BlueMentor

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Innovative Quality Mentoring program for development of a Blue Competence Framework in fin-fish production

Output 4 - Fin-Fish work based pilot delivery testing

D4.2

A basic course on Fish welfare, the biology and physiology of salmon. The lessons slides and structure for the *Fish welfare course*. Piloted lessons on the course.

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Version: Final

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The pilot.

Introduction

The Lifelong Learning Centre of the Westfjords was leading in a project on creation of educational material on fish welfare in relation to salmon fish farming. The project was carried out in collaboration with Ann Cecile Hilling, who has a master´s degree in coastal equipment studies in aquaculture and was the project´s expert leader, and the fish farming company Arnarlax. The structure of the course and the course material are available both in Icelandic and English. The course was piloted in 2021 with a veterinarian who had extensive experience in the aquaculture sector.

The *Fish welfare course* deals with the training of personnel working in fish farming with the purpose of producing a basic training material for aquaculture workers who are mostly manual laborers. It is crucial for the workers to be aware of the health state of the salmon fish and the course is a step to satisfy the needs of the industry for increased knowledge and skills of their employees. The main health problems of farmed fish are reviewed, how they can be identified and dealt with.

Objective

The objective of the project is to encourage managers and aquaculture staff to consider the health and welfare of salmon fish. Also, to minimize the risk in fish farming through education. Research has shown that the main risk in fish farming is the staff themselves. However, this risk can be decreased with more information and staff training.

Structure, materials, and approach

The Fish welfare course

The main topics of the course are biology and physiology, animal welfare and physiological responses, diseases of salmon and diseases prevention and treatments. The course is broken up into four sections, with each section's teaching time expected to be two hours. Teaching is in the form of lectures and slide shows, videos are shown and there are discussions about the subjects. The structure of the course is as follows:

Part one: Biology and physiology

Salmon life cycle

•The salmon life cycle and life cycle of Atlantic salmon in the wild.

Life in fresh water

• The spawning seasons. Spawning, hatching, and “homing”.

Smolting of sea-going juveniles

• Preparation for life in the sea.
• Length of stay.
• Changes in juveniles during the formation of a smolt dress.

Senses

- Salmon physiology.
- Role of swim bladder.
- The salmon's armor and how the skin and scales protect the fish.
- Salinity control.
- The gills and their role.
- Metabolism.
- Senses, smell, sight, taste, hearing, balance and the "second ear" of the salmon.

Part Two: Animal welfare and physiological responses

What is animal welfare?

- The concept of animal welfare and how it is measured.
- Well-being and health are discussed.
- Rules and regulations in Iceland.

Needs of salmon

- Food gathering.
- Breathing.
- Maintenance of physical health and hygiene.
- Safety, rest.
- Social relations, sexual behavior, exploratory needs.

Welfare indicators

- Measurements, observations, information, and analyses.
- Laws on animal welfare, Icelandic regulation.

Physiological responses

- Major environmental changes.
- Development of diseases.

Stress

- Advantages and disadvantages of stress response.
- Three stages in the stress response.
- Stress in fish and the changes that stress can produce.

Pain

- Fish’s perception of pain.
- Research.
- Safety is paramount.

Part three: Diseases

Non-communicable diseases

- Nutrition and deficiency symptoms. Digestive problems, oversaturation.
- Damage caused by machinery.
- Hemorrhagic diseases, injuries caused by predators.

• Degeneration.
• Water quality, hypoxia. Sea and freshwater.

Infectious diseases

• Direct and indirect infections.
• Horizontal or vertical infections.

Bacterial infections

• Kidney disease (BKD) Renibacterium salmoninarum, development of vaccines.
• Typhoid fever (Furuncolosis) Aeromonas salmonicida, vaccinations.
• Cold water vibriosis Vibrio salmonicida, ways of transmission, symptoms, spread, treatmentand vaccinations.
• Chlamydia disease (PGI) Epitelocystis, origin, symptoms, no cure, cost.
• Rubella (Yersinosis) Yersinia ruckeri, ways of transmission, symptoms, preventive measures,treatment.
• Winter sore, Moritella Viscosa, causes, environment, distribution, symptoms, treatment.

Viral diseases

• IPN (Infectious Pancreas Necrosis) Birnaviridae, ways of transmission, mortality, symptoms, prevention.
• PD-disease/Pancreatitis Salmonis alphavirus togaviridae, disease diagnosis, symptoms, ways of transmission, prevention.
• ISA disease- Haemophilus Orthomyxoviridae, ways of transmission, consequences and costs. ISA sickness- HPR virus, prevention.

Protozoa

• Salmon lice Lepeophtheirus salmonis origin, symptoms, life cycle of salmon lice, consequences, treatment.
• Gray louse Caligus elongatus, distribution.

Fungal infection

• Saprolegnia infection routes, consequences, preventive measures, treatment.

Part four: Prevention and treatments

Knowledge

• Experience, learning.
• Routines, records and action plan.

Regulations on aquaculture

• Notification and registration obligation.
• Investigations, involvement of a veterinarian.

Procedures

• Regional procedures, infection control plan, health certificate, disinfection.
• Access to facilities, hygiene, safety, and protective clothing.
• Dead fish release, the response plan: Diseases.
• Station procedures, equipment and its transport between stations, cleaning of feed barge,

resting station.
• Registration forms - Lice counting - registration of dead fish.

Preventive measures
• Timeline of fish farming.
• Fresh water phase.
• Sea phase.
• Approval of medicines, vaccines.

Treatment
• Medical Treatments, Fish Disease Committee.
• Approved medication and other treatments, bathing, Slice- medicated feed.

Summary
• The importance of fish welfare for production.
• Healthy fish is quality fish.
• Key points: Procedures, knowledge and techniques to contain disease and prevent transmission.
• Drug-free lice treatment, natural treatments, breeding, technical treatments.

The target group
The target audience of the course are mostly those with short formal education and work as generally manual laborers. The course material is also suitable for newcomers. The course is intended to provide students with the chance to develop their professional abilities and take on more responsibilities. It is important that the participants have the opportunity to participate in discussions about the subject in which the instructor is involved. It is suitable for the course to take place at the workplace and during working hours.

The pilot
The course was piloted for a group of ten. The group was mixed with variety of backgrounds, including both those with experience in aquaculture and those who were new to the field.. Trial lessons took place in the premises of the Lifelong Learning Centre in Ísafjörður. It is recommended that the course should take place at a fish farm, but it was not possible at the time due to restrictions brought on by the Covid 19 pandemic. On-site teaching, however, is the focus in for the future.
The duration of the course was eight hours, four lessons, two hours at a time. The teaching was based on the lesson plan and was in the form of lectures, slide shows and discussion groups. Videos related to the course and fish farming were also shown. The course aimed to encourage students to strengthen their working skills. At the end of the course, the students were introduced to further studies in the field of fish farming and encouraged to continue education.

Collaboration
As mentioned before, Arnarlax participated in the development of the course. The course is available in Icelandic and in English and as such can serve a wider group of participants. It is an obvious and natural requirement as the majority of fish farming companies in Iceland have staff of foreign origin. The participation of the Lifelong Learning Centre of the Westfjords in the Blue Mentor project made

it possible to complete the development of the material for the course and holding of a pilot class. This will make the course more accessible to the diverse workforce of aquaculture enterprises and give more staff members the chance to advance their professional knowledge of fish biology, physiology, and welfare.

Achievements of the project

There is a great need for more education for various target groups within the aquaculture secor. The general manual laborers with short formal education is a target group that needs special attention within the industry. These are the laborers who are closest to the fish production and therefore need to be well trained and informed about the risk of the industry. The course will have an effect and strengthen the fish farm companies' ability to train newcomers in the aquaculture industry. Participants will have a basis for further training and education which is increasingly in demand. Fish farming is a new profession in Iceland that is expected to expand even further.

Outputs

• The *Fish welfare course*, including slides, which is intended for general manual laborers with a short formal education. Instructional slides on the subject are attached.
• The suggest structure for the *Fish welfare course*.
• A piloted lessons on the course.

Funded by the Erasmus+ Programme of the European Union

Annex - Course slides next page:

Fræðslumiðstöð Vestfjarða
Miðstöð símenntunar á Vestfjörðum

The Lifelong Learning Centre of the Westfjords

FISH WELFARE COURSE

Support literature for the course can be found for free here.

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Part 1: Biology and physiology

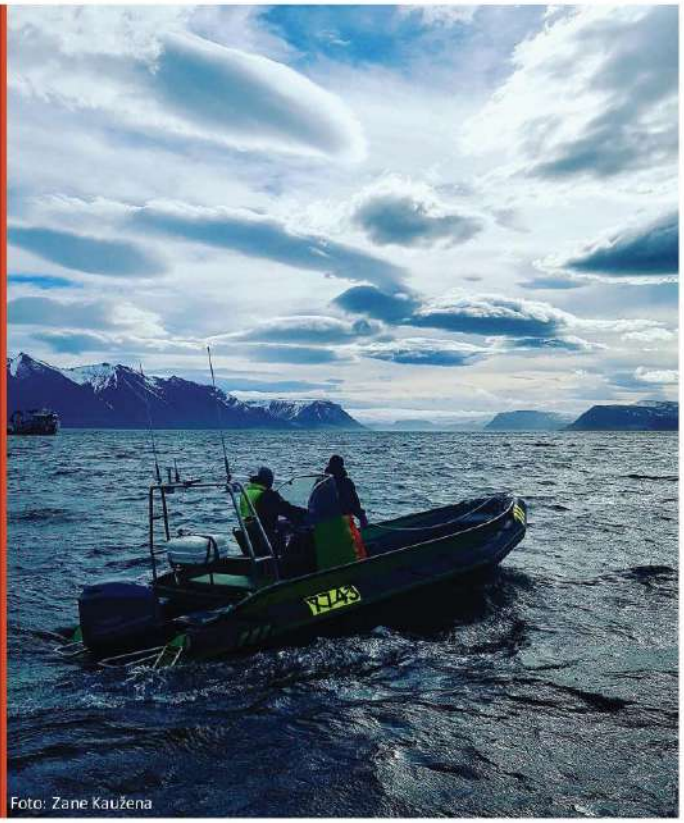

Foto: Zane Kaužena

Salmon life cycle

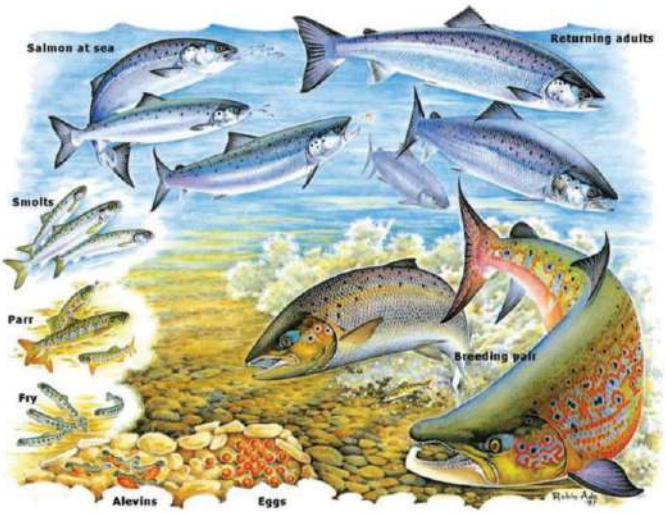

Foto: cefas.co.uk

Atlantic salmon life cycle in the wild

Video: https://www.youtube.com/watch?time_continue=17&v=2fGLzEvWuYA&feature=emb_title

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Life in freshwater

- Atlantic salmon is an anadromous specie that is born in freshwater– migrates to the sea for a period of time, until it returns back to the river to spawn.
- In most cases an Atlantic salmon will migrate up the same river it was born, this mechanism is called "Homing".
- Spawning period ranges between October to January.
- Male and female salmon will complete the spawning process with the female releasing the eggs into a gravel riverbed and the male will follow and release the semen on the eggs and further the female will cover the eggs with more gravel.
- Some of the salmon will be to the point of exhaustion after spawning that they will die, but some survive and will stay in the river until they migrate back to the sea the following spring.

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Foto: Aftenposten

Foto: Sinkaberg Hansen

Life in freshwater

The eggs will start hatching in the spring and for the first 5-6 weeks, the fry survive only on the yolk before they start finding food in the river.

As the fry continue to grow, they will eventually start coming up from the gravel and move freely in the river. At that stage the salmon is called a Parr.

The parr will live in the river for 2-5 years before they start preparing and transforming for life in the sea.

Smoltification

Smoltification is the transformation a salmon goes through to prepare for life in the sea.

In order to start smoltification, the temperature in the river has to reach above 8 degrees Celcius and the fry needs to have grown to the size of 11-15 cm, this is called the smolt window.

If the fry has not reached this size by the time the temperature in the river is optimal, the fry will stay in the river for an additional year.

Smoltification

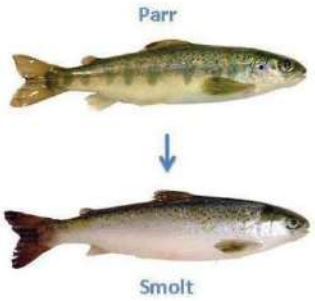

Foto: UIB

Changes during smoltification:

- Colour and bodyshape:
  - Silver colour.
  - Streamline bodyshape.
  - Darkened fins.
  - Parr marks disappear.
- Behaviour:
  - From being an aggressive loner to shoal fish.
  - From swimming countercurrent to downstream.
- Regulation of water- and salt balance:
  - The ability to drink water.
  - Reduction in urine production.
  - The colon changes to be able absorb more water.
- Metabolism and body composition:
  - Bigger swim bladder gives higher buoyancy.
  - Eye pigmentation changes and adapts to life in deeper waters.
  - Gill change.
  - Higher oxygen consumption.
- Hormonal changes.

Life in sea

- When ready the smolt will migrate out to the ocean, where they will stay for the next 1-3 years.
- The salmon will travel in search of food and many go to the area around the Faroe Islands.
- The factors that determine when the salmon decides to mature is not completely known, but it is thought to be due to good years of food access. The salmon gains weight to have enough energy for the long journey home and to produce sperm/roe.

Foto: seafoodsource.com

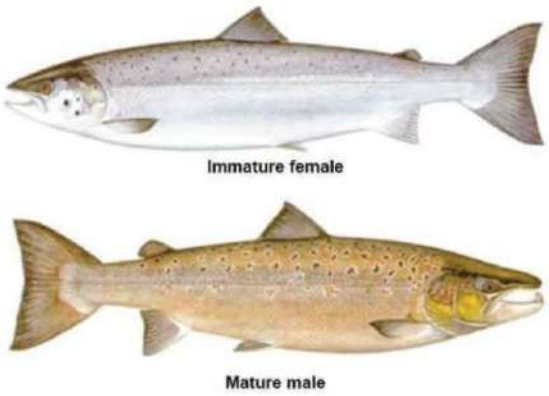

Foto: Alaska native news

Maturation

CHANGES DURING MATURATION

Salmon physiology

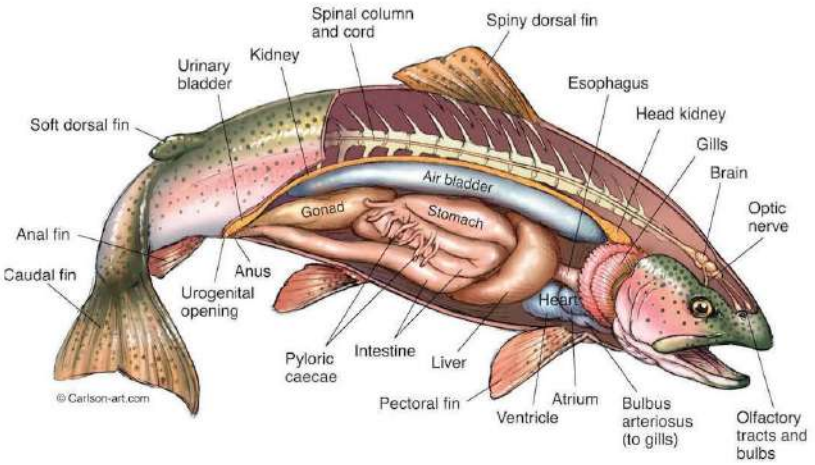

Foto: fairdom.org

Foto: http://bearlyalyssa.blogspot.com

The swim bladder

Creates the ability for the salmon to be weightless in water.

Consists of a gas-filled bladder which changes forms dependent of the dept it is presently in.

Swim bladder of salmon is open which means it has to have access to the surface in order to fill it before going to deeper water.

Salmon can move quickly between different depths without harm.

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Salmon skin

- The skin and scales are the salmon armour against outside threats.
- It protects against physical harm, disease agents and is the most important barrier in controlling the water/salt balance in sea phase.
- It is very adaptable to changes in environment (salinity, temperature, etc).
- If the salmon loses scales and develops wounds:
  - Pain/stress from injury.
  - Challenges in maintaining salt and water balance.
  - Entrypoint for infections.

Foto: Kystlab

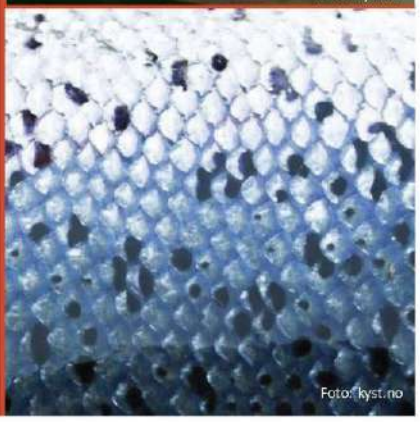

Foto: kyst.no

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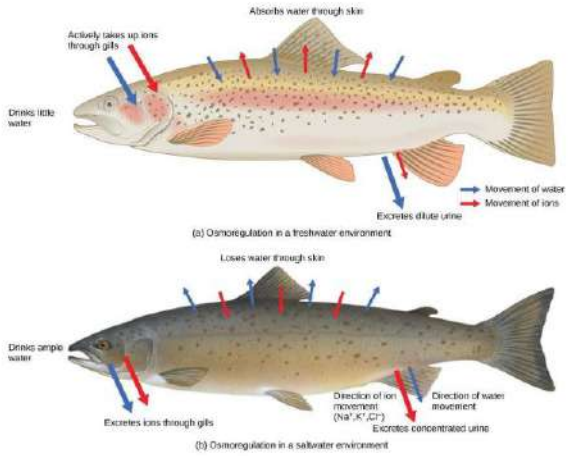

Foto: biology.stackexchange.com

Regulation of water and salt balance

Why do we need osmoregulation?

Video: https://www.youtube.com/watch?v=gXr2y9_e8NA

Gills

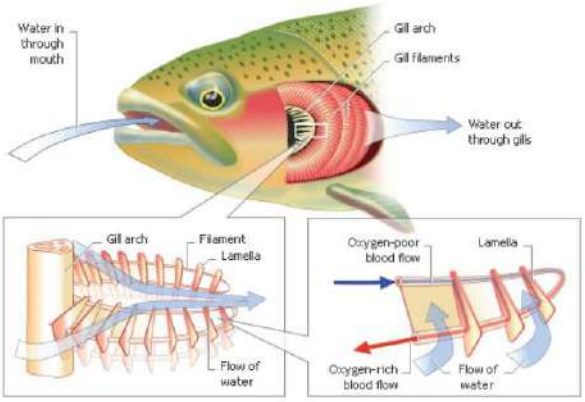

Foto: dadeedee.blogspot.com

Responsible for the salmon's oxygen uptake.

When the water flows over the gills they extract oxygen from the water which passes out of the fish.

The oxygen is absorbed through the capillaries into the blood stream of the fish.

Separates salts and waste products.

Physiological and immunological barrier against harmful microorganisms.

Healthy gills are crucial for the salmon´s health and welfare.

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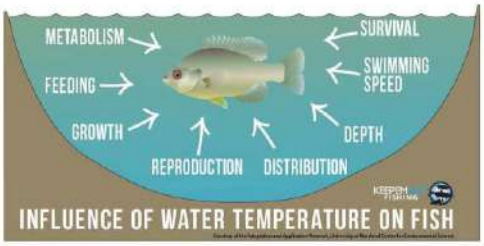
Metabolism



Salmon does not produce any significant heat by themselves and do not have any physical insolation which prevents heat from coming in or out.

Temperature regulates the fish metabolism greatly.

With higher temperatures the metabolism increases:

- Feed intake.
- CO_2 extraction.
- More separation of waste.

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Sensory organs 1

Smell:

- The salmon has a well developed sense of smell. It is believed that the salmon´s ability to find its way back to the native river is greatly dependent on the sense of smell.

Vision:

- One eye on each side of the head gives the salmon a:
  - Wide range of sight.
  - Little overlap.
  - Limited depth vision.

Taste:

- The tastebuds are located:
  - In the epithelium of the mouth.
  - In the pharynx.
  - On the gills.
  - On parts of the body surface.

Sensory organs 2

Hearing and balance:

- Good ability to register vibrations, especially those with low frequency.
- Good hearing of direction.
- Good ability to determine distance.
- Hearing is connected to sensory cells in the inner ear. The swim bladder also serves as connecton in hearing.

Lateral line:

- Registers pressure and current.
- Works as a navigation system.
- The salmons "second ear".

Part 2: Animal welfare and physiological reactions

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What is animal welfare?

A changing term which differs between species, countries and cultures.

Based not only on the health of an animal, but also upon the wellbeing throughout life.

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To think about

"The greatness of a nation and its moral progress can be judged by the way its animals are treated" -Ghandi-

But can it be too much?

Which one of these situations are displaying the most animal welfare?

- The answer is often filled with many nuances.

How to measure animal welfare?

The 5 freedoms:

1. Freedom from hunger, thirst and malnutrition.
2. Freedom from abnormal cold and heat.
3. Freedom from pain, injuries and disease.
4. Freedom from fright and stress.
5. Freedom to exercise normal behaviour.

Welfare needs of salmon 1

(See chapter 2 in the book *Welfare Indicators for farmed Atlantic salmon*)

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Eating and nutrition

- Access to nutritious and healthy food.

Respiration

- Uptake of oxygen and excretion of carbon dioxide through ventilation.

Osmotic balance

- Access to water with right salinity and pH.

Thermic regulation

- Access to the right temperature in order to optimalize metabolism and comfort.

Good water quality

Body maintenance

- The possibility to clean the body, itch and remove parasites.

Source: Stien et.al 2013

Welfare needs of salmon 2

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Hygiene

- Low concentrations of harmful organism (parasites, bacteria and virus).

Safety and protection

- To be able avoid danger and physical harm.

Behaviour control

- Possibility to keep balance and to move freely.

Social contact

Rest

Exploration

Sexual Behaviour

Source: Stien et.al 2013

WI: *All measurements or observations which gives information about how well the welfare needs of the fish is met.*

OWI: Measurements which are conducted through the daily operations are called Operational welfare indicators (OWI).

LWI: Measurements that has to be sent to a laboratory for analysis are called Laboratory based welfare indicators (LWI).

Welfare indicators (WI)

(See chapter 1 in the book *Welfare Indicators for farmed Atlantic salmon*)

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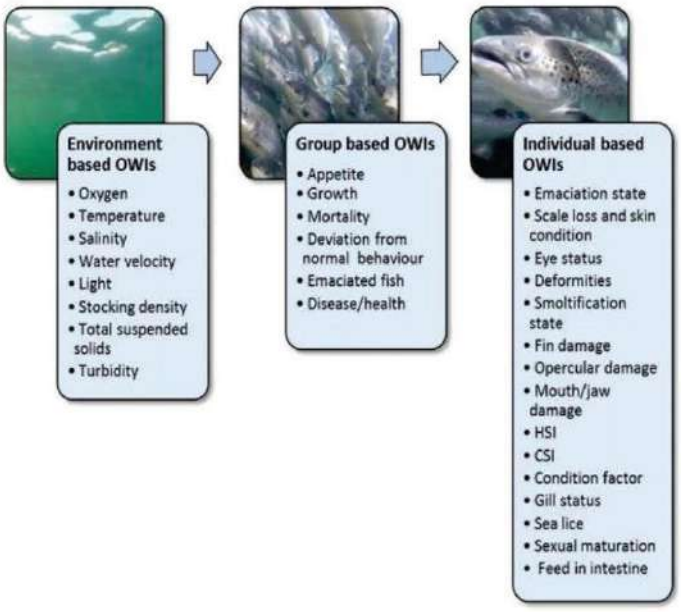
Operational welfare indicators

(See the book part B)

The book *Welfare indicators for farmed Atlantic salmon* describes different welfare indicators for all production forms.

The figure here describes welfare indicators for seacage farming. The book p. 183.



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Rules and regulations

- Althingi Law of animal welfare

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Regulation

of aquatic animal welfare, disease prevention and enforcing legislation in fish farming

1. chapter

1. no.

Purpose, scope and definition

The regulation defines fish farming. Its purpose is to assure good facilities, care, health and welfare of aquatic animals, and prevent and defeat diseases in them. This regulation covers all the opperation in the field.

Icelandic regulations regarding aquaculture species welfare (to be handed out)

Physiological reactions

It is important to take in concideration physio reactions in order to not only understand non epidemic diseases, but also to understand how diseases are able to develop once a fish has been infected.

With environmental changes that might cause stress or pain, a fish might not even be able to fight off the smallest of infections once the immune system is compromised.

Main environmental changes that might cause reactions in fish:

Water quality
Temperature
Stock density

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Physiological reactions 1 - Stress

'It's just something I do every day at 5:00 to get rid of stress before I go home.'

Stress is a natural and important mechanism:

- Fight or flight?
- Activates the muscles and brain.

A physiological response which maintains the equilibrium of the organism and increases survival.

Makes the individual able to perform above ability for a short period of time.

Over time, stress can decrease the individuals ability to grow, reproduce and survive.

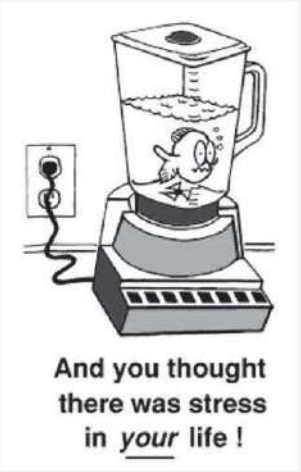
The stress reaction is equal throughout the animal kingdom.

- Do humans tackle stress better than other species?

Stress reaction in 3 phases

1. Primary phase
   - Realease of hormones (adrenalin, noradrenalin and cortisol).
2. Secondary phase
   - The organism tries to adapt to the situation.
3. Tertiary phase
   - Exhaustion, reduction of growth and health.

Stress in fish



Stress leads to changes in:

- Osmoregulation.
- Metabolism.
- Respiration.
- Resistance to disease.

These changes can result in:

- Reduced growth.
- Incomplete smoltification.
- Incomplete maturation.
- Increased susceptibility to disease.
- Increased mortality.
- Deteriorated quality.

Physiological reactions 2 - Pain

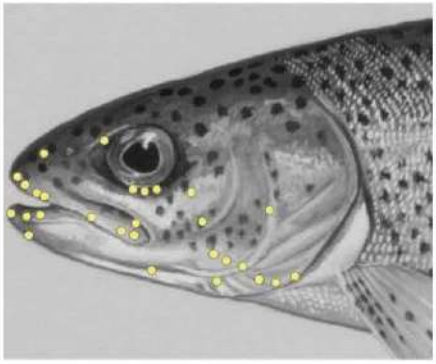
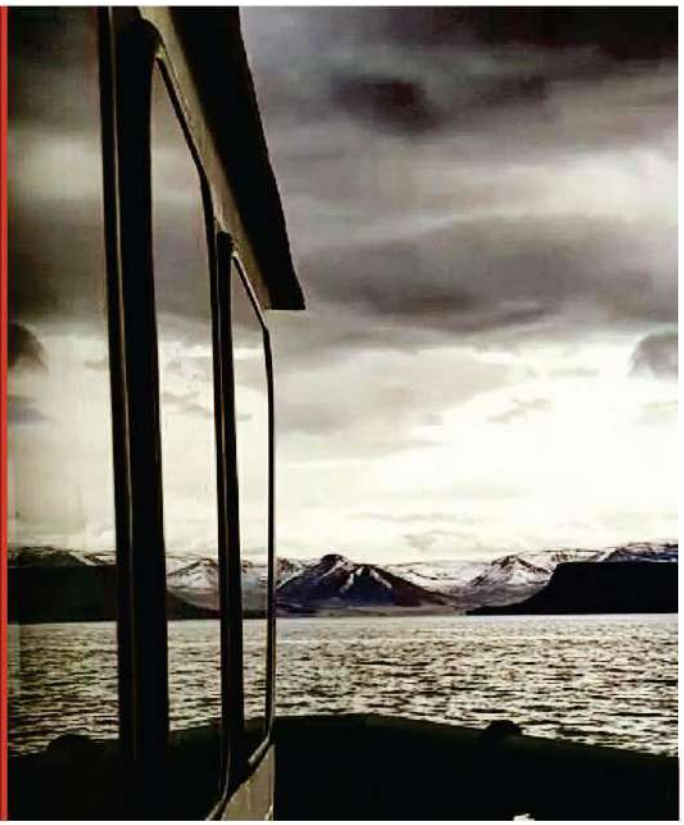


Foto: fishpain.com

Can fish feel pain?

- There is not a 100% probability that fish feel pain.
- Research has been conducted in trout that showed it has 22 pain reseptors around the mouth, that reacts to pain. Though not at the same extent as in humans and mammals.
- Better safe than sorry:
  - One should act as if the fish feels pain during all operations!

Part 3: Diseases



Epidemiology
Some general principles

- Non - infectious diseases.
- Bacterial infections.
- Virus diseases.
- Fungal infections.

Foto: bracketsmackdown.com

What are non infectious diseases?

Take 2 minutes to discuss.

Non-infectious diseases

Ulcer in salmon,

Foto: Åshild Krogdahl, FHF

Nutrition:

- Deficiency diseases, can cause malformations.
- Constipation due to hard pellet.
- Overeating.
- Indigestible vegetabilia (from feed).

Non - infectious diseases

Handling:

- Mechanical damage.
- Skin, eyes, gills.
- Blasted or worn swimming bladder.

Mechanical damage from waterjet removal of sea lice

Foto: Akvakompetanse

Non infectious diseases

Foto: Salmon with HSS from Kystlab

HSS

- Haemorrhagic smolt syndrome.
- Believed to be due to the lack in salt in fish during smoltification.

Videos on HSS behaviour from Marin Helse

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Seawater

Freshwater

Videos:
https://www.youtube.com/watch?v=Hucj8TRDmuY&list=PLK2rZBSF18qVlKIH0A4XIMQpbAVhBR1zw&index=4

https://www.youtube.com/watch?v=o9654fuRKs4&list=PLK2rZBSF18qVlKIH0A4XIMQpbAVhBR1zw&index=1

Injuries from cormorant birds

Foto: Norway Royal Salmon

Non infectious diseases

Predator – injuries

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Non infectious diseases

Malformations:

- Backbone.
- Jaws.
- Heart.
- Septum transversum.
- Organs in the abdominal cavity.
- Structure deformities.

Salmon with siamese twin

Foto: Imr

Salmon with skeletal deformities

Foto: Skretting

Salmon with deformed head

Foto: Fishwell, HIF

Stressed fish due to oversaturation

Foto: Ulf Eriksson, Sintef

Non infectious diseases

Water quality:

- Over saturation, N2.
- Ammonium/ammonia.
- Al, Fe.
- pH.

Medical treatments

Today there are few treatments to diseases that break out in salmon farming. Prevention is the key.

There are however medical treatments to defeat salmon lice infestation.

Committee on Fish Diseases (Fiskisjúkdómanefnd) has to give its approval every single time one wants to use medicines to defeat diseases and parasites.

Medicines that are approved for treating lice infestation:

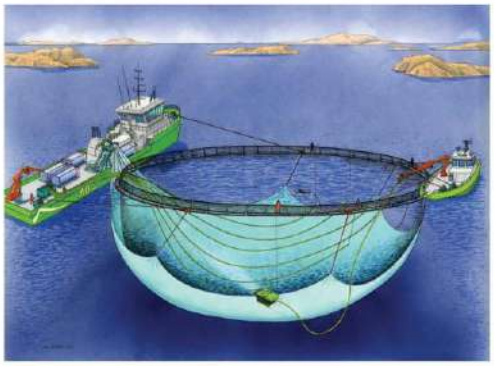


Foto: kyst.no

Alphamax:

- Bath treatment that contains pyretroid which affects the nerve channels of the louse leading it to paralyze and die.
- Does not work optimally at low temperatures under 6 °C , with dirty nets and with high amounts of organic matter in the water. Oxygen level has to be monitored.
- The treatment is done either with the use of wellboat or with tarp that encloses the cage completely.

Preventive drugs

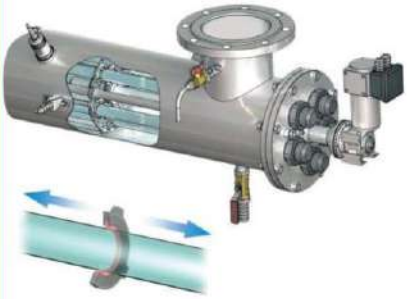
- Any drug that is to be used in Iceland for farmed fish has to be approved by Fisksjúkdómanefnd.
- Today the vaccine used in Iceland is called Alpha Ject 5-3 and contains components against:
  - Furuncolosis (kýlaveiki).
  - Cold water vibriosis (hitraveiki).
  - Vibriosis (víbríuveiki).
  - Winter ulcers (vetrarsár).

Foto: Salmonbusiness

Treatment

Freshwater phase

- Ozone treatment.
- Biofiltration.
- UV treatment.
- Make sure the water quality is optimal at all times.



UV Treatment

Moving bed bioreactor

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Seawater phase

Lice skirts.

Temperature and oxygen measurements.

Camerafeeding to reduce waste.

Dead fish removal.

Fallowing of sites after completed generation.

Cleaning of nets.

Disinfection of equipment going between sites.

Off shore location.

Closed production in sea.

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Preventive technology

Fish farming timeline

60 days 360 days 900 days 901 days

Stöð:
Dagsetning:
Kví númer:

Fiskur númer	Þyngd	Lengd	Roð	Uggar	Tálkn	Lús	Tegund lús	ATH
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Lice counting

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Dauðfiskaskráning
Dagsetning:

Dauðfiskur/kví nr	1	2	3	4	5	6	7	8	9	10
Rotinn										
Horfiskur										
Meðhöndlun										
Afræningjar										
Vansköpun										
Óskilgreint										
Sýnataka										
Vetrarsár										
Sjúkdómar										
Flutningur										
Lús										
Sár										
Annað										
Samtals										

Um meðferð á dauðfiski sjá verklagsreglu 2
Sjá einnig kvittanir fyrir móttöku í skýrslusafni

Dead fish registration

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Routines

Dead fish routines

Dead fish should be removed daily from the sea cage.

Cameras should be used to monitor dead fish in the sea cages.

Dead fish should be wasted in safe and responsible way.

After wasting of the dead fish, all protective chlothes should be cleaned and disinfected.

After wasting of the dead fish, boat and equipment should be sterilized.

In case of a huge amount of dead fish follow the emergency and safety plan of diseases.

Routines

Station procedures

Daily control of cleaning boats.

Weekly control of cleaning work clothes.

The feed barge cleaned regularly as the cleaning plan prescribes.

Do not transfer equipment between stations and facilites without cleaning and sterilising.

When area is in resting, nets should be removed and all equipment cleaned and sterilized.

Routines (from Laxar ehf.)

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Plan of infection prevention – for all concerned

Smolt exposures

The smolt should come from noninfected smolt station. The smolt should be protected against diseases with vaccination (IPN, Furunculosis, PD) and have a health certificate from a veterinarian.

Smolt in the farm should come from the same smolt station.

The employee should watch the delivery of the smolt and document the process of delivery.

The farm boat should be disinfected before delivery of the smolt and the smolt employeer has to deliver cretification that they are not infected.

When the smolt is delivered the employeer should watch and monitor the delivery and make sure there are no health problems.

The fish farm and equipment should be clean when the smolt is delivered.

Routines

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Accessibility and security

Notification of unauthorized access should be visible.

All guests should announce their arrival and wear protective and safety clothing.

All guests have to wash and disinfect their hands.

Register guests arrival to the company.

Disinfect shoes.

Employees should wear clean work clothes that are washed at least weekly.

II. KAFLI
Diseases to be registered
4. gr.

If a veterinarian suspects a disease may be in salmon it should be registered. Also if the veterinarian confirms a suspicion of a disease, he should agree to further investigations and give a report to MAST, (Icelandic Food and Veterinary Authority).

Eldisfiskar: I718	Fiskaberklar	Mycobacteriosis – *Mycobacterium marinum*
I719	Kýlaveikibróðir	Ulcer disease – *Aeromonas salm.* spp. *achromogenes*
I720	Klamydíuveiki	Epitheliocystis – *Chlamydia* spp.
I721	Roðdrep í klaklaxi	Ulcerative dermatic necrosis (UDN)
I722	VEN-veiki	Viral erythrocytic necrosis – *Iridoviridae*
I723	Vetrarsár	Winter ulcers – *Moritella viscosa*
I724	Víbríuveiki	Vibriosis – *Vibrio anguillarum*
I725	Vörtuveiki	Papillomatosis – *Herpesviridae*

Routines

WHAT ROUTINES DO YOU HAVE ON YOUR SITES TO PREVENT DISEASE SPREAD?

2. gr.

Serious notifiable diseases

Eldisfiskar: B413	EHN-veiki	Epizootic haematopoietic necrosis – *Iridoviridae*
B415	Herpesveiki/ OMV-veiki	*Herpesvirus salmonis/H. scophthalmi Oncorhynchus masou* virus disease
B405	IHN-veiki	Infectious haematopoietic necrosis – *Rhabdoviridae*
I701	IPN-veiki	Infectious pancreas necrosis – *Birnaviridae*
I702	ISA-veiki	Infectious salmon anemia – *Orthomyxoviridae*
I703	Roðflyðrusýki	Gyrodactylosis – *Gyrodactylus salaris*
B404	SVC-veiki	Spring viraemia of carp – *Rhabdoviridae*
B401	VHS-veiki	Viral haemorrhagic septicaemia – *Rhabdoviridae*
I704	VNN-veiki	Viral nervous necrosis – *Nodaviridae*

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3. gr.

Other notifiable diseases

Eldisfiskar: I705	Blóðfrumuveirusótt	Erythrocitic inclusion body syndrome (EIBS) – *Togaviridae*
I706	Hindberjaveiki	Proliferative kidney disease (PKD)
I707	Hitraveiki	Cold water vibriosis – *Vibrio salmonicida*
I708	Hvirfilveiki	Whirling disease – *Myxobolus cerebralis*
I709	Kýlaveiki	Furunculosis – *Aeromonas salm.* spp. *salmonicida*
I710	Laxalús/Fiskilús	Salmon louse infection – *Lepeophtheirus salmonis*
Marine louse infection – *Caligus elongatus*		
I711	Nýrnaveiki	Bacterial kidney disease (BKD) – *Renibacterium salmoninarum*
I712	PD-veiki/Brisveiki	Pancreas disease (PD) – *Togaviridae*
I713	Piskirikketsíuveiki	Piscirickettsiosis – *Piscirickettsia salmonis*
I714	Rauðmunnaveiki	Enteric red mouth (ERM) – Yersiniosis – *Yersinia ruckeri*
I715	Spírónúkleusveiki	Systemic spironucleosis – *Spironucleus barkhanus*
I716	Sundmagasótt	Swimbladder nematode of eel – *Anguillicola crassus*

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National regulation on fish farming in Iceland

Regulation

of notification implied diseases

I. chapter

Notifiable diseases

1. no.

If an examination reveals or a veterinarian suspects a notifiable disease or infectious disease, previously unknown in this country, the veterinarian shall immediately notify MAST, (Icelandic Food and Veterinary Authority). Act no. 25/1993 apply on the provisions of an animal diseases and prevention of them. The law also provides necessary precautions in case of suspected infectious disease which is a notifiable disease or if it is detected again.

Prevention

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Knowledge

- To be built over time.
- Fish health course.
- Routines and registrations makes it possible to go back and check if there are changes in fish behaviour.
- Have a plan on how to proceed if there is suspicion of outbreak of disease.
- Know the basics of the national fish health plan.
- Know and use operational welfare Indicators.

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How do we prevent/treat diseases today?

TAKE A COUPLE OF MINUTES TO DISCUSS

Prevention and treatment

Prevention:

Knowledge:
- How does the fish behave when healthy?
- What diseases are out there and how do they affect the fish?

Routines:
- How was the fish yesterday and how is it today?
  - Registration.
- Hygiene/cleaning.

Preventive technology:
- Liceskirts.

Medically:
- Vaccines.

Treatment:

Medically:
- Can we treat this disease?
- If yes, what to treat with?
- If no, do we have to destroy all the fish?

Non medically:
- Delousing.
- Bath treatment with fresh water.

Saprolegnia

Prevention:

- Regular cleaning and removal of dead eggs and other organic matter.
- Sites with a lot of organic matter in the intake water should filtrate it.
- Water treatment with removal of fungi spores.

Treatment:

- Bath treatment with Pyceze.
- Bath treatment with formalin.
- Bath treatment with salt.

Foto: Vetinst

Fungal infections

Saprolegnia

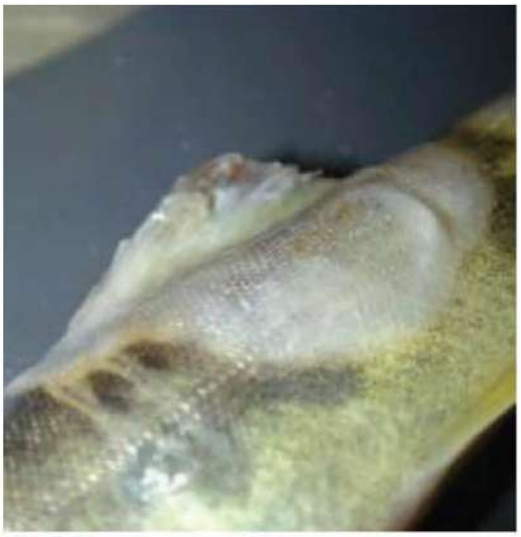


Foto: Kystlab

Fungal infection that kills eggs and fry.

Natural part of the water environment and can be present without causing illness.

Often infects individuals that are weak due to other causes like:

- Handling.
- Injuries.
- Big environmental change.
- High amount of organic matter in the water.

Infects dead eggs and spreads to healthy eggs if not removed.

Can be seen as cottonlike growth on the fish skin and gills.

- Can also affect broodstock during hormonal changes.

The fungi needs dead material in order to produce spores to spread.

Foto: Luseciata

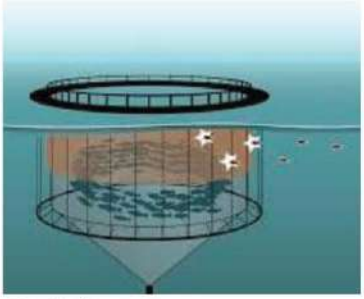


Foto: Sintef

Salmon lice - Lepeophtheirus salmonis

The lice creates wounds on the fish and if badly affected the salmon will have trouble maintaining the osmotic balance and further over time be anemic due to loss of blood.

Fish infested with lice also experience high amounts of stress over time leaving it susceptible to secondary infections.

Treatments:

- Previously medical treatments have been used (through feed and baths), but over time there has been a development of resistancy from the lice in Norway.
- Over the past years there has been much innovation in mechanical removal of lice.
- Cleaner fish.

Sea lice – Caligus elongatus

Foto: Biolib

Ectoparacite that lives on several fish species.

Looks like salmon lice but is smaller and brighter in colour.

Causes the same hardship on the fish as the salmon louse.

Has not had the same focus as the salmon louse, but is monitored through lice counting.

Are less tolerable to freshwater than the salmon louse.

Salmon lice - Lepeophtheirus salmonis

Foto: NINA

Natural ectoparasite found in the northern hemisphere.

Attaches to the salmonids and eats skin, slime and blood.

Often found behind the fins, near the gut and on the head.

The damages the lice inflict on the salmon depends on:

- The size of the fish.
- The number of lice attached.

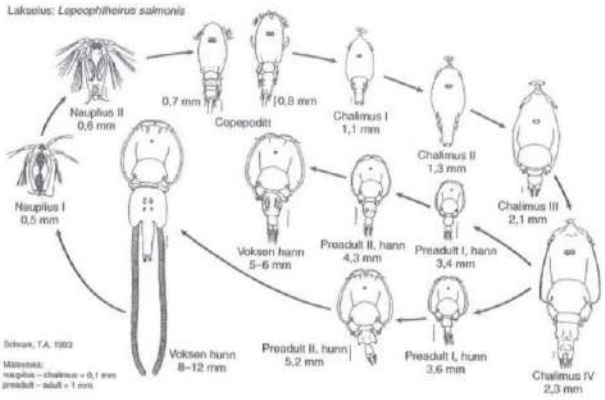
The lice has 8 developmental stages and it sheds its shell between every stage.

All stages are visible to the eyes.

The rate of infection of salmon lice depends upon the temperature in the sea and the stock density in the seacages.

Salmon lice are being closely monitored weekly on all sites and there are defined limits to how much lice one is allowed to have on a site before one has to treat the fish.

The Salmon life cycle



HPR virus – Orthomyxoviridae (ISA-veiki)

Outbreaks may also occur due to mutation. Some of the Norwegian smolts have a virus called HPR0.

Normally it is harmless, but given the right conditions, it can mutate into the HPR virus and cause an outbreak.

Foto: Marin Helse

The mutation is believed to be caused with fish being exposed to stress.

Symptoms:

- Swollen eyes.
- Bleeding in the abdomen.
- Edema in the skin.
- Darkened liver.
- Punctual bleeds.

Treatment:

- None.

Prevention:

- Good hygiene and disinfection going between sites.
- Avoid smolts with HPR0 status.

Parasites

Video from: Marin Helse – Youtube https://www.youtube.com/watch?v=2LyXDnUNCDk

Salmonis Alphavirus Togaviridae (PD-veiki/brisveiki)

Orthomyxoviridae (ISA-veiki)

Foto: Marin Helse

Serious disease that has occurred in most countries with salmon production (not Iceland).

Outbreaks leads to serious economic consequences for the fishfarmers.

In Norway there are about 10 outbreaks every year.

Thrives in temperatures 4-11°C and often breaks out in the spring.

Transferred vertically (in debate) and horizontally.

Affects cells on the inside of the blood vessels and causes bleeds in most of the internal organs leading to the fish losing blood and dying from circulatory failure.

Salmonis Alphavirus togaviridae (PD-veiki/brisveiki)

It´s hard to see particular symptoms of the disease

Foto: Marin Helse

Seawater disease known since the 1970´s.

Transferred horizontally.

Is a well known disease in the south of Norway, but has gradually moved its way north.

Thrives in temperatures 7-18 °C.

Occurs most often during the first year in sea and leads to chronic damage to the pancreas and inhibits the salmon´s production of digestional enzymes leading to loss of appetite and emaciation.

The virus has shown to survive long in the sea, especially if there are organic matter available. Very contagious and big measures are taken in Norway to prevent the disease from spreading further north, especially with wellboats.

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Salmonis Alphavirus Togaviridae PD-veiki/brisveiki

Mynd: Marin Helse

Symptoms:

- Loss of appetite.
- Looser behaviour.
- Fish goes up the surface and does not move.

Treatment:

- None.

Prevention:

- Very hard.
- Wellboats in Norway are to disinfect after moving between sites that are infected and between certain areas.

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Infectious Pancreas Necrosis, Birnaviridae (IPN – veiki)

Foto: Marin Helse

Symptoms:

- Pale liver.
- Spot bleedings in the fatty tissue.
- Increased mortality.
- Looser fish behaviour in smolt recently transferred in seacages.

Treatment:

- None.

Prevention:

- QTL eggs.
- Removal of virus from freshwater sites.

Video from: Marin Helse – Youtube https://www.youtube.com/watch?v=geiC_m9JWSY

Infectious Pancreas Necrosis, Birnaviridae IPN – veiki

Viral diseases

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Infectious Pancreas Necrosis, Birnaviridae (IPN – veiki)

Infects vertically with eggs and horizontally.

Thrives in 8-18 °C.

Outbreaks mostly occur in the summer, 4-6 weeks after smolts enter the sea.

The disease affects in the beginning with major mortality with the high amount of virus present.

Further those individuals who survive will over time die of the injuries that the virus causes, mainly to the pancreas. Over time the fish will lose appetite and die of starvation (can take up to 1 year).

The disease is known to be present in freshwater facilities and lead to several outbreaks over years. The fish would then take the disease with it to the seacages.

Salmon infected with IPN

Healthy Salmon

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Moritella viscosa - Winter ulcers (vetrarsár)

Foto: Marin Helse

The bacteria when affected will keep spreading into the flesh, sometimes so deep that it opens the body cavity of the fish. This will stress the fish extremely and make it hard to keep the osmotic balance to the point where it dies.

Symptoms:

- Big and small rounded wounds with sharp edges.
- Increased change in swimming behaviour in fish with wounds.

Prevention:

- Handle the fish as little as possible during cold temperatures (winter and spring).

Treatment:

- Antibiotics

Moritella Viscosa - Winter ulcers (vetrarsár)

Video from: Marin Helse – Youtube https://www.youtube.com/watch?v=OShArqY5rzM

Yersiniosis – *Yersinia ruckeri* (rauðmunnaveiki)

Video: Marin Helse – Youtube https://www.youtube.com/watch?v=L3Gq698H4Jk

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Moritella viscosa Winter ulcers (vetrarsár)

Foto: Marin Helse

- Described form the first time in Norway and Iceland in the 1980´s.
- Thrives in low temperatures <7 °C.
- Infects horizontally.
- The bacteria is normally found in deep cold waters, when the temperature in the surface decreases in the winter the bacteria comes up from the deep and can attach to salmon especially if the fish has got any injuries from handling, treatment or bad weather.
- It is rare that the bacteria itself causes the wound, but if a salmon has an injury from before the bacteria will infest the wound and make it worse.

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Yersiniosis – Yersinia ruckeri (rauðmunnaveiki)

Foto: Marin Helse AS

Bacteria which is present wherever there is fish farming.

Thrives in temperatures from 7-18 °C.

Is transferred horizontally (via feaces) and somewhat vertically (found in roe and sperm).

Was known to be a freshwater disease but during the past 5 years one has seen more outbreaks of the disease on salmon in sea.

Believed that the bacteria may infect during freshwater phase and breaks out in sea after stressful operations like delousing and transfer with wellboats.

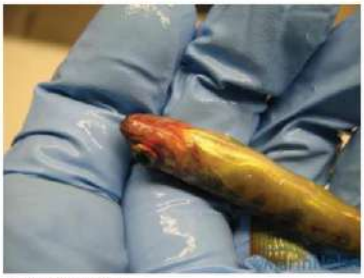


Foto: Marin Helse

Foto: Kevin Ellard

Yersiniosis – *Yersinia ruckeri* (rauðmunnaveiki)

Symptoms:

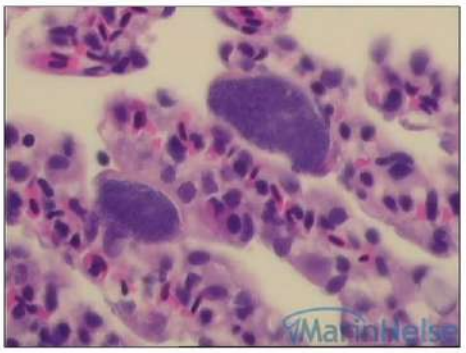
- Swollen eyes (main characteristic).
- Bleeding under the abdomen.
- Massive bleeding in inner organs.
- Increase in odd swimming behaviour and increased mortality.

Preventive measures:

- Vaccine.
- Some fish farmers give the fish a vaccine bath at the size of 3-9 gr before giving the ordinary vaccine at 40 gr.
- Good hygiene at smolt and broodstock facilities to prevent the bacteria from entering the site. When the bacteria has entered a smolt site it is very hard to get rid of.

Treatment when outbreak:

- Antibiotics.



Epitelocystis – Proliferative Gill Inflamation (PGI) (klamydíuveiki)

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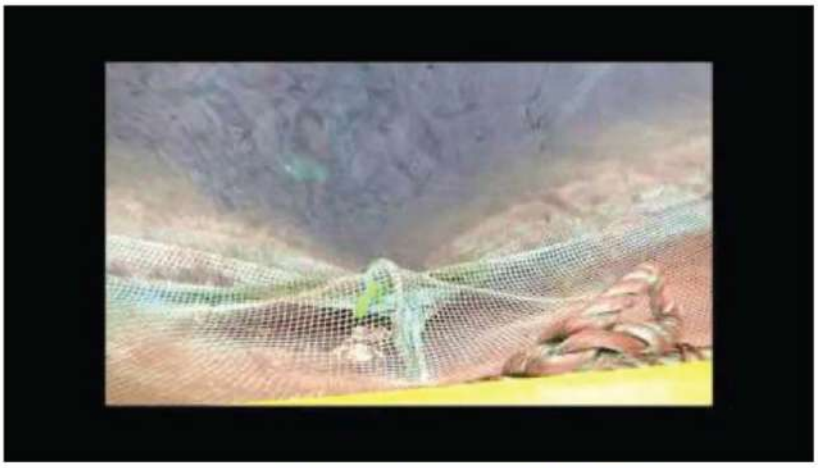
Epitelocystis – Proliferative Gill Inflamation (PGI) (klamydíuveiki)



Video from: Marin Helse – Youtube https://www.youtube.com/watch?v=HamAV2CT-GI

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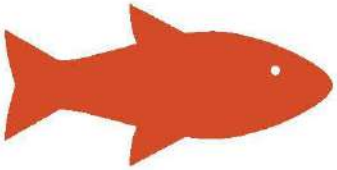
Epitelocystis – Proliferative Gill Inflamation (PGI) (klamydíuveiki)



Gill disease from the bacteria *Branchimonas* which causes big costs to fish farmers in Norway every year, especially in the southwest.

Occurs in sea and fresh water and often breaks out in the summer and fall with warmer temperatures.

Attacks the gills and causes inflammation which makes it hard for the fish to absorb oxygen and maintain salt/water balance.

It is an infection where many other bacterias and possibly viruses interact and colonies of bacteria gets incapsulated into epitelocysts in the gills. The more epitelocysts that form on the gills the more sick the fish gets.

Epitelocystis – Proliferative Gill Inflamation (PGI) (klamydíuveiki)

- Symptoms are:
  - Looser fish that swim in the water column.
  - Dead fish often has pale and slimy gills, open mouth and open gills.
- The disease has caused a lot of mortality in the seawater phase, but is increasingly found in RAS sites. It is thought that it comes in with the intake water and flourishes due to the high amount of bacteria in RAS.
- There are no treatment for it due to the bacteria hiding in cysts in the cells of the fish.
- When found in RAS one has to empty the site completely and clean everything. It is believed that the biofilter are not able to handle this bacteria and therefore one should clean the sites completely. How often this should be done is still to be determined.

Videos of autopsy of salmon infected with Cold water vibriosis - hitraveiki - Vibrio salmonicida

Video from: Marin Helse – Youtube https://www.youtube.com/watch?v=VD5CoGVSaao

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Cold water vibriosis – Vibrio salmonicida (hitraveiki)

- Cold water vibriosis was in the 1980´s one of the biggest disease problems in Norway.
- Today all salmon are vaccinated against the disease.
- If an outbreak were to occur one can treat it with antibiotics.
- The past 15 years there has been just a few outbreaks of the disease every year in Norway and are often seen in the salmon´s last winter in sea due to the vaccine wearing off.

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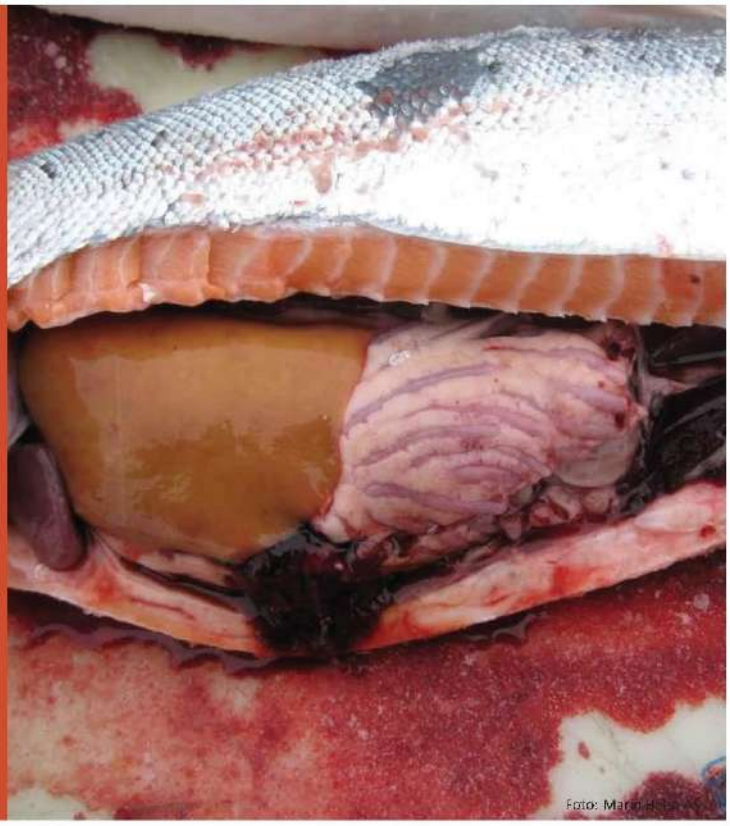

Foto: Marin Helse AS

Furuncolosis - Aeromonas salmonicida

- Attacks salmon at all stages, both fresh and saltwater.
- Outbreaks occurs when water temperature goes over +8 °C degrees.
- The disease is being prevented in Iceland today via vaccines.

Foto: Malviknytt

Cold water vibriosis – Vibrio salmonicida (hitraveiki)

- Bacteria disease which thrives in cold water temperatures < 15 °C. Tends to occur in the winter season.
- Pure saltwater disease which is infected horizontally.
- Outbreaks show low mortality in the beginning but will increase over time and as more fish gets infected. Further symptoms are:
  - Low appetite.
  - Increased amount of looser fish.
  - Pale gills.
  - Bleeding in skin especially in the gut and by the fins.
  - One often finds blood stained fluid in the peritoneum.
  - Bleeds in the swim bladder and fatty tissue.
  - Discoloured liver (grey-brown to yellow).

Bacterial Kidney Disease (BKD)

- In Iceland BKD has occured many times and has had local outbreaks.
- In 2017 all sites in the Westfjords had BKD while only one in the Eastfjords.
- BKD is a problem in Iceland and Chile. In Chile they have tried to develop a vaccine against BKD but with mixed results. The government in Iceland is not allowing the vaccine to be used here.

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Furuncolosis - Aeromonas salmonicida (kýlaveiki)

Course of disease	Symptoms	Autopsy findings
Acute furuncolosis.	Rapidly increased mortality, reduced appetite, darkened color, lethargic fish with increased gill movement.	In very acute outbreaks only dialated bloodvessels and some puncture bleedings. Later bleeding in the swim bladder and internal organs.
Chronic furuncolosis.	Increased mortality, darkened lethargic fish with bleeding in fins, wounds and boils can be visible with looking at the fish in the surface.	Small lesions in the skin, bleeds in the swim bladder, inner organs and muscles, swollen spleen, boils in the muscles with bloody content.

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Bacterial infections

Bacterial Kidney Disease (BKD) (nýrnaveiki)

- Serious chronic disease caused by the bacteria *Renicbacterium salmoninarum.*
- Can be transmitted vertically and horizontally and can have outbreaks both in the sea and freshwater phase of production.
- Fry seem to have little trouble with the disease, but parr and smolts can have high mortality due to bacterial sepsis (blood poisoning) which can lead to grey and swollen organs.
- The disease is often detected shortly after the smolt has gone to the sea with them having abnormal swimming behaviour.
- In sea one can see looser fish where the eyes are swollen and have white «knots» in them. Internally the kidneys will be swollen and with white knots which can also be found in several other organs.

How do diseases spread in Aquaculture?

TAKE A FEW MINUTES TO DISCUSS

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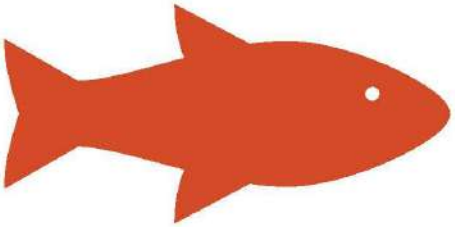
How do diseases spread?



Horizontal Infection:

Direct infection between fish, also called co-habitant infection.

It includes also indirect infection, where a vector is transferring the disease:

- Vectors can be other fish, birds, predators etc.

Vertical infection:

Transferring pathogens between generations

- Eggs.
- Sperm.

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Foto: Ulf Eriksson, Sintef

Non - infectious diseases

Lack of oxygen:

- Suffocation.
- Overcrowding.

Infectious diseases

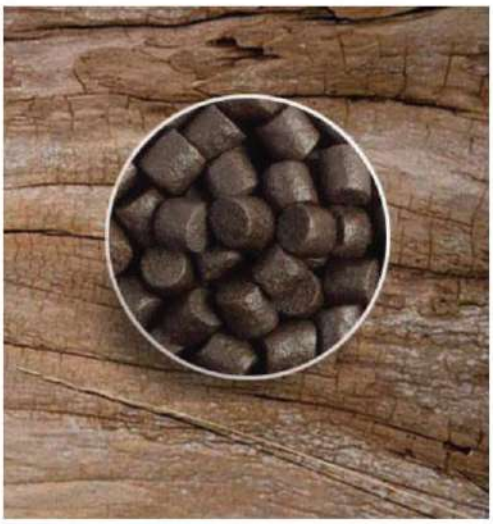

Foto: Skretting

Medicines that are approved for treating lice infestation:

Slice

- Medicinal feed that contains Emamektin Benzoat.
- After digestion the substance will transfer out in the skin layer which the lice will ingest.
- Kills Salmon and Sea lice at all stages of development.
- The feed is given to the fish for 7 days and the effect of the medicine can last up to 6-10 weeks.
- Works at all temperatures, but at cold temperature the effect may be delayed.

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Non-medical treatment of lice

- Due to the increase in resistency in Salmon lice the need for non medical treatments has grown in Norway.
- Biological treatments :
  - Cleaner fish:
    - Lumpfish.
    - Wrasse.
  - Breeding:
    - Can we breed a salmon that can resist lice?
- Technological treatments:
  - Use of fresh water with different technologies.
  - Laser.
  - Termic treatment.
  - Ultrasound.

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Summary

Focus on fish welfare is crucial to the production of healthy fish leading to prime quality product.

Today there are few diseases that are present in Iceland, but the few that are, have caused big losses of fish (ref BKD).

Routines, knowledge and technology are key factors to keeping diseases in check and preventing new diseases from breaking out.