Increasing Industrial Resource Efficiency in European Mariculture
NEWSLETTER
No. 6 – September 2015

Algae increasing value and ecosystem services in Norwegian salmon farms

The global aquaculture industry is the fastest growing food production sector. Fish production growth still outpaces the growth of the world population; in 2012, aquaculture provided almost half of all fish for human consumption and is expected to rise up to 62 percent by 2030. Similarly, Norwegian aquaculture has drastically expanded: since the 1970's, Atlantic salmon (Salmo salar) represents a major industry in Norway. Since 2012, Norway is the dominant exporter and producer of Atlantic salmon worldwide and last year, 378,4 million salmon were farmed. Owing to this expansion, the industry is facing a range of challenges resulting in a call for more sustainable solutions. Integrated multi-trophic aquaculture (IMTA), a practice combining the culture of fed aquaculture fish with extractive species, appears as an appropriate answer, able to help social, economic and environmental dimensions to work together.

Monitoring the ecosystem services provision of IMTA for the Norwegian salmon industry

In the IDREEM project, the Norwegian partners NIBIO and GIFAS are conducting research to highlight changes in ecosystem services provision when adding algae to a salmon farm. They also investigate potential added economic value. This research is conducted on a study site located in an open fjord above the Arctic Circle in Norway (67°04'238''N 14°05'076''E). This Atlantic salmon farm located at Oldervika (Nordland, Norway) was the first one to obtain a license for integrated algae culture on a salmon farm in Norway. Before implementing algae cultivation, GIFAS was only producing Atlantic salmon. During the winter 2014-2015, two algae rafts were added-on a structure placed inside the existing mooring system within the salmon farm (Figure 1).

At NIBIO in Bodø, gametophytes were grown in the laboratory (Figure 2) and seedling lines were prepared (Figure 3). The young sporophytes (Figure 4) were obtained from different wild parents harvested on Oldervika site. During the 2014-2015 winter, 3 km of lines with Alaria esculenta were deployed on the algae rafts. At the end of May, the algae were harvested to be processed as food product. In early June they were harvested to be processed as feed ingredients. Algae ropes were hung to dry to about 40-50% moisture (Figure 5), then the biomass was harvested from the rope and air dried for the food product, or air dried and then sun dried for the feed product. In Mid-July, about 2 tons of fresh Alaria esculenta were harvested and air-dried.

Increasing Industrial Resource Efficiency in European Mariculture
NEWSLETTER
No. 6 – September 2015

Adding algae to a salmon farm brings positive changes in ecosystem services provision

Our algae production demonstrated that growing large amounts of algae would require the development of new techniques and innovative technological solutions for handling, shipping, storing and bio-refining the biomass. In particular, drying algae at large scale would necessitate the design of innovative methods at an industrial level, to reduce manual handling and to homogenize the drying process without damaging the nutritive quality of the product.
In addition, our study, aiming at mapping and evaluating the changes in ecosystem services after the integration of algae cultivation on a Norwegian salmon farm, revealed that growing algae in a salmon farm brings many positive changes in ecosystem services provision hence potentially to the economy. Algae culture could contribute to solve actual and perceived impacts of salmon aquaculture on the ecosystem by recycling its waste and increasing biodiversity.The harvesting period of the algae gave the opportunity to observe the effects on biodiversity. An abundant number of juvenile fishes were found in the macroalgae. The main species observed was the lumpfish(Cyclopterus lumpus – Figure 6).

Nevertheless, it is necessary to consider the surroundings of each service to capture their best values. In the particular case of Oldervika, the farm facilities are playing an education role, aiming at familiarizing students and visitors with the aquaculture industry. Implementing IMTA techniques also equips the region with a new face, which will increase the reputation of the region of Nordland (and Norway) in terms of innovation. An important education phase would also be required to inform people with the advantages that IMTA practices can bring in terms of socio economic value as well as environmental changes. Besides these developments, improvements in terms of healthier climate and cleaner water can be awaited in the upcoming years. This research has also identified other kinds of questions (e.g. legal issues, educational challenges and market concerns) are likely to become decisive topics when taking IMTA to a larger stage.
Our research demonstrates that IMTA can help the aquaculture sector to deal with its current challenges and allow for a more sustainable and socially acceptable industrial growth. The Norwegian case study will be presented during the Aquaculture Europe 2015 in Rotterdam.

Written by Céline Rebours, Julie Stamenic, Tomas Bjørnå and Johan Johansen. Images courtesy of Céline Rebours.

Read more: *http://www.idreem.eu/cms/2015/09/11/seaweeds-create-value-add-ecosystem-services-norvegian-salmon-farms/*

Summer 2015 seaweed harvesting in Scotland

Summer is harvesting season for seaweed growers all over Europe. Lars Brunner (SAMS) shared with us some results of the recent harvest conducted at one of IDREEM's pilot sites for integrated multi-trophic aquaculture in Scotland.

The seaweed was grown in Ardcastle, Loch Fyne on Scotland's west coast. This site is run by Loch Fyne Oysters (LFO) and the Scottish Salmon Company (SSC), our commercial partners in the project, and the site is stocked with a mixture of mussels, oysters, queen scallops and seaweeds. The seaweed cultivation on site has run since 2013, and this year's harvest was the best yet. Two species were cultivated, both kelps –Alaria esculenta and Saccharina latissima. These were settled onto twine at the SAMS hatchery during the winter of 2014/2015, and brought to site in the first months of 2015. On site the 'spools' holding the twine were added to a thicker head-rope and strung parallel to the other lines in the water, at a depth of 2m.

The spring and summer of 2015 have been rather cool and wet in Scotland, without a lot of direct sunlight, however both species have performed well, and when the harvest was undertaken in June 2015, Alaria showed growth in excess of 2m length, with consistent 1.6m lengths for Saccharina, with peak weights per meter of line recorded of nearly 12kg for Alaria and 10kg for Saccharina. A Scottish commercial producer of seaweeds, Mara Seaweed, was present at the harvest, and utilised some of the harvested material for their production of dried, milled product for use as food.

Read more: *http://www.idreem.eu/cms/2015/07/16/summer-2015-seaweed-harvesting-scotland/*

Developing integrated multi-trophic aquaculture at commercial scale in Europe

The European aquaculture industry covers the production of finfish, shellfish and other aquatic species, including algae, in both freshwater and marine conditions. Over the last decade, EU aquaculture has seen little or no volume growth, compared to estimated global aquaculture growth of 7% average projected growth over the same period.

Despite this trend, a report for the European Parliament published in late 2014 about the long term impact of sustainable aquaculture, has identified a growth potential for coldwater marine

species of 4% per year until 2030, which makes a 100% increase over the period, while shellfish production growth is projected at 30% by 2030, an annual growth rate of 1.3% per year.

Along with these forecasts, the report also investigated the productivity improvements due to technology, management and feed quality that are expected to sustain this growth. The need to increase productivity and competitiveness will drive toward larger cages, particularly in offshore locations, seen as an increasing trend for both Mediterranean and coldwater farming. At the same time, shellfish production will continue to be dominated by supported or suspended cultivation systems. According to the study, the outcome of this is that a rising proportion of the increase in large cage culture for fish species and supported/suspended culture for shellfish species, will be achieved by adopting Integrated Multi-trophic Aquaculture (IMTA) farming systems, where species are combined (e.g. salmon, seaweeds, mussels) within a complementary area so as to best use space and to mitigate environmental impact.

At this time it is not possible yet to estimate the percentage production from such systems, due to an uncertain legal framework and to the lack of clear licensing conditions for integrated multi-trophic aquaculture in the different Member States. Nevertheless sustainable aquaculture is an evident component of many recent and new European strategies, including Blue Growth and the Bioeconomy Strategy and Action Plan. Furthermore, the commercial uptake of IMTA aquaculture is a brilliant example of moving towards a circular economy, as indicated by the recent EC communication on the zero waste programme for Europe. Indeed the whole idea behind integrated multi-trophic aquaculture is to take what is considered waste from a primary production process (the effluents from finfish cages) and turn it into valuable secondary products such as seaweeds or shellfish. Improving our knowledge of the different applicable IMTA systems and their footprints will provide answers as to how aquaculture can contribute to these targets. This is the scope of the IDREEM project, where research organization have partnered with SMEs to start IMTA on a commercial scale in Europe.

Learn more in this interview to Adam Hughes (SAMS), IDREEM project coordinator: https://youtu.be/FZCzqszYiWk

Read more: *http://www.idreem.eu/cms/2015/07/20/developing-integrated-multi-trophic-aquaculture-commercial-scale-europe/*

Oysters farmed in oligotrophic waters with integrated multi-trophic aquaculture

Oyster farming is a commercial activity for which medium to high concentrations of nutrients and phytoplankton are required, in order to satisfy the nutritional needs of the farmed organisms and to produce commercially attractive products. These conditions are rarely met in the Ligurian Sea (Italy), that is characterized by oligotrophic conditions. To overcome this limit, a novel IMTA-based approach was adopted by AQUA srl, which involves farming of filter feeders downstream from

finfish cages. The research was conducted with the academic support of the University of Genoa. Both organizations are partners in the IDREEM project.

Integrated multi-trophic aquaculture: growing oysters downstream fish cages

In the experimental set-up tested at AQUA farms, lanterns containing *Ostrea edulis and Crassostrea gigas*were placed downstream from the finfish cages, in order to receive the particulate matter falling off the cages. Lanterns were placed at 7 and 14 m depth to test for an effect of depth in allowing for a higher feed availability and growth. This experiment lasted from June 2013 to May 2014. Shell length, whole wet weight, percent of soft parts and mortality were monitored in November 2013 and May 2014.

Both oyster species reached a legal size for commercialization (60 mm according to the Italian law) during the 12 months farming trial. Their weight placed them both in the medium commercial size class 3 (66-85 g), which sales at a market price of around 9.60 € for *O. edulis* and 2.50 € for *C. gigas*.

Besides demonstrating that oysters can be farmed in the oligotrophic Ligurian Sea, these results provide encouraging evidence that they can be profitably grown to a commercial size by using an integrated multi-trophic aquaculture farming model. Furthermore, this IMTA model offers a potential effective solution for reducing the environmental impact of farm effluents.

Poster presentation by Danilo Pecorino *et al.*

Read more: *http://www.idreem.eu/cms/2015/07/01/oysters-in-oligotrophic-waters-integrated-multi-trophic-aquaculture/*

Multiple IMTA models for different farming conditions

A fundamental task in IDREEM is to demonstrate how the concept of integrated multi-trophic aquaculture can be applied to different conditions and fish-farming systems across Europe. Salmon is the main finfish species grown by traditional fish farms in the Atlantic, while in the Mediterranean, sea bass and sea bream are the most commonly farmed species. The type of IMTA model that can be effectively applied to a traditional fish monoculture, what kind of secondary species to grow and how, is certainly affected by the farming system adopted for finfish as well as by the environmental conditions. In this regard a major difference obviously exists between the Atlantic sea which is rich in nutrients, and the Mediterranean which is quite oligotrophic.

In this video (*https://youtu.be/hUZDGvyD8_g*), Julie Maguire, DOMMRS, provides an overview of the different pilot IMTA sites monitored by the IDREEM project, the similarities and differences among them and how they are performing. We have seven sites in IDREEM , four on

the Atlantic (Norway, two in Scotland and one in Ireland) and three in the Mediterranean (Italy, Cyprus, Israel). All these IMTA sites are different.

In all the Atlantic sites the complementary species (seaweeds, oysters and other shellfish), grow really well, Julie says. *In the Mediterranean, there are less nutrients than in the Atlantic, so the nutrients that the cages give off are really important for the growth of the complementary species* (shellfish, sea urchins, seaweeds as well).*This can be seen indeed by the difference in the growth of these species at the IMTA sites compared to the control sites. It's all very exciting*, she concludes.

Read more: *http://www.idreem.eu/cms/2015/08/05/multiple-imta-models-applied-different-conditions-europe/*

Reducing nutrient discharge with IMTA species in Israel

The southernmost pilot IMTA site of the IDREEM project is located at Suf-Fish farm in Israel. Suf-Fish was established in 1992 and began rearing marine fish in cages in 1993 in the northern Gulf of Aqaba, Red Sea. The first experiences with IMTA at Suf-Fish date back to 2007 – 2009, when a series of preliminary trials were carried out to test the feasibility of rearing mussels next to fish cages in Albania.In 2010, Suf-Fish established a net-cage fish farm adjacent to the Port of Ashdod in Israel, where seabream is farmed. In this location Suf-Fish continues to carry out R&D work aimed at enhancing aquaculture production efficiency and sustainability, by reducing costs and waste and improving the quality of fish and related products.

The fish cages at Suf-Fish farm in the port of Ashdodt

One of the early IMTA experiments conducted at Suf-Fish within the IDREEM project was a test withgrey mullets placed in suspended cages underneath seabream cages. The trial was aimed at assessing the ability of grey mullets to feed on the freshly fallen farm discharge, instead of enriched benthic sediment. Results showed that the mullets do eat the feed, but they can only partially digest it,meaning that freshly produced waste material does not have any nutritional value for mullets. However, aged material that has accumulated over time on the seafloor,becoming enriched in microbes and undergoing chemical alteration, can be available to grey mullets. This indicates that mullets could be used as bioremediators in an IMTA system, provided that their cages are moored directly on the sediment where particulate organic matter can accumulate and be pre-digested by microbes.

Learning from this experience, Suf-Fish is now conducting trials with benthic species that are more able to digest farm discharge, such as sea uchins and sea cucumbers: results are currently being analyzed and will be soon published.A seaweed growth experiment is also ongoing, where Ulva lactuca is grown on nutrient rich seawater pumped from underneath the fish farm. Seaweeds are placed in tanks and the growth rate, protein and starch content, ammonia and phosphate concentration in the water at the entrance and exit point of each tank are measured. Results are encouraging: in around 10 days the trial seaweed biomass grew tenfold.

Read more: *http://www.idreem.eu/cms/2015/08/06/reducing-nutrient-discharge-imta-species-israel/*

Industry stakeholders are mostly in favour of IMTA

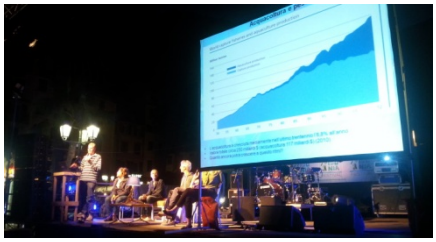
Aquaculture has a fundamental role to play in ensuring Europe's food security. Moreover, the EU's Strategy for Blue Growth identifies aquaculture as a sector which could boost economic growth and bring social benefits through new jobs. Despite this, the social acceptance of aquaculture and the opinion of some industry stakeholders and regulators are negatively affected by reasonable concerns, about some environmental risks that could be associated with unsustainable farming practices. Examples of these are the risk of pollution with organic waste, spreading of pests and contamination with pesticides.

In this context how do people perceive integrated multi-trophic aquaculture? In this video, Marc Shorten – DOMMRS, explains the interesting results obtained by a survey conducted by IDREEM researchers on the social perception and acceptance of IMTA. *When IDREEM started out most of us assumed that there were lots of objections around aquaculture generally. As scientists of course we don't' take it for granted, we go and study it*, Marc says. *At first we looked at the people directly vested in the industry, we talked to them and we found out that some of the stakeholders were against IMTA but the majority of them were not, and their positions were more against aquaculture in general rather than IMTA. Even those who were most against aquaculture agreed that IMTA could help to mitigate some of the potential problems of aquaculture,* he says.

How about the general public? To understand more about this, an online survey was launched in all European countries interested by IDREEM with 2.500 people contacted. What we found is that people were far more positive than negative about aquaculture. *Interestingly, those who already knew about IMTA were really enthusiastic about it, and those who didn't know anything about it, thought it was a good idea once they were informed, that was really good news,* Marc concluded.

Read more: *http://www.idreem.eu/cms/2015/08/05/industry-stakeholders-mostly-in-favour-of-imta/*

AQUA srl at Posidonia Ecofestival of art, environment and sustainable development



AQUA srl took part in the first Posidonia Festival in Santa Margherita Ligure, Italy (4-6 September 2015). Posidonia Festival is an International Ecofestival of Art, Environment and Sustainable Development. It´s a space for dissemination of knowledge and practices that promote the protection of the natural coastal environment and, at the same time, an opportunity for sustainable development, culture and tourism. It is also a laboratory for sustainable solutions for the tourism sector that creates a field for experimentation, reflection and promotion. Seminars and conferences by national and international experts concerningdifferent themes were organized, treated in a participatory, inclusive and proactive way in order to find solutions for a change towards a sustainable future. AQUA participated in the conference session focused on sustainable fishing and aquaculture reporting on IDREEM as an example of sustainable practice in aquaculture.

Read more: *http://www.idreem.eu/cms/2015/09/08/aqua-srl-posidonia-ecofestival-art-environment-sustainable-development/*

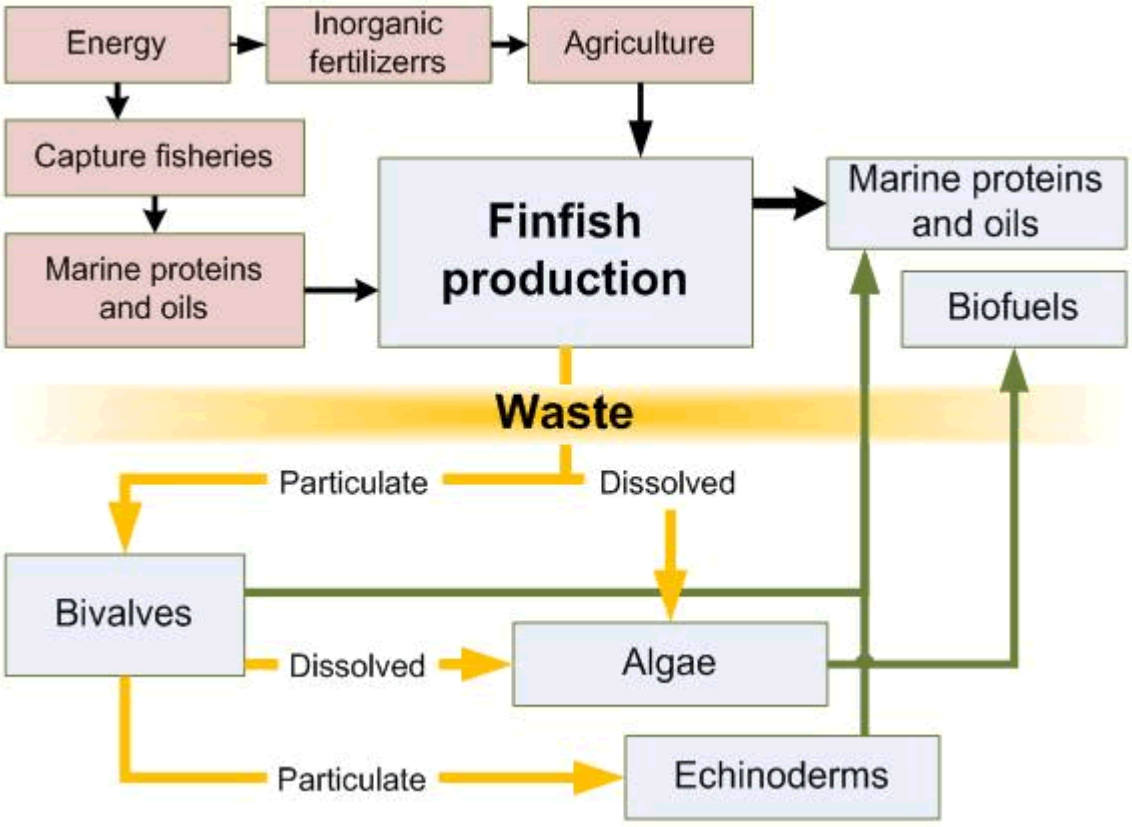
What is IMTA

Aquaculture – sometimes called mariculture when in the sea – is the production of fish, invertebrates (e..g. bivalves) and plants (seaweeds) in aquatic systems and by a variety of production methods. Typically these different types of organisms are grown separately. Integrated Multi Trophic Aquaculture (IMTA) is a concept where different species are grown together in such a way that the invertebrates and/or plants can recycle the nutrients that are lost from the culture of the other species.

An example of this might be a fish farmer who adds fish feed to his cages of fish in the sea knowing that a proportion of the feed, all of the faeces and most of the nutrients in that feed will not end up in his fish but will be lost to the environment. However, if the farmer develops a bivalve culture operation near his fish farm, these filter-feeders might benefit by consuming some of the particles of feed and faeces and so grow faster or bigger than they might otherwise have done. Additionally the farmer might elect to grow some seaweed near his fish farm. These plants can utilise the nitrogen excreted by the fish and the bivalves to enhance their growth. The result is that there is a net reduction of losses to the environment plus new crops to harvest and sell.

Multi trophic aquaculture has been practiced for centuries in freshwater systems, particularly in China. Although the potential benefits of this system are well understood, IMTA is only practiced in the EU by a few specialist companies. The IDREEM project is dedicated to finding out why this is the case and to considering the issues and bottlenecks that may prevent development of this eco-efficient practice. We will consider social, economic and environmental issues with a view to improving our understanding of the technological and financial issues that may stand in the way of IMTA being adopted by aquaculture enterprises and also the social issues that influence consumers and the general public so that we can better understand market issues.

The project is driven by SME involvement, with a bias towards commercial partners. The results of our work will therefore primarily focus on providing routes to IMTA for enterprises in order to create new employment and growth opportunities as well as tasty and healthy seafood and other products.



Read more: *http://www.idreem.eu/cms/what-is-imta/*

Events

October 20-23, 2015, Rotterdam - the Netherlands
Aquaculture Europe 2015

IDREEM PARTNERS

IDREEM is supported by
the European Commission
within the 7th Framework Programme