ANNUAL REPORT, FIRST REPORTING PERIOD, 2014

Development of NOvel, high-quality MArine aquaCULTURE in Sweden - with focus on environmental and economic sustainability

NOMACULTURE

MISTRA

formas

Forskningsrådet Formas

Formas främjar framstående forskning för hållbar utveckling

CONTENT

Development of NOvel, high-quality MArine aquaCULTURE in Sweden - with focus on environmental and economic sustainability

NOMACULTURE

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SECTION 1

1.1. OVERVIEW OF THE FIRST YEAR BY THE PROJECT LEADER

The NOMACULTURE project started out by organizing an initial "think tank" discussion, constituting the entire consortium, at June 16. During this meeting the draft outline of the project was made and overall milestones and deliverables suggested.

The actual start date of the project was September 1st, 2014 and a full day kick-off meeting, including the whole consortium was held at September 23. During the kick off meeting the consortium was organized and timelines and the detailed work plan for the first year, as well as more long termed planning of the main goals of NOMACULTURE were decided on.

All tasks have started as planned and several important achievements have been reached during the first year of the project. These includes appointment of the first PhD student, association of Master students, appointment of research and animal technicians, build-up of RAS for lobster and wolf fish, mind mapping and decisions on technical approaches for protein extraction, blue mussel meal production, modifications of dynamic RAS modelling software and the birth of our first baby lobsters. Within the management and dissemination the NOMACULTURE project has attracted an enormous interest from media, authorities, the region as well as the public and internally, the consortium agreement has been agreed upon and finalized. As project leader for this innovative and ambitious project I can only conclude that the first year has been very successful and followed the timeline well as planned.

1.2 THE WORK FROM AN END-USER PERSPECTIVE

The Swedish unexplored marine aquaculture provides unique possibilities to develop a truly sustainable food-producing industry taking environmental, societal, cultural and economic issues into account already from the beginning - this approach is implemented in NOMACULTURE. Active participation and continuous communication with public and private stakeholders to create a trans-disciplinary consortium are key factors to realize NOMACULTUREs long term goals: to promote marine aquaculture by creating a business model for a spin-off feed company and setting up small scale pilot farms for the two target species; spotted wolf fish and European lobster. NOMACULTURE has from the very beginning attracted a great interest from various stakeholders in the society. This is partly because wolf fish and lobster are well-known and highly demanded seafood species surrounded with a positive image. Already during the first year, NOMACULTURE has been approached by several entrepreneurs and aquaculture companies who wish to start with farming of marine species. These contacts have been channeled via Aquaculture Centre West (ACW), which is the major platform used by NOMACULTURE for external contacts and stakeholder communication. The large societal interest has been manifested through numerous media contacts and newspaper publications (see 2.3). To communicate about the opportunities which marine aquaculture may bring to society, NOMACULTURE has participated in various seminars and public events (see 2.3). During these stakeholder contacts, we have sensed that

there are hopes and expectations from local communities that marine aquaculture in the near future will be an industry creating jobs in coastal communities.

1.3 PROJECT GOALS

The overall objective of NOMACULTURE is to address the challenges of developing ethically, environmentally and economically sustainable multi-trophic, integrated aqua farming systems and new alternative feeds. The long term goal is to establish a marine aquaculture as a truly sustainable food production sector in Sweden. The Swedish west coast communities suffer from decreased employment in the fisheries-based food production sector, while having unique experience and competence in handling seafood. In addition, Sweden has a long coastline offering significant possibilities for development of marine aquaculture. NOMACULTURE therefore aims at developing an economically sustainable industry which complements the fisheries industry and utilizes the know-how of the local communities. Together with current oyster and mussel production, lobster and wolffish aquaculture could enhance local and national food tourism strategies and develop an industry that converges with the local culture.

The first NOMACULTURE strategy is to focus on **aquaculture species** for limited-volume, high market value production, thus minimizing feed use, environmental impact and physical size of the infrastructures. A feasibility study on culture biology of marine fish published by ACW, concludes that the **spotted wolf fish** is one of the most promising species for Swedish culture conditions. Therefore this fish species is chosen together with the **European lobster**, as shellfish representative. Both species are well-known **high-end products** on the domestic market and while new to aquaculture, important research information on their aquaculture biology is available and indicates large potential for aquaculture development.

To meet the challenges of minimizing the local environmental impact of animal production, **semi-closed, multi-trophic recirculation aquaculture systems (IMTA-RAS)** will be developed. The strategy of establishing full environmental sustainability of the production will be met by developing **novel feeds using blue mussels and fish/crustacean by-products** as significant marine feed ingredients. **Life Cycle Assessment (LCA)** will visualize potential trade-offs between local and global environmental impacts and enable optimization of farming systems and alternative feeds.

Results from market analyses and business plans will be used to discuss production possibilities for future entrepreneurs. The economic viability of the production strategy also includes **rigorous quality control** allowing for **marketing strategies** indicating local and sustainable production and top-quality, also opening for environmental certification of the products.

1.4 WORK PROGRESS AND ACHIEVEMENTS DURING YEAR 1

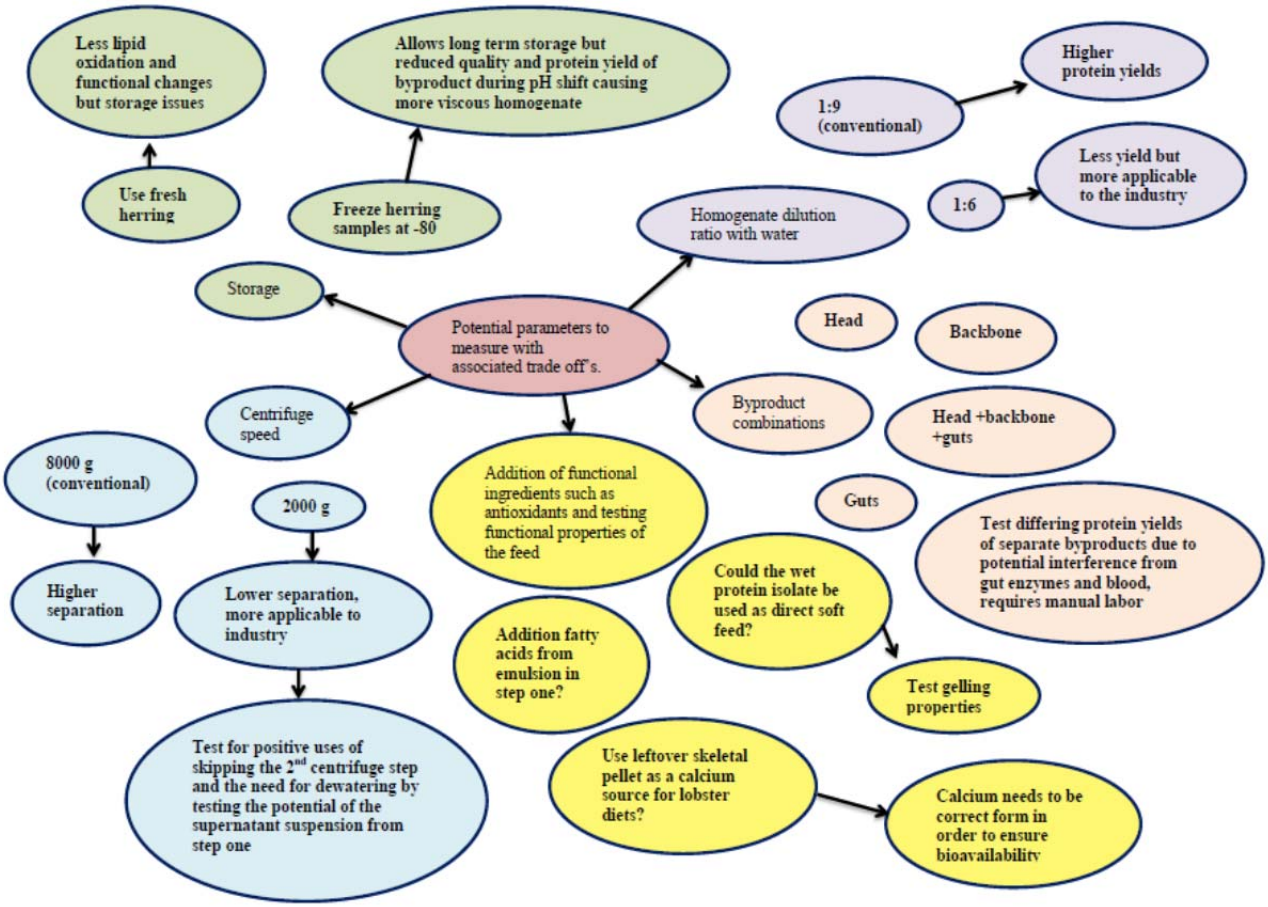
Task 1. Sustainable, formulated feed production

Aims: To develop high quality feed for marine larvae and juveniles based on blue mussels and fish/crustacean by-products as raw material.
Scientist in charge: Ingrid Undeland

Description of work:
An initial meeting has been held at Chalmers with the purpose to discuss the most viable design parameters, and the parameters to measure (responses) for the upcoming experiment for the formulated feed experiment for task one of Nomaculture.

The pH shift process:

The pH shift process has many potential trade-offs related for example to pre-storage of the raw material (e.g. frozen vs fresh), the volumes of water used in the process, the centrifugal forces used in separation, and the exact pH used for solubilization and precipitation; e.g. protein yield, lipid removal, functionality etc. of the final product; Therefore it is important to consider all pros and cons associated with the different process options in order to determine the most viable way forward for the project. It is also important to decide the scale to work in, which in turn is decided by the amount of feed needed for a complete test on lobster larvae, and also on whether the produced protein isolates will be tested as such, or will be mixed with other ingredients. Options that were discussed are summarized by the attached mind map below. Other issues which were raised during the meeting was the need for a stainless steel industrially powered food grinder, a vacuum packing equipment, a large rotor (taking 500 mL bottles) and a new probe for the pH-meter due to the high demand for the equipment at Chalmers. The new PhD-student James Hinchcliffe will assist Ingrid in searching for the aforementioned equipment. Contacts have also been taken with Paul Mattsson AB in Ellös (http://www.paulmattssonab.se/) where herring by-products will be obtained for the feed production. A first collection of raw material will be taking place March 31st, and lab work will be initiated the day after.



Blue mussel meal production:
Blue mussel meal has been successfully produced for production of wolf fish and lobster feed to be used in the initial feeding trials. The project collaborator, Dr. Odd Lindahl (Musselfeed AB) has produced 150 kg blue mussel meal for delivery to the project mid April. The mussel meal have been sifted with a small size mesh to produce a fine mussel meal suitable for feed production to both juveniles and adults.

Task 2. Production optimization for spotted wolffish and European lobster: Growth potential and welfare

Wolffish

Aims: To establish a knowledge-base for optimal growth, improved feed conversion efficiency, and welfare of spotted wolffish in aquaculture.
Scientist in charge: Elisabeth Jönsson Bergman

Description of work:
During the first project period, this task has focused on necessary preparations to be able to receive and keep wolf fish at the department of Biology and Environmental Science (BioEnv). We have applied for and obtained the necessary permits from Swedish Board of Agriculture; 1) ethical permit for the described animal experiments in the project, and 2) import permits for egg, larvae and juveniles from Norway. We have also established contact with Ingemar Granquist, fisherman and skipper at M/S Mira, Fjällbacka. Ingemar Granquist, have searched for and received permit to keep alive common wolf fish that is taken as by-catch, in a form of on-growth aqcuaculture using semi-RAS. Ingemar Granquist, now has a number of specimens that we will transport to our RAS facilities at BIOENV in mid-April 2015. A main part of the work in this sub-Task has been devoted to rebuilding of aquaria systems to be able to keep wolf fish in replicates in tanks which are optimized for this species. We have also devoted time to designing and setting up smaller raceways for eggs and larvae. This work will continue during spring 2015 so that we can run experiments when the first feed has been produced.

Personnel:
Elisabeth Jönsson Bergman (PI) Kristina Snuttan Sundell, Thrandur Björnsson and Henrik Sundh have planned and started to build the RAS for housing wild caught common wolf fish. James Hinchcliffe have been appointed PhD student with main research focus on feed development and growth physiology of both wolf fish and lobster. James have started with the design and building of the wolf fish tanks. The wolf fish group are in contact with Akvaplan-Niva in Tromsö to plan a study trip to look at both research and commercial farming of the spotted wolf fish.

Lobster

Aims: To establish a knowledge-base for optimal growth, feed conversion efficiency and welfare of European lobster in aquaculture.).
Scientist in charge: Susanne Eriksson

Description of work:
Basic **equipment** (1 Aquahive and 10 white incubators) were purchased and is now being set-up in the Culture house at Kristienberg Marine Station (Fig.1a). The first berried lobsters were brought to the station in December 2014 and kept at 12°C (n=2) and 18°C (n=1) (Fig1b). The lobster in 18°C started hatching in January and a **first pilot experiment** was set up in one of

the thermoconstant (TC) rooms at 18°C using black incubators (for fish). Black incubators are not optimal for survival of lobsters but the white incubators had not arrived at this time. The Zoea larvae were fed sterile Copepod paste throughout development (3 Zoeal stages over a 2 week-period) and 33 of the larvae successfully metamorphosed into post larvae (stage 4, Fig.1c). These were moved into individual cups and separated into two treatments. One group (n=16) was given pellets manufactured for Nephrops larvae (including mussel- and krill meal) and the other group (n=17) was given the same formulated feed but with an addition of **probiotica, Sanolife**. The lobsters are now weighed, photographed and measured regularly and the aim is to look at survival, growth, immune competence, colour and if possible also uptake of nutrients across the intestine at termination (using a micro-Ussing chamber set up, UCC-Labs AB). Discussions have started with Torsten Wik on how to create a semi-RAS system in the culture facility.

Fig 1 (a) Setting up the Aquahive for keeping post larval lobsters, incubators are viewed in the background (b) berried Homarus gammarus (c) Postlarvae (stage 4) Homarus gammarus.

Personnel:

Susanne Eriksson (PI) and the two part-time technicians Linda Svanberg and Eric Bergwall are preparing the lobster work for the upcoming season. One Master student will start in May 2015 and look at optimal salinity levels for the lobster larvae from the Skagerrak population. A 2-year post-doc will be hired shortly. Collaborators from Plymouth University and Swansea University will join the team in the summer time and will be looking at tolerance differences between broods and bacterial growth in the culture system.

Task 3. Production systems limiting the environmental impact

Aims: To optimize land-based, multitrophic recirculating aquaculture system (RAS) for wolffish and lobster, minimizing resource use and environmental impact, and to develop a general, robust and flexible simulator for aquaculture systems.

Scientist in charge: Torsten Wik.

Description of work:
As stated in the application the approach to find an optimal RAS design is to use simulation as a tool, since an open search experimental approach alone would be too complex and time consuming to obtain conclusive results from. As a first step an existing dynamic RAS simulator (Wik et al., 2009), which combines the state-of-the-art in wastewater treatment modeling with established models of fish growth, evacuation and respiration, needs to be further developed.

During the fall and winter of the first year, a couple of necessary modifications have been implemented:

- In the original version of the simulator the nitrification was not really split into two separate steps, i.e. from ammonium to nitrite and then from nitrite to nitrate, because this separation has not been considered necessary for activated sludge systems, which is where the model equations originates from. Instead, a very simplified calculation of the nitrite levels based on biofilm equilibrium between the two steps has been used. Since nitrite is toxic to most fish, and nitrite levels in RAS are known to sometimes reach harmful levels, this separation is important to consider.
  The simulator has therefore been extended with one additional solid phase (nitrite oxidizing bacteria (NOB) in addition to ammonium oxidizing bacteria (AOB)), one additional dissolved state (nitrite) and modifications of the corresponding processes.

- The simulator is implemented as a two consecutive steps. The first step is a determination of how much waste that is produced in the fish tanks by the fish and the feeding over time. The second step is a simulation where this waste is the input to a simulation of the entire recirculation system, including all the microbiological degradation and mechanical treatment of the water.
  In the original simulator, the first step was based on a specific way to design the RAS. Based on initial number and body weight of fingerlings, optimal growth (according to TGC), maximum fish density, and the grading time, the feed conversion ratio was used to determine the feeding. Using a so-called waste matrix the produced waste could then be calculated. This is one way of making parts of an optimized situation, but it is too rigid to use for simulating existing plants, for example. The simulator has therefore been updated with alternative operation, where feeding, the number of tanks and the fish density are free variables.

- The simulator has also been extended to model also degassing units, such as trickling filters.

With the above extensions it has become evident that numerical problems hindering simulations are too severe to not be addressed. In a next step it will therefore be needed to investigate a change of program environment (Matlab/Simulink) and model simplifications for units with very short hydraulic retention times (such as trickling filters).

When the numerical problems have been resolved the development will continue to incorporate energy balances, additional fish growth models and models of more types of treatment units. After that, parameters determined experimentally in Task 2 for wolfish and lobster will be transferred to the models to enable RAS simulations to be compared with

experimentally measured concentrations, and finally a study of how to determine an optimal design for these species.

Personnel:
Torsten Wik (PI) have had the main responsibility for the development of the described modifications made to the dynamic RAS simulator. During fall and winter it was planned that a PhD student should start, but unfortunately the intended direct recruitment had to be abandoned and we are now in an external recruitment that should be finished before summer.

Reference: Wik, T., Linden, B. and Wramner, P. (2009). Integrated Dynamic Aquaculture and Wastewater Treatment Modelling for Recirculating Aquaculture Systems, *Aquaculture* 287: 361-370.

Task 4. End-product quality of wolffish and lobster
Aims: To unravel how nutritional and sensory properties of wolf fish and lobster are affected by novel feed ingredients, feeding regimes and culturing temperature.
Scientist in charge: Ingrid Undeland

Description of work:
This task has not started yet.

Task 5. Sustainability assessments: Social, economic and environmental perspectives
Aims: To understand the welfare contribution to the local society by estimating the social, cultural and economic impacts of fish production in monetary units as well as by life cycle assessment (LCA) for environmental aspects.
Scientists in charge: Friedrike Ziegler (LCA) and John Ambrecht (socioeconomics)

Description of work:
The work related to assessment of environmental sustainability using LCA was initiated immediately upon project start by undertaking a literature study of published as well as non-published LCA studies of aquaculture production systems. A thorough review of the literature was performed and summarized in the form of a report, which was finalized during fall 2014. The review provided an overview over the diverse production methods used in aquaculture globally and their performance in terms of energy efficiency. It demonstrated two important factors to be studied in the LCA part of Nomaculture once the production is ongoing: feed (composition and amount required) and grow-out technology, both crucial in determining the environmental efficiency of re-circulating aquaculture systems. We have also started to prepare the LCA modelling by studying the literature on farming technologies in use for wolf-fish and lobster and of course participated at project meetings.
Personnel:
The in-kind contribution of SP Food and Bioscience during 2014 has been in the form of the additional time needed to undertake the literature study and to write a proposal for a Postdoc to be engaged in the project starting 2016. The work addressing the socioeconomic aspects of this task will start in 2016.

Task 6. Test farms for wolf fish and lobster
Aims: To create an arena for research and innovation, training and cooperation between the NOMACULTURE researchers and entrepreneurs.
Scientists in charge: Susanne Lindegarth and Kristina Sundell

Description of work:
This task has not started.

Task 7. Training activities and dissemination

Aims: To promote the unique possibilities for marine aquaculture on the Swedish west coast.
Scientists in charge: Susanne Lindegarth and Kristina Sundell

Description of work:

NOMACULTURE will raise the competence and increase the interest for marine aquaculture through a number of tailor-made training courses and workshops. The training courses within task 7 is planned to commence during Year 2 with a workshop about **Sustainable feed and nutritional quality of farmed fish.** This workshop aims to lift the general competence among authorities and industry about sustainable feed sources, alternative feed ingredients, technologies for feed production, how feed impacts the nutritional quality and discuss health and welfare issues for farmed fish. Two training courses - **Culture systems for spotted wolfish** and **Culture systems for European lobster** - will be held during year 3 or 4 at the test farms for wolf fish and lobster and will include practical training, advice and recommendations on how to set up sustainable aquaculture of spotted wolfish. During year 4, a workshop about **Recirculating Aquaculture Systems – RAS** will be carried out to lift the general competence among researchers and industry about RAS. The workshop will comprise lectures and modelling practises on RAS and Integrated Multi-trophic Aquaculture (IMTA) with blue mussels. As a part of the workshop, the freeware simulator (Task 6) will be demonstrated and distributed. Finally, NOMACULTURE will carry out a workshop about **Life Cycle Assessment, LCA**, which will be a combination of a series of lectures on the concept of LCA as well as example exercises based on the culture systems for the case species.

Dissemination to the public sector aims to make scientific research on marine aquaculture and aquafeed production accessible, interesting and connect it to the scientific and societal goals of NOMACULTURE. Media contacts, publishing on the internet and participation in seminars and public events are major tools used by NOMACULTURE for external contacts and stakeholder communication. This is carried out in many instances through the existing networks, web-site and activities established within Aquaculture Centre West (ACW) at the University of Gothenburg and the progress of NOMACULTURE is published on the web-page of ASW (www.vbcv.science.gu.se).
NOMACULTURE has participated in several seminars and public events during Year 1 (see also 2.3. dissemination). Later during the project, communication to stakeholders will be important tasks during the mid-term (Year 2) and final (Year 4) conference. Already during the first year of NOMACULTURE, a large societal interest has been discerned and this has been manifested through numerous media contacts and newspaper publications (2.3).

1.5 EXPERIENCES AND CONCLUSIONS FROM CONTACTS WITH STAKEHOLDERS AND END-USERS

NOMACULTURE has from the very beginning attracted a great interest from various stakeholders in the society. This is partly because wolf fish and lobster are well-known and highly demanded seafood species surrounded with a positive image. Already during the first year, NOMACULTURE has been approached by several entrepreneurs and aquaculture companies who wish to start with farming of marine species. These contacts have been channeled via ACW, which is the major platform used by NOMACULTURE for external contacts and stakeholder communication. The large societal interest has been manifested through numerous media contacts and newspaper publications (see 2.3). To communicate

about the opportunities that marine aquaculture may bring to society, NOMACULTURE has participated in various seminars and public events (see 2.3). During these stakeholder contacts, we have sensed that there are hopes and expectations from local communities that marine aquaculture in the near future will be an industry creating jobs along in coastal communities.

SECTION 2

2.1 ORGANIZATION OF THE CONSORTIUM

Consortium overview

The project is collaboration between 5 research departments/institutes in Gothenburg:

1. The Department of Biological and environmental sciences (BioEnv) University of Gothenburg (GU)
2. The Department of Business Administration, GU
3. The Department of Biology and Biological Engineering, Food Science unit, Chalmers University of Technology (Chalmers)
4. The Department of Signals and Systems, Chalmers
5. SP Food and Bioscience (former Swedish Institute for Food and Biotechnology, SIK).

The organization and structure of the project is described below (figure 2).
The responsibilities of the different bodies of the project and the working methods are regulated in detail by the consortium agreement (appendix 1).

- The executive steering board is the highest decision making and supervisory body of the project.
- The project leader and project coordinator administers the project and reports to the steering board.
- The Coordinating part administers contacts and reports to MISTRA and steering board.
- The reference group serves as an advisory board to the steering board
- The annual meeting prepares questions for the steering board.

Project leader and project coordinator

Project leader of NOMACULTURE is the main applicant, professor Kristina Snuttan Sundell.
Project coordinator is Dr. Susanne Lindegarth.

Steering board

The steering board consists of the main applicant, all co-applicants and a representative for Region Västra Götaland:

- Prof. Kristina Sundell (chair, Dept. biological and environmental sciences, GU).
- Prof. Björn Thrandur Björnsson (Dept. biological and environmental sciences, GU)
- Dr. Susanne Eriksson (Dept. biological and environmental sciences, GU)
- Prof Ingrid Undeland (Dept. Food Science, Chalmers),
- Doc. Torsten Wik, (Dept. signals and systems, Chalmers),
- Lena Mossberg (Dept of Business Administration)
- Friedrike Ziegler (SP Food and Bioscience)
- Anders Carlberg (Region Västra Götaland)

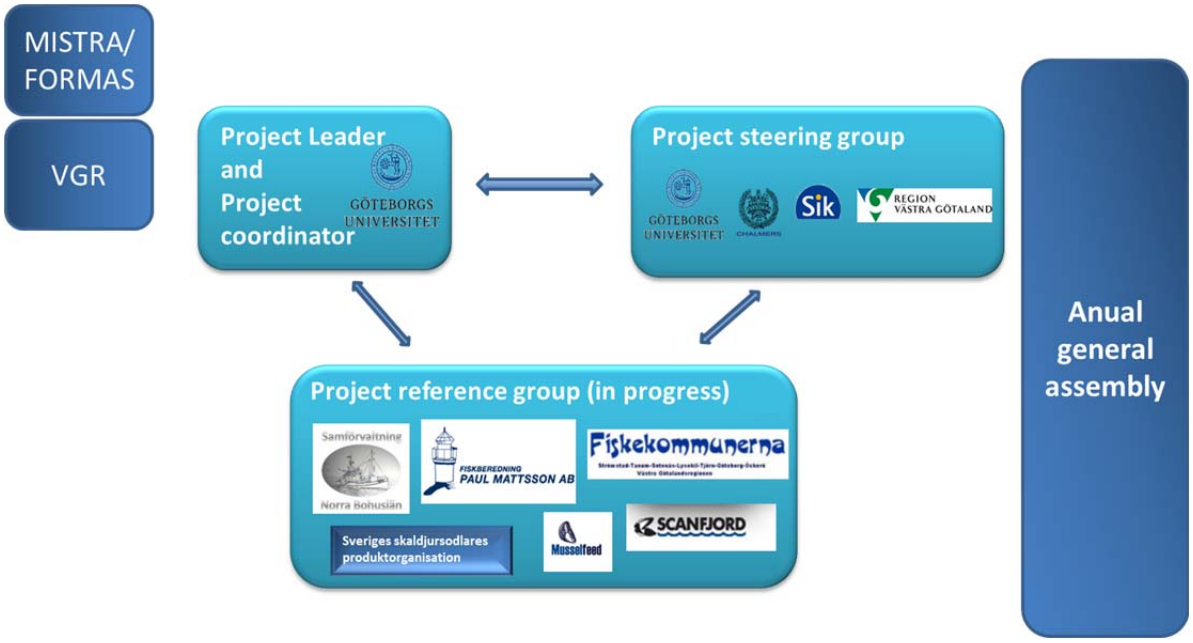


Figure 2. The Organisation of the NOMACULTURE consortium, including the financing bodies, MISTRA/FORMAS and VGR, the steering organization, the reference group and the annual general assembly.

The research team

The interdisciplinary structure of the consortium combines five strong research environments within science, economics and life cycle assessment, comprising eight internationally highly recognized scientists and their research groups. Each research task in the project plan has been designated a scientist in charge. BioEnv participates with 5 senior scientists: Prof Kristina Snuttan Sundell, main applicant (stress, barrier functions, health and immunology), Prof Thrandur Björnsson, co-applicant (endocrinology, growth regulation), Dr E Jönsson Bergman (appetite, feeding behavior, energy metabolism), Dr. Susanne Eriksson, co-applicant (crustacean biology, growth, nutrition), Dr Susanne Lindegarth (mussel biology and farming, stakeholder contact, executive coordinator), Dr. Henrik Sundh (fish welfare and health, stress), and research engineer Dr. Linda Hasselberg-Frank (physiological, molecular biology and histological methods). Chalmers University of Technology (CTH) participates through the Dept of Chemical and Biological Engineering, Food Science unit: Prof Ingrid Undeland, co-applicant (pH-shift technique, soft feed development, fish quality, bioactive compounds) and 2 research engineers (chemical and biochemical analyses) as well as through Dept of Signals and Systems with Doc. Torsten Wik, coapplicant (RAS techniques, IMTA, environmental nutrient leakage modeling, software development). Dept of Business Administration, GU, is engaged through Prof Lena Mossberg (market analysis, customer relationship, food experiences, local produce) and Dr. John Armbrecht (economic impact assessment, cost benefit analysis, cultural economics). The Swedish Institute for Food and Biotechnology participate through Dr Friederike Ziegler (comprehensive Life cycle Assessment) and the Royal Swedish Academy of Sciences contribute through Doc. Odd Lindahl (environmental mussel farming, mussel meal production, recycling of nutrients, trading nutrient discharges). The trans-disciplinary NOMACULTURE consortium also includes public and private stakeholders who will be actively involved in the long-term goals of NOMACULTURE to establish proof-of-principle aquaculture farms and business plans for a feed company.

Collaborators

On-going national and international projects synergize with the project. This includes the on-going collaboration with Skretting ARC and Odd Lindah, Musselfeed AB, on the use of mussel meal as alternative ingredient in aquafeeds through the Nordic Innovation project LIFF. The consortium has ongoing collaboration with Paul Mattsson AB through the Nordic Innovation project PIPE and a Formas/EU-structural fund financed project (222-2010-1780) and with Swedish lobster (*Nephrops* and *Homarus*) fishermen and NORTH BAY SHELLFISH Ltd through the EU funded SME-project "*Nephrops*". Consortium members are coordinating and/or involved in FORMAS projects on aquaculture focusing on growth, alternative feeds and welfare, product quality, the pH-shift process and LCA, *e.g.* the projects *Microbial protein a sustainable feed resource to farmed fish* (229-2009-526), *Fish mucus – the first line of defence against pathogens* (223-2011-1073), *The physiological function of leptin in salmonids: towards improved feed conversion efficiency and quality traits in aquaculture* (223-2011-1356).

Reference group

According to the consortium agreement, NOMACULTURE aims to create a reference group with the purpose to guide and support the steering board in decision-making. The reference group should consist of both public and private stakeholders with close relationships to the project. At this stage, dialogue with potential participating entities is in progress and a reference group will be formalized during mid2015. Meanwhile, stakeholder dialogue is maintained through the consultation group within Aquaculture Centre West.

2.2 EDUCATION

Recruitment of a new PhD-student

In September 2014, a PhD student position in natural sciences, specializing in biology, with focus on tasks 1 and 2; investigating the farming biology of lobster and wolfish using the new feed, was advertised at the GU web, Platsbanken and the EU-site "Euraxess". It was also distributed among the Nomaculture researchers' network. A recruitment group consisting of the supervisor team (Elisabeth Jönsson Bergman, Susanne Eriksson, and Ingrid Undeland) together with one representative of the staff and one representative of the PhD students was formed. A total of 68 applications were received, 28 females and 40 males, from a variety of countries. From these applications, an evaluation was made based on specific criteria and a short list with the 13 top-ranked applications was made. The 13 candidates selected in this step were then evaluated by the members of the recruitment group independently. So each one in the group evaluated these 13 applications and listed their selected candidates in a top and second category. After this, three candidates that were in the top category were invited for personal interviews (two women and one man). However, one of the women declined the invitation. Therefore, two of the candidates from the second category (very close to being top ranked) were also invited. Oral and written references were taken for all applicants that were top and second ranked. Interviews and a written task for the applicants were done in November and December. The PhD-student representative in the recruitment group made a written evaluation of his impression of the interviews, the supervisors took part of this report after they had a discussion among themselves about the outcome of the interviews and the written task. The evaluation committee discussed with the project leader (Kristina Snuttan Sundell) and a decision to put the candidate, James Hinchcliffe in the top position and invite him for a second interview in Gothenburg, was taken. Among the top ranked candidates, James showed the strongest academic experience within in the field, having done his master

on alternative feeds and growth trials in cod, and his master had the focus sustainable aquaculture systems. James further expressed a strong engagement in the subject and teaching. During the two days that James visited Gothenburg we had a formal interview with the recruitment group and James also held a presentation of his thesis work. James was shown around in the labs and at the department of BioEnv/Zoology building and Chalmers/Food sciences department as well as met with the group members and PhD students of the department for talks and possibilities to ask questions. James Hinchliffe was assessed as having a very good potential to successfully pursue PhD-studies and to take on the responsibility of a PhD-studentship in the NOMACULTURE project. James Hinchcliffe was offered the position which he accepted. Mr Hinchcliffe will be affiliated at the Department of Biological and Environmental sciences, but also conduct a significant part of the work at Chalmers University of technology.

2.3 DISSEMINATION

Communication of results (nationally and internationally)

Publications

Hornborg S. and Ziegler F. 2014. Aquaculture and energy use: a desk-top study. OECD report. (Appendix 3).

Seminars

- 30/6: Susanne Lindegarth, as an expert on biomarine resources and aquaculture, participated in a panel discussion about the upcoming National Maritime Strategy. Almedalsveckan (organized by Sjöfartsforum).
- 31/7: Snuttan Sundell gave an open lecture: ”Sustainable seafood production through aquaculture”. Sven Lovén Centre,Tjärnö.

Conferences/workshops

- 2/4 Susanne Eriksson participated in a workshop about Future biobased economy. Chalmers University of Technology (organized by the SEAFARM project)
- 8/4: Snuttan Sundell participated as an invited speaker at Swedish Maritime Day in Gothenburg during the session ”Sustainable biotechnology and smart seafood”. She gave an interactive talk on the theme ”Seafood quiz – 20 questions about fish farming – what do you actually know about the fish you are eating?”
- 4/11: NOMACULTURE is exhibited during the event ”Maritima Klustret i Västsveriges kontaktkonferens”. Snuttan Sundell participated in the exhibition.
- 26/11: Susanne Lindegarth participated as an invited speaker and exhibitor at the conference Blue Growth in Skagerrak. Fredrikstad, Norway (organized by Svinesundskommitén).

Interaction with industry, organizations and agencies

- 22/4: Susanne Eriksson participated in a meeting to discuss the forthcoming National Maritime Strategy with the Ministry of Enterprise and Innovation during their visit to Sven Lovén Centre at Kristineberg.
- 16/6: Meeting with the consultation group within Aquaculture Centre West.
- 17/6: Susanne Eriksson, Snuttan Sundell and Susanne Lindegarth participated in a meeting with a representative from Vinnova to discuss future possibilities for

applications and support from VINNOVA for a Testbed for marine aquaculture. Göteborg.

- 21/8: Meeting with the consultation group within Aquaculture Centre West.
- 26/8: Snuttan Sundell participated in the National Aquaculture Council meeting, as a representative for Aquaculture Centre West. Stockholm (organized by Swedish Board of Agriculture)
- 28/10 and 10/12: Susanne Eriksson participated in meetings with representatives for the project ”Fish and lobster reefs in Sotenäs. Lysekil.
- 8/12: Susanne Eriksson gave a lunch seminar and informed about NOMACULTURE. Göteborg (organized by the Swedish Agency for Marine and Water Management).

Media coverage

- 16/4 A press release about the start-up of NOMACULTURE was sent out and featured in the regional newschannel Västnytt and radio station P1.
- 20/4 Interview with Snuttan Sundell about NOMACULTURE in a newspaper article in Bohuslänningen
- 1/6: Interview with Snuttan Sundell about NOMACULTURE in a newspaper article in GöteborgsPosten (4 pages): “Fiskodlingen går i rätt riktning”.
- 18/9: Interview with Susanne Eriksson about NOMACULTURE in a newspaper article in Lysekilsposten.
- 1/10: Interview with Susanne Eriksson about NOMACULTURE in a newspaper article in Bohusläningen.