

The Icelandic Cod Breeding Program

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Introduction

A little bit of the past

- The project started in 2003 by creating a base-population for cod-breeding
- The company IceCod was established
- The company has two main emphasises
 - Breeding and juvenile production
- The company is owned by both a private companies and the Marine Research Institute



Introduction

present

- Since 2006 we have been breeding individuals from the base-population
- Since 2006 we have started light-manipulation to have off-season spawning
- Since 2007 new hatchery was built, which will be used for family- breeding program and juvenile production
- 2009 we will create the first F2 generation of improved juveniles

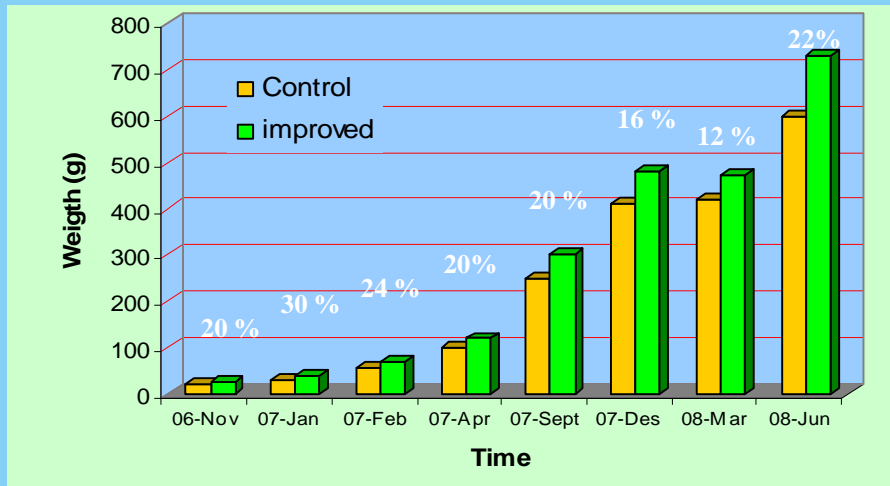


Our research

- Breeding and measuring genetic improvement
- Light-manipulation and production-line
- Egg quality
- Breeding design, simulation studies
- Molecular methods in breeding



Comparing wild and genetically improved year-class 2006

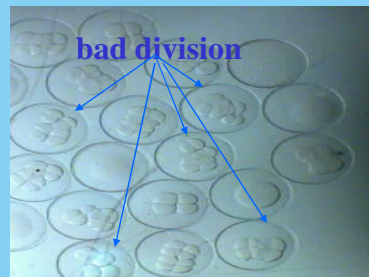
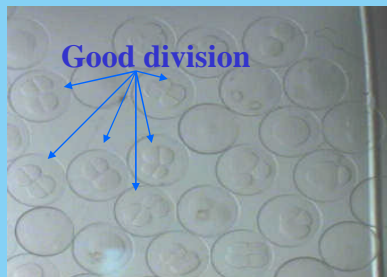


Light-manipulation and production-line

- Cod respond well to light-manipulation.
- This gives opportunity to have many spawning-seasons each year.
- This gives flexibility to offer juveniles at different size and different time each year
- This gives the possibility to shorten the generation interval

Egg quality Needs to be improved

- Low survival
- Irregular cell division



 IceCod

Poor egg quality - possible causes

- Age of the brood fish
- Nutrition for the brood fish
- Timing of spawning
- Water- quality, water temperature
- Handling of the eggs
- Brood fish condition (stress etc.)

 IceCod

Breeding design

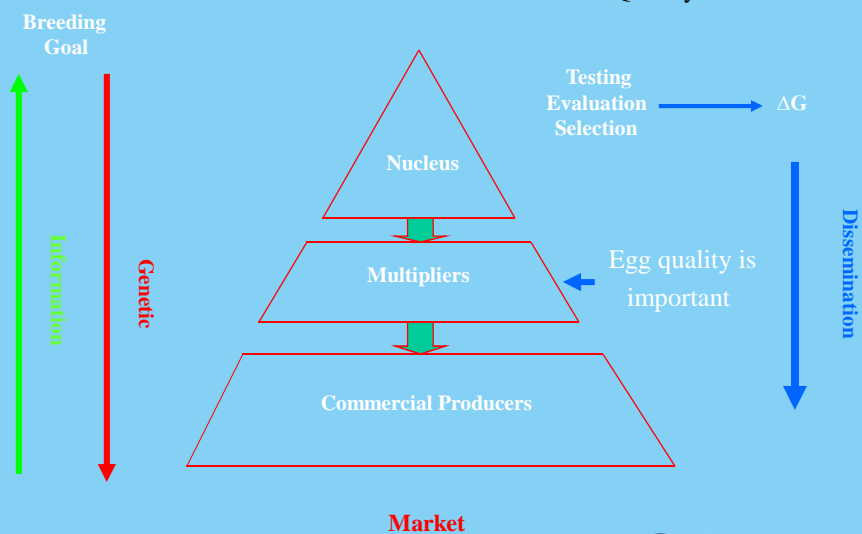
If you are not farming for profit, we wish you well with your hobby

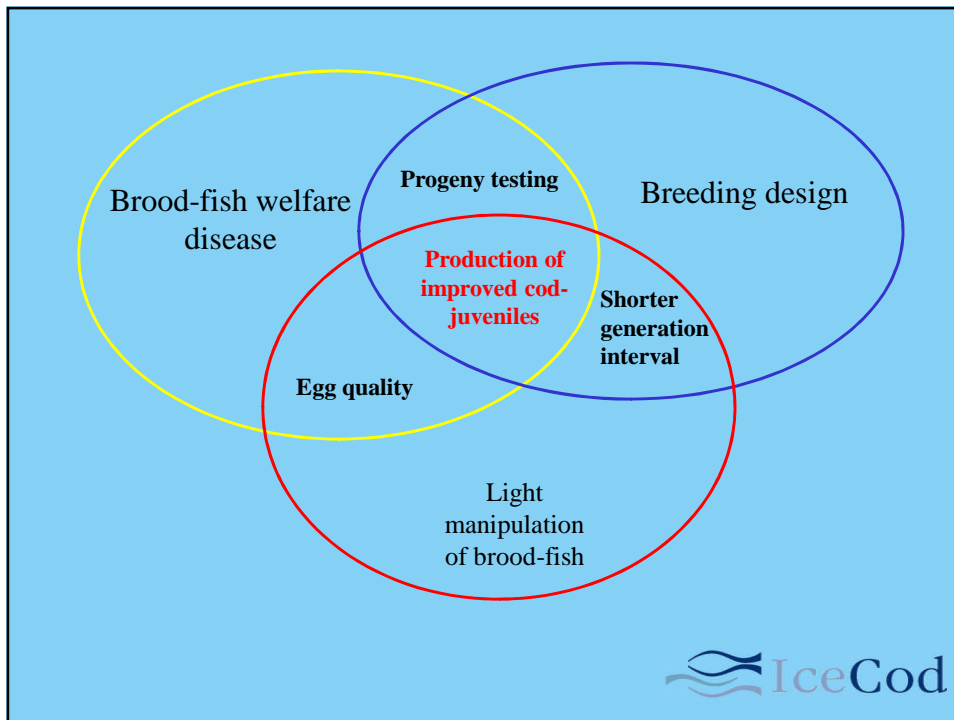
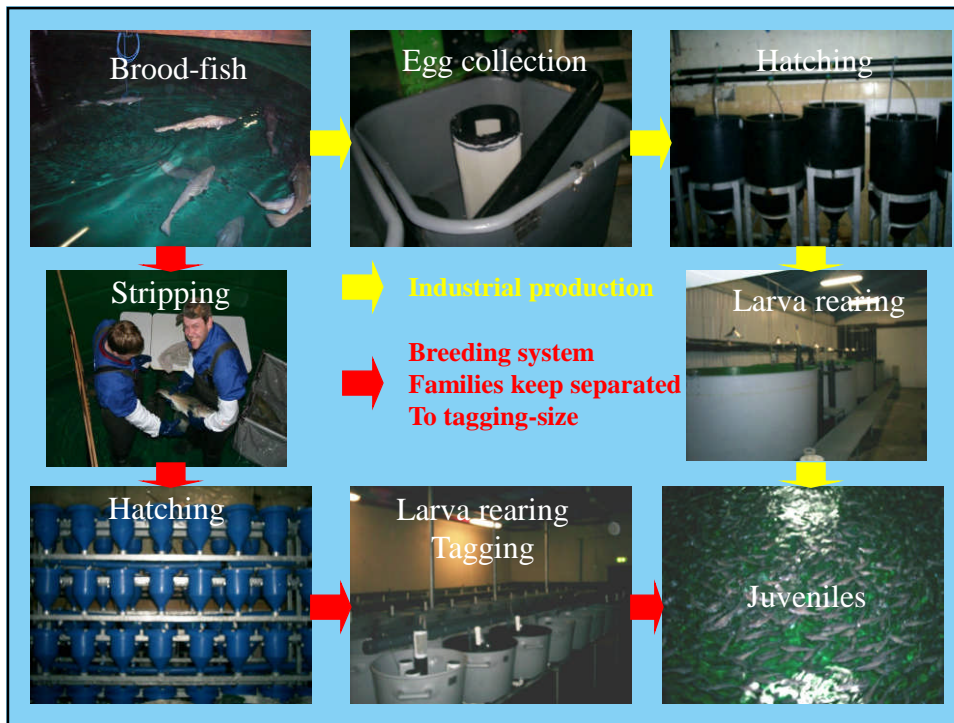
- IceCod breeding system for cod is based on 100 – 150 families
- The breeding system is based on multi-tanks where each family is kept in separate until tagging
- Cod breeding can lead to another approach than in salmon, like progeny testing
- Different breeding methods will be tested in simulation models



Structure of Animal Breeding Programs

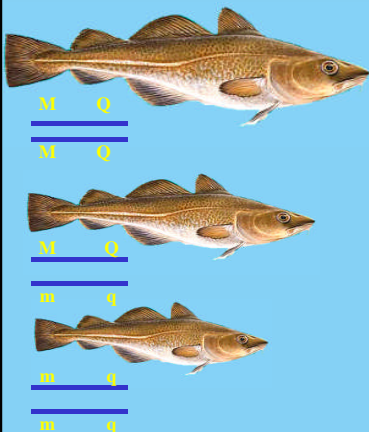
“Mate the Best to the Best and Do that Quickly”





Molecular methods in animal breeding

Q q = QTL/Gene
M m = markers



Most QTL cannot be observed at DNA level
Two types of observable genetic loci

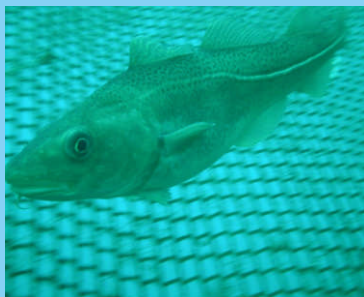
Functional mutations – know genes
•Most beneficial and easy to use
•Difficult to find

Anonymous markers linked to QTL
•Easier to find
•More restrictive and difficult to use

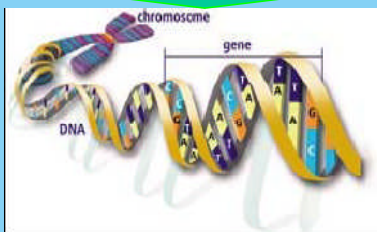
High-throughput Genotyping Technology
Like SNPs has lead to Genomic Selection



Principle of Genomic selection



Genotype for
50,000 SNPs



TRAINING DATA

= Genotype 2,000 Cod with phenotype
for 50,000 SNPs Estimate SNP effects

SNP are treated as 0/1

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1001100100110011010001111001001
00101101000100111001000010111
0011101100110110111001101000001
00110001000011001010001000111
11101001001011101110101100000
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Genomic Selection =

Σ estimates of effects at 50,000 SNPs

$$y_i = \mu + \sum_{\text{random (Bayesian)}} \beta_j g_{ij} + (u_i) + e_i$$

Genomic selection

- Simulation show that using 50,000 – 100,000 SNPs gives the best results
- Genomic selection is expensive, for 2000 animal the cost is 400,000 US \$
- Genomic selection still has to be proven in real breeding systems
- Genomic selection can be an option for cod-breeding after a few years



Summary

- Genetic improvement for growth has been verified
- Cod respond well to light-manipulation - giving alternative ways in production
- Egg quality needs to be improved - vital for multiplying the best material.
- Breeding design is underway

Acknowledgements

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