

Tema for bachelor- og masteroppgaver innen akvakultur:

Produksjonsbiologi, ernæring/ fettforskning, avl og genetikk, fôrteknologi, produktkvalitet

Suggestions for bachelor- and masters projects in aquaculture:

Production biology, nutrition/ lipid research, breeding and genetics, feed technology, product quality

1. Nofima Aquaculture and Breeding and genetics group

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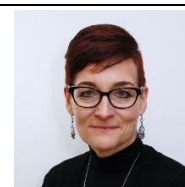
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Master thesis subjects:

Contact person Prof. Bjarne Gjerde

- Genotype by environment interaction for early sexual maturity in rainbow trout.
- Genetic correlation between body weights recorded at five different ages; data from both Atlantic salmon and rainbow trout.
- Genetic variation in early life history traits (egg size, survival) in Atlantic salmon and rainbow trout.
- Dissemination strategies for genetic gain in aquaculture selective breeding programs
- A comparison of genetic gain when applying individual (own performance) and combined (own + sib performance) selection for several traits.
- The use of NIR-spectroscopy to measure fat related traits for breeding in seabass and seabream (Anna Sonesson, N-K Afseth)
- Realization of Optimal Contribution Selection in a practical cod breeding program (Anne Kettunen)
- Genetic variation for optimal body composition in Atlantic Cod (Anne Kettunen, Garret Gifford)

Contact person Prof Ingrid Olesen

Genetics and breeding:

- Prospects for **farming and possibly genetic improvement of (new) low trophic aquaculture species** for the future circular bioeconomy. Literature studies of relevant production systems and technologies, profitability, feasibility and market etc of selected species or species groups (e.g. algae, tunicates, molluscs etc) according to the interests of

the students. Interviews and surveys may also be carried out when relevant stakeholders can be identified as respondents. Pilot experiments may also be considered for addressing certain research questions.

Ethical, legal and social aspects of aquaculture and aquatic genetic resources:

- **Non-market valuation of ecosystem services from aquaculture systems.** This may be farming systems using macro algae and filter feeders (e.g. mussels) mitigating eutrophication of water bodies such as fjords receiving nutrients from effluents and (or) binding carbon to reduce climate changes. (Co-supervision by Prof. Ståle Navrud, School of Economics and business, NMBU)
- **Willingness to pay (WTP) for organic salmon** – correspondence between hypothetical and real choice experiment (Organic aquaculture).
Consumers often state that they are willing to pay extra for products with attributes reflecting common and ethical goods such as fish welfare or environmental services. However, these responses may not be in correspondence with the consumers' actual buying behavior. Data from an experimental market with both stated (hypothetical) and real choice shopping scenarios are available for studying the level of correspondence between WTP for organic salmon fillet in these types of experiments. The results will be valuable for future calibration of similar or related stated consumer responses (Cooperation with School of Economics and Business, NMBU).
- **Norwegian citizen's attitudes to gene edited salmon** to reduce risk of developing cardiac disease in farm salmon. How do Norwegian citizens and other relevant stakeholders relate to the current Gene Technology Act and proposed changes from The Norwegian Biotechnology Advisory Board? Another issue of interest may be the scope for patenting genetic resources by applying gene editing in salmon breeding programs, and the potential implications for access and benefit sharing. This may be one or two thesis that make parts of the research project, CMSEdit (Gene editing for elucidating gene function and refining genomic selection for CMS resistance in Atlantic salmon), funded by the Research Council of Norway. The master student(s) will become integrated members of the highly interdisciplinary project group. (Cosupervision by Anne H. Kettunen)
- **Case studies of corporations involved in the Norwegian breeding programs on how their breeding strategies are affected by different policy instruments for regulating salmon lice** challenges, including the current traffic light system, and how their incentive structure spurs competition or cooperation among fish farmers. The thesis will compare the strategy preferences of different breeding organizations. The study includes assessment of genetic gain vs. investments when including salmon lice resistance in the breeding program (e.g. testing, decreased gain in other traits, exclusion of other possible traits) and collecting experiences from aquaculture industry of use of the genetically improved material (e.g., reduced number of parasite treatments). (Cosupervision by Dr. Anne H. Kettunen)
- **Innovation strategies for small and medium enterprises in Norway versus bigger multi-national corporates** to meet the challenges of climate changes and environmental impacts from aquaculture and seafood production. Studies of documents of different enterprises together with interviews of their key officers in sustainability, research and innovation. Student will be an integrated member of a highly interdisciplinary research group in Nofima covering both green and blue sectors. (Cosupervision by Dr. Antje Gønera).

Contact person Anne Kettunen

2. Nofima, Production biology group

Contact



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Contact person Prof. Øivind Andersen

Master thesis suggestion

Undersøkelser av muskel-hormonet irisin hos laks

Irisin er et nylig oppdaget hormon som øker i muskulaturen ved trening hos mennesker og som regulerer hjertefunksjonen hos sebrafisk. Irisin har tidligere ikke vært undersøkt hos laks, hvor dette hormonet kan ha betydning for velferden til oppdrettslaks.

Masteroppgaven vil bestå av *in vitro* studier av irisin i stimulerte hjerteceller hos laks og undersøkelser av irisin i laksehjerter etter svømmetrening. Oppgaven vil involvere flere forskere ved Nofima med Øivind Andersen som hovedveileder.

Studies of the muscular hormone irisin in salmon.

Irisin has recently been shown to increase in muscle during exercise in humans, and this hormone regulates the heart function of zebrafish. Irisin has not previously been studied in salmon. The master thesis will consist of *in vitro* studies of irisin in salmon muscle cells and molecular studies of irisin in salmon from feeding trials and exercise studies. The thesis will involve several researchers from Nofima with Øivind Andersen as the main supervisor.

3. Nofima, Nutrition group

The group has more than 25 years worked with different aspects of lipid nutrition in fish. Responses to and tolerance for oilseed products and Ω -3 fatty acid requirement has been an area of interest. A main focus of our research is related to the influence of dietary lipids on fish health and interactions between nutrition, metabolic consequences, and genetics. The lipid research group consists for the moment of two Post docs, 2 senior scientists, 1 engineer and 1 master student securing a good teaching environment for the master candidates.

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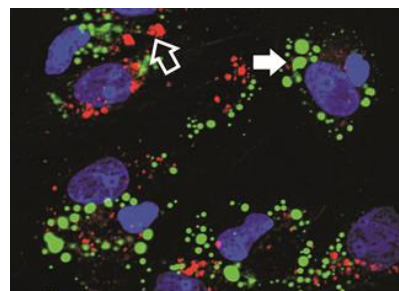
Suggested master thesis subjects

a) Use of cell model systems to study nutrition

The master student will in collaboration with our research team investigate the biological understanding of responses to dietary lipids and interactions with other nutrients.

Methods:

- *In vitro* cell culture (adipocytes, muscle cells, immune cells, bone cells heart cells, stem cells, liver cells)
- Gene expression
- Lipid and fatty acid analysis
- Microscopy



b) Take part in fish feeding trial

Lipids are important components of cells and organs of the salmon body. Changes in fatty acid composition of salmon diets may impact the health and robustness of salmon.



The master student will use samples from feeding trials to investigate physiological effects, growth, feed utilization, digestibility.

Methods:

- Gene expression
- Lipid and fatty acid analysis
- Microscopy

4. Nofima, Department Fish Health

Several possibilities for bachelor or master thesis in Digital pathology.

Description: At Nofima, in the department for Fish Health, we are working with the development of digital pathology for better, un-biased evaluation of tissue biopsies from farmed Atlantic salmon (*Salmo salar*). We have recently invested in a state-of-the-art slide scanner for spatial evaluation of whole tissue sections. For qualitative and quantitative evaluation, tissue specific scoring systems developed in-house that measures changes in key anatomical features and rates the status through a characteristic-based 5-point scale are currently used to evaluate heart and gill micro-architecture. In addition to the scanner, we have invested in a deep learning artificial intelligence (AI) image analysis software (Aiforia, <https://www.aiforia.com/>). So far we have developed an algorithm for digital pathological evaluation of salmon skin. Now we want to develop similar systems for heart and gills.

Department Fish Health: This department has 6 researchers, 1 postdoc and 1 master student at Ås, and we offer a friendly environment with vast knowledge and experience in salmon health and welfare and within the offered assignment.

Contact persons and Co-supervisors: Dr. Elisabeth Ytteborg and Dr. Lene Sveen

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Master thesis subjects

Task: We have heart and gill samples from Atlantic salmon (fig. 1) and would like to develop Aiforia algorithms for these two organs. We have heart and gills from wild, hybride and farmed salmon and want to explore the differences between these different strains further using digital histopathology. Previous studies have shown that the heart shape off farmed salmon is more elongated and less heart-shaped compared to hearts from wild salmon. However, more details in the different strains should be further examined.

Wanted: We need a person (or two) to learn the Aiforia program the different cell types and features of gills and/or heart. We already have histological samples, so a person with skills in R or an eager to learn this system, is preferred. However, interest or skills within histopathology is also highly wanted. If the person wants to learn more histology, different other methods within this field may be added to the task, e.g. staining techniques and microscopy.

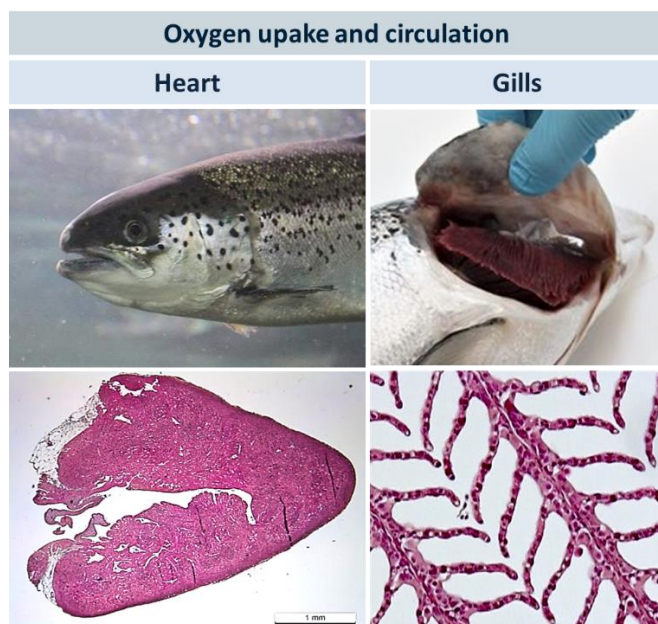


Figure: Heart and gills are important for oxygen uptake and circulation in salmon. Details in structure can be detected through histological evaluation and reveal changes that might influence the health and welfare of the animal. We therefore wish to develop digital programs for histopathological scoring of these two organs.