

# SWEMARC ANNUAL REPORT 2016

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## 1 Svensk sammanfattning

SWEMARC – the Swedish mariculture research center – inrättades som en verksamhet i Centrum för Hav och Samhälle den 1 april 2016. SWEMARC är ett av de sex starka forskningscentrum ingår i Göteborgs Universitets strategiska satsning på viktiga och aktuella samhällsfrågor, UGOT Challenges. Satsningen löper över sex år och fokuserar på stark tvärvetenskaplig forskning för att lösa globala samhällsutmaningar. SWEMARC bygger till viss del på sin föregångare, Vattenbrukscentrum Väst (VBCV), som startade 2011. VBCV utvecklades under sina 6 år till en nationellt väl-etablerad nod och förespråkare för forskning och verksamhet inom vattenbruk i Västsverige. VBCV som plattform för nätverkande och forskning hade sin grund i de naturvetenskapliga institutionerna vilket genom SWEMARCs inrättande nu har breddats att innefatta även statsvetenskap, ekonomi och administration, juridik och design. Detta gör det möjligt för SWEMARC att på ett bra sätt verka för centrumets visioner och mål med hjälp av grundläggande transdisciplinära arbetssätt.

Under sitt första år har SWEMARC:s verksamhet karakteriserats av mycket organisations arbete, som organisatorisk hemvist inom Hav och Samhälle, budgetarbete, verksamhets- och kommunikationsplaner och att utarbeta formerna för samarbetet mellan de ingående institutionerna. SWEMARC har planerat sin verksamhet för att skapa de bästa förutsättningar för att jobba i linje med Göteborgs universitets Vision 2020; t ex rekrytering av världsledande gästprofessorer, samverkan med samhället lokalt och globalt, och nya satsningar på utbildning.

I juni hölls det första årsmötet för alla medlemmar i SWEMARCS generalförsamling sedan det formella bildandet; vi spenderade två dagar tillsammans då vi presenterade forskning och hade en workshop för att gemensamt ta fram en policy för intern kommunikation. I september invigdes centrumet av bl a Rektor i Vasaparken, två blivande gästprofessorer, Profs Costa-Pierce, USA, och Skallerud, Norge, invigningstalade, och det hela avslutades med mingel. Arrangemanget var offentligt och ett hundratal personer närvarade.

SWEMARC generalförsamling har i nuläget nästan 50 medlemmar, och ett av dess mål, att synliggöra och knyta samman den kritiska massa inom forskning för vattenbruk som finns vid GU, har uppnåtts. Tre doktorandtjänster har utlysts varav två tillsattes med start 1 januari 2017, en post doctoral forskare och en ”scholar at risk” har också rekryterats. Planer har lagts för samarbetet med de tre internationella gästprofessorer som kommer att knytas till SWEMARC, som förutom de ovan nämnda också är Prof Yongqi Lou, verksam vid Tongji universitetet i Shanghai. Stor vikt läggs vid att alla nya tillsättningar ska verka som bryggor mellan SWEMARC:s grunddiscipliner för att katalysera arbetet över ämnesgränserna. Ett antal utbytesresor mellan gästprofessorer och värdinstitutionerna vid GU har ägt rum. Till exempel besökte professor Maria Nyström i december Tongji universitetet för att diskutera forskningssamarbetet inom ramen för Yongqi Lous gäst professur. Professor Skallerud och Professor Costa-Pierce var båda i Göteborg i samband med SWEMARC:s invigning. De tillbringade då några extra dagar tillsammans med sina respektive värdinstitutioner, Företagsekonomi och Biologi och miljövetenskaper, för att diskutera kommande uppdrag och aktiviteter som gästprofessorer inom SWEMARC. Prof Costa-Pierce tog även tillfället i akt att besöka Sven Lovén Centrum för marin infrastruktur, både Tjärnö och Kristineberg. Under denna visit färdigställdes också en ansökan från SWEMARCs verksamhetsledare om KSLA:s internationella gästprofessur - Wallenbergprofessuren 2016, till Prof Barry Costa-Pierce, vilken glädjande nog beviljades och installationen ägde rum i januari 2017 under högtidliga former i Stockholms stadshus.

Publikationsmässigt har SWEMARC genererat både vetenskapliga och andra typer av artiklar framförallt via de redan existerande projekten som ingår. En omfattande rapport om recirkulerande vattenbrukssystem har skrivits på uppdrag av HAV, vilken nu är ute på remiss. Exempel på andra samverkansaktiviteter som SWEMARC har arrangerat är: en kurs i tillståndsgivning för vattenbruk med målgrupp entreprenörer, vattenbrukare och myndigheter på SLC-Tjärnö, en workshop i Livscykelanalys, monterpresentation på maritima klusterkonferensen i Göteborg, samt att Juridiska institutionen organiserat ett möte om ”The ecosystem approach in ocean planning and governance” med deltagare från 13 länder. SWEMARC har vidare bjudits in att delta i ett flertal andra nationella events med presentationer och expertpaneler etc. som t.ex. Livsmedelsdagarna,





Tylösand, Forum Blå tillväxt, organiserat av Svinesunds kommitteen, Miljöministerns besök hos Göteborgs stad där eventet "Hur grönt är Göteborg" under 2 dagar diskuterade hållbarhetsmålen ur Göteborgs synvinkel, Arena Grön tillväxt i Region Halland m.m. Vi har också deltagit i olika vetenskapliga möten för att presentera data; t ex på mötet European Aquaculture Society i Edinburgh där SWEMARC var representerat med sex deltagare.

Vi har under första året analyserat hur vår verksamhet och forskning möter Agenda 2030; FN:s globala mål för hållbar utveckling, och har identifierat ett antal mål som vi adresserar. Vi är stolta över att SWEMARC blev utvalt av Göteborgs universitet att bidra då regeringskansliet/UD efterfrågade ett gott exempel på hur Göteborgs universitet jobbar mot hållbarhetsmålen. En 2-sidig beskrivning av SWEMARC med fokus på hur centrumet arbetar med hållbarhetsmålen ingår som underlag till Sveriges medverkan i FN:s "High-level political forum" juli 2017. På utbildningssidan organiserades en kurs om att starta vattenbruk på önskemål från brukarna, där fokus låg på tillståndsgivning. Några av SWEMARC:s medlemmar deltog såväl som föreläsare och som kursdeltagare. Vi har också arbetat med att utveckla en transdisciplinär doktorandkurs i vattenbruk som ska ges hösten 2017, samt börjat planera en nordisk master i "hållbar matproduktion från havet".

Ser vi framåt mot 2017 så väntar ett spännande år! Några av höjdpunkterna är: Våra nyantagna doktorander som på allvar ska sparka igång sina projekt, och ytterligare en doktorand börjar efter sommaren. Gästprofessorerna som ska tillbringa tid i Göteborg och stärka oss i vårt arbete på alla fronter; forskning, samverkan och utbildning. SWEMARC:s medverkan i Almedalen, den stora Internationella konferensen i Marin turism till sommaren (<http://es.handels.gu.se/avdelningar/avdelningen-for-kulturgeografi/cmt2017>), en ny transdisciplinär doktorandkurs i vattenbruk och satsning på nya internationella Masterprogram.

## SWEMARC Annual report Year 2016 – English

### 2 Transdisciplinary collaboration/work

#### 2.1 Description and reflection

Aquaculture and the development and expansion of aquaculture industry in a sustainable way is transdisciplinary in its nature. A red thread through the work of SWEMARC is therefore to cross borders and combine expertise from different areas in order to provide answer to the questions asked. SWEMARC do not aim to combine all subject areas in all activities, but rather to let the scientific question determine the best combination of expertise needed to investigate and conclude on that specific question. In RA 1 and RA 6, all SWEMARC participating departments will be actively involved in the research and out-reach activities – within this these two RA's there will also be direct training of SWEMARC members in transdisciplinary methodologies and formulations. In RA 2, Dept. law and Dept. marine sciences will co-supervise the PhD student and thus jointly plan the research. In RA 3, it is mainly Dept. of marine sciences and political sciences that will co-supervise the PhD student, but the research will also be done in very close collaboration with Dept. biological and environmental sciences and Academy of design and crafts. For RA 4 the PhD student appointed will be co-supervised by Dept. biological and environmental sciences and Dept. for business and administration, but also in this RA there will be a strong research collaboration with Dept. marine sciences and . RA 5 finally will appoint a PhD student at mid-2017 which will be co-supervised between Dept. for business and administration, Dept. biological and environmental sciences and/or Dept. of marine sciences with active research collaboration also with Dept. of political sciences.

During this first year of SWEMARC, specific goals have been set up and activities planned in order to facilitate the transdisciplinary work within SWEMARC:

- guest professors, all three with large experience in inter- and transdisciplinary approaches
- co-supervision of PhD students from an interdisciplinary department
- course on transdisciplinary methodology
- Sea and Society talks – joint participation followed by within SWEMARC discussions
- continued and intensified work with stakeholders on experienced bottle necks and topics identified to be approached for establishment of sustainable aquaculture production.

A SWEMARC study has been initiated through a survey that was handed out to the participants of the course on "Permits for start of Aquaculture companies" arranged in January of 2017. Through the survey a series of 28 cases were collected in which entrepreneurs and aquaculture companies describe the problems

and questions they experience as most problematic at the stage of development they are right now. These cases will be contacted by SWEMARC researchers from all our subject areas, dependent on the need for advice and the stage in which that particular case is, and discussed and followed from a transdisciplinary point of view. Follow up meetings will be made at least every 6 month and different expertise will be assigned to these entrepreneurs and companies dependent on need – a participatory design approach will be used to include as many aspects as possible for the development at an early stage.

## 3 Cooperation and utilization

### 3.1 Reflection and description

Cooperation with stakeholders and engagement in outreach activities is a central part within SWEMARC as the two “legs” of the SWEMARC organization (fig. 1): outreach and cooperation, MARC-SOCIETY and the research, MARC-RESEARCH, are equally important. Building on the already existing center, Aquaculture Centre West (ACW), an array of well-established routes of communication and interactions with stakeholders; the public, the industry as well as local, regional and central authorities and the government, are already in place to be adopted by MARC-SOCIETY. During the first year of SWEMARC, a number of cooperation and outreach activities have been completed, which are listed in appendix 1. Some of the main activities and results of the SWEMARC work are summarized below. We have also devoted time during 2016 to plan SWEMARC’s participation in Almedalen 2017. For international engagement in education which also involves some extent of cooperation, please see section 5, Education.

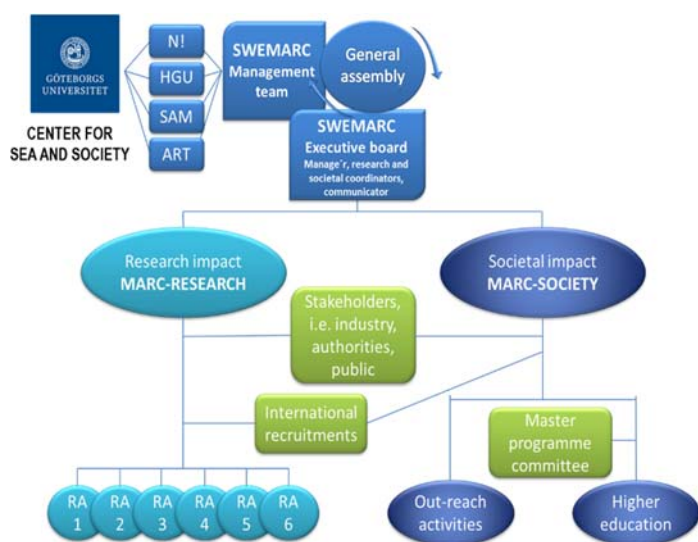


Figure 1: The general organization of SWEMARC

### 3.2 Activities

#### 3.2.1 Cooperation with industry

SWEMARC researchers are cooperating with several aquaculture businesses in joint projects. Together with Scanfjord Mollösund AB and the Norwegian company Akva Future AS, SWEMARC is engaged in testing the growth potential and environmental effects of an integrated multitrophic aquaculture (IMTA) system in the sea. A novel semi-closed system for farming of fish is tested together with co-culturing of blue mussels and macroalgae. The project has received funding for the coming 5 years from the Norwegian Research Council and SWEMARC is a partner in the project. SWEMARC is also cooperating, within the MISTRA funded project Nomaculture, with Smögenlax AB in Kungshamn. Smögenlax is developing a land-based full Recirculating aquaculture system (RAS) for salmon. From 2017, the project BioDras has been granted funding by the European Maritime and Fisheries Fund (EHFF, coordinated by Innovatum) for continued development of this RAS with focus on microbial filters. Another major industrial research focus of SWEMARC is the cooperation with the only Norwegian commercial wolffish farmer, AMINOR AS, which also includes the Nord University in Bodö and Aquaplan Niva in Tromsö. The main aim of this

collaboration is to carry out research and develop protocols for commercial wolffish farming. SWEMARC is further the main applicant for an IMTA project (funding from the EHFF) which involves industry collaboration. The collaboration with ATSEA Technology has been strengthened for seaweed farming research activities. The newly granted EU project: BONUS-OPTIMUS (Optimization of mussel mitigation cultures for fish feed in the Baltic Sea “ involving Danish, Swedish, German and Polish partners on sustainable aquaculture in the Baltic Sea will have extensive collaboration with commercial shellfish farmers in Europe.

### **3.2.2. Conferences and workshops arranged by SWEMARC**

The SWEMARC project NOMACULTURE, which is focusing on biology, feed production, technologies and socio-economic values for sustainable farming of wolffish and European lobster, arranged a research workshop during Feb-March of 2016. During this workshop the ELCE network (European lobster centre of excellence) conducted a joint larval feed experiment at the lobster hatchery at Kristineberg, GU. The experiment ended with a one week workshop where 15 ELCE members from Sweden, Norway, Denmark, Iceland, Scotland and England took part. These represented three different R&Ds and five SMEs. The workshop was funded by the Royal Academy of Sweden Lovén fund. The aim of this joint effort was to fast track the current knowledge of brood-specific survival and development during the lobster larval stages. The results from this spring workshop has been published in the popular scientific journal, Aquaculture Europe, with the international aquaculture stakeholder arena as target group.

In November, a one day workshop on Life-Cycle Analysis (LCA) was held at Wallenberg Center in Gothenburg. The title of the workshop was “How can LCA promote a sustainable aquaculture industry?” and attracted about 30 participants from industry, authorities and academy. (read more [http://swemarc.gu.se/digitalAssets/1609/1609351\\_summary-of-presentations-given-on-november-29th-2016.pdf](http://swemarc.gu.se/digitalAssets/1609/1609351_summary-of-presentations-given-on-november-29th-2016.pdf))

On 7 and 8 November 2016 David Langlet of RA2 arranged, together with colleagues at the Faculty of Law, the a conference on "The ecosystem approach in ocean planning and governance" at the School of Business, Economics and Law at Gothenburg University. The conference, which attracted speakers from 13 countries was attended predominantly by researchers and civil servants from governmental agencies and coastal municipalities. Among the topics addressed at the conference were several issues of core relevance for aquaculture, including environmental quality standards for fresh and marine waters, land-sea interaction, and maritime spatial planning as an instrument for promoting the harmonious coexistence of activities such as ocean-based energy production, shipping and aquaculture. Jonas Nilsson from RA2 presented, together with Susanne Lindegård, SWEMARC at the annual research day organized by the School of Business, Economics and Law at Gothenburg University on 20 October.

### **3.2.3. Invited speakers at seminars and conferences**

The SWEMARC team members are frequently invited to present various aspects of sustainable aquaculture and seafood production i.e. the SWEMARC case. Here are some examples:

- “How green is Gothenburg”, arranged in October by the City of Gothenburg for the Ministry of environment and energy. Susanne Lindegård participated.
- “The future is Blue”, a dialogue forum for regional politicians and stakeholders. The seminar was held in Sarpsborg (Norway) in November and arranged by Svinesundskommittén. Susanne Lindegård presented “The opportunities and challenges for aquaculture in the region”. (read more [http://svinesundskommitten.com/media/148053/sv-no\\_politikertraff\\_dokumentation\\_2016.pdf](http://svinesundskommitten.com/media/148053/sv-no_politikertraff_dokumentation_2016.pdf))
- Arena Green Growth – region Halland. ”Why should we cultivate fish”? A presentation by Snuttan Sundell focusing on land-based fish farming (read more <http://arenagröntillvaxt.se/event/vattenbruk-halland-3010/>)
- White paper Merroir Trend Seminar 2107, arranged by White guide in March 2017. ”Egget” – ett nytt sätt att odla hållbara och goda saker i havet. Kanske kan sjögrurka bli din nya favorit?” presented by Snuttan Sundell (read more [http://whiteguide.se/sites/default/files/wg17\\_gala\\_merroid\\_trend\\_sem.pdf](http://whiteguide.se/sites/default/files/wg17_gala_merroid_trend_sem.pdf))

### **3.2.4 Participation in national conferences and exhibitions**

SWEMARC was present during the Swedish Maritime Day (April 2016) and the Maritime Cluster Conference (November 2016) with an exhibition stand and presented SWEMARC to a mixed audience of national and regional actors.

### **3.2.5 Interaction with authorities, governmental bodies, and regional actors**

SWEMARC team members are frequently engaged as advisors to authorities in various issues. A major assignment during 2016 was the report "Översikt av tekniker för odling av vattenlevande organismer i Sverige -odlingssystem, odlingsarter och foder" which was compiled on behalf of The Swedish Authority for Marine and Water Management. This report will provide a knowledge basis for new guidelines on environmental assessments of Swedish aquaculture by the authority.

Team members are also active in various national and international policy groups and advisory boards. These include the steering group for the Swedish Institute for the Marine Environment, the board of the National Competence Center for Aquaculture (NKfV), the national Aquaculture council hosted by the National board of agriculture as well as the ICES Aquaculture working group (WG-Aqua) and the scientific council for the Norwegian institute of nutrition and seafood research.

The Centre for Tourism and West Sweden Tourist Board and the Northern Bohuslän Tourism, as well as Northern Bohuslän coast municipalities are important stakeholders and partners for the research carried out in research area 6. Contact has been established with Lantmäteriet and the SOM-institute.

### **3.2.5 Media coverage**

SWEMARC researchers have been interviewed and fronted both in newspaper articles, popular scientific papers and radio shows. Some examples are the articles in Väterhavet 2016 about new systems, techniques and species for sustainable marine aquaculture with topics such as research on lobster farming, large scale seaweed farming and overall marine sustainable aquaculture: "Production of smart food in the sea". A particular media interest during the year focused on the European lobster, both from the view of farming techniques for this species and from the view of threats from invading American lobsters into Swedish waters. SWEMARC researchers have been frequently contacted by both newspapers, Radio and TV to act as scientific experts in these issues.

### **3.2.6 Planned MARC-SOCIETY activities for 2017**

One main upcoming MARC-SOCIETY activity during 2017 is the participation in Almedalen. SWEMARC will arrange at least four different activities during the Almedals-week. We have volunteered to design and present the mingle food at the Welcome reception for the "Västsvenska Arenan" in the beginning of the week. SWEMARC will further arrange an exclusive "round table discussion" with invited key persons among politicians, authorities, the farming and food industry as well as environmental organisations during which we will serve a nice dinner. A well-renowned Swedish seafood head chef, Sofia B. Olsson at restaurant vRÅ, has been engaged for these two activities in order to lift the sensation of seafood and together highlight the possibilities and opportunities sustainably produced seafood can offer. SWEMARC is also planning to create and present an exhibition, in the entrance hall of the "Västsvenska arenan" where both innovative video installations and physical 3-D models will present scenarios of designed, sustainable aquaculture systems and tell the story about sustainable production of seafood. Finally, but not least, SWEMARC will arrange one of the 6 seminars in the series of UGOT challenge seminars at Almedalen 2017, high-lightning the strategic goals of GU to challenge the global sustainability questions. Other planned activities during 2017 are participation in Väterhavsveckan, Smögendagarna, Vetenskapfestivalen and the arrangement as well as co-arrangement of at least two specific workshops: "Risker och möjligheter med sjömat" and "Scary food" in collaboration with the Marine cluster in the western region. Swemarc will further participate in the open Sea and Society lunches both as presenters and as auditorium. The SWEMARC PhD students has recently decided to take part in these seminars and then follow that up with discussions around the specific topic of that week's seminar.

### 3.3 Communication

Already at the start of the center, a communicator working 20% for SWEMARC was included (employed at Sea and Society). SWEMARC's first year of work initially focused on discussing and creating a general communication strategy, where the first step was to write a policy for internal, "intra-center" communication. A workshop with the aim of creating the basis for such a policy was held at the first annual meeting in June 2016 where a survey of the internal communication needs among the members of SWEMARC general assembly (GA) was conducted, followed by presentations of ideas and discussions. Based on the resulting material, an internal policy was written and presented to the steering board in September, whereupon it was finalized and approved by the management board, see appendix 4. In the fall, SWEMARC also began the work of shifting the Aquaculture Centre West website to become the SWEMARC website ([www.swemarc.gu.se](http://www.swemarc.gu.se)). A new front page has been made and work has been initiated to complement the website with an English version, along with new content that presents the centre and its activities, news etc. SWEMARC's site also houses information about projects that are part of the centre, for example the MISTRA funded AquaAgri NomaCulture and Kelp. News and press releases have been published continuously. Among other things, local media paid attention to the inauguration of SWEMARC in September. Since our research is part of a strategic research center that addresses critical societal issues, an important task of SWEMARC is naturally to communicate and interact broadly with society (from entrepreneurs, authorities, politicians, the public etc.), as is reflected in our cooperation activities above. We have also participated in meetings with the Grants and Innovation Office, discussing how UGOT challenges centra would like to communicate and be visible in society, for example visual identities with a common style for recognition. It was decided that all centra should aim for participation at Almedalen 2017, as a common means of communication with society and putting the UGOT challenges centra "on the map". Therefore, the management board has approved that SWEMARC devotes time 2017/2017, and a major part of the cooperation budget 2017 for Almedalen. SWEMARC has put lots of efforts into planning the participation in this event during the first project period, as well as the preparation of material. This is the first major external communication activity that we aim for, although we continuously and actively communicate with external actors in line with our plan for knowledge-exchange and utilization of research, see section 3.2.

## 4 Research

### 4.1 Description and reflection

SWEMARC research is organized in six highly integrated research areas (RAs) that address key problems which currently limit the development of sustainable mariculture. The progress within each of these research area is described in this section. In general, the work during the first project period has been characterized by organization, recruitments and planning, but some studies have also been initiated. RA1, the concept of carrying capacities and the current public opinion, will set the framework for the question-driven research areas, RA2 will focus on legal and societal conflicts. RA3 will develop farming systems with strong barriers for low or positive environmental impact and nutrient remediation, RA4 will explore novel marine feeds derived from circular farming systems, assuring high health, welfare and quality without impacting wild fish populations. The focus of RA5 is the consumer perception of mariculture products along with development of future products and markets. The holistic approach to a sustainable expansion of marine aquaculture will be to evaluate the ecological, economical and societal impacts of the combined research outcomes and present strategies and guidelines for concrete actions in RA6.

#### 4.1.1 RA1

*Scientist in charge: Mats Lindegärth*

One main aim of this research area is to study current public opinion and in particular to analyze major factors determining pro-mariculture opinion, in order to understand how a broad support among citizens and stakeholders can be gained. This work has been initiated in a pilot study conducted within the framework of "Medborgarpanelen" (LORE/SOM). This study focused on attitudes towards aquaculture, in particular farmed fish, and comparisons to attitudes in other countries. In another study we have also studied attitudes towards farming activities and consumer preferences. Although we have only done preliminary



analyses of these data, we expect that they will form a valuable background for our participation in this summer's events in Almedalen and in the future they will also provide material for the collaboration with our coming guest professors.

Another important aim of this research area is to summarize the concept of carrying capacity and analyze limiting factors for the development of different types of mariculture, and promote this as a general framework within the program. For this purpose activities are planned in order to facilitate collaboration, mainly with research areas 2, 3 and 6. In particular, we plan to introduce and analyze carrying capacity in relation to sustainability concepts in the legal and regulatory analyses within RA2 and in future activities we will provide models and scenarios to be used in integrated analyses of impacts of mariculture.

Another major achievement of this research area is that we have contributed to a successful multi-disciplinary, EU-funded project on mussel-farming in the Baltic sea. BONUS-OPTIMUS (“**Optimization of mussel mitigation cultures for fish feed in the Baltic Sea** “ will address several dimensions of carrying capacity (environmental impacts, mitigation, socio-economic analyses, mussels as fish-feed etc.) and will provide new international national links and collaborations to SWEMARC. The project involves Danish, Swedish, German and Polish partners on sustainable aquaculture in the Baltic Sea and has a total budget €2 983 209 GU is Swedish contractor with a budget of €354 179. One research engineer has recently been recruited to this project.

#### 4.1.2 RA2

*Scientist in charge: David Langlet*

No actual research was carried out within RA2 during 2016. The focus was instead on getting the required practical and personal structures and resources in place to get research activities going. RA2 has had two meetings both of which have been mainly dedicated to the process for recruiting of a PhD candidate based at the Faculty of Law and working within the framework of RA2. Relevant documents have been compiled to aid the commencement of work of the PhD ones in place and issues relating to the desired focus of the research and (co)supervision have been discussed. The PhD recruited is Jonas Nilsson who started his position on January 1<sup>st</sup> 2017 with Prof David Langlet as main supervisor and Prof. Mats Lindegarth as co-supervisor. Jonas has started his work with an extended literature survey and his project has currently the working name “Management of sustainable industries: example aquaculture”.

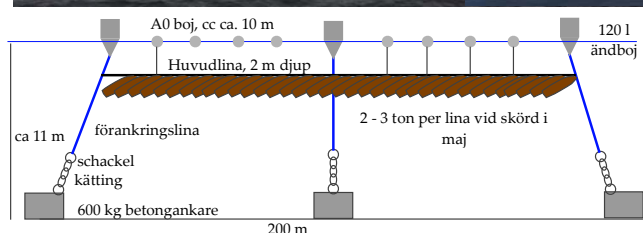
#### 4.1.3 RA3

*Scientist in charge: Henrik Pavia*

During 2016 the first large-scale (2 ha) cultivation of seaweeds in Swedish coastal waters was established within the Kosterhavet National Park (Fig. 1). In parallel, a comprehensive environmental impact study, using a “beyond BACI” approach, and an LCA-study were initiated in order to evaluate the ecological as well as economical sustainability of sea based cultivation of macroalgae in Sweden. New techniques for seeding and sprouting of seaweed juveniles have been developed and evaluated, including the testing of novel seeding substrates in collaboration with ATSEA Technology. Furthermore, we have taken the first steps to initiate a breeding program in order to produce cultivars/varieties for the future cultivation of *Saccharina latissima* in Swedish coastal waters, based on the gene pools of local populations to avoid “genetic pollution” of wild populations. Selection for e.g. high growth rates, high-value compounds, tolerance to high irradiance and water temperature can be performed on both life stages (i.e. gametophytic and sporophytic phase). Gametophytic selection is more rapid, since male and female gametophytes can be propagated vegetatively and preserved for repeated use in a so called “germplasm bank”. However, breeding techniques and preservation of gametophytes are both complex processes, involving multiple cloning steps and an optimal culturing environment. For this part of the projects we have therefore established a new collaboration the group of with Prof. Dr. Shaojun Pang at the Institute of Oceanology, Chinese Academy of Sciences (IOCAS) in Qingdao, China, who are specialised and internationally leading in this topic.

Land-based cultivation of seaweeds has been tested in 2016 with brown (*Saccharina*), red (*Porphyra*) and green (*Ulva*, *Enteromorpha*) seaweeds. Cultivation protocols and techniques to complete the entire life-cycles under laboratory conditions have been successfully established for all study species. The development of breeding protocols for high performing strains is ongoing for *Ulva*. These techniques and strains are

expected to be very useful for RAS-studies within SWEMARC the coming years. A new green-house dedicated to seaweed cultivation, including possible RAS/IMTA-experiments, was constructed at Tjärnö marine research station in 2016.



The first steps towards open (sea based) and closed/semi-closed (sea or land based) IMTAs have been taken in 2016. The co-cultivation of blue mussels and seaweeds (*Saccharina*) were tested in a field experiment in five different water areas around the islands of Orust and Tjärn. For the remediation of eutrophicated coastal waters the co-culturing of mussels and seaweeds holds great promise since both particulate organic material and dissolved nutrients can be extracted simultaneously. The results of our first study imply that both the blue mussels and *Saccharina* perform well at more exposed areas, while only the blue mussels show good growth in the more sheltered, inner areas and that other seaweed species should be tested for co-cultivation under such conditions (Fig 2).

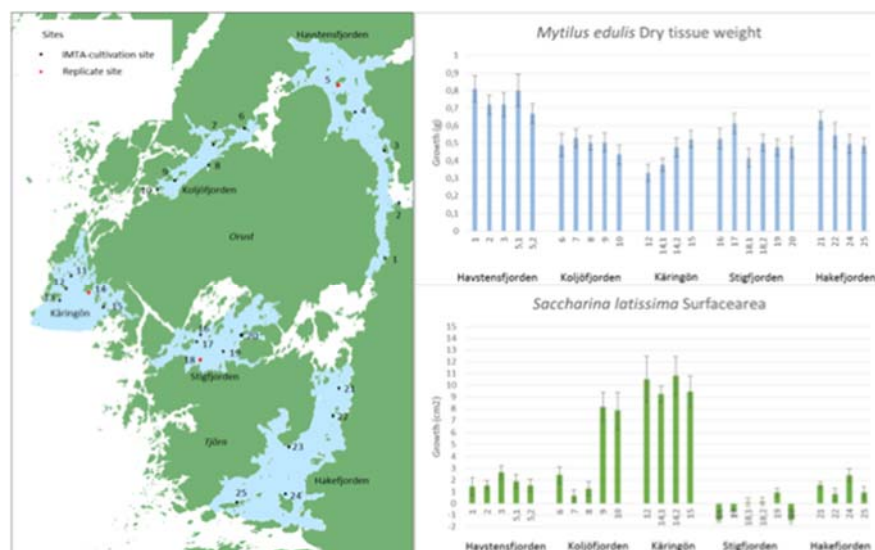
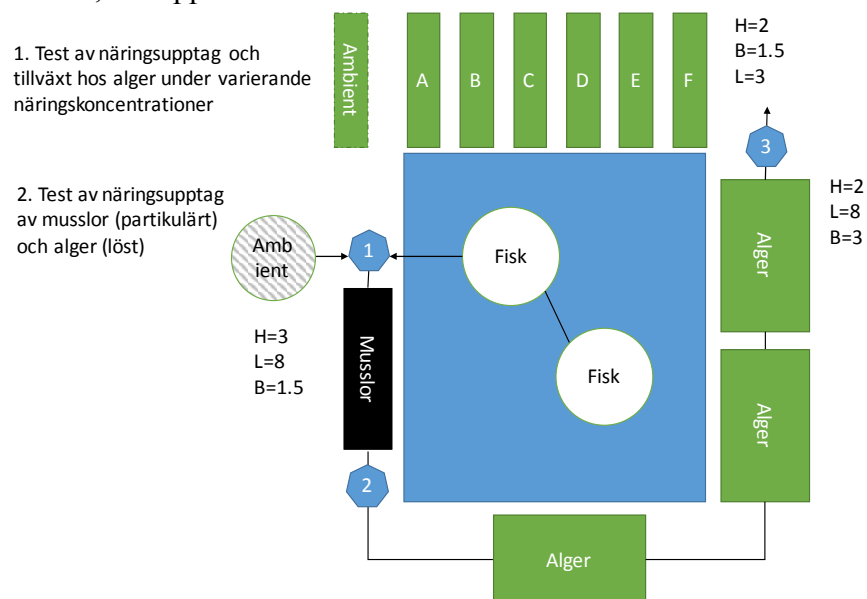


Fig. 2

An innovation project based on a IMTA-approach for closed/semi-closed fish farms has been initiated in in 2016 as a collaboration between SWEMARC and several Norwegian partners, including the company Akva Future AS. A pilot study for the project was conducted at Mollösund in Sweden, but the activities have now moved to a test site at Brønnøysund in Norway. Seaweeds and blue mussels will be cultivated in tanks receiving outlet water from the fish cages in to reduce the nutrient load of the water and to improve the

microbial water quality (Fig. 3). The project has received financial support from the Norwegian research council, see appendix 1.



**Fig. 3**



At the aquaria facilities at the Zoology house in Gothenburg, the new post-doc Jonathan Roques has been working on establishing a RAS-system with high degree of recirculation. In order to evaluate and initiate bioreactors for both nitrification and de-nitrification in the RAS expertise on marine microbes has been recruited to SWEMARC and this RAS. The aim is to house juvenile spotted wolffish in the system that will be obtained from Norway during the Spring of 2017. The water quality at different points of the system is monitored frequently and development of the bacterial communities as well as of algae components in the RAS loop will be a target during 2017. Currently, the system is housing freshwater species, but it will be switched to seawater in April whereupon the buildup of relevant microbiological communities will be initiated.

In collaboration with Smögen Lax AB and R&D, a system for full seawater RAS and low temperatures for farming of Atlantic salmon, *Salmo salar* during the on growth stage is under development. A new pilot-scale system, including both aerobic and anaerobic bioreactors, has been built during 2016 and a startup and monitoring program for this RAS has been established. The system has just been filled with sea water and Atlantic salmon smolts will be introduced into the system in the middle of April after thorough physiological analyses of smolt status on the fish. The long term goal for this system is, apart from the development of nitrification, de-nitrification and anamox bacterial communities also to connect a micro algae filter as a first step extracting dissolved nitrogen and phosphorous before the water is led on to the microbial filters.

#### 4.1.4 RA4

*Scientist in charge: Björn Thrandur Björnsson*

The RA4 is most directly linked to RA3 as the objective of RA4 is to develop new aquaculture feeds to be tested for their effects on growth, health and welfare on species raised in the environmentally friendly culture systems developed in RA3. However, as the feeds (RA4) and the systems (RA3) are being developed in parallel, during this first project year, research within RA3 and RA4 has progressed largely separately, as planned.

### Aquafeed development

#### Background

Mariculture feeds in open systems contribute significantly to organic pollution, and are still to a significant degree based on raw materials from capture fisheries, thus potentially contributing to the overfishing of wild stocks. Current alternative ingredients are mainly from terrestrial plant sources and therefore compete for both freshwater and land resources as well as directly with the human consumption or animal husbandry market.

Consequently, aquaculture is exposed to large changes in availability and price of feed ingredients, amplifying the economic vulnerability of the sector, where feed accounts for over 50 percent of the production cost. From a biological perspective, mariculture feeds are often poorly tailored to meet species and life-stage specific nutritional needs, resulting in risk for reduced growth efficiency, animal health and welfare. Therefore, it is important to identify feed ingredients from new, marine raw materials, especially non-food alternatives from low-trophic level organisms and from underutilized byproduct sources, and include in the development of new feeds.

## Research

The pH shift process, originally developed by Hultin and Kelleher (1999), has been shown to be an efficient means for protein recovery from muscle raw materials. However, few pH shift process-based studies have tested the use of fishery by-products as a potential source of protein. In this task, we have investigated the optimization of the pH shift process and its applicability to producing alternative protein for aquafeed. So far, we have targeted three types of herring by-products as sustainable feed raw materials. These by-products have been backbones, heads and guts. In different combinations, they have been subjected to the pH-shift process as a way to remove bones and skin and thus to concentrate up the proteins.

In short, the process is based on the theory that muscle proteins can be solubilized in water at high (pH 11) or low (pH 3) pH. When proteins are solubilized, they can be separated from insoluble matter such as bones, skin, and to some extent lipids, using centrifugation or filtration.

The process has previously been used e.g. on whole herring; however, it is thought that the most promising use of the pH-shift process is on more unrefined materials that currently have a low value, such as herring by-products.

The parameters we tested include the application of different separation g-forces in two centrifugation steps (8000 g and 800 g). Also, different solubilization acidity (pH 11.3 and 2.8) has been tested for solubilizing the proteins in the first step of the process. Different parts of the herring by-products have also been tested in different combinations. The combinations of by-products tested in the process were; (i) frames, head and viscera together (HFV), (ii) frames and heads (HF), (iii) viscera alone (V). We hypothesized that different combinations of by-product parts will affect protein yield and isolate composition, not least the presence of viscera which contains a lot of enzymes and non-muscle proteins. We have argued that the g-forces used during the two separation steps could affect the outcome of pH-shift process, and should be investigated as it largely affects scalability of the process to industrial scale. To the best of our knowledge, these factors have not been studied before. Also, no previous study has considered the potential of using the products from the pH-shift process as ingredients in aquaculture diets. Table 1 summarizes the total efficiency of each treatment, which is assessed by measuring total protein recovery during the pH shift process. We found that the isolation process gave a significantly higher protein yield at pH 11.3 compared with pH 2.8. Almost 90% of the proteins were on average soluble under alkaline conditions, which gave a total protein yield of 60.4%. The origin of the material or the centrifuge force treatments had no influence on the total yield.

**Table 1:** Protein yields and solubility of the pH shift process for the three origins and two treatments. Data shown is mean value ( $\pm$  standard deviation). (n=12 for the differing origins HFV (heads, frames and viscera), HF (heads+frames) and V (viscera only). n=18 for pH and centrifuge force). Different letters denote a significant difference between origin groups or treatments at the  $p<0.05$  level.

Origin	Total yield (%)
HFV	54.57 $\pm$ 8.39 <sup>a</sup>
HF	52.79 $\pm$ 13.28 <sup>a</sup>
V	57.06 $\pm$ 15.1 <sup>a</sup>
pH	Total yield (%)
11.3	60.4 $\pm$ 10.99 <sup>a</sup>
2.8	49.21 $\pm$ 11.29 <sup>b</sup>
Centrifuge force	Total yield (%)
High	54.45 $\pm$ 12.24 <sup>a</sup>
Low	55.16 $\pm$ 12.83 <sup>a</sup>



When we investigated proximate composition, we found that there were significant differences in proximate composition between the minced herring raw material and corresponding protein isolates produced with different treatments (Table 2). Protein concentrates contained significantly higher moisture than the corresponding original raw material. With all three raw materials, there was a significant increase in protein content from original raw mince to isolate from the pH shift process, up to a 150% increase. Lipid levels were significantly reduced from original raw mince to protein isolate, except for isolates which originated from gut, where lipids levels became more concentrated. Ash was also significantly reduced during the process, whilst an amino acid analysis showed that selected protein concentrates contained all the essential amino acids, in good quantities, which were comparable to the levels found in fishmeal.

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**Table 2:** Mean proximate composition ( $\pm$  standard deviation) from different treatments during the pH shift process (n=3) Mince represents the original raw material from the differing combinations, HFV (heads, frames and viscera), HF (heads+frames) and V (viscera only). Whereas isolate origin represents the mince from which the protein isolate originally came from before the pH shift process.

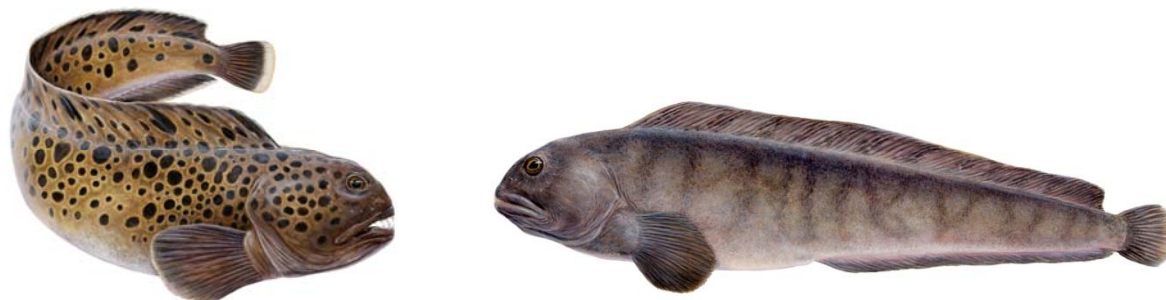
Mince	Moisture (%)	lipid (%dw)	EPA (mg/g dw)	DHA (mg/g dw)	Protein (%dw)	Ash (%dw)
HFV	70.3 $\pm$ 5.79 <sup>a</sup>	10.28 $\pm$ 1.31 <sup>a</sup>	1.87 $\pm$ 0.76 <sup>a</sup>	3.45 $\pm$ 0.61 <sup>a</sup>	38.10 $\pm$ 14.77 <sup>a</sup>	19.25 $\pm$ 9.34 <sup>a</sup>
HF	75.00 $\pm$ 2.84 <sup>a</sup>	10.81 $\pm$ 3.59 <sup>a</sup>	7.24 $\pm$ 2.70 <sup>b</sup>	10.73 $\pm$ 4.20 <sup>b</sup>	35.78 $\pm$ 4.27 <sup>a</sup>	19.65 $\pm$ 2.64 <sup>a</sup>
V	70.9 $\pm$ 2.12 <sup>a</sup>	10.92 $\pm$ 3.55 <sup>a</sup>	7.10 $\pm$ 1.63 <sup>b</sup>	10.87 $\pm$ 1.44 <sup>b</sup>	37.65 $\pm$ 2.96 <sup>a</sup>	12.71 $\pm$ 4.24 <sup>b</sup>
Isolate Origin						
HFV	91.35 <sup>a</sup>	7.58 $\pm$ 2.50 <sup>a</sup>	6.03 $\pm$ 1.94 <sup>a</sup>	15.23 $\pm$ 4.57 <sup>a</sup>	75.09 $\pm$ 12.75 <sup>a</sup>	5.31 $\pm$ 2.13 <sup>ab</sup>
HF	91.67 <sup>a</sup>	8.06 $\pm$ 3.87 <sup>a</sup>	5.73 $\pm$ 2.49 <sup>a</sup>	13.59 $\pm$ 4.78 <sup>a</sup>	75.56 $\pm$ 12.04 <sup>a</sup>	4.56 $\pm$ 1.64 <sup>a</sup>
V	93.4 <sup>a</sup>	12.90 $\pm$ 3.99 <sup>b</sup>	13.76 $\pm$ 5.19 <sup>b</sup>	27.00 $\pm$ 9.22 <sup>b</sup>	75.93 $\pm$ 16.16 <sup>a</sup>	6.75 $\pm$ 2.63 <sup>a</sup>
pH						
11.3	91.28 <sup>a</sup>	11.12 $\pm$ 4.63 <sup>a</sup>	10.76 $\pm$ 5.87 <sup>a</sup>	22.77 $\pm$ 9.76 <sup>a</sup>	77.64 $\pm$ 14.96 <sup>a</sup>	4.99 $\pm$ 1.91 <sup>a</sup>
2.8	92.99 <sup>a</sup>	7.33 $\pm$ 3.57 <sup>b</sup>	6.26 $\pm$ 2.74 <sup>b</sup>	14.45 $\pm$ 5.19 <sup>b</sup>	73.34 $\pm$ 12.31 <sup>a</sup>	6.27 $\pm$ 2.62 <sup>b</sup>
Centrifuge force						
High	90.5 <sup>a</sup>	7.70 $\pm$ 4.42 <sup>a</sup>	7.87 $\pm$ 5.31 <sup>a</sup>	18.33 $\pm$ 9.47 <sup>a</sup>	77.94 $\pm$ 11.84 <sup>a</sup>	5.04 $\pm$ 2.4 <sup>a</sup>
Low	93.78 <sup>b</sup>	10.75 $\pm$ 4.16 <sup>b</sup>	9.15 $\pm$ 4.85 <sup>a</sup>	18.88 $\pm$ 8.3 <sup>a</sup>	74.04 $\pm$ 15.02 <sup>a</sup>	6.22 $\pm$ 2.13 <sup>a</sup>

## Wolffish

### Background

The species for which the novel aquafeeds are being developed are themselves novel species in aquaculture, so that the challenge of RA4 is not only to develop feeds, but to establish a knowledge-base on the aquaculture biology of these species, in particular what their nutritional needs may be to ensure growth and welfare.

The marine fish species in focus are the two closely related wolffish species, the common (or gray) wolffish (*Anarhichas lupus*), and the spotted wolffish (*A. minor*). While previous and current efforts to produce wolffish in aquaculture have favored the use of the spotted wolffish, there are arguments for using the common wolffish as an aquaculture species on the Swedish west coast. Thus, the common wolffish is found along the coast and can be defined as a local species, and it may have higher thermal tolerance than its spotted cousin. While published data on growth rates and attained size favor the spotted wolffish, comparative studies are lacking. Thus, SWEMARC and RA4 will consider both species during the initial phase.



As mentioned, previous aquaculture efforts have focused on the spotted wolffish. It emerged as a candidate for cold-water aquaculture in Norway, Iceland, Canada, and even Chile in the 1990's. The first artificially fertilized eggs were hatched in 1994, and in the ten years that followed, a complete production line was established, supplying the Norwegian and Swedish restaurant markets with more than 100 tons/year at 8-12 €/kg for fish with harvest sizes of 3-5 kg. The prospects of the spotted wolffish aquaculture industry were promising as the species could be described as an ideal aquaculture candidate with attractive characteristics, including high specific growth rates at high culture densities, a high fillet yield, non-aggressive behavior and limited disease problems. Further, the hatched larvae are well-developed and ready to be fed on formulated feed. This has allowed most of the traditional bottlenecks often experienced in production of marine larvae to be avoided. Wild-caught spotted wolffish is not a commodity readily available throughout the year. Icelandic and Norwegian landings of wolffish have been about 15.000 tons annually, mainly for export to other Scandinavian countries, but also to Germany and France. It is generally recognized as a high quality product, and thus a high-price aquaculture niche species. At the only commercial wolffish farm in Norway, fillets were sold to wholesalers for 13-14 €/kg in 2007, and although distribution was limited to a few wholesalers in Norway and Sweden

Due to some serious technical mishaps and lack of venture capital, commercial production ceased in 2007, and it is only since 2015 that a new, commercial wolffish producer, Aminor AS, has been established in northern Norway.

## Research

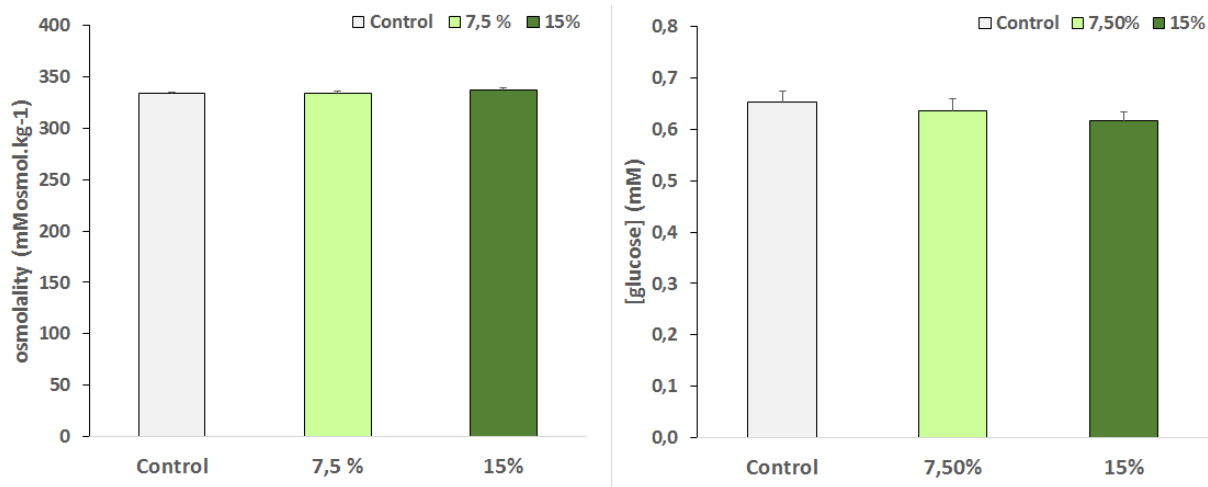
### *Experiments at Bodø, Norway*

Studies on the potential benefits of microalgae supplementation in spotted wolffish diet were discussed and planned during a visit by the UGOT team to the Faculty of Biosciences and Aquaculture, at Nord University, Bodø, Norway, in December 2016.

The experiment was initiated in January 2017 and will be concluded in April 2017, after 12 weeks of exposure to the three different diets.

The fish were obtained from the local, commercial wolffish producer, Aminor AS. At the start of the experiment, all the animals were measured, and 13 individuals were sampled for gut, liver, muscle and skin tissue as a T<sub>0</sub> reference. Subsequently, feeding with the experimental diets was initiated, with three tanks receiving each of the three diets, containing 0, 7.5 and 15% microalgae supplementation. On February 20, after 6 weeks of exposure, a mid-term sampling was carried out. In addition to biometrical data and tissue sampling, blood was collected from 13 individuals per tank, and brain tissue collected from 4 individuals per tank. This was done in order to evaluate the impact of the different diet on stress, metabolism and appetite regulation. The final sampling is scheduled for April 3, 2017. In addition to the parameters previously assessed, the impact of the different diets on the intestinal barrier function will be assessed through the use of Ussing chambers.

The experiment is on-going and thus, the data on growth and physiology from the mid-term sampling are still under analysis. So far, plasma osmolality and glucose levels have been assessed and these parameters indicate no adverse effects of diet supplementation by microalgae.



### ***Experiments at Grindavík, Iceland***

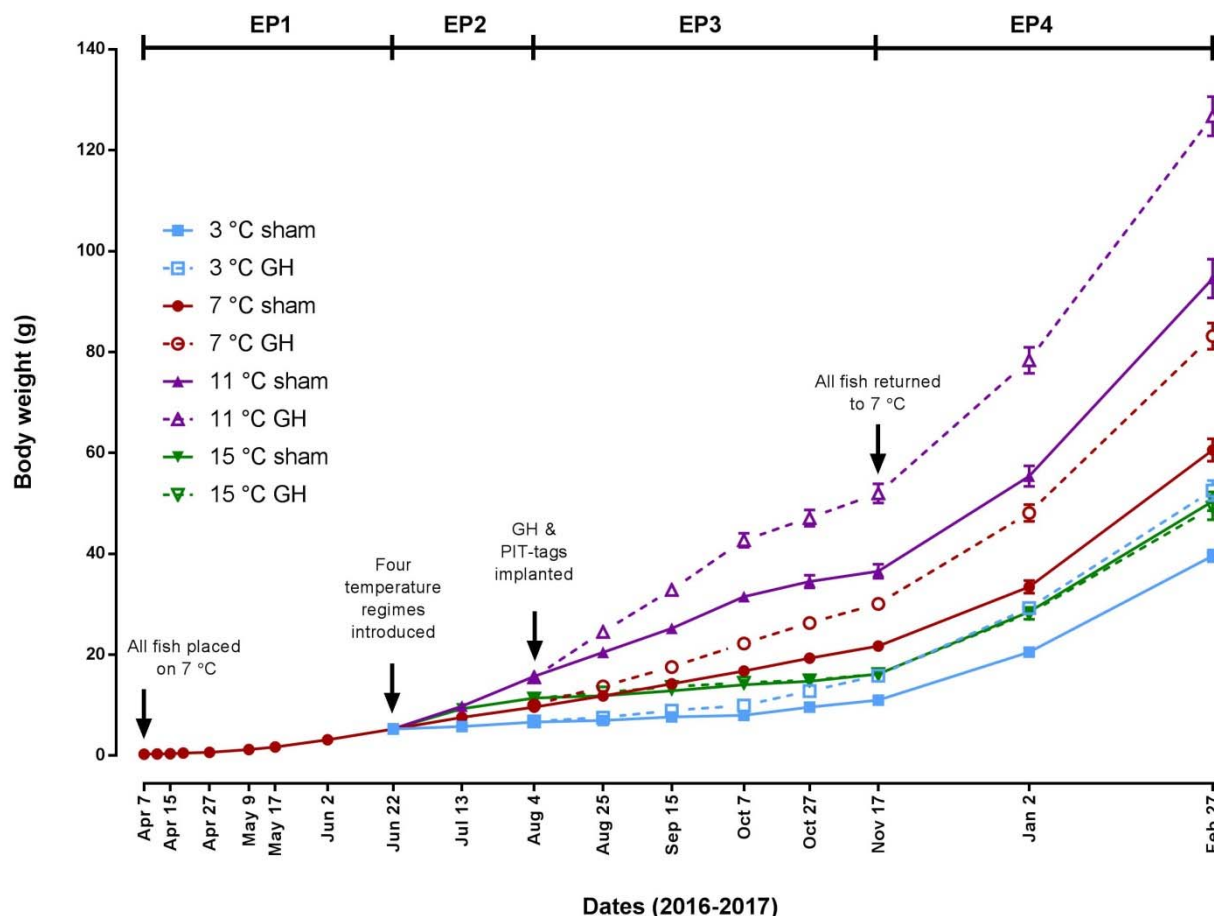
In collaboration with the Icelandic Marine Research Institute (Hafró), a long-term experiment on the juvenile growth of spotted wolffish was initiated in March 2016 and is still ongoing.

Wild egg clutches were obtained by annual bottom-trawling survey by Hafró research vessels and brought to the aquaculture research facilities at Stadur, Grindavík, Iceland.

Hatching and initial yolk-sac larval stage growth was carried out at 7°C (Experimental Phase 1; EP-1).

On June 22<sup>nd</sup>, the larvae were divided into four groups and exposed to culturing temperatures of 3, 7, 11 or 15°C (EP-2), in order to access maximal growth temperature. Subsequent analysis of EP-2 revealed maximal weight growth to occur at 12 °C, but also that growth is good also at lower temperatures of 8-12 °C. As 3 °C, growth is quite slow, but may mimic natural winter conditions. On the other hand, it became also clear that a temperature of 15 °C is very close to the thermal limit of the fish and clearly detrimental for their growth and welfare.

On August 4<sup>th</sup>, half of the fish in each group were given a slow-release growth hormone (GH) implant, while the other half of the fish received sham implants, and growth subsequently monitored over a 9-week period (EP-3). This was done as GH is known to be a potent growth stimulator and can thus reveal “maximal growth potential” of the fish at the various culture temperatures. The subsequent analysis revealed that the GH implant increased both weight and length growth by about 30% in the 3, 7, and 11 °C groups, while in sharp contrast, GH was unable to induce any additional growth at 15 °C, again indicating that this is a near-lethal temperature and key physiological growth processes are being disrupted.



On October 7<sup>th</sup>, all the experimental groups were brought back to the original hatching temperature of 7 °C and Experimental Phase 4 (EP-4) initiated. The purpose of this ongoing EP is to understand if early exposure to different temperature regimes will have long-term effects on growth. A hypothesis, based on observations of wild populations is “optimal” growth temperature during early juvenile development may not result in optimal adult growth.

## Lobster

Gravid female lobsters (*Homarus gammarus*), were caught during autumn 2015, and maintained (“overwintered”) individually in perforated boxes (40L) immersed in a flow-through system with water taken from *ca.* 33m depth. Temperature and salinity varied with season, and maintained within the range of 6-17°C and 31-32‰ respectively. Egg development was monitored every 4-6 weeks, and quantified according to Perkins eye index (1972). The time of hatching was controlled by small adjustments in water temperature (<1°C per day) and temperature at hatching was set to ≈18.5°C. Hatched larvae of discrete provenance was collected, counted and divided between experimental vessels. Larvae from different broods hatched from February to August 2016, providing enough larvae for six different feed experiments on larvae and one on post-larvae (PL). Experimental temperature and salinity was on average 19.2±0.2°C and 32±2 ‰ respectively.

### Larval experiments.

Larval experiments were conducted in 70L cylindroconical vessels i.e. hoppers, installed by Shellfish Hatchery Systems Ltd (Orkney, UK). Hopper water inflow (2.5L/min) and outflow (1mm grade filter) placement is at the top of the vessel. Rigorous aeration was provided from the base of the hopper. Every 2-4 days, larvae were temporarily removed and counted and at the same time the hoppers were cleaned. After 14 days, surviving larvae were placed into Aquahive trays (Shellfish Hatchery Systems Ltd) and floated upon the





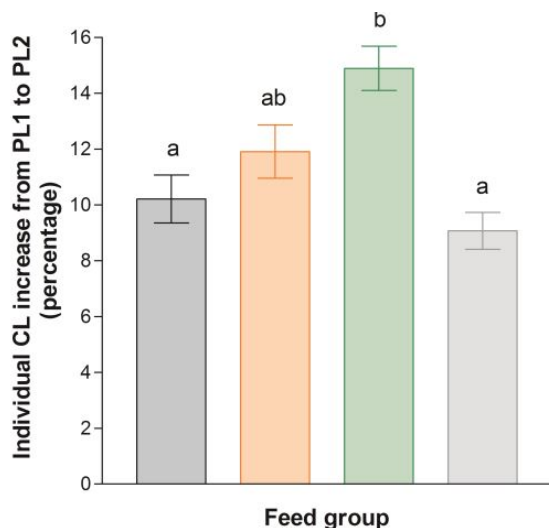
**Figure Left:** Hatching systems. **Centre** 70L hopper system **Right** Floating Aquahive trays with postlarvae.

hoppers with slight aeration, for <7 days to allow larvae to metamorphose to PL. Survival, developmental stage and size were measured in larvae at day 4, 8, 12 and 14 survival. Differentiation between the zoal stages Z1-3 used key attributes such as overall size, eye shape and telson shape (Nichols and Lawton, 1978). For carapace length (CL), subsamples of larvae were removed from hoppers and photographed with the dorsal carapace uppermost. Larvae were accrued in hoppers over 2-3 days, and larvae from the same brood were shared and rationed equally according to provenance on each successive day. Larval stocking density averaged  $850 \pm 150$  larvae per hopper for the different experiments. Larvae were fed wet feed (sterile copepods, Planktonic AS), dry feed (Otohime fish feed) or dead wet conspecifics. Full details of larval experiments are available in a recently published article (Powell *et al.*, 2017).

**Results and conclusions.** The results of the larval experiments suggest that dry feeds with appropriate physical attributes (suitably robust and buoyant to allow distribution across a high energy hopper) are satisfactory for rearing lobster larvae. Results are however highly brood-specific. Dry feeds offer advantages in terms of batch quality and consistency, storage and transport. The use of dry feeds in automated feeders offers further optimisation in terms of reduced labour and mechanisation, and potentially faster development and larger larvae. One experiment indicated that smaller grades of feeds may offer further advantages in terms of larval quality, perhaps due to a greater feed encounter rate or faster handling time. The impact of cannibalism in typical communal hopper-like rearing systems is confirmed. Unfed hoppers suffered from lower survival and slower development than hoppers provided with dry feed; however survivors were larger at Z3 stage. In addition, individually reared larvae (i.e. protected from cannibalism) fed dry feeds were outperformed in terms of survival, development and growth by larvae in the group fed dead conspecifics. The larval experiments suggests that dry feed alone is insufficient to rear lobster larvae, and that surviving larvae in all the hopper based experiments in 2016 had likely, to some degree, benefitted from nutrition arising from cannibalism. Admittedly, the commercial feed used is not designed for lobster larvae, but it is likely to have acted as a food supplement.

#### **Post larvae experiments.**

PL were recruited within 12h hours of metamorphosis and evenly assigned to an array of Orkney cell matrices (5 x 10 cells). Matrices were suspended in hoppers and provided with 1.5L inflow/minute, and aeration. Every PL was provided with an excess (4 pellets/feeding event, twice per day) of 4 proprietary dry feeds *ca.* 1.5mm which. These included 3 feeds (1-3) with increasing amounts of vegetable protein (pea/potato/wheat) replacement of fish meal (a kind gift from Norwegian Lobster Farm AS) and a prototype feed (made by Nomaculture) based on herring protein isolate. Individual cells were cleaned once per day and inspected for mortalities or moults; The CL of all PL was also measured 24h after stocking and after a subsequent moult, to allow absolute length and moult increment to be calculated.



**Figure** Percentage increase in moult increment.  
Different letters denote statistical significance at  $P < 0.05\%$ , error bars  $\pm 1\text{SEM}$ .

**Results and conclusions.** Post larval lobsters fed feeds 1-3 suffered from higher mortality and experienced fewer moulting events than the Nomaculture prototype feed. However, the final proportions of dead PL1, successful PL2 moults were not significantly different. Furthermore, the quality of the PL2 offered Nomaculture was poorer, since nearly half of the surviving PL2 suffered from some degree of exuviae entrapment and eventually died. In terms of growth (both absolute CL, and moult increment i.e. percentage increase of CL from PL1 to PL2 stage), feeds 2 and 3 showed better growth, compared to feed 1 and Nomaculture prototype feed. Onward survival and moulting from PL2 to PL3 was also superior for feeds 2 and 3.

These findings, suggest further investigation could concentrate on feeds 2 and 3 alongside revised versions of novel Nomaculture feeds. Subsequent Nomaculture feeds may note earlier research on the role of phospholipids in reducing “Moult Death Syndrome” or “Exuviae Entrapment syndrome” and the role and importance of astaxanthin (from algal or plant sources) in aquaculture feeds. Three improved novel diets have been formulated for PL lobsters (based on shrimp, mussel and herring meal, plus a typical fish meal control) and these will be tested in 2017.

#### 4.1.5 RA5

*Scientist in charge: Lena Mossberg*

Discussions have been held with Maria Nyström and Carl Johan Skogh at the Academy of design and crafts (HDK) about initiating a project about seafood with particular focus on blue mussels. It will be a focus area in a new design course on master level at HDK. A lecture by Lena Mossberg on shellfish and place branding was held in Grythyttan Spring 2016 at the Granquist symposium. A discussion has also been held with researchers linked to sensory analysis in Grythyttan about future studies. A lecture and workshops were also held by Lena Mossberg in Patagonia, Chile with participants from both industry and official authorities linked to tourism, food, restaurants as well as to aquaculture.

A preliminary agreement with Guest professor Kåre Skallerud has been suggested. Professor Skallerud was here giving a lecture at the inauguration of Swemarc. During his visit the project was discussed and a preliminary work plan was carried out. A number of articles have been published by the Mossberg research group: An article on food, storytelling and concept development has been accepted for publication in European Planning Studies. A special issue on food has been a major concern during 2016 and it was accepted for publication in Scandinavian Journal of Hospitality and Tourism during the year. It is now published with three articles, see also appendix 1.

1) Sandhiya, Goolap and Lena Mossberg (2017), Exploring the concept of extraordinary related to food tourists' nature-based experience, *Scandinavian Journal of Hospitality and Tourism*, 17(1): 27-43.

2) Andersson, Tommy and Lena Mossberg (2017), Travel for the sake of food, *Scandinavian Journal of Hospitality and Tourism*, 17(1): 44-58.

3) Andersson, Tommy, Lena Mossberg, and Anette Therkelsen (2017), Food and tourism synergies: perspectives on consumption, production and destination development, *Scandinavian Journal of Hospitality and Tourism*, 17(1):1-8.

The PhD student within foremost RA6 will also work in collaboration with the group connected to RA5. The research area for the position has been defined and an announcement has been made at the School of Business at the School. The planning for the International Congress on Coastal and Marine Tourism, 2017 started during 2016. This Congress is also linked to the RA5. Please refer to RA6 for more information about the Congress.

#### 4.1.6 RA6

*Scientist in charge: John Armbrecht*

Initiation of a group interested in studying the geographical areas which are best suited for establishing aquaculture. Carl Dahlberg has finalized an initial effort to identify areas in Northern Bohuslän where the establishment of aquaculture is possible from a biological/ecological perspective. The initiative partly takes into account the interests of the tourism industry and leisure sector as well. Kristina Lindström at the Centre for Tourism and West Sweden Tourist Board is responsible for continuing developing layers in GIS which reflect the interests of the tourism industry. Within RA6 there is a need to continue and build upon this mapping process to identify and analyze areas which are of particular interest for the marine industries. A secondary benefit is to showcase how GIS can be used as a tool for urban planning. Primary stakeholders: Tourist Board in western Sweden; Kristina Lindström, Carl Dahlberg, Northern Bohuslän Tourism, Municipalities, Anders Larsson, John Armbrecht

An important part in the development of aquaculture is the inclusion of the local population. Creating acceptance is a precondition for a joint coexistence with e.g. maritime tourism. To enhance skills in the maritime field, researchers in and related to SWEMARC have sent in a bid and received approval to organize the International Congress on Coastal and Marine Tourism, 2017. The conference title is "Global Challenges, Local Solutions". Research that is of relevance to SWEMARC is presented. Individuals and organizations in other countries working with similar challenges as SWEMARC are invited to build new and strengthen existing networks. Particular focus is to involve researchers and practitioners from the "Global South" that might otherwise have limited opportunities to participate in similar conferences.

Organizing committee:

Dr. John Armbrecht, Head of Centre for Tourism

Dr. Kristina Lindström, Researcher at Centre for Tourism & the Unit for Human Geography

Dr. Erik Lundberg, Researcher at Centre for Tourism & Marketing

Dr. Andreas Skriver Hansen, Researcher at the Unit for Human Geography & CFT

Marie Örninge, External Relations, School of Business, Economics and Law

Kajsa Folmeus Strandberg, Communication Officer, School Business, Economics and Law

One PhD student will be employed within RA6 in 2017. The research area for the position has been defined and an announcement has been made at the School of Business at the School. Tutors should be selected to allow for interdisciplinary research.

A review of the literature in the field of 'locals' attitudes' has been compiled. Relevant concepts and terms are identified. Scales to approach some objectives of the RA 6 are identified. The review will later on be prepared for submission to a scientific journal.

Contact has been established with municipalities in northern Bohuslän, Lantmäteriet and SOM-institute to carry out studies on the attitudes of local people with acceptable samples and data quality.

#### 4.2 Recruitments

Three PhD-students have been recruited during SWEMARCs first year (affiliated with Dept law, Dept of Biological and Environmental Sciences, and Dept Marine Sciences), the recruitments of these three are described below. A fourth PhD-student will be recruited during 2017; the announcement has been made at the School of Business and Economics. SWEMARC was also fortunate to be able to get the opportunity to employ a "scholar at risk" as a research engineer for at least one year (MISTRA). With funding from MISTRA within the project Nomaculture, which is part of SWEMARC, we have also recruited a post-doc for two years. For all recruitments, our ambition to strengthen the transdisciplinary environment and facilitate for collaborations across subject borders. The young scientists recruited will benefit from SWEMARCs transdisciplinary environment through planned networking activities, to secure that they get to know each other, and opportunities and meeting places for them to interact and exchange knowledge. One

such already existing activity is the Thursday seminars arranged by Sea and Society that all PhD-students should participate in, and which will be followed by discussions and reflections. The PhD-students will also be encouraged to sign up for the transdisciplinary aquaculture course in the fall 2017. In our plans we have also included meetings between the PhD students and the guest professors during their visits, the guest professors themselves have clearly stated that they wish to prioritize this. One aim with such meeting is to discuss and formulate research questions and get advice on experimental design. Furthermore, the supervisor groups for each PhD student are organized so that they should contain researchers from at least two different disciplines. Thus, we assure a transdisciplinary supervision but we also recognize the need for the PhD-students to focus on scientific questions within their discipline, to be able to publish in good quality journals and to become experts within a subject.

#### **4.2.1 PhD-students**

Two persons applied for the PhD position at the Law Faculty, one woman and one man. The man was a Swedish national, the woman was residing in Sweden and had a background in Slovakia and Hungary. Both were interviewed by the Research Committee of the Faculty of Law. Eventually, the male candidate, Jonas Nilsson, was selected. He was deemed to have significant experience of working with EU and Swedish regulatory issues pertaining to aquaculture.

The total number of applicants for the PhD-position in Natural sciences with specialization in biology, marine fish physiology and aquaculture was 71; 2 females and 69 males, and 18 nationalities. Five of the applicants were called for interview (1 female, 4 males, 3 nationalities). The evaluation committee consisted of Associate Professor Elisabeth Jönsson Bergman, Professor Kristina Sundell, and Professor Björn Thrandur Björnsson, and PhD-student James Hinchcliffe. After the first evaluation the top five candidates from the evaluation short list were called for interviews. Two of the interviews were done through Skype since the applicants came from abroad, and three were done in person. A number of questions were prepared on beforehand, and a number of the same questions were asked all candidates. Each interview took about 1 hr. After the interviews, Ida Heden was offered the position which she accepted. She held such educational background (MSc.) and merits that she were assessed to be able to successfully carry out the PhD-studies and research tasks outlined in the position.

Matthew Hargrave from England with a Master Degree in Marine Biology from University of Plymouth, was offered the third PhD-position that was announced 2016 within SWEMARC, with placement at the department of Marine sciences, Tjärnö. There were 66 applicants, 24 women and 42 men from >10 countries. Three candidates were called to Skype-interviews, and two of them to a physical meeting and a written test at Tjärnö. The selected candidate was deemed to be well qualified and highly motivated to take on the PhD-position.

#### **4.2.2 Research engineer**

Fayez Alsaleh was recruited through a “Scholar at risk” initiative, funded by the strategic research council Mistra. He was appointed after the summer, with placement at the research station Kristineberg where he works with the lobster farming.

#### **4.2.3 Post-doc**

A post-doctoral position in fish physiology with focus on fish farming biology and marine aquaculture was announce within the Nomaculture project, which is a part of SWEMARC.

The position was announced in June and the evaluation was completed in September. The number of applicants was 17, 2 females and 15 males, 8 nationalities. 3 persons were called for interview (3 males, 2 nationalities). The evaluation committee consisted of associate Professor Elisabeth Jönsson Bergman, Professor Kristina Sundell, and Professor Björn Thrandur Björnsson. After the first evaluation the top four candidates from the evaluation committee’s short list were called for interviews. All interviews were done through Skype, to give an equal situation for all candidates, and each interview took about 1 hr. The candidates were allowed to give a 10-minute presentation of themselves in the beginning of the interview. The chosen candidate, Jonathan Roques, held such research experience and merits that he was assessed to be



able to successfully carry out the job assignments outlined in the position. Dr Roques had the highest merits in terms of publications among the candidates. Dr Roques had working experience from aquaculture research, including fish, RAS systems and farming conditions, and physiological competence and techniques. Dr Roques also has experience from research collaboration and supervision.

### 4.3 Research collaborations (incl. international)

The starting of SWEMARC opened up for the recruitment of three world-leading guest professors, which was the start of new collaboration. **Prof Yongqi Lou** received a visit from Prof. Maria Nyström, at Tongji University in Shanghai (Gothenburg's sister city) at the College of Design and Innovation, which focuses on "seafood culture". Maria gave a lecture and presented SWEMARC at the Tongji University and Prof Lou's coming guest professorship and cooperation in SWEMARC were discussed. Prof Yongqi Lou will hopefully be involved on SWEMARC's participation in Almedalen 2017.



**Prof. Barry Costa Pierce** was awarded as the holder of the KSLA Wallenberg Professorship 2017, and was installed in the City Hall of Stockholm 28th January 2017. During this visit, he also spent some days discussing plans and activities within SWEMARC Kristina Sundell. They both also attended a meeting with Henrik Östergren at Stockholm resilience center, who is one of the scientists in charge of the keystone dialogue initiative "Seafood Business for Ocean Stewardship". Prof Costa-Pierce will start his guest professorship with a first visit Göteborg in May 2017. He will then focus on speaking with the new PhD students and post docs in SWEMARC and work with planning of the coming PhD course (see below) and the coming Master program. Barry Costa Pierce also spent a few days in Sweden in September 2016, for the SWEMARC inauguration. Then he also visited both marine research stations at the Sven Loven center for marine infrastructure at Tjärnö and Kristineberg to see the experimental facilities and meet the researchers. **Prof Kåre Skallerud** will start his guest professorship with a one month long stay in Göteborg, probably from mid-September to mid-October. He presented his research at the SWEMARC inauguration in September. Prof Skallerud would also like to meet with the young researchers but also to discuss consumer and public attitudes and markets for aquacultured products with all interested.



SWEMARC has already at the start a strong scientific and stakeholder network. Four of the SWEMARC researchers are board members in the Swedish National Competence Center for Aquaculture (NKfV; <http://www.nkfV.se/>), Susanne Lindegård is the coordinator of the Maritime cluster in West Sweden (<http://maritimaklustret.se/english/>) and Sundell is a member of the Swedish Aquaculture council (Swedish board of agriculture) and the Swedish representative in the ICES working group on aquaculture, WG-AQUA. Together with active project collaboration with several aquaculture oriented university units and institutes in Sweden, this reflects the strong network and ongoing national collaboration in the area. Internationally, SWEMARC members have numerous long-term collaborations with internationally leading universities, research institutes and aquaculture operations. This includes leading European mariculture countries such as Norway, Iceland, Denmark, Great Britain, Portugal and Spain. Also USA, Canada, Japan and New Zealand are parts of present collaborative networks, as well as South Africa and China through MISTRA (Urban futures), UN Habitat and CUMULUS networks on design for social innovation.

During 2016, the strong international aquaculture network of SWEMARC has expanded and been reinforced, not the least with end-users. We have established collaboration with Scanfjord Mollösund AB, Sweden and the Norwegian company Akvafuture AB. SWEMARC is also cooperating, within the MISTRA funded project Nomaculture, with Smögenlax AB with RAS-systems in Kungshamn. From 2017, the project BioDras has been granted funding by the European Maritime and fisheries fund (coordinated by Innovatum) for continued development of this RAS with focus on microbial filters. Another major industrial research focus of SWEMARC is the cooperating with the only Norwegian commercial wolffish farmer, AMINOR AS. This collaboration also includes the academic partners Nord University in Bodø and Aquaplan Niva in Tromsø. New collaboration with an Icelandic partner, the Icelandic Marine Research Institute (Hafró), has also been initiated. SWEMARC further is the main applicant for an IMTA project

(funding from the European Maritime and Fisheries Fund) which involves industry collaboration. A new collaboration with the group of with Prof. Dr. Shaojun Pang at the Institute of Oceanology, Chinese Academy of Sciences (IOCAS) in Qingdao, China, working with marine algae farming has also been established.

#### **4.4 Scientific publications**

Please see appendix 1.

#### **4.5 Conference participation**

Please see appendix 1.

#### **4.6 External grants**

Several external grants within the SWEMARC framework have been awarded. These include a 5-year research project about IMTA-systems, funded by the Norwegian research council. The project BioDras, coordinated by Innovatum, was awarded the European Maritime and fisheries fund, with start 2017. The BONUS-OPTIMUS (“Optimization of mussel mitigation cultures for fish feed in the Baltic Sea “ will address several dimensions of carrying capacity (environmental impacts, mitigation, socio-economic analyses, mussels as fish-feed etc.) and will provide new international national links and collaborations to SWEMARC. The project involves Danish, Swedish, German and Polish partners on sustainable aquaculture in the Baltic Sea and has a total budget €2 983 209 GU is Swedish contractor with a budget of €354 179. One research engineer has recently been recruited to this project funded by MISTRAs program for “scholars at risk”. A 5-year bilateral SIDA-program between Mocambique and UGOT has been partly funded and is also under negotiation for more funding. The aim of this program is for African students to do Ph D or post docs part time in Mocambique and part time I Göteborg. The program will start summer of 2017. So far, 2 Ph D students and 1 post docs have been funded to work with Aquaculture related questions: *Aquaculture and seeding of oyster*, *Conservation biology of portunid crabs*, *Sustainable aquaculture of prawns*, and will thus be part of SWEMARC. These students will spend half their time in Sweden.

SWEMARC has further received co-financing for 2017 by VGR (1.1 million SEK for 2017), the Wallenberg guest professorship/KSLA, awarded to Barry Costa-Pierce (1.2 million SEK). Another awarded grant 2016-2021 where H Pavia was co-applicant is “Brown algae as feed additive in chicken diets - for a sustainable production and safe consumption”. A first stage proposal has also been submitted to the EU Horizon 2020 call Eointensification and three applications are under negotiation with the European Maritime and Fisheries fund.

### **5 Education**

#### **5.1 Description and reflection**

Higher education as well as courses and activities directed towards stakeholders are an important part of the SWEMARC engagement. A lot of University courses are already ongoing within the different departments and discussions around development of these courses to create interaction and involvement of complementary competences are ongoing, to change the course syllabus to be more transdisciplinary. One main aim of SWEMARC is to investigate the possibilities to build more joint educational efforts, both at the level of targeted courses for stakeholders and at the level of university programs and courses. Discussions of several approaches are ongoing within SWEMARC and in collaboration with the Center for Sea and Society e.g. regarding joint Master programmes and PhD courses.

#### **5.2 Activities**

SWEMARC together with NKfV arranged a tailor-made course on the subject ”How to start an aquaculture business – focus on legal and environmental aspects”. The course was held between December-February and consisted of web assignments and a three day intensive on-site course with lectures and discussions, which was held at Tjärnö marine research station. The course attracted 35 entrepreneurs and regional/local officials and the course was highly appreciated and sought after (read more <http://swemarc.gu.se/aktiviteter/kurser>).

SWEMARCs international engagements include cooperation with universities and organizations in Southern Africa (Kenya, Mozambique and South Africa). As examples, student and staff exchange is planned between the Nelson Mandela Metropolitan University in Port Elizabeth (SA) and UGOT. Also a 5-year bilateral SIDA-program between Mocambique and UGOT has been partly funded and is also under negotiation for more funding. The aim of this program is for African students to do a PhD or post docs part time in Mocambique and part time in Göteborg. The program will start summer of 2017. Two Ph D students and three post docs that will spend half their time in Sweden have been funded so far. Three projects on Aquaculture are included:

- Aquaculture and seeding of oyster
- Conservation biology of portunid crabs
- Sustainable aquaculture of prawns

An international trans-disciplinary PhD course *Transdisciplinary approaches to sustainable marine aquaculture* is planned in November 2017, to be held at SLC Kristineberg and Tjärnö. During 2016 the course was planned and a syllabus was created (see Appendix 2). Teachers will be from the different disciplines in SWEMARC, as well as externally invited. The guest professors have been involved in the planning and will also teach on the course.

A curriculum for a Nordic master in Sustainable Aquaculture is under development. This programme is planned to be transdisciplinary in its form and methodology and goes currently under the working name “Sustainable food production from the ocean”. Discussions are ongoing between the GU and the University college of Holar, Iceland, DTU, Hirtshals, Denmark, The Northern University, Bodö, Norway and University of New England, USA and an application to the Nordic Council is planned for September. SWEMARC is also involved another transdisciplinary master programme that are jointly planned within the Center for Sea and Society, with the working name: Master programme in Sea and Society.

## 6 Complete academic environments

### 6.1 Description and reflection

SWEMARC has, already from the planning stage, taken a “complete academic environment-perspective” as reflected in the organization of SWEMARC (Fig 1) with its two major parts in MARC-research and MARC-society (both education and cooperation). We have specific coordinators for both research (E Jönsson Bergman) as well as cooperation (S Lindegarth). We also have a designated communicator; Maria Holmkvist. Overall responsible for development of educational activities in SWEMARC is the leader K Sundell, who has so far worked together with Barry Costa Pierce and Maria Nyström among others, to create transdisciplinary PhD-course and she has also devoted time to launch a new Nordic Master programme in aquaculture in the future. Equally important is to spread new knowledge to the public and stakeholders and we place great emphasis on educational outreach activities. The transdisciplinary nature of the research within SWEMARC calls for an approach that engages society; for example the research involving participatory design, and citizen surveys in municipalities. SWEMARC also works tightly together in dialogue with entrepreneurs in identifying relevant research questions, and have an external advisory board that can give further input to societal relevance. The core of SWEMARC is the young scientists, not the least the new PhD-students that can focus on the hands-on research and move the field forward scientifically. They will be fostered in a complete academic environment, with teaching and outreach included in their working tasks.

## 7 Economy: Expenses and active persons

### 7.1 Description and reflection

SWEMARC is overall following the planned budget for the first year. However, due recruitment of new personal sometimes being a slower process than anticipated the costs for new personal has stated a bit later than planned. The main discrepancy from budget is that none of the 4 PhD students were accepted and could start their positions during 2016, whereas in the budget it was planned that all 4 should have been payed salaries during 6 month of 2016. However, 3 PhD students are now appointed and the last is announced for so the costs for the PhD students will start to be used during 2017.

## 7.2 Economic report 2016 and Q1 2017

SWEMARC - UGOT CHALLENGES vid Göteborgs universitet - Ekonomisk uppföljning år 2016 och för Q1 2017										
2016	Ansvar 3150	Ansvar 2220	Ansvar 2260	Ansvar 2490	Ansvar 3020	Ansvar 3130	Ansvar 3151	Ansvar 3152	Ansvar 6300	Summa
<b>Totala intäkter</b>	-803 664	-825 527	-615 683	-181 884	-121 548	-1 794 746	-424 440	-1 577 004	-240 504	-6 585 000
- varav anslag	-803 664	-825 527	-615 683	-181 884	-121 548	-1 794 746	-424 440	-1 577 004	-240 504	-6 585 000
- varav interna bidrag										0
- varav externa bidrag										0
<b>Totala kostnader</b>	0	314 555	0	140 797	2 566	571 273	418 974	0	227 345	1 675 509
- varav personalkostnader		196 796		13 329	1 199	256 882	271 078		132 681	871 966
- varav driftkostnader		27 450		122 171	995	139 298	62 335		11 219	363 467
- varav resekostnader		6 952				19 694	297			26 943
- varav publikationskostnader										0
- varav interna bidrag				789						789
- varav indirekta kostnader (OH)		83 357		4 507	372	155 399	85 264		83 445	412 343
<b>Utfall</b>	-803 664	-510 972	-615 683	-41 087	-118 982	-1 223 473	-5 466	-1 577 004	-13 159	-4 909 491
2017 Q1, daterad 2017-03-31	Ansvar 3150	Ansvar 2220	Ansvar 2260	Ansvar 2490	Ansvar 3020	Ansvar 3130	Ansvar 3151	Ansvar 3152	Ansvar 6300	Summa
<b>Totala intäkter</b>	-110 853	-399 474	-171 516	-43 290	-68 379	-711 258	-151 782	-165 304	-240 072	-2 061 928
- varav anslag	-110 853	-399 474	-171 516	-43 290	-68 379	-711 258	-151 782	-165 304	-240 072	-2 061 928
- varav interna bidrag										0
- varav externa bidrag										0
<b>Totala kostnader</b>	11 602	100 374	0	13 659	0	566 022	121 735	431 166	63 887	1 308 445
- varav personalkostnader	0	72 229		10 094		349 544	76 240		44 441	552 548
- varav driftkostnader	9 444					53 526	5 743	15 488		84 201
- varav resekostnader	9 444					36 245	5 743	2 760		54 192
- varav publikationskostnader										0
- varav interna bidrag								415 678		415 678
- varav indirekta kostnader (OH)*	2 158	28 145		3 565		162 952	39 752		19 446	256 018
<b>Utfall</b>	-99 251	-299 100	-171 516	-29 631	-68 379	-145 236	-30 047	265 862	-176 185	-753 483

\* ) De direkta kostnaderna är ofullständiga eftersom OH-triggern körs första veckan i april för mars månad.

to be compared with the overall budget for SWEMARC 2016-2022:

Budget hela perioden							
	2016	2017	2018	2019	2020	2021	Sum
<b>Direkta kostnader</b>							
Lönekostnader	2 822 863	6 032 332	8 468 808	6 956 517	3 416 219	2 808 801	30 505 541
Driftsmedel	437 684	1 044 881	1 457 599	1 375 432	709 327	426 570	5 451 492
Utrustning	0	0	0	0	0	0	0
Lokalkostnader	440 196	922 794	1 245 007	1 043 761	556 565	452 820	4 661 143
Totala direkta kostnader	3 700 743	8 000 006	11 171 414	9 375 710	4 682 112	3 688 192	40 618 176
<b>Indirekta kostnader</b>	1 307 254	2 887 943	4 194 961	3 553 950	1 699 162	1 313 199	14 956 468
<b>Totalt budgeterade kostnader</b>	<b>5 007 996</b>	<b>10 887 950</b>	<b>15 366 375</b>	<b>12 929 659</b>	<b>6 381 273</b>	<b>5 001 391</b>	<b>55 574 644</b>

Granted funding from UGOT Challenges and expected co-financing from Västra Götalandsregionen (VGR):

	2016	2017	2018	2019	2020	2021	2022	TOTALT
<b>UGOT-challenge</b>	6 585 000	6 585 000	8 220 000	8 245 000	8 245 000	8 245 000	3 330 000	49 455 000
<b>VGR</b>	840 000	1 100 000	1 100 000	1 100 000	1 100 000	1 100 000		6 340 000
<b>Summa intäkter</b>	7 425 000	7 685 000	9 320 000	9 345 000	9 345 000	9 345 000	3 330 000	55 795 000

Expected results SWEMARC the entire period:

	2016	2017	2018	2019	2020	2021	2022	TOTALT
<b>Resultat:</b>	2 417 004	-3 202 950	-6 046 375	-3 584 659	2 963 727	4 343 609	3 330 000	220 356

## 7.3 Members and organization

The general assembly currently has 47 members at the University of Gothenburg (see appendix 3), representing expertise from four faculties; the natural and social sciences, business economics and law, Social Sciences and Fine, Applied and performing arts. Three international guest professors are affiliated. Professor Kristina Sundell at the Department of Biological and Environmental sciences is the director of SWEMARC. She is the chairman of the management group, which has the following members:

- Björn Thrändur Björnsson, Dept. Biological and environmental Sciences. Deputee member: Susanne Eriksson, Dept. Biological and Environmental Sciences
- David Langlet, Dept of Law



- Maria Nyström, Academy of Design and Crafts
- Henrik Pavia, Dept. Marine Sciences. Deputy member: Mats Lindegarth, Dept. Marine Sciences
- Bengt Liljeblad. Dept Earth sciences
- Lena Mossberg, Dept of business administration. Deputy member John Armbrecht, Dept of business administration
- Susanne Lindegarth, Dept of Marine Sciences
- Elisabeth Jönsson Bergman, Dept of Biological and Environmental Sciences.
- Johan Martinsson, Dept of Political sciences, co-opted member. Deputy member: Niklas Haring, Dept. of Political Sciences.

The steering board has had regular meetings every 4 weeks during the first project period – a total of 8 meetings during 2016.

The executive group runs and coordinates the daily activities in SWEMARC and has regular meetings at least once per week. It consists of the director Kristina Sundell, the communicator Maria Holmkvist at Sea and Society, the coordinator for cooperation Susanne Lindegarth, and the coordinator for research, Elisabeth Jönsson Bergman.

Each of the six research areas described above has a research leader (RA-leader):

RA1: Mats Lindegarth

RA2: David Langlet

RA3: Henrik Pavia

RA4: Björn Thrandur Björnsson

RA5: Lena Mossberg

RA6: John Armbrecht

The research leaders have the overall responsibility for the research activities in each RA, including calling for research meetings, reporting, and following the progress.

There are three international guest professors in SWEMARC. Prof Kåre Skallerud, School of Business and Economics, University of Tromsø, Norway will contribute and participate mainly in the work within RA5 and RA6. Prof Lou Yongqi, College of Design and Innovation, Tongji University, Shanghai, China within design-driven sustainable communities and will mainly be active in RA3, 5 and 6.

Prof. Barry Costa-Pierce, Professor & Chair of the Department of Marine Sciences, and Director of the Marine Science Center, University of New England, USA has the focus focus is ecological/ecosystem approaches to aquaculture, where he will contribute with his expertise, but also to a large extent to educational activities in SWEMARC as well as mentoring activities for young scientists and PhD-students.

