

Open session
**Sustainable aquaculture: Research needs and perspectives for
aquaculture science**
**Wednesday 19 September 2012, 14:00–18:00, Sydneshaugen
Scandic Bergen City Hotel, Bergen Norway**

Co-Chaired by Adi Kellermann (ICES) and Erik Olsen (ICES)

Aquaculture is a growing maritime economy sector in response to the increasing demand for sea food, resources for producing pharmaceuticals and renewable energy. This growing sector bears potential for development and societal benefits in coastal areas. However, compliance with environmental regulations, production of feeds for aquaculture, disease control and escapees are issues at stake where marine research needs to come in and help develop options for sustainable use. The Open Session aims at providing a forum for an exchange between the aquaculture and maritime industry and their research needs and what the marine research community and ICES Expert Groups in particular can offer. Speakers from the maritime and marine communities in Europe and the Americas were invited.

The Co-Chair Adi Kellermann set the scene by introducing the Marine and Maritime Research and Technology Forum (MARCOM) which aims at bringing together and enhancing cooperation between the marine and industrial research communities. One of the areas of common interest identified by the Forum was the entire area of sea food, from capture and culture to market and processing. The ICES Annual Science Conference in Bergen, Norway was seen as the ideal opportunity to invite the industry to an exchange of views on the subject.

There were three presentations made by the industry:

Torgeir Edvardsen (EATIP) gave an overview of the EU seafood market situation and pointed to the global food security needs; roughly 2 per cent (140 million tonnes) of food comes from capture fisheries and aquaculture with an estimated additional 7 million tonnes needed by 2013. As compared with other protein sources, sea food production has a low carbon dioxide footprint. He introduced the thematic activities in EATIP ranging from topic areas like food quality to consumer behaviour. Future aquaculture will diversify in terms of new species, production methods and novel food resources. In general, top priorities for research will be:

- sustainable raw materials for fish feed,
- innovation for environmentally sustainable production,
- ensure good governance
- improve fish health,
- better perception of consumer behavior

Petter Arnesen (Marine Harvest) focused on science needs for marine farming in a European industry perspective. Given that many wild stocks are fully or overexploited, there is a clear need for increased sea food production from

marine farming. Asia accounts for the bulk production with Europe and the Americas being next but way below. Europe still imports the majority of its sea food consumption and clearly has a demand for increased production. Knowledge-based sea farming requires strong R&D initiatives. He presented some examples of research fields relevant to improve sea food farming and make position it for the future global market:

- Fish feed (e.g., reduce dependency on fish meal and fish oil by novel sources, replacements)
- Further reduction of carbon footprint in fish feed
- Diseases (e.g., vaccines)
- Parasites (e.g., sea lice)
- Fish welfare (e.g., stress measures)
- Improvement of fish containment systems (e.g., through multidisciplinary approaches) and elaborate husbandry practices
- Breeding & Genetics (e.g., improve resistance, feed utilization)
- Sustainability of farmed fish – wild fish interactions (e.g., genetic, disease/parasite transfer)
- Ecosystem interactions and biomass carrying capacity for farming areas
- Spatial planning (e.g., space for more farming sites, science to optimize)
- Technology (e.g., suitable netting material avoiding holes & escapes)
- Product quality (nutritional quality and food safety)
- Consumer and Market (e.g., improve consumer understanding of aquaculture)

Ulf Winther (AVS Chile) presented science needs seen from a Latin-American perspective. In this area, capture fisheries accounts for 11-12 % of global yields while the aquaculture production grows faster than the global average. Salmon and trout dominate production, followed by crustaceans, molluscs and plants. A total of 80 species is farmed. There is a lack of strategic planning from the governments' side and research is mostly carried out by universities without linkages to the industry. However, most small companies produce for the local markets while the big players produce for export with only few strong trade associations pushing for R&D. International cooperation is thus needed. Research needs are governed by drivers different from those in Europe:

- Technology for producing juveniles with high, consistent quality is available – but needs improvement
- In general there is a lack of basic knowledge of producing promising species that restricts diversification and production growth
- Need to develop hatchery techniques for fresh water and marine species
- R&D needed to develop simple methods to produce seeds and juveniles – adapted to small scale farmers

- Genetic improvement programs needed – which will result in environmental issues
- R&D on sanitary issues are needed in general and for native species – in addition to sanitary infrastructure
- In addition to R&D, capacity building is crucial

The Co-Chair Erik Olsen presented the plan to establish a new high-level, parent working group in ICES (WGAQUA) which will deal with producer's research needs, take on board the academia and develop the expertise present in ICES. The background is an increased demand for advice on sustainability and aquaculture is in many places seen as having a too high environmental impact. At the same time, pressure on the coastal zone from other human activities (petroleum, shipping, mining, extraction, renewables) is increasing. Consequently there is a need to be able to compare the impacts of aquaculture with other human activities (total and cumulative impacts). Further, there seems to be a wish that advice on aquaculture should be developed to achieve a similar structure and level of quality control as fish-stock advice while currently ICES is not seen as the prime authority on aquaculture. The proposed vision of the new group is to develop the science and advice for sustainable aquaculture in the ICES area. The following priorities will be considered:

- Economic and ecological efficiency (IMTA, off-shore issues, spat supply, new species, bioremediation, goods and services, animal welfare and domestication)
- Management tools to ensure sustainability (Marine Spatial Planning, thresholds and indicators, carrying capacity, pest and predator management, eco-certification, risk assessment and uncertainty, EU Framework Directives)
- Interactions with natural environment and fisheries (escapees, sea lice, carrying capacity, pest and predator management, spat supply, climate change, goods and services, impact on fisheries)

Peter Cranford (BIO Halifax) presented the transatlantic (Canada/Norway) science on integrated multi-trophic aquaculture, its efficiency and the viability of an ecosystem based approach to sustainable aquaculture. He introduced the concept of integrated multi-trophic aquaculture (IMTA) where the by-products from one species become inputs for an extractive species of commercial value within one culture system. According to conclusions published by FAO, integrated aquaculture should be looked upon as a very important tool to facilitate the growth of marine aquaculture and promote sustainable development. He advocated that most ICES countries have potential for IMTA development:

- IMTA systems under development or at commercial scale: Canada, Chile, China, Ireland, South Africa, the United Kingdom (mostly Scotland) and the United States of America
- Groundwork conducted toward development of IMTA: Scandinavia, especially Norway

- Research projects related to the development of IMTA: France, Portugal and Spain

A number of case studies from Canada (CIMTAN), Norway (EXPLOIT), as well as Canadian/Norwegian cooperation on waste plume dynamics were presented which deal with ecosystem interactions and socio-economical issues. In summary,

- Research has indicated that IMTA may be an important tool to facilitate the growth of marine aquaculture and promote sustainable development.
- Open water IMTA system design is in its infancy and requires general and site-specific ecosystem-based knowledge.
- Research is underway worldwide to further study the viability and effectiveness of open water IMTA under different hydrographic conditions.
- Considerable scientific debate exists on the potential for shellfish to effectively extract particulate fish wastes (and parasites such as sea lice).

Dorte Bekkevold (DTU Aqua, Charlottenlund) presented the issue of genetic interactions between wild and cultured organisms. There is concern that escaped or released farm fish will negatively impact fitness – and ultimately survival - in wild populations of con-specifics. This potentially poses a problem for sustainability in aquaculture, also with regards to being perceived as ethically unacceptable. However, escaped/released fish reared in captivity generally perform sub-optimally in nature. Competition with wild fish, spread of diseases and hybridisation are potential impacts. Case studies from Norway and Denmark were presented as well as the EU FP7 funded project AquaTrace (2012-2016) on European sea bass, sea bream and turbot population genetic studies. In conclusion, the research questions are:

- Which populations are already affected – and to which extent?
- What determines whether we see introgression or not?
- Quantitative evolutionary-ecological examination of domestication process
- What is the actual effect on fitness of wild populations?

Conclusions presented on the problem of genetic interactions were:

- Release of captivity reared fish is rarely a good conservation measure – almost irrespective of the genetic material used – and should be avoided wherever possible,
- Aquaculture escapees commonly do affect genetic composition of wild populations, although commonly less than expected from sheer numbers.
- Introgression mechanisms are yet understudied; knowledge would help steer mitigative actions.
- What can be done?

- Prevent escapes (and minimise releases) and sterilise farm fish (e.g. by triploidisation)
- Setting up conservation plan on local or regional level, e.g. to assess if farming should be avoided in some areas where wild populations are at risk (based on ecological and genetic studies).

Bengt Karlson (WGHABD) presented a brief report on recent harmful algal blooms in the ICES area. They have occurred in new geographical locations recently and feature fish killing algae, algae causing shellfish toxicity, and cyanobacteria. The activities of the ICES/IOC Working Group cover

- Yearly reporting of Harmful Algal Bloom events
- Database on Harmful Algae Blooms Events – HAEDAT
- An upcoming Cooperative Research Report on HAB's in the ICES area
- ICES-PICES-IOC Workshop on HAB's in a Changing World in 2013
- ICES-IOC workshop on novel in situ techniques in 2014
- 2013 WGAHBD meeting in Belfast
- 2013 IOC International Panel on Harmful Algal Blooms in Paris

Gilles Doignon of DG-MARE (European Commission) commented on the presentations and presented the Commission's view on the enhanced cooperation perspective. He welcomed the MARCOM initiative through ICES as a timely exercise and DG MARE is certainly be excited to see this happen. Innovation: Novel approaches to increase European aquaculture production concomitantly with technologies reducing the environmental impact will be encouraged by specific objectives of funding schemes to be released within the implementation of the Integrated Maritime Policy. Green fisheries and green aquaculture are political objectives in line with the intention of the aquaculture industry. New farming techniques, both onshore and offshore should be exploited for sea food for EU consumption, but perhaps also for the production of bio-fuels. Producing marine resources for the use in the pharmaceutical industry is another future activity which has great potential and may see rapid growth soon. Professionalization: sea food production in the future needs to be flexible and adaptable to market changes. Aquaculture has potential to foster economic activities and benefits locally. Locally produced sea food can be specifically labelled and certified as healthy and fresh food (e.g., advertising Omega 3 PUFAs). The concept of organic farming could also be adopted by the industry. The Commission welcomed ICES moving towards providing scientific advice to the aquaculture sector.

The representatives of the aquaculture industry inquired about the procedures in the ICES advisory system, the compilation of the scientific data and knowledge, the advice drafting and review process and the ways and means of communicating it to the clients.

Petri Suuronen (FAO) commented much along the same lines. He pointed to the increasing importance of aquaculture in the light of exhausted capture fisheries in terms of new resources and the growing importance of aquaculture. Solving the problem of feed production by developing alternatives to fish meal and fish oil and providing opportunities for developing countries without compromising

the goods and services delivered by coastal ecosystems will be future challenges. Aquaculture and capture fisheries are currently strong interlinked. The increasing sustainability requirements for food production in aquaculture will put more pressure on capture fisheries too. The fish meal and fish oil currently used in aquaculture feed have to be based on sustainable capture fisheries – otherwise the entire production chain is sustainable.

The Chairs concluded with thanking all speakers and the about 60 attendants of the workshop for their active engagement and lively discussion.

Annex 1: Workshop Agenda

- 14:00 Opening of session (Chairs)
- 14:10 Science Needs seen from the European Technology and Innovation Platform perspective: Torgeir Edvardsen (European Aquaculture Innovation & Technology Platform, EATIP)
- 14:30 Science Needs seen from a European industry perspective (Petter Arnesen, Marine Harvest)
- 14:50 Science needs seen from a Latin American industry perspective (Ulf Winther, AVS Chile)
- 15:10 Discussion of science needs
- 15:30 Coffee break (30 min)
- 16:00 Presentation on new ICES group on sustainability in aquaculture (Erik Olsen, IMR)
- 16:20 Presentation of ICES science on integrated aquaculture: Peter Cranford (BIO Halifax)
- 16:40 Presentation of ICES science on genetic interactions: Dorte Bekkevold (DTU-Aqua)
- 17:20 Recent harmful algal blooms in the ICES area: Bengt Karlson (ICES/IOC WGHABD)
- 17:20 Customer needs (governments need for advice) (Gilles Doignon, DG MARE)
- 17:40 Wrap-up discussion