



# Cod Farming in the Nordic Countries

Grand Hotel, Reykjavík  
21 September 2011

## Sponsors:



### Organizers of the conference

This event is being organised in co-operation with “Go for Cod”, Norwegian Seafood Centre.

### Conference Committee in Iceland

Björn Björnsson, Marine Research Institute

Valdimar Ingi Gunnarsson, Sjávarútvegsthjónustan ehf.

Theódór Kristjánsson, IceCod ehf.

### In co-operation with:

Jørgen Borthen, Norwegian Seafood Centre.

Conference secretariat (for information on registration, accommodation and travel)

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## Meeting program

08:00 **Registration**

09:00 **Welcome, Minister of Fisheries and Agriculture in Iceland**

### **Session 1: Important biological challenges and bottlenecks in cod farming**

*Chairman: Albert K. Imsland, Akvaplan-niva Ltd.*

09:10 Control of sexual maturity in cod farming – status and future solution, Ørjan Karlsen, Institute of Marine Research.

09:30 Mortality, diseases and vaccination – status and future solution, Grethe Adoff, Norwegian Seafood Centre.

09:50 Growth potential of farmed cod, Agnar Steinarsson, Marine Research Institute

10:10 Status of selective breeding of cod in Iceland, Norway and Canada, Theódór Kristjánsson, IceCod Ltd.

10:30 Discussion

10:50 **Coffee break**

### **Session 2: Industrial view: Current setback in cod farming - Where do we go from here?**

*Chairman: Kristján G. Jóakimsson, Hradfrystihusid Gunnvör Ltd.*

11:10 Status and future plans of cod farming in Norway, Hogne Bleie, Atlantic Cod Farms

11:30 Status and future plans of cod farming in Iceland, Jónas Jónasson, IceCod Ltd.

11:50 Progress of the EIRCOD project and cod farming in Ireland, Richard FitzGerald, National University of Ireland

12:10 Status of capture based aquaculture of cod - Where do we go from here? Kjell Midling, Nofima

12:30 Discussion

12:50 **Lunch**

### **Session 3: Poster presentations**

*Chairman: Björn Björnsson, Marine Research Institute*

13:50 Presentations, 5 min per poster

1. Live feed enrichment for improved quality and survival of intensively reared cod larvae, Rannveig Björnsdóttir, Matís Ltd./University of Akureyri, Jónína Th. Jóhannsdóttir, Hugrún L. Heimisdóttir, Agnar Steinarsson, María Pétursdóttir, Hólmfríður Sveinsdóttir, Oddur Vilhelmsson and Albert K. Imsland
2. Impact of probiotic intervention on microbial load, development and performance of farmed Atlantic cod (*Gadus morhua* L.), Hélène L. Lauzon, Matís Ltd., Sigríður Gudmundsdóttir, Agnar Steinarsson and Bjarnheidur K. Gudmundsdóttir
3. Expression of key genes related to unspecific immune responses in cod larvae, Eydís Elva Þórarinsdóttir, Matís Ltd./ University of Akureyri, Jónína Th. Jóhannsdóttir, Agnar Steinarsson, Kristinn P.





Magnússon and Rannveig Björnsdóttir.

4. The effects of salinity on growth rate of Atlantic cod, Tómas Árnason, Marine Research Institute, Bergljót Magnadóttir, Agnar Steinarrsson, Björn Björnsson and Björn Th. Björnsson
5. The effects of growth, salinity and temperature on humoral parameters of Atlantic cod, Bergljót Magnadóttir, Institute for Experimental Pathology, Keldur, University of Iceland, Björn Th. Björnsson, Björn Björnsson, Agnar Steinarrsson and Tómas Árnason
6. Mortality of farmed cod in sea cages, Árni Kristmundsson, Institute for Experimental Pathology, Keldur, University of Iceland, Bardi Ingibjartsson, Kristján Ingimarsson, Kristján G. Jóakimsson and Valdimar I. Gunnarsson
7. Problem of early sexual maturation in farmed cod; triploidy induction as a possible solution. Amid Derayat, Marine Research Institute, Agnar Steinarrsson, Árni Magnússon and Björn Björnsson
8. Short term exposure to continuous light delays sexual maturation and increases growth of Atlantic cod in sea pens, Albert K. Imsland, Akvaplan-niva Ltd., Henriette Hansen, Bjørn Roth, Atle Foss, Erik Vikingstad, Marit Bjørnevik, Mark Powell, Christel Solberg and Birgitta Norberg
9. Lipid tolerance of Atlantic cod, Jón Árnason, Matís Ltd., Rannveig Björnsdóttir and Helgi Thorarensen
10. Effect of water quality on the growth of juvenile cod, Helgi Thorarensen, Hólar University, Albert K. Imsland, Snorri Gunnarsson, Arnthór Gústavsson, Ingólfur Arnarson, Jón Árnason, Agnar Steinarrsson and Rannveig Björnsdóttir
11. A quick, least-invasive, inexpensive and reliable method for sampling Atlantic cod (*Gadus morhua*) post-larvae for genetic analyses, Luca Mirimin, National University of Ireland, Damien O'Keeffe, Angela Ruggiero, Majbritt Bolton-Warberg and Richard FitzGerald.
12. Are temperature optima for growth of Atlantic cod consistent across the species range? Majbritt Bolton-Warberg, National University of Ireland, Damien O'Keeffe and Richard FitzGerald.

15:30 **Coffee break**

#### **Session 4: Processing of farmed and wild cod**

*Chairman: Sveinn Margeirsson, Matís Ltd.*

16:00 Processing of cod – difference between wild and farmed cod, Kristín A. Thórarinsdóttir, Matís Ltd.

16:20 Processing of farmed cod – technology development, Rúnar Birgisson, Marel Ltd.

16:40 Optimised chilling during processing and transport of fresh fish, Björn Margeirsson, Matís Ltd.

17:00 Discussion

17:20 **Reception hosted by the Icelandic Minister of Fisheries and Agriculture**

#### **Icelandic Fisheries Exhibition 2011**

The Icelandic Fisheries Exhibition will be open from 22-24 September in Smárinn, Kópavogur about 5 km from the conference hotel. Further information is to be found on the exhibition web site: [www.icefish.is](http://www.icefish.is)





## Additional posters

The effect of early weaning strategy on growth potential and deformity incidence in farmed cod, Agnar Steinarsson, Marine Research Institute

Humoral response in early stages of infection of cod (*Gadus morhua* L.) with atypical furunculosis, Bergljót Magnadóttir, Institute for Experimental Pathology, Keldur, University of Iceland, Berglind Gísladóttir, Sigríður S. Audunsdóttir, Birkir Th. Bragason and Sigrífur Gudmundsdóttir.

How to reduce feeding cost by 30-40% in on-rearing of Atlantic cod, Henriette Hansen, Bjørn Roth, Atle Foss, Erik Vikingstad, Marit Bjørnevik, Mark Powell, Christel Solberg Birgitta Norberg and Albert K. Imsland





## Cod farming in Norway

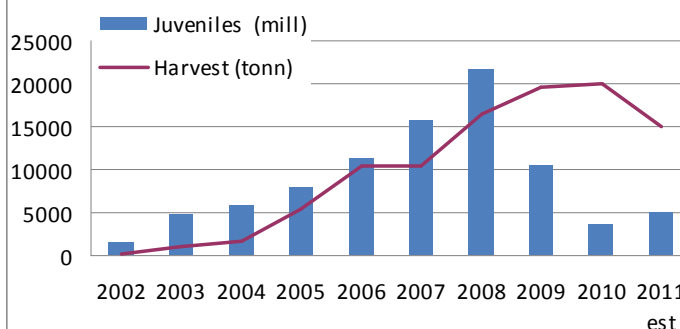
Grethe Adoff, Go for Cod- network, Norwegian Seafood Centre, Bontelabo 2, 5003 Bergen, Norway, grethe@sjomat.no



Cod farming in Norway has the last two years shown a negative development. Decreasing production, lower prices and a reluctance to invest money to develop the industry is a fact. Less public funding of research and industry projects has added to the negative trend which has closed down many of the cod farms. The number of juvenile facilities has been reduced from 18 to 2 commercial facilities the last 5 years, and there is now a shortage of juveniles to fill the demand from cod farmers. In 2010 there were less than 5 million juveniles stocked in cages, and this year there might be even less.

**On the positive side we experience better growth due to successful breeding programs, better juvenile quality and improved management routines. Cod farming has proved to be a commercial industry run by professional and skilled people.**

### Production of cod in Norway 2002 - 2011



### Breeding and egg production

The cod farming industry has 3 different breeding programs for farmed cod all of which aim to supply the hatcheries with eggs all year round. Breeding has shown promising results and currently eggs are produced from the second (F2) and third generation (F3) of broodstock. The Department of Fisheries is financing the national breeding program at Nofima in Tromsø. Their broodstock comes from groups of coastal cod as well as offshore cod (Skrei). Family groups are selected for growth and disease resistance. Expected improvement of growth is 12 – 15 % per generation according to Nofima. A long term goal of the breeding program is to include meat quality, sexual maturation, skin color and resistance to a number of diseases.

Marine Breed Ltd. is a private breeding company which also supplies the industry with eggs from breeding groups from selected families. Selection from third generation started in 2010 from broodstock of selected groups from wild populations from coastal cod and Skrei.

Both companies aim to have eggs available on an all year basis, but eggs are not always available to the hatcheries when needed. Because of the market situation, the price of eggs has gone up the last few years.

In addition to the two main breeding companies, Havlandet Marin Yngel AS in Florø has its own broodstock and has been running a breeding program successfully.



Island sept 2011



## Juvenile production

A number of hatcheries were built in the early 2000. At the peak of the production 18 facilities produced juveniles for sale. In 2008 a total of 22 million juveniles were produced. The financial crisis hit cod farmers and hatcheries sold out before closing down one after another in the following two years. Today the two remaining hatcheries will try to supply the farmers with juveniles, but the supply will be limited in the coming year. It takes 6 months from hatching to produce a 10 gram juvenile. Given the right conditions (temperature, feed) these can be grown to 100 g either on land or in specialized cages.

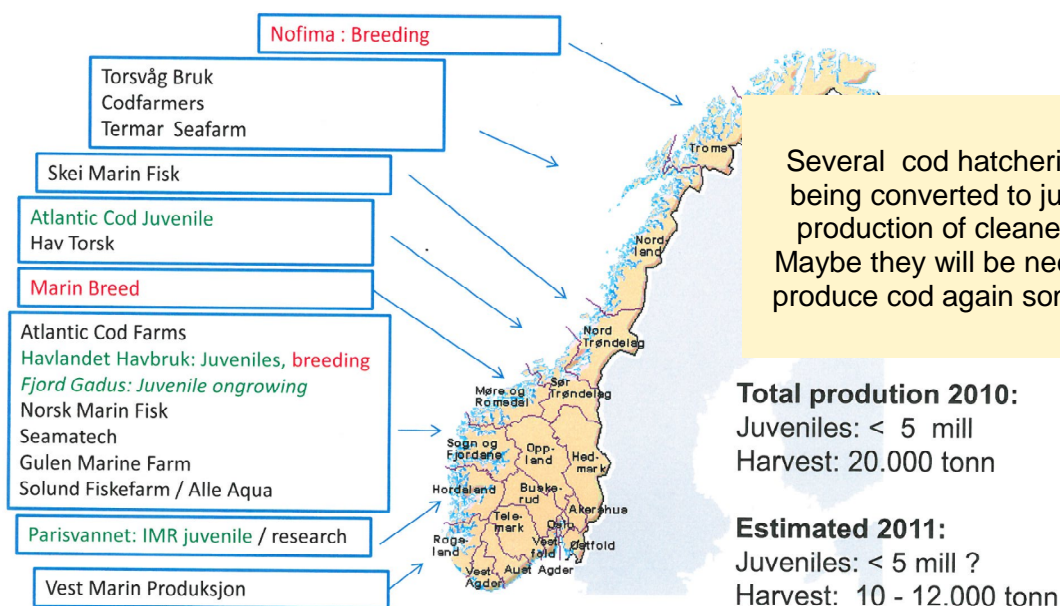


Photo: Terje van der Meeren, IMR

The quality of intensively produced juveniles have improved, but there are still some who claim that

juveniles reared from natural zooplankton are better both in quality and have better growth potential.

## Cod production in Norway 2011



## On—growing

There are now remaining approximately 10 companies producing farmed cod most of them small companies. This summer the two largest companies Codfarmers and Atlantic Cod Farms decided to join forces and merged. The companies are located in Nordland and Møre and Romsdal which are considered the best areas for on-growing of cod.

The goal is to reach harvest size of 3 – 4 kg before reaching sexual maturation after 16 – 18 months. This seems possible, but sexual maturation is still not com-



Farmed cod from Norsk Marin Fisk





pletely under control and production might be prolonged until 24 months or even longer. The best growth rate is seen until 1 kg. Larger fish can show a stagnation in growth and therefore it is difficult to reach harvesting size before sexual maturation. Growth is dependent on good locations, juvenile size

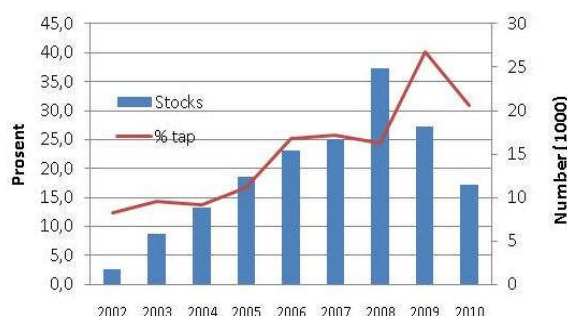
and quality, feeding routines and what time of year fish is set out in cages.

The preferred size for harvesting is > 3.5 kg, but very often small fish is harvested to make up volume.

## Fish health

Diseases and losses in production has been a major problem. The most important diseases are the bacterial diseases Francisellosis, Vibriosis and Atypical furunculosis. The viral diseases are less common, but VNN and IPN have been detected in farmed cod. Parasites like cryptocotyle, trichodina and lice may cause skin irritations, loss of appetite and in rare cases mortalities. Other problems like egg retention and intestinal problems have been seen to cause mortalities, often in otherwise healthy fish. Another health problem is known as looser fish, a condition caused by a number of fish in a cage that won't eat thus becoming moribund and eventually dies. This may be the explanation for unexplained losses which most cod farmers have experienced to some degree.

**Stocks and losses in codfarming 2010**



## Harvesting

Farmed cod has obtained a good reputation in most markets today. Cod has traditionally been sold gutted head off, but today more farmed cod is being processed for fillets and specially produced loins. Atlantic Cod Farms' harvesting facility in Ålesund utilizes the liver, roe and heads which increases the value of the fish. There are 3 – 4 harvesting plants for cod which this year is expecting a total volume of 15,000 tons round weight of farmed cod.

### ***Cod loins, a new consumer product***

*A completely new fresh cod product was launched on the market last year under the brand name STRØM. The cod is slaughtered, filleted and packed within four hours of swimming in the sea.*



## Cod producers and contacts

Atlantic Cod Farms	Hogne Bleie	hogne@atlanticcodfarms.no
Atlantic Cod Juveniles	Finn Christian Skjennum	finn.skjennum@atlanticcodfarms.no
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## Cod farming in Iceland

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For the last few years cod farmers and researchers have gained experience and made some improvements in farming of cod. Research and development work will continue to be the most important area to focus on for cod farming, especially selective breeding of cod.

### Juvenile production

Each autumn from 2003 to 2008, about 1 million 2-5 g cod juveniles were collected in an inshore area in Northwest Iceland and reared in Háafell's nursery during the winter months; in the following spring 60,000-700,000 juveniles have been stocked in sea cages. Capture of wild juveniles has been stopped and the last stocking in sea cages with wild juveniles was performed in spring 2009. With selective breeding and better culture technology it is expected that the quality of the hatchery produced juveniles will surpass that of the wild juveniles.

The hatchery production was first carried out at the Mariculture Laboratory of the Marine Research Institute (MRI) but IceCod Ltd. has recently taken over the production of cod juveniles (Fig. 1). In the years 2004-2010 the hatchery production has been 100,000-350,000 cod juveniles per year and the production is expected to increase in the coming years (Fig. 2).

### Selective breeding

Selective breeding is an important aspect of cod farming activities in Iceland. The company Icecod Ltd. was established in the year 2003 to take care of the cod breeding program in Iceland. Icecod's main shareholders are Stofnfiskur, MRI, Fiskey, Hradfrystihúsid-Gunnvör (HG) and HB Grandi. Juvenile production is located at Hafnir, Reykjanes peninsula. On-growing is located at the HG sea cage station in Isafjardardjúp, North West coast and the HB Grandi sea cage station in Berufjörður on the east coast. The project is supported by a grant from the AVS R&D Fund (AVS stands for Added Value in Seafood).

### On-growing

In Iceland mainly two methods are used for cod

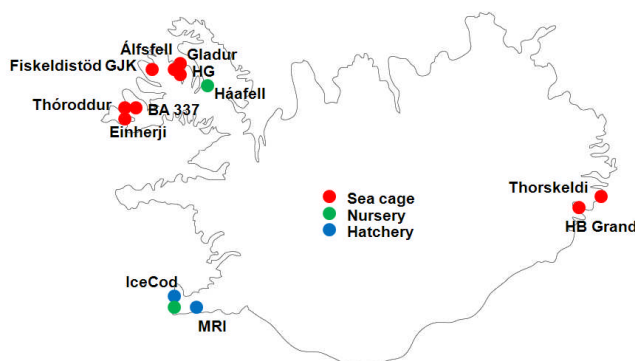


Fig. 1. Location of cod farms in Iceland.

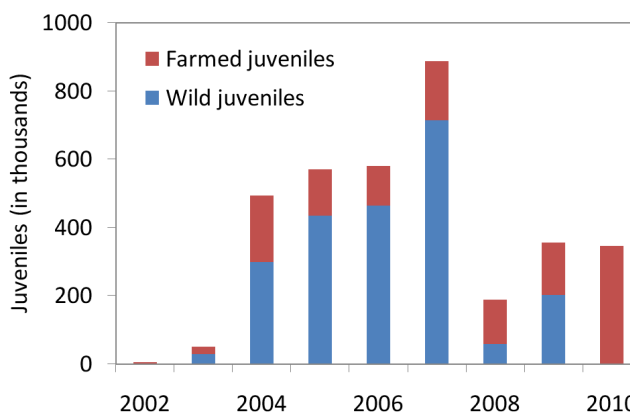


Fig. 2. The production of wild farmed and farmed juveniles stocked in sea cages in the years 2002-2010.

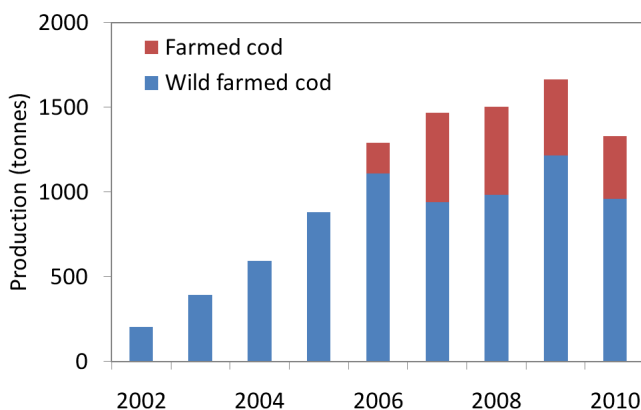


Fig. 3. The production of wild farmed and farmed cod in the years 2000-2010.



farming: one is based on capturing wild cod for on-growing, the other one is based on growing hatchery produced juveniles to market size. There are mainly two size-classes of fish captured for on-growing: juveniles (2-5 g) and 1-2 kg cod.

Today 9 farms are producing cod, 8 on-growing wild cod only, 2 using both wild cod and hatchery produced juveniles and 1 using only hatchery produced juveniles (Fig. 1). The slaughtered volume of farmed and wild farmed cod has increased from 200 tonnes in year 2002 up to around 1,300-1,600 tonnes in 2006-2010 (Fig. 3). HG and HB Grandi, the two largest producers of farmed cod in Iceland, are vertically integrated seafood companies, controlling the juvenile production, on-growing, harvesting, packaging and marketing of the products.

### Diseases

The main problem in cod farming has been the losses in production due to diseases but with more experience this problem has been gradually reduced. The most important losses are due to the bacterial diseases Vibriosis and atypical furunculosis. Viral diseases have not been detected in farmed cod. Parasites like *Gyrodactylus sp.*, trichodina, costia and *Loma sp.* have been found to cause mortalities.

### Export

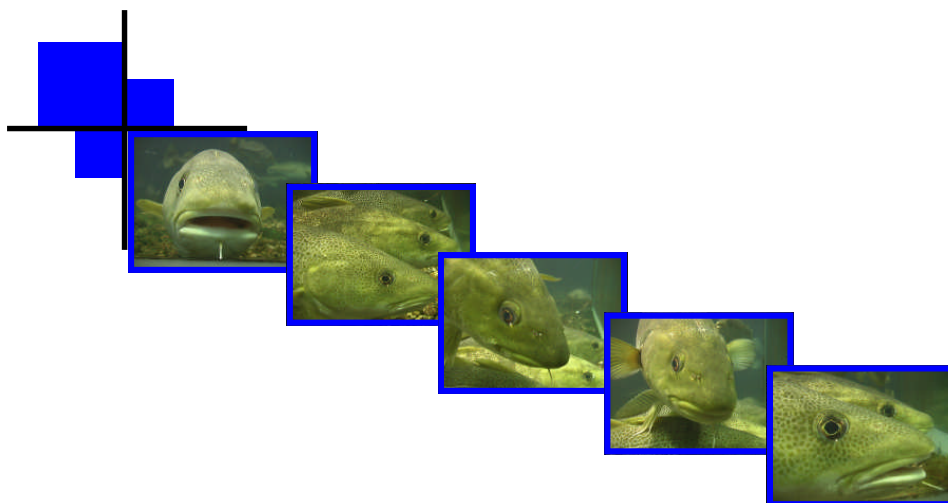
Most of the farmed cod are filleted pre-rigor for the production of fresh loins. The remainder of the fillet is mainly frozen. Farmed cod has obtained a good reputation in most markets today.

### The future

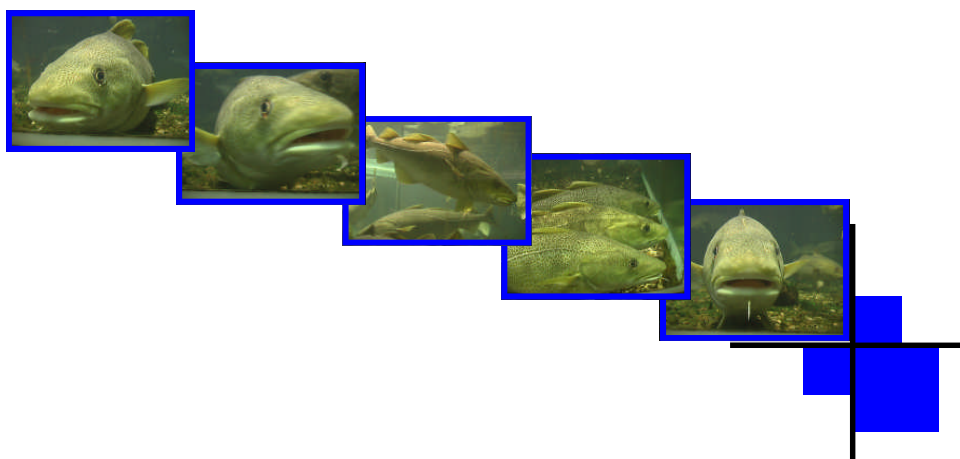
Today it seems that on-growing of wild cod is more economically efficient than using hatchery produced juveniles. For the next few years the production of cod will still be based mainly on on-growing of wild cod. Next few years, no increase in farming of wild cod is expected, but slow growth in production of farmed cod. Before up scaling it is necessary to improve growth rate with selective breeding, prevent sexual maturation, reduce mortality and produce vaccine for the most common diseases. The prognosis for the next few years is 1,500-2,500 tonnes of farmed cod, including on-growing of wild cod. With success in research and development it is expected that production will start to increase after the year 2015, especially when the breeding program begins to deliver cod juveniles with much faster growth rates.

### Cod producers and contacts

Hradfrystihúsid-Gunnvör (HG)	Kristján G. Jóakimsson	kgj@frosti.is
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## **Presentations of institutes and research firms**







## Norsk Sjømatsenter – The Norwegian Seafood Centre: A national competence and resource centre for the seafood industry

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Norsk Sjømatsenter (SNS) – The Norwegian Seafood Centre - is an independent innovator in developing use and presentation of knowledge and competence about seafood.

SNS has been organized as a foundation since 1998 and has a total of 60 members of seafood companies, research institutions and national organisations.

SNS offers:

- Coordinating research and development projects.
- Business developing networks, e.g. responsible for the Norwegian national cod network “Go for Cod”.
- Symposiums, conferences, workshops and seminars, 2010: 6 different events. Cooperation with R&D and organisations in the seafood

sector.

- Organizing study trips and courses, and stands on national fairs.
- Exchange and development of information and knowledge.
- Tailormade training experience for employees in the fish industry, export companies, retail, restaurants and hotels.
- A culinary theatre where seafood is being demonstrated in a kitchen and where the “audience” can take part in the preparation. Totally 55,000 people have visited the culinary theatre.
- 10 employees who are highly educated and experienced.
- Organise WEB- conference systems.

### Research institutes in cod farming

Institute of Marine Research	Ørjan Karlsen	<a href="mailto:orjan@imr.no">orjan@imr.no</a>
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Nofima Marin	Ingrid Lein	<a href="mailto:ingrid.lein@nofima.no">ingrid.lein@nofima.no</a>
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University of Bergen	Are Nylund	<a href="mailto:are.nylund@bio.uib.no">are.nylund@bio.uib.no</a>

### Other contacts

FHL: Trude Nordli  
Innovation Norway: Svein Hallbjørn Steien  
Norges Forskningsråd: Kjell Naas  
Mattilsynet  
Pharmaq: Yngve Lystad  
NCE aquaculture: Bjørn Gjellan Nielsen

### Feed producers

Skretting - Erlend Waatevik  
Aller Aqua - Sturle Skeidsvoll  
Biomar - Reidar Heggdal





# Institute for Experimental Pathology at Keldur, University of Iceland

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## General information about the institute

The Institute for Experimental Pathology, at Keldur, was established in 1948. It is under the Administration of the Ministry of Education and affiliated to the administration of the Faculty of Health Sciences of the University of Iceland. The institute employs around 60 people.

## Principal roles of the Institute are:

- Basic medical and veterinary research
- Applied research, diagnostic services, animal disease control and expert advice in collaboration with the Chief Veterinary Officer of Iceland
- Development, production and distribution of vaccines against animal diseases
- Provision of research facilities for University instructors and other experts
- Further education and communication of new information to veterinarians
- Rearing of laboratory animals for research
- Research and development in biotechnology

The Institute is divided into four departments; i.e. Administration, Fish Disease Laboratory, Department of Virology and Molecular Biology and Department of Bacteriology, Parasitology and Pathology.

The main role of the Fish Disease Laboratory is:

- Diagnosis of diseases of farmed and wild fish and shellfish
- Routine health surveillance of farmed and wild fish and shellfish
- Research on various aspects related to fish diseases, immunology and vaccinology

Among research activities within the Department of Virology and Molecular Biology are studies on fish immunology. The Institute has access to facilities outside Reykjavík for experiments with live fish, i.e. at the Marine Research Institute Mariculture Laboratory near Grindavík and at The Research Centre in Sandgerði.

## Scientists at the Institute, including students, involved in research on cod farming

- Árni Kristmundsson, biologist, M.Sc. fish diseases (esp. parasitology), epidemiology



- Bergljót Magnadóttir, zoologist, Ph.D. fish immunology
- Bjarnheidur K. Guðmundsdóttir, microbiologist, Ph.D. bacterial virulence, immunology, vaccinology
- Ívar Örn Árnason, biologist, M.Sc. bacteriology; detection methods
- Johanna Hentschke, biochemist, Ph.D. student, bacteriology; bacterial virulence
- Matthías Eydal, biologist, B.Sc. parasitology, epidemiology
- Sigríður Steinunn Audunsdóttir, biologist, M.Sc. student; immunology
- Sigríður Guðmundsdóttir, immunologist, M.Sc., fish immunology, vaccinology, probiotics
- Sigurdur Helgason, bacteriologist/fish pathologist, Ph.D. fish diseases, epidemiology

## Main research activities related to cod farming

- Epidemiology and monitoring of diseases of farmed cod
- Susceptibility of cod to various bacterial and parasitic pathogens
- Development of an oral vaccine for fish
- Research on experimental and commercial vaccines against bacterial diseases
- Research on virulence factors of relevant fish pathogens
- Studies of the effects of age, environmental conditions, immunostimulants and disease on the immune system of cod
- Studies of the acute phase response in cod



## Marine Research Institute

Skúlagata 4, P.O. Box 1390, 121 Reykjavík, Iceland  
tel. 354-575-2000, fax 354-575-2001, hafro@hafro.is, www.hafro.is

### General information about the institute:

The Marine Research Institute (MRI) is a governmental institute with headquarters in Reykjavík and five branch laboratories all around Iceland. It has one Mariculture laboratory near Grindavík on the south west coast and two main research vessels, Árni Fridriksson (70 m) and Bjarni Saemundsson (50 m). The three main areas of activities of the MRI are the following:

- to conduct research on the marine environment around Iceland
- to provide advice to the government on allowable catch levels
- to inform the government, the fishery sector and the public about the sea and its living resources

The MRI has a staff of about 60 scientists, 70 research assistants and 40 crew members.

### Scientists involved in research on cod farming:

- Agnar Steinarsson, C.Sc. aquaculture (agnar@hafro.is): quality of eggs, larvae and fry
- Björn Björnsson, Ph.D. aquaculture (bjornb@hafro.is): growth rate, temperature and stocking density; ranching; behavioral control using sound
- Tómas Árnason, M.Sc. aquaculture (tommi@unak.is): growth rate and salinity
- Amid Derayat, Ph.D. aquaculture (amid@hafro.is): triploidy
- Hjalti Karlsson, B.Sc. marine biology (hjalti@hafro.is): ongrowing of cod in seacages; behavioral control using smell and light
- Valdimar I. Gunnarsson, M.Sc. fisheries (valdimar@sjavarutvegur.is): cod farming statistics

### Main research activities related to cod farming at MRI:

- Development of protocols to improve the quality and survival of eggs and larvae.
- MRI is a large shareholder in Icecod Ltd. which has carried out selective breeding since 2003.
- Various growth rate studies with the aim to establish the growth potential and optimal rearing conditions for cod. It has e.g. been established how optimal temperature for growth decreases with weight of cod and how growth rate can be estimated from temperature and body



The Marine Research Institute Mariculture Laboratory near Grindavík.

weight. Also the optimal rearing density of juveniles has been estimated.

- Supervising data collection by the cod farmers which have been assigned cod quota for on-growing and making an annual report based on the results. In some cases the MRI has been directly involved in research projects in cooperation with the cod farmers.
- Experimental ranching of cod in two fjords: Stöðvarfjörður 1995-96 and Arnarfjörður 2005-2006. Large herds of free-ranging cod were formed with regular feeding with capelin and herring. Cod showed high fidelity to their herds and displayed high growth rate.
- Behavioral control of wild cod using sound, smell and light with the aim to collect fish for on-growing purposes. Also using light to attract euphausiids to seacages to reduce feed requirements



# Matis Ltd. – a dynamic Icelandic Food and Biotech R&D Company

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tel.: +354-422 5000, fax: +354-422 5001, [matís@matís.is](mailto:matís@matís.is), [www.matís.is](http://www.matís.is)

## General information about the company:

Matís is a dynamic R&D company which offers various services to the food industry in Iceland and abroad in close collaboration with research institutions and universities in Iceland and abroad. Matís employs many of Iceland's most competent scientists in the field of food technology and food research: food scientists, chemists, biologists, engineers and fisheries scientists. Furthermore, many M.Sc. and Ph.D. students are doing research at Matís and working on their theses. Employees at Matís are around 100. The research at Matís emphasizes on biotechnology, new processing technology, aquaculture, the processing and improved quality of chilled seafood products and the safety and wholesomeness of marine seafood.

## Scientists involved in research on codfarming:

- Rannveig Björnsdóttir ([rannveig.bjornsdottir@matís.is](mailto:rannveig.bjornsdottir@matís.is)). Ph.D., Cand.Sc. in Fish immunology & Pathology. Preventive measures during the first stages of marine aquaculture.
- Jón Árnason ([jon.arnason@matís.is](mailto:jon.arnason@matís.is)). Dr. Scient in Animal Nutrition. Fish nutrition, feed development and aquaculture technology.
- Helene L. Lauzon ([helene.l.lauzon@matís.is](mailto:helene.l.lauzon@matís.is)). Ph.D. in Food Science (Microbiology). Development of preventive measures during the first stages of cod aquaculture.
- Jónína Jóhannsdóttir ([jonina.johannsdottir@matís.is](mailto:jonina.johannsdottir@matís.is)). M.Sc. in Molecular Biology. Preventive measures during the first stages of marine aquaculture.
- Ólafur Ögmundsson ([olafur.ogmundarson@matís.is](mailto:olafur.ogmundarson@matís.is)). M.Sc. in Environmental technology. Aquaculture technology.
- Sigurjón Arason ([sigurjon.arason@matís.is](mailto:sigurjon.arason@matís.is)). B.Sc. in Chemistry and M.Sc. Chemical and processing Engineering. Handling and processing of farmed fish, feed and feeding studies.
- Ragnar Jóhannsson ([ragnar.johannsson@matís.is](mailto:ragnar.johannsson@matís.is)). B.Sc. Chemistry and Ph.D. in Chemical Engineering; Designing of aquaculture facilities. Developing production and business plans for aquaculture operations



and environmental studies.

## Main research activities at Matís related to marine aquaculture:

Marine aquaculture, especially cod farming, is progressing rapidly in many countries. This development could have a considerable impact on the markets for both wild as well as aquaculture fish in the future. Matís' goals in aquaculture are therefore to reinforce and strengthen marine aquaculture with emphasis on the whole production chain from hatch through the growth period.

- Survival of larvae during the first stages, with special emphasis on prebiotics and probiotics, is an important research area.
- Research projects also focus on reducing the cost of feed without negative impact on growth, health and quality of the final product.
- Matís runs projects on farming technology, use of light in cod farming as well as optimization of farming technology.
- Product quality, filleting yield, process ability and the safety of farmed products are furthermore important aspects of Matís' research projects.
- All research is carried out in collaboration with the farming industry as well as other R&D bodies and universities in Iceland and abroad.





## Department of Aquaculture and Fish Biology Hólar University College

Háeyri 1, 550 Saudárkrókur  
tel. 354 455 6300, fax 354 455 6301, bjakk@holar.is, www.holar.is

Hólar University College is located in northern Iceland. The Department of Aquaculture and Fish Biology offers undergraduate programmes in aquaculture and fish biology and an M.Sc. programme in aquatic biology. The Department also runs courses for the United Nations Fisheries Training Programme. Furthermore, a number of graduate students from other universities are affiliated with the department, working on their projects under the supervision of departmental staff.

The department has good facilities for research and teaching in laboratories and two fish farms with access to both freshwater and seawater. Through a special contract with the Ministry of Fisheries and Agriculture the Department runs the Icelandic breeding program for Arctic charr. In total, 18 staff and graduate students are involved in research in the Department.

The principal roles of the Institute are:

- Providing education in aquaculture and fish biology
- Research in aquaculture and fish biology
- Breeding of Arctic charr for aquaculture

Scientists involved in research on aquaculture and fish biology:

- Arnthór Gústavsson (addi@holar.is) M.Sc. aquaculture
- Bjarni Kristófer Kristjánsson PhD, head of department, (bjakk@holar.is), fish evolution and ecology
- Einar Svavarsson M.Sc. (einsi@holar.is), breeding programmes
- Helgi Thorarensen PhD (helgi@holar.is), aquaculture, water quality and fish physiology
- Ólafur Sigurgeirsson M.Sc. (olisig@holar.is), aquaculture and feed development
- Stefán Óli Steingrímsson PhD (stefan@holar.is) fish behaviour and ecology

Main research activities related to cod farming:

- Developing and testing feed for cod, primarily aimed at defining the minimum protein requirements of cod, testing protein from different sources in feed and lipid content of feed.



Verid, Hólar University College Facility for Research and Teaching located at Saudárkrókur.

- Behaviour of cod juveniles with special reference to cannibalism.
- Effect of water quality on the growth and welfare of cod



## IceCod Ltd.

Stadarbergi 2-4, 221 Hafnarfjörður, Iceland  
tel +354 5646300, gsm +354 6936306, fiskur@stofnfiskur.is

IceCod's aim is to do selective breeding of Atlantic Cod. The major shareholders are Stofnfiskur Ltd., HBGrandi Ltd., Hraðfrystihúsið Gunnvör Ltd., the Marine Research Institute, Fiskey Ltd. and Cod on dry land Ltd. The manager is Jónas Jónasson.

The company has since 2003 been working on selective breeding of cod. During the first 3 years a wild broodstock was caught around the Icelandic coast and stripped. This formed the base population for future selective breeding. The first round of selection was performed in 2006 where 20% improvement in growth was achieved.

Theódór Kristjánsson M.Sc. is the coordinator of the project (theodor@stofnfiskur.is).

IceCod runs its own fish farm at Hafnir on the Reykjanes Peninsula. Two cohorts of broodstock are kept there where one is light manipulated to produce eggs off season. A family tank facility was built in 2008 where 106 families can be kept separate until tagging.

The company aim is to improve the Icelandic cod stock for farming around Iceland in the coming years.





## Pictures from the cod farming conference in 2005







## Pictures from the cod farming conference in 2008







## FEEDMILL - FÓÐURVERKSMIÐJA



Laxá Feedmill Ltd.  
specialises in production  
of fish feed



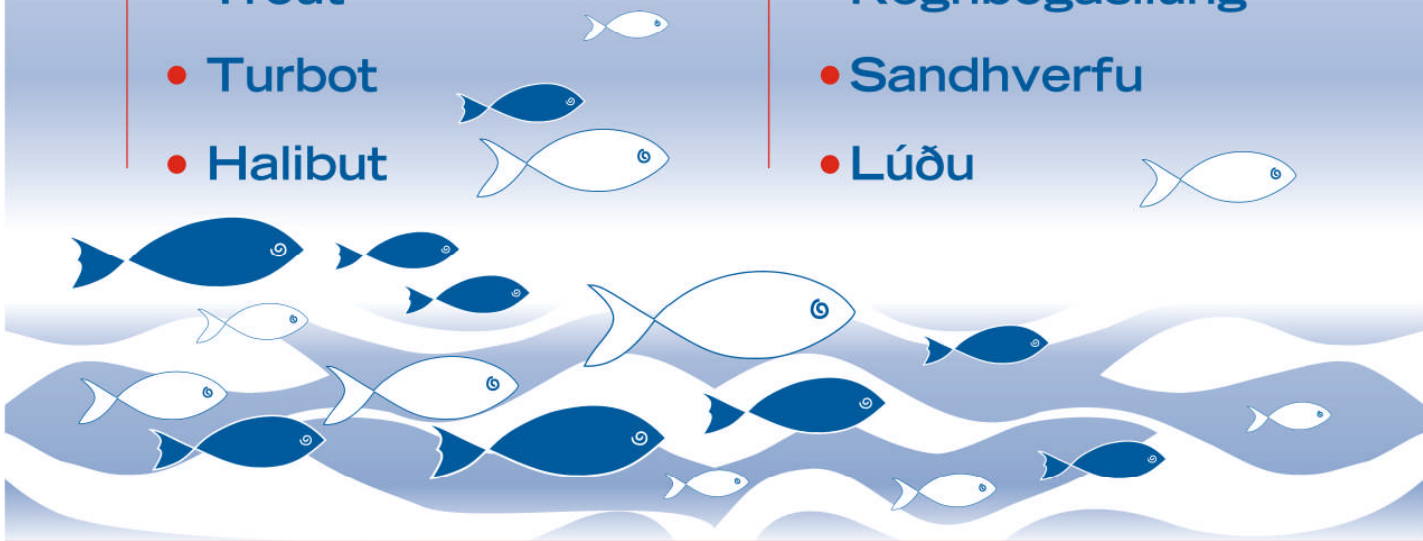
Fóðurverksmiðjan Laxá hf.  
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**We produce feed for:**

- Cod
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- Arctic Char
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**Við framleiðum m.a. fóður fyrir:**

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# Pump, Grade & Count

## Heathro Fish Pump

- Fish size from 0.2g to 400g
- High capacity
- Combined lift 9 meters
- Horizontal transfer of fish over 500 meters
- Easy set up and move around site
- Use with 3" to 6" hoses
- Very gentle on fish
- Wireless remote control



## VAKI Fish Grader

- Accurate grading of fish from 0.5g to 200g
- High capacity up to 150.000 fish per hour
- 4 grades
- Very gentle on fish
- Two sizes, 96cm and 140cm diameter
- No belts or rollers
- Variable speed



## VAKI Fish Counter

- Fish size from 0.2g to 400g
- Over 99% accuracy
- Up to 200.000 smolts per hour
- Average weight and size distribution
- Images are saved for verification of the counting
- Counting report
- Multi channel options
- Special Wellboat version

