 1995-2005 Spain, Italy, Denmark, France, Holland, Other countries. (source: Fishstat Plus, FAO).

Despite the reduction of overall mussel production in Europe the local production in Ireland and Skotland has increased up to 40.000 tonnes/year in each country. Dutch companies have invested in Ireland. Norway has also increased mussel farming up to 4.000 tonnes/year in 2005. After 2005 the Norwegian production fell again and the industry is now being reorganized in order to increase production again. In Denmark the main production came from bottom culture but the industry is now being reorganised towards hangline culture. In 2007 Denmark produced 1.400 tonnes and after the decline of the Limfjord mussel Danish producers aim at increase of hangline culture production up to 20.000 tonnes in 2013. In Sweden the mussel production has been from 500 to 2.000 tonnes in the last 10 years.

Increased international trade

In the last years the international trade of mussel has been 225 thousand tonnes/year. (image 8). 85% of import is into European countries. France is the largest importer with 40.000 to 50.000 tonnes import/year. Belgium, USA, Italy, Germany and Netherlands import 20.000-30.000 tonnes/year each country.



Mynd 5. Import of fresh and processed mussel by country 1990 to 2005. France, Belgium, USA, Italy, Germany, Holland, Spain, Other countries. (Source: Fishstat Plus, FAO).

Holland was the largest exporter of mussel in 2003 to 2005 with around 50.000 tonnes/year. New Zealand and Spain exported around 30.000 tonnes each per year and 15.000 to 20.000 tonnes/year were exported from China and Greece. Chile has increased export from 5.000 tonnes in year 2000 to 25.000 tonnes in 2006. Spain is involved in Chilean mussel farming. Spanish companies in Chile count for 44% of Chilean mussel export. Spain is also Chile's most important market for mussel.

Increased European import

As European countries have not met home market demand for mussel the import has increased and doubled in value from 1999 to 2006. Import to Europe peaks in autumn months and reaches the low in summer months.

To meet reduced local production the Dutch mussel industry has increased its import to be able to hold its position as Ireland provided 60% of live mussel imported into Holland in 2006. Due to increased demand the Dutch price for Irish mussel rose from 80 Eurocents in 2005 to 1,7 Euro/Kg in 2007 (first 7 months of 2007).

Higher price for fresh live mussel in Europe

Reduced mussel production in Europe has been reflected in higher unit prices. For example the wholesale price for Dutch mussel on the Paris Rungis market has risen from 1 Euro/Kg 1999 to 2,8 Euro/Kg in 2007 (image 6).

Price is very variable depending on origin, quality, season and other factors.

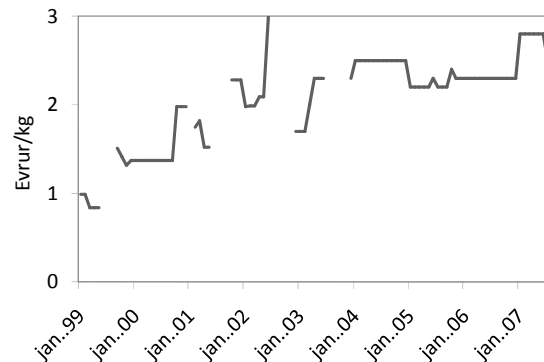
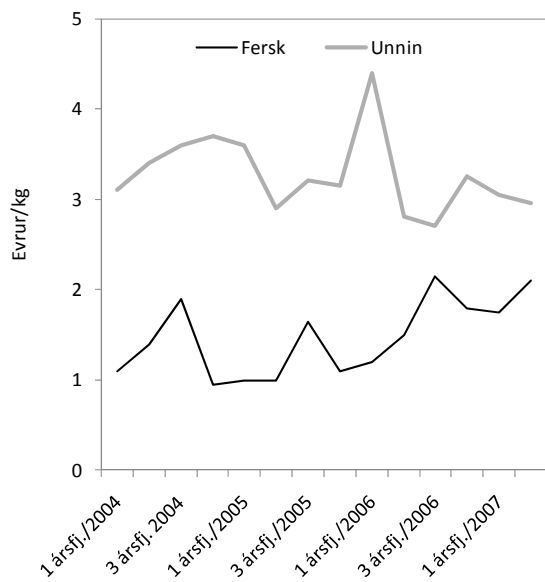


Image 6. Wholesale price for Dutch live mussel on Paris Rungis 1999 to 2007 (Source: MAREE, Rungis).

The following examples are FOB prices of fresh mussel exported from Ireland and Norway. The price of Irish mussel has got higher and is on average around 2 Euros per Kg from 2006 to 2007. 60 % of Irish mussel went to France in 2007 and 35 % to France.

Norwegian mussel export has not been successful as the Irish. Norway has exported mussel in 25 Kg bags or larger. Price per Kg. has increased from 3,52 Nkr to 7,98 in 2007. The reason for the higher price is that there was less Norwegian export has been reduced from 3.500 tonnes in 2004 to 1.000 tonnes in 2007.

Norwegian producers have set up a life hold station in France from where the mussel can be distributed fresh live. Canada has exported fresh live mussel to England at prices 3,5 to 4 Euros/Kg CIF



(Image 7) Euro/Kg FOB-price of fresh (Fersk) live and processed (Unnin) mussel from Ireland from 1st quarter 2004 to 2nd quarter 2007. (Source: Irish Sea Fisheries Board).

Steady price of processed

Official data on market unit prices often have limitations. The data does not always include information about type of product. In many cases the market information concern frozen vacuum packed mussel with or without added

ingredients. Import from third countries like Chile and New Zealand has increased in the last years.

From 2006 to mid-2007 the export Kg price of processed Irish mussel was around 3 Euros. This is probably mostly frozen-vacuum packed mussel. The unit price for fresh live mussel has gone up while the unit price of processed mussel has dropped slightly. On the other hand the prices do fluctuate between seasons (image 7). Another example is processed mussel import to France and Spain for 2,6 Euro/Kg January to April 2007. Information on type of product is lacking

A large part of Chilean mussel production is exported. From the year 2000 the export price has remained around 2,2 USD/Kg despite significant increase in volumes. The Chilean mussel is mostly presented as frozen, halfshell and canned.

Productin development in the next years.

The EU countries have experienced a dramatic decrease in production sites. The increased mussel production in the northern part of Europe has not met the decreased offer from the center EU countries. Many factors indicate that mussel farming will move further north in Europe, to areas with more open spaces for farm sites. Open sea mussel farm techniques and equipment are being developed in the older mussel countries and the new technique could possibly increase mussel offer again.

Price development.

Today the market price for mussel is at a historical peak. If the offer is not increased in the next years it is likely that unit prices stay high at least for fresh live mussel. The EU market for fresh live mussel is protected against competition from other continents. It is unlikely that fresh live mussel will be imported from other parts of the world. Still the first Canadian mussel has been imported into the EU in air cargo where Canada benefits from the low rating of Dollar against Euro.

Countries outside Europe will have more effect on the processed mussel market. Freezing the mussel opens ways for lower transport cost and better market position. Increased import of mussel into Europe is

mostly based on processed mussel and is possibly the reason for price decrease on Irish mussel. (image 7). Increased import of processed mussel will possibly have a negative impact on unit prices in Europe in the next years.

4.3 Competitiveness

Evaluation of profitability of Icelandic mussel production.

At the start of “The mussel project” in the year 2000 an attempt was made to evaluate profitability of Icelandic mussel production. The result of the project evaluator at that time was that it was difficult to evaluate profitability as Iceland had very little experience in mussel farming so far. In another evaluation from 2004 it was estimated that there was great size benefit in the industry. A 100 tonne farm shows little if any profitability and a 2000 tonne farm is profitable. Both examples with processing and sales. The estimates have very limited local input as no significant mussel production is established. Continued development work will show if mussel farming can be profitable or not.

Competitiveness – fresh live mussel

Production cost is the main factor in competitiveness and the countries that can produce the cheapest product have the strongest position on the market. Price on market is only an indicator of profit in the short term but not in the long run.

Many indicators point to a decreased offer against demand for fresh live mussel on the EU market in the next years. As long as demand is not met the Icelandic mussel producers can expect to be able to enter the market. If on the other hand the price on market decreases the ability to produce with minimum cost will determine the competitiveness of the producers.

Abundant space for mussel farming is available in Iceland. This allows the Icelandic growers to develop large and economic mussel farms with high level of technology. The opportunity for Icelandic producers is also in the markets that are ready to pay for higher quality.

Competitiveness – Processed products.

In the processed mussel products the price of

such products on the market determines the competitiveness of such products from Iceland. Iceland will meet competition from Chile and New Zealand. In a Irish report it is concluded that competition with Chile is very difficult because of the low production costs in Chile. Same report concludes that the only advantage on the Irish side is to distinguish high quality from Chilean mass production.

Chile plans for a great increase in mussel production in the next years which will most probably affect price development. On the other hand it is interesting that while Irish companies work on lower production cost the industry in Scotland works on raising the prices, resulting in higher return prices for the Scotland industry than the Irish.

New Zealand has also exported a lot of mussel into the EU. New Zealand mussel industry has developed a high level of technology. It will be difficult to compete with New Zealand and Chile on the processed market in the next years. Despite the great difference in transport distance the transport price is very similar for frozen mussel. Also it is likely that Asian countries will enter the EU market.

5. Management and infrastructure

5.1 Access to culture areas

Mussel farming and rural development.

The Icelandic fjords offer a suitable environment for mussel farming. The farming areas in Europe have been reduced as a result of nature protection and expansion of other activities. To get access to more farm areas the industry reaches further north inside Europe.

Mussel farming relates to rural development issues as it takes place in rural areas. If mussel industry is successfully developed it can create many new primary jobs in rural areas as well as the secondary jobs, with a positive effect on the rural economy.

Licences

To get the licence for a mussel farm one must apply first for a 200 tonne licence to the community health and safety authorities. For further development f.ex. of product sales, state authorities must approve the operation.

Environment evaluation

Mussel farms with more than 200 tonne year-production have a report obligation to the National Planning Agency which will estimate the need for a formal environment impact evaluation. If such an evaluation is needed the contracted evaluator reports and an operation licence is issued as a result and in function of the evaluator report.

Operation licence

After the health and safety licence is issued the mussel farm must apply for a operation licence at the Directorate of Fisheries regardless of the size of the farm. The licence applications must be made in writing with information about ownership, species in culture, size of farm, culture methods, vocational knowledge and other licences.

Directorate application shall include information about authority to use areas that will be taken under the operation as well as constructions. Information about disease related issues, ecological factors and other issues the directorate wishes for.

Health and safety inspections

Before mussel farming starts a health and safety inspection has to be carried out. A directorate licence is not issued until a positive result is ready from the health and safety inspection. After the licence is issued the culture area is monitored on regular basis. The organisation responsible for the inspections and monitoring is MAST (The Icelandic food and veterinary authority) in cooperation with the Marine research institute and the Icelandic food research institute.

5.2 Culture and harvest

Knowledge on local conditions

Results from the Icelandic mussel culture experiments show a significant difference between culture areas. Each and every aquaculturist will have to study and know his own area in details in order to adjust the culture techniques. At the Icelandic Marine Research Institute the stakeholders can find experts in biological and physical environment factors as well as experts in the biology of the blue mussel. (appendix 4).

Culture technique

Knowledge on culture technique is limited within the government institutes so the aquaculturists have gathered knowledge from neighbour countries. The local research institutes have expert knowledge on natural factors such as plancton which is relevant concerning timing of spat collection. The research bodies also have knowledge on the predators such as the eider duck and are helpful in developing ways to avoid predator damage.

Harvest

Before harvest is allowed the algae toxins must be measured and checked against criteria. Algae toxins are not measured in Iceland today so a time consuming process has to be followed through to get results from the direct meat tests. With increased culture and number of tests it will become more economic to run the tests in Iceland – at the Food research inst. MATIS. (appendix 3).

The mussel farms

The development of the mussel farms can take different directions. In the neighbour countries some aquaculturists have specialized in seed production. The seed is socked out in farms with better conditions to grow to market size. Contractors specialised in harvest can then take the mussel to the processing factories where it is packed for market.

The large available culture areas offer the Icelandic mussel industry to foster large

farms with machinery and equipment for large scale production.

5.3 Packing, transport and marketing

Pökkun á ferskum kræklingi

Icelanders have developed knowledge and technology at a high level in seafood processing and this knowledge is useful in the development of mussel processing. Still the processing and handling of live bivalves is new to Icelanders. On the other hand there is extensive experience in processing like freezing and canning.

Health and safety monitoring is established after many years of active industry in other bivalves.

It is common that aquaculturists and processors run in separate companies, although in some examples the same company handles all the production chain from farming to sales.

The Icelandic mussel company Nordurskel ehf has led development in mussel processing. The other Icelandic mussel companies have the choice of selling harvest to Nordurskel or to develop their own processing.

Transport

Icelanders have a long experience in seafood transport with sea- and air-cargo. Iceland is connected to a high number of strong market points. Sea cargo leaves Iceland several days per week for several different destinations. In short, Iceland has a developed network of transport destinations for seafood, especially in Europe.

Marketing

Iceland has exported seafood for a long time with good results. Icelandic marketing and sales firms have the knowhow to put a new seafood product to the market. Also to establish cooperation with local distributors in stocking and distribution.

6. Status, results and suggestions

A. Status and tasks

- Market price is variable but has risen in the last years. Older culture areas in Europe can not produce more and prices therefore likely to stay high in the coming years.
- Total consumption exceeds 700.000 tonnes/year and demand increases.
- As long as market prices stay high the Icelandic producers can stay on market despite the cost of transport.
- Processed mussel holds a steady price on European market where source countries outside Europe hold up the competition.
- The quality of the Icelandic mussel is high and is stable across seasons.
- Iceland has to meet higher transport cost than competitors located inside market regions. A prerequisite for marketing of Icelandic fresh live mussel is the delivery on time at a competitive price.
- Iceland offers extensive culture areas. At the same time the culture areas in Europe can not be expanded. Iceland offers enough space for mass production of mussel. The mussel industry in Iceland will probably rely on good quality high technology level and high quantity production.
- Development of services for the industry will reduce investment risk and attract investors.
- Development of services for mussel farming meets objectives of supporting aquaculture.
- Mussel farming is an environment friendly industry as the mussel is not fed on introduced food but feeds itself on plancton.
- Health and safety of culture areas is at a very high standard.
- Cadmium in mussel is above the European minimum level in several areas in Iceland.
- Mussel farming is a good opportunity to increase number of jobs in Icelandic rural areas.
- Spat collection has proven to be reliable and correct methods ensure little fouling.

- No invasive species have caused problems so far.
- It takes 2 to 3 years to grow the mussel up to market size compared to 18 to 24 months in Holland.
- Production is still very limited and only samples have been presented to EU market. Growers should be able to start mass production based on the development to date.
- Eider ducks has been a significant predator on culture lines and will most likely be a problem in the industry.
- Monitoring of toxic algae in seawater has been established.
- Monitoring of algae toxins is at a preparatory stage and samples are still sent abroad.
- Mussel production fits well to the Icelandic fish industry.

B. Results

- The committee concludes that in the long term a competitive mussel industry can be developed in Iceland.
- Abundant aquaculture sites are available and infrastructure is ready for the new industry but a great deal of research and development work is ahead before extensive investments.
- It is important that development is industry-driven but government and authorities should support the development and related research.
- It is important that the number of risk factors are reduced in order to create interesting investment opportunities in the mussel industry.

C. Suggestions for development of mussel farming in Iceland.

Government institute services

Suggestion 1: A cooperation committee.

In countries where the mussel industry has been successfully developed the industry and government institutes have worked closely together. Canada and Ireland are good examples.

Suggestions:

- It is suggested that a cooperative committee is established between industry and officials. Chairman of committee represents the Ministry of Fisheries and Agriculture. The food and marine research institutes appoint members of the committee as well as the industry association.
- The purpose of the committee is to synchronize the work of the official bodies and the industry. Make suggestions concerning new culture sites, issues concerning toxic algae and companies who will get financial support for operating algae toxin- and heavy metal tests, as per suggestion 3 here below.
- The role of the Marine Research Institute and the Food Research Inst. will be to write the sampling plan in order to ensure the results can be published

Suggestion 2:

Areas for mussel farming leases have become very limited in Europe and mussel farms sometimes have to compete with other industries for space. Such conditions can come up in Iceland. Possible conflict with other industries should be evaluated in order to avoid conflict. New culture areas should be checked for toxic algae and heavy metals.

Suggestions:

- It is suggested that health and safety surveys will be paid by government funds.
- Toxic algae survey should be followed through in culture areas. A mussel farm must have the operation license in order to get the health and safety inspection.
- It is suggested that a committee for the planning of coastal areas finishes its work as soon as possible

Suggestion 3: Health and safety of product

Toxic algae

Algae toxins can cause considerable harm to the farm business. In Iceland very little information has been collected on the frequency and distribution of algae toxins.

Suggestions:

- Toxic algae tests should be paid from government funds.
- Mussel farmers have to present a plan for operations indicating for example when the plan is to harvest mussel.
- Test samples should aim at reflecting the frequency of algae toxins in the culture site through all seasons of the year.

Cadmium

In general the Icelandic mussel meets all criteria concerning health and safety. One exception is that the heavy metal Cadmium is detected above EU minimum limits in several areas. The Cadmium is of natural origin but not industry pollution.

Suggestions:

- Cadmium level tests on mussel harvest should be financed by government funds in the start of the mussel industry development.
- The committee suggests further data collection in the purpose of mapping the areas to be avoided because of high Cadmium levels.
- The committee suggests that the results of the Cadmium research will be used in order to raise the minimum level of allowed mussel Cadmium contents in the EU, in compliance with the suggestions of the international CODEX UN committee.
- The committee suggests that this research will be financed with government funds and directed by a cooperation workgroup of government and industry.

Research and Development

Suggestion 4: Culture technique and transport

Culture technique

Mussel farmers have step by step acquired the skills and knowledge to farm mussel in Icelandic conditions. Eider ducks have often caused damage on culture lines. Methods to avoid the problem have to be further developed.

Suggestions:

- The development of specific culture techniques in each local area is a task for the individual aquaculture companies. If needed the companies can apply for government R&D grants.

Transport

Iceland is located in a distance from the market and the cost of transport is higher than from producers located inside market areas. Transport with flight is expensive and only possible for the higher priced products. Ship freight is cheaper but takes longer time and demands a water tank station on the market side. Would not be possible for packed mussel.

Suggestion:

- The committee suggests that the ministry of fisheries and agriculture provides funding for exploring of diverse transport ways for fresh mussel to markets.

Appendix 1. Cadmium and other trace chemicals

Data have been collected since 1990 on heavy metals and other toxins in eleven locations around Iceland. Tests from two locations in the NorthWest part of Iceland show that Cadmium level is under EU limits (1mg/Kg) in most cases. Heavy metals with maximum-criteria such as Pb, As, Hg are in all cases far below criteria limits. PCB is measured among the lowest levels found in the the Atlantic. Other biochemicals measured (DDE, HCH, HCB) are also very low, close to detection limits. (*Report: Matís 28-07 Monitoring of the marine biosphere around Iceland in 2005-2006*).

Recently a report on trace chemicals in NW-Iceland was published. In short the results presented in the report are that levels of Cadmium in Blue Mussel from Arnarfjörður are higher than in samples taken in other areas in NW-Iceland, with a significant difference (T-test, $\alpha = 0,05$ (5%)). At the same time the samples show that the levels of iron, copper, manganese and zinc are lower than in on other NW areas. Also the tests show that in 9 out of 10 mussel samples the cadmium levels are above the allowed EU limit. Samples from Hestfjörður and Ósafjörður also showed levels above limit. Samples from Dýrafjörður, Seyðisfjörður and Patreksfjörður were below but close to minimum limit. The results indicate that high levels of Cadmium do not originate from sedimentary layers in the area.

The results of the project give information about that speciality of Icelnadic sea areas in relation to trace chemicals. Such information is important concerning work on limit criteria setting for food in cooperation with the EU, such as higher limits for cadmium content. Results from the project has already been used to support raising of EU limits for cadmium. The project report has been sent to the EFSA committee concerning data collection for evaluation of cadmium in food. (Matis report 44-07 “*snefilefni í lífverum við NV-land*”)

Appendix 2. SWOT – Mussel farming

Strength	Weakness
<ul style="list-style-type: none"> - Abundant space and pure waters - Easy spat collection - Less epifauna than known in other - Good meat yield and consistent quality - Only one spat set per year 	<ul style="list-style-type: none"> - Limited knowhow and - High level of equipment damage and mussel loss from - Greater distance from market than for competitors and higher transport cost - More time needed for transport resulting in decreased - Slower growth and more difficult climate than in competition regions. - Long waiting time for algae toxin tests.
Threat	Opportunity
<ul style="list-style-type: none"> - The mussel industry will not run at same production cost as in competition regions - Cadmium content too high in some of the - Eider ducks cause damage in mussel farms and no legal method to get rid of the ducks - Great production increase in countries like Chile where production cost is low is a threat in frozen mussel products. 	<ul style="list-style-type: none"> - High unit prices and demand more than offer on - Freezing and processing to reduce cost of transport - Produce the high price products like MAP packs to reduce relative transport cost. - Adapt the culture technique more to the Icelandic conditions - Grow mussel in areas where cadmium levels are under limits - Work on raising the limits for cadmium in shellfish in international - Build larger mussel farms to reduce the relative damage of eider ducks - Sell fresh mussel in early summer season when Icelandic mussel is in better condition than other on the market - Export unprocessed mussel in ship freight to life hold stations in Europe

Apendix 3. Service – Matís ohf.

Memo on a Quality Surveillance System for Icelandic shellfarming

If Iceland builds extensive shellfarming industry it is normal that a quality monitoring system is developed for the industry. (f.ex. like the Canadian system) The Icelandic food research MATIS has the position to develop a quality surveillance system. MATIS has 5 annex laboratories around Iceland and the professionals of the laboratories have experience and education in work for the aquaculture.

MATIS can take on work in the below fields:

Sample collection

The annexes can handle sample collection for the shellfarming industry as a service project.

Growth inspections

Samples of mussel correctly taken from culture ropes for tests on size, weight, meat yield etc.

Toxic algae

Mussel farming needs a monitoring on levels of algae toxins in edible parts. The toxins in question are complicated chemicals. The most common toxins are known as ASP, DSP- and PSP toxins which can cause diarrhea, nerve paralysing and memory loss. MATIS can handle the chemical testing for the toxins. In the beginning the tests will be done abroad but should be done in Iceland as the industry grows to ensure test results in time.

Chemical pollution

MATIS can follow through tests on levels of mercury, led, cadmium, copper, zink and other elements. The laboratories have recently been equipped with new instruments to ensure reliable testing of heavy metals. Moreover MATIS can test for PCB and other bio-chemical substances s.a. Dioxine. The tests are done in Iceland and in a partner laboratory in Germany.

Microorganisms

Testing and analysing for microorganisms is well established at MATIS and the institute can handle all work concerning microorganisms in mussel can be handled at MATIS.

Parasites

Analysing of parasites can be followed through at MATIS. The institute works on parasite analysing in cooperatoin with other local institutes.

Health and safety inspections

The Health and Safety Department of MATIS can handle all sides of health and safety inspections in cooperation with the food regulator authority (MAST). The experts at MATIS have extensive experience in work with inspections and monitoring of various chemical and microorganism factors and have worked on site evaluations for the Icelandic aquaculture.

Annex 4. Service– Marine Research Institute

Memo: Site evaluation for shellfarms

1. A project is in course in cooperatoin of the Marine Research Inst. and the Vör research center in Ólafsvík West Iceland for evaluation of environment factors in Breiðafjörður. The project is scheduled for 2007 to end 2009. Sample stations are four in outer part of Breiðafjörður and four in the inner part. Samples are taken form these stations all year round. (1 sample in september to january, 2 amples in april and august and 3 in other months).

The evaluated factors are:

Nutrition (at 0, 5, 10 meters depth and bottom)

Pelagic algae (at 0 og 10 meters depth)

Salinity (surface and bottom)

Temperature (in surface and at bottom)

Oxygen (surface and bottom)

Acidity (surface and bottom)

A fluor-light detector has been added to the project for measuring of chlorophyll content in the water column. Chlorophyll testing is starting on year 2008. Sea current monitoring is planned in cooperation with the Marine Research Inst. In 2008 samples for zooplankton are collected from April to September.

2. A Project is in course in cooperation of the Marine Research Institute, MAST, The Environment Agency and aquaculturists on the monitoring of toxic algae. The monitoring is ongoing every year from April to October. In 2007, four locations were included in the monitoring; Hvalfjörður (Hvammsvík), 2 stations in Breiðafjörður (Flatey and Skipavík) and Eyjafjörður. Samples are taken for analysing and counting of toxic algae. This project will be continued.
3. A project is in plannig for a site evaluation for the fishing of Iceland Cyprine concerning toxic algae in NE Iceland.
4. A project is in planning for mussel farm site evaluation in Tálknafjörður and Patreksfjörður in NW Iceland. This project will be followed through in cooperatoin of the Marine Research Inst. and the West-Fjords Development Office starting April 2008

The factors to be evaluated are: Nutrition, Plancton, Salinity, Temperature, Currents.