

OFFSHORE MARICULTURE CONFERENCE2012

17-19 October • Hilton Hotel Izmir • Turkey

Two day Conference, including Gala Dinner (Hosted and organised by the Turkish Ministry of Food Agriculture and Livestock).
19 October 2012: Visit to offshore fish farm

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Conference Handbook

Progress and prospects for offshore aquaculture

This is a must attend event for anyone involved in, or looking to become involved in, this rapidly expanding sector of the aquaculture market. Including: farming companies, research organisations and suppliers looking to update themselves on the latest policies, products, research and case studies within the fin/shell fish and seaweed offshore farming sectors. With 80% of Turkish fish farms based offshore, the spotlight on Turkey will be of particular relevance to Government officials from farming nations looking to learn how they can adapt Turkey's successful spatial planning policy into their own Ministries of Fisheries/Environment and Tourism.

Conference chair: Neil Sims, co-Founder and co-CEO, Kampachi Farms. **Welcome by:** Dr Durali Kocak, Director General for Fisheries & Aquaculture, Turkish Ministry of Food Agriculture & Livestock. **Keynote speakers:** Paul Holthus, World Ocean Council and Alessandro Lovatelli, Aquaculture Officer, Aquaculture Management and Conservation Service (FIRA), Fisheries and Aquaculture Department, FAO of the UN

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OFFSHORE MARICULTURE CONFERENCE2012

Dear Delegate

On behalf of the organisers, Mercator Media, the team and I would like to welcome you all to the Offshore Mariculture Conference 2012, the fourth conference in the series.

The discussions about whether to bring this year's event to Turkey were instigated at the 2010 conference, and I would like to thank the Turkish Ministry for Food, Agriculture and Livestock for all their support and for hosting the gala dinner tonight onboard the Lamia Superyacht. A special thank you must go to Hayri Deniz from the Ministry for all his hard work putting this together.

I would also like to thank our very pro-active chairman Neil Sims, Alistair Lane of the European Aquaculture Society, Camli/Pinar and the Izmir Fishfamers' Association for organising the fish farm visit on day three, plus all our sponsors: Proflex/Flexabar, Fusion Marine, Kilic, Skretting and Akva

Over the past two years aquaculture has been the fastest growing sector in Turkey, and the country now has more than 2100 fish farms. Approximately half of these farms are Marine representing 53% of Turkey's total aquaculture production tonnage.

Internationally, Turkey is the third fastest growing country in the aquaculture sector and it should, therefore, be no surprise that delegates from no less than 21 different nations have made their journey to Turkey to join this year's Offshore Mariculture conference.

We trust you will enjoy the two day Conference with its varied programme and speakers, the networking opportunities during the breaks, the Ministry's gala dinner and the Fish farm visit on the 19th

The team and I are very much looking forward to meeting you during the next few days and to finding out and discussing the further developments within this important sector.

Best wishes for a successful conference and exhibition.

Yours sincerely



Marianne Rasmussen-Coulling
Events Director
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Welcome Address

Durali Koçak



BIOGRAPHY

I graduated from Veterinary Faculty of Ankara University in 1887. I have Ph.D. on animal feeding and feeding diseases from the same university.

I have been working for General Directorate of Fisheries and Aquaculture of Ministry of Food, Agriculture and Livestock (MoFAL) as General Director since 2011.

Previously; I worked for Province directorate of Malatya of Ministry of Agriculture and Rural Affairs as Veterinary Surgeon, Ankara Lalahan Veterinary Research Institute of Agriculture and Rural Affairs as Researcher, General Directorate of Protection and Control of Agriculture and Rural Affairs as Section Director and General Directorate of Protection and Control of Agriculture and Rural Affairs as Vice Director General responsible fisheries in 1988, 1989-1997, 1998-2003 and 2004-2011 respectively.

My expertise's are animal feeding and feeding disease and fisheries management.

Durali KOÇAK (Ph.D.) - Director General for Fisheries and Aquaculture

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NEIL ANTHONY SIMS

Kampechi Farms, LLC



BIOGRAPHY

Neil Anthony Sims is co-Founder and co-CEO of Kampachi Farms, LLC, based in Kona, Hawaii, and in La Paz, Mexico. Over the past two decades, Sims has led teams that have accomplished a number of breakthrough developments in pearl oyster culture, offshore aquaculture legislation and regulation, marine fish hatchery technology, open ocean mariculture systems, and most recently, untethered open ocean 'drifter pens': the Velella project.

Sims co-founded Kona Blue Water Farms in 2001, applying cutting-edge hatchery technologies to 'difficult-to-rear' marine fish larvae: snappers, groupers, and yellowtail/jacks. Resolving this production bottleneck led to the first integrated marine fish hatchery and open ocean fish farm in the US. By 2008, over 500 tons of sashimi-grade Kona Kampachi® was being harvested annually (over 1 million pounds) from submersible pens on the Kona offshore site.

Most recently, Sims co-founded Kampachi Farms, LLC, to expand the commercial growth of high-value, warm-water marine fish globally, and to pursue "next generation" technologies, including: remote offshore systems, more sustainable and scalable feeds, and new species development.

Sims is also the founding President of the Ocean Stewards Institute, the open ocean mariculture trade association that advocates for the balancing of rational, responsible development of the open oceans with protection of marine resources and habitats.

Sims has also provided consulting services to UN-FAO, regional agencies and governments, and currently sits on the Steering Committee for the Seriola-Cobia Aquaculture Dialogue (SCAD) and the Technical Advisory Board for the WWF-sponsored Aquaculture Stewardship Council. Sims resides in Kona, Hawaii.

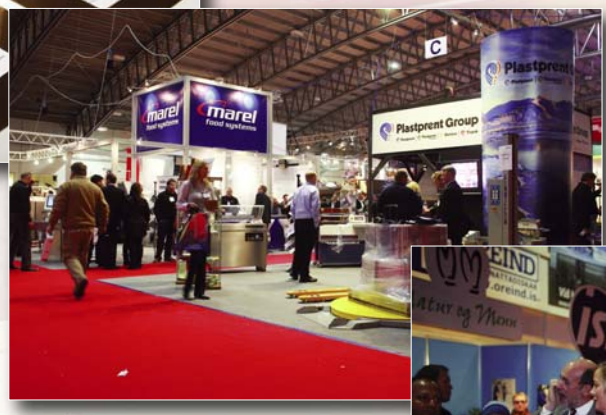
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SESSION 1

INTRODUCTION TO OFFSHORE MARICULTURE AND KEYNOTE PRESENTATIONS

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Is open ocean mariculture in a morass, or a time of marvels? Assessing changes from the initial OSM conference in 2004, to OSM 2012

Neil Anthony Sims
Kampechi Farms, LLC



BIOGRAPHY

Neil Anthony Sims is co-Founder and co-CEO of Kampachi Farms, LLC, based in Kona, Hawaii, and in La Paz, Mexico. Over the past two decades, Sims has led teams that have accomplished a number of breakthrough developments in pearl oyster culture, offshore aquaculture legislation and regulation, marine fish hatchery technology, open ocean mariculture systems, and most recently, untethered open ocean 'drifter pens': the Velella project.

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Most recently, Sims co-founded Kampachi Farms, LLC, to expand the commercial growth of high-value, warm-water marine fish globally, and to pursue "next generation" technologies, including: remote offshore systems, more sustainable and scalable feeds, and new species development.

Sims is also the founding President of the Ocean Stewards Institute, the open ocean mariculture trade association that advocates for the balancing of rational, responsible development of the open oceans with protection of marine resources and habitats.

Sims has also provided consulting services to UN-FAO, regional agencies and governments, and currently sits on the Steering Committee for the Seriola-Cobia Aquaculture Dialogue (SCAD) and the Technical Advisory Board for the WWF-sponsored Aquaculture Stewardship Council. Sims resides in Kona, Hawaii.

Introduction: Since 2004

This paper reviews recent advances in open ocean mariculture technologies, and the growth of the industry offshore, to attempt to answer the question: Is this progress? Has the industry moved forward in any meaningful way since the inaugural Offshore Mariculture Conference in Ireland, in 2004?

The first Offshore Mariculture Conference was held at a time when there was great optimism about the potential for the Blue Revolution to move into deeper, more exposed waters, further offshore, and to begin to fulfil some of the promise - and the perceived need - for increased seafood production. At that time, several Irish salmon farming sites had pioneered robust surface pen systems in exposed farm locations. New projects in Hawaii and Puerto Rico were also trailblazing commercial operations using submerged pens – both Sea Stations and Aquapods – using new species – moi and cobia – that offered great potential.

Since then, there has been an increasing sense that the industry is being constrained by biological, technological, financial and policy limitations. New species have presented new challenges, and markets have not responded as strongly as might have been anticipated, given the quality of the product, the broadening demand, and the sustainability marketing message. No significant new net pen systems have been developed, and the advances with existing pen systems seem to have come slowly. The global financial crisis of 2008 has evolved into an extended malaise of tight credit and nervous investment, and progressive policy steps have been equally hobbled.

However, for the participants in a revolution, change can never come fast enough. It might instead be argued that since 2004, there have been a number of developments that, while not seeming to be dramatic, may be of great consequence in the long term. When viewed from some advantageous perspective (say, a decade hence, or at Offshore Mariculture 2020), these last eight years may be regarded as having been pivotal breakthroughs for the industry. Perhaps we are truly witnessing the dawning of the Golden Age of the Blue Revolution. Perhaps this really is a time of marvels.

The two broad areas of most noteworthy change in offshore mariculture - that have gone somewhat unheralded - include:

- changes in public perception towards aquaculture in general and open ocean fish farming in particular, that has been accompanied by – or perhaps led by, or perhaps followed by – important changes in the policies of the environmentalist NGO community, and forward-looking development agencies and governments;

- major technological developments that have resolved the most salient issues of sustainability and economic viability, and have rendered undeniably viable the culture of fish far offshore.

Public perceptions and NGO attitudes

There has been a dramatic change in the public perception of aquaculture since 2004. Back then, if a consumer was at all aware of aquaculture, it was probably a negative association. The public still labored under the delusion that wild fish stocks were virtually infinite, and the only reason for commercial fishermen being unable to make a living was government overregulation.

That perception has dramatically changed. Regular news stories over the past several years have highlighted the looming nature – nay, the immediacy – of the seafood crisis. This imperative has been splashed from the cover of the New York Times Magazine (“The End of Tuna”), to the cover of Time Magazine (“The End of Fish”) to books-turned-into-movies (“The End of the Line”). Everyone now knows that it is the end of something.

Seafood distributors are now increasingly vocal regarding the growing tightness of supply. As China moves towards becoming a net importer of seafood, the global seafood market dynamics are shifting. Distributors – needful of product to distribute, and sounding at times somewhat panicked – have led the initiatives for opening US Federal waters in the Gulf of Mexico to aquaculture. Increases in prices for most high-end seafood over the last few years

also provides a greater investment incentive, allaying one major concern – the long-term market prospects – for any fish farmer seeking project financing, or any financier wanting to wade deeper.

In terms of the environmental / NGO perceptions of aquaculture, 2004 was perhaps a low-point. The early industry missteps had been amplified and / or exaggerated by 'special self-interests' … possibly commercial salmon fishing interests, possibly eNGOs that viewed the industry as a great fund-raising tool and membership multiplier. Nearshore aquaculture was the proving ground that allowed open ocean mariculture to evolve, but proved also to be an easy target for opponents. It was easy to whip up opposition when your favourite viewplane, or fishing hole was about to be put to the veritable plough. Offshore aquaculture might be able to avoid most of the perceived objections to industry scale-up, but then so can nearshore aquaculture - in most instances (outside of Asia) - and both are usually tarred with the same brush. In the end, it seems to not matter how far offshore or how little impact is likely: people that pick a fight with fish farming usually do so on principle, and pay little heed to fact, or location differentiators.

Most salmon fishermen never miss a chance to express vehement opposition to open ocean mariculture, in spite of the fact that around 40% of so-called "wild" Alaskan salmon is farmed for the first year of its life, and then is deliberately allowed to escape to the wild (i.e. "released"), where it wrecks who-knows-what untold havoc on the ocean ecosystem. These attitudes are driven by deep self-interest - i.e. a fear of market competition that is anything-but the American ideal, and is the antithesis of the much-vaunted image of the independent Alaskan. Given the ability of these aquaculture opponents to sustain multiple conflicting dualities in their minds at once, it is unlikely that they are probably ever going to change their attitudes. Aquaculture – nearshore or offshore – will always threaten wild fish market share, because it is – or it should be – a more efficient, more scalable food production system.

In the years around 2004, however, there was also concerted, well-funded opposition to the concept of open ocean mariculture from almost all quarters of the eNGO arena. "Fish farming" was widely considered a pejorative, and a bane that must be banished, on the basis of its environmental impacts, its disease issues, and its purportedly wanton consumption of precious Peruvian anchovies. No-one in the environmental community at that time seemed to want to explore the question "Un-ecologically sound … compared to what?" This has now changed remarkably.

The environmental impacts of cattle and other livestock are now becoming increasingly understood. Terrestrial livestock production results in an estimated 18% of all Greenhouse Gas Emissions. Feral pigs are decimating native forest habitats from Florida to Hawaii to Australia. No-one is calling for a global ban on poultry production because of bird flu, or a halt to pig farming because of swine flu. Fish-In : Fish-Out ratios for pigs and chickens are also rather poor; and there is an increasing recognition that aquaculture may indeed be the best and highest use of these eminently renewable, generally very well-managed fisheries. Most eNGOs have therefore come to this same conclusion: marine aquaculture, if done right, is relatively benign, and open ocean mariculture is perhaps a more benign form. (Though the eNGOs differ markedly in how vocally and explicitly they present this argument to their membership).

The economics of fishmeal and fish oil demand and supply have proven to be far stronger drivers for innovation than environmental concerns about FI:FOs. (Nothing quite focuses a feed nutritionists' mind so much as a boom in demand for fishmeal for chickens or piglets to feed a rising Asian middleclass.) And while some plaintive voices still advocate for increased human consumption of anchovies, there is broader recognition that this is, and should be, simply a question of market preferences, and supply and demand. Short of some Stalinist-like mandate to "Eat your anchovies, damnit!," the market should be allowed to direct resources where governments and people see most efficient use, and greatest desirability.

Aquaculture is increasingly recognized as an essential part of the future global food supply, and – if done right, such as in open ocean mariculture – as an environmentally-sound protein production system. In early 2012, Conservation International and Worldfish Center jointly co-authored a study (Blue Frotneirs - Hall, et al, 2012) that concluded that of all the animal protein production systems, aquaculture was far and away the most environmentally sound option. World Bank has recently led formation of the Global Partnership for Oceans – which includes a number of leading eNGOs, such as IUCN, Conservation International and Nature Conservancy – that has increasing aquaculture production as one of its five fundamental pillars.

There are still some last bastions of Luddite bullheadedness against cultured seafood – Anchorage and Vancouver, and the shrimp docks of Alabama – but the rest of the world is swimming increasingly with the currents. As eNGOs have begun to recognize that open ocean mariculture – if done correctly – is an essential part of the solution to that which ails the oceans, they have begun to seek ways to use market forces to guide best practices, and to direct their attention – quite correctly – to actual problems that beset the planet, and the seas, and the fish within them.

Certification of sustainability – the SCAD

The World Wildlife Fund was the first major eNGO to embark on a more rational approach, recognizing that certification of sustainability for the best fish farm performers could be a far more effective tool to encourage change. WWF led the Aquaculture Dialogs, in putting these principles into practice, by offering an Aquaculture Stewardship Council imprimatur of the same calibre as the Marine Stewardship Council's certification of wild fishery sustainability. The Seriola and Cobia Aquaculture Dialogs (SCAD) were initiated in 2006, as the flagship species for open ocean mariculture - and while progress has been slow towards adoption of a set of standards for the SCAD, the final Dialog is now planned for Japan, and draft standards should be available for a first public review by early 2013. The SCAD standards will then provide a mechanism for open ocean mariculture producers to differentiate themselves in the market-place, which will hopefully allow some recouping of the greater capital and operating costs that they incur, and some broader recognition of the overall ecological common-sense of culturing fish further offshore, in deeper water. This should hopefully translate into both some greater profitability, but also some ongoing access to more sites, as the market and consumers will be more ready to accept industry growth that has a third-party auditor.

Other eNGOs have followed the WWF lead, with greater emphasis on certification, and now "Aquaculture Improvement Programs" driven by large retailers and foodservice providers (modelled after the "Fishery Improvement Programs" that are now widely heralded by eNGOs and the market). There has been a palpable redistribution of eNGO effort away from aquaculture, and towards more pressing problems of wild stock management and ocean acidification – i.e. things we all should be really worrying about. Similarly, larger foundations that previously funded much of the eNGO anti-aquaculture activism (refer to Vivian Krause's blog, if you have not yet seen it) have now either recognized the error of their ways (i.e. admitted they were outright wrong), or reassessed where they might more effectively deploy their limited resources, for betterment of the planet (i.e. admitted maybe they could do better). Since 2004, there has also been increasing awareness of the health benefits of a diet containing lipid-rich seafood, the insignificance of the PCB / mercury scare for most seafood consumers and all aquaculture products, and the threats to heart health from a diet too heavily dependent on fatty land animals (e.g. Mozzafarian and Rimm, 2006). While seafood consumption in some countries – such as the US – has stagnated, demand for high-value marine fish continues to boom globally, while stocks last. These are the species where open ocean mariculture commands a compelling competitive advantage. No-one will choose to eat tilapia sashimi or basa sushi more than once … nor should they have to.

Technological advances

Technological advances in open ocean mariculture have abounded in the last 8 – 10 years. This has certainly not been at a pace sufficient for industry's appetite. (Which of us doesn't lie awake in the wee hours of the night, and stare at the ceiling and conjure up images of innovations and improvements that they would love to test?) But it might be fairly postulated – at this point in time – that the major technological challenges to open ocean mariculture have been resolved.

Where previously, economies of scale were a major impediment to profitability, new, larger net pens have more recently been tested, and proven. Submersible pens of around 7,000 cu meters are now in operation in Panama and Hawaii. PolarCirkel pens, as large as 50 m diameter, have been deployed and operated successfully in highly-exposed waters, such as along the southern coast of Newfoundland.

New netting materials have also come onto the market, and been put into the ocean, with astounding effectiveness at curtailing escapes, predator interaction and marine mammal entanglement, biofouling and associated fish health. New copper-alloy chain-link mesh, PET monofilament mesh, and Kevlar-stainless-steel mesh materials have all proven to be predator-proof – and dramatic footage will be shared in presentations at the conference. These materials can also either provide resistance to biofouling, or be easier to clean, resulting in better fish health. (For biofouling control, both Sea Stations and Aquapods now have systems for alternating the net pen orientation, or inverting the pen, to allow mesh to be cleaned in-air.) Perhaps the breakthroughs of greatest long-term significance have been in the realm of sustainable diets. While this issue is of concern for all aquaculture, it is particularly germane to the high-value, 'carbohydrate-intolerant species' (sometimes erroneously called 'carnivores') that are almost ubiquitously the subject of culture in open ocean aquaculture systems. New diets have lowered fishmeal and fish oil inclusion to de minimus levels. Several recent research trials have demonstrated culture of marine fish – and no discernible difference in taste of the product - on diets that render the operations net marine protein producers (i.e. a FI:FO ratio of under 1:1). This is the Holy Grail of marine fish nutrition, and both provides a stable economic footing for future industry growth (with feed prices pegged to prices for soy products, rather than being subject to the vagaries of El Nino), as well as negating any previous anxieties, however misplaced, about the ecological sustainability or social inequality of using reduction fishery products in aquaculture. Some new diets purport to eliminate marine proteins entirely – these are currently being tested at a commercial scale. Alternative sources of oil – from innovative strains of soy, to microalgae – also offer potential for replacement of all forage-fishery sourced fish oils in open ocean mariculture diets in the near future.

Similarly, fish farming in general has seen tremendous progress with vaccines and other therapeutants for control of diseases over the last 8 – 10 years. Conversely, however, these advances are of less significance to the open ocean culture industry, where at the present - and envisioned - scales of production, and at the depths and degrees of disconnect between substrate and cultured stock, the pests, parasites, bacteria and viruses are likely to have less impact than in shallower or nearer-shore production systems. Still, these powerful tools represent an increasing level of assurance for production of high-value species.

The remaining obstacles

One of the major remaining obstacles to growth of aquaculture offshore is the same obstacle that hobbles much else in aquaculture expansion – and indeed, in economic expansion globally: financing. The financial foundation for growth offshore has changed dramatically since 2004. At that time, the pioneering operations in Hawaii and Puerto Rico were the equivalent of Silicon Valley garage operations: projects that were bootstrapped largely by the

sheer willpower of the founders. Given the major changes in capital markets since 2008, and the global constriction on private investments as banks and investors have increasingly hoarded cash, the very fact that open ocean mariculture has continued to survive and expand is greatly encouraging. (We might well have been bemoaning the withering of the bloom).

Much of this investment has come from either family institutions, or from commercial fishing interests that are keen to find new avenues for seafood growth. The industry still pines for more cash – aquaculture, by its very nature, is highly capital intensive. But there is growing recognition among institutional investors of the opportunities that are looming, and greater awareness of the technical and financial rewards for open ocean aquaculture in more exposed situations (both literally, and figuratively).

In the US, and some other jurisdictions, government's inability to move above or beyond the anti-aquaculture activist scare-mongering of past decades represents a considerable constraint to industry growth. This limits investment, new technology development and the benefits that might flow to humanity and the oceans from growth in responsible open ocean mariculture. However, even politicians read newspapers, and can see that wild seafood cannot keep pace. Fish are leaving - stocks are either decreasing, or fish are being bought at dockside with yuan, not dollars. The power of this logic will eventually prevail, or else the proponents and adherents of open ocean mariculture will speak other languages, and the jobs, profits and products from open ocean mariculture will flow where they are most welcomed.

Ensuring a Place for Offshore Mariculture: The Threats and Opportunities of Ocean Governance, Planning and Industry interactions

Paul Holthus
Executive Director,
World Ocean Council



BIOGRAPHY

Paul is the founding Executive Director of the World Ocean Council, the international business leadership alliance on "Corporate Ocean Responsibility". The WOC brings together oil/gas, shipping, fisheries, aquaculture, tourism, offshore renewables and other ocean industries – creating an unprecedented ocean business community and private sector leadership in addressing shared marine sustainability challenges. Paul has held senior positions with the UN Environment Program and international environment organizations, including serving as Deputy Director for the Global Marine Program of IUCN (The World Conservation Union).

Since 1998, Paul has worked primarily with the private sector to develop practical solutions to sustainable development of the marine environment. He has worked in over 30 countries with companies, communities, industry associations, UN agencies, international NGOs, and foundations. Paul is a graduate of the University of California and the University of Hawaii, with advanced degrees in marine resource management and international business.

Abstract

The future space of offshore mariculture is increasing challenged and complex due to changes in ocean governance, the development of ocean planning and the growing kinds and levels of other ocean use. Offshore mariculture risks being left out as the ocean becomes the last managed ecosystem. Offshore oil and gas, shipping, ports, renewable energy, fisheries, and other ocean uses are putting increasing pressure on the marine environment. All ocean industries are coming under increasing scrutiny as the impacts of ocean activities accumulate. Ocean industries are subject to a growing number of international, regional and national ocean governance development, e.g. creating marine parks for open ocean areas. Marine spatial planning (MSP) is being developed in the EU, US, Australia and elsewhere to allocate marine areas for various and marine conservation. It is not clear how nascent offshore mariculture will fare in the policy and planning developments in the face of existing, well established ocean users and the growing ocean conservation movement. It is critical that offshore mariculture develops an understanding of issues, stakeholders and processes involved in ocean governance and MSP, and engage proactively and constructively with other ocean industries. Ocean policy and planning developments present both challenges to future access and opportunities for offshore mariculture to secure a predictable framework for

investment and development. International cross-sectoral sector industry leadership to engage ocean policy and planning and create business benefits through collaboration is being developed through the World Ocean Council.

1. INTRODUCTION

1.1. Ocean Industries and the Marine Environment

Offshore mariculture depends on healthy, productive marine ecosystems. The single most important factor determining the state of the seas is the way business is done in the marine environment. Whether it is the headline events, or the multitude of major trends and minor incidents - a seafood species overexploited, an invasive species introduced, chronic oil spillage, plastic garbage tossed overboard - injuries large and small from growing commercial use of the ocean are adding up to cumulative impacts on a dynamic, inter-connected marine ecosystem.

These cumulative impacts affect offshore mariculture operations and viability. Companies and entire sectors need to understand the impacts associated with their ocean activities and develop, test and implement the best practices expected of responsible operators. Otherwise they risk losing the legal,political or social license to operate. Simple regulatory compliance may no longer suffice, as governments cannot monitor every action by every operator at sea.

Many good people in good companies are working to address impacts and sustainability, but more remains to be done. Identifying problems and developing solutions must be based on good science and credible risk assessment, and must be tacked at the scale in which the impacts are occurring. The best efforts by a single company or an entire industry will not be enough to address major and cumulative effects in the inter-connected marine “commons”. Responsible companies have the most to benefit from collaboration with others in the ocean business community in developing solutions to shared marine environmental issues. They also have the most to lose by not doing so.

Companies with a long-term view of their ocean business are looking to collaborate within and between industries on solutions to mutual marine environmental challenges. Working together in a pre-competitive context can result in synergies and economies of scale. Protecting the seas to protect your business makes good business sense. This is especially true for offshore mariculture.

2. RESPONSIBLE OCEAN BUSINESS IN CROWDED SEAS

2.1. Growing Ocean Use, Impacts and Concerns

Although the ocean covers over 70% of the earth’s surface, it is an increasing crowded place. In addition to rapidly growing aquaculture, ocean industries such as shipping, oil, fisheries, and tourism are big and have been expanding rapidly, with increasing impacts to the marine environment. Seaborne shipping already accounts for 90% of global trade, and worldwide cargo will continue to rise in the coming decades, notwithstanding the current economic downturn. The offshore oil industry is expanding and moving into ever deeper waters and new areas. In the seafood sector, human consumption of seafood grew from 20 - 85 million tons during 1960 – 2002, at the same time that the FAO estimates that 70% of fish stocks have become fully- or overexploited. Add in the other ocean uses, such as the doubling of cruise ship passenger capacity in the past 20 years, the recent growth in desalination, aquaculture, offshore wind farms, and the overall mix becomes complex.

Underlying this growing level and variety of industry activities is an ocean in trouble. Oceans provide 59% of the world’s ecosystem benefits; nearshore marine areas alone (5% of the Earth’s surface) provide 38% of these global benefits. Unfortunately, the global marine environment, its unique biodiversity and its life-sustaining resources are being degraded,

destroyed and overexploited at an ever increasing rate and global scale.

2.2. The Challenge of Sustainability in an Interconnected Marine World

Sustainable development of the dynamic, interconnected marine environment presents unique challenges for industry. As marine environmental health declines, aquaculture and other ocean industries are being held responsible for their impacts by the public, governments, non-government organizations (NGOs), and inter-governmental organizations (IGOs). Advocacy groups are aggressively confronting ocean industries on a sectoral basis (e.g. all offshore mariculture), incident basis (e.g. disease outbreak), or local basis (e.g. site water quality). Moreover, action on marine environmental concerns are increasingly being pursed through internationally coordinated campaigns, e.g. ocean zoning, marine protected areas (MPAs), ocean noise, marine debris, greenhouse gas emissions. Unfortunately there is often not a corresponding coordination of effort by the sectorally fragmented ocean business community to engage these crosscutting issues.

Ocean stakeholders are pushing for increased regulation in a variety of international venues where international ocean rules are established. The aquaculture, fisheries and seafood industries have a longstanding and productive interaction with the UN Food and Agriculture Organization (FAO). For the maritime transport sector, the International Maritime Organization (IMO) of the United Nations (UN) provides the forum for rulemaking related to this global industry. However, many ocean sustainability issues cut across the realm of individual industry sectors and are being actively taken up in other arenas in which there is little or no private sector involvement.

For example, some of the most important ocean governance developments are being pursued through the non sector-specific international policy processes covering oceans, e.g. the Convention on Biological Diversity (CBD) and the UN Convention on the Law of the Sea (UNCLOS), the Convention on the International Trade in Endangered Species (CITES), etc. Coordinated industry participation in these processes is lacking, as is balanced, comprehensive information regarding industry efforts to address marine environmental issues. Marine industries are often portrayed only as the cause of ocean problems.

As a result, private sector access to ocean resources, services and space - even by companies with the best environmental record - is increasingly at risk due to the loss of the “social license” to operate. Many of the threats are related to ocean governance and planning, and often emanate from the fact that the offshore mariculture industry is not well engaged and in which other stakeholders have sophisticated, well organized agendas and involvement.

There have been limited efforts by responsible companies to differentiate themselves from poor performers and try to do business in a more environmentally sustainable way. However, the efforts of one company or even a whole sector are not enough to address collective global impacts by a diverse range of industries in a shared global ecosystem.

3. OFFSHORE MARICULTURE AND OCEAN GOVERNANCE, PLANNING, AND INDUSTRY INTERACTIONS

3.1. Ocean Governance

There is a substantial legal and policy framework regarding the governance of ocean areas. The international "playing field" and "rules" for the sustainable development of the ocean are being established through these organizations, programs, and agreements, most of which are UN related. Some are more comprehensive and others are very much sector oriented.
The international legal for this includes:

- United Nations Convention on the Law of the Sea (UNCLOS).
- Chapter 17 of Agenda 21.

- World Summit for Sustainable Development 2002; and
- Convention on Biological Diversity (CBD).
- 1995 Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities.
- International Maritime Organization convention and protocols (such as MARPOL, the London Dumping Convention, Oil Pollution Preparedness Responses and Control (OPRC).
- 1995 UN Fish Stocks Agreement, and the FAO Code of Conduct for Responsible Fisheries.
- The United Nations Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks.

Numerous other international agreements cover more specific aspects of the sustainable development of oceans and coasts. These include: the International Maritime Organization (IMO) conventions on marine pollution from sea-based sources; the UN Environment Program (UNEP) Global Program of Action for Protection of the Marine Environment from Land-Based Activities; the UN Food and Agriculture Organization (FAO) Code of Conduct for Responsible Fisheries; the Convention on the International Trade in Endangered Species (CITES); and several Regional Seas Conventions.

Ocean governance is inherently multi-sectoral and international, requiring the participation of all stakeholders. As the primary user of the marine environment, and source of many ocean impacts, the private sector is best placed to develop and drive solutions, but is often not doing so in a way that addresses the global scale of the issues. Industry efforts to address its impacts are usually piecemeal and reactive, usually undertaken by one company in a limited area.

The problem is that there are few incentives for leadership in environmental responsibility and collaboration in a shared global ocean ecosystem. It is often not clear how, and with whom, to work on the complex, intertwined, international marine issues. Actions taken by one company to be a good ocean steward generate costs that are not perceived to have benefits, resulting in a competitive disadvantage and few incentives to tackle shared environmental problems.

Priorities for industry in relation to ocean issues include a need to focus on processes, rather than individual issues or stakeholders. This is particularly true for those processes with the potential to create long term involvement or relationship-building in addressing ocean issues. It is critical to determine the processes, issues, approaches and tools likely to have a 'material' impact on industry operations in the marine environment. The situations that affect the access to ocean space and resources and the social license to operate will clearly be priorities. Due to the global interconnected nature of the ocean environment and industry operations, ocean businesses must engage in processes, issues or stakeholders at an international scale.

The Convention on Biological Diversity (CBD) is one of the priority ocean legal and policy processes which has been lacking industry involvement until recently. However, developments that potentially affect industry operations in the marine environment may occur in other arenas and it is important to monitor major policy processes, some of which are not specifically ocean related. These processes also provide a good opportunity for engaging with NGOs. Industry interaction with other ocean industries in the ocean business community via the World Ocean Council (WOC) creates the potential for economies of scale and business benefits in addressing ocean sustainability, stewardship and science.

3.2. Ocean Planning/Marine Spatial Planning (MSP)

Spatially oriented management of the marine environment is emerging as a major approach to the sustainable development and management of marine ecosystems as the levels and kinds of human use increase. Spatial planning is a well-developed tool for managing land use in many areas where it is a key component of development and environmental management.

An incremental, permit-by-permit approach to land use planning has been increasingly replaced by a broader, more comprehensive spatial approach.

There are similarities between land use planning and marine spatial planning (MSP), as both seek to reconcile competing claims for use of space. There are also significant differences including: (a) MSP must address activities on the seabed, in the water column as well as on the two-dimensional surface; (b) many maritime activities are mobile, e.g. fishing and shipping, using marine space but without permanent structures; and (c) land use planning takes place in a context of land tenure rights which do not have a marine equivalent. Instead activities in the marine environment are regulated through a range of sectoral laws, plans and licenses/permits.

MSP is often associated with the establishment of marine protected areas (MPAs). As more MPAs were created in recent years, the environment community realized that an ad hoc, one–off approach would not lead to effective large scale conservation and the concept of MPA networks emerged. Unfortunately, even strategically-planned networks do not necessarily lead to effective marine conservation at the largest scale and planners began to explore the concept of broader spatial management. Unfortunately, MSP has often lacked a clearly articulated vision for the multiple use of marine areas, creating a lack of certainty for ocean area developers and users. This is exacerbated by the sector-by-sector responsibilities for determining development of the marine environment, at national and international levels.

The most critical elements of MSP include:
- Providing a strategic, integrated and forward-looking framework for all uses of a marine area in support of sustainable development, taking account of environmental, social and economic objectives.
- Allocating space in a rational manner that optimizes uses, avoids or minimizes conflicts and maximizes synergy between sectors.
- Applying an ecosystem approach to the management of marine environment by maintaining ecological processes and resilience to ensure the environment has the capacity to support social and economic benefits derived from the ecosystems.
- Identifying, conserving, and where necessary and appropriate, restoring or recovering important resources and components of marine ecosystems.

Key aspects of developing and implementing successful zoning include:
- Locating and designating zones based on the underlying topography, oceanography, and distribution of biotic communities.
- Designing systems of permits, licenses, and use rules within each zone.
- Establishing compliance mechanisms, and creating programs to monitor, to review, and to adapt the zoning system.

The private sector must be involved in MSP from the outset by companies that want to be responsible industry operators and create the “buy in” to the management plans - significantly increasing the potential success in implementing marine area management. Unfortunately, the private sector is often not involved at key ocean zoning developments, especially at the international level, and is not engaged in a constructive, coordinated manner that brings together the range of industries operating in the marine environment. Without business involvement there is a significant risk that marine management plans will not include full consideration of the existing and potential economic activities in the areas.

Constructive industry involvement requires sustained, systematic efforts to identify the relevant stakeholders and build the relationships with those who will respond to good faith efforts by industry efforts to become involved in the ocean planning process. Where there is a need for additional science, revised policies, or new regulations to facilitate the development and implementation of spatial management, there is more likely to be support for these if they

have a sense of ownership emanating from active involvement in the process. Industry involvement in MSP is constrained by a number of factors, including: 1) Lack of understanding of the movement and momentum behind ocean zoning efforts; 2) Limited engagement in the multi-stakeholder processes where ocean zoning is most rapidly being developed; 3) Lack of means for engaging the broader ocean business community on marine management and sustainability issues.

MSP or ocean zoning efforts are underway in several countries and in a few transboundary areas (Table1).

Table 1. Recent Marine Spatial Management Efforts: National and Transboundary

COUNTRY	AGENCY	PROJECT
Australia	Great Barrier Reef Marine Park Authority	Great Barrier Reef Marine Park zoning
Australia	National Ocean Office	Marine Bioregional Planning
Belgium	Flemish Ministry of Mobility & North Sea	Master Plan for the Belgian Part of the North Sea
Canada	Fisheries and Oceans Canada	Eastern Scotian Shelf Integrated Management (ESSIM) Project
Canada	Fisheries and Oceans Canada and New Brunswick	Southwest Bay of Fundy Marine Resources Use Plan
China	State Oceanic Administration	Territorial Sea zoning
Denmark, Germany, The Netherlands	Wadden Sea Secretariat	Trilateral Wadden Sea Cooperation Area
Ecuador	Galapagos National Park, Ministerio del Ambiente	Galapagos Marine Reserve Zoning
Finland	Finnish Natural Heritage Service (Metsahallitus)	BALANCE Project (Baltic Sea Management-Nature Conservation and Sustainable Development of the Ecosystem through Spatial Planning)
Italy, Slovenia, Croatia	Italian Ministry for the Environment and Territory	ADRICOSM (Adriatic Sea Integrated Coastal Areas and River Basin Management System Pilot Project)
Germany	German Federal Ministry of Transport, Building and Housing; Federal Office for Building and Regional Planning	EEZ and Territorial Sea Planning
Netherlands	Ministry of Transport, Public Works & Water Management—North Sea Directorate	Integrated Management Plan for the North Sea 2015
New Zealand	Department of Conservation	Regional Coastal Plan for Northland
Norway	Department of Environmental Protection	Barents Sea and sea areas off the Lofoten Islands
United Kingdom	Department of Environment, Food, & Rural Affairs (DEFRA)	Irish Sea Pilot Project
USA	National Ocean Policy	Coastal and Marines Spatial Planning, based on 9 Regions for US waters
USA	National Oceanic & Atmospheric Administration (NOAA)	Florida Keys & Channel Islands National Marine Sanctuaries (zoning)
USA	California	California Ocean Resources Management

There exist several arrangements under which high seas spatial protection measures have been taken, with varying levels of protection (Table 2). The variety of arrangements demonstrates that spatial management in Areas Beyond National Jurisdiction (ABNJ) is being undertaken in a piecemeal fashion, but not in an organized comprehensive framework of MSP.

Table 2. Recent Marine Spatial Management Efforts: Areas Beyond National Jurisdiction

ORGANIZATION	MEASURES
Regional Fisheries Management Organizations (RFMOs)	• SEAFO: 10 bottom fishing closures • NEAFC: 8 bottom fishing closures
	• NAFO: 4 bottom fishing closures • GFCM: 3 trawl closures and trawl ban >1000m • SPRFMO: precautionary trawl restrictions, and "frozen footprint"
Regional Seas Conventions	• Barcelona Convention: Pelagos Sanctuary SPAMI • OSPAR: Portugal MPA on claimed extended continental shelf • OSPAR: Several protected ares situated within OSPAR high seas with no known continental shelf claims
Antarctic Treaty and CCAMLR	• Antarctic Treaty: 16 ASPAs, 3 ASMAs • CCAMLR: Several species-specific closures as well as 2 full fisheries closures, 2 CEMP monitoring sites, and area-wide gillnet ban and trawl ban
Other International Conventions	• IMO (thru MARPOL): 2 Special Areas • IMO can also designate PSSAs, but there are none in ABNJ • IWC: 3 ocean basin whale sanctuaries
International Agreements	• Pelagos Sanctuary for Mediterranean Marine Mammals • Agreement Concerning the Shipwrecked Vessel RMS Titanic
ACCOBAMS	• 8 MPAs, two of which include high seas areas were proposed as part of the Mediterranean Common Dolphin Conservation Plan. • 6 important cetacean areas, two of which include high seas areas
Voluntary Industry Measures	• SIODFA: 4 voluntary trawl closures on Indian Ocean seamounts

3.3. Industry Collaboration in Sustainable Ocean Use

As the private sector is the primary ocean user, it is well placed to develop and deliver solutions in response to society's demands that marine ecosystem use is sustainable and industry impacts are minimized. The ocean business community can develop this leadership and deliver ocean sustainability solutions that work for business, rather than being forced to react to conditions advanced by other stakeholders. Cross-sectoral ocean business community of leadership and collaboration is needed among those who want to address marine environmental issues, differentiate themselves from poor performers, collaborate with like-minded companies within and across sectors, and engage ocean stakeholders and policy processes. Given the size and scope of ocean industries, visionary companies and executives have a particular opportunity to provide leadership in collaborative, industry-driven ocean sustainability.

With the establishment of the World Ocean Council (WOC) there is now a structure and process for companies to seize this opportunity and create an international industry leadership alliance on the ocean. The UN Secretary-General's 2010 report on oceans and the law of the sea noted there is a need to "create awareness and understanding among industry of the ecosystem approach, marine biodiversity and marine spatial planning; develop regional ocean business councils; and strengthen efforts to create a global crosssectoral industry alliance to constructively engage in United Nations and other international processes relevant to oceans, through organizations such as the World Ocean Council."

Ocean sustainability issues are increasingly affecting the future of ocean health. Industry leadership onsustainability issues is not only important to the future of the industry operations, but also to the future ofthe ocean. Industry leadership in "Corporate Ocean Responsibility" is

essential to navigating this critical juncture and ensuring the long term health of both the ocean and responsible industry use of marine space and resources. Responsible industry performers are well positioned to develop and drive businessoriented solutions to marine environmental challenges and collaborate with other ocean industries and stakeholders in ensuring the health and continued economic use of the seas.

Many policy, practical and public reputation aspects of ocean industry activities are now affected, if not dominated, by environmental concerns. These issues are affecting all industries that use ocean space and resources, e.g. offshore aquaculture, oil and gas, shipping, fisheries, ports, tourism, ocean renewable energy, seabed mining, dredging, etc. This is creating important needs and opportunities for collaboration, synergies, and business benefits among the ocean business community. Unfortunately ocean industries are not engaging in a coordinated systematic approach to many of the developments affecting their ability to do business in the ocean, missing opportunities for collaboration and economies of scale in developing solutions.

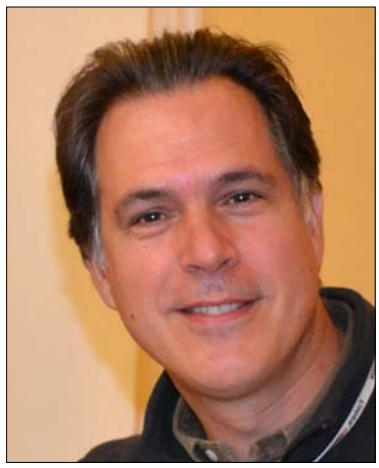
To address the ocean sustainability issues and opportunities critical to business, the WOC is creating an unprecedented global, cross-sectoral industry alliance. The WOC is catalyzing proactive, collaborative efforts towards “Corporate Ocean Responsibility” by bringing together the diverse mix of ocean industry sectors. Cross-sectoral leadership and collaboration will result in significant business value for the operators committing to the vision of a healthy and productive ocean that supports sustainable use by the responsible ocean business community.

Appendix: Acronyms

ACCOBAMS	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Areas
ABNJ	Areas beyond national jurisdiction
ASMA	Antarctic Specially Managed Area
ASPA	Antarctic Specially Protected Area
CCAMLR	Convention on the Conservation of Antarctic Marine Living Resources
CEMP	CCAMLR Ecosystem Monitoring Program
EC	European Commission
EEZ	Exclusive Economic Zone
EU	European Union
GFCM	General Fisheries Commission for the Mediterranean
IMO	International Maritime Organization
IWC	International Whaling Commission
MARPOL	International Convention for the Prevention of Pollution from Ships (MARine POLlution)
MPA	Marine protected area
MSP	Marine spatial planning
NAFO	Northwest Atlantic Fisheries Organization
NEAFC	North East Atlantic Fisheries Commission
OSPAR	Oslo-Paris Agreement (NE Atlantic)
PSSA	Particularly Sensitive Sea Area
RFMO	Regional fisheries management organization
SEAFO	South East Atlantic Fisheries Organization
SIODFA	Southern Indian Ocean Deepwater Fishers' Association
SPAMI	Specially Protected Areas of Mediterranean Interest
SPRFMO	South Pacific Regional Fisheries Management Organization

Moving further offshore: FAO's perspective on technical, environmental and policy implications

Alessandro Lovatelli
Aquaculture Officer,
FAO of the UN



BIOGRAPHY

Alessandro LOVATELLI – A marine biologist and aquaculturist, he obtained his bB.Sc. and M.Sc. degrees at the universities of Southampton and Plymouth (United Kingdom), respectively. He first got involved with the aquaculture industry back in 1985 when he was recruited by an Italian company as a clam hatchery biologist working on both the endemic and exotic carpet clam (Tapes spp.). His first experience with FAO dates back to 1987 working as a bivalve expert attached to an FAO/UNDP regional project. His subsequent FAO assignment was in Mexico working on a regional aquaculture development project funded by the Italian Government. From 1993 to 1997 he worked in Viet Nam, Somalia and then again in Southeast Asia. In Viet Nam he headed the aquaculture and fisheries component of a large European Union project developing, among other activities, ten regional aquaculture demonstration, training and extension centres. In Somalia he acted as the lead aquaculture and fisheries consultant for the European Commission. Following an additional year in Viet Nam as one of the Team Leaders under the Danish-funded Fisheries Master Plan Project, he was recruited by FAO as the Aquaculture Advisor attached to the FAO-EASTFISH project based in Denmark (now Eurofish). In 2001 he once again joined the FAO Department of Fishery and Aquaculture in Rome. The main activities currently focused on are marine/offshore aquaculture development, transfer of farming technologies and resources management. Mr Lovatelli has coordinated and co-authored a number FAO technical reviews and papers mainly focused on marine aquaculture development.

Bremerhaven Declaration of the Future of Global Ocean Aquaculture – Recommendations for the development of a new industry

Harald Rosenthal

President, World Sturgeon Conservation Society



BIOGRAPHY

Dr. Rosenthal was senior scientist at the Marine Biology Institute of Helgoland, Germany, until 1989 and thereafter Professor for Fisheries Biology and Aquaculture at the University of Kiel until he retired in 2003. He holds several honorary degrees from Canada, Scotland, Poland and Greece.

Professor Rosenthal is the founder and acting President of the World Sturgeon Conservation Society, a global platform dealing with key issues related to rehabilitation programmes of these highly endagered group of ancient fish species which are at the brink of extinction in several parts of the world.

He also is a member of the Royal Swedish Academy of Sciences, Stockholm (Agriculture, Forestry and Fisheries)

He is the Editor-in-Chief of the Journal of Applied Ichthyology and also Associate Editor of the Acta Adriatica and Editorial Board member of the Acta Ichthyologia and Piscatoria (Poland). Previously he served for more than two decades on the editorial board of the journals “Aquaculture”, “Marine Biology”, “Helgoland Marine Investigations” and “Aquaculture Engineering” (on the latter as a founding board member). During his 50 years of professional life he supervised many PhD and Diploma students and was teaching at several universities in over 10 countries. He also worked on projects in over 20 countries and authored or co-authored over 400 scientific publications while also organising and partiicipating in many international conferences on aquaculture, marine environment and on sturgeon conservation issues.

He was instrumental in preparing the Action Plan on Sturio Conservation presented to the Bern Convention and recently assisted in formulating the Turkish Sturgeon Action Plan which will be published in the near future.

Although retired for many years, Professor Rosenthal is still actively participating in research work, teaches at Universities abroad and supervises research programmes in Europe and countries overseas.

He is the Programme Chair and Organizer of the “Aquaculture Forum Bremerhaven” and led the major Workshop on: “Open Ocean Aquaculture development – from visions to reality: the future of offshore farming“ which was held in March 2012 in Bremerhaven. This conference prepared under his guidance the resulting BREMERHAVEN DECLARATION on the subject which was than signed by session chairs, speakers, programme committee members and many participants from about 16 countries. The declaration will be presented on the first day of the Izmir offshore aquaculture conference October 17, 2012.

Aquaculture Forum
BREMERHAVEN

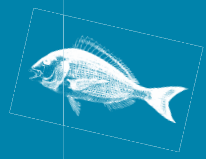


Bremerhaven Declaration
on the Future of Global Open Ocean Aquaculture

1

Part I

Preamble and Recommendations



Workshop I — **March 26 – 27, 2012**

OPEN OCEAN AQUACULTURE DEVELOPMENT

From visions to reality: the future of offshore farming

www.aquaculture-forum.com

Investment in sustainable fisheries
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bis

BREMERHAVEN DECLARATION
on the Future of Global Open Ocean Aquaculture



PREAMBLE

Workshop I of the Aquaculture Forum Bremerhaven was attended by about 100 participants from 16 countries, representing experts from industry, science, investors, regulators, and consumers. The initial concept for preparing the declaration was conceived at the "Marine Resources and Beyond Conference" held in 2011 and finalized in 2012 during the "International Workshop on Open Ocean Aquaculture", both held in Bremerhaven, Germany.

The participants of the workshop discussed a number of pertinent issues related to open ocean aquaculture while

- **recognizing** that global food security, human health and overall human welfare are in serious jeopardy since the production of living marine resources for vital human foods cannot be sustained by natural fisheries production even if these resources are properly managed at levels of optimum sustainable yields;

- **realizing** that the gap between seafood supply and demand is increasing at an alarming rate as these are nutrient-dense foods considered extremely important for human health and well-being. On the other hand the development of aquaculture has been remarkable and today provides more than half of all fish destined for human consumption;

- **confirming** that conventional land-based and coastal aquaculture will continue to grow, thereby playing in the future a growing role in quality food supply. However, this much needed developoment will only delay the widening of the gap in seafood supply and unconventionally new and modern technologies such as offshore farming systems are required to significantly assisting in closing this gap.

- **noting** that the world is too dependent however on aquaculture development and its exports, as aquaculture is threatened by coastal urbanization, industrialization, and water pollution. Weighing these trends we believe that it is urgent that the world develop offshore aquaculture, while complying with the FAO Code of Conduct for Responsible Fisheries and Aquaculture as well as with other environmental regulatory frameworks in support of sustainable aquaculture development;

- **finding** that Offshore aquaculture will require much higher inputs of capital but also needs a new level of cooperation from a wide range of social, technological, economic, and natural resource users;

- **discovering** that over the past decade major advances and new concepts have evolved, and several of them have been successfully tested at the pilot scale level, while others have failed.

- **learning** that these experiments and scale-up trials have led us to believe that offshore aquaculture does have substantial potential to bring global aquaculture production to new levels to meet future huamn needs;

- **believing** firmly that strategies need to be developed with strong participation of all affected stakeholders interested in the social-ecological design and engineering of innovative offshore aquaculture food systems;

- **recognizing** that the integration of offshore food and energy systems (e.g. aquaculture systems and windfarms; oil and gas) appear to be especialy promising, but will require a high level of innovative technology, the use marine spatial planning, and transparent, adaptive management for spatial efficiency and conflict resolution;

- **concluding** also that open ocean aquaculture if intelligently designed can be incorporat into overall cooperative fisheries restoration and management strategies.

Following these discussions the undersigning Workshop participants (which included the core group of the global expertise on the subject) formulated a series of specific recommendations. We call upon national, international, intergovernmental agencies, as well as the industries, potential investors, scientists, regulators and NGOs of the respective countries to strongly support these recommendations with the aim to provide a healthy and environmentally sustainable bio-resource system that can substantially contribute to meet the future demands of our societies. We herewith request immediate action to provide the means and resources for implementing the recommendations listed below.

RECOMMENDATIONS

Recommendation 1

Compliance of Open Ocean Aquaculture with the United Nations Convention of the Law of the Sea (UNCLOS) and other global, national, and regional legal requirements is needed.
A legal framework for Open Ocean Aquaculture should have clear standards and thresholds according to best environmental practices and best available technologies while also addressing issues of public trust, ownership, and liabilities.

Recommendation 2

Planning for Open Ocean Aquaculture for both research as well as for commercial enterprises should, from the start, consider the economies of scale required for its sustainable development in regard to its social and economic viability.

Recommendation 3

There is an urgent need to address how societal values and policies affect the acceptance, structures, and types of offshore aquaculture.

Recommendation 4

There is an urgent need to plan for the comprehensive development of land and water-based infrastructures needed for the technical and logistical support and supply of Open Ocean Aquaculture that incorporates the multi-dimensional interacting factors for successful operations.

Recommendation 5

Priority should be given to the culture of species well-established in aquaculture (preferably natives) which can provide large quantities of seafood for which aquaculture technologies are known and have the potential to become acclimated to offshore farming conditions.

Recommendation 6

Organize international research and development platforms involving countries active or intending to initiate Open Ocean Aquaculture development projects.

Recommendation 7

Investigate whether the cultivated species can provide high value marine products other than foods which can also be simultaneously obtained thereby contributing substantially to the economic viability of offshore operations.

Recommendation 8

Create education and training networks to provide the required multidisciplinary and interdisciplinary expertise for safe and professional operations of Open Ocean Aquaculture systems.

Recommendation 9

Utilization of Open Ocean Aquaculture systems as potential environmental quality monitoring stations should be promoted as part of the international ocean observing systems networks.

Bremerhaven, March 27, 2012

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2012 – 2013 Aquaculture Forum BREMERHAVEN

Business and science for a sustainable European aquaculture

WORKSHOP STRUCTURE AND CONTENT

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Workshop III — February 18 – 19, 2013

FINFISH NUTRITION AND AQUACULTURE TECHNOLOGY AT THE CROSSROADS 3

The future of fish nutrition; high versus low tech systems or integrated aquaculture?

With the expansion of the industry it is obvious that fishmeal replacement is a must. New protein sources may not be the prime concern but marine fats are to meet the demanded quality and provide the required level of unsaturated fatty acids. What are the future solutions? Further, the trend towards intensification will continue and water will be at the premium in most resource systems. Recycling of water is one issue but integrated recycling systems where wastes become valuable resources, providing options for optimizing the utility of natural resources (water, nutrients, energy.

Visits to exprimental facilities and to commercial producers can be organized (optional)

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AQUACULTURE PRODUCT QUALITY AND CONSUMER DEMANDS 2

The Djungel of Labelism: Do we need to label the labellors?

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DEVELOPMENTAL TRENDS AND DIVERSIFICATION IN EUROPEAN AQUACULTURE 4

New species and/or new products from established aquaculture species?

The rapid growth of the industry in several parts of the world has been based on a limited number of species. Several new species are now in production, the names of which were largely unknown by the consumers 10 years ago. Can we expect this trend to continue? Should we try to investigate in option to diversify aquaculture through the development of culture know-how for new species?

Alternatively, should we diversify products derived from a limited number of species for which our knowledge on reproduction, growth, nutrition, and health is well established? Does future aquaculture produce only for the food market or will aquaculture species become increasingly the bioreactors to extract additionally high-prized substances needed by others than the food markets? Will freshwater or marine species dominate the future mass production systems?

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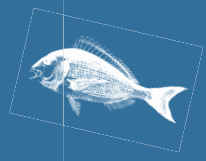
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Bremerhaven Declaration
on the Future of Global Open Ocean Aquaculture

1

Part II
Recommendations on subject areas and justifications



Workshop I — **March 26 – 27, 2012**

OPEN OCEAN AQUACULTURE DEVELOPMENT
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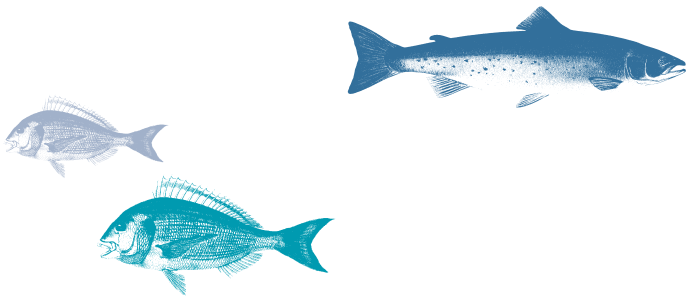
Ministry of Economics, Labour and Ports
Freie Hansestadt Bremen

Bremerhavener Gesellschaft für Investitionsförderung und Stadtentwicklung mbH
bis



Testing new structures for offshore seaweed farming:

Preparation of Laminaria harvest from the ring formerly located at Helgoland Roads in the harbour of Helgoland. The ring was lifted from the water by a land-based crane.





BREMERHAVEN DECLARATION Part II
Recommendations on subject areas and justifications

Recommendation 1

Compliance of Open Ocean Aquaculture with the United Nations Convention of the Law of the Sea (UNCLOS) and other global, national, and regional legal requirements is needed.
A legal framework for Open Ocean Aquaculture should have clear standards and thresholds according to best environmental practices and best available technologies while also addressing issues of public trust, ownership, and liabilities.

Justification

At present there is an incomplete legal framework available for the development of aquafarming in open waters. Based on the UN Convention of the Law of the Sea (UNCLOS) using the terms "Open Ocean Aquaculture" as well as "offshore" seem to be questionable, and may have no legal relevance.

To date, offshore aquaculture has been defined as being in exposed sites, or in high energy environments (Ryan 2005), and not by distance from the coast, but this term has no legal meaning. Legally it is critical whether marine aquaculture is located within the territorial waters of the coastal state, in the EEZ, or on the High Seas. Therefore, precise definitions of offshore aquaculture orientated to zoning as defined in the UNCLOS is more appropriate to develop a common legal framework. Thus, marine aquaculture which is operated in the territorial seas of a state can only legally be described as "coastal aquaculture".

For aquaculture operations in the EEZ and the continental shelf the term "EEZ aquaculture" is a more appropriate legal term that is defined clearly in an international legal framework. Besides this basic definition, there remain numerous unsolved legal aspects in many jurisdictions as to the licensing procedures. We believe it is time for governments to resolve these in order to offer potential investors a clear legal structure from the beginning, and to develop appropriate terminology to match the legal situation in compliance with international and national rules and standards. There are also many regulations in existence for many other coastal and open ocean operations with regard to technologies and logistics such as navigation and safely standards, both for equipment and operators. These should be carefully checked, adopted, or amended as appropriate.

There is an urgent need to establish an international working group that addresses these legal issues to provide the necessary guidance for legal frameworks. The terms of reference should elaborate on options to harmonize and simplify the application process to achieve a more uniform licensing format applicable to various jurisdictions.

At present there are differing and confusing permit procedures in place that are not only time consuming, but also prevent development. Zoning in the context of marine spatial planning should be incorporated into legal frameworks to better facilitate licensing and monitoring obligations (see also justification under recommendation 3 as well as 6).

Recommendation 2

Planning for Open Ocean Aquaculture for both research as well as for commercial enterprises should, from the start, consider the economies of scale required for its sustainable development in regard to its social and economic viability.

Justification

Many trials in the past focused on technical feasibility by developing various technological details for best performance in harsh environments without due consideration of the minimum scale of production needed to bring the investment and operational costs per production unit down to realistic levels in order to reach profitability.

Furthermore, the necessary infrastructure development offshore and related onshore infrastructure needs have not yet been sufficiently considered in relation to scale in space and time. These issues need urgent attention in research and development efforts, which should be done at a larger scale in order to provide the needed data for sound economic feasibility assessments. This should include the assessment of infrastructure co-use, e.g. together with offshore wind farms, in order to create possible economies of scope.

Recommendation 3

There is an urgent need to address how societal values and policies affect the acceptance, structures, and types of offshore aquaculture.

Justification

In the development and implementation of offshore aquaculture projects, considerable progress has been made in methods and tools that assess biophysical and economic pre-conditions in terms of site selection and adaptive technologies.

On the other hand, social, cultural or political conditions surrounding aquaculture projects are seldom explicitly addressed in marine spatial planning. As a consequence, the implementation of projects and establishment systems fail due to factors that could have been foreseen if a more thorough analysis would have been employed that paid sufficient attention to the socio-economic dimensions of aquaculture. Besides general criteria and strategies to be employed, there are regional and local differences in the social-economic settings that need to be addressed in order to minimize the risks for undesirable outcomes. Especially in the offshore realm, stakeholders of aquaculture projects encompass a wide range of actors with different and often contrasting views, objectives and capacities that can act as detrimental forces to the overall sustainability of offshore aquaculture projects and investments.

There is a need to take also a more holistic approach including appropriate risk assessment methodologies as outlined in the GESAMP 2008 (Report and Studies No 76) on "Assessment and communication of environmental risks in coastal aquaculture", where risk communication between stakeholders and consensus building is one of the key issues in conflict resolution.

Along the same line of arguments it seems advisable to also involve farmer organisations and governing bodies of regional environmental agreements[1] to develop rules, standards and thresholds. Close reference to the FAO Code of Conduct on Responsible Fisheries and Aquaculture and the FAO Ecosystems Approach to Aquaculture are recommended.

1 HELCOM, ICES, OSPAR in European waters and other respective agreements in other jurisdictions



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Recommendation 4

There is an urgent need to plan for the comprehensive development of land and water-based infrastructures needed for the technical and logistical support and supply of Open Ocean Aquaculture that incorporates the multi-dimensional interacting factors for successful operations.

Justification

Aquaculture in exposed sites and in the open ocean requires efficient support systems in the ocean as well as ashore that must support effective logistics for both transportation and storage. Additionally, specific equipment permitting a high level of automation is needed to minimize service and maximize safety at sea. Furthermore, extended lifetimes for both instrumentation and structural materials will be needed to permit ease of handling under adverse environmental conditions.

The social acceptance of aquaculture in general and offshore farming in particular may change with increasing food concerns. These issues must be addressed. It can be anticipated that job opportunities will most likely be very important in the aquaculture onshore support sectors in technology development, supplies, transportation, feed production, and hatcheries and less so in the grow-out offshore facilities where maintenance and services will be reduced to a minimum and most likely replaced by largely automated systems. This will require decisionmakers to be aware of the large potential for job creation if more comprehensive land-water infrastructure planning is conducted for the full development of Offshore Aquaculture.

Recommendation 5

Priority should be given to the culture of species well-established in aquaculture (preferably natives) which can provide large quantities of seafood for which aquaculture technologies are known and have the potential to become acclimated to offshore farming conditions.

Justification

Using species already well-established in aquaculture has the advantage that most of their physiological, behavioural and stress responses are well understood. The use of species with known performance characteristics helps to make appropriate technology adjustments to species needs in offshore settings without extensive and expensive lead times. Furthermore, using such well-known species may allow to combine them in various trophic assemblages following the FAO Ecosystems Approach to Aquaculture protocols that details social-ecological concepts with the goals of optimal benefits for economic and ecological interactions with marine ecosystems.

4

Recommendation 6

Organize international research and development platforms involving countries active or intending to initiate Open Ocean Aquaculture development projects.

Justification

Going offshore is costly and risky and needs large investments. In order to realize synergetic effects, common use of infrastructure and logistics could lead to more effective and timely developments, involving all major countries presently active or intending to initiate Open Ocean farming developments. Because of the large scale, multi-disciplinary and interdisciplinary approaches needed, and because of the need for large teams to address the very complex and interacting factors that determine success, it is unlikely that a local or national project alone would be cost effective.

Testing the complex design criteria and various operational parameters needs to be studied simultaneously to achieve full comparability of results. Such development platforms would allow operations to be scaled at commercially viable scales while also combining past experiences. This would enhance greatly the chances for success, thereby saving time and resources while greatly reducing the risks of failures. An additional spin-off would be the development of common standards for both technology and environmental certification.

Recommendation 7

Investigate whether the cultivated species can provide high value marine products other than foods which can also be simultaneously obtained thereby contributing substantially to the economic viability of offshore operations.

Justification

Operating Open Ocean Aquaculture systems is expensive. Besides the economies of scale, the diversification of products gained from the same species can contribute to economic sustainability. Therefore, species should not only provide high quality products for food markets but also be researched to serve as bioreactors for products urgently needed by other industries.

There are a wealth of substances that may be extracted or specifically produced from these species for use in industries such as cosmetics, pharmaceuticals, general chemistry, energy and other specific production lines. So far, little emphasis on products other than for food markets have yet been explored in aquaculture, although the use of skin, bones, cartilage, intestines and other by-products are traditionally used from fish and shellfish. Recently, several new products have been developed from algae, invertebrates and fish, often using processing wastes, which are considered as new resources rather than as wastes.

Innovative research and development has great potential to open new markets but also to enhance cost-effectiveness of operations. Such multi-product concepts would also need to be properly accommodated by the respective certification and labelling systems as new criteria will be required in terms of both economy and ecology.

Recommendation 8

Create education and training networks to provide the required multidisciplinary and interdisciplinary expertise for safe and professional operations of Open Ocean Aquaculture systems.

Justification

There are substantial opportunities to investigate the interactions between potential multiple uses of ocean observations, fisheries, aquaculture, reserves, and their ecological, economic, social and technological interactions. Marine technology research parks in an ocean area could attract considerable funding. Some marine scientists have touted the considerable ancillary benefits of increases in non-consumptive use values for research, multidisciplinary education, hands-on training at realistic scale, diving, photography, tourism, and conservation of marine biodiversity. Use of ecological design and engineering principles and practices could allow design optimization of energy generation, seafood production, biodiversity, and marine ecosystem health in research and education centers that could potentially benefit all stakeholders and increase research and development funding to boost the "innovation economy" [2].

2 One model is an innovative R&D strategy recently announced in Ireland at a recent meeting titled, "Harnessing Ireland's Potential as a European and Global Centre for Ocean Technology". Ireland plans to develop 10 "Ocean Innovation Test Platforms" that will allow companies to form partnerships in order to test new concepts, equipment, technologies, and solutions in real-life situations. Called "SMARTOCEAN Innovation Clusters" they seek to target newly emerging niche markets (marine renewable energy, environmental monitoring, and water management), as well as established markets (oil and gas, aquaculture, maritime transport, tourism, coastal erosion) to develop innovative and competitive production systems and service models and target both niche and high value markets.


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Recommendation 9

Utilization of Open Ocean Aquaculture systems as potential environmental quality monitoring stations should be promoted as part of the international ocean observing systems networks.

Justification

Offshore aquaculture systems need environmental monitoring for both system management and meeting standards of environmental regulations. There are also expensive global, regional and local environmental monitoring networks, often using remote sensing, submersible vehicles, drifters, ship-born data profiles, and other means. The option should be explored to align the development of Open Ocean Aquaculture with the international Open Ocean Observing Systems organizations that would enlarge the worlds' ocean observations station density for better environmental monitoring of the ocean.

Bremerhaven, March 27, 2012

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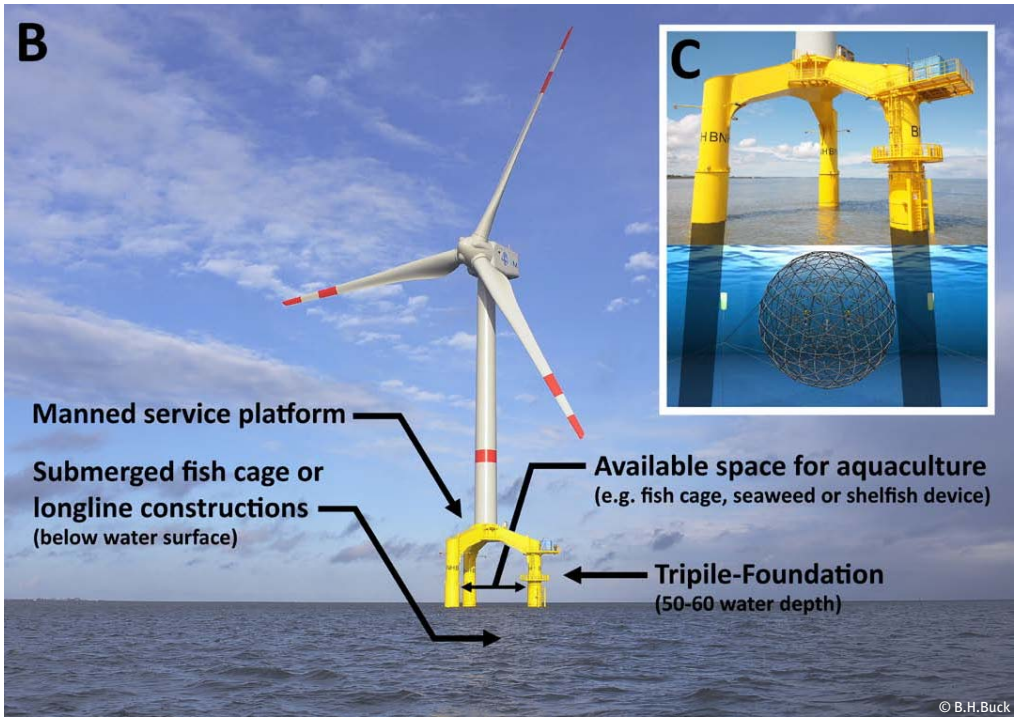
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6


A
Open space for the
installation of
aquaculture devices
(e.g. feed, equipment)
© B.H.Buck


B
C
Manned service platform
Submerged fish cage or
longline constructions
(below water surface)
Available space for aquaculture
(e.g. fish cage, seaweed or shelfish device)
Tripile-Foundation
(50-60 water depth)
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2012 – 2013 Aquaculture Forum BREMERHAVEN

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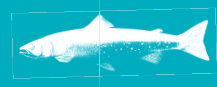
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WHERE DO WE GO FROM HERE?
ANSWER: FURTHER! DEEPER!

This plenary session will consist of an open discussion on future directions for open ocean mariculture. With developments such as the Velella project (unanchored net pens – the so-called 'drifter cage'), renewed interest in marine agronomy, proposals from World Bank representatives for aquaculture trials in Areas Beyond National Jurisdiction (ABNJ), and eNGO focus on conservation of High Seas areas, the open ocean mariculture industry needs to ask: "How far into the future, and how far offshore, do we dare to look?"

If there is any possibility that open ocean mariculture may move into High Seas / ABNJ areas within the foreseeable future, then this conference needs to discuss the implications, and begin to lay the groundwork to support these next steps. A draft Resolution for adoption by the conference will be presented, that requests UN-FAO conduct a study to determine the management and governance structure of aquaculture in the High Seas / ABNJ areas, and that encourages innovative research and development, and commercial scale-up where appropriate.

SESSION 2

PLANNING & DEVELOPMENT – INTERNATIONAL CASE STUDIES

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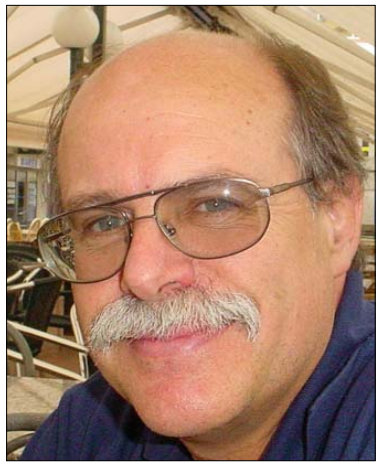
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Planning and management of aquaculture parks for sustainable development of cage farming in the Philippines.

Patrick White
Senior Aquaculture Consultant
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BIOGRAPHY

Patrick G. White is a specialist in temperate and tropical marine fish/shrimp production, impact of aquaculture on the environment, site selection suitability and Climate Change impacts on aquaculture. He has over 30 years experience in the aquaculture sector and has working in the Mediterranean region for over 20 years and the Middle East for over 5 years. He has worked in Saudi Arabia, Oman and Kuwait and has a good understanding of the local species and environment.

He has worked on aquaculture Park projects using modeling and GIS to;
- study to develop the methodology for identifying potential sites and sustainable carrying capacity for mariculture Parks in the Philippines.
- study to identify potential freshwater, brackishwater and marine aquaculture sites, aquaculture zones and sustainable carrying capacity in Saudi Arabia
- study to identify potential marine cage sites in the Province of Krabi, Thailand

Abstract

Abstract
The Philippine Government promotes aquaculture to contribute for its food security and poverty alleviation programs. However aquaculture activities are not well-planned, managed, monitored nor regulated, leading to “hot spots” of over-development. Consequently, this led to environmental degradation and the occurrence of fish kill incidents.

The Bureau of Fisheries and Aquatic Resources (BFAR) has developed the concept of Mariculture Parks to facilitate the development of responsible and sustainable cage culture development and provide livelihood opportunities along the coats. The number of Mariculture Park s is continually increasing from 46 in 2009 to 55 Mariculture Parks in 2011 growing milkfish, groupers, siganids in cages and seaweeds on longlines. These Mariculture Parks are strategically located in various points along the East Seaboard and West Seaboard designed to connect the Philippine Mariculture Industry to the international market through a live fish trade network.

The study developed the tools and framework for the identification of potential new cage farming areas for Mariculture parks. It worked with stakeholders in existing mariculture parks to develop better management practices and analyse the different aquaculture business models and the positive and negative socio-economic impacts leading to increased profitability, socio-economic benefits and improved sustainability in relation to the environment.

The study developed the methodology to identify new suitable aquaculture zones, calculate sustainable aquaculture carrying-capacity for these zones and minimise impact to the environment in these zones.

The study used wave modelling to categorise the level of exposure, used GIS to help identify potential new areas for mariculture parks based on site exposure, wave height, bathymetry and coastal infrastructure and modelled the potential sustainable carrying capacity for the zone and optimal layout to minimise environmental impact using Tropomod model.

1. Introduction

The Philippine Government promotes aquaculture to contribute for its food security and poverty alleviation programs. With its expanded fish production program in late 60's to early mid 80's, aquaculture's contribution were mostly coming from brackishwater culture in fishponds where some if not most were former mangrove forests but converted for pond development and fish culture. In big inland water bodies, e.g., Laguna de Bay and Taal Lake, etc., fin fish notably milkfish (locally called bangus) and Tilapia have been reared, and such provide a steady fish supply in the local markets especially in Metro Manila area and neighbouring provinces.

Declining trend of marine fishes caught by municipal (small-scale fishers) and commercial fishing boat operators (with over 3 gross tons of boats/vessels) prompted the government in partnership with private sectors to intensify aquaculture and in recent years had formalized it as forefront program for the country's incremental fisheries production. However, due to inadequate planning, implementation and poor monitoring including weak regulations particularly at the local level, aquaculture practices especially fish cages in some areas encountered environmental degradation and had occurrence of fish kills. Credible coastal environment coupled with widespread socioeconomic welfare of marginalized group still remain a recurring issues.

Aquaculture in the Philippines is an important part of rural development, poverty alleviation and source of livelihood in rural areas. However aquaculture activities are not well-planned, managed, monitored nor regulated, leading to "hot spots" of over-development. Consequently, this led to environmental degradation and the occurrence of fish kill incidents.

To further strengthen government's program in promoting the development of mariculture park where clusters of qualified small-scale farmers and private sectors are encouraged to relocate in designated coastal areas, environmental monitoring and modelling towards sustainable AquaPark implementation was found necessary, of which a socioeconomic study is part of it.

1.1 Project Rationale and objectives

The project AquaPark "Planning and management of aquaculture parks for sustainable development of cage farms in the Philippines" has provided technical assistance to BFAR for planning and management of Mariculture Parks to ensure responsible and sustainable development.

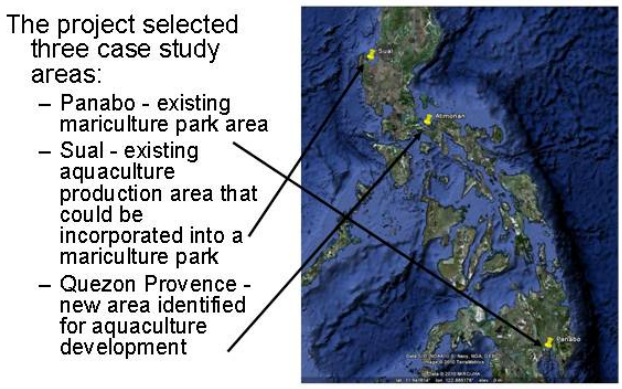
The project aimed to enhance the government's capabilities in identifying new aquaculture zones, calculate sustainable aquaculture carrying-capacity for these zones, and develop guidelines for good aquaculture practice in these zones. This will allow the Government to

plan the development of new aquaculture areas in a responsible and sustainable way based on the carrying capacity of the area for aquaculture.

1.2 Case study areas

The project selected 3 case study areas Panabo, Sual and Quezon Province to undertake the research.

Figure 1. Case study areas in the Philippines.



1.3 Status of Mariculture Parks.

The total number of cages in forty-six Mariculture Park's (as of 2009) is 2,137 of which 1,559 are growing milkfish, 578 cages are growing groupers, siganids and seaweeds. The number of Mariculture Park s is continually increasing (50 Mariculture Parks as of April 2010 and 55 as of January 14, 2011). These are strategically located in various points along the East Seaboard and West Seaboard designed to connect the Philippine Mariculture Industry to the international market through a live fish trade network. Of the 46 mariculture parks established in 2009, only seven can be considered operating on commercial scale while the others are at various levels of development, are newly-established and still others need to be rehabilitated.

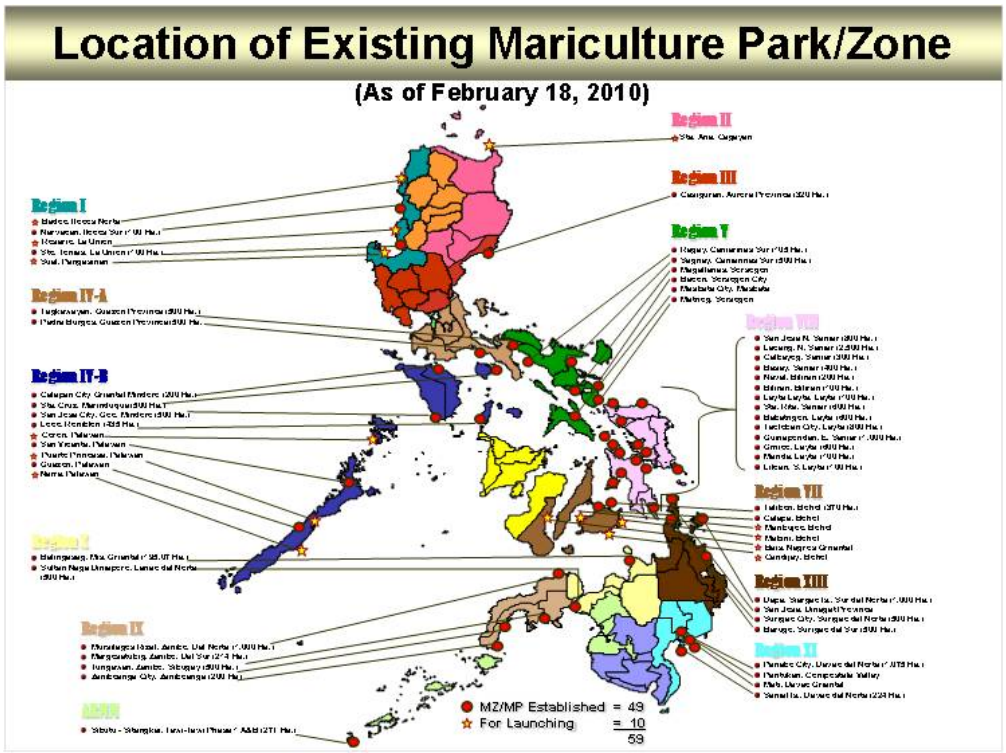


Figure 2. Location of Mariculture Parks in the Philippines.

The benefits of MARICULTURE PARKs so far recorded are increased fish production from marine cage industry (from 321 MT in 1997 to 62,097 MT in 2007), livelihood and job opportunities and reduced illegal fishing activities.

The identified issues and concerns of Mariculture Park operation are summarized as follows:

- Inequitable resource use and limited capital of small fisherfolks. This has led to the perception that Mariculture Parks are pro-rich which would further marginalize the poor fisher folks;
- Employment of the fisherfolks in Mariculture Parks are short-lived, several of them are not re-hired

Panabo Mariculture Park

About 1,075 ha of marine water body was designated as the Mariculture Park in 2006. Within this area, about 60 ha were allocated for marine fish cage and 20 ha for seaweed production all adjacent to 3 coastal barangays. As of July 27, 2010 results of monitoring and inventory from Panabo Marine Park Technical Working Group (PMP-TWG) showed that 348 unit operators have already occupied the area and within the year since its establishment in 2006 and expected to expand into 431 cages until the end of 2010. Collective information from PMP-TWG revealed that to have such total number of fish cages, the allocated marine water area could still maintain its carrying capacity.

Panabo City Mariculture Park production survey

The production survey was conducted at PCMP in April 2010. It has a total area of 1,075 hectares, wherein 33 ha were allocated for marine fish cages and 20 ha for seaweed farming. An expansion of more than 30 ha for marine cages has been proposed. At the time of the survey in 2011, there were a total of 302 fish cages installed. However, not all were operational. Some were recently harvested, while others are in the fallowing stage, e.g. cleaning and repairing of nets, etc.

The species cultured in this mariculture park are milkfish, which is the most common, followed by siganids, grouper and pomfret. The sampling size used in this survey was 85 cages, covering those cages culturing milkfish, grouper, siganid, pomfret, and a polyculture of milkfish and siganids.

The production cycle from stocking to harvest range from two to 5 months, while the average is 4.3 months. Those farmers that engaged in shorter culture period start at the grower stage, rather than with fry/fingerlings which is the normal practice. The average stocking was 15,000 fry per cage.

1.4 Environmental impact at Panabo Mariculture Park

The spatial extent and level of local environmental impact caused by a fish farm is determined by natural conditions such as bottom topography, sediments and currents, in combination with the size of fish production and operational practices. A major factor in preserving environmental quality is an optimal location and operation of the farm, conforming to the existing environmental conditions.

Organic enrichment in the sediments is one of the most important environmental effects associated with fish farming. The primary causes are wasted food pellets and fish excrements. In areas with water currents insufficient to remove of spread this material over a larger area, organic material may accumulate on sea floor below or in the vicinity of fish farms and there can be a build-up of nutrients leading to eutrophication and possibly algal blooms.

Bacterial decomposition may lead to anoxic conditions in the sediments and overlying water and to formation of methane and hydrogen sulphide (H2S) gas. Both low oxygen concentrations the presence of methane and H2S have detrimental effects (eg. Reduced growth rates, increased disease frequencies) on fish in the cages near the impacted areas.

Under extreme conditions, anoxic water and the toxic gasses may even cause mortality and algal blooms to develop.

Survey results

During the environmental survey, the following data were taken: CTDO, grab, corer, water depth, and water sample. These methodologies will analyse the sediment condition, hydrodynamics and bathymetry.

Sediment Condition

In analyzing the sediment condition, it is important to note the organic carbon content, species of flora and fauna present and pH. Black layer of the corer column was also noted to measure the depth of H2S, which will give information on the anaerobic layer.

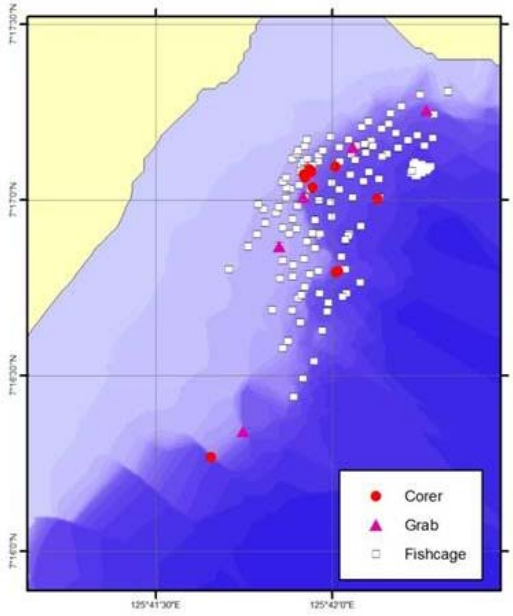


Figure 3. Sediment sample locations

Organic content in sediments is typically quantified using loss-on-ignition (LOI) analysis. LOI measures mass loss after incineration. Ignition loss is related to the organic carbon content of the sediment.

The LOI analyses were undertaken on 2 - 5 cm^3 sample of sediment which was initially dried in pre-weighted ceramic crucible at approximately 100°C overnight, allowed to cool in a desiccator, and weighed. Next, the samples were heated to 500°C in a muffle furnace for 4 hours, and allowed to cool overnight in the furnace. The next morning, the samples were placed in a desiccator, cooled to room temperature, and weighed again. The percentage of the dry weight lost on ignition can then be calculated to give the LOI value.

In Panabo, the value ranges from 3.04% to 11.42%, with an average of 7.82%.

1.5 Use of modeling to predict wave height and exposure

Panabo bay in the Philippines was investigated for appropriate locations of aquaculture parks. These locations should have limited wave exposure, so that the aquaculture parks can withstand heavy storms. The STWAVE model has been utilized as a tool to predict the wave height based on historical meteorological data in areas where there is no or limited wave data collection.

STWAVE Characteristics

The STWAVE model is easy-to-apply, flexible and robust model for nearshore wind-wave growth and propagation. It utilizes the SMS (Surface-Modeling-System) as graphical interface (www.aquaveo.com), where several other models are incorporated. The model code written and maintained by the U.S. Army Corps of Engineers (Smith et al., 2001)

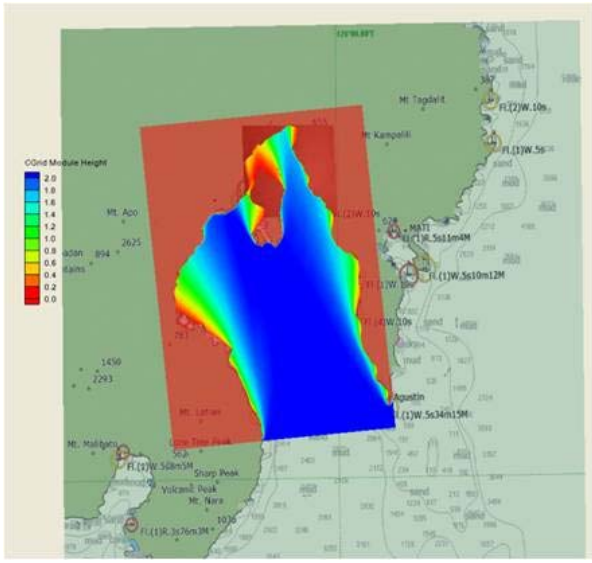
The model assumes constant boundary forcings (wind and waves), and estimates a stationary solution (steady state) and is capable of quantitively describe the change in wave parameters (wave height, period, direction and spectral shape) between the offshore and the nearshore.

Main input data

The main input data required to run the model are as follows;

- Bathymetry. (provided from oceanograpic charts and own measurements)
- Wind speed in model domain. (long term wind-data extracted from meteorological measurements from the local area)
- Wave height at ocean boundary (Long term offshore wave data retrieved from www.buoyweather.comn, and are extracted from hindcast data from a global WAM wave model)
- Wave energy spectrum. (default by the model/ defined by user)

Figure 4. STWAVE modeling of significant wave height (m) for Panabo when incoming ocean waves and wind are from south-southwest. The blue colour shows the largest wave, and red the smallest . The dark red colour in the model domain is land.



The STWAVE model may also illustrate the directional spreading and wave speed (Figure 6) or the wave period. The model can be simulated for wave and wind input from various angles. The SMS graphical interface easily reveals sheltered areas, potentially appropriate for aquaculture parks.

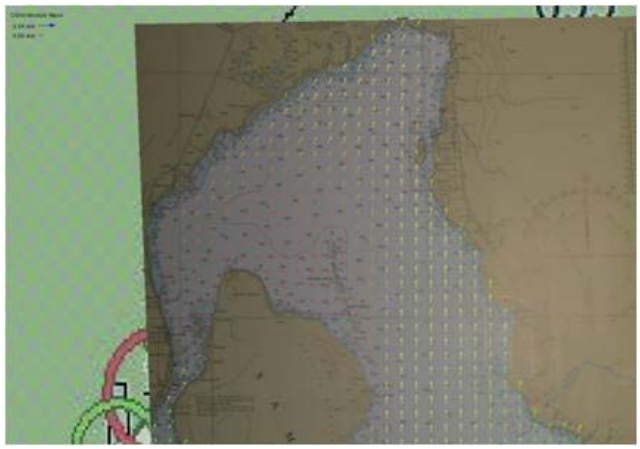


Figure 5. STWAVE-modeling of the wave direction and speed. The colours of the arrows denote the wave speed.

STWAVE-modeling of the significant wave height (m) for the area of the innermost part of the Panabo. The different illustrations show the results when ocean wave and wind come from.

1.6 Use of modelling for carrying capacity estimation, site optimisation and IMTA

The TROPOMOD model is a particle tracking model which simulates the dispersion of waste feed and waste faecal particles from fish cages. Using depth and current velocity data from environmental surveys and husbandry data such as cage layouts and feed ration from production surveys, TROPOMOD was used to predict flux of waste solids to the sea bed (grams waste feed and faeces m^{-2} sea bed day^{-1}). This was then related to a level of impact on the sediment benthos. The model was used to examine the existing situation at the Panabo Mariculture Park and then test various scenarios for site optimisation and future production of the Park.

TROPOMOD was also used to predict flux and nutrient plume from the fish culture to various Integrated Multi-Trophic Aquaculture (IMTA) units. These predictions were used to locate IMTA units in optimum locations relative to the finfish culture and some estimations of IMTA production were made.

TROPOMOD was developed from similar models validated elsewhere for other important aquaculture fish species (DEPOMOD - Cromey et al., 2002; CODMOD – Cromey et al. 2009; MERAMOD – Cromey et al. (In press)) and shellfish species (Shellfish-DEPOMOD – Weise et al., 2009). Some of these models are used for regulation of aquaculture.

1.6.1 Criteria for AquaPark zoning

TROPOMOD was used to predict flux of waste feed and faeces to the sea bed from fish cages for different scenarios (g solids m^{-2} day^{-1}). Using data from the validation studies, the predicted flux was categorised into benthic impact categories of moderate (1 to 15 g m^{-2} d-1), high (15 to 75 g m^{-2} d-1) and severe (75+ g m^{-2} d^{-1}).

Different scenarios for the Panabo Mariculture Park were run in TROPOMOD by creating aquaculture zones with different species, cage layouts and husbandry practices. The objective was to optimise each zone in the model to provide a balance between minimising impact and maximising production. Organisation of the Mariculture Parks into zones resulted in areas between and within zones that were free of cage structures allowing flushing and minimisation of sediment waste flux. These areas of lower flux were created to encourage remediation of sediments.

Model input data and definition of scenarios

For existing situations, TROPOMOD was set up for Panabo using cage positions from Google Earth images and bathymetry from site surveys. Measured particle settling velocity data for waste feed and faecal particles for Milkfish and Grouper were used across all scenarios.

Two different husbandry practices were created using information collected from production surveys. 'Poor feeding' scenarios represented high rations of poor quality feed, with high feed wastage (27 %) and poor digestibility (49 %). In contrast, 'good feeding' scenarios represented achievable FCR's via careful feeding with lower rations, waste (10 %) and improved digestibility (56 %). Typical feed ration and cage size were taken from production surveys for two different types of Milkfish production, namely 'inshore' and 'offshore' (incorporating polar circles) and Grouper culture.

1.6.2 TROPOMOD modelling of Panabo AquaPark

Two scenarios were undertaken for Panabo AquaPark.

Scenario A - Three 10 ha offshore Milkfish zones with similar cage size and production to Sual were added to the existing situation (Figure). As these offshore areas are mostly deeper than 30 m, dispersion resulted in large footprint of MODERATE impact, with HIGH impact directly underneath the cages. No areas of SEVERE impact were predicted.

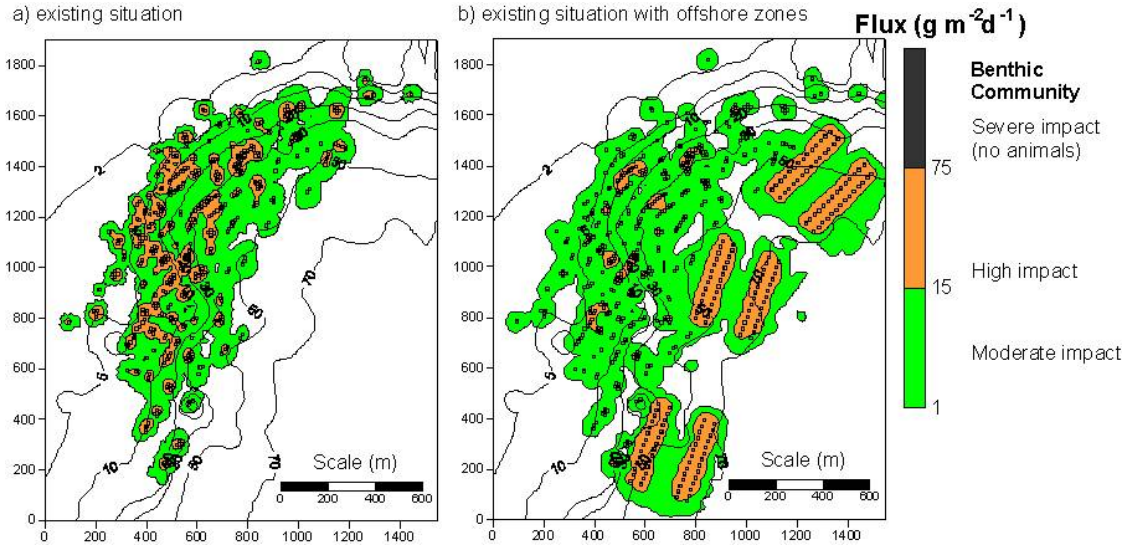


Figure 6. TROPOMOD predictions of Panabo showing a) existing situation and b) existing situation with three 10 ha offshore zones added.

Scenario B - Reorganisation of the Mariculture Park with 3 inshore Milkfish zones in greater than 15 m depth, 2 offshore Milkfish zones (polar circle type cages), and 9 inshore zones of Grouper (Figure 7). MODERATE impact (green colour) was predicted between groups of cages in each zone, as well as between each zone. No overlap was predicted between the deposition footprints of the inshore Grouper and Milkfish cages. There is MODERATE impact or less predicted between the inshore and offshore Milkfish zones.

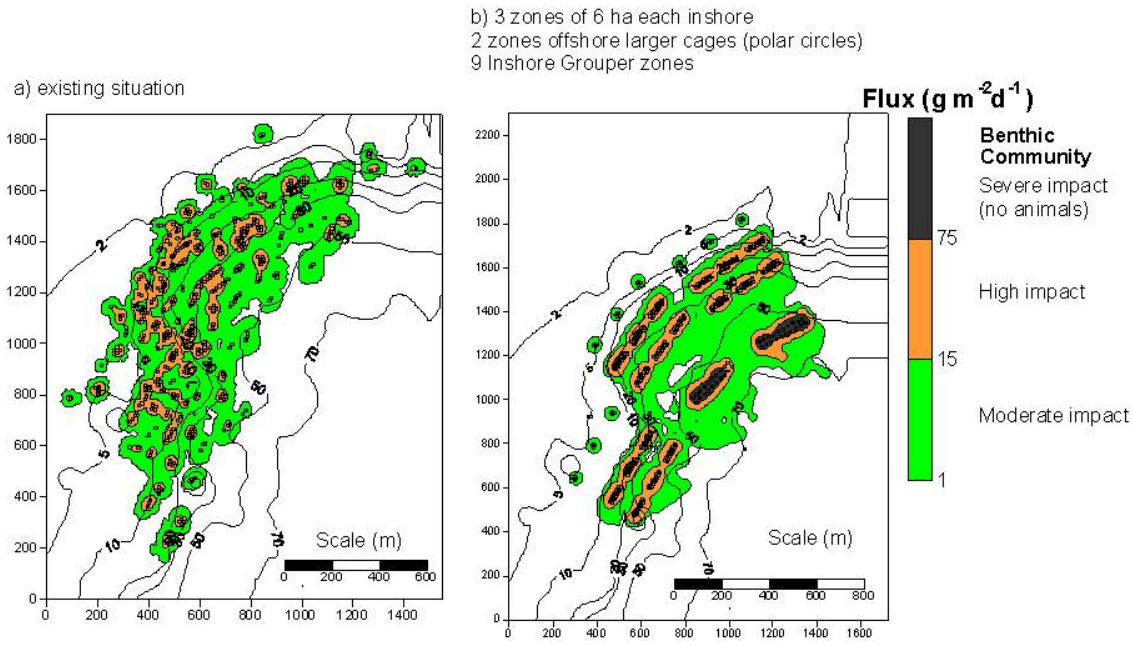


Figure 7. TROPOMOD predictions of Panabo showing a) existing situation and b) 3 inshore zones of Milkfish, 2 offshore zones of Milkfish in large cages, and 9 inshore zones of Grouper.

1.7 Integrated Multi-Trophic Aquaculture (IMTA) and TROPOMOD modelling

TROPOMOD model was developed to allow testing of different IMTA culture types and criteria established (

Figure). The different IMTA modules were added to determine how much of the waste discharged from the cages intersected the IMTA modules. The percentage of waste feed and faeces intersecting suspended (e.g. oysters on rope/raft) and benthic culture (e.g. sea cucumber pens) was determined, as well as optimum distance and depth. Similarly, a dissolved nutrient plume was simulated to determine how much of the plume intersected seaweed culture at different distances from the cages and at what depth. From these results, IMTA zones were created in the model grid and the production of each IMTA zone estimated (see annex for criteria used and production rates).

Four Milkfish cages were set up in the model using typical husbandry information and Panabo current meter data. IMTA modules representing different types of integrated aquaculture were then added to determine how much waste discharged from the cages intersects the IMTA. 'Cage in a cage' culture was also simulated, showing an inner cage containing Grouper surrounded by an outer cage of Milkfish.

Based on the high nutrient load in the surrounding waters both natural and predicted from aquaculture, the IMTA zones were primarily not expected to be nutrient limited. In organising the zones, it was assumed that availability of space, current flow, oxygen and light were the main influencing factors. In the current situation for both AquaParks, the amount of space between cages where IMTA units could be placed without reducing current flow was limited and so this was not attempted.

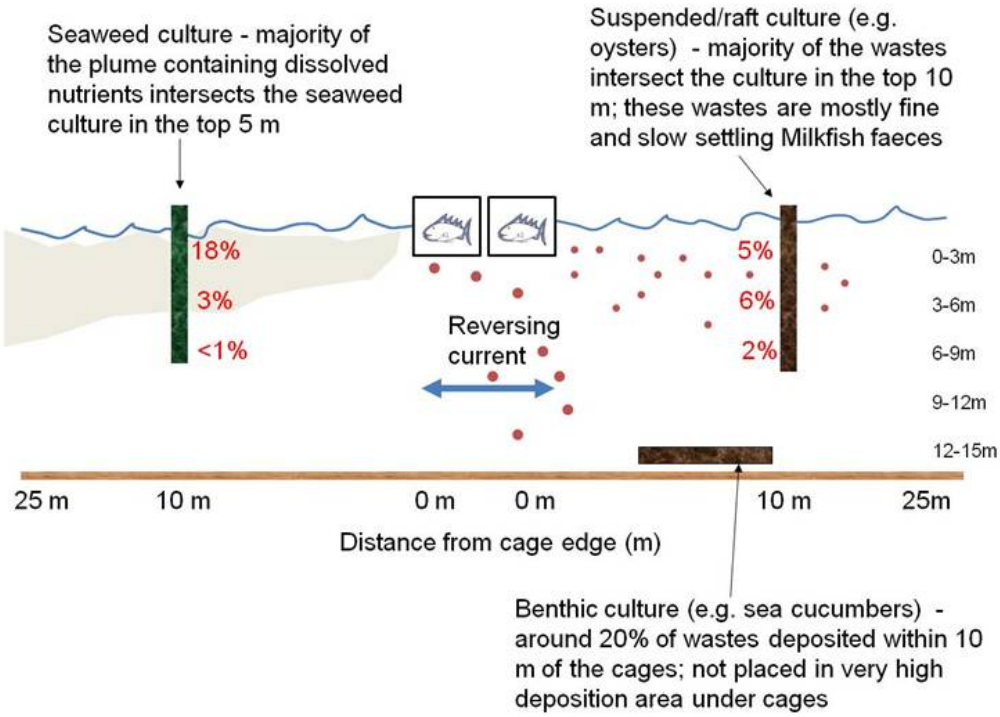


Figure 8. IMTA scenarios with 4 Milkfish cages and Panabo current meter data with seaweed, suspended culture (e.g. oysters) and benthic structures (e.g. sea cucumbers). The model was used to determine optimum distance and depth.

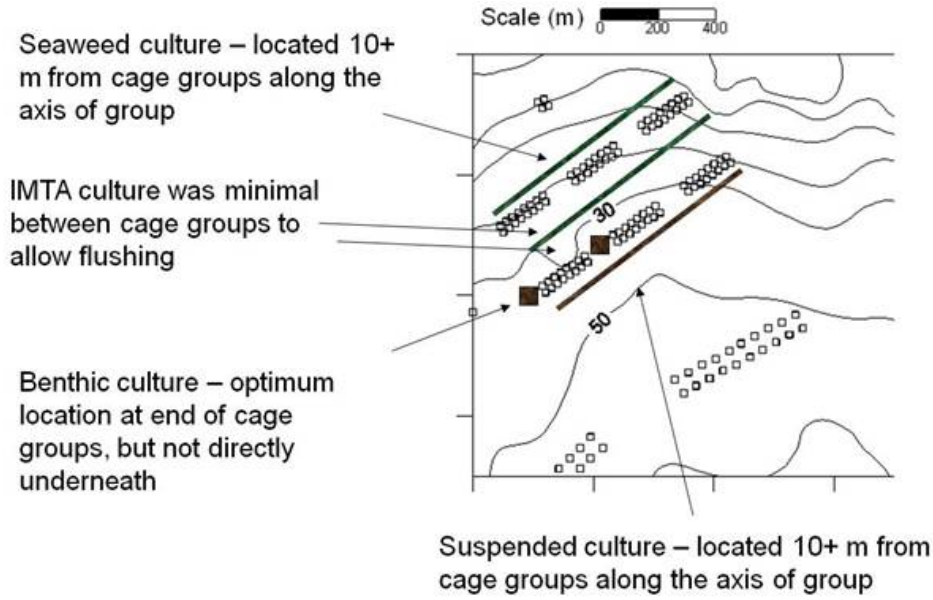


Figure 9. Criteria for location of IMTA units based on TROPOMOD modelling of waste plume and particles from Milkfish and Grouper culture.

IMTA zones and Panabo Mariculture Park

Small IMTA zones for seaweed and oysters were placed within each finfish zone (close to cages), where larger sized zones were located between finfish zones. A large seaweed zone was located between the inshore and offshore Milkfish zones, and a large oyster zone was placed inshore of the finfish culture zones. IMTA units were not placed close to the South-East

side of cages as this is the direction from which current enters the Mariculture Park. There is additional space to the South-East of the finfish culture area but this is in 50 m depth so no IMTA was located there. There is additional space also to the North-East and South-West of the main finfish culture area outside of the model grid which could be utilised for IMTA, not shown in the estimates below.

Table 2. IMTA zones in the Panabo Mariculture Park and production estimates close to the finfish cages. These zones are in the model grid near to cage culture and additional space for IMTA zones may be available in the Mariculture Park away from the cages.

IMTA type	No of zones	Zone size (ha)	Estimated production
Grouper	9	1	30 t yr^{-1}
Milkfish	3	6	7,175 t yr^{-1}
Milkfish	2	2	2,565 t yr^{-1}
Seaweed	20	15	413 wet t yr^{-1}
Oyster	14	35	417 (rafts) or 278 (longlines) t yr^{-1}
Sea cucumber	30	-	-

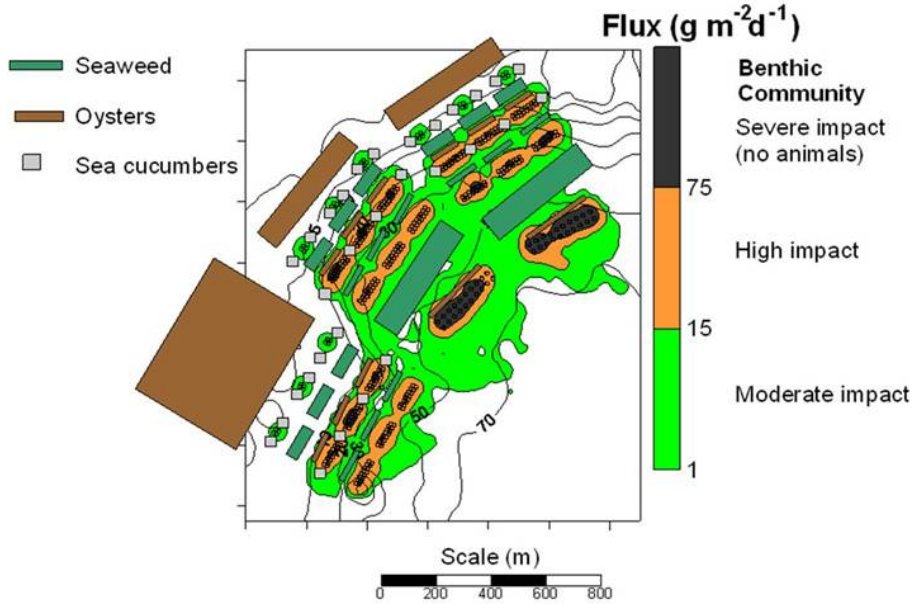


Figure 10. Optimised production and IMTA zones for Panabo Mariculture Park.

Development of large-scale aquaculture parks

As aquaculture is developing, there is now a demand for larger commercial farms to be established by local and foreign investors. This development calls for the development of larger commercial Aquaculture Parks using larger cages and more intensive culture systems such as are used for salmon farming in Norway and seabass and seabream farming in the Mediterranean.

The Mariculture park framework will be adapted to cater for these larger companies along the lines of aquaculture zones selected using approved site selection criteria and where maximum sustainable carrying capacity has been estimated. The aquaculture zones will be separated into different operating sites owned and managed by different companies but with cooperation and coordination between the owners on stocking time, and harvesting time, biosecurity and health management.

The development would need three main planning and management measures

- Develop a Governance framework for large commercial offshore aquaculture Park development
- Develop an infrastructure plan that is covering the whole operation (upstream, production and downstream)
- Develop zone management plan

Governance framework

The development of a governance frame work for large commercial aquaculture Park development to ensure sustainable and responsible operation

- Zone identification using site and zone selection criteria
- Carrying Capacity estimation using modelling for environmental and social capacity
- Buffers between farming independently owned enterprises
- Organisation and powers of the Park developers and managers
- Private Public partnership
- Business to business development
- Code of Practice for commercial aquaculture enterprises

Infrastructure plan

The development of a shared infrastructure plan that is covering the whole operation (production and ancillary)

- Port and boat moorings (loading and unloading gear, boat maintenance)
- Cage making and launching area
- Feed storage (private sector
- Net washing equipment, net repairs and antifouling area
- Fish nursery facilities to grow the fry to fingerling size
- Cage and boat servicing and maintenance
- Ice-making, harvesting, packing/processing
- Navigational corridors
- Site boundary marker buoys/radar deflectors
- Security at sea
- Weather forecasting and extreme weather warnings
- Etc.

Integrated management plan

The develop of an integrated zone management plan for

- Coordinated stocking and harvesting
- Marketing and sales cooperation
- Biosecurity and health management (SPF stocking, fallowing, coordinated treatments, etc.)
- Better Management Practices & certification
- Environmental monitoring
- Minimisation of negative environmental and social impact
- Advocacy and public relations
- Etc.

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Strategy for the Sustainable Development of Shellfish Farming in the open ocean of The Basque Country

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BIOGRAPHY

Dr. Diego Mendiola (m) is Senior Research scientist at the Marine Aquaculture Technology Department of AZTI-Tecnalia. He has broad experience into research on animal physiology, bioenergetics and husbandry strategies with special emphasis in the development of new technologies and species for marine aquaculture. He is currently very focused into the aquaculture engineering and economics fields of RDTi. He has worked during 12 years at the interface of the fisheries and aquaculture local marine industry, gathering technological and socioeconomic knowledge to enable valuable communication channels between local stakeholders (fish farmers, fishermen, technology supplier & producers, scientists, wholesaler and investors). He has leaded the technical diagnosis of the Basque Country Marine Aquaculture Strategy Plan 2009-2014. He belongs to the Scientific Board of JACUMAR (Spanish Ministry) on behalf of the Basque Country region since 2008. He belongs to the Board of Directors of the European Aquaculture Society since 2010. He is participating (as institutional representative) within (i.) the Spanish Fisheries and Aquaculture Technology Platform (PTEPA); (ii.) the European Aquaculture Technology Platform (EATip); (iii.) the AQUAT-Net platform; and (iv.) the EFARO Platform. Leaded or leading, as project manager, several European Fisheries Funds (EFF) funded projects; (i.) Applicability of the aquaculture-based wellboat concept within the commercial bait boat tuna fishery of the Bay of Biscay; (ii.) Development of open ocean shellfish farming in the Bay of Biscay; (iii.) Feasibility studies on sustainable production of cold water marine species through RAS technologies; (iv.) and some other projects at public and/or private level.

WP leader within E.U/FP7 funded projects such as: Prevent Escapes- Assessing the extent and causes of escapes of fish from sea-cage aquaculture and developing measures to prevent escape. Recently, involved in specific technology development and/or transfer activities for private companies. Two MSc students supervised. Current supervisor of two aquaculture related doctoral thesis linked to the Basque Country University.

Abstract

Recently, the Regional Government has decided to promote aquaculture with the aim of creating a sustainable and complementary activity to both the local fishing sector and the food industry operating within the region. Offshore production offers a new perspective for shellfish

in the region (Cantabric Sea), as no expansion of this food production sector within intertidal, subtidal nor open ocean environment has ever occurred due to restrictions on, environmental protection, maritime aspects and/or conflicts with local stakeholders. Among others, the Mediterranean mussel Mytilus galloprovincialis, the European flat oyster Ostrea edulis, the Japanese oyster Crassostrea gigas and the manila clam Ruditapes philippinarum, represent some of the most popular locally occurring species in the region; However, every shellfish product consumed in the region is imported.

A comprehensive data set relating to (i.) reduction of users conflicts; (ii.) characterization of technologies and operation requirements; (iii.) most physical, geomorphic, human use, oceanographic and ecological considerations for appropriate selection of sites for open ocean shellfish culture; (iv.) market analysis; and (v.) business models, was developed.

In general terms, a general consensus was reached on the following aspects: (i.) the existence of numerous niches and market opportunities linked to the local shellfish exploitation; (ii.) the suitability of involving the local fisheries sector as key player within the shellfish production system and operations; and (iii.) the need for commitment, between all the stakeholders, towards the sustainable (economic, environmental and socially understood) development of the activity.

Initially, primary production, in the region, is expected to be abundant, heterogeneous and variable between different seasons. Several substantial areas of flat sand bottoms totaling 1400 Ha, have been successfully identified. Although, the region is known for high energy sea conditions, and therefore presents structural and operational challenges, the conditions are not unlike conditions in other countries, where shellfish submerged productions have been in operation without damage for decades (Langan, 2007). Therefore, it is likely feasible that customized submerged longline systems can be built to withstand ocean conditions and produce shellfish species in the Bay of Biscay. However, the development of some specific in situ investigations is highly recommended, before commencing with any commercially oriented activity.

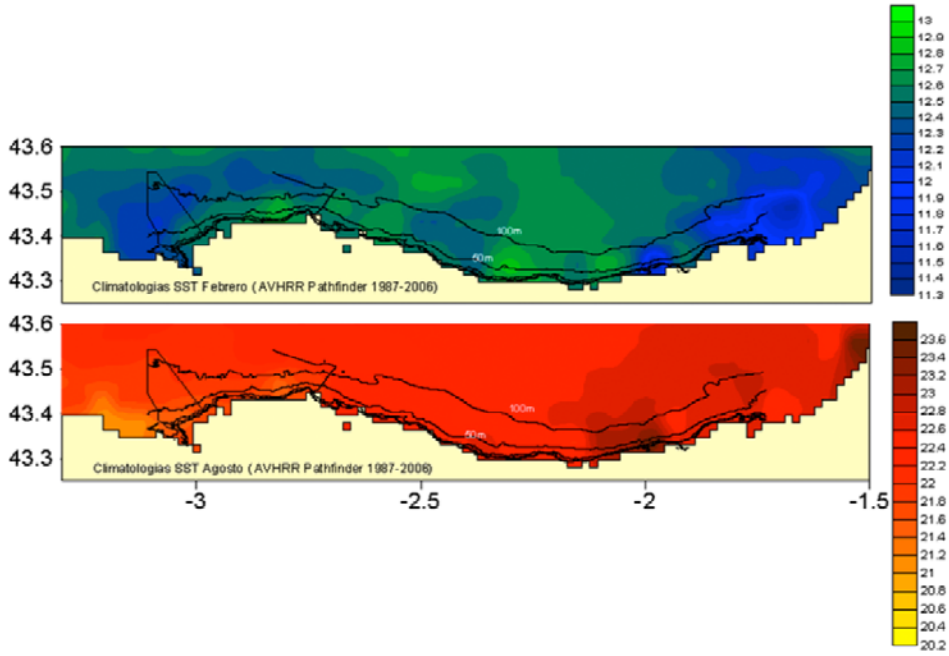


Figure 1: Average range of sea surface temperature (maximum and minimum) within the target region

Navigating the regulatory currents of offshore aquaculture in Western Australia

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BIOGRAPHY

John Eyres, a Fisheries Management Officer in the Aquaculture Branch of the Western Australian Department of Fisheries, is currently responsible for coordinating and planning the development of the Western Australian Mid-West Aquaculture Zone.
John has worked for the Department of Fisheries since 2007 and his previous responsibilities included the regulation of fish translocations in Western Australia. He completed the degree of Master of Science at Edith Cowan University in 2005; his research project involved investigation of changes in seagrass communities at varying proximities to mussel aquaculture.

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SHORT ABSTRACT

The Western Australian Government is committed to the development and establishment of the aquaculture industry as a legitimate user of the State's resources and a strategically important industry that needs to be accommodated in coastal zone management planning. To achieve its objectives, the Government is removing unnecessary regulatory impediments to the growth of the aquaculture industry and facilitating approvals processes. This paper looks at the process involved with the identification and establishment of Aquaculture Zones that will streamline the environmental approval process for commercial projects within zoned areas and provide an "investment ready" platform for investors.

The Western Australian Department of Fisheries has responsibility for the management of fisheries within three nautical miles of Western Australia's coastline. Management by the Department is principally guided by the Fish Resources Management Act 1994. The objects of this legislation guide the Department to develop and manage aquaculture in a sustainable way by:

- ensuring the impact of aquaculture on aquatic fauna and their habitats is ecologically sustainable and that the use of all aquatic resources is carried out in a sustainable manner; and

- fostering the sustainable development of aquaculture, including the establishment and management of aquaculture facilities for community or commercial purposes.

Aquaculture zones provide a key management tool to achieve similar objectives in other jurisdictions of Australia and around the world. Previously, the regulatory framework required operators to navigate through a complex, multi-layered approvals process that included the following legal prerequisites:

1. Commonwealth government approval may be required under *Environment Protection and Biodiversity Conservation Act 1999*. If an aquaculture operation is likely to have a significant impact on matters of National Environmental Significance, approval is required from the Commonwealth government. Potential exists for Commonwealth approval to be attained through joint assessment with the State under a bi-lateral agreement.

2. State government environmental approval is required under the Western Australian *Environment Protection Act 1986*. The Environmental Protection Authority of Western Australia undertakes an environmental impact assessment of some proposals and schemes referred to it under Part IV of the *Environmental Protection Act 1986*. The assessments include consideration of ways in which the proposal, if implemented, could avoid or reduce any impact on the environment.

3. State government environmental approval is required under Part V of the *Environment Protection Act 1986* prior to construction of a restricted premises and, or, to discharge to the environment.

4. A Department of Fisheries (State government) issued aquaculture licence and lease is required under the *Fish Resources Management Act 1994*.

Technical environmental studies, which are required to underpin environmental approvals under the *Environment Protection and Biodiversity Conservation Act 1999* and Environmental Protection Act 1986 can be substantial, both in terms of financial and time investment. Approval under the *Environment Protection and Biodiversity Conservation Act 1999* is only required for projects likely to have a significant impact on matters of National Environmental Significance; however, State approvals are generally required for all operations where feed is being added to a natural system.

Previously, marine finfish approvals have taken a number of years to complete the State approvals process. Start-up aquaculture operations facing significant capital infrastructure investment can be stifled by the cost of the environmental approvals process, which can mean the difference between a project being viable or not. Without aquaculture zones, Western Australia would not present as attractive a location for investors seeking to establish aquaculture ventures, when compared to other states where approvals are already streamlined.

It has become a priority of the Department to implement measures to more efficiently achieve the object of the *Fish Resources Management Act 1994* for the aquaculture sector, particularly marine finfish producers. The process to streamline approvals process started with amendments in 2011 to the *Environmental Protection Act 1986* and a formal agreement between two Western Australian Government agencies; the Department of Fisheries, and the Department of Environment and Conservation. The execution of the agreement means the Department of Fisheries is now responsible for the environmental management of the aquaculture industry. Mariculture proponents are no longer required to obtain approvals from the Department of the Environment and Conservation.

The second major step to streamlining the approvals process was achieved through recent amendments to the *Fish Resources Management Act 1994*, Section 101A (2A) of which now provides the power for the Minister for Fisheries to declare an area of Western Australia's marine waters to be an aquaculture zone. In Western Australia, an aquaculture zone is being defined as an area of State waters selected according to its suitability for a specific aquaculture sector (in this case marine finfish producers), characterised by a streamlined approvals process. The State government has demonstrated its support for streamlining approvals through a "zones approach" by providing $1.85 million to establish the first two zones in Western Australia. One zone will be established in the Kimberley and one in the Mid-West region of the State. The Kimberley zone will be the first of the two zones to be established, and it is anticipated to be in place during 2013. The Mid-West zone establishment process is just commencing, and the zone is anticipated to be in place during 2014. The government is not seeking financial contribution from the industry to recover the costs of establishing these aquaculture zones.

The Department of Fisheries will use the funding primarily to gain strategic environmental approval from the Environmental Protection Authority for each of the zones. If required, Commonwealth approval in accordance to the *Environment Protection and Biodiversity Conservation Act 1999* will also be attained for the zones. As the proponent for these assessments, the Department of Fisheries has commissioned technical specialists to undertake environmental field studies, to obtain data which will be used to build a robust, predictive hydrodynamic and nutrient model for each of the zones. The products of this work will be used to ensure the values and potential effects are identified, understood and managed.

No marine finfish aquaculture ventures have previously been undertaken in Western Australia on the scale anticipated for the zones; consequently, a key component of establishing a zone has been to establish the scope of technical field and modelling work required to gain approval under the *Environmental Protection Act 1986*. The technical scope for the Kimberley Aquaculture zone provides an interesting case study of the likely minimum benchmark that will be required to underpin the establishment of zones of this nature in Western Australia.

The Kimberley Aquaculture zone site is located at Cone Bay, within the Kimberley region of the State (Figure 1). The Kimberley coast is remote, topographically complex and the region experiences some of the largest tides in the world. Tides are semi-diurnal, with spring tides in Cone Bay ranging between 7 and 11 meters and neap tides as low as 2 metres. In Cone Bay, seasonal variation in ambient environmental conditions can result from rainfall and cyclone events, causing significant fluctuations in environmental conditions, such as water quality. Combined with the strong tidal regime, high summer monsoonal rainfall generally results in highly turbid coastal waters. Benthic primary producer habitats in Cone Bay include fringing coral reefs, ephemeral seagrasses and extensive soft sediment areas characterised by the presence of microphytobenthos (Oceanica, 2011). An existing marine finfish aquaculture operation producing approximately 2000 tonnes of barramundi (*Lates calcarifer*) per annum is established within the boundary of the zone.

Given the Cone Bay ecosystem is tidally driven and highly flushed, it is anticipated that the environmental impact of an operation with a carrying capacity in the vicinity of 20,000 tonnes per year would be minimal; however, to gain the requisite environmental approval, the Department of Fisheries must demonstrate this is the case. To understand the potential impacts it is first necessary to understand the hydrodynamic processes operating within Cone Bay. This can be achieved by modelling predicted changes related to aquaculture activities, which potentially affect water quality, deposition, and benthic communities. This information can be used in subsequent ecological modelling to assess the extent of potential impacts to environmental receptors such as benthic primary producers and marine fauna.

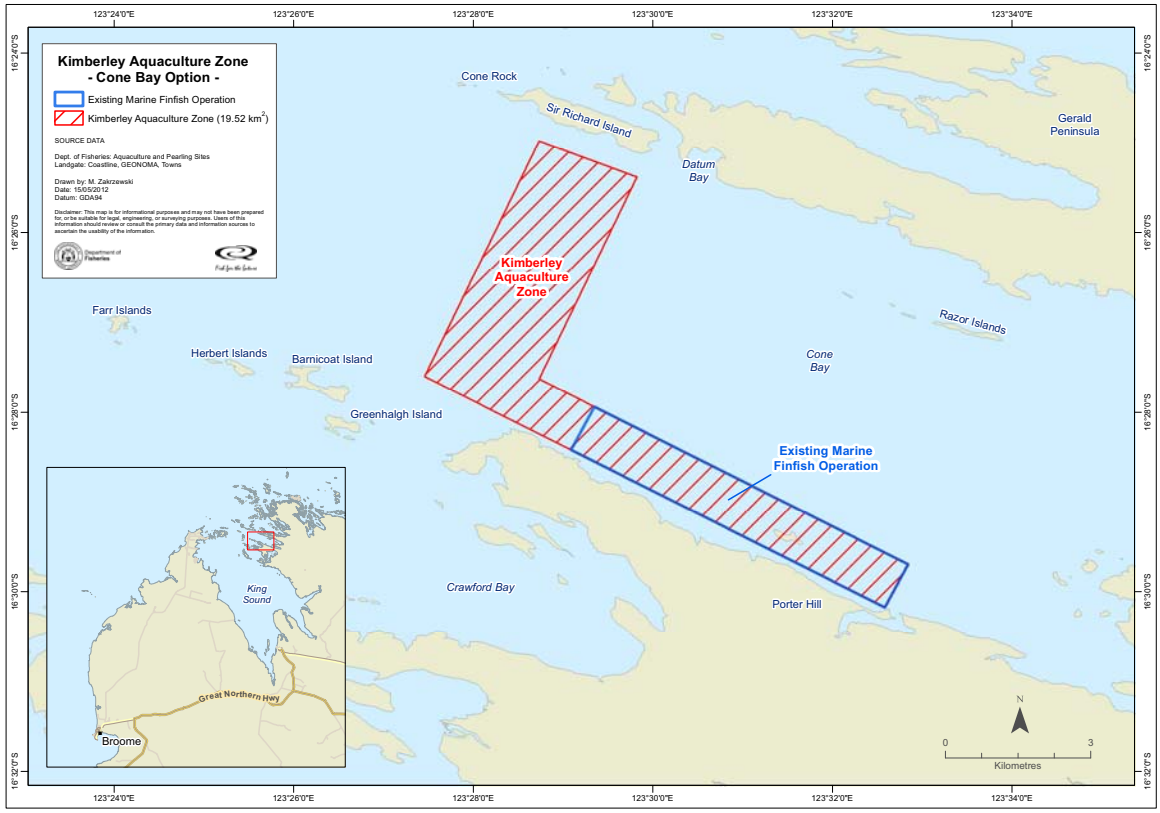


Figure 1: Location of the Kimberley Aquaculture Zone

To fully accommodate large water movements, the model domain will extend some distance outside Cone Bay (approximately 40 km) to accurately model the area of influence and account for boundary affects. A three-dimensional model unstructured, variable grid will be used to allow for high horizontal and vertical resolution around the cage locations, with coarser resolution away from areas of interest. This approach facilitates accurate representation of the stratification and dispersion of feed and waste.

The baseline data collection period will be shorter than the recognised temporal standard due to project schedule constraints. Data will be collected over two seasons, representing the wet season and the shoulder of the Kimberley region.

During these seasons the following data will be collected to inform the hydrodynamic model:

- Vertical profiles of current speed and direction as well as pressure (sea level) at

selected strategic locations using Acoustic Doppler Current Profiler (ADCP) covering several neap-spring tidal cycles within each season;

- Vertical profiles of temperature and salinity at selected locations, using intervals and durations sufficient to capture variations caused by meteorological conditions; and

- Daily-resolved wind information from a representative location.

The hydrodynamic model will inform an environmental model which will account for the deposition of particular waste and dissolved nutrients and oxygen by using both Lagrangian (particle-based) and Euler (concentration-based) computational techniques. The following environmental data will be collected to inform the environmental model (DHI / Oceanica, 2012):

- Temperature, salinity and dissolved oxygen profiles (sea surface to seabed) measurements at a number of stations inside the study area, including before and after feeding, in and around the existing farm cages;

- Water column sampling (including profiles, if vertical variations are shown to be of importance) for ammonium, nitrate, phosphorous and total nitrogen;

- Phytoplankton composition to species level including analysis of the carbon, nitrogen and phosphorous content and ratios along with chlorophyll-a;

- Seabed nutrients; Total Organic Carbon, Total Organic Nitrogen, Phosphorous, and Inorganic Phosphorous, at a number of stations across the study area and under the existing farm; and

- Infauna community composition to species level (DHI / Oceanica, 2012).

Benthic habitat mapping, sampling and analysis will be undertaken to understand the sensitivity of the local biota and to define key ecological receptors and triggers. Due to the remote nature of the Kimberley region, only very limited habitat mapping was previously undertaken in this part of Western Australia, and environmental data for the site is limited. Figure 2. is a general conceptual model that outlines the main cause-effect pathways between mariculture, environmental and ecological parameters. The intent of the flow diagram is to capture major cause-effect pathways relevant to fin-fish aquaculture. The diagram is not intended to capture subtle or synergistic effects.

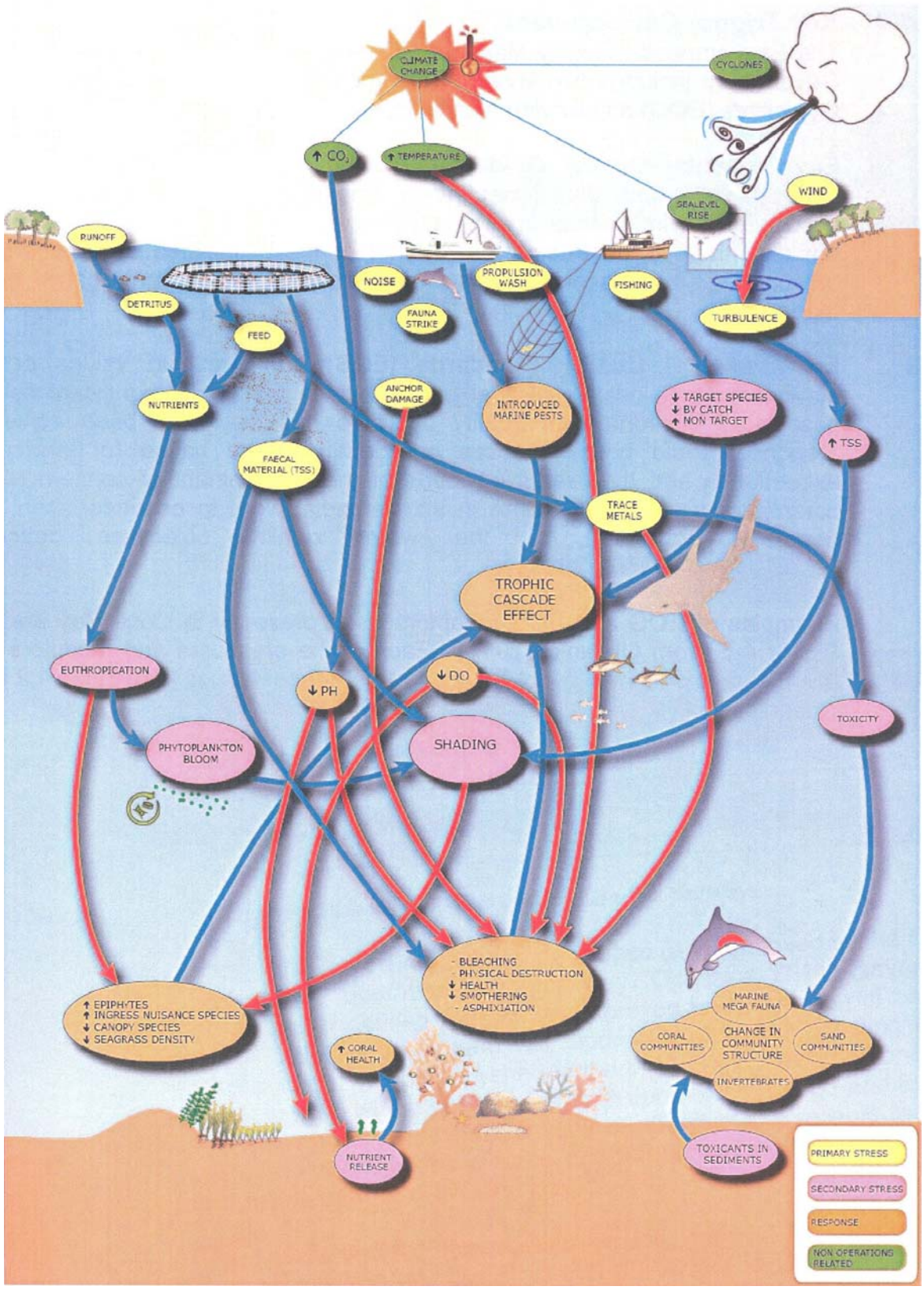


Figure 2: General conceptual model of a marine ecosystem influenced by sea cage aquaculture (Oceanica / DHI, 2012)

The Department of Fisheries will use this scope of work to underpin its application for a strategic environmental approval from the Office of Environmental Protection Authority for the zones. We expect the outcome of this work will provide a guide to the level of technical field studies and modelling complexity, required in the future to describe the potential impacts of other aquaculture operations. The data gathered and information generated through this process will be made publicly available and may be used to support other future developments in the region; be they aquaculture or other industry sectors.

Assuming the studies sufficiently demonstrate the environmental acceptability of aquaculture development in the Kimberley Aquaculture zone, aquaculture proponents who fit within the requirements of the strategic approval (gained by the Department), will not be required to undertake any further up-front technical studies before gaining a derived approval of the Environmental Protection Authority. Aquaculture proponents within the zone are only required to apply to the Department of Fisheries for an aquaculture licence. This abbreviated and simplified two-step process for proponents within an aquaculture zone will represent significant efficiencies in streamlining cross-agency government approvals processes.

The Department of Fisheries is also of the view that the establishment of well-located aquaculture zones in the marine waters of Western Australia will afford a sustainable competitive advantage that will attract significant investment in aquaculture.

Western Australia's proximity to Asian growth markets; our advanced marine science; engineering capability and extensive, relatively sparsely populated coast, mean the implementation of a "zones approach" to management will create an opportunity to develop and position the Western Australian marine finfish aquaculture sector in the international marketplace.

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Allocation Zones for Marine Aquaculture (AZA) – a tool for improving governance of responsible aquaculture in the General Fisheries Commission for the Mediterranean (GFCM) area

Hayri Deniz
DG for Fisheries and Aquaculture
Ministry of Food, Agriculture and Livestock



BIOGRAPHY

I graduated from Fisheries Faculty of Mediterranean University in 1887. I have Ph.D on sea bass and sea bream production from Dokuz Eylul U., Institute of Marine Science and Technology.

I have been working for Aquaculture Department, DG for Fisheries and Aquaculture of Ministry of Food, Agriculture and Livestock as Mariculture Expert and Project Coordinator.

Previously; I worked for Bodrum Fisheries Research Institute of Ministry of Agriculture and Rural Affairs (MARA) as Researcher, Province Directorate of Konya of MARA as Aquaculture Expert, Mediterranean Fisheries Research, Training and Production Institute MARA as Researcher, General Directorate of Agricultural Production and Development of MARA as Mariculture Director in 1988-1991, 1992-1993, 1993-1994 and 1995-2011 respectively.

I have been working as “National Coordinator” below international and national projects on aquaculture:

- Developing a Roadmap for Turkish Marine Aquaculture Site Selection and Zoning Using an Ecosystem Approach to Management
- Determination of Environmental Impacts of Fish Farm to the Marine Ecosystem
- Sustainable Development of the Aquaculture Sector from Postharvest Perspective with Focus on Quality, Traceability and Safety
- Recovery of Sturgeon Population in Turkey: Habitat Assessment and Restocking

I have also administrative duties in international and national organizations such as General Fisheries Commission for Mediterranean (GFCM), Europe Fisheries Organization (EUROFISH), Mediterranean Coastal Foundation (MEDCOAST) and Committee for Turkish Coastal Zone Management (KAY).

My expertise is on mariculture management, offshore sea farming, interactions between mariculture and other coastal sectors and integrated coastal zone management and lagoon management.

SESSION 3

EQUIPMENT UPDATE BY MANUFACTURERS

Further details will be available in the conference proceedings download

Your Partner in Aquaculture Technology



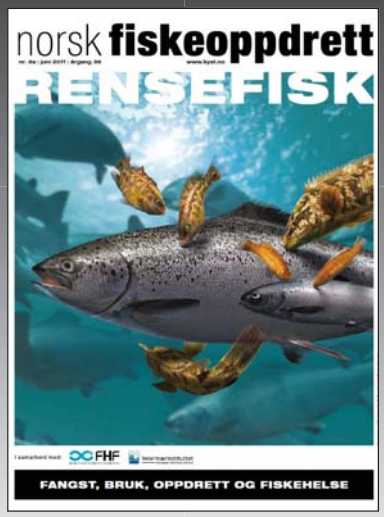
AKVA group is a leading supplier of cage farming aquaculture technology - from single components to complete projects. Large numbers of cages, workboats, net cleaners, nets, feed barges, feed systems, sensors, cameras, underwater lights and software are currently in use on a wide variety of farms all around the world. A wide range of quality products provide maximum reliability and cost effectiveness.



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Flexgard Antifouling in Aquaculture – present and future

Barry D. Pazian
Technical Sales Manager,
Flexabar-Aquatech Corporation



BIOGRAPHY

Barry D. Pazian is Technical Sales Manager at Flexabar-Aquatech Corporation. Barry worked at Flexabar for 40 years, initially as a driver while attending university, then developing products and finally servicing customers. Barry has his articles published in the branch-related media.

AUTHORS
Barry D. Pazian, Ejgil Bek Røjkjær , Maksim Mironenka

In the early days of the aquaculture industry it became apparent that fish cages had to be protected from marine growth and fouling during the typical growth cycle of the fish. Initially formulations developed for application to boat hulls were used and adopted.

The New Jersey based Flexabar group has over 50 years of experience, providing environmentally safe marine related coatings for anti-fouling in harsh ocean environments. Flexabar were the first company to provide water-based product technology, featuring an ultra-low VOC content combined with a controlled leach-out.

The Flexabar group has state-of-the-art manufacturing as well as a full in-house research and development capability. The company is fully staffed with professional managers, chemists, technical personnel and a full working laboratory. Innovations have included commercial products and concepts resulting in patents, government registrations and U.S. Coast Guard approved and UL listed products.

The group specializes in water-based antifouling coatings for the demanding fish farming industry under the well-known Flexgard brand.

That same product technology is applied in the Aquagard waterbase antifouling bottom boat paint, and related products. The first generation products for these applications have over 40 years of proven history. Today, the Aquagard brand represents a full line of related products for anti-fouling protection, serving the boating industry.

The Flexabar group has some of the finest commercially proven products, meeting environmental regulations at a competitive price currently being sold to the market place.
The Flexabar Group consists of:

- Flexabar Corporation – manufacturer/R&D lab company and supplier of OEM products.
- Flexabar-Aquatech Corporation – sales service to the aquaculture industry.
- Flexdel Corporation – sells, markets and supplies technical service for
- Aquagard Waterbase Antifouling Bottom Boat Paint, and related products.

Export to Europe, Middle East, Asia and Africa is handled by Flexabar Sole Sales Representative to these areas – ProFlex ApS Innovative Coatings.

ProFlex ApS Innovative Coatings is a trade company with more than 15 years of experience within supplying the antifouling and various net treatment solutions to aquaculture and commercial fisheries.

ProFlex ApS has achieved strong position within the customers from Northern Europe (Norway, Sweden, Denmark, Finland, Faroe Islands, UK and Scotland) and Mediterranean area (Spain, Italy, Turkey, Greece and Malta).

ProFlex ApS is well known as reliable partner and supplier with huge experience within industry, quick and just-in-time delivery and high level of service.

Fouling problem and existing solutions

Surfaces immersed in the marine environment become colonised by marine organisms, a process which is called fouling (Railkin, 2004). Within minutes of immersion, a surface becomes 'conditioned' through the adsorption of macromolecules such as proteins, present in the water. Bacteria colonise within hours as may unicellular algae, protozoa and fungi. These early colonisers form a biofilm, which is an assemblage of attached organisms that is often referred to as microfouling or slime. Finally a layer of macrofouling colonises the surface, consisting of larger algae such as brown and green seaweed, and invertebrates such as barnacles, mussels, ascidians and hydroids.

Top 6 fouling groups are:

- Mussels (e.g. Mytilusedulis)
- Algae (e.g. Laminaria saccharina)
- Barnacles (e.g. Megabalanus sp.)
- Tubeworms (e.g. Pomatoceros spp.)
- Ascidians (e.g. Ciona intestinalis)
- Hydroids (e.g. Obeliasp.)

Most types of fouling can be divided into following groups (Table 1).

Fouling Type	Problems caused
Algae	Problems for infrastructure/equipment Increase in weight
Tubeworms	Problem for stock Reduction in shellfish value
Mussels	Problem for infrastructure/equipment Increase in weight Competition for food
Barnacles	Problem for stock Reduction in shellfish value Problem for infrastructure
Ascidians	Problem for stock Problem for infrastructure Competition for food Reduction in shellfish growth Disease (e.g. Amoebic Gill Disease)

Table 1. Types of fouling vs. problems caused

Fouling is a complex and recurring problem in all sectors of aquaculture industry. Given the low cost margins, current priorities of the industry and operating environments it is vital that low cost, practical and easily applicable methods are found and introduced to control fouling.

The diversity and intensity of fouling in aquaculture is site specific, depending on season, geographic location and local environmental conditions. There are many problems associated with fouling in aquaculture (Lane and Willemsen, 2004). Problem areas include fouling on infrastructure (immersed structures such as cages, netting and pontoons) and stock species (farmed species, particularly shellfish such as mussels, scallops and oysters). Fouling greatly reduces the efficiency of materials and equipment: it physically damages equipment (abrasion/brittleness/increased load) and flow can be significantly reduced directly reducing foods supply. Fouling communities can directly compete for resources with cultured organisms and can include predators and harbour diseases. In addition fouling can have direct toxic affects: a number of benthic marine organisms within fouling communities produce secondary metabolites that act as antipredation strategies or natural antifoulants. These chemicals can be toxic to other marine organisms, including cultured organisms. Significant losses of cultures are also attributable to deoxygenation and degradation products when fouling communities die or simply swamp the cultures/cages preventing oxygen and waster product exchange. Table 2 lists major problems caused by fouling.

Direct problems	Indirect problems
–Reduction in water flow up to 100%	–Increase in labour up to 20%
–Increase in weight of infrastructure up	–Increase in production costs up to
–Competition for food with stock specie	EUR80.000 per farm and year
–Decrease in product value up to 90%	–Harbouring of disease organisms

Table 2. Major problems caused by fouling

The costs associated with fouling can be very significant (Beaz et al., 2005). The replacement of nets is expensive, annual costs to replace nets and reapply antifouling for a medium-sized UK salmon farm are estimated to be ±EUR120.000 and fouling can reduce growth rates by over 40%.

For many small (often family-run) businesses this can be the difference between profit and loss in a sector under extreme economic pressure.
Unlike other industries where fouling is a problem, such as shipping, few studies have examined the impact and sought cost-effective solutions for the aquaculture industry. The most common methods to control the problem are mechanical cleaning or using antifouling coatings.
Mechanical cleaning, involving brushing, scraping or cleaning using water jets, is labor-intensive and tedious (Hodson et al., 1997). Air/sun drying when nets are hoisted out of the water and desiccation or heat kills but does not remove fouling. Applying a biocidal coating on the surface is still widely used in aquaculture. Net coatings are usually low-tech versions of coatings for vessels. Small amounts of the active substance are released to deter or kill the fouling. The lifetime of such coatings, mostly based on copper oxide (Cu_2O), is limited.

Most common antifouling strategies are:

- *Cleaning, or Physical Removal*
  - ♣ Burning
  - ♣ Air drying (1 empty cage needed = 15% of total volume)

- ♣ Immersion in hot water/brine/freshwater
- ♣ High pressure washer (approx. EUR1.000)
- ♣ Net Washers (start from EUR150.000; net washing station starts at EUR 1 million)
- ♣ Cleaning disks (up to EUR 30.000)
- ♣ Pergolari Washer

- *Biological control*
  - ♣ Fish, crabs, snails, sea urchins

- *Chemical control*
  - ♣ Antifouling Protective Coatings (e.g. copper, copper oxide, zinc oxide & halogenids)

Strategies from other industries that can be adapted:
- ♣ Biocide free coatings
- ♣ Ultrasound
- ♣ Electricity
- ♣ UV

Some other antifouling methods certainly exist, examples of which are biological control using grazers (Hidu et al. 1981; Lodeiros & Garcia 2004); avoidance when cultures are removed or repositioned during periods of heavy fouling settlement (Rikard et al., 1996); new materials (coatings) such as silicone based fouling-release coatings (Baum et al., 2002), generally in combination with mechanical cleaning (Hodson et al., 2000) or coatings for netting and shellfish based on natural antifoulants (McCloy and De Nys, 2000; De Nys et al., 2004); new cage designs to limit fouling on shellfish (Gillmor, 1978) or fish net cages (Menton and Allen, 1991); and spraying with an antifouling solution such as acetic acid (Carver et al., 2003). These methods are only being used locally or are under development.

The wide diversity of potentially available antifouling solutions is summarized in Figure 1.

Fouling persists as a significant practical and economic barrier to the development of competitive aquaculture and there is a need for cost effective, sustainable solutions to the fouling problem.

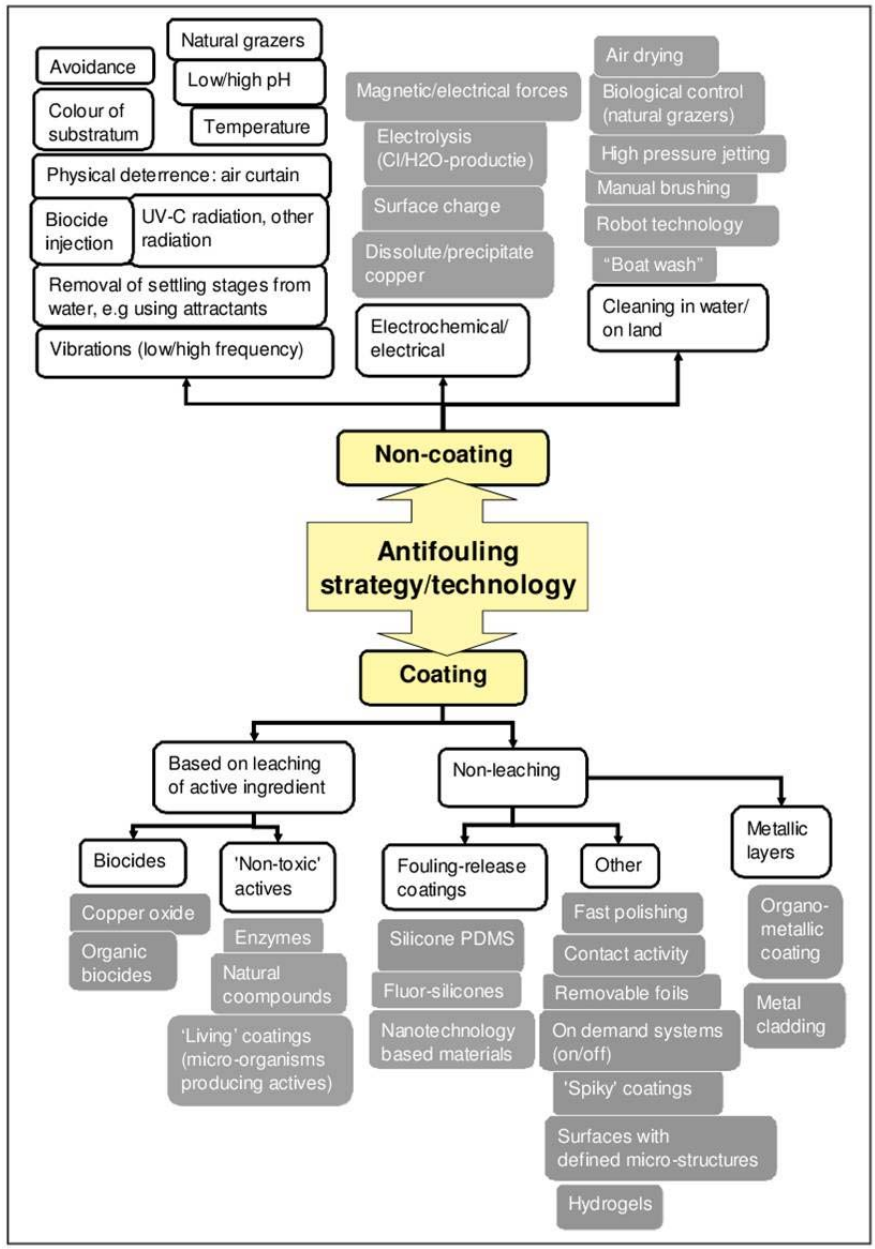


Figure 1. Antifouling strategy/technology

Flexgard antifouling net coatings

Flexgard water based antifouling net coating was developed in conjunction with government agencies in Norway, the UK and Canada, as the Chilean industry.
Flexgard has become accepted by aquaculture industry and the government agencies that oversee its operation. This product provides many of the properties desired by both groups, namely:

- Relatively low environmental impact.
- Compatible with species to be raised.
- Easy to apply.
- Simple clean up and dilution with water.
- Controllable leach out.

- Reduced exposure to the user to toxic chemicals.

As the aquaculture industry continued to grow, so did the regulation of it and all products used in connection with the processes. Of course because of its nature antifouling coatings received a great deal of attention. In the United States, Canada and the United Kingdom these products now had to be registered with the regulating government agencies before they could be sold or used. Using Flexgard waterbased antifouling net coating that was supplied to the Canadian and United States governments, protocols were established and studies conducted to assess the efficacy of the products, the impact of treated cages on the environment and the fish reared in them.

The results show there is no appreciable difference in the copper contained in the flesh of either batch of salmon (Figure 3.1, 3.2, 3.3). The studies were commissioned by the New Brunswick Salmon Growers Association and conducted by LRIE.

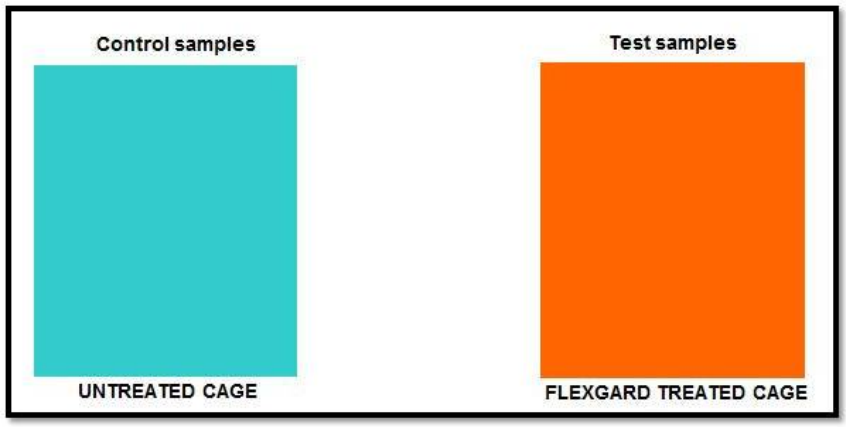


Figure 3.1. Salmon flesh analysis

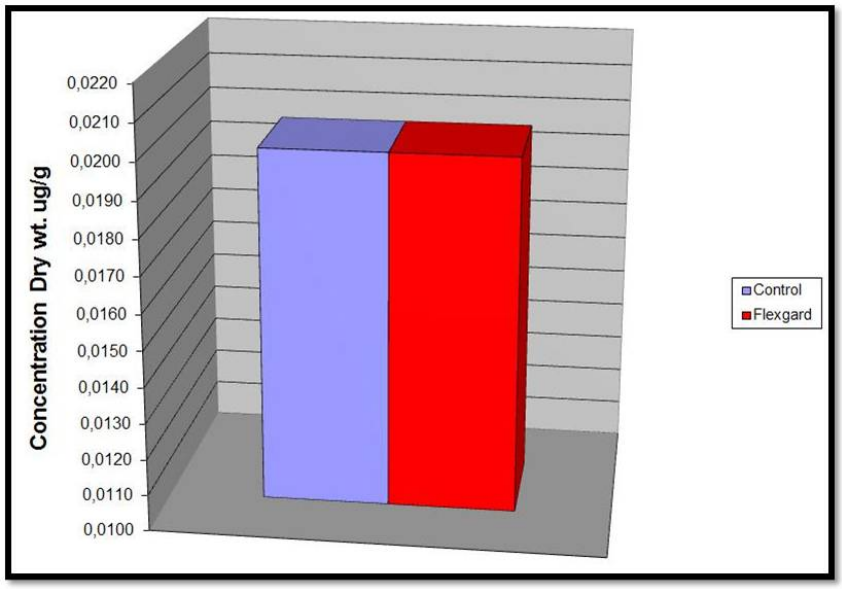


Figure 3.2. Salmon flesh copper concentration

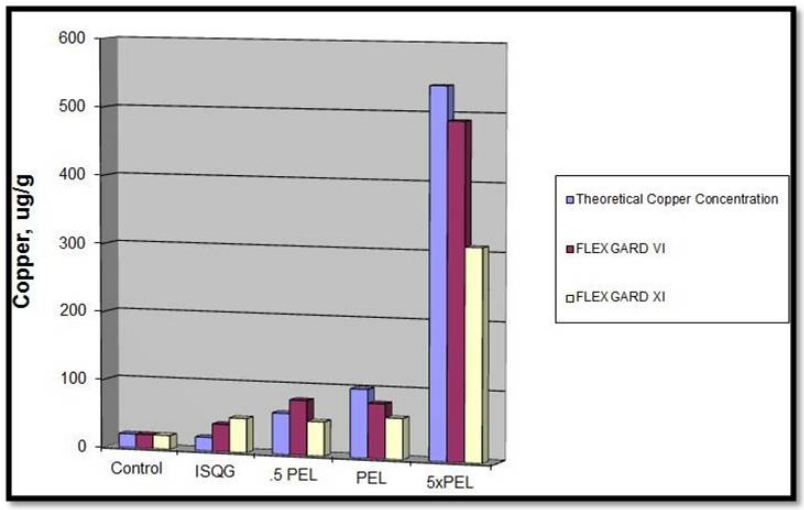


Figure 3.3. Spiked sediment copper concentrations

It is evident that today's formulations of Flexgard antifouling net coating have evolved into highly serviceable products.

Current Flexgard product range includes following most commonly used products.

FLEXGARD VI is a water based antifouling treatment for aquaculture nets. FLEXGARD is easy to apply and dries by evaporation of water from the system so no highly specialized equipment is required.

FLEXGARD VII-HD is a water based antifouling treatment for aquaculture nets that provides a high level of protection against HYDROIDS and other hard fouling such as MUSSELS. Flexabar has developed FLEXGARD VII-HD after receiving requests from the customers from all over the world which have a problem with fighting the growth of hydroids and mussels on their nets. Existing products available on the market were not effective against this specific problem.

FLEXGARD VII-HD combines the benefits of traditional antifouling and due to its special active ingredients highly effective against hydroids and other hard fouling. It employs a controlled leach rate, reduced copper technology which helps to limit heavy metal introduction to the environment. At the same time keeps the operational and service costs low due to reduced growing.

FLEXGARD XI-C CONCENTRATE is a water based antifouling treatment for aquaculture nets. This is a concentrated product and should be diluted before application. The degree of dilution is governed by several factors including but not limited to, mesh size and leg weight and the degree of protection desired. FLEXGARD XI-C is easy to apply and dries by evaporation of water from the system so no highly specialized equipment is required. Product allows achieving considerable savings compared with traditional antifoulings. At the same time providing the user with all the benefits of FLEXGARD antifouling.

FLEXGARD treated nets promote good fish health by maintaining clean cage nets. It is friendly to the environment, by employing a polymeric resin matrix for controlled leach rate, FLEXGARD is able to employ lower copper loading than most competitive products ensuring less copper released to the environment (Figure 3.4). Flexgard provides effective antifouling protection for a period between 5 and 12 months (Figure 3.5).

It is important to realize that all the research and regulations established were done using water based antifouling materials. Flexgard water based antifouling net coating meets worldwide government regulations, such as low-VOC (volatile organic compounds) and low leach out. This product has been used for over 35 years and has proved to be effective and practical net treatment in the fish farming industry, i.e. keeping nets free of marine growth during the fish growing cycle.

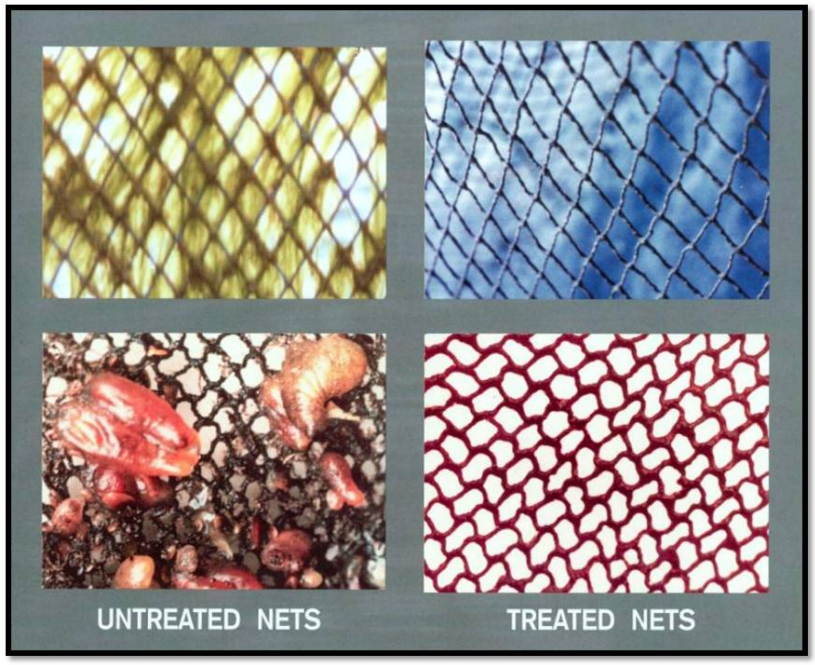


Figure 3.4. Flexgard treated and untreated nets after 22 weeks

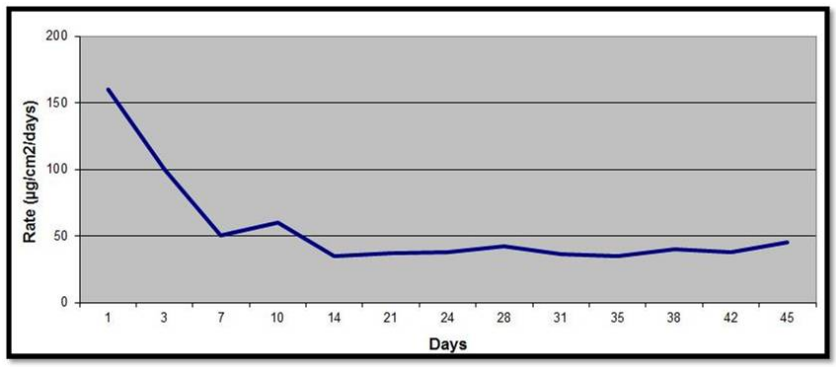


Figure 3.5. Leach rate of copper, Flexgard antifouling

New trends in aquaculture industry and new product development at Flexabar

In order to continue to serve the industry, Flexabar has to continue to improve and fine-tune their products. With increased pressure to the environment from the aquaculture industry, there will be increased pressure to produce products with improved environmental profiles. It is now predicted that antifouling coatings used in the Cuprous oxide is and will probably continue to be for some time, the primary biocide in use for aquaculture cage nets. This being the situation research and development has focused on improving the cost effectiveness and efficiency of the cuprous oxide. In order to accomplish this we are looking at a few different approaches.

One approach is to modify the coatings matrix in an attempt to better control the leach out of the biocide in this case the cuprous oxide. This is done by the blending of different resin systems and co-grinding of the cuprous oxide with select clays or other fillers to enhance its distribution throughout the coating and regulate it's release.

A formulation that follows this approach is FLEXGARD VIII experimental #110. This is a formulation based solely on cuprous oxide as the biocide at a highly reduced level. It is a concentrated formulation designed to be diluted up to a maximum of 1:1 (100%) by volume. The formulation is in its second round of field testing (fall 2012; spring 2013) after generally positive feedback on the 2011 trials. If efficacy results are up to expectations the product will be commercialized and the process of bringing it to market will begin. The benefits of this product are more stable pricing do to a lessened reliance on cuprous oxide which is a commodity and a reduced impact on the environment. At this time, while we have had favorable feedback we are striving to extend the period of efficacy during the upcoming round of trials.

A second approach being taken is the incorporation of co-biocides or boosters in the formulations; this is also done in conjunction with the formulation methods outlined in the previous paragraph.

We are investigating two materials in these formulations. The first, copper pyrithione is incorporate into our FLEXGARD VII formulation. On its own the copper pyrithione provides no anti-fouling properties however when formulated at relatively low levels in conjunction with cuprous oxide it provides increased efficacy against certain target organisms such as mussels and hydroids.

This is a specialty product which is usually employed at sites or at times when these particular organisms are a severe problem.

The draw backs of this formulation are the cost as it is a premium level offering and the fact that to this point we have not been able to concentrate the material, so it is only offered as a ready to use product. On the plus side the pricing is relatively stable do to the lower levels of cuprous oxide and it reduces the environmental impact.

The second co-biocide we are investigating is zinc pyrithione; like the copper based version, on its own it shows little to no value as an anti-fouling agent. When used in conjunction with cuprous oxide again at relatively low levels it allows the formulator to significantly reduce the cuprous oxide loading.

FLEXGARD VIII experimental formula #181 is based on this combination. Like formulation #110 this is a concentrated product designed to be diluted up to a maximum of 1:1 (100%) by volume.

This formulation has undergone a full season of efficacy testing in North and South America during the 2011 seasons. In 2012 we are undergoing efficacy testing in Northern and Southern European Waters in addition to North and South American retests.

Additionally toxicology data is being assembled along with fish flesh analyses to assure suitability for aquaculture use.

If all test results are as expected this formulation will be available mid-2013 to 2014 as a commercial offering. Again it will enable a more stable pricing structure while reducing the environmental impact of farms from an anti-fouling standpoint.

Outside the realm of antifouling coatings, products are offered and being developed to

address the area of organic aquaculture and in applications where antifoulants may be prohibited for one reason or another.

Several water based net treatments are offered that protect the net fibers from the impact of the environment and net washing machines and also ease the removal of fouling organisms. Testing is also presently being conducted on the ability of some of these products to seal the copper in previously anti-fouled nets so they may be used in areas where the antifouling coatings are no longer permitted.

Formulations are offered a various price points and performance levels and some can be custom tailored to provide a degree of stiffness or softness as desired by the customer.

Long term research is being conducted on metal free biocides, biocide free antifoulants and easy release coatings where the fouling organisms are removed with very little mechanical effort.

Do to cost and regulatory considerations in addition to developmental considerations much of this remains more of a concept than a reality but is still an area of much effort. Aquaculture will have to reach new low leach out standards for copper.

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SESSION 4

SPECIES AND FEED

Offshore Marine Fish Culture in the Americas: Status, Issues and Perspectives

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BIOGRAPHY

Dr. Darryl Jory is an aquatic biologist with over 28 years experience in global aquaculture business development, management, research and teaching. His experience includes business development and technical support to the aquaculture, aquafeed and biotechnology industries in several countries around the world. He currently works for Aquatic EcoSystems, Inc. (Florida USA), a leading provider of aquaculture equipment and technical services and solutions.

He is also the Editor of the Global Aquaculture Advocate, official publication of the Global Aquaculture Alliance (GAA). GAA is an international, nonprofit trade association dedicated to advancing environmentally and socially responsible aquaculture. Its trade magazine covers the entire farmed seafood production and marketing value chain, and is widely distributed to producers and industry leaders in over 80 countries around the world. Jory has also been associate editor and columnist for other technical publications, including shrimp columnist and tilapia co-columnist for Aquaculture Magazine; associate editor for World Aquaculture Society (1995-2005).

His education includes B.S., M.Sc. and Ph.D. degrees in Marine Biology and Living Aquatic Resources from the University of Miami (Miami, Florida USA), as well as an Executive M.B.A. (International Business & Operations Management) degree from Nova Southeastern University (Ft. Lauderdale, Florida USA). He was also a Fulbright Scholar Postdoctoral Fellow at the University of Oriente, Margarita Island, Venezuela. He has been an Adjunct Professor of Aquaculture at the University of Miami's Rosenstiel Graduate School of Marine and Atmospheric Science since 1988.

Dr. Jory has participated in over 120 scientific congresses, meetings and workshops worldwide – with numerous papers presented, including keynote and invited. He also is a reviewer for aquaculture, aquafeed and marine biology manuscripts for various scientific journals as well as frequent reviewer of commercial aquaculture proposals for various U.S. agencies. He has 85 papers, articles, book chapters and monographs published, and is certified as a Professional Animal Scientist (PAS, Aquaculture & Animal Nutrition) by the American Registry of Professional Animal Scientists.

Offshore Aquaculture in Portugal – development and integration of new species

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BIOGRAPHY

Pedro Pousão-Ferreira is responsible for the Offshore Fish Farm Pilot-Project of Olhão and for the Fish Farm Pilot Station at the National Institute for Biological Resources. Researcher with large experience in all areas of fish production and offshore aquaculture.

Carlos A.P. Andrade is Head of Marine Aquaculture Division at the Fisheries Directorate of the Regional Government of Madeira.

Responsible for the Ponta da Galé Offshore Fish Farming Pilot-project and for Calheta Mariculture Centre. Over 20 years experience in professional areas such as aquaculture planning, offshore fishfarming, fish breeding and larval culture.

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In Portugal, offshore aquaculture enterprises are located in the southern province of Algarve, and in Madeira Island. This presentation aims at describing the offshore aquaculture operations in the country and the culture systems in use, namely tuna traps, fish cages and long-lines for bivalves (oysters, clams and mussels).

Tuna traps and oyster long-lines are leading the investments in the Algarve. These on-growing systems are situated in the open sea, under the influence of strong winds from SE and sea storms from SW, frequently producing 10.0 m height waves. However, the geographical situation in the route of tuna migration to the Mediterranean Sea favor the establishment of tuna traps, whereas the high productivity resulting from the vicinity of coastal upwelling areas, coastal lagoons and fish cages may support the bivalve production.

Conversely, the clean/oligotrophic seawaters around Madeira Island, plus the stable and high temperatures motivated the development of offshore fish farms. Two commercial fishfarms are in operation producing seabream, Sparus aurata.

The modest growth of the offshore mariculture sector in Portugal has been attributed to complex and slow licensing procedures, but also due to the limited market for the short list of production species. The recent establishment of marine areas for offshore aquaculture development and promising results farming new fish species (Pagrus pagrus, Argyrosomus regius, Seriola spp., Pseudocaranx dentex) may ensure production diversification and competitiveness of the industry for the near future.

Challenges in the supply of quality “seed” to the offshore fishfarming industry: the mesocosm hatcheries of semi-intensive methodologies

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BIOGRAPHY

Carlos Andrade, Lic., MSc., PhD, is the Head of Marine Aquaculture Division at the Madeira Fisheries Directorate (Portugal) and manager of Calheta Mariculture Centre. He has over 20 years experience of R&D in aquaculture. He started his career introducing offshore fishfarming technologies to Portugal and working in cooperative projects with the private sector. Since 2001, he has been involved in design and development of mesocosm fish hatcheries. His current research interests and most recent publications address the improvement of production control and larval quality in fish hatcheries.

ABSTRACT

This paper describes the experience at Centro de Maricultura da Calheta, Madeira Island, Portugal, with the establishment of a mesocosm hatchery of semi-intensive methodologies and the fry production trials with gilthead seabream (Sparus aurata), white seabream (Diplodus sargus), red porgy (Pagrus pagrus) and striped jack (Pseudocaranx dentex). High larval performance, as given by growth in total body length, survival and swimblader inflation, was obtained with the larval species under trial. Modifications to the standard feeding regime and tank management for each species proved more appropriate to their biology. Results demonstrate that mass-production of good quality fish larvae is feasible using semi-intensive mesocosm, with low technological inputs and at an affordable cost. This type of hatchery system seems appropriate for the self-sufficiency of small fishfarms and also, to promote species diversification and quality fry for the offshore aquaculture industry.

INTRODUCTION

Mariculture is expected to continue expansion in order to satisfy the increasing world demand for marine food products. Trends in aquaculture development include increased production, improved management, and continuing diversification of species and culture systems (Subasinghe et al., 2009). Also, consumer and market awareness and influence are growing.

There is an increasing demand for products from economical and environmental sustainable sources.

Mesocosm hatcheries using semi-intensive culture methodologies are well positioned to supply juvenile fish to the offshore fishfarming industry and contribute to the sustainable development of aquaculture. These hatcheries are characterized by large tanks for fish larvae production at low densities, with live prey production within the tank supplemented by exogenous sources of feed (Divanach and Kentouri, 2000). The technology is easily adaptable to the production objectives and is particular suitable for organic fishfarming and culture trials with new candidate species for aquaculture (Andrade et al., 2012b).

This presentation aims at describing the experience at Centro de Maricultura da Calheta, Madeira Island, Portugal, with the establishment of a mesocosm hatchery in 2002 for the production of guilthead seabream Sparus aurata and the trials with candidate species for aquaculture, namely red porgy Pagrus pagrus, white seabream Diplodus sargus and striped jack Pseudocaranx dentex. The relevance of the biological, technical and economical characteristics of this type of hatchery to species diversification and the self-sufficiency strategy of small scale offshore fishfarms is discussed.

Description of the mesocosm hatchery and rearing methodologies

The hatchery at Centro de Maricultura da Calheta (CMC) includes 8 broodstock tanks of 10 m3 volume, 4 fibreglass cylinder tanks of 40 m3 volume for larval rearing, 11 fibreglass square tanks for larval weaning and juvenile growth, plus life food chain facilities and laboratories. All tanks were originally dark grey or black colour.

The fish eggs are collected daily from broodstock tanks, their quality and quantity evaluated. Following disinfection (0.06% formalin for 5 minutes) the eggs are seeded into each of the 40 m3 tanks for egg incubation and larval rearing. The initial stocking density varies at 5 to 8 eggs/L.

The initial larvae rearing protocols followed the one described by Divanach and Kentouri (2000). The “green water” technique is used with live phytoplankton (Nannochloropsis spp.) kept at 2x105 cells/mL, filtered seawater (10μm) at low exchange rate (10% to 200% daily) and continuous light (1000-2000 Lx). Enriched rotifers were added twice daily from 2-3 days after hatching (DAH) to 26-30 DAH to maintain a density of 2-4 individuals/mL. Newly hatched Artemia are added at 10-18 DAH, followed by enriched metanauplii 5 days later, added twice a day and kept at a density of 0.1-0.5 individuals/mL. Dry diets are supplied to larvae from 20-22 DAH. At 40-60 DAH all larvae specimens are usually transferred and complete weaning in 10m^3 tanks, with the exception of P. dentex larvae in our experiment, collected at 23 DAH.

Following the initial growth trials of gilhead seabream larvae in mesocosm, the rearing protocols were modified to adapt to most recent knowledge of the larvae biology and culture requirements of the other species (Andrade et al. 2010; 2011; 2012a) and to improve culture management (Andrade et al., 2012b).

In the case of red porgy larvae the protocol modifications included lower light intensity, natural photoperiod from 18 DAH, late entry of Artemia and anticipating larvae transfer to juvenile rearing tanks at 32 DAH.

For white sea bream larvae the density of enriched Artemia in tank was doubled in response to high demand at 7.5mm TL, about 15 DAH.

Considering the striped jack positive phototropism at early stages leading to larvae concentration at the surface, we have tested larval rearing in a white tank for 10 DAH. The highly cannibalistic behaviour of red porgy and white seabream post-larvae and juveniles also

prompted tests using white colour rearing tanks. White colour background tanks have been suggested to decrease aggressiveness in the case of white seabream juvenile culture (Karakatsouli et al., 2007).

Results of the production trials
The fry from different species produced under mesocosm conditions presented better growth performance (in total length, TL) and survival rate (SR) than reported from intensive systems:

Sparus aurata TL=3.7516e0.0293day, R2=0.9404; SR=31.9% SB=97%
Pagrus pagrus TL=3.212e0.039day, R2=0.995; SR=15.3%; SB=95.7%
Diplodus sargus TL=3.6355e0.0413day, R2=0.9824; SR=25%; SB=100%.

High rate of inflated swim bladder (SB) was common, namely 100% inflation for white seabream, in agreement with the low percentage (<2%) of total deformities.

Striped jack larval total length at 21 DAH was similar to reported by Masuda and Tsukamoto (1998) using a green water rearing technique. However, this species presented a very low survival (0.04%).

Larvae reared under mesocosm of semi-intensive methodologies presented faster growth and ontogenetic development compared to larvae from intensive rearing methods (Andrade, personal observation). The larvae produced in mesocosm are also more robust as indicated by stress tests (Roo et al., 2010). Semi-intensive mesocosm make use of large volume tanks. The low water turnover produces more stable environmental culture conditions, negligible water currents and promotes endogenous sources of live feed. These conditions reduce physical stress to larvae, and the constant density and the diversity of live feeds will eventually match the larvae needs. Moreover, the large tanks and the use of the green water technique provide a variety of habitats that larvae may take advantage during their ontogenetic development – for instance, red porgy larvae migrate deeper in the rearing tank from 5.5 (about 14 DAH) with the development of the sight and locomotion systems, thus enlarging their foraging areas.

Improvements of the rearing methods

The modifications to the culture methods essayed to each species resulted in better outputs at larval and post-larval stages.

1) Considering the alterations to the feeding regimes:

- The change to natural photoperiod lowered red porgy stress during a critical stage of the eye development and maturation of digestive system.
- The late entry of Artemia at lower density seemed appropriate to red porgy larval biology. Undigested Artemia in larvae faeces were not detected in our culture trials.
- With the early increase of Artemia density and phasing out of rotifers, the white seabream larvae presented no signs of stress and faster growth. This may diminish risks associated with the uncertain production of rotifers and lower the production costs.

2) Regarding the rearing tanks modifications:

- The white rearing tank walls reflected the light uniformly promoting the homogeneous distribution of striped jack larvae population in the water column. This allowed the cleaning of surface oil film and consequently, promoted better conditions for swim bladder inflation;
- Early transfer of red porgy post-larvae to shallower and white background colour tanks improved control over inert diet feeding and diminished cannibalistic behaviour;

- Again, white seabream fry transfer to white background tanks reduced aggressive behaviour and mortalities due to cannibalism.

Despite the good production results using semi-intensive mesocosm methodologies, there are constraints associated with the use of large larval rearing tanks. These are summarized bellow and are the aim of present R&D at CMC:

- The monitoring and control of water quality parameters;
- The higher residence time of enriched rotifers;
- The patchy occurrence of prey and the uneven distribution of inert feed;
- The control and/or introduction of zooplankton, namely copepods;
- The assessment and control of larval quality.

The cost of fry

Two mesocosm larval rearing tanks were used for each production trial. A team of 3 CMC technicians was able to perform all the tasks involved in the production of 2 g juveniles, including life feed production.

Due to the low cost of the facilities and operational costs (particularly labour and live feed), the cost price of guilthead seabream juveniles was estimated at an affordable 0,14 euros per unit. This cost is more significant if compared to the cost of 0,16 euros per unit for seabream juveniles produced under intensive systems at the smallest commercial scale – 5 million juveniles output (Andrade, personal observation).

Conclusions

Our experience with mesocosm hatcheries of semi-intensive methodologies shows that this technology produces larvae of high quality, at low level of technological input and at reasonable cost. The methodologies are easily adaptable to the production objectives of the hatchery, particularly in the case of candidate species for aquaculture. Therefore, these hatcheries may be regarded an interesting option to meet the increasing fry demand from the aquaculture industry and the self-sufficiency of small size offshore fishfarms.

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Genetic Strategies for Offshore Aquaculture: Improvement vs. Mitigation of Potential Impacts

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BIOGRAPHY

Employment History & Experience:
July 2000 - Present: Specialist & Professor;
July 1995 - June 2000: Associate Specialist;
September 1991 - June 1995: Assistant Specialist
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State-wide aquaculture specialist. Duties include educational programming and technical support for producers throughout the state, with an emphasis on production of crawfish, catfish, baitfish, pet turtles, alligators,hybrid striped bass and other game fish, tilapia culture in recirculating systems, and miscellaneous minor species. Additional work involves inland recreational fisheries, commercial fisheries and a variety of aquatic ecology topics. Audiences include aquaculture producers, Extension agents, governmental agencies, university students and the general public. Associate member of the Graduate Faculty. Research responsibilities include genetic improvement and evaluation of regional alternative species for commercialization.

Abstract

In aquaculture brood stock and hatchery management, it is not uncommon for two conflicting genetic “goals” to emerge. One involves “improvement,” which in many instances simply refers to adaptation of a captive population to the production strategy. Improvement approaches are generally well-defined and understood, and can be easily adapted to the particular spawning biology of the species in question. Another, more complex and abstract goal involves avoidance of potential genetic impacts from escapees on local populations. In certain circumstances, use of polyploid offspring from “improved” stocks may satisfy this requirement, but this approach is often problematic. Typically, this goal requires brood stock management and hatchery practices to produce a cultured stock that closely resembles the local population in terms of genetic make-up. Although at first glance one might think this requirement could be satisfied simply by recruiting breeding stock from local populations, the realities involved in attaining the desired result are far more complex. The genetic make-up of both captive and wild populations must be regularly monitored (e.g. allele frequencies and polymorphisms in microsatellite DNA, allozymes and mitochondria). Additionally, an understanding of local gene flow may be required, but methodologies are available to identify population structure on local and regional scales. The reproductive biology of any given marine species will influence not only husbandry practices but also the practical steps required to maintain a representative broodstock in the face of phenomena such as genetic drift and inbreeding depression.

March 1991 - August 1991: Fisheries Biologist Programs Manager – Biometrician. Louisiana Department of Wildlife and Fisheries, Research Division, Baton Rouge, LA USA.
November 1987 - January 1991: Director of Research and Operations. Aquaculture Technologies, Lebeau, Louisiana and Belzoni, Mississippi, USA.
July 1980 - December 1980: Lab Water Quality Analyst and Field Operator. Water and Industrial Waste Laboratories, Lafayette, Louisiana, USA.

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Ph.D.: Wildlife and Fisheries Science (Aquaculture), Louisiana State University, December 1987.
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Coursework: Quantitative Genetics, Fisheries/Aquaculture, Statistics, Wildlife Management.
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Book:
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Popular Literature – Over 100 articles in trade/agricultural publications. Genetics and Breeding columnist for Aquaculture Magazine 1996-2008.

Presentations – Over 70 presentations at professional/scientific meetings

Extension/Educational – Over 40 extension/educational publications

Affiliations, Activities:
World Aquaculture Society: WAS 25th Anniversary Steering Committee. Program Committee - 1998, 2000. Currently serving as Associate Editor for Genetics, Journal of the World Aquaculture Society.
U.S. Aquaculture Society: Vice-President, 2004. Chair, Student Affairs Committee, 2005 and 2006.
National Aquaculture Association: Scientific Review Panel for aquatic nuisance species reports and documents generated by the Gulf of Mexico Program (GMP). Industry representative on the GMP Nonindigenous Species Focus Team. Producer session organizer.

USDA Southern Regional Aquaculture Center: Technical Committee.
Louisiana State Seafood Industry Advisory Board: Chair, 2005 - 2008.
Louisiana Aquaculture Association: Secretary/Treasurer 1992 - 2001, Organizer for association-sponsored workshops and tours at Aquaculture Expo and Aquaculture America (2000).
Aquaculture Magazine: Genetics and Breeding Columnist, March 1996 - 2008.
International Journal of Recirculating Aquaculture: Editorial Board Member (1999-2003).

Nutritional Support to Fish Health in Offshore Mariculture

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BIOGRAPHY

Dr. Umberto Luzzana is Marketing and Product Manager in Skretting, where he is also part of the Skretting Sustainability Global Team. He earned his PhD from the University of Milan, and has been a Visiting Scholar at the University of Washington and a Project Manager at the University of Milan. In addition to his experience as fish nutritionist both in research and industry positions, he has been an Expert Evaluator and an External Advisor for the European Commission and is also member of the FEFAC Task Force on Contaminants and Additives in Fish Feeds. Dr. Luzzana co-authored more than 30 peer-reviewed papers on fish nutrition and is serving as a reviewer for several scientific journals.

INTRODUCTION

Farmed fish in offshore mariculture live in a variable and challenging environment. Nutrition plays an important role in supporting fish health and welfare, but needs to adapt to such a variable environment. In fact, nutrient requirements of the fish may be different under different conditions or according to the physiological process to be supported (growth, immune response, reproduction…), and as a consequence differentiated feeding protocols need to be developed and applied. This approach may be defined “Active Nutrition”, where different levels of nutrition are identified as follows:

1. Optimized nutrition: provide the fish the optimal nutrition for standard farming conditions, in order to get the most effective cost-benefit ratio.
2. Proactive nutrition: provide the fish proper nutritional support to prepare them to face stressful or adverse scenarios in the best condition. Preparation of gilthead seabream (Sparus aurata) to wintertime is an example of Proactive nutrition.
3. Specific nutrition: provide the fish the nutrition needed under specific conditions. Specific diets for European seabass (Dicentrarchus labrax) at temperature above the optimal range for this species are an example of Specific nutrition.

Proper nutritional support to fish health requires a multi-level approach which takes into account immune response, gut health and microflora control. This paper will review recent advances in these areas which are applied in status-of-the-art nutritional solutions to support fish health.

Supporting Immune System

Many substances have been demonstrated to enhance non-specific defense mechanisms in fish (Sakai, 1999). Among those, glucans and vitamin C are probably the most documented (Robertsen et al., 1994; Gabaudan and Verlhac, 2001), but more recently other micronutrients such as for instance nucleotides have also been recognized to play an important role (Li and Gatlin, 2006). Together, dietary components such as the cited ones enhance immune response in fish both at cellular and humoral level.

Oxidative stress also needs to be controlled when dietary solutions to support fish immune system are designed. In fact, Reactive Oxygen Species (ROS) produced by macrophages to kill pathogens and inflammatory responses to pathogens may also damage the host cells and tissues if not properly neutralized in due time. There are also indications that fish kept at temperature above their comfort range are subjected to oxidative stress.

A proper antioxidant balance therefore has to be part of nutritional solutions supporting immune system. Different antioxidants may be used in fish feed formulations, and appropriate combinations of antioxidants acting at different levels need to be designed. For instance tocopherols are lipid-soluble antioxidants, while ascorbic acid is a water-soluble antioxidant which revitalizes oxidized vitamin E. In addition, enzyme co-factors such as selenium (part of glutathione peroxidase system) also need to be part of the antioxidant package.

Nutrition can therefore support immune response, but it is recommended not to rely on single nutrients, as different substances act at different levels (immune system stimulation, support and antioxidant protection). A reliable nutritional solution to enhance the immune system of farmed aquatic organisms must therefore include all the different active components playing complementary roles in the different metabolic pathways involved in the defense mechanisms of the fish against the pathogens. In addition, the feed formulation itself should be specifically designed to provide proper nutrition as required to maximize the positive effects of the dietary active components, avoid antagonistic effects on bioavailability of micronutrients and ensure high palatability to support feed intake.

Enhancing Gut Health And Function

Gut is an important organ not only in relation to nutrient digestion and absorption, but also from an health perspective, being part of the first integumental defense line which protect fish from pathogens (Ellis, 2001).

Several stressors may negatively impact gut health and therefore reduce its ability to act as a barrier against viruses, bacteria and parasites. This is for instance the case of gilthead seabream at low temperature, where intestinal lesions such as increase in mucous cells and necrotic epithelial cells in the gut are common (Ibarz et al., 2010). It should be noted that even in the absence of typical Winter Syndrome symptoms and related mortality, gilthead seabream digestive function is compromised following exposure to cold, in terms of reduced capacity for protein digestion and amino acid absorption (Sala-Rabanal et al. 2003).

A further example of negative impact of environmental stress on intestinal health is increased gut permeability demonstrated in Atlantic salmon (Salmo salar) at 18°C (Fig. 1, from Fontanillas et al., 2008). As already mentioned for gilthead seabream in wintertime, the altered gut structure and function may not result in increased mortality, but reduction in feed intake and growth rate are usually evident.

These examples suggest that, even under conditions which, although stressful, apparently do not significantly impact fish health, specific nutritional support may be needed to ensure proper gut functionality. An healthy gut obviously will ensure faster recovery when stressors are removed and normal conditions are back.

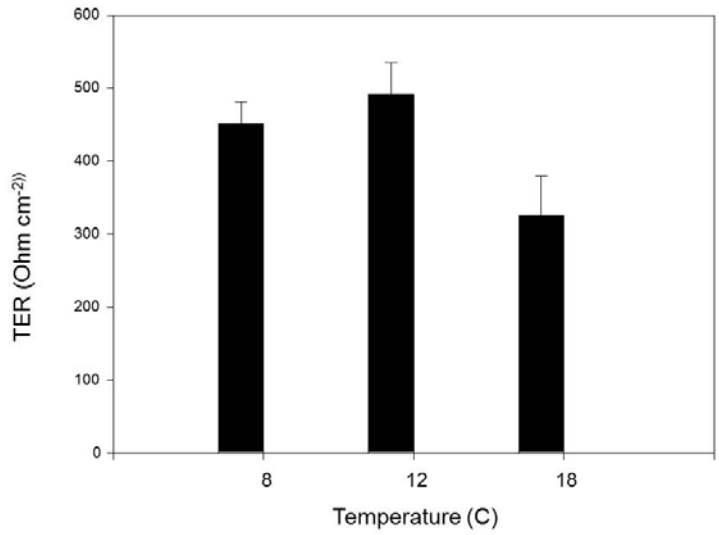


Figure 1

Several dietary components such as organic acids (Lückstädt, 2008, Scollo et al., 2012) and nucleotides (Li and Gatlin, 2006) have been proved to be beneficial for gut structure and function in fish. Some of these components act as antimicrobials and growth promoters, others provide energy for intestinal epithelium renewal, a process with high energy requirement, and/or influence different cellular functions relevant to gut health while also positively affecting intestinal morphology. Such nutritional solutions are therefore essential to complement immune system enhancers in an Active Nutrition perspective.

Controlling Gut Microflora

The possibility of influencing gut microflora composition through the diet is being increasingly recognized, although further research is needed in this area (Merrifield et al., 2010; Ringø et al., 2010b). The introduction of innovative methods such as PCR and denaturing gradient gel electrophoresis (DGGE) allows a reliable evaluation of intestinal microbiota composition, making further advancement in our understanding of dietary effects on gut microflora possible (Hovda et al., 2007).

Gut microflora plays a significant role in supporting fish health (Gómez and Balcázar, 2008), as many pathogens enter fish body through the gut and because intestinal bacteria produce metabolites with health effects. Lactic acid bacteria, which are considered to be part of the normal intestinal microbiota of fish from the early stages of life, play an important role in competing against invading populations of non-indigenous microorganisms, including pathogens that attempt to colonize fish gut through competition for nutrients and adhesion sites, formation of metabolites such as organic acids and hydrogen peroxide and production of bacterocins (Ringø et al. 2005).

Supporting intestinal beneficial microflora such as lactic acid bacteria therefore appears to be a further tool to protect fish from invading pathogens (Ringø et al., 2010a). Since nutrition can play an important role in this respect, dietary solutions to support fish health should also include components with positive impact on gut microflora composition.

Conclusion

Nutritional solutions are available to support fish health in offshore mariculture, including Proactive nutrition to prepare the fish for facing adverse conditions and Specific nutrition to

satisfy fish requirements under unfavorable conditions. Immune system modulation, gut health and microflora are all important areas to be covered in designing diets aiming at supporting fish health. This flexible approach which may be called Active Nutrition is recommended as part of an integrated health management plan, which should include suitable farm location and design, fish/eggs introduction control, genetic selection, biosecurity and hygiene, continuous monitoring and early diagnosis, responsible use of antimicrobials, vaccination programs together with environmental and health associated nutrition.

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SESSION 5

INTEGRATION WITH OTHER TECHNOLOGIES AND NEW APPROACHES TO FARMING

Co-location of offshore quaculture and wind energy projects – feasibilities and constraints

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BIOGRAPHY

Michael W. Ebeling works at the Institute of Sea Fisheries, which is part of the Johann Heinrich von Thünen-Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries. Mr. Ebeling is dealing with fisheries, fish processing and aquaculture economics, in particular in the realm of offshore aquaculture. He is also affiliated to the University of Applied Sciences Bremen, where he is lecturer for quantitative methods and economics. Since several years Mr. Ebeling is also involved in the European Fisheries Policy and just recently he has become chairman of the STECF Sub-group on Research Needs.

Michael W. Ebeling has studied Economics, Economic History, Economic Teaching, Political Science and Philosophy at the Johannes Gutenberg University Mainz, the Westfälische Wilhelms University Münster and the Carl von Ossietzky University Oldenburg where he made his Diploma.

After his Diploma he worked at the University of Kassel on Institutional Economics, especially about the role of law and legal institutions in Economic Development and in a project dealing with modelling of Regional Innovational Systems. Turning back to Oldenburg University he was engaged in an empirical project on Management Accounting in the German banking sector. Since 2007 he is now affiliated with the Institute of Sea Fisheries.

Since his Diploma he is also working as a private consultant and has dealt with a variety of issues ranging from the modeling of regional economic impact of changes in fishery in Northern Norway due to climate changes, the evaluations of studies dealing with regional economic impacts of airports to the evaluation of reports concerning national data collection actions under the European Fishery Framework. Furthermore he is assessing the commercial feasibilities of aquaculture recirculation systems.

Authors

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Keywords: Multi-use, Offshore-wind farm, Mariculture, Economic feasibility

Marine and freshwater aquaculture production is increasing on a global scale. However, in Europe the situation is different. Regulations and administrative procedures are only one reason to hamper a significant increase of aquaculture production. A more or less recent focus of research and commercial interest are regions off the coast beyond the coastal sea for open ocean aquaculture. Here, a newcomer – the offshore wind farm industry – could act as a synergetic partner.

The authors have been involved and are still engaged in a couple of projects dealing with mariculture in offshore wind farms or its vicinity, ranging from fish to mussel and algae production. This presentation will include the biological, physical and economic assessment of fish, mussel and macroalgae mariculture in offshore wind farm sites, based on the results of various projects. Different uses of the products will be discussed and their impacts on economic profitability will be the focus of this contribution. Possible economies of scope by an aquaculture co-use of wind farm areas will be assessed as well.

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Open Ocean Culture of Macroalgae, Use of Algal Extracts in Diets for Marine Finfish, and Bioenergy from Macroalgae

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Macroalgae and Macroalgae Aqauculture

Macroalgae, also known as “seaweeds”, "aquatic plants" or “sea vegetables”, form a large group of amazing aquatic plants, widely used for human food in China, Japan and Korea. It is also an ingredient in animal feed, including fish feed, cosmetics and fertilizers (McHugh, 2003). Various macroalgae are also used to produce the hydrocolloids (or phycocolloids) alginate, agar and carrageenan as thickening and gelling agents. Macroalgal extracts are to be found in a wide range of common products we use daily such as toothpaste, shaving foam, ice cream, cheeses, candy, beer, shower gels, bacteriological agar and paper. Increasingly macroalgae are being investigated for the biological activity of their extracts, which are finding applications in pharmaceuticals, biotechnology and food preservatives (Schuenhoff et al., 2006). In addition, macroalgal products are used in textiles and printings to achieve the desired consistency in dyes, paints, and inks. There are many macroalgae companies producing a range of seaweed based marine therapy (Thalassotherapy) products which include seaweed bath salts, bubble bath, shampoos, shower gel, soaps, facial scrubs, body masks, moisturisers and foot bath salts (De Roeck-Holtzhauer, 1991; Turan and Cirik, 2008). Developments in the paper pulp industry have made macroalgae practical alternatives to the use of trees (De Poli et al., 1994; You, 2008). There are also potential uses for macroalgae in wastewater treatment due to their ability to absorb nutrients, heavy metal ions such as zinc and cadmium from polluted water (Ryther et al., 1975; Schramm, 1991a).

Over the last twenty years, several studies have investigated the possible use of macroalgae as a source of biofuel (Bird and Benson, 1987; Brehany, 1983; Bruton et al., 2009; Flowers and Bird, 1987; Hanisak and Ryther, 1986; Morand et al., 1991; Gao and Mckinley, 1994; Kelly and Dworjanyn, 2008). First generation biofuels, such as biodiesel and bioethanol derived from biomass, have their environmental benefits related to carbon-neutral energy. However, increasing biofuel production from land crops strains the global food supply. Due to these limitations, second generation (bio) fuels- from biomasses that generate carbon neutral energy without competing with food production have been developed. These can be produced from the residual non-food parts of current crops, as well as energy crops, such as macroalgae.

Macroalgae aquaculture already represents 23% of the world’s aquaculture production, but its potential is far from being fully exploited. Macroalgae cultivation techniques are standardized, routine, and economical. Despite the variety of life forms and the thousand of macroalgal species described, seaweed aquaculture presently uses only about 100 taxa. The genera Laminaria, Undaria, Porphyra, Eucheuma/Kappaphycus, and Gracilaria account for about 98% of global production (Sahoo and Yarish, 2005; Yarish and Pereira, 2007). However, cultivation of other commercially important species, such as Palmaria, Chondrus, Gigartina, Gelidium, Pterocladia, Hypnea, Asparagopsis/Falkenbergia, Ecklonia, Macrocystis, Sargassum, Cystoseira, Monostroma, Ulva and Caulerpa takes place in many different places (Critchley and Ohno, 1997, 1998, 2001; Critchley, et al., 2006; FAO, 2003; Kain-Jones, 1991; McHugh, 2003; Schramm, 1991b; Troell et al., 2006).

The world macroalgae industry produces over 15 million tons (fresh weight) annually with a total value of over US $ 7 billion (FAO, 2006). Value of food products for human consumption contribute US $ 4-5 billion of this, with the single most valuable crop being Porphyra or ‘Nori’, worth over US $1.3 billion. Substances that are extracted from macroalgae - hydrocolloids - account for a large part of the remaining value, while smaller, miscellaneous uses, such as fertilizers and animal feed additives, make up the rest. Over 90% of the market is supplied by cultivation. The farming of macroalgae has expanded rapidly as demand has outstripped the supply available from natural resources.

China is the largest producer of macroalgae with 10.9 million tons (wet weight) followed by the

Philippines (1.5 million tons), Indonesia (0.91 million tons), the Republic of Korea (0.77 million tons) and Japan (0.49 million tons) (FAO, 2009). While the bulk of China's contribution mainly comes from the cultivation of Laminaria japonica, 50 % of Korea production is contributed by Undaria pinnatifida and 75 % of Japan's contribution comes from the cultivation of Porphyra sp. Philippines and Indonesia are involved mainly in the cultivation of Kappaphycus alvarezii and Eucheuma denticulatum (carragenophytes) as well as Gracilaria species (agarophytes).

Use of Algal Extracts in Diets for Marine Finfish

The long-term sustainability of aquaculture may be limited by its present over-dependence on fish meal and fish oil (FAO, 2002). Furthermore, fish feeding represents over 50% of operating costs in intensive aquaculture, with protein being the most expensive dietary source (Lovell, 2002). For this reason, an intensive effort during these last decades has been made in order to evaluate the potential of alternative protein sources in aquafeeds (Alexis, 1997). Even though several studies were conducted to evaluate the replacement of fish meal by plant ingredients in diets of marine fish species, data about the potential use of macroalgae in fish diets is limited (Appler, 1985, Nakagawa et al., 1987, Hashim and Mat Saat, 1992, Davies et al., 1997 and Wahbeh, 1997).
Today, macroalgae with elevated protein content and production rates are receiving increasingly attention as novel feeds with potential nutritional benefits (Buschmann et al., 2001 and Rupérez and Saura-Calixto, 2001) and as possible ingredient in fish diets (Appler, 1985, Davies et al., 1997 and Wahbeh, 1997). Production of macroalgae has been increasing in the last decades but cultivation on a commercial scale remains restricted to a few species. Nitrogen-enriched conditions like the effluents of fish farms, where seaweeds are used as biofilters, can increase their protein content (Lahaye et al., 1995). A part of their potential nutritional value as protein substitutes, macroalgae may also give an important contribute in fish diets as lipid sources, and binding or colouring agents. (Nakagawa et al., 1987; Hashim and Mat Saat, 1992).

Use as Aquafeed

The results of various recent work show that macroalgae as dietary additives contribute to an increase in growth and feed utilization of cultured fish due to efficacious assimilation of dietary protein, improvement in physiological activity, stress response, starvation tolerance, disease resistance and carcass quality. In fish fed macroalgae-supplemented diets, accumulation of lipid reserves was generally well controlled and the reserved lipids were mobilized to energy prior to muscle protein degradation. Several feeding trials have been carried out to evaluate macroalgae as fish feed and they have been used fresh as a whole diet and dried macroalgal meal has been used as a partial or complete replacement of fishmeal protein in pelleted diets. Dietary inclusion levels in previous studies varied from 5 to 100 %. Fishmeal-based dry pellets or moist diets were used as control diets. The results of the earlier growth studies showed that the performances of fish fed diets containing 10–20 % macroalgae meal were similar to those fed fishmeal based standard control diet. The responses were apparently similar for most of the fish species tested. These inclusion levels effectively supplied only about 3–5 % protein of the control diet. In most cases, these control diets contained about 26–47 % crude protein. This shows that only about 10–15 % of dietary protein requirement can be met by macroalgae without compromising growth and food utilization (FCR 1.5 –2.0). There was a progressive decrease in fish performance when dietary incorporation of algal meal rose above 15–20 %. Recent work by Kalla et al. (2008) appears to indicate that the addition of Porphyra spheroplasts to a semi-purified red seabream diet improved SGR. In addition, Valente et al. (2006) recorded improvements in SGR when dried Gracilaria busra-pastonis replaced 5 or 10 % of a fish protein hydrolysate diet for European seabass. However, the conclusions of the latter authors are confused by the fact that the test diets were not iso-nitrogenous with the control diet; in fact test diets had a lower protein level.

While studying the effect of two seaweeds (Undaria pinnatifida and Ascophyllum nodosum) at different supplementation levels for red sea bream, Yone et al. (1986a,b) observed best growth and feed efficiency from a diet containing 5 percent U. pinnatifida followed by a diet containing 5 % A. nodosum. Similarly, Mustafa et al. (1994b) observed more pronounced effects on growth and feed utilization of red sea bream by feeding a diet containing Spirulina compared to one containing Ascophyllum. In another study, Mustafa et al. (1995) studied the comparative efficacy of three different algae (Ascophyllum nodosum, Porphyra yezoensis and Ulva pertusa) for red sea bream and noted that feeding Porphyra showed the most pronounced effects on growth and energy accumulation, followed by Ascophyllum and Ulva.

More recently, Oceanfeed a commercial salmon seaweed-based diet was formulated by the company called Ocean Harvest Technology, Ltd. The diet contains of from a mix of Ulva, Ascophyllum nodosum, Sargassum, Gracilaria, Laminaria, Palmaria, Maerl, Polysiphonia, Falkenbergia, Delleseria, Osmundia pinnatifida, Plocamium cartilagineum. And, the diet showed improved weight gain, better feed conversion ratio's better growth index, a higher gutted weight and less mortality, better natural pigmentation and reduced lice recruitment and re-population. And, it was concluded that using the disclosed seaweed-based diet could therefore save a fish farmer on feed use (based on feed conversion ratio), and produce healthier and better fish with less money spent on feed (Kraan and Mair, 2010, Kraan et al., 2010).

Open Ocean Culture of Macroalgae

“Offshore” or “Open ocean” cultivation refers to growing macroalgae in waters that are generally too deep for even giant kelp to survive own their own and that are free from the direct influence of land. Open ocean macroalgae cultivation systems are large macroalgae farms that located in natural or artificial upwelling of deep ocean waters for nutrient supply.

Large-scale macroalgae culture is attractive due to low cost technologies that have been in operation for decades, and the multiple uses of the product as food, feed, chemicals and biofuel. Yields of macroalgae can be as high as 80 mt dw ha-1 y-1 in modern intensive pond farms, while extensive low technology coastal farms regularly get yields above 20 mt dw ha-1 y-1 (Neori et al., 2004). Macroalgae can take up 29 mt carbon ha-1 y-1 in modern intensive farms and 7.3 mt carbon ha-1 y-1 in low technology farms (Sinha et al. 2001).

Macroalgae are now being promoted in polyculture systems as integral part of integrated multi-trophic aquaculture (IMTA) (Bushmann, et al., 1994, 2001, 2008; Chopin, 2006, Chopin, et al., 1999b, 2001, and 2008; Cirik, et al., 2006; Neori, 2007 and 2008; Neori, et al., 1996, 2000, and 2004; Neori and Shpigel, 1999; Schuenhoff, et al., 2003 and 2006; Shpigel and Neori, 1996; Shpigel, et al., 1993a; Troel, et al., 1997, 1999, 2003, and 2006; Turan, et al., 2006; Whitmarsh, et al., 2006, and Yang et al., 2004). The IMTA approach, besides being a form of ecologically-balanced aquaculture management, diminishes possible environmental impacts from aquaculture (Yang, et.al., 2006). The effluent water from fish farms usually contains high levels of nutrients that can cause problems to other aquatic life in adjacent waters. Macroalgae can often use such nutrients, so trials have been undertaken to farm macroalgae in areas adjacent to fish farms (Cohen and Neori, 1991; Krom and Neori, 1989; Neori and Shpigel, 1999; Neori, et al., 1989, 1996, 2004; Nunes et al., 2003; Fei, 2004; Kang et al., 2007; Xu et al., 2008).

IMTA Macroalgae farming provides exciting new opportunities for valuable crops of macroalgae with higher production. IMTA practice combines the cultivation of finfish with shellfish and macroalgal species for an ecologically-balanced aquaculture management approach. IMTA increases the long-term sustainability and profitability per cultivation unit as the wastes of the main cultured species are biomitigated through conversion into feed, fertilizer, and energy through additional commercially valuable species. In this way, otherwise costly waste mitigation processes become revenue-generating cultivation components,

which, by their harvest, export nutrients of carbon, nitrogen and phosphorus outside of the coastal ecosystem. It is important to note that 830 tons of CO2 can be taken up annually by a 1,000 mt fish-2,000 mt shellfish-500 mt macroalgae farm and 1,230 tons of CO2 can be taken up annually by a 1,000 mt fish-7,000 mt macroalgae farm (Neori, 2008).
The macroalgae IMTA component may include species of Gracilaria, Porphyra, Eucheuma/Kappaphycus, Laminaria, Undaria, Ecklonia, Macrocystis, Ulva, and Caulerpa. However, other commercially important species, such as Palmaria, Chondrus, Gigartina, Hypnea, Sargassum, Cystoseira, Asparagopsis/Falkenbergia etc. have also high potential in IMTA systems. Today, Several IMTA projects are being conducted in different parts of the world. The goal is to develop for different aquaculture environments suitable modern IMTA macroalgae farming components. IMTA technologies are one of the macroalgae culture approaches that are bound to play a major role worldwide in sustainable expansions of the aquaculture operations within balanced ecosystem, to respond to a worldwide increasing fuel demand with a new paradigm in the design of the most efficient CO2 removal systems against global warming (Turan and Neori, 2010).

Bioenergy from Macroalgae

As the need for renewable energy continous to grow, macroalgae farming has the potential to help meet future energy needs. The ocean cover over 70% of the Earth's surface. Use of just 1% of tha along the ocean margines could supply about 3.5 billion dry ton of macroalgal biomass annually, if the production rates already achieved in coastal macroalgae farms in countries like China with a production of ~116 tons dry macroalgae y-1 km-1 (Turan and Neori, 2010). This is the three-times the maximum amount of terrestrial biomass that can be collected annually in countries like the US. Such systems would not compete with the availability of fresh water, land, and nutrients needed to sustain terrestrial agriculture. Large-scale open ocean macroalgae cultivation for biofuel production is the key for sustainable bioenergy production.

The culture of macroalgae has unique characteristics, which make it different and in many ways attractive in comparison with other biofuel sources. Macroalgae are autotrophic organisms that produce biomass using sunlight extract from the water dissolved inorganic nutrients, including carbon. Several macroalgae species are perhaps the most attractive of all CO2 removal and biofuel aquatic crops, thanks to very high yields and low cost of production. Therefore, efficient production of biodiesel and bioethanol from macroalgae has been considered (Bird and Benson, 1987; Flowers and Bird, 1987; Hanisak and Ryther, 1986; Morand et al., 1991; Gao and Mckinley, 1994; Kelly and Dworjanyn, 2008).

Macroalgae can be viewed as miniature biochemical factories, and are more photo-synthetically efficient than terrestrial plants as well as being highly effective CO2 fixers. Many species of macroalgae are rich in oil or sugars that can be converted into biofuels; as a result the biofuel productivity of algae per unit area is much higher compared with conventional farm crops, such as wheat and maize. Producing a ton of dry algal biomass utilizes approximately 360 kg carbon, 63 kg nitrogen and 8.6 kg phosphorus (Sinha, et al., 2001).Utilization of anthropogenic CO2 as an industrial by-product for macroalgae production holds great promise not only as a carbon sink, but also as a source of food, fodder, fuel and pharmaceutics.

The recent Algal Biomass Summit (Seattle, October 08) stressed the importance of algae to deliver such a mix of energy, feed and industrial products. From an ecological point-of-view, generation of biomass should not aim to a single application, treating the remainder as a 'waste', but towards a comprehensive solution to several challanges, including bio fuel, carbon sequestration and waste remediation. The goal therefore should be the integration of the processes. Mass balance and energy balance, complemented by exergy analysis, can guide the optimisation of the technologies and economics of using macroalgae, regarding carbon

sequestration, biofuel production and generation of macroalgal products. Additional attractive characteristics of macroalga based biofuels include (a) some macroalgae are rich in oil, others in easily processable carbohydrates and proteins, (b) macroalgae of different species can be grown anywhere, in marine, brackish and fresh water, (c) macroalga can grow well on liquid domestic and industrial wastewaters and on streams polluted by agriculture, reducing pollution as they grow, (d) macroalgal biomass is desirable and valuable for a diverse array of commercial purposes, depending on species, quality and quantity.

Previous research on macroalgae biofuels production

The interest in macroalgae for biofuel lies in their high carbohydrate (e.g. polysaccharide) content. Macroalgae were first proposed as a possible source of energy by Howard Wilcox in the late 1960s, who presciently considered their production not only as a solution to the energy crisis but also for global warming (Wilcox, 1975). Much research was carried out by the US during the 1970's and early 1980's to develop open ocean macroalgae farms to produce a substitute for natural gas, an energy source then considered in the USS to be approaching depletion. The Marine Biomass Program, supported between 1979 and 1985 with over $50 million by the U.S. Dept. Of Energy had as its ultimate objective to replace the entire US natural gas supply with 25,000 square miles of floating open-ocean farms. The concept was to cultivate the giant kelp Macrocystis pyrifera, which was thought to have very high productivity, and for which already extensive experience in harvesting wild stocks with specially built ships off the San Diego coast existed. In World War I over a million tons of giant kelp were harvested there and fermented with bacteria to produce acetone, a critical ingredient in munitions for the British Navy (Neushel, 1989). The harvested biomass was to be anaerobically digested to produce biogas. However, the great difficulties of working in the open ocean, even with near-shore simulations of the production systems, and the instability of cultivation of giant kelp, among other problems, resulted in the program not achieving any significant results in open ocean cultivation (Huesemann et al. 2010). Nevertheless, a great deal of basic information on kelp physiology, growth rates, composition, productivity and conversion to methane was developed by this program (Bird and Benson, 1987; Chynoweth 2002). But the main reason this effort was abandoned by the early 1980s, was the change in political leadership in the US, as well as the finding of large new resources of natural gas in the US, following natural gas price deregulation.

Potential of macroalgae for biofuels

Macroalgae are again being considered as a biofuel feedstock for similar reasons as thirty years ago: because they are thought to have very high biomass yields (though still this remains to be established) and, perhaps most importantly, because they don't compete with agricultural crops for land, water resources, and potentially fertilizers. The three most commonly mentioned fuels that could be derived from macroalgae are methane, ethanol, and butanol. The interest in macroalgae for biofuels was recently re-initiated, mainly in Japan, Korea and Europe. In Japan, Tokyo Gas studied the production of biogas from seaweed that was collected from biomass naturally deposited on beaches after storms and high tides (Huesemann et al. 2010). However, several factors, such as the small amounts and sporadic nature of such harvests, the sand and dirt collected along with such biomass, and the transportation costs and etc, make such operations impractical. Thus most attention has focused on off-shore cultivation of local seaweeds, with a popular candidate species being Laminaria japonica, the most common seaweed currently used for food and chemical production, and already considered thirty years ago for such applications (Tseng 1981; Chynoweth 2002, 2005). In Ireland, Laminairia ssp and Ulva ssp, are being considered because of their relatively high carbohydrate content (Bruton et al. 2009). Ulva can be readily digested to methane gas and seem to lack epiphytes, e.g. microalgae growing on the surface of the seaweed thallus, which can interfere with their production (Chynoweth 2002, 2005). Other species also evaluated for fuel production in the 1980s, include Gracilaria tikvahiae

(a red algae species), notable for its high yields in on-shore cultivation tests (Hanisak 1987). Another interesting macroalga is Sargassum, (a brown algae species) (Chynoweth 2002, 2005).

Macroalgae Processing to Fuels

Processing of seaweed requires the removal of debris, e.g. any dirt or sand, washing off excess salt, and reducing the water content to the extent feasible. For ethanol and butanol fermentations, the macroalgae cell wall polysaccharides must first be broken down through microbiological, enzymatic, chemical or/and thermal processing. Although macroalgae do not contain lignin nor, generally, cellulose, the polysaccharides, both structural and storage, must be broken down by such means to become accessible to the yeast or bacteria involved in the ethanol, butanol fermentations. Polysaccharide breakdown and fermentations would require development of specialized micro-organisms, but this should be readily amenable to modern biotechnological technologies. For example, Horn et al. (2000), in Norway, reported on testing several bacteria and yeast to ferment Laminaria hyperborea (a brown macroalgae) to ethanol, finding that the yeast Pichia angophorae could convert both laminaran and mannitol into ethanol. Adams et al. (2009), using Saccharina latissima (a brown macroalgae, which, as its name implies, is quite high in sugars), showed that the one hour pretreatment at pH 2 and 65 ˚C used by Horn et al. (2000) was not required to produce ethanol from this alga. Optimal pretreatment conditions to release monosaccharides and thus increase ethanol yields have been studied in Korea by Jeong and Park (2010) and Wi et al. (2009). In the USA, the major current effort on macroalgae for biofuels is by a partnership of a small California company, Bio Architecture Lab (BAL) with Dupont Corp. in a $6 million Project funded by the US DOE (under the ARPA-E program), to develop a low cost butanol fermentation program. It is not clear if BAL intends to produce the macroalgae for this Project in the USA; it has started a production Project in Chile. BAL uses synthetic biology to develop microbial pathways and enzymes for converting macroalgae into fuels. BAL has also partnered with Statoil of Norway to develop technology for the conversion of Norwegian seaweed into ethanol. BAL is responsible for the conversion to ethanol technology, and Statoil for the development of the seaweed cultivation process, for Saccharina latissima (Statoil 2009a). One of the plantings of Saccharina latissima will be outside Tjeldbergodden methanol plant in Norway which has favorable water temperature in addition to CO_2 and NO accessibility (Statoil 2009b). Anaerobic digestion does not require any particular pre-treatment or bacterial selection, though a high S content in seawater and seaweeds will required scrubbing of the biogas. Compared to the challenges of cultivating macroalge for biofuels, the conversion processes do not present major challenges.

Current Worldwide Projects related with Macroalgal Biofuel Production

The past two or three years have seen a major upswing in the interest in open ocean cultivation of seaweeds for biofuels. This is driven perhaps more by the recognition of the limitations of land-based biofuel systems, both of higher plants and microalgae, than any particular appearl of macroalgae, other than the promise of essentially unlimited area, water and CO2. A few examples of recent projects initiated are:

- In Japan, the Ocean Sunrise Project will investigate the farming of Sargassum fulvellum and its conversion to ethanol production in unused maritime areas around Japan (Aizawa et al. 2007). Organic compounds, salt, and ash leftover from processing would be used for cattle feed and fertilizer. This Project also plans to adapt farming technology used for Laminaria and Undaria pinnatifida in coastal zones to offshore areas, with rope cultures configured as a trawl net. Water bag transport and storage systems for the harvested biomass are being proposed. Clearly these concepts are hypothetical.

- In Indonesia, the Korea Institute of Technology (KIIT) and partners will develop seaweed cultivation to provide biomass for ethanol production, leasing 25,000 hectares of coastal

waters for this project. Indonesia coastal areas have large natural seaweed beds unlike Korea, and Korea will supply the conversion technology and most funding. Similarly, a Project under the South Korea National Energy Ministry plans to create a 35,000-hectare offshore seaweed forest for producing ethanol from macroalgae.

- In Brazil, the State of Rio Grande do Notre Agricultural Research Company (EMPARN) is developing large-scale production techniques for fuel from seaweed.

- In Japan, Tohoku University and Tohoku Electric Power Company claim to have discovered a natural yeast for the conversion of macroalgae into ethanol. Their conversion rate after two weeks was 200 mL of ethanol from 1 kg macroalgae.

- At the University of Maine, there is a Project on the life cycle assessment of macroalgae for biofuel and the study of the conversion of Algefiber® from Eucheuma spinosum (red algae) into carboxylic acids to be converted into alcohol fuels.

- In India, the Central Salt and Marine Chemicals Research Institute (CSMCRI) has produced ethanol from the species Kappaphycus alvareziii (red algae).

- In Denmark, scientists are trying to apply similar ethanol conversion technology from Horn et al (2000) to the gren algae Ulva lactuca which is abundant in their area (Huesemann et al. 2010).

- In Korea, the Korea Institute of Industrial Technology recently reported on the saccharification and conversion of Gelidium amansii (red algae) into ethanol (Yoon et al. 2010). The group selected this species because of its wide variety and growth rate. Also, red seaweed has no lignin and its galactan and glucan content can be processed into monosugars of glucose and galactose that can be readily converted to bioethanol.

- Sustained commercial cultivation of macroalgae has successfully been done with Laminaria japonica in China which showed yields of about 25 t/ha (Bruton et al. 2009).

- For offshore farming, German scientists investigated an offshore ring system for Laminaria saccharina (Buck and Buchholz 2004). The design is for food production but can also be used for fuel. First macroalgae sporophytes are grown in the lab to a suitable length, and then they are places in the ring structure. The ring structure has been found to be stable in offshore farming.

- The Sustainable Fuels from Marine Biomass Project (BioMara) in the UK and Ireland, plans to investigate the economics and feasibility of using macroalgae for methane and ethanol production.

Conclusions

Macroalgal biomass can contribute in meeting to some extent global renewable bioenery, such as methane, ethanol and butanol and biobased products, including desired products for aquafeeds. The timely transition to renewable fuels and biobased products from macroalgae critically depends on scientific progress in three areas, which are:

- Macroalgal biology and biotechnology: identification and development of macroalgae varieties that maximize production of macroalgal fuels and biobased products,
- Engineering: development of open ocean culture technologies and farm designs that sustainably produce large quantities of macroalgae feedstock at low cost, including IMTA.
- Social sciences: communication to the relevant parties of the social, socio-economic and environmental benefits that large scale macroalgal fuel and bio-product production can

have; overcoming opposition to innovation, gaining of socio-political support and public involvement.

Critical to this and other innovative developments is the acceptance by the public financial system of its obligation to support long-term research and innovation programs, ensuring that emerging ideas that are explored consider overall societal needs. Only the public financial systems, e.g., governments and the World Bank, have the resources and time to fund the required investments. Such efforts need a strong political will for their active steering in the right direction.

Preconditions for an accelerated development for industrial applications will be:

- Government regulations, shaping a competitive environment for the private sector
- Public-private partnerships, prototyping new processes by collaborations between research and industry
- An educational infrastructure, drawing together the best possible human resources.

When vigorously pursued, direct conversion of macroalgae into fuel represents one of the very few major options that humankind has to provide socially, economically and environmentally robust and resilient renewable fuel, whose production answers additional major human necessities rather than creating them, and with energy security that is guaranteed in a humanitarian instead of confrontational manner. With scalable macroalgae-fuel conversion technology, nations can become sustainable producers and exporters at the level of regions, cities, communities and individual citizens. This may well give rise to a paradigm shift, from the current model where fuel is provided at the lowest possible direct cost by large-scale industries, with a considerable disregard for environmental and societal concerns, to an energy system where fuel is a sustainable source of economic growth for the public that principally owns its source of energy and the benefits that come with it.

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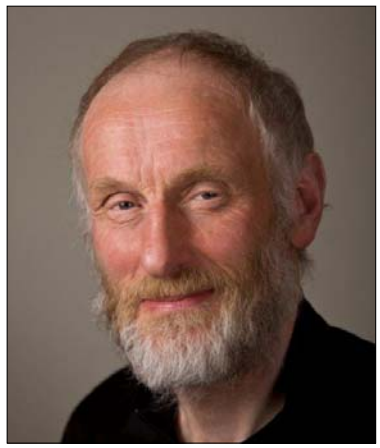
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SESSION 6

INNOVATIVE CAGE TECHNOLOGIES

Strengthening and control of cage components

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BIOGRAPHY

Name: Ludvig Karlsen
Born: 25081945
Nationality: Norwegian
Present position: Associate professor
Degrees: M.Sc., Civ. Ing. Naval Architecture and Marine Engineering, NTH, 1971

Work experience:
1972-73: Military service, Marine, HAS (Ship damage control school), Haakonsvern, Bergen
1973-74: Scientist at SFI (today Marintek), Trondheim
1975-1981: Senior Scientist at Institute of Fishery Technology Research (FTFI), Catching Division (today IMR), Bergen.
Main fields of work: Selective (shrimp) trawls, Bottom longline technology
1981-1985: Associate Professor University of Tromsø, Department of Fisheries/Norwegian College of Fisheries, Tromsø: Main teaching and research field- Fishing gear and fishing vessel technology.
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Present research and teaching activities and fields of interests:
Fish Catching and Fish Farming Technology, Underwater Technology.

Abstract

Going offshore with fish cage farming involves many challenges compared to farming activities in more sheltered waters. Although the term “offshore” for a long time have been frequently used in book titles, chapters, contributions and so on, the corresponding content very seldom have justified the use of the offshore phrase. In as well Norwegian as other North Atlantic countries salmon farming at real “offshore” sites/locations, like for instance in the offshore petroleum industry, is something we today only can “dream of”. To support this rather pessimistic statement, a map is given to show the development in farm location sites related to a typical outer coastal area topography of the west coast of Norway. However, in the struggle to be able to go “a bit more offshore”, the biggest challenge appears to be related to the strength and endurance of the main components of the farm as the cage nets, the floating structures, whatever it is circular ring or steel platform designs, and the anchoring system. Since 2004, partly as a result of many farm damages with loss of fish, Norway have a

mandatory certification system for all floating salmon cage farms, based on NS (Norwegian Standard) 9415, covering the main farm components as listed above. The main decisive parameters for the certification requirements in the standard are the significant wave height and the ocean current speed on the farm location as well as size and depth of the cages, but also water depth and bottom type and topography are important factors to include with respect to engineering and control of the anchoring system. The experience with the certification system is described in view of strengthened requirements to designs and materials for steadily increasing dimensions of the cages, both in surface area and net depth, and main problem areas which have been disclosed for more exposed farming cites, are described and discussed. In particular, bottom weighting of the cage nets by use of point weights or bottom weight rings, are both analysed and described. At the end new ideas for improved solutions and technology for offshore farming are dealt with/discussed, as well as particular problems related to fish living conditions, handling and husbandry in rough offshore conditions.

Introduction

In some ocean-based fish farming countries, including Norway, lack of available sea areas for locating farm structures in more sheltered areas like fjords and island sheltered coastlines, is becoming more and more crucial for further farm establishments. The area space problem is to a high degree also related to the very strict governmental rules for giving allowance to new farm locations, and for the rules of minimum distances between farms to better cope with infectious deceases. The crucial factor for whether more exposed and even offshore sea areas may be an alternative for salmon farming, is without doubt the sea state as expressed as maximum significant wave heights in rough or severe weather conditions. A very import factor for whether fish farming may be possible in exposed/offshore areas is thereby also the climate pattern of the country/region, particularly with respect to how strong winds that may occur and, more important, the frequency of and length of periods with strong winds. In this respect there are very big differences between the northwest-pacific countries like Japan, Korea and China and the northeast Atlantic countries like Norway, Ireland, Scotland and the Faroe Islands. For the pacific countries the Typhoons are, even though stronger, so less frequent and, not least important, so well and long time forecasted that temporary precautions with respect to the protection of farm structures is an alternative. In comparison, the more than rough enough North-Atlantic winds are, particularly in the winter period, so frequent and unpredictable that any farm at any time must be ready to face them.

To put the issue about more exposed and thereby also possible offshore locations for fish farming in a more realistic context, the typical development in farming site locations related to fjord and coastal topography in Norway is illustrated by L (location)-numbers on the schematic map showed in figure 1. Today site location L3 is the most typical and most used one, both for establishments of new farms and for farms which have been moved from earlier used L1 and L2 locations. In addition to the differences between the various sites with respect to wind fetch length, which can be seen from the map sketch, also water depths at the sites have changed dramatically from typically 20 (could be only 10 for the first farm establishments) for locations L1 and L2 to 50 to 200 meters for locations L3 and L4.

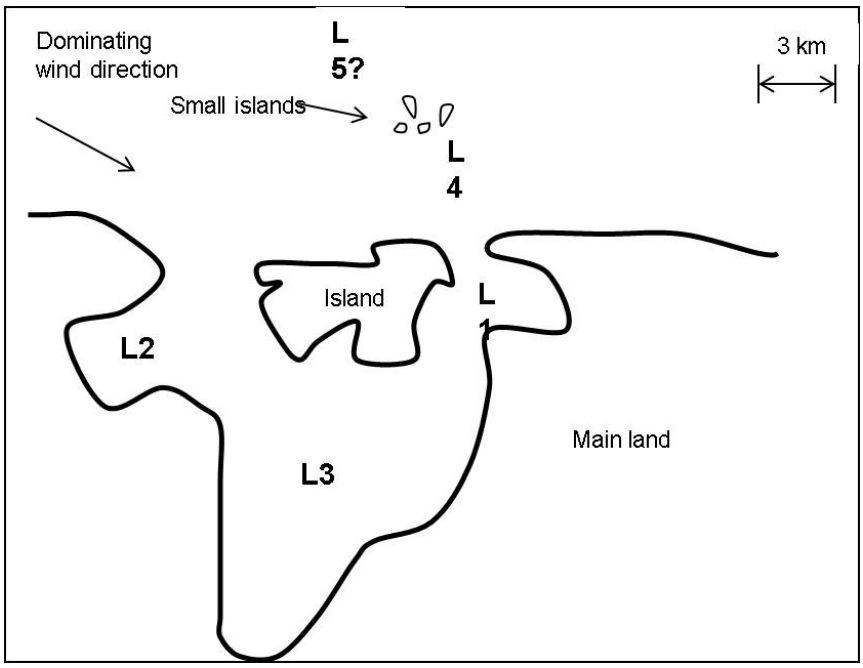


Fig. 1. Schematic map illustrating a typical Norwegian coastal area adjacent to the Norwegian Sea/Atlantic Ocean at 63o N, with given site locations for salmon fish farms. Modified from Karlsen, 2005 (3)

As indicated on the map drawing, location L5 have a question mark, indicating very strong doubts by the author whether it is possible to implement for farming in the near future. The reason is that the L5 location, although situated not so far outside the coastal line, is quite ”open” for strong winds and waves from the directions SW to NE, with no indication of sheltering devises towards these directions. On the other hand, the typical small islands inside of the site will generally not be of much help because winds from the land direction in this region are rather weak.



Fig. 2. Photograph of an existing salmon fish farm outside the North-West Norwegian coast in good weather conditions. The picture is taken in SE direction, towards mainland which can be seen in the background. The shown farm is sheltered by small islands in the SW direction but is rather more exposed towards NW (camera position), i.e. a typical L4 location where Hs possibly could be as high as 4m in severe wind conditions from NW. This farm location can by no means be said to be “offshore”.

To help to be able to make further evaluation of the possibilities for offshore fish farming in NE Atlantic waters, table 3 summarizes the (time) frequencies of observed (measured) significant wave heights, both annually and in the winter season (December-February).

Table 1. Significant wave height statistics in Western Norwegians waters (Area 4), after BMTL, 1986 (1).

Hs (M)	Annual, All directions,		December-February, All directions	
	% within Hs-	% larger than	% within Hs-interval	% larger than
0-1	9.3	90.7	4.8	95.2
1-2	27.9	62.8	19.2	76.0
2-3	27.6	35.2	25.8	50.2
3-4	17.6	17.6	21.1	29.1
4-5	9.2	8.4	13.4	15.7
5-6	4.4	4.0	7.4	8.3
6-7	2.0	2.0	3.9	4.4
7-8	1|.0	1.0	2.0	2.4
>8	1.0		2.4	

The pessimistic statement regarding (cage) farming possibilities at locations similar to L4 and L5, and particularly during the (long Norwegian) winter season, is well underlined by the Ocean Wave Statistics for Western Norwegian waters given in table 1. As can be seen from the table as many as 35.2% of the waves (all directions) in the actual waters have significant wave heights above 3m, and 17.6% higher than 4m on an annual basis, while in the Dec-Feb period the figures are even worse with 50.2% of the time more than 3m and 29.1% more than 4m.

The significant wave heights referred to, 3 and 4m, are today regarded as a maximum for reasonable safe cage farming with state of the art Norwegian farming equipment and farm running procedures.

Ocean current considerations

With respect to current velocities it is in general not so that going offshore implies higher (surface) current velocities than in more sheltered areas where farming is well established today. Looking into the Norwegian waters situation the highest currents speeds are generally found in the coastal sound areas, and most common between islands in outer fjord areas where fish farming also is well established. This is due to the big tide differences, particularly in the northern Norwegian waters, leading to very big volumes of water to run in and out of large fjords in about 6 hours intervals. The nominal offshore current running along the coastline is in general less than I m/sec. In a general view the tidal current velocities will be related to the (surface) area of the fjord inside the sound/narrow passage, divided by the passage area at the site from the surface to the bottom. In northern Norway in particular “Saltstraumen” is a well known “current”, with a maximum current speed of about 7 knots, and other areas as for instance at the outer Lofoten and other North-Norwegian islands, tidal current speeds of 3 to 4 knots is often the case. To practice fish farming in so high water speeds is recognized impossible for various reasons. No farmer would try to do it, and not only due to farm structure strength considerations. Particularly cage net deflections, resulting in reduced as well as less accessible cage volumes for the fish, is a recognized big problem in this context. In a general view a maximum ocean current speed limit of about 1 m/sec is recommended with the Norwegian state of the art technology of today. However, there are farm locations which may experience higher current velocities for shorter periods, due to particular conditions as very high water level (storm flood) and direct wind driven (surface) current in heavy weather situations. Such extraordinary current situations shall be included in the standardized requirements as referred to in next chapter.

Norwegian Standard, NS 9415

Very early in the Norwegian Salmon farming development, which started about 1070 and is today counting for more than one mill ton production yearly, needs for standardized control of salmon farms became obvious. At the first, at about the early 1980's the standard was reflecting an agreement among the producers of fish cages, of which there were very many in Norway. Although the fish farm net production was rather new, the producing companies had very long experience as producers of netting gears, first of all purse seines, for the fishing industry. In view of both time of experience as well as dimensions and design complexity, fish farm cages may appear rather small and simple compared to a large deepwater purse seine. Also with respect to lacing line ropes, particularly for the float line and ground line, both numbers of ropes and force reinforcement in the lacing/sewing processes is much more complex fo purse seines than for fish farm cages.

However, despite the more simple requirements as described, fish cages soon turned out be more disputed between producer and user than fishing gears ever were, for various reasons. And it often came to court trials due to cage and material failures, with often big losses of more expensive fish than was the case for purse seines. This situation resulted in a written standardized agreement called "Bransjestandard" in the 1980's in Norway on how to construct and make fish cages. This standard is the basis for NS9415 of today, which got its first version in 2003. The main purpose, as reflected in the additional naming of the first standard was "to prevent escape of fish (salmon) from fish farm cages", as an important measure to prevent/reduce so-called "genetic pollution" in the numerous salmon rivers in Norway. An additional governmental regulation to the standard about salmon farming states it in principle a crime to loose live salmon into the sea which also may be punished by jail.

The existing standard, titled NS 9415. E:2009 Marine fish farms Requirements for site survey, risk analyses, dimensioning, production, installation and operation was implemented in 2009, with a lot of changes and improvements compared to the 2003 standard. In the next we shall have a short introduction to the main parts of the standard and make some consideration to their importance and problematic areas.

Table 2. Main chapters/parts of NS9415

Chapter nr	Chapter heading
5	Site surveys (investigation requirements)
6	Load and load combinations
7	General requirements regarding main components of marine fish farms
8	Requirements regarding net pens
9	Requirements regarding floating collars
10	Requirements regarding rafts
11	Requirements for moorings

Of the main parts/divisions of the standard as listed in table 2, chapters 8, 9 and 11 are the main regarding the certification of the main farm parts as specified in the chapter headings, net cages, floating structures and the mooring components, and which are valid for any cage farm structure. Regarding chapter 10, feeding rafts, they are particularly considered related to their anchoring systems, as they possibly could create hazard to the other farm structures if they should "get in trouble" in rough weather, due to their very big mass and weight (several hundred tons). On figure 2 a feed raft can be seen on the picture.

Chapter 5 (of the standard): Establishment of dimensioning current velocity

In general there is a requirement that ocean current velocities and directions shall be measured by proper equipment over at least one month period. According to the standard the following multiplication factors shall be used to find the dimensioning current as a result of the return period on basis of one month's current measurement.

Return period - years	Multification factor
10	1,65
50	1,85

Determination of wind-induced ocean waves:

Ocean waves at the farm site to be approved shall either be determined by wave measurements or by calculation. As wave measurement is a rather complicated and expensive method to derive wave characteristics, in practise all wave determination on an actual farm location for certification, is made by formula calculation or determination by use of diagrams with wind speed, effective fetch length and wind duration as parameters. For the calculation the derived values are based on that the wind duration is long enough to create fully developed sea state, while in the diagram treatment the wind duration is one of the three implemented parameters.

The following formula is prescribed to calculate the adjusted wind velocity (Ua) at the site

where U10 is the "10 year wind" at the site which in general is derived from longtime wind measurements statistics at a level of 10 meters above ground.

On basis of the adjusted maximum wind velocity, Ua, and the "effective fetch length", Fe, on the site, the significant wave height, Hs, and the wave period, Tp, shall be calculated according to the formulas:

The effective fetch length (Fe) shall according to the standard be established by use of a "recognized method" and will always in fjord and island water areas be less than the nominal fetch length which is the actual distance to nearest land structure in the wind direction.

Bottom topography and type:

An investigation of bottom topography by use of detailed maps or field investigations by use of high frequency echo sounders, and bottom sediment types is prescribed in the standard.

Chapter 8: Net cages

In NS9415 the requirements to net cages are very detailed both with respect to minimum mesh strength and breaking strength of the construction ropes in the cages. To ease design and construction work for any cage size in question, the requirements are tabulated for all farm sites with maximum significant wave height of 2.5 meters and with maximum ocean current velocity of 0.75 m/sec. The principle for the calculations based on the tabulated data is to decide on the dimension grade of the (actual) cage which is reflecting the volumetric size of the cage. The dimension grade is not only determining the maximum allowable weight/biomass of fish in the cage but also the hydrodynamic area as well as eventual influence of added mass on derived forces in severe weather conditions. The main table outputs as function of the dimension grades are the minimum mesh strength of the cage webbing as function of the mesh size and the minimum rope strength for all structure ropes

of the cage net. Cages with dimensions outside the tables are classified as having 0 dimension grade, which have to be fully analysed with respect to forces and necessary material dimensions. There exist on the Norwegianmarket two analysing programs and several companies offering their engineering services for net makers as well as for floating collar producers and suppliers of anchoring systems. Several companies are also offering their services in the certification process for both producers and farmers.

Floating collars

The standard is requiring that both maximum tension forces in the bridles supporting the floater from the anchoring system as well the stress in the collar material is analysed and found not to exceed the allowable material stress for the environmental conditions (waves and current) derived on the site. The analyses and control shall include actual bridle system configuration (see figure 4) and is also implying verification of material strength and endurance when one bridle or one of the anchor lines are broken. All analyses of forces and stresses have to be adjusted for both a load factor (between 1 and 1.5) and a material factor (up to 5 for fibre ropes with knots).

Anchoring system

The standard requires a detailed design drawing of the anchoring system, including all anchor lines, buoys and bridles from the buoys connection (“connecting point”) to the floating structures. The main results from final “Anchoring report” are the tension forces in all anchor lines and bridles, as well as the necessary anchor holding capacities, the forces in the buoy lines and the buoyant capacities of the floats.

Actual salmon farm types and improvement measures for offshore farming

Today there are two dominant types of floating structures in the cage farming for Atlantic Salmon; the steal platform type (figure 3)and the circular plastic collar type (figure4).

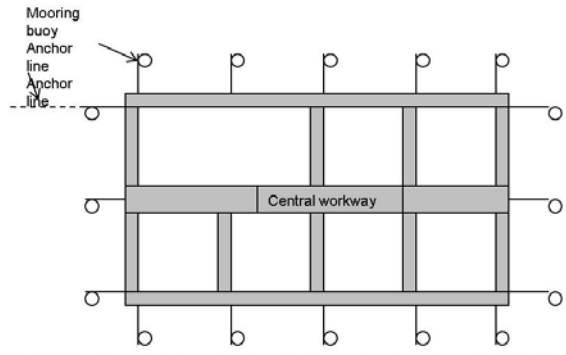


Fig. 3. Typical layout design of, and anchoring system for salmon plant steel platform.

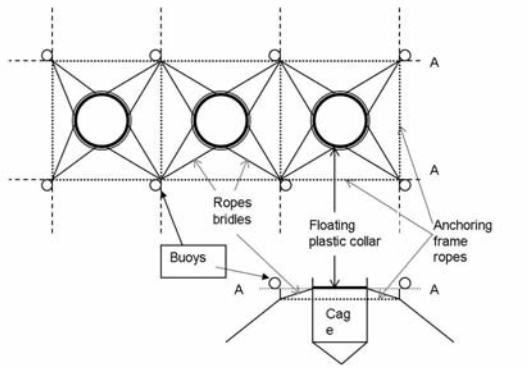


Figure 4. Standard one row mooring system design for row-mounted circular fish cages. (From **Karlsen, 2009**)

The circular ring plastic collar net cage systems are undoubtedly more robust and reliable for exposed waters as well as for potential more offshore farming, compared to the more rigid steel platform types. The main reason is that the plastic collar cage ”move and work easier with the waves”, including to a certain degree bend their shape after the wave shape during when the waves are propagating through the cages, securing a more gentle force transfer both to the net and to the anchoring system, than is the case for the platform type. The mooring system for row-arranged circular ring catches showed in figure 4 is a prosperous system also for more open sea farming. The system consists of an “underwater” rope frame, allowing for easy access for service boats to the cages, also in bad weather conditions. In addition the system counts for a flexible connection between the relative rigid system and the

cages, because the rope connection to the cage collar may be changed to the near buoy positions, near to surface. The plastic collar system configuration showed in figure 4 illustrates the internal dependencies of the three main components of a modern salmon fish farm, namely the cage net, floating collar and the anchoring system. The safety reliability of the farm as well as of the fish in it, is fully dependant of the strength reliability of all the main components.



Figure 5. Details of newest versions of plastic ring collar floaters

On the two pictures on figure 5, from the Aqua-Nor exhibition in Trondheim, are showed three new interesting details for improving plastic ring floaters for use on more exposed/offshore locations, as that both plastic pipes are icopor-filled (only one is mandatory), bottom weight rings are attached by chains going through vertical metal pipes on the clamps and bridle rope chain attachment through a bowed metal pipe on the clamp. The actual pipe diameter of the collar on the right picture 600 mm, which, with a PDR of 11, means a pipe material thickness of 54.5 mm.

Improved anchoring for offshore farms

A proposal for an improved anchoring system both for platform and plastic collar farms for more exposed and eventual offshore locations is showed in figure 6. The basic idea is to put so much flexibility in the mooring lines that even large wave generated movements of the structures are not fully stretching the lines and thereby not generating full loading on them even in very rough seas.

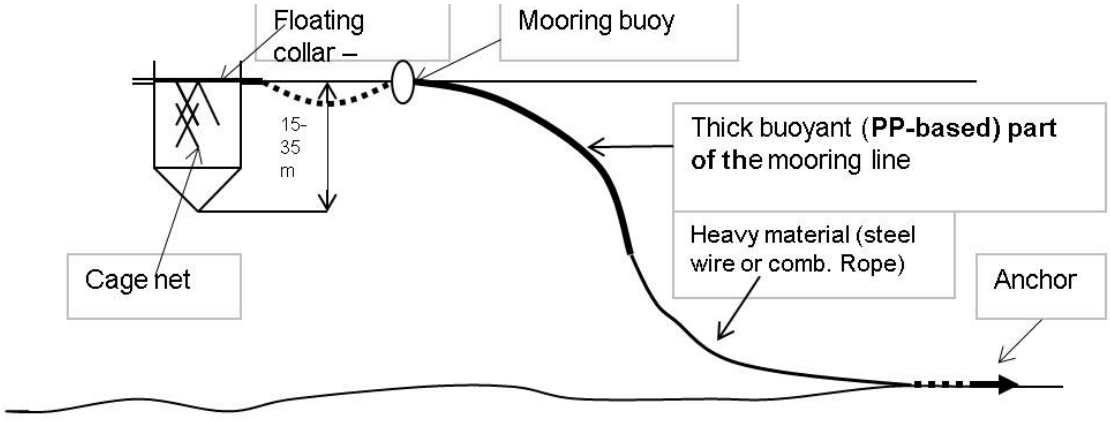


Fig. 6 Proposal (exaggerated) for mooring line design for single moored plastic ring fish farm cages in more exposed or offshore waters

Submersibles/TLC/Considerations for new solutions

For a long time various solutions for fish cages to be used in more exposed or offshore waters have been proposed/described, among them the Norwegian Ocean System barge and TLC

(submersible), the American Spar and various spherical shapes, among them one used as symbol picture for this conference, but so far without much success. When trying to find a simple explanation for why they for instance have not found any use in the Norwegian salmon (exposed site) farming in combat with the well proven (simple) floating open net cage solution, the key words could be volume efficiency, fish handling (possibility and) efficiency and also fish safety and well-feeling. Also use of breakwaters to protect farm fish cages in outer coastal exposed North Atlantic waters, which for a period was investigated on, and also used commercially in Norway (Amble, 1987), have not proved to have much future.

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Development of Shark Resistant Aquaculture Containment Nets

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BIOGRAPHIES

Felipe Ramirez

As a graduate from Florida International University in Miami, FL, where he earned his BA in International Relations in 2003, Felipe has spent his most of his career in the commercial marine and industrial markets. His career has taken him from the very north of Canada to the very southern tip of Chile, where he has seen some breath-taking sites and worked with amazingly interesting characters from all walks of life.

Along with his “Commercial Fish” team, he looks forward to being able to providing better and more sustainable ways of feeding the world with fish through using innovation to bring down some of the barriers that are impede progress in expanding aquaculture in a sustainable and responsible way for all stakeholders.

Margot van Wunnik

With a background in Analytical Chemistry and Polymer Science, Margot has worked within DSM for over 27 years, fulfilling different roles in varying R&D areas. Since 2006 Margot has been within DSM Dyneema as Application Development Specialist, with her main focus on Aquaculture and Commercial Fishing, were she has supported the development of several predator solutions.

Together with DSM Dyneema’s ‘Commercial Fish’ team, her passion lies in looking to provide innovative sustainable solutions for growing healthier fish to feed today’s and tomorrow’s population.

Abstract

Damage to aquaculture cages from predators can lead to huge economic losses by losing fish to the predator and/or allowing captive fish to escape into the surrounding environment. Finding solutions to predation problems is essential to the future of offshore aquaculture especially in warm waters where sharks are more prevalent. The prominent solution to predators is to use a secondary anti-predator net made of a thicker material than the

containment net. Using a single net that resists predator attacks is simpler and more economical. Sample nets were sewn onto 1.8m cylindrical cages, baited with fish carcasses and deployed at different locations in South Eleuthera, The Bahamas. Video cameras were also deployed to observe shark behavior, damage caused, and identify species and size of the sharks. Sample nets were attacked by nurse (Ginglymostoma cirratum), blacktip (Carcharhinus limbatus), and bull (Carcharhinus leucas) sharks that measured up 2.2 meters total length. The sharks were unable to tear the nets and only minor abrasion on a few strands was observed. This demonstrates that a single net can be used to reduce damage caused by sharks in an aquaculture cage without the use of a secondary anti-predator net.

Introduction

Predators causing damage to aquaculture cages have led to major fish losses in many locations around the world where cage aquaculture is practiced. It is most severe in areas where sharks can come into contact with aquaculture cages and are much more abundant; which occurs primarily in tropical waters. Few studies have been able to assess the extent of damage caused by shark to cages as the aquaculture industry is less developed in many of these regions. Sharks can be devastating to cages, as their serrated teeth are much more effective cutting tools than those of other predators such as pinnipeds. Sharks can easily remove large patches of netting from a cage, as in the case at the Cape Eleuthera Institute (CEI), in The Bahamas, where damage to the netting on an OceanSpar SeaStation™ 3000 was extensive in the past. About 60% of their fish were lost due to escapements through holes ripped by sharks during their grow-out season in 2008, including holes in the anti-predator net which was installed on the lower half of their SeaStation™.

DSM, a life and material science company, together with NET Systems, Inc., a leading netting company, prototyped shark resistant nets using a combination of SK75 1760dtex Dyneema® fiber with other materials (patent pending) in Ultra Cross construction (a technique used by NET Systems.) Although the prototypes tested very well in the lab, they needed to have their shark resistance tested in the field. The goal of the trial was to demonstrate that the nets can sustain severe attacks from large sharks without sustaining any tares or holes.

Methods

Prototypes nets were sewn onto bait cages at the Cape Eleuthera Institute, in South Eleuthera, The Bahamas, as seen in figure 1. The bait cages consisted of two iron rings, 0.4m in radius, connected by three spokes to an axel which was 1.8m long. The axel projected 6cm beyond the rings to allow the cages to be elevated on triangular supports were welded together to avoid twisting. The nets were sewn evenly around the rings to avoid any folding or bunching and to tightness comparable to a typical aquaculture cage. The mesh size of the nets was 42mm. Four or five pieces of bait were sewn to the inside of the cages using tarred twine. Bait included whole and half bonita (Sarda spp), whole bonefish (Albula vulpes), whole barracuda (Sphyraena barracuda), grouper (Myceropercaspp) racks, amberjack (Seriola dumerili) steaks, and lionfish (Pterois spp) racks. The circular ends of the cages were sewn shut.

The cages were deployed in January, April, and June 2011 at two different locations close to the CEI campus: The Saddle and next to the SeaStation™. The Saddle is in a dredge hole, 12m deep and roughly 20m off shore and CEI's SeaStation™ is in 31m of water and 3km off shore. With each cage deployment, an underwater video camera was also deployed to capture shark attacks. Cages were checked for bites daily by a team of SCUBA divers. If no bites were found, the divers would add fresh bait to the cages and recover the cameras. If bites were observed by the divers, the cage was recovered using lift bags, brought back to campus for photos and analysis, then re-baited and redeployed the next day. The trials lasted for 24 days.



Results

Each prototype received at least 7 bites and as many as 12. Bites were often on the same area of the cages which makes determining an exact number difficult. Nurse sharks (G. cirratum), and blacktip sharks (C. limbatus) were observed by cameras at the Saddle. The largest backtip sharks were estimated to be 180cm. Nurse Sharks, bull sharks (C. leucas) and great hammerheads (Sphyrna mokarran) were also observed at the SeaStation™ site. The largest bull shark at this location was estimated to be 220cm. The video confirmed bites from several nurse sharks and two blacktip sharks at the Saddle, and one nurse shark bite and two bull shark bites at the SeaStation™ site. Our most successful prototype showed no broken strands in the net at any point in the trial. Minor abrasions were observed at the site of bites.



Figure 2 shows the most severe damage observed during the trial.

Discussion

The findings of this study indicate that this technology is a promising solution to the predation problems that have been a major growth barrier to the growth and nuisance in both warm water aquaculture and temperate aquaculture. The SeaStaion™ at CEI has now been outfitted with the best netting construction and we continue to monitor its performance on a larger scale. A full cage trial will eliminate the effect of a curved biting surface created by the small bait cages used which may have made penetrating the nets easier as the surface fit the sharks mouths better.

The video footage confirmed bites from three species: nurse, bull and blacktip. Bull sharks are strong biters and were observed biting with a lot of effort, but a wider variety of sharks would add strength to the results. Sharks of 220cm are large but do not represent the “worst case scenario” shark. Observing bites from larger sharks would build more confidence in the nets.

The nets are designed to be single layer containment nets, which eliminate the need for additional anti-predator netting. This reduces costs and labor (cleaning and maintenance) for aquaculture operators and also reduces the drag created by an extra net, which allows more water to flow through the cage. Increased water flow can reduce parasitism, increase dissolved oxygen inside the cage, and disperse wastes more effectively.

The successful demonstration of the shark resistant properties of these nets shows that this is could be the solution to shark predation on aquaculture cages and possibly for other biting predators, such as marine mammals. The benefits of such a technology extend beyond the elimination of mortalities and escapements which makes this an attractive alternative to anti-predator nets or predator removal.

Acknowledgements

At the risk of forgetting very important people who made this possible, the authors would like to thank Karla Cosgriff and Thiago Soligo for their roles in building a partnership between CEI and DSM and NET Systems as well as Aaron Shultz for his support throughout the study. This study would not have been possible without the support of CEI’s staff especially Katelynne Wolf, Ryan Lind, Lisa Holton, Broq Maxey and the other members of the aquaculture research team, as well as Ian Hamilton and the Shark Ecology and Conservation Program.

Copper-Alloy Mesh In Offshore Aquaculture Systems – A New Net Material For Cage Farming In The Southern European Seas

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BIOGRAPHY

Prof. Dr. Murat Yigit

M.Sc.: Ondokuz Mayis University, Grad.School of Natural & Appl. Sci., Turkey (1996).
Ph.D.: Ondokuz Mayis University, Grad.School of Natural & Appl. Sci., Turkey (2001).
Research fellow: Kagoshima University, Faculty of Fisheries, Aquatic Animal Nutrition, Kagoshima, JAPAN (1998-2001).
Visiting Scientist: University of New Hampshire, Ocean Engineering Institute, Durham-NH, USA (2005).
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Profile

Dr. Murat Yigit has been working at Canakkale University (COMU), Faculty of Fisheries in Turkey since 2003, and has held respective positions as Vice Director of the Graduate School of Natural and Applied Sciences, or member at the University's Educational Commisions, and Administrative Boards. Dr. Yigit is presently the Head of Aquaculture department at COMU. He is an expert in Offshore Aquaculture Systems and Aquatic Animal Nutrition. He has been a visiting Assist.Professor at the University of New Hampshire, Ocean Engineering Institute, USA. Before he joined COMU, he has been in Japan for research in Marine Nutrition at Kagoshima University. Dr. Yigit has published numerous papers and articles based on his knowledge and experience with the aim to support the sustainability of the World Aquaculture industry.

Research Areas

Offshore aquaculture Systems, Marine Nutrition (Alternative resources & Feed optimization)

Research Emphasis

Dr. Yigit's interests are in the field of Open ocean aquaculture and Aquaculture Nutrition, and his research interests are in the areas of offshore aquaculture system developments, environmental friendly diets supporting sustainability of aquaculture industry. His current

research projects are: Open Ocean Aquaculture: Environment friendly offshore aquaculture systems; Integrated Multi Trophic Aquaculture Systems (IMTA); Marine Nutrition: Alternative protein sources potentially replacing fish meal in diets.

Courses Taught

Marine Aquaculture III SU314; Cage Farming and Technology SY5006; Trout and Salmon Culture SY5007; Flatfish culture SY6014; Digestion Physiology and Metabolism SY6003; Aquaculture Politics SY6015.

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ABSTRACT

Growth of organic matter on marine farm systems creates a variety of challenges for fish farmers. Blockage of mesh blocks water flow, which decreases the oxygen content in the cage environment, causing lower feed intake, hence slower development of fish. A sanitary environment helps to reduce stress for fish due to fewer net changes and reduced labor for cleaning. In the present study, copper-alloy nets were used in offshore type HDPE cages and investigations were made to search the durability and strength of copper-alloy nets under farm conditions. Growth performance and feed utilization experiments were conducted on Sea bass and Sea bream stocked into copper-alloy mesh deployed in a 2-bay grid in the Strait of Çanakkale, Turkey, for a period of 387 days.

Growth rates and average feed conversion ratios recorded during the growth experiment in the copper-alloy net cages were promising considering the rough weather conditions at the offshore test site.

Overall copper-alloy net material has demonstrated good performance in terms of its suitability for use in Aquaculture. During the course of the study, very limited biofouling was recorded and very limited net deformation was observed on the copper-alloy net material, presenting a promising alternative net material for the sustainability of cage aquaculture industry.

INTRODUCTION

The growth of organic matter on marine cage nets creates a variety of challenges for fish farmers. Blockage of mesh impedes water flow, which decreases the oxygen content in the cage environment. This leads to a lower feed intake, causing slower development of fish. A more sanitary environment translates into reduced stress for fish because of fewer net changes and reduced labor for cleaning.

Sea bass and sea bream are the two main species dominating Marine Aquaculture in the

Mediterranean. Turkey and Greece are the two leading countries in Sea bass and Sea bream culture in the European Aquaculture Industry. Hence, introducing any innovative method or material in the area may affect the whole Mediterranean Mariculture industry. It is also well known that Sea bream with its strong, sharp teeth can bite on the traditional nylon nets, causing damage on the net and fish may escape. Hence the use of double nets is common in the Mediterranean aquaculture industry.

Research has been conducted at Çanakkale Onsekiz Mart University in Turkey with collaboration of University of New Hampshire, Mechanical and Ocean Engineering Departments in the USA, in order to search an effective way to improve aquaculture in the Southern European Seas. The research location (Çanakkale Strait) withstands approximately 12 storms each year, resulting in three to 5m-high waves. In addition, water flows in both directions along the strait, from the Sea of Marmara to the Aegean, forcing a surface current in one direction and an undercurrent in the other. Strong weather conditions in the area require a durable material for successful fish farming.

In the present study, copper-alloy nets have been used in offshore type HDPE cages in order to investigate the durability and strength of the copper-alloy nets under farm conditions, with growth performance and feed utilization experiments on Sea bass and Sea bream stocked into copper-alloy mesh deployed in a 2-bay grid in the Strait of Çanakkale, Turkey.

MATERIALS AND METHODS

Growth Experiments

Two net pens, each with a volume of 150 cubic meter were designed as part of a collaborative research effort between the University of New Hampshire (UNH) and Çanakkale Onsekiz Mart University (COMU). The fish cages were developed to support the creation of a small scale demonstration farm, located in the Çanakkale Strait, off the coast of Çanakkale, Turkey. The surface gravity-type, octagonal shaped fish cages had a diameter of 6m and net chamber depth of 5m. Two different types of copper-alloy mesh were used in the experimentation, which will be called as Cage 1 and Cage 2 hereafter.

Cage 1 mounted with copper alloy 1 was stocked with European Sea bass (Dichentrarchus labrax) juveniles with an initial mean weight of 2g in July 2011, while Cage 2 mounted with copper alloy 2 was stocked with young Auxiliary Sea bream (Pagellus acarne) with an initial mean weight of 39 g in April 2012.

Hatchery reared Sea bass juveniles were obtained from a commercial marine hatchery (IDA Gida Co.) in Çanakkale, Turkey, and transported to the marine facilities of the Faculty of Fisheries of Çanakkale Onsekiz Mart University in Çanakkale, Turkey. After acclimation to the new environment, a total of 5000 fish (2 g initial mean weight) were transferred to the cage mounted with copper-alloy mesh.

Sea bream have been stocked into Cage 2 mounted with copper-alloy mesh from March to April 2012. Approximately 1100 Sea bream of around 30-40 g have been stocked into the cage. The experimental fish, obtained from the fishermen, were acclimatized to the culture conditions for one month. During the acclimatization period, fish were hand fed 2-3 times a day and fish behavior was monitored underwater during the feed distribution from surface. A total of 700 fish have been acclimatized in Cage 2 and are well adapted to the cage environment and feeding very well on commercial Sea bream diets. Fish were weighed and the feeding trial has been started by end of April 2012.

Prior to start of the experiment, a hundred fish were randomly sampled and weighed. Ambient water temperature ranged from 8 to 26 °C during the course of the study. Fish were hand fed

twice daily at 09:00 and 17:00 for 387 days in copper-alloy Cage 1 with Sea bass from July 2011 to August 2012, and for 125 days in copper-alloy Cage 2 with Sea bream from April 2012 to August 2012. Commercial Sea bass and Sea bream diets with optimum protein and lipid levels (P/E ratio) have been used during the growth experiments. Daily feed intake for both fish species has been recorded for growth and feed data evaluation. Feeding activity was monitored carefully to ensure an even distribution of the feed to all fish in each cage.
Besides the growth experiments, underwater monitoring of biofouling on the copper-alloy mesh and the cage conditions in terms of durability and strength have been periodically recorded by SCUBA diving activities.

Weekly - Monthly Inspection and Maintenance

All the system, including cage, net material, bridle lines and collectors are being checked by divers weekly (Fig. 1). Any problem that might have encountered is being reported immediately and necessary measures are taken accordingly.



Fig. 1. Weekly inspection of the materials in both cages.

Besides monthly inspection of the near surface parts of the system, all other mooring parts are being controlled divers monthly (Fig. 2). Any problem that might have encountered is being reported immediately and necessary measures are taken accordingly.

A heavy growth of mussels (Mytilus galloprovincialis) are present on the test farm site, and all

the ropes (bridle lines and anchor lines), with mussel growth need to be cleaned by divers every month in order to secure the safety of the entire system.



Fig. 2. Monthly inspection of the mooring system.

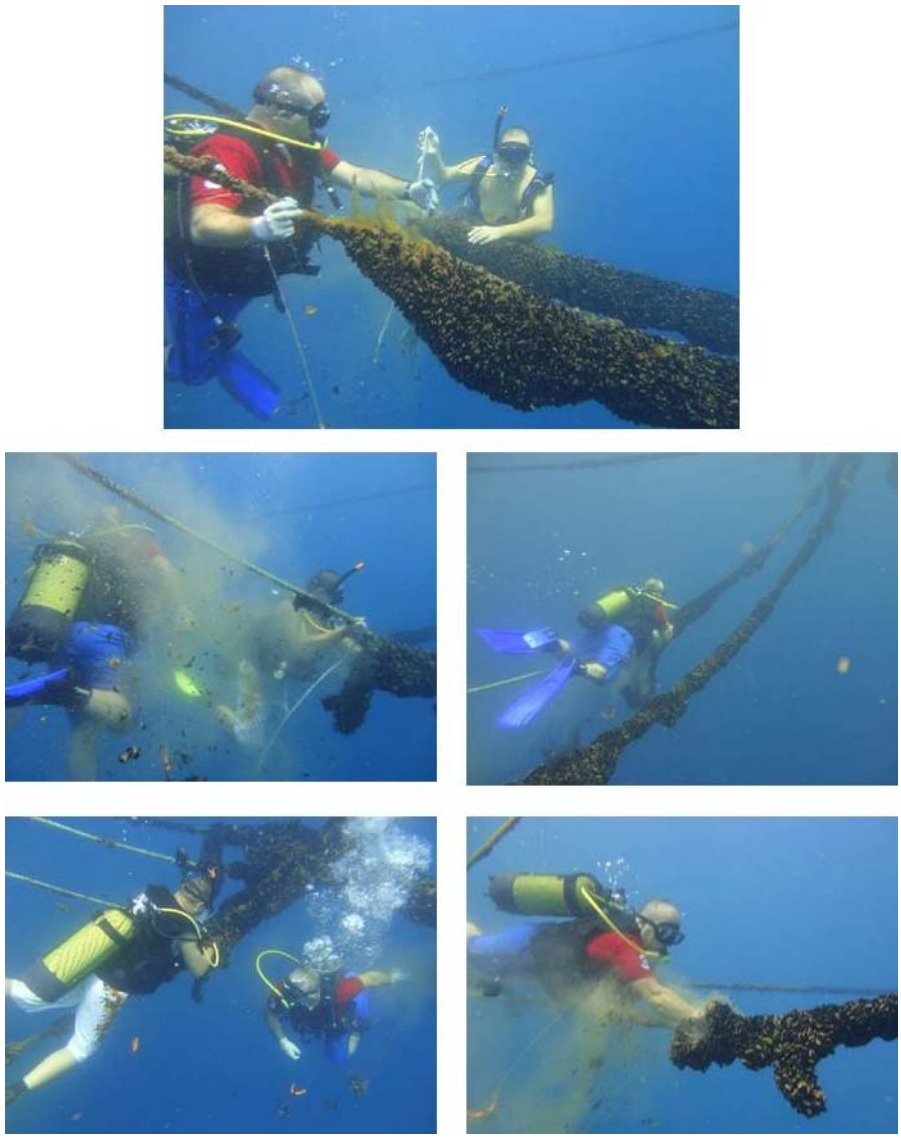


Fig. 3. Cleaning of the mooring system.

RESULTS

I - Growth Experiments - Cage 1

Experimental fish in Cage 1 has been hand fed until satiation for a period of 387 days since the start of the feeding experiment in June 2011. Growth performance and feed utilization results for the experimental periods are given in Table 1, and Fig. 4-8. A significant decrease in sea water temperature from 24 °C to 8 °C has been recorded over the winter season (Fig. 2). Despite the low water temperature recorded during the winter period, experimental fish in copper-alloy net Cage 1, still showed reasonable growth performance during the feeding periods relative to industry norms. Growth rate decreased drastically during the winter season from November to April, due to the low water temperature around 8 °C in average. However, overall growth rates and average FCRs recorded during the growth experiment in the copper-alloy net Cage 1 are promising considering the rough weather conditions at the offshore test site.

The growth performance or feed utilization indices in terms of specific growth rate (SGR), relative growth rate (RGR), and biological feed conversion ratio (FCRbio), tended to increase with the increase of water temperature starting from April 2012. Significant increase in growth

performance or feed utilization has been recorded for the summer periods as expected.

Table 1. Growth performance and feed utilization of Seabass juveniles in copper-alloy offshore cage for 387 days (means ± SD for triplicate groups), (initial body weight: 2 g)

	Periods								
	Day 25	**Day 55**	**Day 95**	**Day 125**	**Day 150**	**Day 188**	**Day 263**	**Day 312**	**Day 387**
	Aug	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Apr**	**June**	**August**
FW (g)	6.41	13.71	22.55	23.10	23.15	23.65	27.76	37.7	101.2
RGR, in periods	220.4	113.9	64.54	2.42	0.23	2.15	17.40	35.6	168.8
SGR (%/day)	4.66	2.45	1.21	0.08	0.01	0.06	0.20	0.62	1.32
RGR (%)	220.4	585.4	1027.7	1055	1057.6	1082.5	1288.3	1782.5	4960.5
TFI (%)	3.78	2.60	20.02	2.01	1.75	1.45	1.05	0.86	0.53
FCRbio	0.90	0.96	1.15	1.50	1.56	1.61	1.60	1.49	1.06

FW, Final fish weight at end of period (g)
RGR in periods, Relative growth rate (%)= [(wt at end of prd - initial wt)/initial weight] x 100
SGR in periods, Specific growth rate (%/day)= [(ln wt at end of prd-ln initial wt)/days] x 100
RGR, Relative growth rate (%)= [(final wt - initial wt)/initial weight] x 100
SGR, Specific growth rate (%/day)= [(ln final wt - ln initial wt)/days] x 100
TFI, Total feed intake (%)=[100 x (total food distributed)]/average live wt/2/days
FCRbio, Biological Feed conversion ratio= feed/wt gain

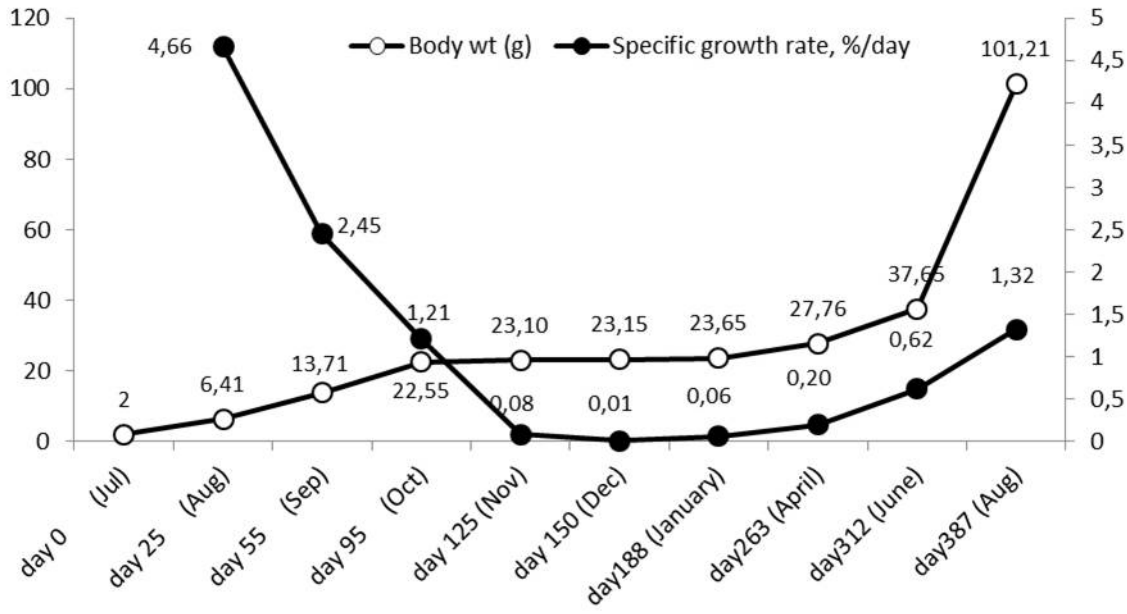


Fig. 4. Body weight and SGR of Sea bass juveniles in Copper-alloy net cage for a period of 387 days from July 2011 to August 2012.

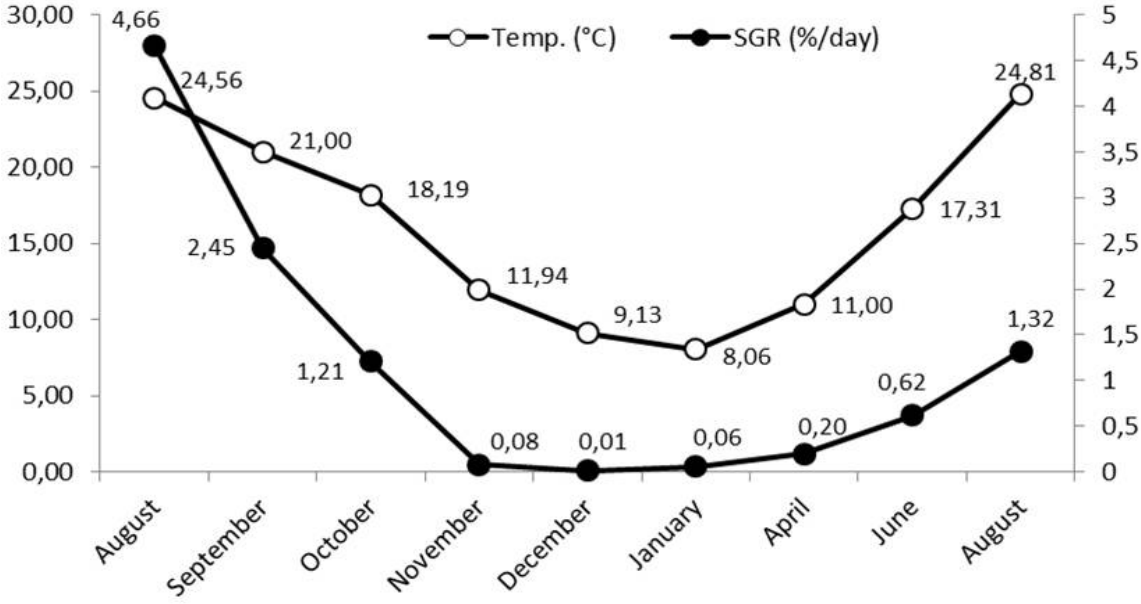


Fig. 5. Relation between temperature and SGR of Sea bass in copper-alloy net cage for a period of 387 days from July 2011 to August 2012.

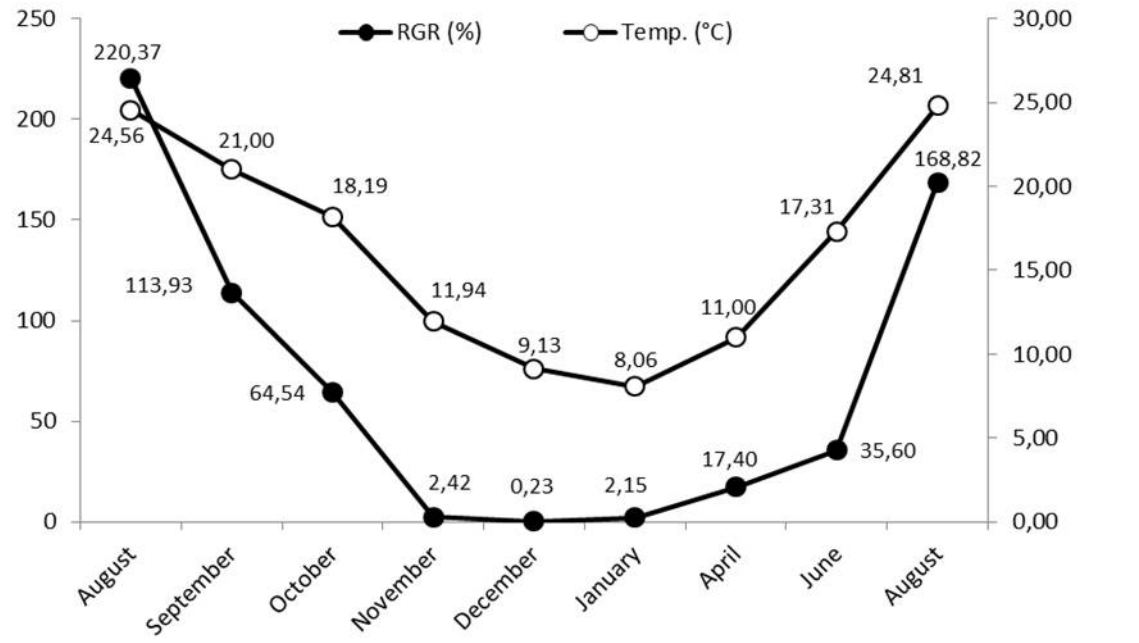


Fig. 6. Relation between temperature and RGR of Sea bass in copper-alloy mesh for a period of 387 days from July 2011 to August 2012.

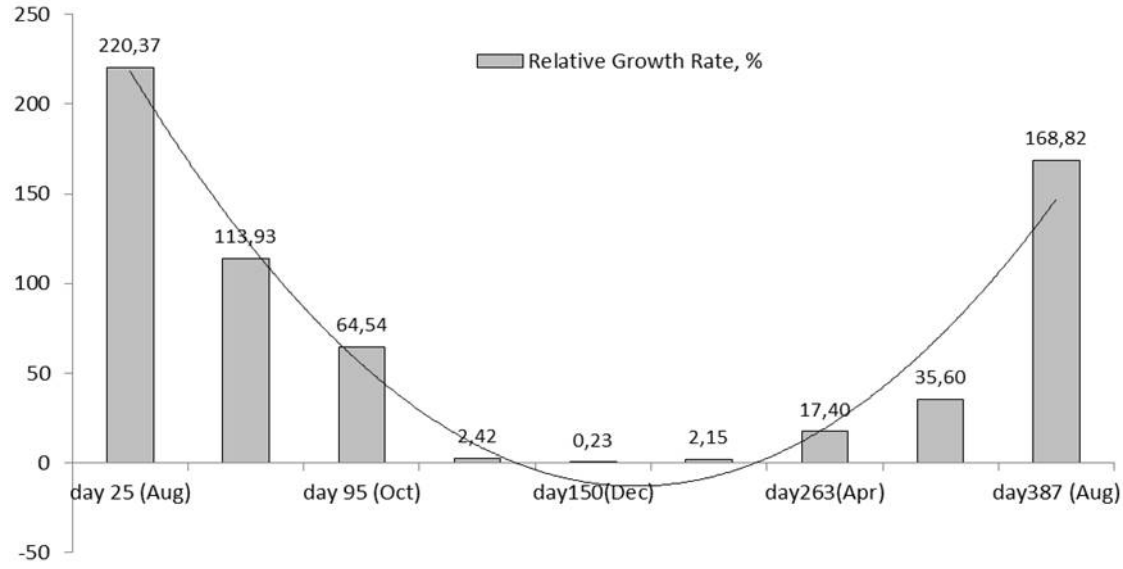


Fig. 7. Relative growth rate (%) of Sea bass juvenile's growth in Copper-alloy net cage in offshore conditions for 387 days from July 2011 to August 2012.

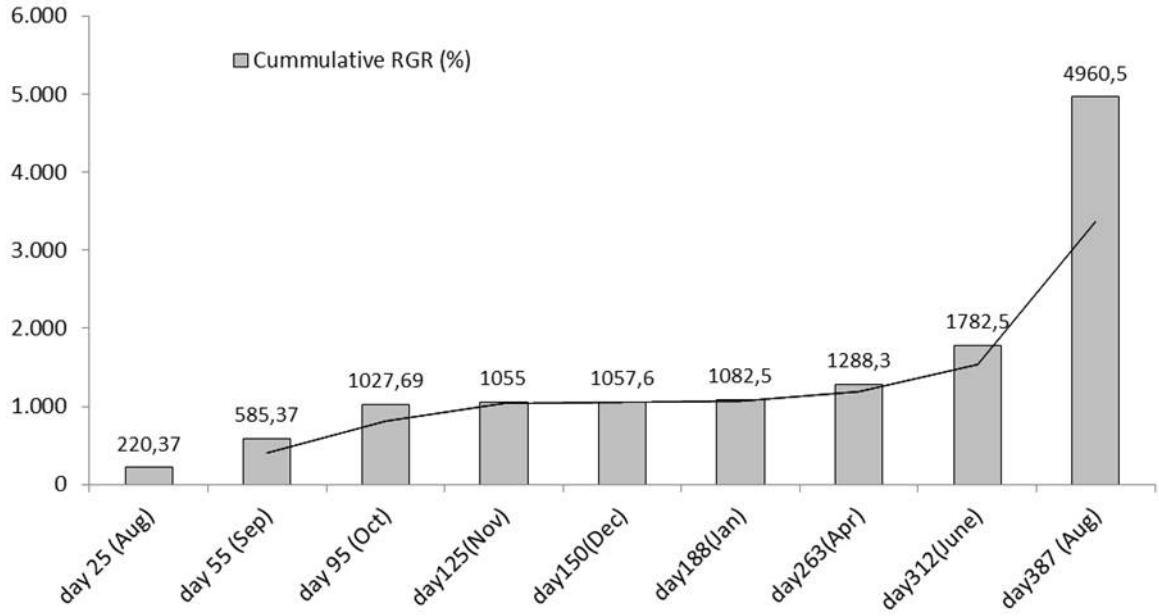


Fig. 8. Cumulative relative growth rate (%) of Sea bass juvenile's growth in Copper-alloy net cage in offshore conditions for 387 days from July 2011 to August 2012.

II - Growth Experiments – (Cage 2)

Sea bream have been stocked into Cage 2 mounted with copper-alloy mesh from March to April 2012. About 1100 Sea bream of around 30-40 g have been stocked into the cage. The experimental fish, obtained from the fishermen, were acclimatized to the culture conditions for one month. During the acclimatization period, fish were hand fed 2-3 times a day. Fish behavior was monitored underwater during the feed distribution from surface. Some fish have been lost during the adaptation period. A total of 700 fish have been acclimatized in Cage 2 and are well adapted to the cage environment and feeding very well on commercial Sea bream diets. Fish were weighed and the feeding trial has been started by the end of April

2012. Daily feed intake has been recorded for growth and feed data analyses. Prior to start of the experiment, a hundred fish were randomly sampled and weighed. The average weight has been recorded as 39.18 gram with a standard deviation of 6.38. The largest fish in the sample was 47.3 g, and the smallest one 31.4 g. The intention was to stock large size fish in to the cage, in order to avoid the long term growth period from 2-5 g to 30-40 g of fish weight that is the size when sea bream can be introduced in the copper-alloy mesh size available.

Fish were sampled and weighed periodically over the 125 days since the start of the trial. Growth and feed utilization data are given in Table 2 and Fig 9-10.

Table 2. Growth performance and feed utilization of Sea bream in copper-alloy cage for 125 days (means ± SD for triplicate groups), (initial body weight: 39.18±6.38 g)

125 days (means ± SD for triplicate groups), (initial body weight: 39.18±6.38 g)

Periods	FW (g)	RGR (%)	SGR (%/day)	TFI (%, bw)	FCRbio
Day 50 (May)	51.7	31.9	0.55	0.78	1.41
Day 125 (August)	81.41	57.44	0.61	1.04	1.86
Cumulative RGR (August 2012)		*107.8*			

FW, Final fish weight at end of period (g)
RGR, Relative growth rate (%)= [(final wt - initial wt)/initial weight] x 100
SGR, Specific growth rate (%/day)= [(ln final wt - ln initial wt)/days] x 100
TFI, Total feed intake (% body wt)= [100 x (total food distributed)]/average live wt/2/days
FCRbio, Biological feed conversion ratio= feed/wt gain

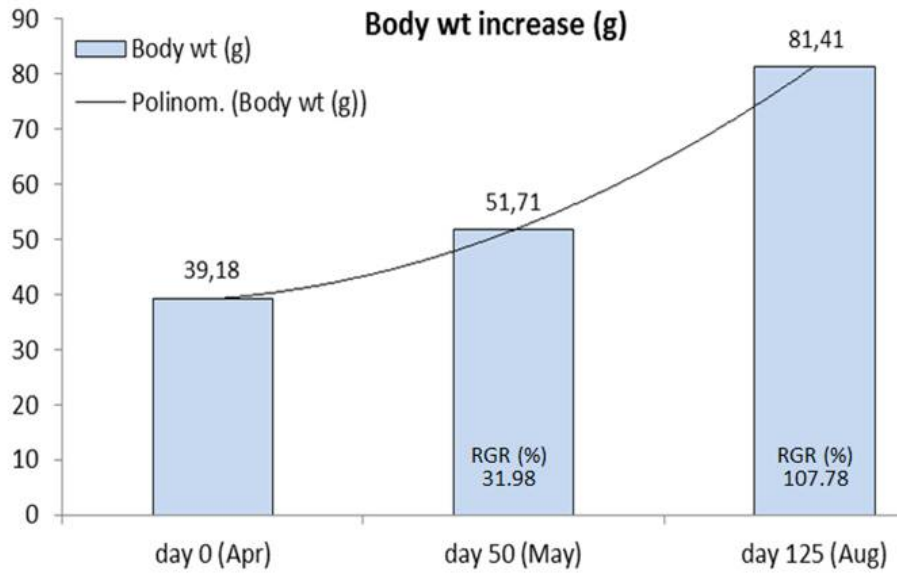


Fig. 9. Growth trend of Sea bream in copper-alloy mesh for a period of 125 days from April to August 2012. Cummulative Relative Growth Rates (RGR) given in columns.

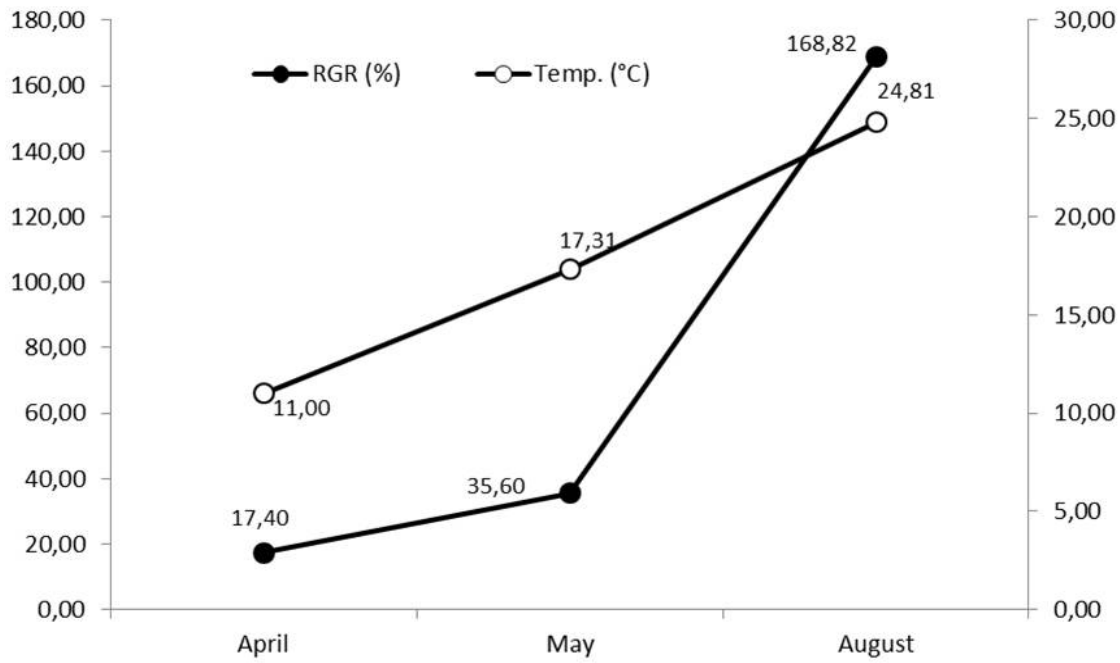


Fig. 10. Relation between temperature and RGR of Sea bream in copper-alloy mesh for a period of 125 days from April to August 2012.

III - Cage Conditions and Maintenance (Cage 1 and Cage 2)

Overall it can be concluded that there is no growth of organic matter on the copper-alloy net material used in both Cage 1 and Cage 2 since July 2011 (Fig. 11).



Fig. 11. A bridle line (rope) with mussel growth in the foreground and Copper-alloy mesh in the back ground with no growth of organic matter.

The only organism that attaches itself in between the net mesh is the Hydrozoa (Fig. 12), which then causes loss of coloration on the copper-alloy net. The mussel growth occurred at only some small parts of the nets (Fig. 13), could be attributed to the Hydrozoa serving as a host for the mussels, or mussel might have attached at those parts which have been corroded or caused to lack of coloration at some parts. It is also interesting to observe the mussel growth on the bottom panel rather than the side panels. However, overall the mesh openings were successful, and the open mesh without any bio-fouling improves better water flow, which

increases the oxygen content in the water. This may have led to a high feed intake, hence a high SGR of fish even in low water temperature during the winter season. From underwater monitoring, it can be seen that fish condition is well and no disease symptoms are available, probably due to a more sanitary environment and reduced stressful conditions.

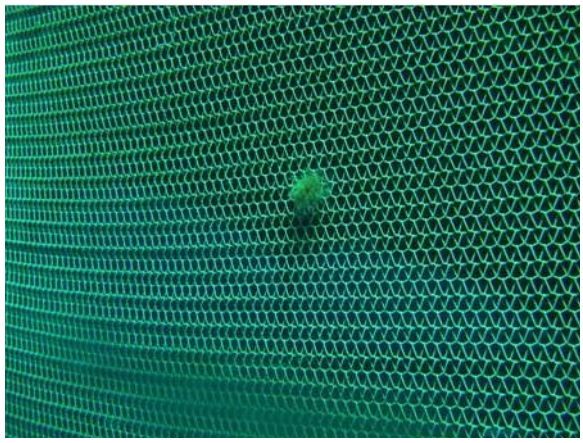


Fig. 12. A Hydrozoa on copper-alloy net material in Cage 1.

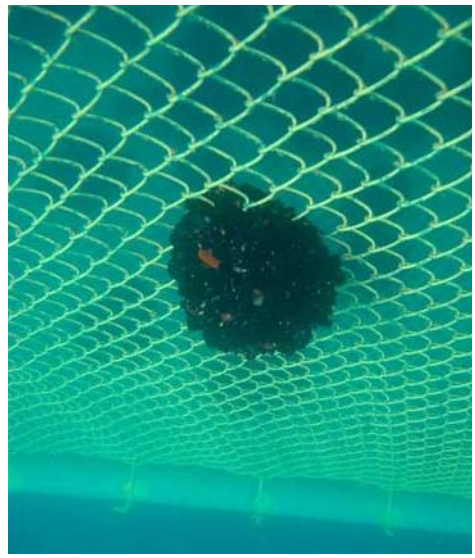


Fig. 13. Local mussel growth on copper-alloy net in Cage 2.

Periodical control of cage material underwater has shown that the material used in Cage 2, is resistant and no holes (except minor ones) have been observed so far. The diameter of the copper-alloy wire has been measured weekly in 1 m increments from water surface to 5m of depth with a caliper in both Cage 1 and Cage 2. Since the deployment of the offshore cage no significantly measureable material loss has been observed in the copper-alloy net material used in Cage 2. However, a 3-fold material loss has been recorded in the copper-alloy net material used in Cage 1.

Two different wire diameters have been used on the mesh in Cage 1, namely, a thicker wire diameter on the horizontal wire and a thinner diameter on the zigzag shaped wire. The initial two wire diameters used on cage1, have been identified and compared to the final wire diameters in Table 3.

Table 3. Comparison and Identification of Initial 2 wire diameters to the final wire diameters used in the copper-alloy mesh on Cage 1.

Wire Type	**Wire diameters (mm)**		**Max. Stress Ratio**
	Initial July 2011	Final June 2012	
Horizontal wire	2.7	2.4	1.42
Zigzag wire	2.2	1.4-1.9 (average 1.6)	3.18

The loss of material affects the bending stress and increases it more than three fold in this case. Using the simple bending stress formula:

$\sigma_b = - My / I$

and

$I = \pi r^4 / 4$

for a circular cross section we can show that for the same bending moment M the stress ratio becomes;

$(r_o / r_f)^3$

where
ro = original material radius and
rf = final material radius.

For example for ro = 2.2 mm and rf = 1.5 mm, this ratio becomes 3.18, as given in Table 3. These failures and intensive diving work for securing the fish in Cage 1 has been reported in earlier progress reports. These failures were minor at the beginning and could be fixed by divers, however, the gaps continued to enlarge and wires were broken, breaking off from the bottom rim and upper rim at many points, so that fixing required intensive diving work (Fig. 14, 15) under winter conditions in the Strait of Çanakkale. And from fish farmer's point of view, it was very difficult to secure fish in cage under these conditions. However, it is important to note that the alloy used in Cage 1 is a first generation alloy while the material used in Cage 2 was a second generation alloy. A second generation alloy for Cage 1 is being considered for retrial.

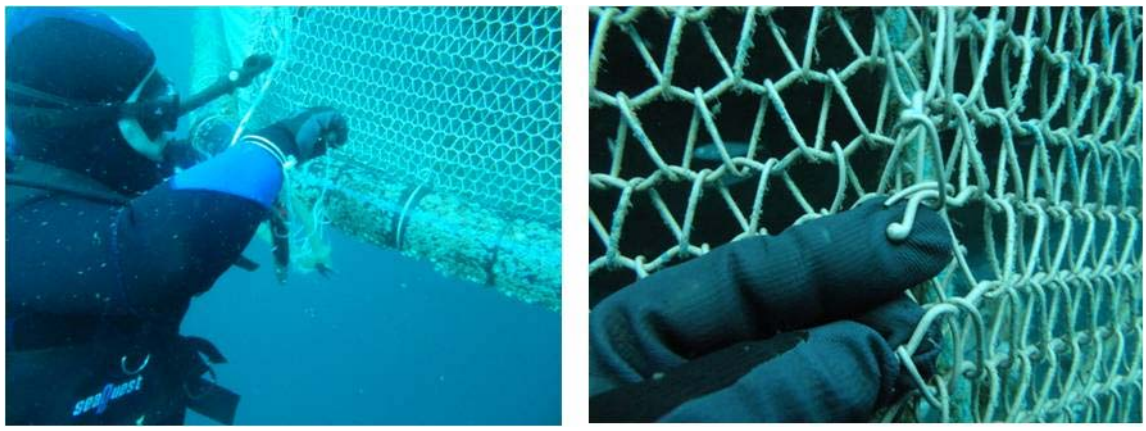


Fig. 14: Divers are repairing the failures in the copper net mesh on Cage 1 (December 2011).

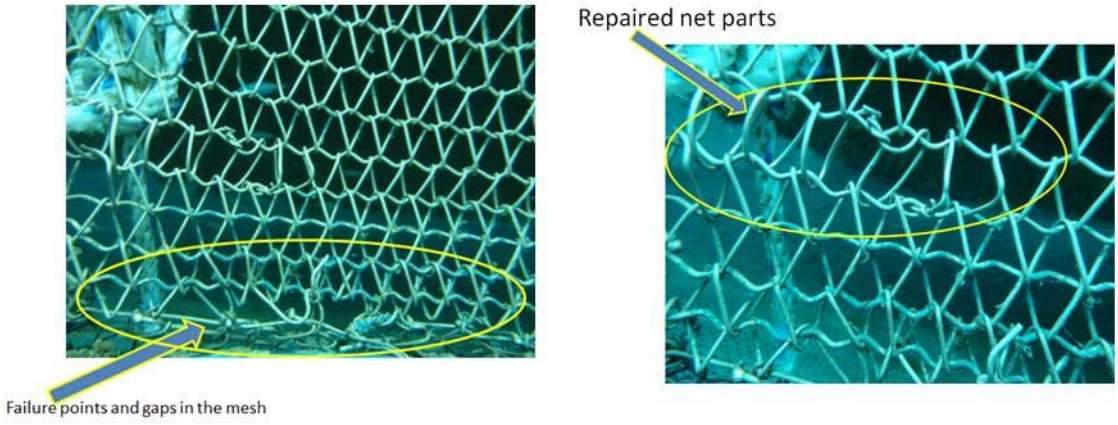


Fig. 15: Failures and gaps detected and repaired in the copper net mesh on Cage 1 (December 2011).

As mentioned earlier, no organic growth has been recorded on the copper-alloy net material used in both Cage 1 and Cage 2.

It is interesting to observe the mussel growth on the bottom panel rather than the side ones (Fig. 16, 17). However, overall the mesh openings were successful, and the open mesh without any bio-fouling improves better water flow, which increases the oxygen content in the water. From underwater video recordings, it can be seen that these organic growth at the bottom panel can easily be pulled out by divers.



Fig.16. Mussel growth on the side panel



Fig.17. Mussel growth on the bottom panel (Cage 2), August 2012.

No material loss has been recorded for the copper-alloy used in Cage 2 since the start of the experimentation and the condition of the cage is performing well, except minor failures which could easily be fixed by divers (Fig. 18, 19, 20).

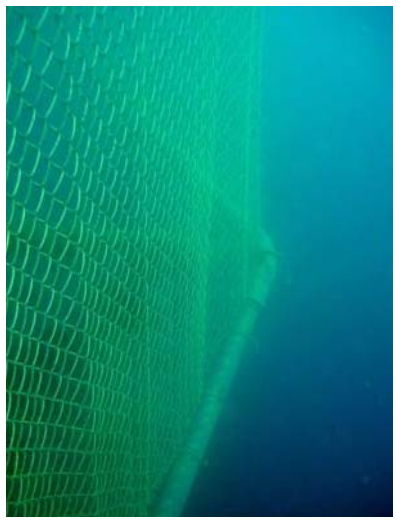


Fig. 18. Underwater views of Cage 2 in June 2012.

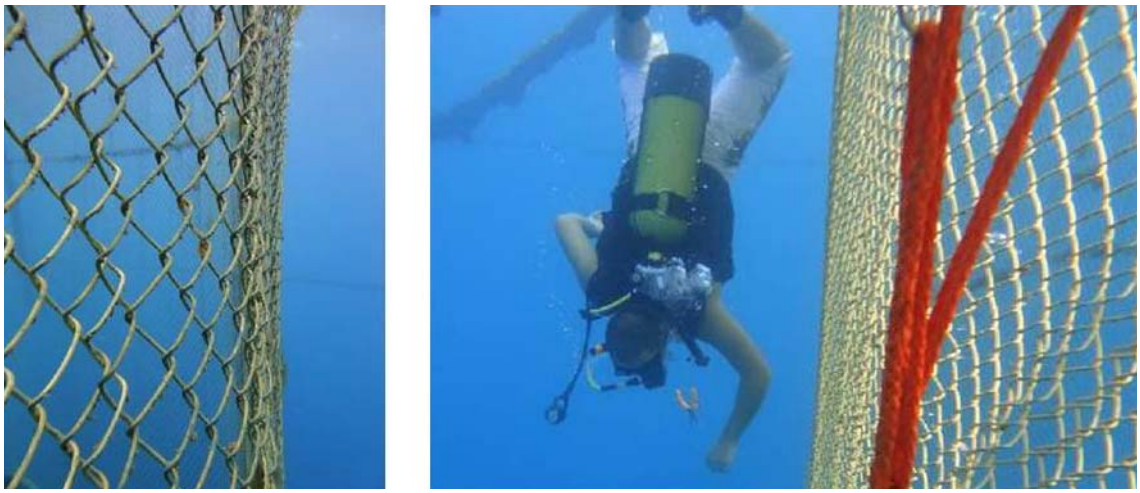


Fig. 19. Underwater views of Cage 2 in August 2012.

In Cage 2, only on one corner, the wire that is holding the net and going through the double loops around the upper pipe got broken on 2 points and some of the loops got loosen. However this was recorded once at one corner only and fixed by divers easily (Fig. 20).

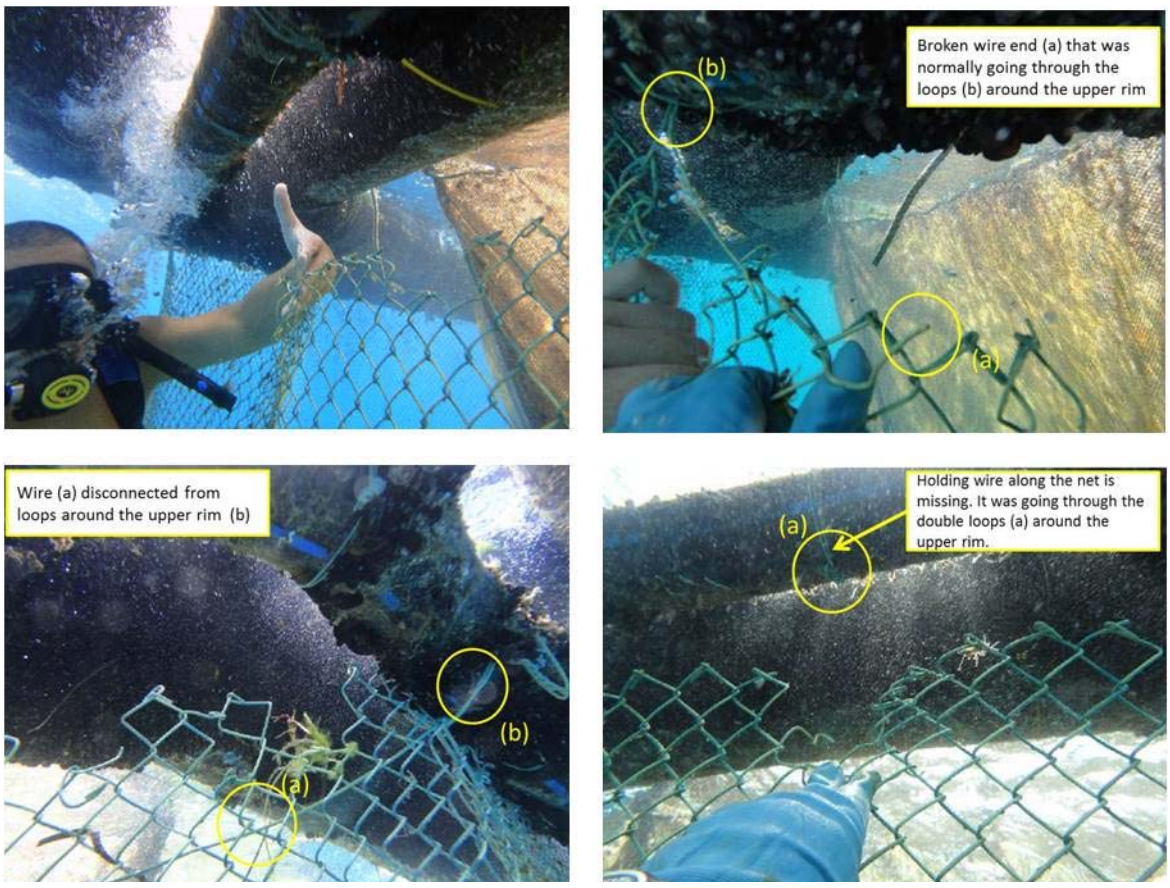


Fig. 20. Broken wire on Cage 2 at the upper rim.

DISCUSSION

It is well known that water temperature is a limiting factor for fish growth, and the decline of water temperature from 24°C to 8°C during the course of the study, influenced feed intake and

growth of Sea bass juveniles in Cage 1. However, SGRs and FCRs in the present study were relatively higher than those reported in previous studies under similar temperature conditions. Akbulut et al. (1999) reported SGRs and FCRs changing from 2.76%/day and 2.43 in August (25°C) to 0.21%/day and 2.76 in June (20°C), respectively, for seabass juveniles reared in net cages in the Black Sea (Turkey) under similar water temperatures and fish sizes. SGRs and FCRs recorded in the present study were also higher than those reported by Yildiz and Sener (2004) for similar size seabass juveniles even under higher water temperature conditions compared to the present study. In an investigation conducted on a commercial seabass cage farm located in the Aegean Sea (Izmir, Turkey), Hossu et al. (2005) reported SGRs and FCRs of 1.4-1.7%/day and 1.29-1.59, respectively, for seabass juveniles reared under higher water temperature conditions (Aegean Sea) compared to the present study in the Strait of Çanakkale. Baki and Kalma (2010) reported mean values of 0.41%/day, 50.63% and 3.41 for SGRs, RGRs and FCRs, respectively, in seabass reared in the Black Sea (Turkey), under water temperatures ranging from 9°C to 22°C. The discrepancies recorded for growth data and feeding rates between January and March could be attributed to the very low water temperature during these months when compared to the southern water temperatures in the Aegean. Hence the data for February and March have not been reported here. Similar discrepancies for SGRs or FCRs in Seabass grown in waters with relatively low temperatures have been reported by Akbulut et al. (1999) in the Black Sea, where the authors reported SGRs of -0.18, -0.07, 0.05, 0.08 %/day from January to April, and the FCR could not be calculated or estimated for December, January and February. The lowest water temperature reported by Akbulut et al. (1999) was 7.9°C in March, and increased to 9.9°C in April and 15.3 °C in May, where the SGRs tended to rise again with the increase of water temperature. Similar results were observed in the present study, with the lowest water temperature of 8.06°C in January, and the increase of water temperature to around 11°C in April has also induced RGR and SGR which were low over the winter period.

In general, findings in previous reports are lower than those of the present study in terms of SGRs, RGRs, or FCRs when compared under similar water conditions. Feeding rates recorded in the present study fell within the range reported by Hossu et al. (2005) in Sea bass juveniles with average body weight of 1.4-1.8 g.

CONCLUSION

Overall, copper-alloy net material has demonstrated good performance in terms of its suitability for use in Aquaculture. During the course of the study, very limited biofouling was recorded and very limited net deformation was observed on the copper-alloy net material, presenting a promising alternative net material for the sustainability of cage aquaculture industry.

ACKNOWLEDGEMENT

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The Prospect of SPM Cages for Offshore Mariculture

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BIOGRAPHY

Mohamed Shainee, BEng. (Hons.), MSc., MMM., has over 10 years of experience in the technical, business and policy related areas on fisheries and marine resources in the Maldives, which is his home country. He has worked as the advisor to the Minister of Fisheries; Managing Director of the largest public company (Maldives Industrial Fisheries Company); and as a civil servant in charge of the fisheries and marine technology related areas in the Ministry of Fisheries and Agriculture, Maldives. Academically, he is currently undertaking a PhD in offshore fish cage designing in NTNU, Norway; holds a Masters in Marine Management from Dalhousie University, Canada; MSc. in Marine Technology from NTNU, Norway; and BEng. (Hons.) in Marine Technology from University of Plymouth, UK. He also has been actively working as a national and international consultant in the environmental projects, including carrying out some of the largest EIAs in the Maldivian coastal development projects.

Abstract

Catering the demand for food is very much a technological challenge, as it is a socio-political challenge. The technological challenge is to find a viable solution for mariculture development in energetic offshore waters. At present there are only few successful cage design concepts operable in offshore conditions. In a series of recent works by the authors, the single point mooring (SPM) cage concept has been identified as a potential mariculture cage concept in offshore waters. In the meantime, SPM fish cage systems for offshore fish farming are gaining support for its environmentally friendly and economically favorable characteristics. The success of self-submersible SPM cage concepts depends on the operational performance in an offshore environment. It is well established that excessive current on a single point moored structure will trigger submergence as the drag on the system increases. However, for the purpose of fish production, it is also important that the cage system is able to submerge during increased wave heights to avoid volume reduction within the cage and to avoid high circular or orbital water motion experienced beneath a wave crest or wave trough. Therefore, by using a numerical code, Aqua-Fe, the paper will investigate the submergence characteristics of the SPM cage system in random wave regimes with current to confirm if SPM cage concepts respond as effectively to such waves as in the case of regular wave regimes with current.

1. Introduction

World food production is now consistently outpaced by consumption (Hanjra and Qureshi, 2010). The human population has reached 7 billion in 2011, putting more pressure to increase the food production to meet the demand. A key challenge, therefore, faced by the society and science is to increase the food production to meet the food demand for humanity. Amongst the major food producing sectors, agriculture is currently by far the main provider, contributing about 98% to the total food production (Duarte et al., 2009). However, the limitation in fresh water resources (Rijsberman, 2006; UNESCOWWAP, 2009; Yang et al., 2003) and land availability for agriculture production are realized amongst some of the bottlenecks to continue to cater for the demand from the increasing population.

Fisheries or more specifically capture fisheries are even less a contender as the key global food source for the increasing population. While there are some ambiguities on the definite status of world fishstocks (see (Shainee et al., 2011b) for details), it can be safely argued that the world fisheries have little, if any, room for further expansion (Olsen et al., 2008), and food production from the wild is likely to remain at best static for the foreseeable future (Bostock et al., 2008).

Based on this scenario, the solution to the problem of food shortage is to enhance the production from aquaculture that does not either depend on the wild fish harvest, or available fresh water supply or diminishing cultivable land. Given that near-shore aquaculture shares a narrow coastal strip of water with other public and private coastal users, it is often in direct competition with other natural and societal coastal services such as fisheries, infrastructure and leisure activities (Baldwin et al., 2002; DeCew et al., 2005; Duarte et al., 2009; Naylor et al., 2000). Therefore, the way forward is to make use of the 90 percent of the world's ocean space that does not currently contribute significantly to world food or seafood production, which also provides the scope for limitless expansion (Corbin, 2007). Hence, many authors suggest that moving further offshore is the most viable solution (Marra, 2005; Olsen et al., 2008; Shainee et al., 2011a), which also will cause less environmental concerns (Marra, 2005; Shainee et al., 2011a) compared to inshore or coastal aquaculture.

This creates an overall interest and justification for investments in offshore aquaculture, although there are currently very few offshore cage systems that are suitable for widespread use. Therefore, the aim of the current research is to add to the previous work in investigating the prospect of single point mooring (SPM) cage systems in offshore mariculture by analyzing the cage system in random waves. The paper first summarizes the work carried out to derive the concept of SPM cage systems, and then presents the results of numerical simulations, showing the submergence characteristics of the cage concept. This is in order to show its potential to be a viable cage concept for offshore mariculture.

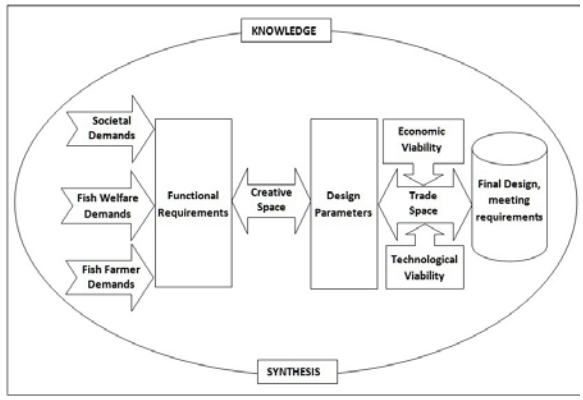
2. Some Recent Work on Aquaculture Cage Designing

The concept of SPM cage system was derived through an on-going PhD study of the first author. The overall aim of the research is to find a viable cage design concept for mariculture. Therefore, an attempt was first made to formulate a framework (Shainee et al., 2011a) in order to conceptualize a design of a cage system. Next, the framework of design (see Fig. 1) was applied to derive requirements and to identify technical components for designing a sustainable cage system (Shainee et al., 2011b). Then, the focus of the research was to derive a cage design concept that can function efficiently (Shainee et al., 2012b). The following is a brief overview of these steps.

2.1 Theory of Design

As elegantly stated by (Suh, 1990), design may be formally defined as "the creation of synthe-

sized solutions in the form of products, processes or systems that satisfy perceived needs through the mapping between the functional requirements in the functional domain and the design parameters in the physical domain, through the proper selection of design parameters that satisfy functional requirements". Applying design theory and principles to fish cage designing, the work clearly suggested that there is a need to further expand aquaculture production. Further, the possibility of moving further offshore is far too attractive to avoid or delay dealing with the challenges of severe offshore conditions (Shainee et al., 2011a). The paper outlined a framework for designing aquaculture cage systems (Fig. 1) and pointed out that the most prominent cage design concept would be a system placed in offshore waters with optimum biological conditions which provides both the best structural integrity to the system as well as welfare for the fish and the farmer.



2.2 Cage Design Requirements and Technical Components.

Following the framework for designing, systems engineering principles were then adopted to derive requirements and to identify technical components for designing a sustainable offshore cage system (see (Shainee et al., 2011b). Systems engineering practices offer a methodical and well disciplined approach for the design, realization, technical management, operation and retirement of a system (Faust et al., 2011). The results can be quantified and the general process is well recognized amongst the fellow designers. The paper identified the key stakeholders and their needs, and established the following five measures of effectiveness (MOEs), which were derived by reviewing the guiding and source documents, and further by identifying those requirements without which the design will not be acceptable:

1. The designs shall not harm the fish farmer in the performance of routine tasks.
2. The designs shall not compromise the production due to difficulty in access for the performance of routine husbandry tasks.
3. The designs shall be technologically achievable solutions.
4. The designs shall be economically feasible solutions.
5. The designs shall be acceptable with respect to the natural environments.

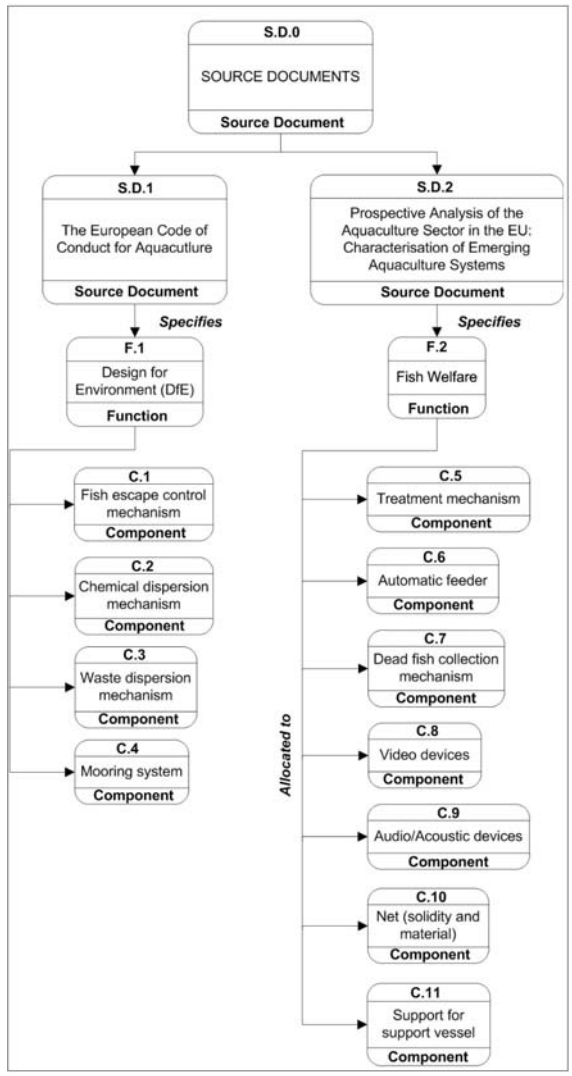


Fig. 2 Requirement traceability information model (Shainee et al., 2011b).

Artifacts of model-based systems engineering

provided a repository of information for the designer (as indicated by the requirement traceability information model (see Fig. 2)), and a communication mechanism for validating the requirements with the stakeholders.

2.3 Formulating a Design Concept

Artifacts of model-based system engineering formed a requirement baseline for designing offshore fish cage systems. Therefore, existing offshore design concepts were reviewed and analyzed to derive a potential cage design concept for offshore mariculture. The paper (Shainee et al., 2012b) claimed that the current offshore cage designs follow the hypothesis that the optimal design of an offshore fish farm is mainly related to finding the best solution to structurally resist the severe environmental conditions. However, based on previous studies by the authors, the paper outlined that the ability to reduce the energy, such that the cages offer a stable and safe environment for the fish and the farmer should also be a key design criterion. Hence, the safety and welfare of the fish and the fish farmer should be given at least the same priority as the structural integrity of the system. Categorizing and analyzing the existing cage design concepts (see Table 1) through a panel of experts, the paper concluded that SPM self-submersible cages represent a viable design concept in offshore mariculture.

3. Self-Submersible SPM Cage System – The Concept

Class	Type	Definition
Cages designed to resist and dissipate detrimental environmental forces.	Gravity type floating net cages	Systems designed to be wave compliant
	Floating rigid cages	Systems designed to be robust and sturdy enough to resist severe environmental conditions
Cages designed to avoid detrimental environmental forces.	Submersible cages	Systems designed to be operated on the surface most of the time, and submerged during severe environmental conditions
	Submerged cages	Systems designed to be operated below the surface most of the time, and surfaced for necessary husbandry tasks.
	Single Point Mooring (SPM) self-submersible cages	SPM systems designed to be operated on the surface most of the time, and able to self-submerge during severe environmental conditions

The aim of the self-submersible SPM cage system proposed is to harness the advantages offered by both SPM and submersible cage systems. The main advantage of submersible cage systems is the ability of the cage to be submerged during severe weather in order to reduce the wave induced forces on the system. The main advantage of the SPM cage system would be to reduce the environmental impacts (Goudey, 2002; Goudey et al., 2001). In submersible cage systems, including most of the SPM submersible cages proposed to date, the cage is generally submerged by automatic or manual ballasting and de-ballasting. The need for intervention in order to submerge the cage either by human or automatic control increases the complexity and cost of operation. Therefore, self-submergibility of the proposed system is an added bonus to the SPM cage design concept.

Single point mooring is the key to self-submergence. In such a system the forces acting on the cage system and the mooring itself are focused to the mooring point, where a resultant force, FH, is effectively decomposed into the tension, T, in the mooring line and a vertical downward force component, FV, at the mooring point (see Fig. 3). Therefore, a cage system can be designed such that the reserve buoyancy (excess buoyancy after compensating for the weight of the net, sinkers and other parts of the cage) is set to be less than the vertical downward force component resulting from a prescribed environmental condition that could inflict damage to the system or hinder the welfare of the fish.

As detailed by (Shainee et al., 2012a), the success of self-submersible SPM cage concepts depend on the operational performance in an offshore environment. It is well established that excessive current on a single point moored structure will trigger submergence and further

submerge as the drag on the system increases (DeCew et al., 2010). However, for the purpose of fish production in offshore waters, it is also important that the cage system is able to submerge during increased wave heights, to avoid volume reduction within the cage and to avoid high circular or orbital water motion experienced beneath a wave crest or wave trough. Higher relative motion may cause damage to the fish due to contact pressure from the net, which may further cause osmotic trauma and mortalities.

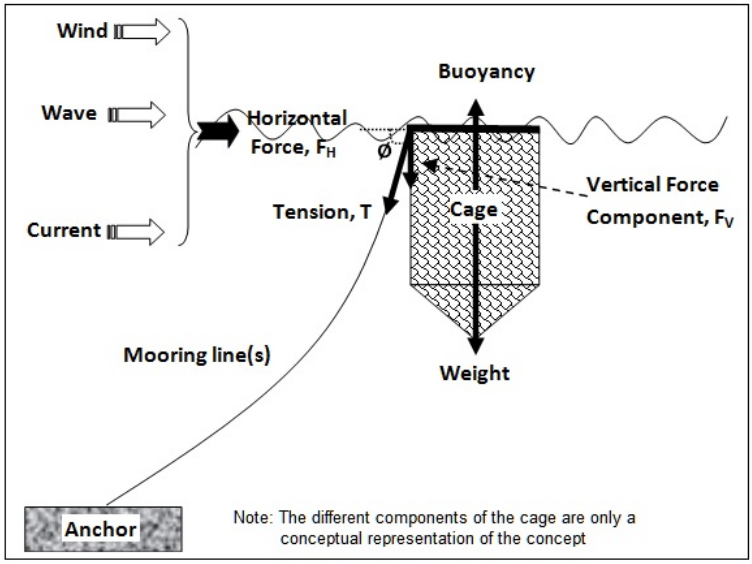


Fig. 3 A schematic representation of a SPM selfsubmersible fish cage (Shainee et al., 2012b).

It has been documented that fish, like salmon, which is by far the most important farmed species in Norway and the dominant global production of fish in sea-cages, avoid the energetic surface layer during stormy weather and dive deep into the cage (Anras et al., 1999). In fact, this behavioral response is so strong that it overrides vertical distribution towards other favorable environmental variables such as temperature and light (Oppedal et al., 2011). Further, new studies with more accurate experimental set-up have demonstrated that the submergence of salmon to shallower depths for 2-3 weeks will not considerably impact the growth or compromise the welfare of the fish (Dempster et al., 2008; Dempster et al., 2009). Several other fish species have already been successfully farmed in submerged and semi-submerged conditions (Dempster et al., 2009).

Therefore, for effectively utilizing the self-submergible SPM cage concept at offshore sites, it is important that the system achieves submergence for increasing wave heights. Consequently, the system should be able to reach equilibrium at a depth that is appropriate for the fish being cultured. Hence the submergence characteristics of the system should be predictable and controllable so that the operator or designer can tune the cage design to the environmental and biological conditions of the relevant site.

4. Numerical Simulation of the Self-Submersible SPM Cage System

In order to investigate the submergence characteristics of the self-submersible SPM cage system, the hydrodynamic forces acting on the system need to be determined. Though hydrodynamic analysis of offshore structures is a mature engineering discipline, similar analysis for aquaculture cage systems is still an evolving science. However, there have been many studies, numerical, scaled experimental modeling and in-situ measurements, in order to investigate the response of aquaculture cages to current and waves using different methodologies. One fundamental step is to determine whether viscous effects or potential flow effects are the dominant forces acting on the structure. If the design wave height (H) and wave length (λ) is 10 and 5 times larger, respectively, compared to the characteristic cross-sectional dimension (D) of the offshore structure, the structure can be considered to be a small body, where the assumption is made that the presence of the structure in the fluid flow does not influence the flow itself (Faltinsen, 1990). In this case, a modified Morison equation can be utilized to estimate the hydrodynamic forces acting on the structure.

4.1 Description of the Numerical Model, Aqua-FE

The Aqua-Fe numerical code, developed at the University of New Hampshire, USA, is a finiteelement computer program developed specifically for open ocean aquaculture applications. Truss, buoy, cable and net elements are incorporated into the program to model various parts of the marine structures and mooring systems. Hydrodynamic forces on the structural elements are calculated using the Morison equation which is modified in order to account for the relative motion between the structural element and the surrounding fluid as described by (Haritos and He, 1992), where the fluid force per unit length acting on a cylindrical element is represented as

$$\mathbf{f} = C_1\mathbf{V}_{Rn} + C_2\mathbf{V}_{Rt} + C_3\dot{\mathbf{V}}_{n} + C_4\dot{\mathbf{V}}_{Rn} \quad \text{----------} \quad (1)$$

where VRn and VRt are the normal and tangential components of the fluid velocity relative to the structural element, n V is the normal component of the total fluid acceleration and Rn V is the normal component of fluid acceleration relative to the structural element. Bold letters are applied in order to denote vectors and matrices. The coefficient C1 is given by1/2ρwDCnVRn; the coefficient C2 = Ct; C3 = ρwA; and the coefficient C4 =ρwACm. D and A are the diameter and the cross-sectional area of the element in the deformed configuration, ρw is the water density, Cn and Ct are the normal and tangential drag coefficients, Cm is the added mass coefficient. Note that Cn and Cm are dimensionless, while Ct has the dimension of viscosity.

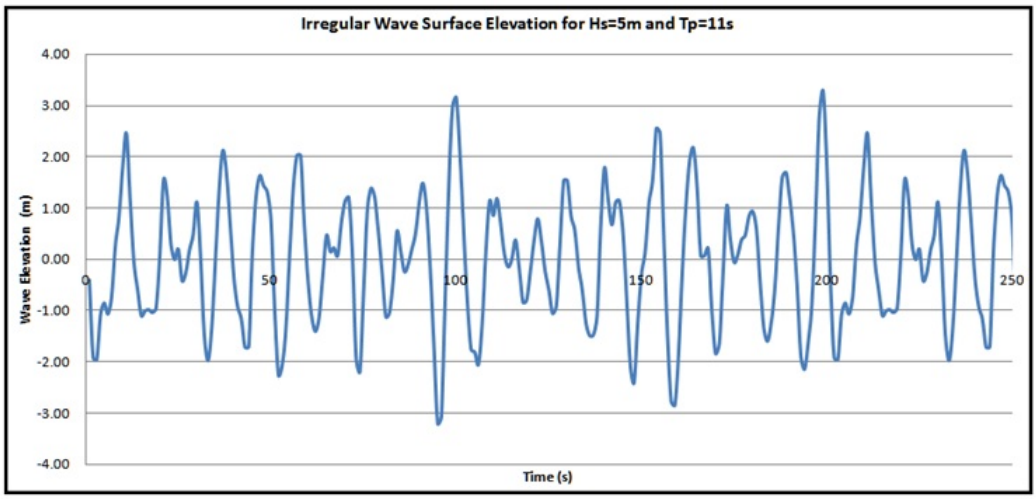
Aqua-Fe has been extensively applied to various open ocean fish cages and mooring systems and validated by comparison with physical modeling results and field data (Tsukrov et al., 2005). In Aqua- Fe the loading includes current and waves modeled by linear (Airy) or 2nd order Stokes theory. For the simulations of irregular or random waves, input time series are first generated using the random phase approach. The surface elevation (η) as a function of time (t) was calculated as a superposition of 100 single monochromatic waves having random phases (εj) according to

$$\eta(t) = \sum_{j=1}^{n} a_j \cos(\varepsilon_j - \omega_j t) \quad \text{----------} \quad (2)$$

Where $\omega_j = 2\pi f_j$ are the radian wave frequencies. The amplitudes (a_j) were obtained using

$$a_j = \left(2S(f_j)\Delta f\right)^{0.5} \quad \text{----------} \quad (3)$$

Where S(fj) is the wave spectral density, and fj is the wave frequency (ranging from 0.05 to 0.6 Hz) with ▲f of 0.005 Hz. The result of this computation for Hs=5m and Tp=11s is shown on Fig.4



Time trace of the input random wave used in simulations.

Aqua-FE calculates both the normal and tangential drag coefficients, at each time step, based upon the value of the Reynolds number (Ren) as described below (Choo and Casarella, 1971).

$$
\begin{aligned}
C_n &= \frac{8\pi}{\mathrm{Re}_n\, s}(1-0.87s^{-2}) && (0<\mathrm{Re}_n\le 1);\\
C_n &= 1.45+8.55\mathrm{Re}_n^{-0.90} && (1<\mathrm{Re}_n\le 30);\\
C_n &= 1.1+4\mathrm{Re}_n^{-0.50} && (30<\mathrm{Re}_n\le 2.33\times10^5);\\
C_n &= -3.41\times10^{-6}(\mathrm{Re}_n-5.78\times10^5) && (2.33\times10^5<\mathrm{Re}_n\le 4.92\times10^5);\\
C_n &= 0.401(1-e^{-\mathrm{Re}_n/5.99\times10^5}) && (4.92\times10^5<\mathrm{Re}_n\le 10^7)
\end{aligned}
\qquad \text{----------} \qquad (4)
$$

$$
C_t = \pi\mu(0.55\mathrm{Re}_n^{1/2}+0.084\mathrm{Re}_n^{2/3}) \qquad \text{----------} \qquad (5)
$$

where, Ren = ρwVRnD/μ and s = -0.077215665+ln (8/Ren). The model also incorporates the buoyancy, weight, inertia and elastic forces of the element. More details of the numerical procedure implemented in Aqua-Fe are described by (Tsukrov et al., 2003; Tsukrov et al., 2005).

4.2 Description of the Cage System

Since the aim of the current work is to investigate if the self-submersible SPM cage concept can be efficiently used in offshore conditions, very little effort was spent towards the detailed design of the cage system. However, some effort is associated with analysis of the main characteristics of a design that is applicable to the particular type under investigation. As such, the cage system (illustrated in Fig. 5) is made of two smaller 10-sided polygons constituting the top and bottom frame, and with 2 larger 10-sided polygons at the middle part. The idea is to have as small a cross-section as possible in the high energy surface layer, while providing a nearly vertical wall in the middle for the fish to swim around more naturally. The slanting at the upper part of the cage allows further reduction of the drag forces. The corners of the polygons (10m apart, vertically) are connected by vertical tubes, giving stiffness to the structure and providing a framed structure to fix the nets. Based on the pretension of the net structure, this allows nearly zero deflection of the net. The cage structure is assumed to be made of 5mm steel tubes. The mooring configuration is chosen to partly counteract the moment created by the pull at the mooring points. The mooring system, assumed to be made of nylon rope, consists of 4 bridle lines in order to distribute the forces evenly. Table 2 provides the geometrical and material properties of the cage system.

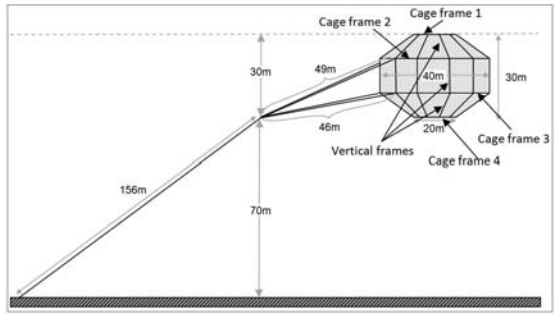


Fig. 5 Schematic representation of the cage system.

Table 2. Geometric and material properties of the cage system.

Parameter	Size/Property
Mooring line	
Diameter (m)	0.6
Effective density (Kg/m³)	1140
Modulus of elasticity (Pa)	3.85E+09
Bridles	
Diameter (m)	0.4
Effective density (Kg/m³)	1140
Modulus of elasticity (Pa)	3.85E+09
Cage Frame 1	
Diameter (m)	0.5
Effective density (Kg/m³)	310
Cage Frame 2	
Diameter (m)	0.3
Effective density (Kg/m³)	515
Cage Frame 3	
Diameter (m)	0.3
Effective density (Kg/m³)	515
Cage Frame 4	
Diameter (m)	0.3
Effective density (Kg/m³)	1472
Vertical Frames	
Diameter (m)	0.2
Effective density (Kg/m³)	1460/1690*
Net	
Diameter of twine (m)	0.002
Half-Mesh size (m)	0.0166
Effective density (Kg/m³)	1140
Solidity (%)	24

4.3 Load Cases

The joint frequency distribution of significant wave heights and spectral peak periods for the

Northern North Sea given by (Faltinsen, 1990) were used to generate the input surface elevation for Aqua-Fe (see Table 3). Simulation results for current speeds at levels of 0.1, 0.3, 0.5, 0.7, 0.9 and 1m/s for each of the wave heights at levels of 2, 5, and 10m are presented in this paper.

Significant Wave Height (m)	Spectral Peak Period (s)
1	7
2	8
3	9
4	10
5	11
7	13
9	14
10	14

Table 3. Wave parameters used in the analysis

The current profiles were assumed to be constant over the depth. Hydrostatic conditions adopted in the analysis allows an excess buoyancy of about 69kN (17% of weight) in the cage system. In this scenario the bottom ring (Frame 4) and vertical frames were fully ballasted with seawater. An arbitrary water depth of 100m with a mooring line slope of 1:2 was applied in the present study.

5. Results and Discussions

The previous analysis to investigate the viability of the self-submersible SPM cage concept clearly showed a good potential for the concept in offshore mariculture, as the response of the cage system toincreasing wave heights implied considerable additional submergence for realistic environmental conditions at offshore sites (see (Shainee et al., 2012a)). The results suggested that for realistic hydrostatic conditions (excess buoyancy of the cage system) the proposed cage design concept responded well to increasing wave heights. The results also suggested that the cage design can be adjusted in order to achieve a desired level of submergence. However, these results were based on regular waves, which are seldom found in offshore sites, and therefore, the system response to a random wave regime needed to be carried out to verify the effectiveness of the concept.

As illustrated in Fig. 6, the simulation results for random waves reveal a similar response to the regular wave case. It is observed that the proposed cage concept exhibits an increased submergence for increasing wave regimes. At low current speeds, the cage system is overly buoyant and the response to increasing wave heights corresponds to a vertical oscillation which is in phase with the heave amplitude. For any realistic hydrostatic condition, as simulated here, there will be some intermediary current speed and wave regime that will cause the drag forces to exceed the reserve buoyancy of the structure and hence trigger the submergence. Note that it is neither the intention nor desirable to submerge the cage in smaller waves and lower currents.

As observed from the simulation results for the regular wave cases, at shallower submergence depths, the increased wave regime increases the effect of submergence, and clearly adds to the submergence compared to that caused by the current alone. This is not readily seen for the random wave case presented here as the overall forces exerted in the random wave case are smaller than those for the regular case. Therefore, to see the same effect, the reserve buoyancy for the random wave case needs to be decreased. This was clearly evident when the system was simulated for the same regular waves with the same current speeds, but with different excess buoyancy (see (Shainee et al., 2012a)).

As the system is submerged deeper the effect of the wave regime almost diminishes to zero. As we know, for deep water ($h/L \geq 0.5$, where h is the water depth and L is the wave length), water particle motion at a depth corresponding to half the wave length is only 4 percent of its value at the surface. Therefore, the effect of the waves to cause additional submergence diminishes with the depth. This suggest that the self-submersible SPM cage concept is most efficient for intermediary waves and currents, which is very encouraging as this would be the most likely physical environment experienced at offshore sites.

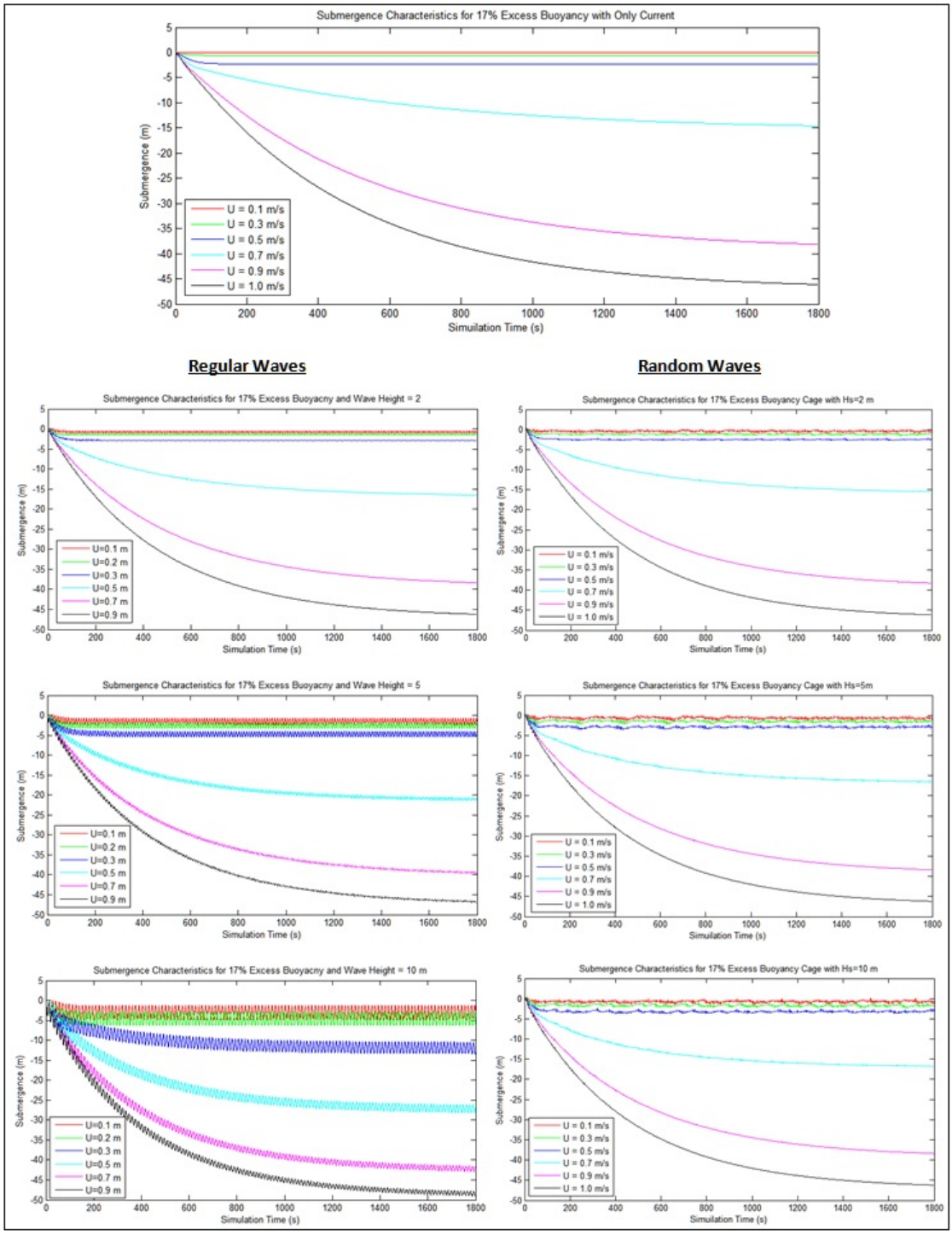


Fig. 6 Submergence characteristics of the cage system for regular and irregular waves.

6. Conclusions

The analyses presented in this paper clearly suggest that the self-submersible SPM cage concept can function as a viable offshore mariculture cage concept. The cage responded well to increasing wave regimes by giving additional submergence due to added waves. However, as explained in section 5, the excess buoyancy needs to be decreased to see this effect more clearly. The results presented in this paper confirm the previous findings (Shainee et al., 2012a), that the self-submersible SPM cage concept is viable in offshore mariculture. The next

logical step along this line of work is to confirm the numerical simulations by comparing them with experimental results.

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Growing Shrimp in Open Ocean Net Pens on Single Point Moorings

Steve Page
President, Ocean Farm Technologies



BIOGRAPHY

Steve Page is the inventor of the Aquapod™ net pen containment system and the General Manager of Ocean Farm Technologies Inc. Page's professional background began with the establishment of an environmental design and consulting business in 1976, building on his education at Stanford University and the University of Michigan. He sold this business in 1988, going to work for the Maine Department of Environmental Protection, followed by work as Regional Manager for Waste Management Inc. Although he has been land farming all his life, his experience in fish farming began in 1999, when he was hired by Atlantic Salmon of Maine (ASM) and Ducktrap River Fish Farm (Fjord Seafood USA) as Environmental Compliance Officer. In 2003 Page was promoted to General Manager of ASM. When Fjord Seafood sold ASM in 2004 Steve founded Ocean Farm Technologies Inc. to manufacture equipment for deep water open ocean aquaculture. Page and his family operate an apple orchard and beef farm in coastal Maine.

Abstract

Since 2009, Ocean Farm Technologies Inc. has been supplying Aquapod™ net pens to customers who have been growing L. vannamei, white shrimp. These net pens have been installed on several types of moorings; however recent installations have all been on unique tension-leg single point moorings (SPM) that have proven to be very successful. In a marriage of biology and engineering the challenges and successes of open ocean shrimp cultivation will be presented along with detailed descriptions of the single point mooring systems. Adaptations of growing techniques for different environments, and use of the single point mooring for various fish species will also be presented. The economic and operational advantages and disadvantages of SPM vs. grid moorings are compared as applicable to different scales of operation.

Poki Pens, The Velella Project, And Next Steps

Neil Anthony Sims
Kampachi Farms



BIOGRAPHY

Neil Anthony Sims is co-Founder and co-CEO of Kampachi Farms, LLC, based in Kona, Hawaii, and in La Paz, Mexico. Over the past two decades, Sims has led teams that have accomplished a number of breakthrough developments in pearl oyster culture, offshore aquaculture legislation and regulation, marine fish hatchery technology, open ocean mariculture systems, and most recently, untethered open ocean 'drifter pens': the Velella project.

Sims co-founded Kona Blue Water Farms in 2001, applying cutting-edge hatchery technologies to 'difficult-to-rear' marine fish larvae: snappers, groupers, and yellowtail/jacks. Resolving this production bottleneck led to the first integrated marine fish hatchery and open ocean fish farm in the US. By 2008, over 500 tons of sashimi-grade Kona Kampachi® was being harvested annually (over 1 million pounds) from submersible pens on the Kona offshore site.

Most recently, Sims co-founded Kampachi Farms, LLC, to expand the commercial growth of high-value, warm-water marine fish globally, and to pursue "next generation" technologies, including: remote offshore systems, more sustainable and scalable feeds, and new species development.

Sims is also the founding President of the Ocean Stewards Institute, the open ocean mariculture trade association that advocates for the balancing of rational, responsible development of the open oceans with protection of marine resources and habitats.

Sims has also provided consulting services to UN-FAO, regional agencies and governments, and currently sits on the Steering Committee for the Seriola-Cobia Aquaculture Dialogue (SCAD) and the Technical Advisory Board for the WWF-sponsored Aquaculture Stewardship Council. Sims resides in Kona, Hawaii.

Abstract

This presentation reviews recent research and development by Kona Blue Water Farms and Kampachi Farms to develop new technologies and resolve the remaining challenges to sustainable, scalable, profitable open ocean mariculture.

The PoKi pen project sought to integrate several innovations into a single surface pen design

that incorporated: a Norwegian HDPE floatation system, a rigid steel weight ring and mort retrieval system, and Kikkonet – a robust, monofilament mesh from Japan. The goal was to examine the efficiency and effectiveness of the PoKi pen, and to assess resulting impacts on fish health and escapement, marine mammal interactions and feeding efficiencies. The overall performance of the PoKi pen, the essential design improvements, and the significance of the findings will be discussed.

The Velella beta-trial tested an unanchored pen array entrained in regional ocean-current eddies in the lee of the Big Island of Hawaii. This trial represented the first farming of fish in U.S. Federal waters, and the world's first unanchored fish pen trial. Velella drift tracks ranged from 3 nm – 75 nm offshore of Kona, in waters averaging around 4,000 m deep, withstanding winds over 45 kts and seas up to 20 ft high. Growth performance, feed conversion ratios, fish health and survival were all highly encouraging. The task now is to resolve the technological challenges (minimizing labor costs by automation or better remote command-and-control; reducing diesel consumption and drag when towing pens), but still retain the impressive biological performance of the fish. A deep-water single-point mooring trial is being planned for a 2,000 m deep site 6 nm offshore of Kona, Hawaii – the Velella gamma-test.

SESSION 7

EQUIPMENT UPDATE BY MANUFACTURERS

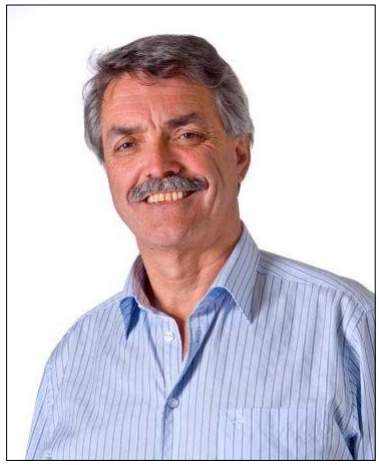
Further details will be available in the conference proceedings download

SESSION 8

HUSBANDRY AND SITE SERVICES

Exposed Industrial Salmon Farming – experience and needs for development

Finn Victor Willumsen
ACE - AquaCulture Engineering AS



BIOGRAPHY

Date of birth 20 December 1950
Nationality Norwegian

EDUCATION:
1978 Master of Science (Cand real) in Marine Biology
1978 – 2005 Education in management, economy, pedagogy, psychology and aquaculture

PREVIOUS AFFILIATION:

2006 -	Managing director for large scale research facilities (in AquaCulture Engineering - ACE)
2004 - 2006	General Manager and developer of service companies (in Intrafish Services)
2002 - 2003	Adviser and business developer in marine fish farming (in A-Pro-Pos)
2001 - 2002	Customer Solution Manager of IT systems supplies for aquaculture (in AKVASmart)
1999 - 2001	Marketing and International Marketing & Sales Manager (in Superior Systems)
1998 - 1999	Business developer in Asia (in MaqSEA)
1996 - 1998	Project Manager in Indonesia for marine monitoring (in OCEANOR)
1990 - 1995	Quality Manager, Department Manager and Consultant (in OCEANOR)
1986 1990	General Manager for hatcheries and co-ordinator for fish farms (in TiMar)
1984 1986	Aquaculture Adviser (in Directorate of Fisheries, Norway)
1979 1984	Lecturer (in University, high school and comprehensive school)

MAIN FIELDS OF WORK:
Organisation development and management of change processes
Establish companies and organisations in Norway and abroad; Internationalisation
Development, marketing and sales of management for hire and services
Aquaculture Development and Integrated Coastal Zone Management
Risk analyses and Site Selection in Aquaculture Industry
Marine Monitoring and Marine Environmental Impact Assessment Studies
Technology Transfer, Education and Training
Working with different species (salmon, halibut, shellfish, cod)

LECTURES:
Different lectures in:
• Aquaculture, Large scale research, Marine Ecology, Marine Monitoring,

REPORTS:
Different reports in fields like aquaculture, marine environment and marine monitoring

PUBLICATIONS
20 publications in different aspects of aquaculture and marine environmental studies

Authors

Finn Victor Willumsen (ACE – AquaCulture Engineering AS); Alf Jostein Skjærvik (SalMar ASA); Anders Sæther (Marine Harvest); Ivar Nygaard (MARINTEK)

Background

Access to suitable areas at sea for a sustainable salmon production in Norway has become a limitation as in other countries. Partly this is caused by interest of conflicts (recreation, fishing, ship routes etc.), partly it is caused by the need for areas with higher production capacity. This situation has made some of the producers, and mainly the large companies in Norway, start looking for areas that are more exposed than areas which were used for fishfarming before.

The definition of exposed areas in Norway is not very clear, but significant waves height more than Hs 3m and current speed above 1m/s are limitation factors often used. In Mid-Norway it is further typically to use large plastic cages (Ø 40m or Ø 50m). ACE (AquaCulture Engineering) is a large scale (similar to industrial standard) infrastructure company that support farmers, suppliers and R&D institutions to do testing of new or improved technical solutions for fish farming at sea. One of the test sites for ACE has a Hs beyond 3.1 and have measured current speed at 0.94 m/s.

In November and December 2011 Mid-Norway was hit by 4 storms called Berit, Cato, Dagmar and Emil. Berit hit the coast at the same time when it was a storm flood with water level 1.1m above average normal level in this area. This caused extreme conditions and forces on some farms, and two farms had damages creating escapees. On initiative from SalMar and Marine Harvest, ACE was asked to coordinate a test to see what actually was happing below the surface under such rough weather conditions. This was the reason for the project called "Testing of large cage under extreme conditions" which was executed in December 2011 and January 2012. In order to have the best facilities available, Ocean Basin Laboratory at MARINTEK (a subsidiary of SINTEF) in Trondheim was used for the trials. A consortium on 7 farmers (SalMar Farming; Marine Harvest; Lerøy Hydrotech; Mainstream; Nordlaks; Midt-Norsk Havbruk; Nova Sea) , 4 suppliers (Aqualine; AKVAGroup; MøreNot; Egersund Net) and 2 research institutions (MARINTEK and SINTEF Fisheries and Aquaculture) participated in the project together with ACE.



Figure 1: Principle drawing

Target and methods

The main target was to test the behaviour of a realistic model of a plastic cage with a circumference of 157m with a bottom ring under different current and wave's conditions. This is the typical cage used in Mid-Norway, and the same type which were damaged by the storms. To test this it was built a 1:16 scale model (Figure 1.) which had the same components as the original cages. The most critical areas were equipped with sensors to measure the forces that affected the construction. In addition the Ocean Basin Laboratory is equipped with cameras from different angels above and below water level. Monitors showing the behaviour of the model are in a special showroom. Here the results were discussed among the participants.

It was established a test matrix (table 1). Based on the on-going results the test matrix was somewhat changed during the test period. The priority was to test the model under the most extreme conditions.

Table 1: Test Matrix

Test nr.	Test identifikasjon	Bølge-kond.			Strøm		Mærd konfig.	Kommentarer
		Hs (m)	Tp (s)	Retning	Cu (m/s)	Retning		
3010	IRR H4.5 T8 D0 C0.7/0 35 KG/M, CL200, F	4.5	8	0	0.7	0	35 kg/m, CL200, F	CL 200 kg, Fast
3020	IRR H4.5 T10 D0 C0.7/0 35 KG/M, CL200, F	4.5	10	0	0.7	0	35 kg/m, CL200, F	CL 200 kg, Fast
3030	IRR H4.5 T8 D90 C0.7/0 35 KG/M, CL200, F	4.5	8	90	0.7	0	35 kg/m, CL200, F	CL 200 kg, Fast
3040	IRR H2.5 T6 D0 C0.7/0 35 KG/M, CL200, F	2.5	6	0	0.7	0	35 kg/m, CL200, F	CL 200 kg, Fast
3050	IRR H2.5 T6 D0 C0.50/0 35 KG/M, CL200, F	2.5	6	0	0.50	0	35 kg/m, CL200, F	CL 200 kg, Fast
3060	IRR H2.5 T6 D90 C0.7/0 35 KG/M, CL200, F	2.5	6	90	0.7	0	35 kg/m, CL200, F	CL 200 kg, Fast
3070	IRR H4.5 T8 D0 C0.7/0 35 KG/M, CL200,GL	4.5	8	0	0.7	0	35 kg/m, CL200,GL	CL 200 kg, Glidelodd 50 kg
3080	IRR H2.5 T6 D0 C0.7/0 35 KG/M, CL200,GL	2.5	6	0	0.7	0	35 kg/m, CL200,GL	CL 200 kg, Glidelodd 50 kg
3090	IRR H4.5 T8 D0 C0.7/0 80 KG/M, CL1500,GL	4.5	8	0	0.7	0	80 kg/m, CL1500,GL	CL 1500 kg, Glidelodd 50 kg
3100	IRR H2.5 T6 D0 C0.7/0 80 KG/M, CL1500,GL	2.5	6	0	0.7	0	80 kg/m, CL1500,GL	CL 1500 kg, Glidelodd 50 kg
3110	IRR H4.5 T8 D0 C0.7/0 80 KG/M, CL1500,F	4.5	8	0	0.7	0	80 kg/m, CL1500,F	CL 1500 kg, Fast
3115	IRR H4.5 T8 D0 C0.7/0 80 KG/M, CL1500, ØF	4.5	8	0	0.7	0	80 kg/m, CL1500, ØF	CL 1500 kg, Fast, Økt forspenning
3116	IRR H4.5 T8 D0 C0.7/0 93 KG/M, CL1500, ØF, ØS	4.5	8	0	0.7	0	93 kg/m, CL1500, ØF, ØS	CL 1500 kg, Fast, Økt forspenning, Økt stivhet i bunnring
3120	IRR H2.5 T6 D0 C0.7/0 80 KG/M, CL1500,F	2.5	6	0	0.7	0	80 kg/m, CL1500,F	CL 1500 kg, Fast
3125	IRR H2.5 T6 D0 C0.7/0 80 KG/M, CL1500, ØF	2.5	6	0	0.7	0	80 kg/m, CL1500, ØF	CL 1500 kg, Fast, Økt forspenning
3130	IRR H4.5 T8 D0 C0.7/0 80 KG/M, CL200,F	4.5	8	0	0.7	0	80 kg/m, CL200,F	CL 200 kg, Fast
3136	IRR H4.5 T8 D0 C0.7/0 93 KG/M, CL200, ØF, ØS	4.5	8	0	0.7	0	93 kg/m, CL200, ØF, ØS	CL 200 kg, Fast, Økt forspenning, Økt stivhet i bunnring
3140	IRR H2.5 T6 D0 C0.7/0 80 KG/M, CL200,F	2.5	6	0	0.7	0	80 kg/m, CL200,F	CL 200 kg, Fast
3170	IRR H4.5 T8 D0 C0.7/0 ENKELTL, CL1500	4.5	8	0	0.7	0	Enkeltl, CL1500	Enkeltlodd 200 kg, CL 1500 kg
3180	IRR H2.5 T6 D0 C0.7/0 ENKELTL, CL1500	2.5	6	0	0.7	0	Enkeltl, CL1500	Enkeltlodd 200 kg, CL 1500 kg

Model

The model was built in a 1:16 scale and based on a cage with 157m circumference, net 15m deep in the cylindrical part and a 10m deep in the conic part. The model contained anchors, anchor lines, frame moorings, connection discs (see Figure 2) and floaters, floating cage, net, bottom ring, side chains and bottom weight. The different dimensions of the elements as size, weights and rigidity were calculated and down-sized based on the real data.



Figure 2 – connection disc

The model was somewhat changed before the last test period, to see how a more stiff bottom ring would affect the net and the rest of the construction.

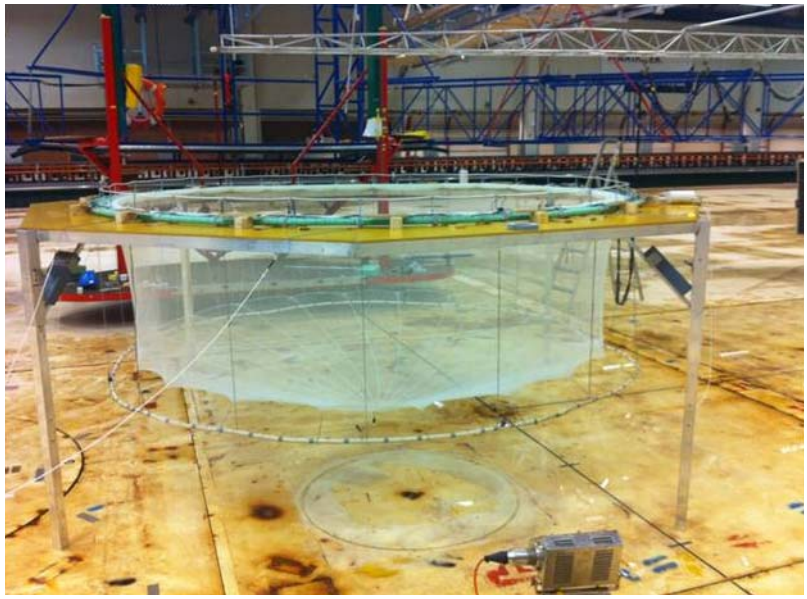


Figure 3: Installation of 1:16 scale model

Instrumentation and measurements

The model was equipped with sensors like 6 accelerometers and 16 force rings (see fig 4). Measuring the forces of different parts of the model was important, in order to see the extent of forces that affected different parts of the construction and eventually an oblique distribution of forces on the total construction.

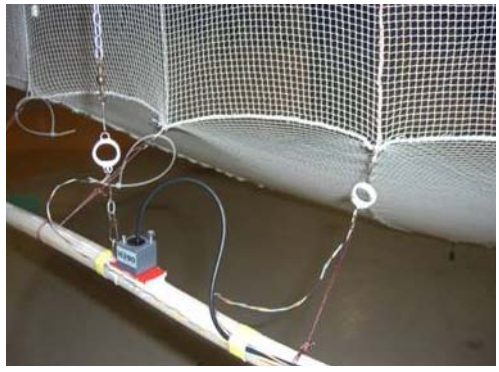


Figure 4: Accelerometers and force rings attached to the bottom ring and the lines to the net

Video was taken of all trials by 3 under water cameras from different angels and 1 from below the water level. A fifth camera was in addition set up under the roof to see more exact the form of the floater.

Under the calibration, the wave elevation was measured. During the trials the current was measured during the current calibration. Forces were measured in vertical chains, cock feet, fastening points of net against the bottom ring and the anchor lines and the floaters,



Figure 5: Net and bottom ring with vertical chain

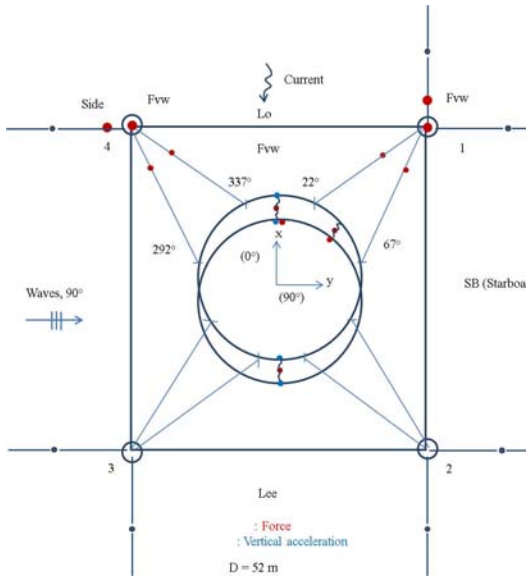


Figure 6: Principle sketch of the instrumentation

Ocean Basin Laboratory

Ocean Basin Laboratory in Trondheim has a regular depth on 0 - 10 m and is 80m x 50m in extent. Current speeds in model scale can be regulated from 0 – 0.25 m/s and the maximum model scaled wave height is 0.5m. Full scale wave height in the trial was 2.5m and 4.5m with direction lengthwise and crosswise of the current direction (see table 1). In addition to the testing of irregular waves a shorter period on regularly waves was executed.

Terms

Wave height is the distance between bottom and top in a wave. Significant wave height Hs (used in the weather forecast) is the average high of the 1/3 highest measured waves in a defined period of time (often 3 hours). The maximum wave height which can be expected is 2 times the significant wave height.

Results

The test trials were executed under weather conditions with a combination of extreme current conditions and waves (4.5 m Hs is adjacent to Hmax 8 m). Few if any farms in Norway are established under such conditions. However the trials showed that under such extreme situations farms are not safe regarding escapees without special precautions.
The most important observations done during the project were:

a) Significant contact between the net wall and the vertical chain
b) Tug forces in the vertical chains were biggest on the lee side
c) The heaviest bottom ring (80 – 93 kg/m) was best in keeping a cylindrical net
d) Increased stiffness of the bottom ring kept a better circular form of the net
e) Substantial tug forces were measured in anchor lines caused by waves



Figure 7: Figure of the cage in Test 3130: Hs = 4.5 m, Tp = 8 s, Vc = 0.7 m/s, 80 kg/m bottom ring, 200 kg bottom weight.

Some additional observations:

a) Forces on cock feet were bias
b) The cage ring and bottom ring did often move in different phase
c) Tug in the fastening points were measured
d) The heaviest bottom weight (1500 kg) was necessary in order to stretch out the cone
e) Single weights were less suitable than the bottom ring

Based on the results from the project the farmers have used this to improve the security of their farms through courses and new preventing actions as well as more measurements and control.

A sum up should be that the managers of the farms should:

1. Do a careful control of the constructions and prioritize the farms that are most exposed
2. Adjust the equipment and the technical solutions to the site conditions
3. Assure the farm on spots at the construction where there might be wear and tear
4. Adjust the stiffness of the bottom ring based on the current forces at the site
5. Make sure that the centre weight is large enough and fit the stiffness of the bottom ring.
6. Be aware of the relation between the buoyance of the ring, size of the bottom weight and the size of the centre weight
7. Do frequent and careful inspection of the farm over and under water and use divers and ROV after heavy weather.

Service Vessels For Operation Of Exposed Salmon Sites

Mats Augdal Heide
Product Designer,
SINTEF Fisheries and Aquaculture



BIOGRAPHY

Mats Augdal Heide has been working for more than a decade with aquaculture technology, as a scientist at SINTEF Fisheries and Aquaculture. Trained in product design engineering, his main focus has been on development of user-centered technical solutions. He has experience from both land-based and sea-based aquaculture, including farm design, health and safety issues, but currently focuses on vessels for aquaculture use, primarily wellboats and service vessels.

1. Introduction

Over the last decade, Norwegian surface-based salmon farming technologies have undergone significant changes. Although the main components have remained the same, the farms and support systems have grown considerably in size. Ten years ago, circular floating collars were typically 90m in circumference. Today the same type of floaters has a circumference of 160m, with each cage containing roughly four times the biomass as before. In addition, new cages are generally located at more exposed sites than earlier, giving fish farmers more challenging conditions for their operations. In the same period, the Norwegian Standard NS9415: Marine fish farms. Requirements for design, dimensioning, production, installation and operation has come into effect, specifying mandatory requirements for the farming equipment and installation procedures.

Service vessels are defined as the vessels that carry out installation, maintenance and other heavy lifting operations at the fish farms, except daily operations. The developments in farming technologies mentioned above have increased the capacity requirements for these vessels. To meet these developments, new vessels have been outfitted with more powerful cranes and hauling equipment, but the vessels themselves have not increased much in size, and have remained just under a length limitation of 15m (Figures 1-2). This is a result of Norwegian regulations, specifying more costly requirements in regard to certificates, inspection and crew competence for ships 15m and above. Limited capabilities and more exposed operation have resulted in a growing consensus that existing vessels are inadequate for current demands.

With the support from the Research Council of Norway, a group of twelve industry participants have joined forces with R&D, aiming to amend this situation through the project "Service Vessel 2010". Although many of the participants are competitors, the project has created an

environment where all participants cooperate to find solutions to common problems. Aiming to develop safer, more efficient and more environment friendly service vessels, the project has created results in several areas:

- Macro level: Market analysis and build regulations
- Micro level: Vessel and deck equipment design

Results from each area are presented below.

2. Results

2.1 Market analysis

A basic market analysis of the service vessel domain was carried out. Using interviews, public information and statistics as basis, a PEST analysis (external analysis grouping political, economic, social and technological factors) gave the following conclusions:

- The market volume for service operations will generally grow with the production volume. No expectations of significant changes in tasks.
- Vessel operators need larger vessels, suitable for exposed operations, but are uncertain whether large vessels will be competitive, given current regulations.
- Mergers or partnerships between companies are likely due to stronger efficiency- and quality assurance demands, plus scale advantages.

2.2 A need for new regulations

A simplified set of build regulations (in practice: recommendations) are currently used in Norway for vessels with length over all under 15m, with no formal inspection of new vessels, and no certificate requirement. The project participants considered these regulations as a major obstacle for future developments. In an effort to change this, the group created a list of initiatives pointing out where regulations need changes, and suggesting corresponding solutions. The list was sent to the Norwegian Maritime Authority in June 2011. Main points in initiative:

- Introduction of mandatory requirements.
- Third-party quality assurance of vessel design and capacities to ensure vessel safety.
- Specific additions to close critical holes in current regulations (e.g. stability requirements for multi-hull vessels).
- General changes to ease the transition towards larger vessels.

The Norwegian Maritime Authority is currently updating the build regulations, aiming to put a new set of regulations in effect from January 2013.

2.3 Equipment development: 5 critical operations

The project participants identified five critical operations to be used as a starting point for equipment development. These were the following:

1) Installation of mooring
2) Net handling
3) Installation of feed barge
4) Transport of floater
5) Operation of bottom ring

The following development activities focused on safe and efficient solutions to these challenging operations. The results are mainly presented as sketches and drawings, and include several

concepts for specialized equipment (figure 3).

2.4 Future vessels: the platforms for operations

Using identified needs as a basis for development, the participants came up with two different solutions for the next generation vessel. The 24m long MD240cat by Marin Design AS (figure 4) can be characterized as an evolutionary up scaling of existing vessels; whereas the 41m long, single-hull Macho40 by Møre Maritime AS (figure 5) is based on offshore construction/AHTS vessels. Both vessels are commercial designs currently being marketed. 3D models of the vessels were made to assist the marketing process, and gave the possibility to "test" equipment designs on representations of real vessels.

3. Summary and conclusions

Our indicators point towards that acceptable operation of exposed sites will require some larger vessels. The first ones to emerge will be outfitted with generic equipment, focusing on heavy lifting and increased carrying capacity. The first new build in Norway above 15m is currently underway, and will be finished spring 2013 (a 24.6m long Solstrand Trading design, to be delivered to FSV Group). Further on, increased specialization is expected, including more specialized equipment and vessels outfitted for specialized tasks.

Acknowledgements

The project is supported by the Research Council of Norway. Project partners are Møre Maritime AS, Marin Design AS, Marine Harvest Norway AS, Folla Maritime AS, Nærøysund Aquaservice AS, Moen Marin AS, Lerøy Hydrotech AS, Biotrål AS, Gripfisk Service AS, Midt-Norsk Havbruk AS, InPower AS, Triplex AS and the Norwegian University of Science and Technology, with participation of Aquaculture Engineering AS, the Norwegian Labour Inspection Authority and the Norwegian Maritime Authority.



Figure 1. Service/work vessel, picture taken in 2003. Length over all 12m.



Figure 2. The FollaCat 50-950 "Fosnakallen" represents a state of the art service vessel, completed spring 2007. Main dimensions: 14.95 x 9.5m.

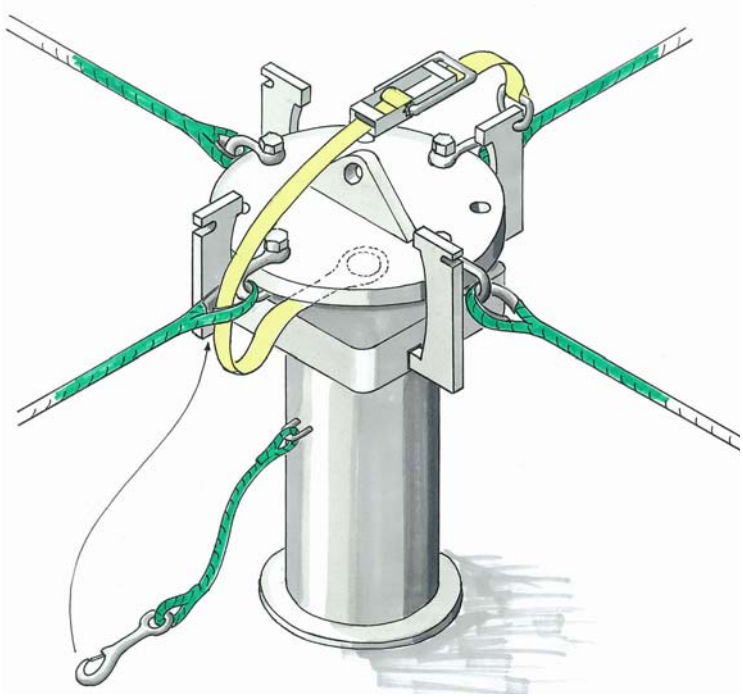


Figure 3. Concept sketch, illustrating a specialized handling solution for moorings.



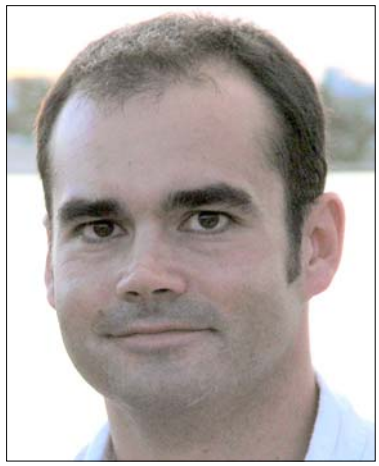
Figure 4. New service vessel design, Marin Design MD240cat.



Figure 5. New service vessel design, More Maritime Macho40.

Aquaculture Livestock Insurance

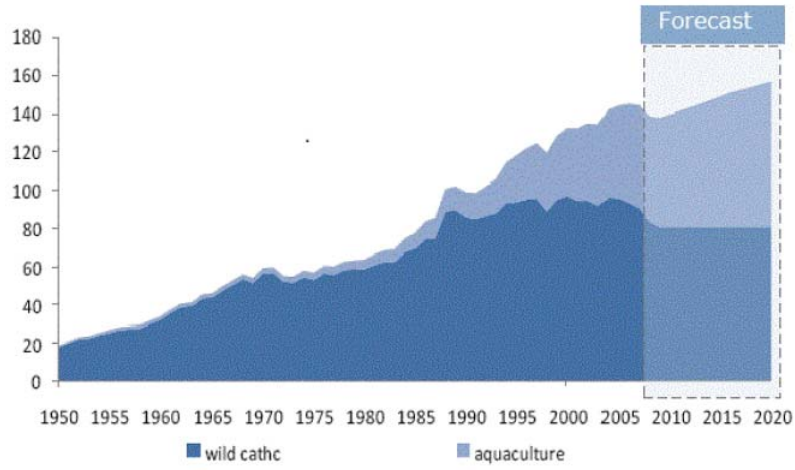
Cédric Audor
GUIAN S.A



BIOGRAPHY

Born in 1973, Cédric Audor has always been involved on the aquaculture trade.
After obtaining a diploma techinician in fishfarm, he obtained also a diploma of ingeneer in aquaculture and in water ressource management in France.
He worked for 3 years for the french agricultural ministry, on aquaculture projects and was also teacher in an aquaculture specialized school in France.
In 2004 he built a french speaking newspaper for fishfarmers: AquaFilia. He is still the manager of this newspaper and involved on it.
For more than 3 years Cédric Audor is working for a marine brooker : GUIAN S.A who decided to work on the aquaculture livestock insurance. He is in charge of this department. He created 2 years ago a specific policy named AquaSecure and is know in charge of the developpement of this market. GUIAN S.A, thanks to this developpment is know covering around USD 100 000 000 of fish, all around the world, in all species

The industry's projected growth to 2020:



With aquaculture, the fish, the crustaceans or even the molluscs you farm represent the future income of your business. Losing this source of income as a result of a mechanical fault, bad weather or even disease will deprive your business of its livelihood. Not to mention the fact that you will then have to reinvest in new stock so that you can return to former income levels, but only once a full production cycle has been completed. Given these risks, livestock insurance is not something you can afford to ignore. It will guarantee your future income and ensure the long-term survival of your business. For a sector that has begun to cross international barriers and that is now attracting ever greater capital investment, taking out livestock insurance is also a way of reassuring banks as to the sustainability of your business and of guaranteeing repayment of its loans.

Who are we?

GUIAN SA is acting as Marine Insurance Broker since 1931, the third generation now is managing the Company.

Originally operating only from Le Havre, the company was first specialised in marine transport and fishing. However, with the expansion of the business and the opening of offices in Paris and Marseille, river transport cargo insurance were added to our portfolio.

GUIAN SA has started developping aquaculture insurance early 2008 and a specialist on this field joined the Company to lead the dedicated team. Cedric Audor has more than 15 years of professional experience and worked for the Ministry of Agriculture and managed the Aquaculture Research and Development Department. He also created a French professional newspaper specialized in aquaculture : AquaFilia (www.aquafilia.fr), still under his control.

At last, and in order to have the best coverage as possible, GUIAN SA has built his own Insurance Policy named AquaSecure and has selected some of the main and strong Insurance and re-insurance Companies (CATLIN and PARTNER RE) for underwriting these risks.

Aquaculture is the core business of our selected Insurer for 4 decades and thanks to his skill and experience we can provide insurance for all species of fish, algae, shellfish and crustaceans, offering the best possible conditions.

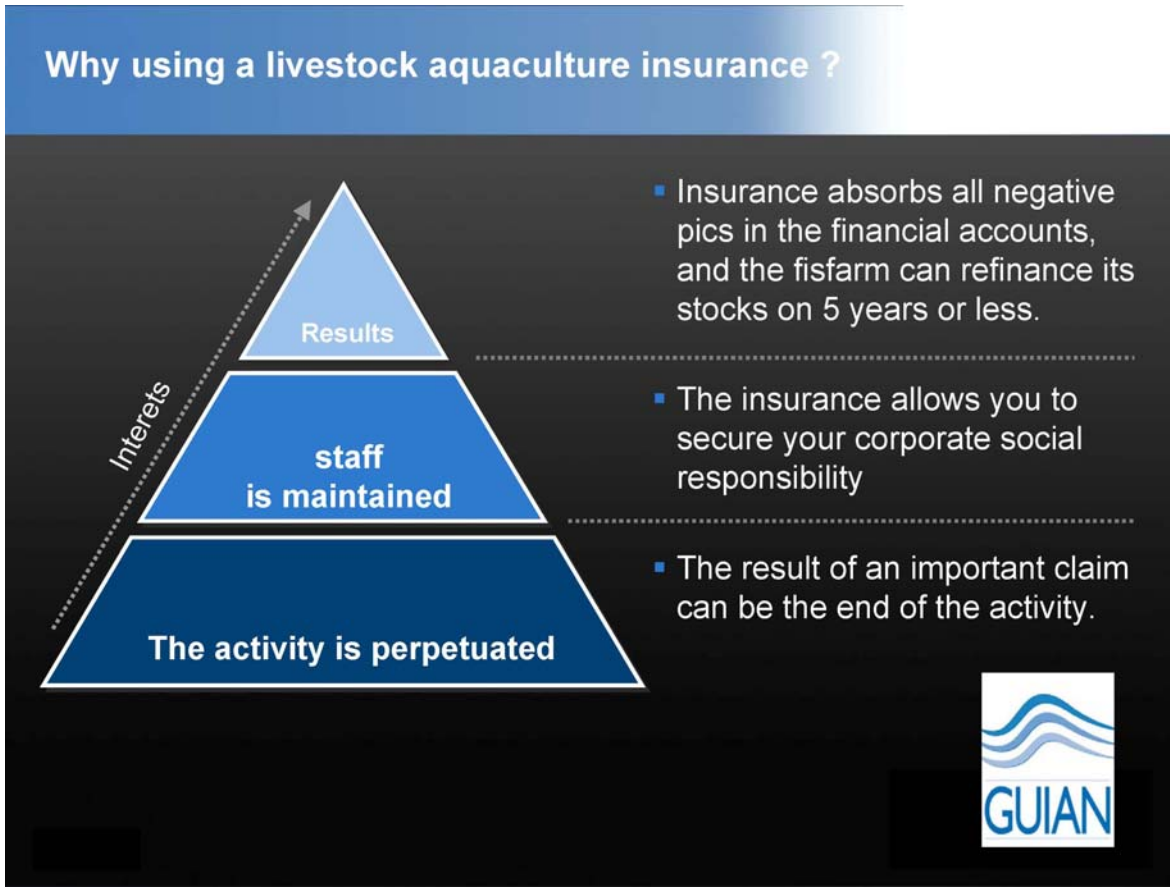
In the interests of providing a policy that meets the ever-changing demands of our clients, we always endeavour to update our policy to ensure the best terms for our clients.

How is the aquaculture insurance trade today?

The world of the aquaculture livestock insurance is a really small one. Today, only 3 underwriters are able to propose specific coverage adapted to aquacultre livestock insurance. Those 3 underwriters are Catlin, Sunderland & GAIC. Our specific wording AquaSecure have been built with Catlin. A so small number of underwriters don't allow the brookers or clients to make important competition.

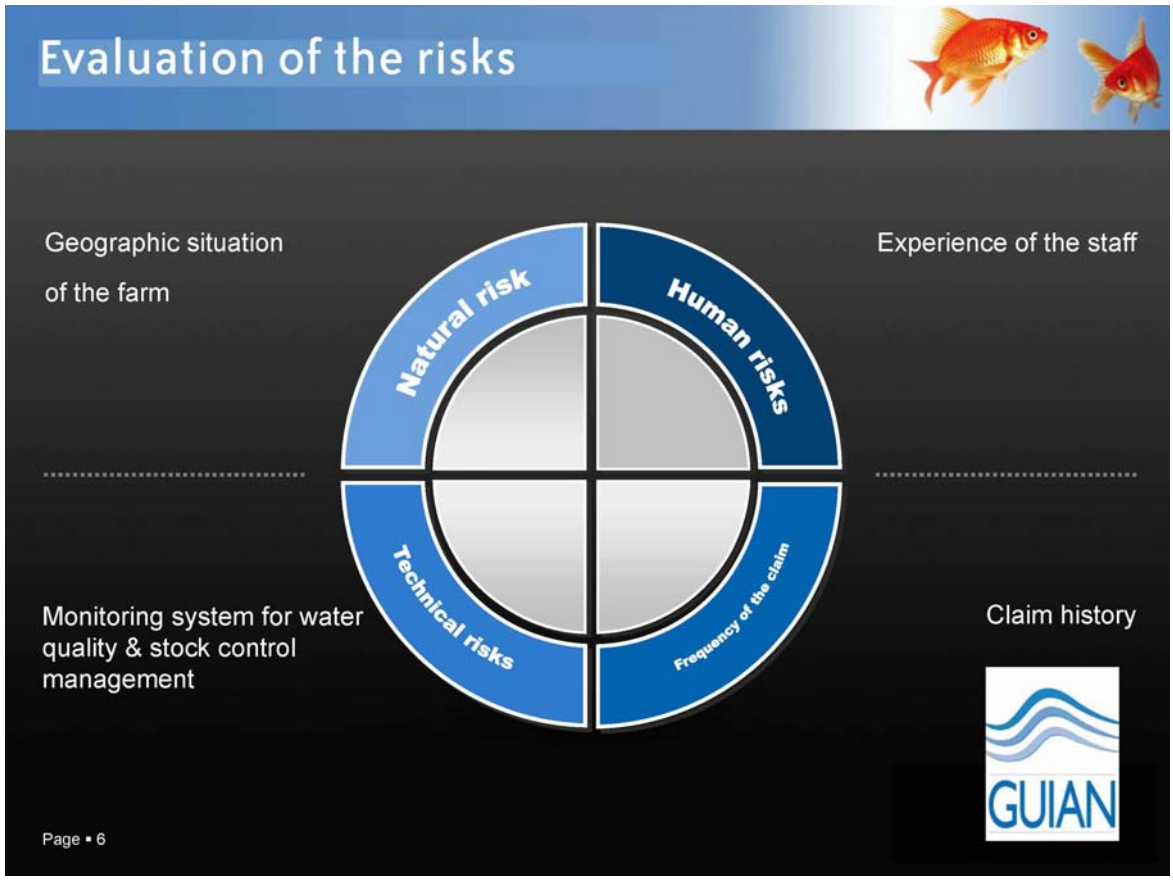
Any other policy, coming from other undewriters on the européan market are not specific coverage for aquaculture crops. Most of the time, it is an agricultural livestock insurance. Fish farmers have really to be very careful with this kind of agricultural policy because they are not adapted to fish farm. For example, they are not covering collision for offshore farms, they are not covering desoxygenation or algal bloom and many other risks which are very specific to aquaculture activity.

The worldwide premium for aquaculture livestock insurance and for all species is actually around 60 000 000 USD. This 'small' value, compared to a trade which is improving very fast let us think that many farms are not covered or badly covered with agricultural and non adapted policy.

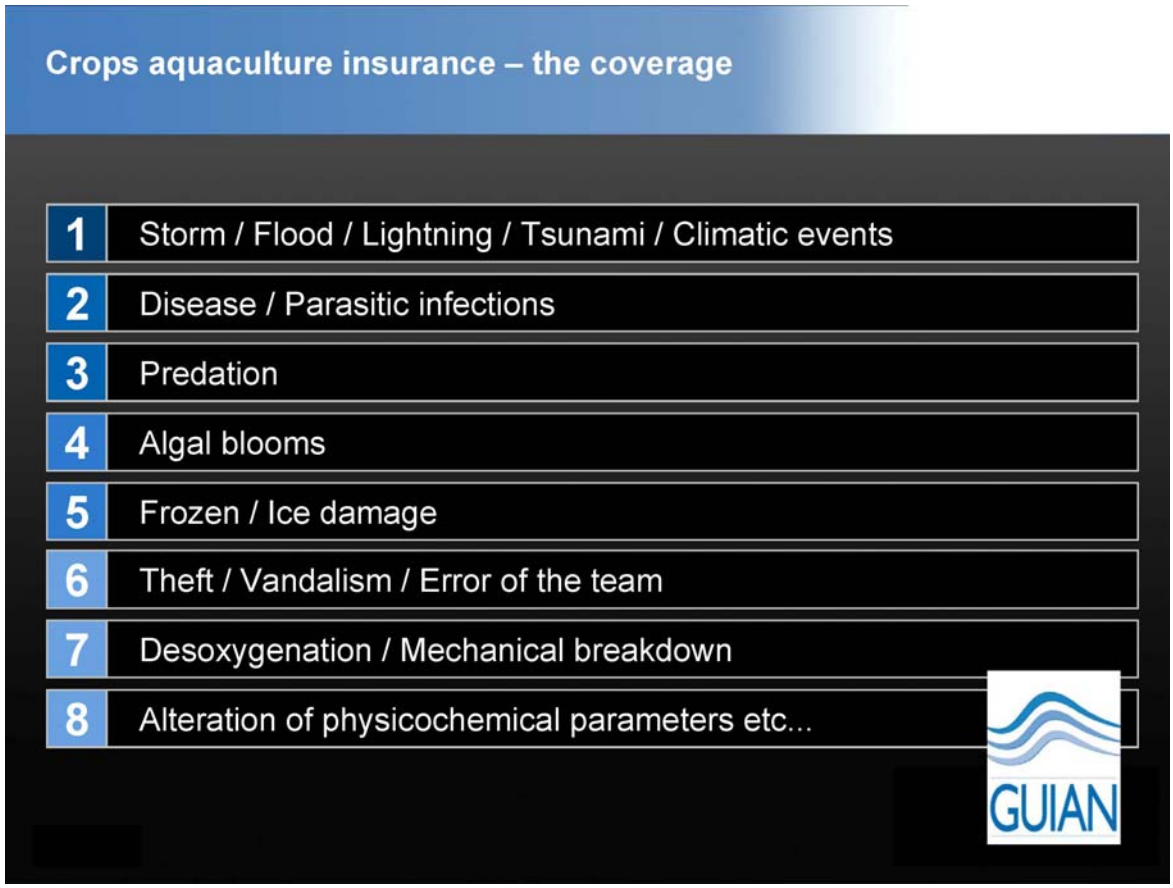


Livestock insurance: what coud be covered? How does it work?

However, there is obviously quite a bit of difference between insuring a tuna farm and a seabass hatchery, or even between a land-based trout farm and a sea-cage salmon farm. The risk calculated by the insurer will therefore be specific to each business and will naturally depend on many factors such as the type of farming, the species to be insured and the location amongst other things.



For an offshore operation, insurers will in particular look at the anchorage systems and the size of the installation, and will determine all weather-related risks. In a closed circuit farm or hatchery, they will rather focus on what equipment has been put in place to ensure continuity of the oxygen and water circuits in the event of a mechanical or electrical fault. Whatever the type of business, the skills and experience of the managers, operators and technicians will also be taken into account, as will the farm's animal health and welfare management procedures. In this respect, any quality, biosafety, mortality management and even vaccination procedures overseen by a consultant veterinarian or a recognised healthcare institution will be highly valued. The policies currently being offered by insurers are relatively comprehensive, with traditional products available to insure businesses against natural disasters, equipment breakdown, pollution, deoxygenation, disease and parasite infestations, theft and other wilful damages. However, only a few number of insurers is truly specialised in this type of risk. To ensure the very best high quality cover, owners need to choose between these few specialist providers in order to avoid any nasty surprises.



All livestock policies offered by specialist insurers work on the same principle. The policyholder and the insurer agree on a fixed compensation scale based on an agreed value, which must be clearly set forth in the schedule of insurance. The whole policy is then based around this scale, which is broken down by size, age or generation depending on which species is being covered. It is used not only to calculate payouts but also the size of the premium. It is usually based on the farmer's production cost. In order to ensure the premium as fair as possible, a provisional figure is calculated at the start of the policy based on a planned production volume. Then, throughout the life of the insurance, the policyholder must provide the insurer regular reports on his stock (volumes) so that the premium can be adjusted at the end of the policy to the size of the stock that was actually being farmed during the period covered by the policy. Amongst other things, these stock declarations ensure the policyholder pays a premium ultimately based on his actual production figures. They will also be used as the basis for calculating the compensation in the event of loss of stock (e.g. following a storm on an offshore farm). The schedule of insurance, which overrides the general terms of insurance and is specific to each policyholder. It must therefore contain this compensation scale, as well as an exhaustive list of all the heads of cover for which the business is insured. This cover is normally given in the form of named risks, which is always better than policies for "all risks excluding..." which are often open to dispute or even incorrect interpretation in the event of a claim.

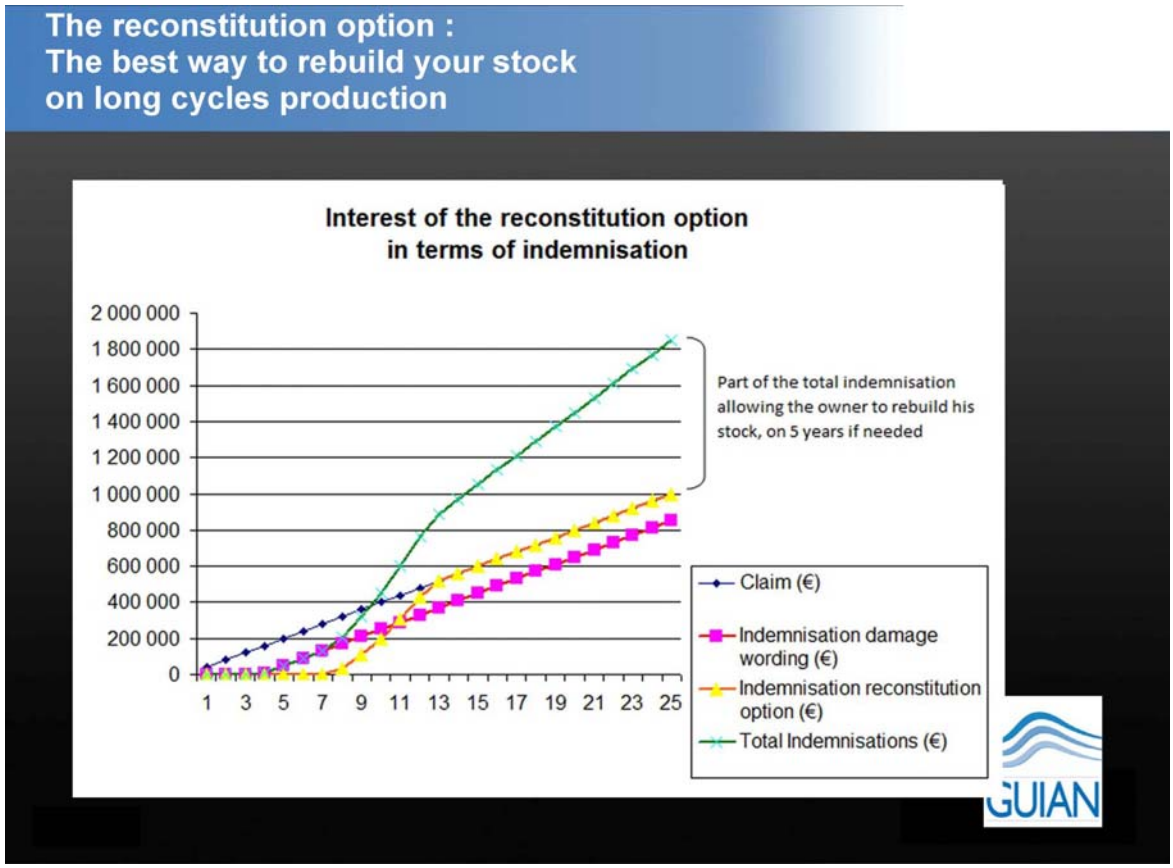
What's new in terms of aquaculture livestock insurance?

In view of an extremely small aquaculture livestock insurance sector (only three specialist insurers in the world) suffering from little innovation, four years ago a France-based broker decided to enter this market: Guian S.A.

Furthermore, in case of claim or just for having some advice, all of our clients have access

24/7 to an Hotline with a specialized aquaculture veterinarian. This is an unprecedented strategy for a broker. It combines technical ability and privileged relationships with reinsurers. However, through such collaboration with true specialists in this field, Guian S.A. has triggered genuine interest among both European and American fish farmers. Frédéric Guian, Director of Guian S.A., describes his company's strategy: "We are developing our product in two main areas - quality of service with the experience of a true specialist, and solid relationships with reinsurers. In fact, we are the only broker with a separate reinsurance department and aquaculture division. This means that with our knowledge of their sector, we can guarantee customers that the policy we offer them will be fully suited to their business needs. This concept of service quality is reinforced by the advice that we can give customers to ensure their business complies as closely as possible with the requirements of the insurers and reinsurers. In addition, thanks to our Reinsurance Department we are also able to employ sufficient resources for 100% coverage of the largest farming sites.

This was how we were able to find backing to insure one of our clients in America for $60 million, whilst the primary insurer could only take on $12 million". With extensive experience of the difficulties faced by farmers, Guian has amongst other things developed a brand new stock regeneration product designed specifically for farms with long production cycles (greater than 2 years).



Cédric Audor, Head of aquaculture at Guian, explains the motivation behind this product. "A few months ago, some sturgeon farmers told us that if there was a major accident at their site they would not have the financial resources to re-start their business. This is because they would have to fund their stock over 5-6 years before income returned to an acceptable level. And this was despite the fact that they had traditional livestock insurance that covered them on the basis of their production cost. We realised that there was a lack of any insurance products targeted specifically at long-cycle farms. We therefore created an optional add-on for our traditional policy, the aim of this was to find breeding stock for up to 5 years in the event

of a major loss. This add-on works under the same terms of cover as the traditional policy and on the basis of an agreed value so that it is as simple as possible for all parties. It is a truly innovative product and it was important that we were able to meet a need that had been clearly described to us by professionals." Guian has therefore now positioned itself as a specialist in this sector and the preferred partner of European farmers. Feel free to visit our website at any time : www.insuranceaquaculture.com

SESSION 9

THE TURKISH OFFSHORE SECTOR – PLANNING, EXECUTION AND SUCCESS



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Turkey's Successful Spatial Planning Policy Story Which Includes Turning CrisesTo Our Advantage In Offshore Mariculture

Hayri Deniz
DG for Fisheries and Aquaculture
Ministry of Food, Agriculture and Livestock



BIOGRAPHY

I graduated from Fisheries Faculty of Mediterranean University in 1887. I have Ph.D on sea bass and sea bream production from Dokuz Eylul U., Institute of Marine Science and Technology.

I have been working for Aquaculture Department, DG for Fisheries and Aquaculture of Ministry of Food, Agriculture and Livestock as Mariculture Expert and Project Coordinator.

Previously; I worked for Bodrum Fisheries Research Institute of Ministry of Agriculture and Rural Affairs (MARA) as Researcher, Province Directorate of Konya of MARA as Aquaculture Expert, Mediterranean Fisheries Research, Training and Production Institute MARA as Researcher, General Directorate of Agricultural Production and Development of MARA as Mariculture Director in 1988-1991, 1992-1993, 1993-1994 and 1995-2011 respectively.

I have been working as "National Coordinator" below international and national projects on aquaculture:

- Developing a Roadmap for Turkish Marine Aquaculture Site Selection and Zoning Using an Ecosystem Approach to Management
- Determination of Environmental Impacts of Fish Farm to the Marine Ecosystem
- Sustainable Development of the Aquaculture Sector from Postharvest Perspective with Focus on Quality, Traceability and Safety
- Recovery of Sturgeon Population in Turkey: Habitat Assessment and Restocking

I have also administrative duties in international and national organizations such as General Fisheries Commission for Mediterranean (GFCM), Europe Fisheries Organization (EUROFISH), Mediterranean Coastal Foundation (MEDCOAST) and Committee for Turkish Coastal Zone Management (KAY).

My expertise is on mariculture management, offshore sea farming, interactions between mariculture and other coastal sectors and integrated coastal zone management and lagoon management.

I am member of EAS, MEDCOAST, WWF, World Sturgeon Conservation Society (WSCS), JICA Association and Balkan Environment Association (B.EN.A).

Hayri DENIZ (Ph.D.) – Chair of EUROFISH & Vice Chair of GFCM-CAQ
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Abstract

Turkey is a peninsula and has a wide selection of lakes, ponds, reservoirs, rivers and springs, with a major potential for aquaculture. With a coastal line of 8,333 km and 177,714 km of rivers, the marine and inland water sources suitable for fisheries and aquaculture cover approximately 26 million hectares.

Official figures indicate that total fishery production in 2010 was 653.080 tons and 167.141 tons come from aquaculture. Aquaculture although being a very young sector, has been incising very rapidly and it has 26 % ratio of total fishery production of Turkey. Aquaculture is playing an increasingly important role in the Turkish economy, as fishery products are the only products of animal origin that can be exported to the EU.

However the current distribution of sea farms, most of them located in the Aegean region in enclosed bays or coastal waters where they compete with other activities is considered a constraint and the main problem for the future expansion of the sector.

Both government and private sector were learned lessons after facing the serious problems in year by year. After new Environmental Low entered into force, Ministry of Food, Agriculture and Livestock (MoFAL) was put into practice several actions with other related stakeholder.

Turkish Government developed a National Mariculture Development Plan (NMADP) for minimizing conflicts and to providing stable grounds for the future growth of the marine aquaculture sector in 2008. Integrated coastal zone management models were developed and implemented with the consensus of all related institutions and stakeholders and inshore marine fish farms were moved to new allocated offshore zones in 2009. There are also national and international projects for solving the problems and developing the sector in a sustainable way.

Although it is very young, there have been showed very important improvements in aquaculture sector: In 2002-2011, the increase on aquaculture production, as a volume was 209%. Turkey now has a 25% share of the European sea bream and sea bass market and is the 3rd fastest growing country in the World in aquaculture. Furthermore, aquaculture was recorded as fastest growing sector in Turkey in the past two years. Turkey has occupied first place in trout, second place in sea bass and sea bream production among European countries. Approximately 25.000 people are employed in the sector.

Latest developments in the aquaculture sector place Turkey in an important position both in the Mediterranean basin and among the European countries.

1. INTRODUCTION

Turkey has a great potential for aquaculture with a coastal line of 8,333 km and 177,714 km of rivers, the marine and inland water sources which is approximately 26 million ha (Table 1). It is known that there are 247 species in the Black Sea, 200 in the Sea of Marmara, 300 in the Aegean Sea and 500 in the Mediterranean. However, only few species of commercial interest represent almost the 60 percent of the total Turkish production (DENIZ, 2001).

Table 1 Aquatic Resource in Turkey

Marine Resources	No of Resources	Surface Area (ha)	Coastline (km)
Seas	4	23,475,000	7,144
Istanbul & Dardanelles	2	1,133,200	1,189
Total	6	24,607,200	8,333
Freshwater Resources	No of Resources	Surface Area (ha)	Length (km)
Natural Lakes	200	900,118	-
Dam Lakes	159	342,377	-
Ponds	750	15,500	-
Rivers	33	-	177,714
Total	1,142	1,261,995	177,714

Source: MoFAL

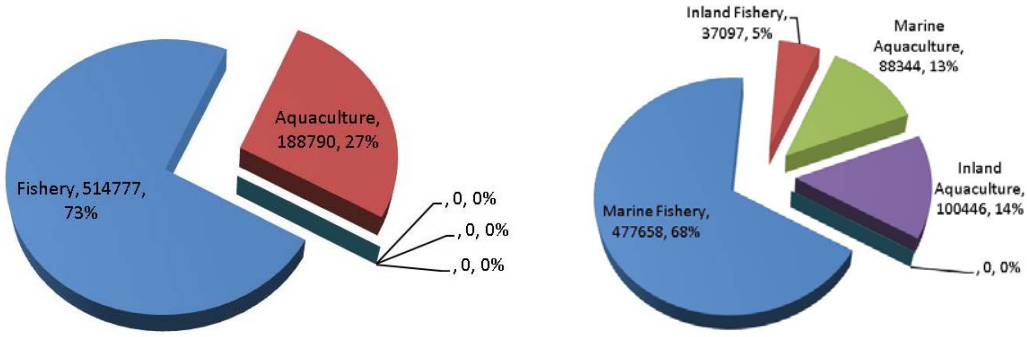
Official figures indicate that total fishery production in 2011 was 703,545 tons (Table 2), comprising fishery 485,939 tons, and aquaculture 188,790 tons. Contribution of aquaculture was 27% as a volume, and 52% value in total fisheries production in 2011 (Figure 1).

Table 2 Fishery and aquaculture production in Turkey in the past decade (tons)

Year	*Fishery Production*	*Contribution (%)*	*Aquaculture Production*	*Total Fisheries Production*	*Contribution (%)*
1999	576824	90	63,000	636,824	10
2000	503,345	86	79,031	582,376	14
2001	532,753	89	67,244	594,977	11
2002	566,682	91	61,165	627,847	9
2003	463,074	86	79,943	587,715	14
2004	504,987	85	94,010	644,492	15
2005	380,381	78	118,277	544,773	22
2006	488,966	81	128.943	661.991	19
2007	589,129	82	139,873	772,323	18
2008	453.113	76	152,186	646,310	24
2009	425.275	75	158,729	623,191	25
2010	485,939	74	167,141	653,080	26
2011	544,755	73	188,790	703,545	27

Source: MoFAL, 2011

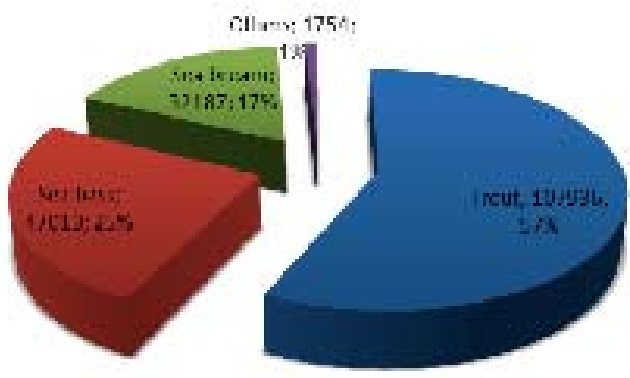
Figure 1 Contribution of Turkish fisheries production in 2011 (volume, tons)



Source: MoFAL & TURKSTAT

The main developments took place during the 1990s with the rapid increase in sea bass and sea bream production, the development of rainbow trout and sea bass farming in the Black Sea, mussel in the northern Aegean and Sea of Marmara, and more recently the development of turbot culture in the Black Sea. The sector has developed to such an extent that Turkey is currently the third largest finfish aquaculture producer in the World, first largest producer of rainbow trout and the second largest producer of sea bass and sea bream production in Europe (Figure 2).

Figure 2 Distribution of aquaculture productions by species in 2011



Source: MoFAL & TURKSTAT

Aquaculture is an important economic activity in the coastal and rural areas of many countries. It offers opportunities to alleviate poverty, creates employment, helps community development, reduces overexploitation of natural aquatic resources, and contributes enhancing food security. For example it is estimated that the aquaculture sector in Turkey provides employment for around 25,000 people.

Current per capita fish consumption is very low comparing to many European countries, but it is expected that all these development will lead to increases in domestic fish consumption. In fact there are some indicators that this is happening already. On the other hand wild fish stocks are already under pressure from over-fishing, environmental degradation and pollution. Annual fish consumption per capita in the world is about 16 kg. However, the fish consumption in Turkey is around 8 kg. As the annual per capital fish consumption of EU countries is 25 kg, the consumption in Turkey needs to be doubled to reach world average and tripled to reach EU consumption level (DENIZ, 2008).

167. AQUACULTURE IN TURKEY

Aquaculture in Turkey started with carp and trout farming in the 1970s and developed with gilthead sea bream/sea bass farming in the Aegean and Mediterranean seas in the mid1980s, followed by cage culture of trout in the Black Sea during the 1990s and more recently tuna rearing in the Aegean Sea and the Mediterranean Sea in the early 2000s. Sector has rapidly developed into 2.163 farms with total 404,634 tons capacity in 2012 with governmental supports and technical developments. There are 1,791 inland fish farms with 225,304 tons capacity and 372 marine farms with 179,330 tons capacities.

The Euphrates and the Tigris river systems which are within the GAP Region consist of 2,235 km of rivers, 6,481 hectares of natural lakes, small lakes and approximately 129,987 ha of dam lake, the construction of which has been completed by DSI and opened for operation, are suitable for inland aquaculture. There is increasing need for the development of aquaculture

as natural resources become scarcer. Several natural water resources make Turkey an ideal country for aquaculture development (GOZGOZOGLU, 2003).

Aquaculture in Turkey has grown considerably over the past 10 years to keep pace with consumer demand for fresh, high quality fish. Demand for seafood in domestic market alone is expected to increase considering low per capita of 10 kg, which is very low for a country like Turkey.

The first aquaculture practices in Turkey initiated in the inland waters were during the 1970s for trout production and in 1985 for sea fish production. Due to the late commencement of aquaculture practices compared to other countries and to unconscious practices during its initiation years as well as inadequate follow up of relevant technological development, aquaculture in Turkey has relatively been underdeveloped (OKUMUS & DENIZ, 2007).

The sector has developed to such an extent that Turkey is currently the third largest farmed finfish producer in Europe and first largest producer of rainbow trout, the second largest producer of both sea bass and sea bream. The rising aquaculture sector in Turkey that has recently began to develop, ranks among the sectors having a promising future. It is rapid development has been driven by various factors including relatively high demand for fish, availability of sheltered sites and good water quality, government supports, until recently lose or flexible regulations, high private sector interest for aquaculture investment, rapid development of specific marine hatchery technology and low labor cost.

Aquaculture is one of the fastest growing industries in Turkey having grown in volume by over 20% for the past 10 years. During the 1990s production from three major species, rainbow trout, sea bass and bream increased rapidly until 2000 and then declined during the following two years due to serious general economic crisis faced by the country in general and has continued to increase again after two years up to now (Table 3).

Table 3 Aquaculture of commercially important species: 2002-2010 (tons)

Years	Carp	Trout	Sea trout	Sea bream	Sea bass	Mussel	Others	Total
2002	590	33.707	846	11.681	14.339	2	-	61.165
2003	543	39.674	1.194	16.735	20.982	815	-	79.943
2004	683	43.432	1.650	20.435	26.297	1.513	-	94.010
2005	571	48.033	1.249	27.634	37.290	1.500	2.000	118.277
2006	668	56.026	1.633	28.463	38.408	1.545	2.200	128.943
2007	600	58.433	2.740	33.500	41.900	1.100	1.600	139.873
2008	629	65.928	2.721	31.670	49.270	196	1.772	152.186
2009	591	75.657	5.229	28.362	46.554	89	2.247	158.729
2010	403	78.165	7.079	28.157	50.796	340	2.201	167.141
2011	207	100.239	7.697	32.187	47.013	5	1.442	188.790

Source: MoFAL & TURKSTAT

3. AQUACULTURE MANAGEMENT

Aquaculture Legislation

Article 13 of the Fisheries Law states that those who wish to farm aquatic species for commercial purposes are obliged to apply to Ministry of Food, Agriculture and Livestock (MoFAL) by informing the Ministry about the location, characteristics and management of the facilities, and submit the enterprise's project and plans. Permission is issued by MoFAL if there are no adverse effects in terms of public health, the national economy, navigation or science and technology (GOZGOZOGLU, 2007).

The provisions of the last paragraph of Article 4 of the Fisheries Law 1380 are also applicable

for production units to be established in the sea and inland waters. According to Article 13 of the Fisheries Law, the procedures and principles related to aquaculture are determined by the Aquaculture Regulation, which was issued in 2004. This regulation was amended in 2007 and 2009 and adds fish welfare issue. This regulation covers and sets out rules for the following issues:

- Site selection for inland and marine farms
- Application and evaluation procedures for fish farming licenses
- Approving the projects and issuing licenses
- Improving production capacity, species etc, cancellation, site changes and sales
- Other aquaculture activities (tuna fattening, organic farming, etc.)
- Importing brood fish, egg and fry
- Compulsory technical staff employment
- Fish health management
- Environmental impacts and protection
- Monitoring and control of farming activities
- Fish welfare

Licensing procedure

The Directorate General for Fisheries and Aquaculture (DGFA) of MoFAL is responsible for aquaculture activities. All aquaculture producers must have an aquaculture license of registration from the Aquaculture Department of DGFA. The details of the application, issuing and cancellation of the aquaculture license are described in the Aquaculture Regulation.

Entrepreneurs or applicants need to submit their applications either to central office (Aquaculture Department of DGFA in Ankara) or Provincial Directorates of MoFAL with all the relevant supporting documentation - for example a written application with species, capacity and production system clearly mentioned and a map of the area.

Applications for trout, carp, sea bass and sea bream on-growing farms and hatcheries for these species up to two million fry/year capacity can be submitted to the Provincial Directorates, whilst applicants for other on-growing species (namely turbot, sturgeon, eel, algae, mollusks and crustacean species) and trout, carp and sea bass/sea bream hatcheries with a annual capacity of more than two million have to apply directly to the Aquaculture Department in Ankara. A team of experts from the central or provincial office then visits the site and prepares a preliminary survey report. If the report is positive, a preliminary license is issued for eight months and can be extended up to four months. Supporting documentation submitted for the preliminary license must include an application letter, site map, the preliminary survey report and a water quality report.

According to current EIA legislation those fish farms with annual capacity of less than 30 tons do not require an EIA. Fish farms may require EIA and this is decided upon by EIA commissions in each province which have between 30-1,000 tons annual capacities. Farms must submit an EIA report if they produce over 1,000tons per annum.

The entrepreneur prepares the full project documentation, which includes a farm or hatchery design and feasibility report and an environmental impact assessment (EIA) report. Approval is also needed from other related institutions dependent on the nature of the project. If the project is approved the license is issued and is issued with a ‘Producer Certificate’; this usually takes about 1 year. The rental contract period for marine cages sites is a maximum 15 years and the contract can be terminated earlier by the government.

4. INTERACTIONS WITH OTHER COASTAL SECTORS

Aquaculture rather young sector comparatively agriculture and livestock, its legislations and

technical guidelines are changed and updated by the reason of providing progress and meeting with the implementation difficulties.

Problems have been mainly occurred in marine aquaculture at Aegean and Mediterranean coasts, which were already established most of sea bass and sea bream farms, with other sectors which are very noteworthy for tourism, environmental protection, maritime, recreation etc.

First commercial marine aquaculture was started with sea bream and sea bass in closed and sheltered bays by using traditional, small size wooden cages in Mugla City in Turkey in 1985. Marine aquaculture zones were determined by MoFAL along the all coastlines in 1988 and were provided moving of sea farms in these zones. However, current allocated zones had been started deficient for new applications because of rapid developments of culture technique; cage-made, fish feed technology. Therefore, studies on determination of potential aquaculture zones were reviewed by order of 1993, 1998, 2000 and 2008 because of the circumstances of aquaculture which were developed and alternated.

After new Environmental Law come into force, new aquaculture zones were determined once again with consensus of all related institutions according to the Environmental Law and Notification on Defining Sensitive Enclosed Bays and Gulfs Areas in Coastal Waters where fish farms shall not be set up. After The Environmental Law was put into practice for implementing Articles related fish farms, inshore marine farms were moved to new offshore areas.

In addition to marine aquaculture competitions and conflicts have been wearied well up increasingly until now which were started to encounter with other sectors, after rapid development of other sectors, especially tourism and increasing of environmental sensibility as from 2000. There is confronted with same problems by reason of graduated conflicts between aquaculture and others and amendments of regulations without enough consultations and agreements with stakeholders.

4. SPATIAL PLANNING POLICY WHICH INCLUDES TURNING CRISES TO ADVANTAGE IN OFFSHORE MARICULTURE

Up to now, all progressed developments and encountered difficulties in the sector have been provided an opportunity of revaluation and restructuring themselves for either public bodies or private sector.

New regulations is into force and existing ones is amended which meet requirements and coherent with EU regulations. For instance, Aquaculture Legislation was amended and aligned with EU regulations including fish welfare in 2009. In addition, notification related site selection and monitoring for fish farms were put into effect 2007 and 2009 respectively.
As a result of encountered problems, there become aware of inadequate of separate planning for sustainable management of sector and studies agreed by all stakeholders have been initiated in order to create integrated coastal plans. In this respect, after the new Environmental Law was put into force, new marine culture sites, which are far away the shore and intensively cultured provinces, was determined by especially Ministry of Food, Agriculture and Livestock, Ministry of Environment and Urban Planning (MEUP) and all stakeholders and then all inshore marine farms moved these sites.

In addition to regulation and planning, national and international projects have been carried out in a scientific way in order to sustainability of aquaculture sector. These projects are:

- FAO Technical Cooperation Project (TCP/TUR 3101) on Developing a Roadmap for Turkish Marine Aquaculture Site Selection and Zoning Using an Ecosystem Approach to Management.
- National Project on Determination of Environmental Impacts of Fish Farm to the Marine Ecosystem

Turkish Government developed a National Mariculture Development Plan (NMADP) for minimizing conflicts and to providing stable grounds for the future growth of the marine aquaculture sector in 2008. Integrated coastal zone management models were developed and implemented with the consensus of all related institutions and stakeholders and inshore marine fish farms were moved to new allocated offshore zones in 2009.

6. CONCLUSION

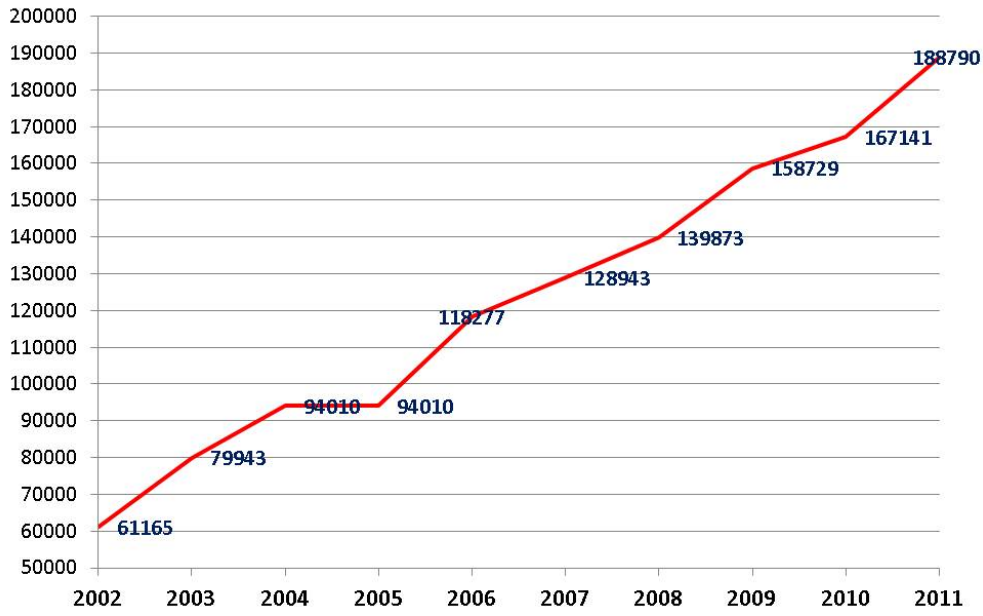
World total fisheries production was 149 billion tons and 49% of this comes by aquaculture in 2011. Proportion of aquaculture in total production has been increasing rapidly. Aquaculture is most growing food production sector in the World in the past decade.

Turkey has great potential for aquaculture developments with inland and marine resources. Total fisheries production in 2011 was 703,545 tons and contribution of aquaculture was 27% as a volume, and 52% value in total fisheries production. There are 2.163 fish farms in 2012 with 404,634 tons per year, including 1,791 inland fish farms with 225,304 tons capacity and 372 marine farms with 179,330 tons capacities in Turkey.

Although it is very young, there have been showed very important improvements in aquaculture sector (Figure 3):

- In recent 10 years, aquaculture production is increased 209%.
- Aquaculture was recorded as fastest growing sector in Turkey in the past two years.
- Turkey now has a 25 % share of the European sea bream and sea bass market.
- Majority of the fish production, being the only animal product exported into EU countries in Turkey.
- Turkey is the 3rd fastest growing country in the World in the aquaculture.
- Turkey has occupied first place in trout production among European countries.
- Turkey has occupied second place in sea bass and sea bream production in the World.
- Approximately 25.000 people are employed in the sector.
- Latest developments in the aquaculture sector place Turkey in an important position both in the Mediterranean basin and among the EU countries.

Figure 3 Growing trend of aquaculture sector in the past decade in Turkey



Source: MoFAL & TURKSTAT

In addition to all succeeded improvements, there have been faced with a host of serious conflicts and problems between the sectors from time to time for being coastal areas which are also very important both aquaculture and other coastal sector.

Nevermore, all parties have learned to be necessary making coastal plans with participatory and conciliatory approach from encountered conflicts and problems and to be enabling successful management by using collective intelligence.

On these grounds, there were determined new offshore zones and incorporated into Integrated Coastal Plans, after then, all inshore sea farms were moved to new determined offshore areas.

Thanks to this, encountered crisis was converted into opportunity and Turkey was assumed the status of making marine aquaculture under the best environmental conditions among the countries Mediterranean and Europe. Thus, conflicts were minimized and provided largely consensus by other sectors.

Lastly, same projects have been carried out and participated in national, regional and international level such as Developing a Roadmap for Turkish Marine Aquaculture Site Selection and Zoning Using an Ecosystem Approach to Management, Determination of Environmental Impacts of Fish Farm to the Marine Ecosystem, Indicators for Sustainable Development of Aquaculture and Guidelines for their use in the Mediterranean and Developing siting and carrying capacity guidelines for Mediterranean aquaculture.

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The Success Story Of Kilic Deniz In Turkish Off-Shore Sector

Öznur Yıldız Basruh
Project and Quality Systems Manager
Kilic Sea Products



BIOGRAPHY

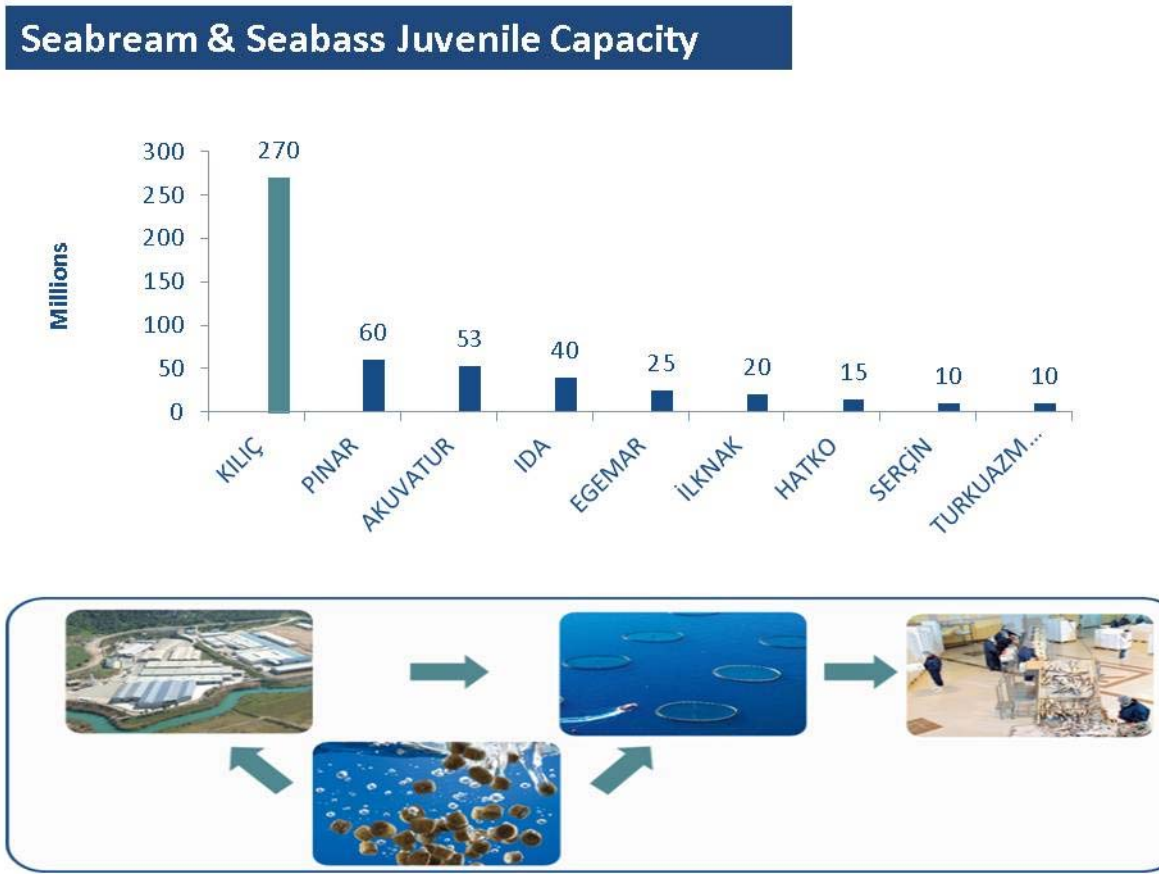
Öznur Yıldız is an Engineer of Agriculture (Department of Aquaculture) and is educated to Masters level. She is the Manager of the Quality Management Systems and Project Manager at Kılıç Holdings. She is responsible for managing all of the Company's fish farms & new research projects, food certification, environmental and quality management systems. She has more than 18 years of experience in the Aquaculture sector, specialising in the farming &proccessing of Sea Bass, Sea Bream and Trout.

Abstract

- **Kılıç Group Presentation**

- October 2012
- Historical Overview
- Highlights of Kılıç
- Founded in 1993, Kılıç Deniz has become the leading Turkish aquaculture company with an annual production capacity of 393.5 million juvenile fish (as of year 2012, seafish and trout included).
- Kılıç Deniz facilities are composed of 36 fish growing units, 5 juvenile fish hatcheries, 2 adaptation units and 2 fish feed production sites and 3 processing and packaging facilities.
- Housing a fully integrated processing structure and a total production capacity of 34,315 tons of harvested fish in 2012.
- Kılıç Deniz is also the market leader in providing juvenile fish to other aquaculture producers in the country
- The Company's main production plants are located in Muğla and Aydın, where seabream and seabass are produced.
- Kahramanmaraş, Kayseri and Gaziantep facilities were established to produce trout on dam lakes.
- Starting from the hatcheries and reaching consumers through distributors and retail channels, Kılıç Deniz can boast its strong performance due to a fully integrated aquaculture operations.
- The 5 hatcheries and 2 adaptation units, where juvenile fish is brought in, vaccinated and fed and grown to a certain weight, is the starting point of the operations.
- Once the fish have reached adequate weight, they are then transferred to the aquatic growing units, where they are fully grown to ready-for-sale size and then transferred to the processing plants.

- Supporting adaptation units and cages, Kılıç Deniz also has a fish-feed production facility, therefore capturing the whole vertical integrated aquaculture business model.
- The fish are placed in expandable polystyrene «EPS» boxes and sent for shipment to export markets and domestic customers
- The Company also sells cleaned, packaged, fillet fish and intends on growing this business unit and also produces the EPS boxes that are needed for shipment

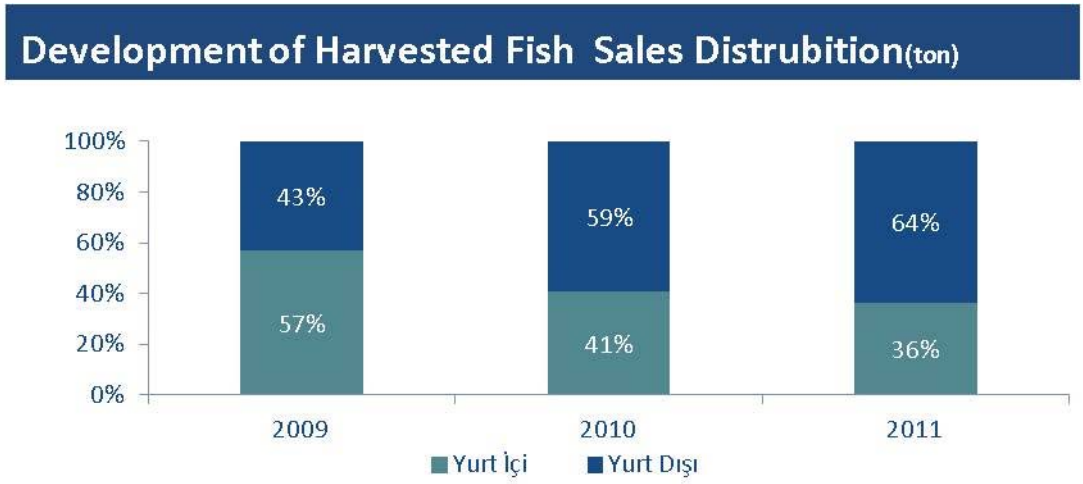


- **An International Player**

- Kılıç Deniz
- With constantly increasing capacity and production volume Kilic Deniz has become an important player in Mediterranean Region by focusing on foreign sales.
- 64% of 2011 harvesting fish volume was sold in foreign areas (2003; Italy).
- According to data of "Turkish Exporters' the company took 287th place among the largest exporting companies in Turkey in 2010.
- Kilic Deniz is the leading player in Turkish aquaculture, the only sector in which Turkey can export food animals to Western markets.

- **Sustainable Strong Financial Performance**

- Kilic Deniz took 271st place in the "Year 2010 Production to Sales ISO 500" list.
- Kilic Deniz increased sales figures of 2010 and 2011 by 45% and 46%, respectively.
- The growth in the sales of the company is supported by the increase in harvesting and fingerling fish production of the company, as well as the increasing fish prices around the globe.

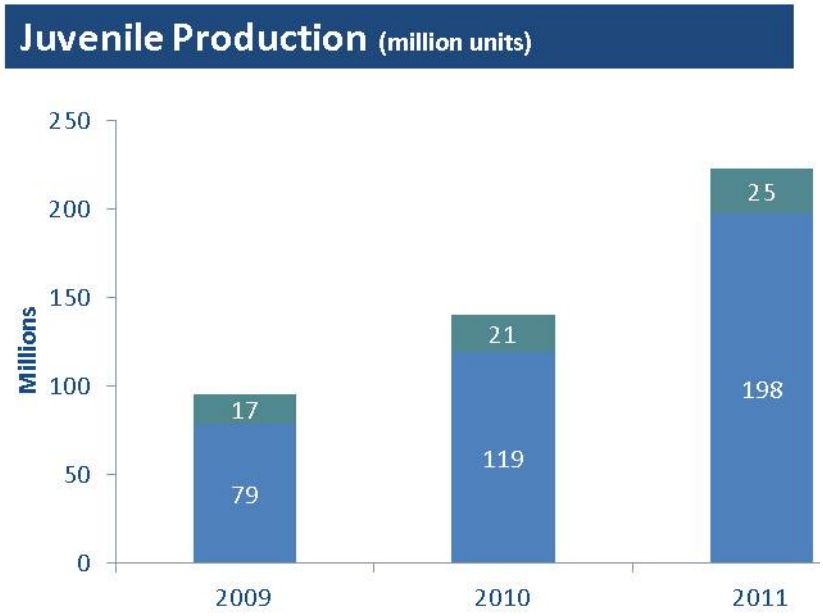


- **Organizational Structure**

- With more than 20 years' history in the sector, Chief Executive Officer, who is also a Founding Member, and Chief Production Officer of the Company have vast experience in production processes and market dynamics.
- The upper management of the Company (CEO and CFO) convey to the company their significant experience and knowledge gained in various international companies.
- In 2012 the Company has started to use SAP system, which is expected to make significant contributions to full integration structure of the Company.
- The Company is audited by international independent audit firm PricewaterhouseCoopers.

- **Growing Market**

- As the natural fish stock in seas decrease, aquaculture arises as the alternative to meet fish demand.
- While global aquaculture has grown by 5.8% between 2001 and 2009 based on CAGR (Compound Annual Growth Rate) figures, between 2001 and 2010 Turkish aquaculture sector has shown a growth of 10.7% based on CAGR figures.
- The fish produced by aquaculture change according to geography. Mediterranean basin is mainly home to bass and bream production.
- 73% of bass and bream aquaculture in Mediterranean basin is performed by Turkey and Greece.
- Despite rising domestic consumption, both countries sell the largest part of their bass and bream production to foreign markets like Italy, France and Spain. Growing markets of Russia and Middle Easy have also proved to be important export regions in recent years.
- Kilic Deniz is the largest Turkish aquaculture company supplying the abovementioned foreign markets.
- Hatcheries and Adaptation Facilities
- In 1997, Kılıç Deniz launched seabream and seabass juvenile production in Ören Hatchery with an annual production of 4 million.
- Today, with an annual juvenile capacity of 343,5 million, Kılıç Deniz owns one of the largest seabream and seabass juvenile production capacity in the world. In addition, Kılıç Deniz operates one of Turkey's largest trout facility in Kahramanmaraş with an annual capacity of 50 million juveniles.
- The facilities for production of seabeam and seabass are located in Muğla and Aydın while the trout production takes place in Kahramanmaraş, Kayseri and Gaziantep.

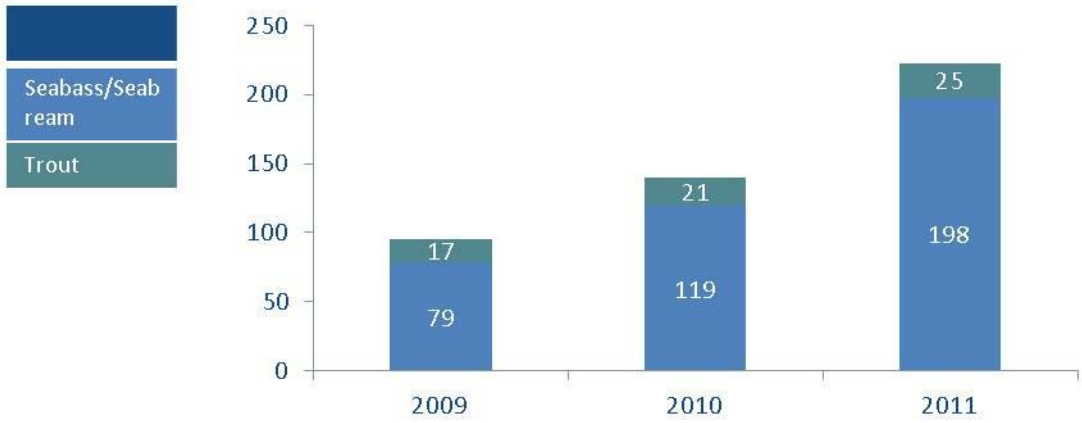


Production Capacity

Facility	Juvenile Capacity (million)	Fish Type
Bafa	146	Seabass/SeaBream
Ören	80	Seabass/SeaBream
Akarca	39	Seabass/SeaBream
Yaşyer	39	Seabass/SeaBream
Güvercinlik	39,5	Seabass/SeaBream
Kahramanmaraş	50	Trout

- **Hatcheries and Adaptation Facilities**

- Hatchery is where the breeding procedure starts. In hatcheries, it is possible to acquire eggs any month of the year by adjusting various factors such as water temperature and light intensity
- Fish eggs reach larvae state in 30 to 35 days and are nurtured by three kinds of larvae feed: algae, rotifer and artemia. Once reached larvae state, seabass and seabream need 35 and 45 days, respectively for the adaptation facilities
- And also R&D department works on new species Red Porgy, Sole, Common Dentex, White Grouper, Sharp snout Sea bream, Corb, Long fin Yellowtail, Turbot, sturgeon
- The environment of adaptation facilities is highly regulated in order to adapt juvenile fish to sea conditions



- At the end of adaptation period, fish reach a weight of 2.5 to 5 grams and become juvenile fish. The period of fish from eggs to juvenile takes approximately 120 days
- Juvenile fish is either sold to other fish farms or transferred to Kılıç Deniz's cages
- **Fish Farming - Cages**

- Kılıç Deniz manages offshore fish farming for seabream and seabass and inland fish farming for trout

Offshore Fish Farming

- Seabream and seabass fish farming takes place in Bodrum, Muğla and in Didim, Aydın with a total capacity 27.590 tons
- From the placement of juveniles from hatcheries into cages to the harvested period of seabass and seabream, the process requires extensive diligence and inspections ensured by experienced engineers, underwater divers and expert personals as well as underwater cameras
- Daily fish feeding are provided through an automatic process and regulated under the surveillance of underwater cameras.
- Caging Facilities are committed to obey the environmental legislation and always ensure to keep environmental effects in minimum
- Kılıç Deniz establishes its commitment to protecting environment by holding universally-accredited certificates such as ISO 14001 (Environmental Management System certificates)

Inland Fish Farming

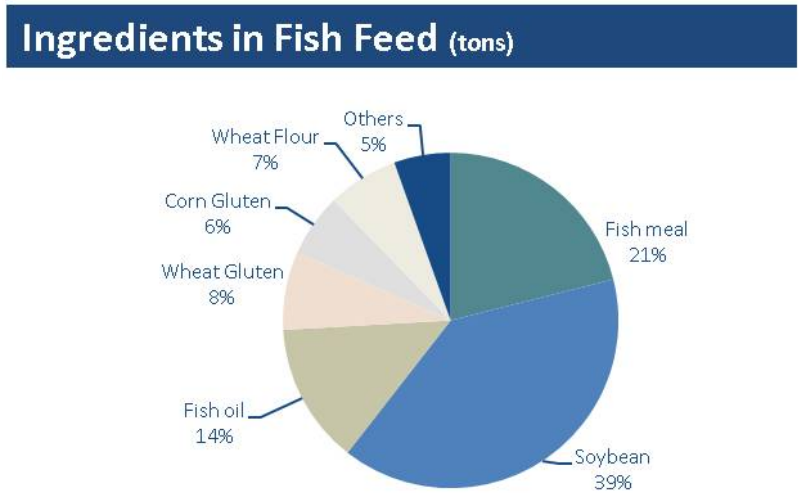
- Trout farming has been performed in Kahramanmaraş Sır Dam, Kayseri Bahçecik Dam and Gaziantep Karkamış Dam reservoirs since 2010. The production in all reservoirs reached a capacity of 6.725 tons.
- Fish remain in these cages for the remainder of their breeding period
- On average, it takes approximately 12 to 15 months for sea bream and 18 to 22 months for sea bass to reach their average, portion sizes

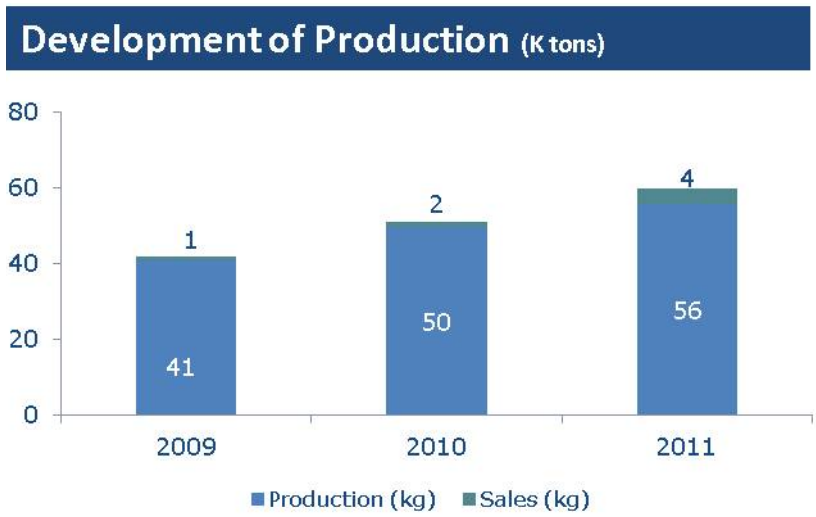
- **Processing & Packaging**

- There are two processing and packaging facilities that Kılıç Deniz operates. The facility for processing and packaging seabream and seabass is located in Milas and the facility for trouts processing and packaging is located in Kahramanmaraş.
- The facility in Milas was founded in 2000 and has a capacity of 19 584 tons/year. The facility in Kahramanmaraş was founded 2008 and has a daily capacity of 6 000 tons/year.

- **Fish Feed Production**

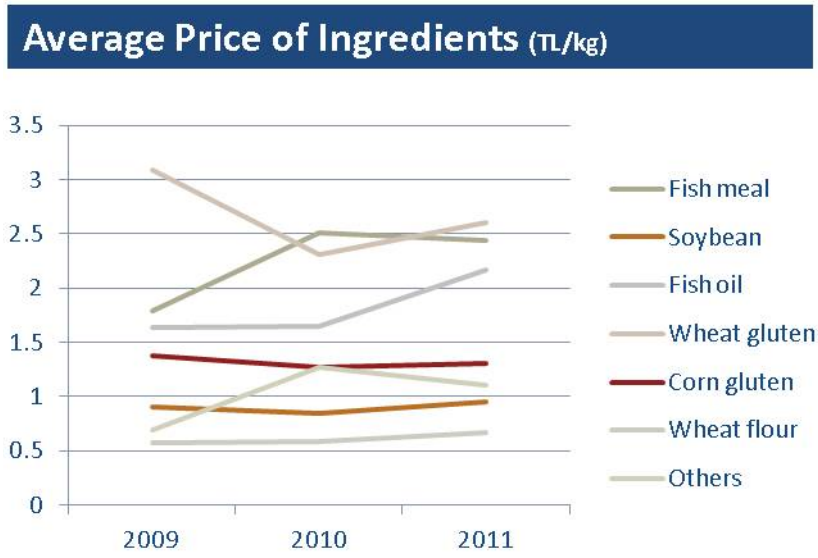
- The fish feed facility, one of the largest extruder fish feed factory in Turkey with an annual capacity of 80.000 tons, operates under Aqua-K brand
- The fish feed facility consists of 2 factories operating next to each other and a warehouse in which fish feed bags are stored before shipped to the cage units and customers
- The factories are located in Milas Muğla, in a close proximity to the cages
- Most fish feed are produced for the internal usage of the cages facilities. As the demand from the cages are determined by the known number of fish in the cages and also backed by historical usage trends, the fish feed facility can plan production in advance with close proximity
- The facility utilizes cutting-edge production systems such as ECS (expansion control systems) and VC (vacuum coating), ensuing world class production standards
- The facility holds accredited world-standard certificates such as ISO 9001 Quality Management Certificate, ISO 22000 Food Safety Management System and GLOBAL G.A.P - Mixed Feed Production Standard





- **Fish Feed Production**

- With enough capacity in hand, Kılıç Deniz has been able to increase its production depending on the demand from the cage facility
- Most of the fish feed produced were for the use of the cage facilities, which accounted for 93% of total production in tons.
- The scale of production provides a competitive advantage over its rivals, allowing Kılıç Deniz to negotiate at better terms with feed raw material suppliers



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Organizatörler adına, Mercator Media, takımım ve ben serisindeki dördüncü konferans olan Açık deniz Deniz Ürünleri Yetiştiriciliği Konferansına hoş geldiniz demek istiyoruz.

Bu yılki konferansın Türkiye'de düzenlenmesi tartışmaları 2010 konferansında başlamıştır ve T.C. Gıda, Tarım ve Hayvancılık Bakanlığı'na bütün destekleri ve Super yat Lamia'da düzenlenecek olan gala yemeğine ev sahipliği yaptıkları için teşekkür ederim. Bakanlık'tan Hayri Deniz'e tüm emekleri için özellikle teşekkür ederim.

Ayrıca ilerici oturum başkanımız Neil Sims'e, Avrupa Su ürünleri Yetiştiriciliği Topluluğu'ndan Alistair Lane'e , üçüncü gündeki balık çiftliği gezisi için Çamlı/Pınar ve İzmir Balık Yetiştiricileri Derneği'ne, sponsorlarımız olan: Proflex/Flexabar, Fusion Marine,Kılıç, Skretting ve Akva'ya teşekkür etmek istiyorum.

Son iki yılda su ürünleri yetiştiriciliği Türkiye'deki en hızlı büyüyen sektördür ve ülkede şu anda 2100'den fazla balık çiftliği bulunmaktadır. Bu çiftliklerin yaklaşık yarısı denizdedir ki bu da Türkiye'nin toplam su ürünleri üretim tonajının %53'ünü temsil etmektedir.

Uluslararası alanda Türkiye, su ürünleri yetiştiriciliği sektöründe en hızlı büyüyen üçüncü ülkedir ve bu nedenle 21'den fazla ülkenin delegelerinin bu yılki Açık deniz Deniz Ürünleri Yetiştiriciliği Konferansına katılmak için Türkiye'ye gelmeleri şaşırtıcı olmamalıdır.

Çeşitli konuşmacıları ve ilginç programıyla iki günlük konferanstan, kahve aralarındaki iletişim fırsatlarından, Bakanlığın gala yemeğinden ve 19.Ekim'deki balık çiftliği gezisinden keyif alacağınıza inanıyoruz.

Ben ve ekibim, bu birkaç günde sizinle tanışmayı ve bu önemli sektördeki gelişmeleri öğrenmeyi ve tartışmayı dört gözle beklemekteyiz.

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Durali KOÇAK



ÖZGEÇMIŞ

Ankara Üniversitesi Veterinerlik Fakültesinden 1987 yılında mezun oldum. Aynı üniversitede "Hayvan Besleme ve Beslenme Hastalıkları" konusunda Doktora yaptım.

Gıda Tarım ve Hayvancılık Bakanlığında 2011 yılından itibaren "Balıkçılık ve Su Ürünleri Genel Müdürü" olarak görev yapmaktayım.

Daha önce sırasıyla; 1988 yılında Tarım ve Köyişleri Bakanlığı Malatya İl Müdürlüğünde "Veteriner Hekim" olarak, 1989-1997 yıllarında Lalahan Veteriner Araştırma Enstitüsünde "Araştırmacı" olarak, 1998-2003 yıllarında Koruma ve Kontrol Genel Müdürlüğünde "Yem Hizmetleri Şube Müdürü" olarak ve 2004-2011 yılları arasında Koruma ve Kontrol Genel Müdürlüğünde "Su Ürünlerinden Sorumlu Genel Müdür Yardımcısı" olarak görev yaptım.

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Neil Sims

Kampachi Balık Çiftlikleri Kurucu Ortağı ve Eş İcra Başkanı



Neil.Anthony Sims Kona, Hawaii'de ve La Paz , Mexico'da kurulmuş LLC, Kampachi çiftliklerinin ortak-kurucusu ve eş-CEO'sudur. Son 20 yılda, Sims inci istiridyesi üretiminde, açık deniz su ürünleri yetiştiriciliği mevzuatı ve düzenlemeleri, deniz balığı kuluçka teknolojisi ve son olarak da, bağlanmamış açık deniz 'sürükleyen (drifter) tekne ağıllar ' : Velella Projesi gibi çığır açan gelişmeleri başaran takımları yönetmiştir.

Sims 2001 yılında kurulan Kona Blue Water Çiftliklerinin ortak kurucusudur, çiftlik ileri kuluçka teknolojileri kullanarak 'yetiştirilmesi zor olan' kapan levrek, lağos, sarıkuyruk balığı larvalarını üretmiştir. Bu üretim darboğazını aşmak, Amerika Birleşik Devletleri'ndeki ilk entegre deniz balığı üretim istasyonları ve açık okyanus balık çiftliğinin oluşmasına yol açmıştır. 2008 yılı itibariyle Kona açık deniz sahasındaki sualtı ağıllarından yıllık 500 tondan fazla sashimi ayarında Kona Kampachi (1 milyon pounddan fazla) elde edilmiştir.

En son olarak Sims, yüksek değerli ılık su deniz balığının küresel olarak ticari yetiştiriciliğini genişletmek ve uzaktan kontrollü açıkdeniz sistemleri, daha sürdürülebilir ve ölçülebilir yemler ve yeni türler geliştirme gibi yeni nesil teknolojileri takip etmek için kurulan Kampachi Çiftliklerinin, LLC, ortak kurucusudur. Ayrıca, deniz kaynaklarının ve yaşam ortamının korunarak rasyonel ve sorumlu açık okyanus üretimini dengelemeyi savunan açık okyanus deniz tarımı ticaret birliği olan Okyanus İdarecileri Enstitüsünün kurucu başkanıdır.

Sims ayrıca Birleşmiş Milletler Gıda ve Tarım Örgütü, bölgesel acenteler ve devletlere danışmanlık hizmeti vermekte ve şu anda Seriola –Cobia Su ürünleri Diyaloğu Yürütme Komitesi'nde ve WWF'nın sponsor olduğu Su ürünleri İdarecilik Konseyi'nin Teknik Danışmanlık Kurulu'nda üye olarak yer almaktadır. Sims Kona Hawaii'de ikamet etmektedir.

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1 – OTURUM

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Bu gelişme mi? 2006-2012 yılları arasındaki Açıkdeniz Deniz Ürünleri Yetiştiriciliği Konferanslarının değerlendirilmesinde metrik sistemin kullanılması

Neil Sims
Kampachi Balık Çiftlikleri Kurucu Ortağı ve Eş İcra Başkanı



ÖZGEÇMIŞ

Neil.Anthony Sims Kona, Hawaii'de ve La Paz, Mexico'da kurulmuş LLC, Kampachi çiftliklerinin ortak-kurucusu ve eş-CEO'sudur. Son 20 yılda, Sims inci istiridyesi üretiminde, açık deniz su ürünleri yetiştiriciliği mevzuatı ve düzenlemeleri, deniz balığı kuluçka teknolojisi ve son olarak da, bağlanmamış açık deniz 'sürükleyen (drifter) tekne ağıllar' : Velella Projesi gibi çığır açan gelişmeleri başaran takımları yönetmiştir.

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Açıkdeniz deniz ürünleri yetiştiriciliği için bir yer oluşturma: Okyanus yönetimi, planlama ve endüstri etkileşimlerinin tehdit ve fırsatları

Paul Holthus
Dunya Okyanus Konseyi icra Direktöru



ÖZGEÇMIŞ

İcra direktörü, Dünya Okyanus Konseyi

Paul, 'Birleşik Okyanus Sorumluluğu' üzerine uluslararası iş liderlik birliği olan, Dünya Okyanus Konseyi'nin kurucu icra direktörüdür. DOK ortak deniz sürdürülebilirliği sorunlarına yönelerek benzersiz bir okyanus iş topluluğu ve özel sektör liderliği yaratarak petrol/gaz, taşımacılık, balıkçılık, su ürünleri, turizm, açık deniz yenilenebilir ve diğer okyanus endüstrilerini bir araya getirmektedir. Paul, Birleşmiş Milletler Çevre Programı ve uluslararası çevre organizasyonları'nda kıdemli pozisyonlarda ve Dünya Koruma Birliği Küresel Deniz Programı'nda Genel Müdür Yardımcısı olarak görev yapmıştır.

1998'den beri deniz ortamının sürdürülebilir gelişimi için pratik çözümler geliştirmek üzere özel sektörle birlikte çalışmaktadır. 30 u aşkın ülkede şirketler, topluluklar, endüstri kuruluşları, Birleşmiş Milletler acenteleri, uluslararası sivil toplum örgütleri ve kuruluşlarda yetkili pozisyonlarda bulunmuştur. Holthus California Universitesi ve Hawaii Üniversiteleri'nden Su Kaynakları Yönetimi ve Uluslararası İşletme Bölümlerinden iyi derecelerle mezun olmuştur.

ÖZET

Açık Deniz Su Ürünleri Yetiştiriciliği için Alan Temin Etme: Okyanus Yönetimi, Planlamada ve Endüstri Etkileşimlerinde tehditler ve fırsatlar

Açık deniz ürünleri yetiştiriciliği için alan tahsisinin geleceği, okyanus yönetimi, okyanus planlamasının gelişimi ve diğer okyanus kullanım çeşitleri ve düzeylerindeki artışlar nedeniyle zorlaşmaya ve karmaşıklaşmaya başlamıştır. Okyanus en son yönetilen ekosistem olduğu için, açık deniz su ürünleri yetiştiriciliğindeki riskler ihmal edilmeye başlanmıştır. Açık deniz petrol ve gaz, taşımacılık, limanlar, yenilenebilir enerji, balıkçılık ve diğer okyanus kullanımları deniz ortamına gittikçe artan bir baskı uygulamaktadır. Okyanuslarda faaliyet gösteren tüm sectörlerde, okyanus aktivitelerin den kaynaklanan birikimin etkileri ile ilgili araştırmalar gittikçe artmaktadır. Okyanus endüstrileri açık

okyanus alanları için, deniz parkları yaratmak gibi, artan sayıda uluslararası, bölgesel ve ulusal okyanus yönetimi gelişimine ihtiyaç duymaktadır. Deniz koruması amacıyla deniz alanları tahsis etmek için AB, ABD ve Avustralya'da ve diğer yerlerde Mekansal Deniz Planlaması (DMP) geliştirilmektedir. Yeni kurulan açık deniz su ürünleri yetiştiriciliğinin, mevcut okyanus kullanıcıları ve büyüyen okyanus koruma hareketinin önünde nasıl ayakta duracağı belli değildir. Açık deniz su ürünleri yetiştiriciliğinde okyanus yönetiminde bulunan sorunlar, paydaşlar ve süreçlerin anlaşılması çok önemlidir. Okyanus politikası ve planlama gelişmeleri yatırım ve gelişimde öngörülebilir bir çerçeve sağlamak, açık deniz su ürünleri yetiştiriciliğinde gelecekle ilgili hem zorluklar hem de fırsatlar sunmaktadır. Dünya Okyanus Konseyi aracılığıyla okyanus politikası ve planlamasına girmek ve işbirliği yoluyla iş menfaatleri yaratmak için uluslararası sektörler arası endüstri liderliği geliştirilmektedir.

Balık çiftliklerinin açık denize taşınması: FAO'nun teknik, çevresel ve politika göstergelerine bakışı

Alessandro Lovatelli

FAO Balıkçılık ve Su Ürünleri Yetiştiriciliği Bölümü, Su Ürünleri Yetiştiriciliği Yönetimi ve Koruma Servisi Su ürünleri Yetiştiriciliği Yetkilisi



ÖZGEÇMIŞ

Alessandro Lovatelli– Bir deniz biyoloğu ve su ürünleri yetiştiricisi olarak lisans ve yüksek lisans derecelerini sırasıyla Birleşik Krallık Southampton ve Plymouth Üniversitelerinden almıştır. Deniz tarağı kuluçka biyoloğu olarak endemik ve egzotik kum midyesi (Tapes spp.)üzerinde çalışırken bir İtalyan şirketi tarafından işe alınınca, 1985'te su ürünleri yetiştiriciliği endüstrisine girmiştir. FAO ile ilgili ilk deneyimi bir FAO/UNDP bölgesel projesi ile ilgili çift kabuklular uzmanı olarak çalıştığı 1987'ye kadar uzanır. Daha sonraki FAO görevi , maddi olarak İtalyan hükümeti tarafından desteklenen Meksika'da bir kültür balıkçılığını geliştirme projesiydi. 1993 – 1997 arası Vietnam, Somali ve tekrar Güneydoğu Asya'da çalıştı. Vietnam'da büyük bir AB projesinin su ürünleri ve balıkçılık bölümünün on tane bölgesel su ürünleri yetiştiriciliği uygulama, eğitme ve genişletme merkezine liderlik yaptı. Somali'de Avrupa Komisyonu adına su ürünleri ve balıkçılık baş danışmanlığı yaptı. Daha sonra tekrar Vietnam'da Danimarka destekli Balıkçılık Master Plan Projesi kapsamında takım liderlerinden biri olarak Danimarka merkezli (şimdi Eurofish) FAO/Eastfish projesine bağlı su ürünleri yetiştiriciliği danışmanı olarak FAO tarafından görevlendirilmiştir. 2001'de bir kez daha Roma'daki FAO Balıkçılık ve Su ürünleri yetiştiriciliği departmanına katılmıştır. Son zamanlardaki aktiviteleri deniz/ açık deniz su ürünleri geliştirme , yetiştirme teknolojileri transferi ve kaynak yönetimi üzerinde odaklanmaktadır. Bay Lovatelli, özellikle deniz ürünleri yetiştiriciliğinin geliştirilmesi konulu FAO'ya ait birkaç teknik inceleme ve makaleyi koordine etmiş ve ortak yazarı olmuştur.

Küresel Okyanus deniz ürünleri yetiştiriciliği ile ilgili Bremerhaven Bildirgesi (Yeni bir endüstrinin gelişimi için öneriler)

Harald Rosenthal
Su Ürünleri Yetiştiriciliği Forumu Oturum Başkanı &: Dünya Mersin Balığı Koruma Derneği Başkanı



ÖZGEÇMIŞ

Dr. Rosenthal, 1989'a kadar Almanya Helgoland Deniz Biyolojisi Enstitüsü'nde bilim adamı ve sonrasında 2003'te emekli oluncaya kadar Kiel Üniversitesi Balıkçılık Biyolojisi ve Su ürünleri Yetiştiriciliği'nde profesör olarak çalışmıştır. Kanada, İskoçya, Polonya ve 1989'a kadar Almanya Helgoland Deniz Biyolojisi Enstitüsü'nde bilim adamı ve sonrasında 2003'te emekli oluncaya kadar Kiel Üniversitesi Balıkçılık Biyolojisi ve Su ürünleri Yetiştiriciliği'nde profesör olarak çalışmıştır. Kanada, İskoçya, Polonya ve Yunanistan'dan birçok onur dereceleri vardır. Prof. Rosenthal dünyanın çeşitli yerlerinde soyu tükenmenin eşiğinde olan eski balık türlerinin rehabilitasyon programları ile ilgili konularla uğraşan küresel bir platform olan Dünya Mersinbalığı Koruma Topluluğunun kurucu ve vekil başkanıdır.

Ayrıca İsveç Kraliyet Bilim Akademisinin (Tarım, Ormancılık ve Balıkçılık) üyesidir. Uygulamalı Balık Bilimi dergisinin baş editörü ve Acta Adriatica'nın yardımcı editörü ve Acta Ichtyologia and Piscatoria (Polonya) dergisinin yazı işleri kurulu üyesidir. Akuakültür, Deniz Biyolojisi, Helgoland Deniz Araştırmaları ve Su ürünleri Mühendisliği dergilerinin yazı işleri kurullarında 20 yıldan fazla hizmet vermiş ve sonuncu dergide yazı işleri kurulu üyesidir. 50 yıllık profesyonel yaşamında, birçok Doktora ve diploma öğrencisine danışmanlık yapmış ve 10'dan fazla ülkenin üniversitelerinde ders vermiştir. 20 den fazla ülkede projelerde çalışmış ve 400 ü aşkın bilimsel yayında yazar ya da ortak yazardır. Ayrıca su ürünleri yetiştiriciliği, deniz ortamı ve mersin balığı koruma konularıyla ilgili birçok uluslar arası konferansı organize etmiş ya da katılmıştır.

Bern Konvansiyonunda sunulan Mersin balığını koruma hareket planını hazırlamakta etkili olmuş ve yakın gelecekte yayınlanacak olan Türk Mersin balığı Hareket planının belirlenmesinde yardımcı olmuştur.

Birçok yıldır emekli olmasına karşın, Prof. Rosenthal hala araştırma çalışmalarına aktif olarak katılmakta, yurt dışı üniversitelerde ders vermekte ve Avrupa ve deniz aşırı ülkelerde araştırma programlarına danışmanlık yapmaktadır.

Kendisi Mart 2012'de Bremerhaven'da yapılan 'Bremerhaven Su ürünleri Yetiştiriciliği Forumu' nun program başkanı ve düzenleyicisidir ve ana çalıştay olan ' Açık Okyanus Su Ürünleri Yetiştiriciliği Geliştirilmesi – Vizyondan Realiteye: Açık deniz yetiştiriciliğinin geleceği' başlıklı çalıştayı yönetmiştir. Daha sonra oturum başkanları, konuşmacılar, program komite üyeleri ve 16 ülkeden gelen birçok katılımcının imzaladığı Bremerhaven Bildirgesiyle sonuçlanan konferans kendisinin rehberliğinde hazırlanmıştır. Bildirge İzmir Açık deniz Su Ürünleri Yetiştiriciliği Konferansının ilk gününde (17. Ekim. 2012) sunulacaktır.


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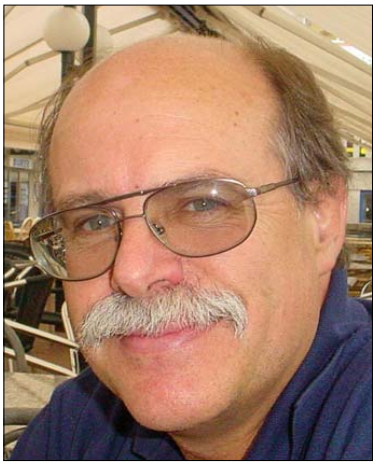

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2 - OTURUM

PLANLAMA VE GELIŞME- ULUSLARARASı ÖRNEK ÇALıŞMALAR

Filipinler'de sürdürülebilir kafes balıkçılığı için su ürünleri yetiştiriciliğiparklarının planlaması ve yönetimi

Patrick G White
Kıdemli Su Ürünleri Yetiştiriciliği Danışmanı



ÖZGEÇMIŞ

Patrick G. White ılıman ve tropik deniz balığı/ karides üretiminde, su ürünleri yetiştiriciliğinin çevreye etkisi konusunda, alan seçme uygunluğunda ve su ürünleri yetiştiriciliğinde iklim değişikliği etkileri konusunda uzmandır. Su ürünleri yetiştiriciliği sektöründe 30 yıldan fazla tecrübesi vardır. Ve Akdeniz Bölgesi'nde 20 yıldan fazla, Orta Doğu'da 5 yıldan fazla süredir çalışmaktadır. Suudi Arabistan, Umman ve Kuveyt'te çalışmıştır ve yerel türler ve çevre hakkında geniş bilgisi vardır. Coğrafi Bilgi Sistemi ve modelleme kullanarak yer belirleme projelerinde çalışmıştır.

- Suudi Arabistan'da potansiyel tatlı su, hafif tuzlu su ve deniz su ürünleri yetiştiriciliği alanlarını, su ürünleri yetiştiriciliği bölgelerinin ve sürdürülebilir taşıma kapasitesini belirlemek için,

- Tayland Krabi Bölgesi'nde potansiyel deniz kafes alanlarını belirlemek için,

- Filipinlerdeki deniz ürünleri yetiştiriciliği parkları için potansiyel alanları ve sürdürülebilir taşıma kapasitesini belirlemek için metodoloji geliştirme konularında çalışmalar yapmıştır.

ÖZET

Filipin Hükümeti, gıda güvenliği ve yoksulluğu azaltma programlarına katkı için su ürünleri yetiştiriciliğini desteklemektedir. Ancak su ürünleri yetiştiriciliği aktiviteleri iyi planlanmamış, iyi yönetilmemiş, izlenmemiş ya da düzenlenmemiş olduğu için aşırı gelişmede sıcak noktalara sebep olmaktadır. Sonuç olarak bu durum çevresel bozulmaya ve balık ölümlerine yol açmıştır.

Balıkçılık ve Su Kaynakları Bürosu, sahiller boyunca geçim kaynağı fırsatlarını sağlamak ve sorumlu ve sürdürelebilir kafes yetiştiriciliği gelişimini hızlandırmak için "Deniz Ürünleri Yetiştiriciliği Parkları" kavramını oluşturmuştur. Kafeslerde süt balığı, orfoz, denizkedisi

(siganid) ve uzun halatlarda deniz yosunu yetiştirilen deniz ürünleri parklarının sayısı 2009'da 46'dan, 2011'de 55'e çıkmıştır. Bu parklar Filipin Deniz Ürünleri Yetiştiriciliği Endüstrisini bir canlı balık ağıyla uluslararası pazara bağlamak amacıyla Doğu Kıyı şeridi ve Batı Şeridi boyunca çeşitli noktalarda stratejik bir şekilde konumlanmıştır.

Bu çalışma, Deniz Ürünleri Yetiştiriciliği Parklarında kafes yetiştiriciliği yapılabileck yeni potansiyel alanlar belirlemek için araçlar ve çerçeve geliştirmiştir. Mevcut yetiştirme parklarında daha iyi yönetim uygulamaları geliştirmek için ve artan karlılığa, sosyo-ekonomik menfaatlere ve çevresel sürdürülebilirliği geliştirecek olumlu ya da olumsuz sosyo-ekonomik etkileri ve farklı su ürünleri yetiştiriciliği iş modellerini incelemek için paydaşlarla çalışılmıştır. Çalışma, yeni uygun yetiştiricilk alanları belirlemek, bu alanların sürdürülebilir su ürünleri yetiştiricliği taşıma kapasitesini hesaplamak ve bu alanlardaki çevreye etkiyi azaltmak için yöntem geliştirmiştir.

Çalışmada, denizin açıklık düzeyini kategorize etmek için dalga modellemesi kullanılmıştır. Ayrıca alanın açıklık düzeyi, dalga boyu, batimetre ve zemin altyapısı göz önünde bulundurularak deniz ürünleri yetiştiriciliği için potansiyel yeni alanlar belirlemek için CBS (Coğrafi Bilgi Sistemi) kullanılmıştır. Alanın potansiyel sürdürülebilir taşıma kapasitesi modeli ve çevreye etkiyi azaltmak için Tropomod model kullanarak optimal planı yapılmıştır.

Bask Bölgesindeki açık okyanusta sürdürülebilir kabuklu deniz ürünleriyetiştiriciliğini geliştirme stratejisi

Dr. Diego Mendida
AZTI Tecnalia, Deniz Araştırma Bölümü



ÖZGEÇMIŞ

Dr Diego Mendiola (m), AZTI- Tecnalia'nın Deniz Ürünleri Yetiştiriciliği Teknolojisi Bölümü'nde kıdemli araştırmacı bilim adamıdır. Hayvan fizyolojisi, diri erkeliler (biyoenerjetik) ve deniz ürünleri yetiştiriciliğinde yeni türler ve teknolojiler geliştirmeyle ilgili hayvancılık stratejileri araştırmalarında geniş tecrübesi vardır. Günümüzde su ürünleri mühendisliği ve Araştırma Geliştirme ve Teknoloji İncelemenin ekonomik alanlarına odaklanmıştır. Yerel paydaşlar (balık yetiştiricileri, balıkçılar, teknoloji tedarikçileri ve üreticileri, bilim adamları, toptancılar ve yatırımcılar) arasındaki değerli iletişim kanallarını sağlayacak teknolojik ve sosyoekonomik bilgiyi toplayarak, balıkçılık ve su ürünleri yetiştiriciliği yerel deniz ürünleri endüstrisinin ara yüzünde 12 yıl boyunca çalışmıştır. Bask Bölgesi Deniz Ürünleri Yetiştiriciliği 2009-2014 Strateji planı teknik teşhisini yönetmiştir. 2008'den beri Bask Bölgesi adına JACUMAR (İspanya Bakanlığı) Bilimsel Kurulu üyesidir. 2010'dan beri Avrupa Su ürünleri Yetiştiriciliği Topluluğu Yönetim Kurulu üyesidir. Kurumsal temsilci olarak

(i) İspanya Balıkçılık ve Su ürünleri Yetiştiriciliği Teknolojisi Platformu (PTEPA)
(ii) Avrupa Su ürünleri Yetiştiriciliği Platformu (EATip)
(iii) AQUAT-Net platformu
(iv) EFARO platformuna katılmaktadır.

Avrupa Balıkçılık Fonunun (EFF) desteklediği aşağıdaki gibi birçok projede
(i) Biscay Körfezi ton balığı av teknelerinde su ürünleri yetiştiriciliği amaçlı well boat kavramının uygulanabilirliği
(ii) Biscay Körfezinde Açık Okyanus kabuklu deniz ürünleri yetiştiriciliğinin geliştirilmesi
(iii) RAS (Uzaktan erişim hizmetleri) teknolojileriyle soğuk su deniz ürünleri türlerinin üretimi üzerine fizibilite çalışmaları
(iv) Ve diğer kamu ya da özel projelerde başkanlık etmiş veya yer almıştır.

Kaçakları Önleme- Su Ürünleri yetiştiriciliğinde deniz kafesinden kaçağın boyutları ve nedenleri ve kaçakları önlemek için önlemler geliştirmek gibi AB/ FP7 destekli projelerde WP(iş paketi) lideri olarak yer almıştır.

Son zamanlarda özel şirketler için spesifik teknoloji geliştirme transfer aktivitelerinde yer almıştır. İki yüksek lisans öğrencisine danışmanlık yapmıştır. Hali hazırda, Bask Bölgesi Üniversitesi ile bağlantılı olarak su ürünleri yetiştiriciliği konulu iki doktora tezine danışmanlık yapmaktadır.

ÖZET

Bask bölgesinin açık okyanus kısmında sürdürülebilir kabuklu deniz ürünü yetiştiriciliğinin gelişimi için strateji

Son zamanlarda Bölgesel Hükümet bölgedeki yerel balıkçılık sektörüne ve gıda endüstrisine sürdürülebilir ve tamamlayıcı aktivite yaratmak amacıyla su ürünleri yetştiriciliğini desteklemeye karar vermiştir. Açık denizi üretimi gel git , alt gel git ve açık okyanus çevresinde çevre koruma ve denizcilikle ilgili sınırlamalar ve yerel paydaşlarla yaşanan anlaşmazlıklar nedeniyle gelişmediğinden bölgede (Cantabric Denizi) kabuklu deniz ürünleri üretimi için yeni bakış açıları sunmaktadır. Akdeniz midyesi *Mytilus galloprovincialis, Avrupa yassı istiridye Ostrea edulis, Japon istiridyesi Crassostrea gigas* ve Manila deniz tarağı *Ruditapes philippinarum* bölgedeki en popular ve yaygın türlerdendir. Ancak bölgede tüketilen bütün kabuklu deniz ürünleri ithaldir.

(i) Kullanıcıların anlaşmazlıklarının azaltılması
(ii) İşletme ihtiyaçları ve teknolojilerin karakterizasyonu
(iii) Açık okyanus kabuklu deniz ürünleri yetiştiriciliği için uygun alan seçimiyle ilgili fiziksel, jeomorfik, insan kullanımı, oşinografik ve ekolojik yönler,
(iv) Pazar analizi ve
(v) İş modelleriyle ilgili veriler geliştirilmiştir.

Genel olarak, aşağıdaki konularda toplu fikir birliğine varılmıştır:

(i) Yerel kabuklu deniz ürünleri kullanımıyla ilgili sayısız niche ve pazar fırsatlarının varlığı
(ii) Kabuklu deniz ürünleri üretimi sisteminde ve işletmesinde yerel balıkçılık sektörünün ana aktör olarak girmesini sağlamak
(iii) Tüm paydaşlar arasında (ekonomik, çevresel ve sosyal olarak anlaşlır) sürdürülebilir aktivite gelişiminine taahhütte bulunma ihtiyacı.

Başlangıçta, bölgedeki ilk üretimin bol, heterojen ve farklı mevsimler arasında değişken olması beklenmiştir. Toplam 1400 ha'lık kabuklu yetiştiriciliğine çok uygun bazı düzlük alanlar başarıyla belirlenmiştir. Bölge yüksek enerjili deniz koşullarıyla bilindiği ve bundan dolayı yapısal ve işletmesel zorluklar arz etmesine rağmen, kabuklu deniz ürünlerinin su altı üretimlerinin onyıllardır sorunsuz devam ettiği diğer ülkelerdeki koşullardan farklı değildir (Langan, 2007). Bundan dolayı, Biscay körfezindeki okyanus koşullarına dayanacak ve kabuklu deniz ürünleri üretecek özel uyarlanmış su altı halat sistemleri yapılması uygun olabilir. Ancak herhangi bir ticari kaynaklı aktivite başlatılmadan önce sistemlerin belirli araştırmalarının yerinde yapılması şiddetle önerilir.

Şekil 1. Hedef bölgede deniz yüzey ısısının (maksimum ve minimum) ortalama düzeyi(range)

Batı Avustralya'da Açıkdeniz su ürünleri yetiştiriciliğinde düzenli akıntılarınyönetimi

John Eyres
Batı Avustralya Hükümeti, Su Ürünleri Şubesi, Balıkçılık YönetimiGörevlisi



ÖZGEÇMIŞ

John Eyres, Batı Avustralya Balıkçılık Bölümü'nün Su Ürünleri Yetiştiriciliği Şubesinde Balıkçılık Yönetimi Yetkilisi olarak Batı Avustralya Orta-Batı Su Ürünleri Yetiştiriciliği Bölgesi'nin geliştirilmesini koordine etmek ve planlamaktan sorumludur.

John Eyres 2007'den beri Balıkçılık Departmanında çalışmış ve Batı Avustralya'da balık yer değiştirmelerinin düzenlenmesi konusunda görev almıştır. 2005'te Edith Cowan Üniversitesi'nde Yüksek Lisansını tamamlamıştır; araştırma projesi midye yetiştiriciliğine yakın alanlardaki deniz yosunu topluluklarındaki değişikliklerin araştırılmasıyla ilgilidir.

ÖZET

BATI AVUSTRALYA'DA KIYI VE AÇIK DENİZ SU ÜRÜNLERİ YETİŞTİRİCİLİĞİNDE DÜZENLİ AKIMLARIN SEYRİ

Düzenlemelerle ilgili genel bakış
Avustralya'da su ürünleri yetiştiriciliği gelişimi özellikle kıyı bölgesi için oldukça karmaşık düzenlemelerden etkilenmiştir. Endüstriye hükümet müdahelesi azaltılmış ve su ürünleri yetiştiriciliği yönetimi ve düzenlemesi Devletin ve daha az olarak da yerel hükümetlerin sorumluluklarına girmiştir. İngiliz Uluslar Topluluğu sularında çok az su ürünleri yetiştiriciliği faaliyeti olmasına rağmen karantina gibi ilgili ulusal konularda koordinasyon olarak rolü vardır; ancak bu durum açık deniz su ürünleri yetiştiriciliğinin gelişmesiyle değişebilir.

Rekabetçi kaynak kullanımı ve toplum algısı kıyı bölgesi yönetimini etkileyen iki ana faktördür. Batı Avustralya'da toplum kıyı bölgesinde ticari balıkçılık ve açık deniz madencilik aktivitelerinin yapılmasına alışmış durumdadır. Buna karşılık su ürünleri yetiştiriciliği hala yeni bir sektör olarak algılanmaya devam etmekte ve toplumdaki birçok kişi için potansiyel olarak bilinmeyen bir şeydir. Avustralya'nın esas nüfus merkezleri özellikle kıyı bölgelerinde yerleşiktir ve bundan dolayı halk deniz ortamıyla yakın bir ilişki oluşturmuştur. Sonuç olarak endüstri yanlış yönlendirici bilgilerin sonucunda ortaya çıkabilecek olumsuz algıların giderilmesi için çalışmaya devam etmelidir.

Batı Avustralya'da su ürünleri yetiştiriciliği endüstrisi ayrı yerel hükümetlerin şartlarının yanısıra sayısı beşe kadar çıkan eyalet hükümetlerinin şartlarına da uymak zorundadır. Toplu halde bu gereklilikler endüstrinin gelişimini olumsuz etkileme olasılığı olan, tahammül edilmesi zor düzenleyici bir rejim oluşturmaktadır. Daha da karmaşık hale getirmek için, Batı Avustralya kıyılarından itibaren, üç deniz mili Devlet kontrolü altında, bunun ötesindeki sular ise İngiliz Milletler Topluluğu suları olarak kabul edilir ve farklı bir düzenlemeye tabidir. Bu düzenleme engelleri arasında, Batı Avustralya su ürünleri yetiştiriciliğindeki işletmeciler endüstrinin temelini geliştirip, genişletmeye çabalamaktadır. Devlet zorlukları kabul etmiş ve düzenlemelerle ilgili süreçleri basitleştirme işini üstlenmiştir.

Durum ve gelecek planlaması

Batı Avustralya hükümeti su ürünleri yetiştiriciliği endüstrisinin gelişmesi için mevzuattaki gereksiz engelleri kaldırmaya ve kıyı kullanım yönetiminde su ürünleri yetiştiriciliğini eşit kullanıcı haline getirilmesine çaba sarfetmektedir. Bu süreç Su Ürünleri Diaresi ve Çevre ve Koruma Dairesi arasında mutabakat anlaşması yapılmasıyla başlamıştır. Mutabakat anlaşması Balıkçılık Departmanını su ürünleri yetiştiriciliği endüstrisinin çevre yönetiminden sorumlu hale getirmektedir. Bundan önce, belirli sektörler lisans almaya ve hem Su Ürünleri Dairesine hem de Çevre Koruma Dairesine yıllık rapor vermeye mecburdu. Başta bu anlaşma endüstrinin üzerindeki baskıyı bir miktar azaltsa da hala yapılacak işler var. Anlaşmanın uygun bir şekilde uygulanması ve değerlendirmesi ve mümkün olan kısımlarda mevzuat yükünü kaldırması gerekmektedir.

Mevzuattaki zorunlulukları azaltmanın bir başka adımı da, 2011'in sonlarında, Su Ürünleri Bakanlığı'nın Batı Avustralya kıyı sularında deniz balığı için iki su ürünleri yetiştiriciliği alanının kurulması için bir finansal kaynak paketi ayırdığını ilan etmesidir.

Su Ürünleri Dairesi Batı Avustralya'nın Orta Bölgelerinde ve Kimberley'de bir Su Ürünleri yetiştiriciliği alanı oluşmasını sağlayacak projeyi yönetmektedir. Bu bölgelerin belirlenmesi ve kuruluşu bölge alanının içinde ticari projeler için çevresel onay sürecinin ana hatlarını oluşturacak ve yatırımcılar için 'yatırıma hazır' bir platform oluşturacaktır.

Bu sonuca ulaşmak için esas görev Su Ürünleri Dairesindedir, bu görev bölgeler için Çevre Koruma Yetkililerinden stratejik çevresel onayları almaktır.

Kimberley kurulacak ilk bölgedir. Su Ürünleri Dairesi 2013 sonu itibariyle oluşturulabilmesi için bölgeyi ve çevresel özelliklerini tanımlamaya başlamıştır.
Bölgeler projesi olarak özellikle büyük ölçekli su ürünleri yetiştiriciliği işlemlerini ve onayları desteklemek için teknik çalışmaların kapsamını değerlendirmek için acenteler arasında ortak bir standart oluşturmakta sorunlar ortaya çıkmaktadır.

Türkiye'nin açık deniz su ürünleri yetiştiriciliğinde krizleri avantajadönüştürmeyi de içeren başarılı alansal planlama politikası öyküsü

Hayri Deniz
T.C. Gıda Tarım ve Hayvancılık Bakanlığı, Balıkçılık ve Su Ürünleri Genel Müdürlüğü



ÖZGEÇMIŞ

Akdeniz Üniversitesi Su Ürünleri Fakültesinden 1987 yılında mezun oldum. Dokuz Eylül Üniversitesi, Deniz Bilimleri ve Teknolojisi Enstitüsünde "çipura ve levrek yetiştiriciliği" konusunda Doktora yaptım.

Halen Gıda Tarım ve Hayvancılık Bakanlığı, Balıkçılık ve Su Ürünleri Genel Müdürlüğü, Yetiştiricilik Daire Başkanlığında "Deniz Ürünleri Yetiştiricilik Uzmanı" ve "Proje Koordinatörü" olarak görev yapmaktayım.

Daha önce sırasıyla; 1988-1991 yıllarında Tarım ve Köyişleri Bakanlığı (TKB), Bodrum Su Ürünleri Araştırma Enstitüsünde "Araştırmacı" olarak, 1992-1993 yıllarında Konya Tarım İl Müdürlüğünde "Su Ürünleri Yetiştiricilik Uzmanı" olarak, 1993-1994 yıllarında Akdeniz Su Ürünleri Araştırma, Eğitim ve Üretim Enstitüsünde "Araştırmacı" olarak, 1995-2011 yıllarında Tarımsal Üretim ve Geliştirme Genel Müdürlüğünde "Deniz Ürünleri Yetiştiriciliği Şube Müdürü" olarak görev yaptım.

Yine aşağıda belirtilen uluslararası ve ulusal projelerde "Ulusal Proje Koordinatörü" olarak görev yaptım:

- *Ekosistem Esaslı Yönetim Modeli Kullanılarak Deniz Balıkları Yetiştiriciliğinde Yer Seçimi için Yol Haritasının Oluşturulması Projesi (FAO TCP)*
- *Balık Çiftliklerinin Denizel Ekosisteme Olan Etkilerinin Belirlenmesi (TUBITAK)*
- *Su Ürünleri Yetiştiricilik Ürünlerinin Hasat Sonrası Kalite, İzlenebilirlik ve Güvenilirliği Açısından Sürdürülebilir Sektörel Gelişimi Projesi (FAO Bölgesel TCP)*
- *Mersin Balığı Stoklarının Belirlenmesi, Yaşam Ortamlarının Araştırılması ve Doğal Stokların Zenginleştirilmesi (FAO TCP)*

Ayrıca; Akdeniz Genel Balıkçılık Komisyonu (GFCM) Yetiştiricilik Komitesi, Avrupa Balıkçılık Organizasyonu (EUROFISH), Akdeniz Kıyı Vakfı (MEDCOAST) ve Kıyı Alanları Yönetimi Türkiye Milli Komitesi (KAY) gibi uluslararası ve ulusal organizasyonların görev yapmaktayım.

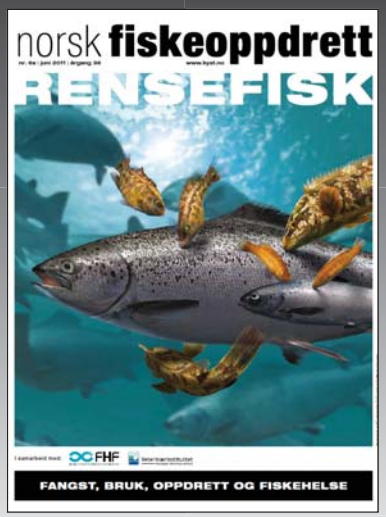
Uzmanlık alanlarım deniz ürünleri yetiştiriciliği ve yönetimi, açık deniz balık yetiştiriciliği, yetiştiricilik ve diğer kıyısal sektörlerin etkileşimi, bütünleşmiş kıyı alanları yönetimi ve lagün yönetimidir.

Üyesi bulunduğum sivil toplum kuruluşları ise Avrupa Su Ürünleri Yetiştiriciliği Derneği (EAS) MEDCOAST, WWF Türkiye, Dünya Mersin Balıklarını Koruma Derneği (WSCS), JICA Derneği ve Balkan Çevre Koruma Derneğidir (B.EN.A).

3 – OTURUM

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4 – OTURUM

TÜRLER VE YEMLER

Amerika'da Açıkdeniz Balık Yetiştiriciliği: Durum, Sorunlar ve Bakış Açılar

Darryl Jory
Küresel Su Ürünleri Yetiştiriciliği İttifakı Editörü ve Gelişim Müdürü



ÖZGEÇMIŞ

Dr Darryl Jory, küresel su ürünleri yetiştiriciliği gelişimi, yönetimi, araştırma ve öğretimi konusunda 28 yıldan fazla deneyimi olan suyla ilgili bir biyologdur. Tecrübeleri dünyada bir çok ülkede iş geliştirme, su ürünleri yetiştiriciliğine teknik destek, besin ve biyoteknoloji endüstrilerini içermektedir. Şu anda, (Florida, ABD) su ürünleri ekipmanı, teknik hizmetler ve çözüm tedarikçisi olan Akuatik Ekosistem Şirketi'nde çalışmaktadır.

Kendisi ayrıca Küresel Su ürünleri yetiştiriciliği Birliği'nin (GAA) resmi yayını olan Global Aquaculture Advocate'ın editörüdür. GAA çevresel ve sosyal açıdan sorumlu su ürünleri yetiştiriciliğini geliştirmeye adanmış kar amacı gütmeyen uluslar arası tescilli bir dernektir. Onun ticaret dergisi tüm yetiştirilmiş deniz ürünü üretimini ve pazarlama tedarik zincirini kapsar ve dünyada 80'i aşkın ülkedeki üreticiler ve endüstri liderlerine dağıtılmaktadır. Jory, Dünya Su Ürünleri Yetiştiriciliği Topluluğu'nun yardımcı editörü (1995 – 2005), Aquaculture dergisi'nde karides ile ilgili makale yazarı, tilapi ile ilgili ortak yazardır.

Lisan, yüksek lisans ve doktora derecelerini Miami Üniversitesi'nde (Miami, Florida, ABD) Deniz Biyolojisi ve Yaşayan Su Kaynakları konusunda yapmıştır, ayrıca Nova Southeastern Üniversitesi (Ft Lauderdale, Florida, ABD)de Uluslar arası İşletme ve Operasyon Yönetimi konusunda yüksek lisans yapmıştır. İlaveten Venezuela , Margarita adası, Oriente Üniversitesi'nde Fullbright burslu doktora sonrası akademi üyesidir. 1988'den beri Miami Üniversitesi'nin Rosenstiel Deniz ve Atmosferik Bilim Yüksekokulu'nda misafir profesördür.

Dr Jory 120 den fazla dünya çapında bilimsel kongre, toplantı ve çalıştaya katılmış ve açılış ve davetli konuşmacı olarak sayısız bildiri sunmuştur. Çeşitli bilimsel dergilerde su ürünleri yetiştiriciliği, besin ve deniz biyolojisi ile ilgili makalelerin ve çeşitli Amerikan ajanslarının ticari su ürünleri yetiştiriciliği önerilerinin denetçisidir. 85 adet bildiri, makale, kitap bölümleri ve monografı yayınlamıştır ve Amerikan Profesyonel Hayvan Bilimcileri Sicil Dairesi tarafından Profesyonel Hayvan Bilimcisi (PAS; Su Ürünleri Yetiştiriciliği ve Hayvan beslenmesi) olarak tasdik edilmiştir.

Portekiz'de Açıkdeniz Su ürünleri Yetiştiriciliği -Yeni türlerin gelişimi ve entegrasyonu

Pedro Pousão-Ferreira
Calheta Deniz Ürünleri Yetiştiriciliği Merkezi, INRB, I.P./ IPIMAR ve C.A.P. Andrade,
Olhao Açıkdeniz Balık Çiftliği Pilot Projesi



ÖZGEÇMIŞ

Pedro Pousão-Ferreira Olhão Açık deniz balık çiftliği pilot projesi ve Ulusal Biyolojik Kaynaklar Enstitüsü'nde Balık Çiftliği pilot istasyonu sorumlusudur. Tüm balık üretimi ve açık deniz su ürünleri yetiştiriciliği konularında büyük tecrübesi olan bir araştırmacıdır.

Carlos A.P. Andrade Madeira Bölgesel Hükümeti'nin Balıkçılık Müdürlüğü'nde Deniz ürünleri yetiştiriciliği Bölüm Başkanıdır.

Calheta Deniz Ürünleri yetiştiriciliği merkezi ve Ponta da Galé açık deniz balık yetiştiriciliği pilot projesinden sorumludur. Su ürünleri yetiştiriciliği planlaması, açık deniz balık yetiştiriciliği, balık üretimi ve larva üreticiliği gibi profesyonel alanlarda 20 yıldan fazla tecrübesi vardır.

ÖZET

Portekiz'de Açıkdeniz Su Ürünleri Yetiştiriciliği – Yeni türlerin gelişimi ve entegrasyonu

Portekiz'de açık deniz su ürünleri yetiştiriciliği işletmeleri Madeira Adası ve Güney Algarve eyaletinde kurulmuştur. Bu sunumda ülkede faaliyette olan açık deniz su ürünleri yetiştiricilik işletmleri ve orkinos tuzakları, balık kafesleri ve çift kabuklular (istiridye, deniz tarağı ve midyeler) için uzun halatlar gibi kullanılmakta olan yetiştiricilik sistemlerini anlatılacaktır.

Orkinos balığı tuzakları ve istiridye uzun halatları Algarve'deki yatırımların başını çekmektedir. Bu büyüyen sistemler sıklıkla 10.0m yükseklğinde dalgalar oluşturan güneydoğudan kuvvetli rüzgarlar ve güneybatıdan deniz fırtınaları alan açık denizde yerleşmiştir. Ancak, Akdeniz'deki orkinos balığı göç rotasındaki coğrafi durum orkinos balığı tuzakları kurulmasını kolaylaştırmakta, kıyı yukarı doğru akıntı alanları, kıyı lagünleri ve balık kafeslerinden ortaya çıkan yüksek üretkenlik çift kabukluların üretimini desteklemektedir.

Diğer yandan, Madeira Adası civarındaki temiz/ oligotrofik deniz suları ve istikrarlı ve yüksek ısılar, açık deniz balık çiftliklerini teşvikve etmiştir. İki ticari balık çiftliği çipura (Sparus aurata) yetiştiricilik faaliyetlerini sürdürmektedir.

Açık deniz su ürünleri yetiştiriciliğinin gelişimi için deniz alanlarının kurulması ve yeni balık türlerinin (Pagrus pagrus,Argyrosomus regius, Seriola spp, Pseudocaranx dentex) yetiştiriciliğinde elde edilen umut verici sonuçlar, yakın gelecekte üretim çeşitliliği ve endüstride rekabeti sağlayabilir.

Açık deniz balık yetiştiriciliği endüstrisinde kaliteli yavru teminindeki zorluklar: yarı yoğun metodolojilerde mesocosm kuluçkahaneler

C.A.P. Andrade
Yarı yoğun kültür yöntemlerini kullananCalheta Deniz



ÖZGEÇMIŞ

Carlos Andrade (Lisans, Yüksek lisans, Doktora), Portekiz Madeira Balıkçılık Müdürlüğünde Deniz Ürünleri Yetiştiriciliği Bölüm Başkanı ve Calheta Deniz ürünleri yetiştiriciliği Merkezi müdürüdür. Su ürünleri yetiştiriciliği AR-GE konusunda 20 yıllık deneyimi vardır. Kariyerine Portekiz'de açık deniz balık yetiştiriciliği teknolojilerini tanıtarak ve özel sektörle işbirliği projelerinde çalışarak başlamıştır. 2001'den beri mesocosm balık kuluçkaları tasarımı ve gelişimiyle ilgilidir. Son günlerdeki araştırma ilgi alanları ve en güncel yayınları, balık kuluçkalarında üretim kontrolü ve larva kalitesinin geliştirilmesiyle ilgilidir.

ÖZET

Natacha Nogueira Madeira Bölgesel Hükümeti Balıkçılık Müdürlüğü, Calheta Deniz Ürünleri Yetiştiriciliği Merkezi'nde araştırmacıdır. Su ürünleri yetiştiriciliğinde ilgi alanları: balık larva üretimi ve balık beslenmesi araştırmalarıdır.

Açık deniz balık yetiştiriciliği endüstrisine kaliteli 'tohum' tedariğindeki zorluklar: yarı-yoğun metodolojilerle mesocosm üretim istasyonları

Deniz ürünleri yetiştiriciliğinin dünyada artan deniz ürünleri talebini karşılamak için büyümeye devam edeceği beklenmektedir. Su ürünleri yetiştiriciliği gelişimindeki eğilimler artan üretim, gelişen yönetim, türlerin çeşitliliğinin sürekli oluşu ve yetiştiricilik sistemleridir. Ayrıca tüketici ve Pazar farkındalığı ve etkisi büyümektedir. Ekonomik ve çevresel olarak sürdürülebilir kaynaklardan elde edilmiş ürünler için artan bir talep vardır.

Yarı-yoğun kültür metodolojileri kullanan mesocosm üretim istasyonları açık deniz balık yetiştiriciliği endüstrisine juvenil balık sağlamak ve su ürünleri yetiştiriciliğinin sürdürülebilir gelişimine katkıda bulunmak için iyi konumlanmışlardır. Bu üretim istasyonları harici besin kaynaklarıyla desteklenmiş tank içinde canlı prey üretimi ile büyük tanklarda düşük yoğunlukta balık larva üretimiyle karakterizedir. Bu teknoloji üretim hedeflerine kolaylıkla uyarlanabilir ve özellikle yeni aday türlerle organik balık üretimi veya yetiştirme denemeleri için uygundur.

Bu sunum Portekiz, Madeira Adası, Calheta Deniz Ürünleri Yetiştiricliği Merkezi'nde çipura Sparus aurata üretimi için bir mesocosm üretim istasyonları kurulmasıyla yapılan deneyi anlatmayı hedeflemektedir. Diğer iki tür için de yüksek larva performansı elde edilmiştir: mercan, Pagrus pagrus ve sargoz, Diplodus sargus. Mercan larva üretimi için, artemya kullanımı sınırlamalarından dolayı şu andaki araştırma canlı besin zincirine kopepodları sunmaya odaklanmaktadır. Striped jack (Pseudocaranx dentex) larvası gibi pelajik balıklarla yapılan ilk denemeler düşük larva hayatta kalımıyla sonuçlanmıştır fakat bu türlerin kuvvetli pozitif ışığa yönelimini çözecek yetiştiricilik yönetiminde önemli gelişmeler yapılmıştır.

Açık deniz su ürünleri yetiştiriciliği için genetik stratejiler: gelişime karşı azaltmanın olası etkileri

Dr. Charles C Greg Lutz
Louisiana Devlet Üniversitesi, Tarımsal Üretim Merkezi, Su Ürünleri Araştırmaları

ÖZGEÇMIŞ

Iş geçmişi&tecrübeleri
Temmuz 2000 – Günümüze kadar; Uzman & Profesör
Temmuz 1995 – Temmuz 2000: Yardımcı Uzman
Eylül 1991 & Temmuz 1995 : Yardımcı Uzman
Louisiana State University Ziraat Merkezi, Baton Rouge, LA USA.

Eyalet çapında su ürünleri yetiştiriciliği uzmanı. Görevleri kerevit, yayın balığı, akyem, küçük su kaplumbağası, timsah, hybrid çizgili levrek ve diğer av balıklarının üretimi ve dolaşımlı sistemlerde tilapi yetiştiriciliği ve çeşitli azınlık türlerin üretiminde tüm eyaletteki üreticilere eğitim programlaması hizmeti ve teknik destek vermektir. Ek olarak iç kara rekreasyonel balıkçılık, ticari balıkçılık ve çeşitli su ürünleri ekoloji konularıyla ilgili çalışmalar yapmaktadır. Hitap ettiği grup su ürünleri yetiştiricileri, geliştirme birimleri, hükümet temsilcileri, üniversite öğrencileri ve genel halktır. Yüksek Lisans Fakültesi'nin üyesidir. Araştırma sorumlulukları, bölgesel alternatif türlerin ticari amaçlı genetik geliştirilmesi ve değerlendirilmesidir.

ÖZET

Açık deniz balık yetiştiriciliği endüstrisine kaliteli 'yavru' teminindeki zorluklar: yarı-yoğun metodolojilerle mesocosm kuluçkahaneler

Su ürünleri yetiştiriciliğinde anaç stoğu ve kuluçka yönetiminde, birbiriyle çelişen iki 'hedefin' ortaya çıkması alışılmamış değildir. Biri 'gelişim', ki bu birçok yönden tutsak populasyonun üretim stratejisine uyarlanması demektir. Gelişim yaklaşımları genellikle iyi belirlenmiş ve anlaşılmıştır ve belirtilen türlerin yumurtlayan biyolojisine kolaylıkla uyarlanabilir. Diğeri, daha karmaşık ve soyut olan hedef yerel populasyonlarda kaçaklardan gelen olası genetik etkiden kaçınmakla ilgilidir. Bazı koşullarda 'geliştirilmiş' stoklardan poliploid yavru kullanmak bu ihtiyacı karşılayabilir fakat bu yaklaşım genellikle sorun yaratır. Tipik olarak, bu hedef genetik oluşum açısından yerel populasyona çok benzeyen stok üretmek için anaç stoğu yönetimi ve kuluçka uygulamalarını gerektirir. İlk bakışta bu ihtiyacın yerel populasyondan alınan anaç stoğuyla karşılanabileceği düşünülebilir fakat istenen sonucu elde etmek için gerçekte yapılması gerekenler çok karmaşıktır. Tutsak ve vahşi populasyonlardaki genetik oluşum düzenli bir şekilde gözlenmelidir (örneğin, mikrosatelit DNA'da, alozimlerde ve mitokondrideki alel frekanslar ve polimorfizmler). Buna ek olarak yerel gen akışının da anlaşılması gerekir fakat yerel ve bölgesel ölçekte populasyon yapısını belirlemek için metodolojiler mevcuttur. Herhangi bir deniz türünün üreme biyolojisi sadece hayvancılık uygulamalarını değil tipik bir anaç stoğunu genetik sürüklenme ve melezleme baskılamasına karşı muhafaza etmek için gereken pratik adımları da etkileyecektir.

Açık deniz su ürünleri yetiştiriciliğinde balık sağlığı için besin desteği

Dr. Umberto Luzzana
Skretting Güney Avrupa Ürün Müdürü



ÖZGEÇMIŞ

Iş geçmişi&tecrübeleri
Temmuz 2000 – Günümüze kadar; Uzman & Profesör
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ÖZET

Açık deniz deniz ürünleri yetiştiriciliği için genetik stratejiler: Gelişmeye karşı potansiyel etkileri azaltma

Su ürünleri yetiştiriciliğinde anaç stoğu ve kuluçka yönetiminde, birbiriyle çelişen iki 'hedefin' ortaya çıkması alışılmamış bir durum değildir. Biri 'gelişim', ki bu birçok yönden avlanan populasyonun üretim stratejisine uyarlanması demektir. Gelişim yaklaşımları genellikle iyi belirlenmiş ve anlaşılmıştır ve belirtilen türlerin üreme biyolojisine kolaylıkla uyarlanabilir. Diğeri, daha karmaşık ve soyut olan hedef yerel populasyonlarda avcılıktan gelen olası genetik etkiden kaçınmakla ilgilidir. Bazı koşullarda 'geliştirilmiş' stoklardan poliploid yavru kullanmak bu ihtiyacı karşılayabilir fakat bu yaklaşım genellikle sorun yaratır. Tipik olarak, bu hedef genetik oluşum açısından yerel populasyona çok benzeyen

stok üretmek için anaç stoğu yönetimi ve kuluçka uygulamalarını gerektirir. İlk bakışta bu ihtiyacın yerel populasyondan alınan anaç stoğuyla karşılanabileceği düşünülebilir fakat istenen sonucu elde etmek için gerçekte yapılması gerekenler çok karmaşıktır. Yakalanan ve doğal populasyonlardaki genetik oluşum düzenli bir şekilde gözlenmelidir (örneğin, mikrosatelit DNA'da, alozimlerde ve mitokondrideki alel frekanslar ve polimorfizmler). Buna ek olarak yerel gen akışının da anlaşılması gerekir fakat yerel ve bölgesel ölçekte populasyon yapısını belirlemek için metodolojiler mevcuttur. Herhangi bir deniz türünün üreme biyolojisi sadece besicilik uygulamalarını değil tipik bir anaç stoğunu genetik sürüklenme ve melezleme baskılamasına karşı muhafaza etmek için gereken pratik adımları da etkileyecektir.

Uluslararası Sularda Deniz Ürünleri Yetiştiriciliğiyle ilgili genel tartışma

Neil Sims
Kampachi Çiftlikleri, ABD & Harald ROSENTHAL-Bremer¬haven Su Ürünleri Yetiştiriciliği Forumu Oturum Başkanı, Almanya & Alessandro LOVATELLI, Su Ürünleri Yetkilisi, FAO



ÖZGEÇMIŞ

Neil.Anthony Sims Kona, Hawaii'de ve La Paz , Mexico'da kurulmuş LLC, Kampachi çiftliklerinin ortak-kurucusu ve eş-CEO'sudur. Son 20 yılda, Sims inci istiridyesi üretiminde, açık deniz su ürünleri yetiştiriciliği mevzuatı ve düzenlemeleri, deniz balığı kuluçka teknolojisi ve son olarak da, bağlanmamış açık deniz 'sürükleyen (drifter) tekne ağıllar ' : Velella Projesi gibi çığır açan gelişmeleri başaran takımları yönetmiştir.

Sims 2001 yılında kurulan Kona Blue Water Çiftliklerinin ortak kurucusudur, çiftlik ileri kuluçka teknolojileri kullanarak 'yetiştirilmesi zor olan' kapan levrek, lağos, sarıkuyruk balığı larvalarını üretmiştir. Bu üretim darboğazını aşmak, Amerika Birleşik Devletleri'ndeki ilk entegre deniz balığı üretim istasyonları ve açık okyanus balık çiftliğinin oluşmasına yol açmıştır. 2008 yılı itibariyle Kona açık deniz sahasındaki sualtı ağıllarından yıllık 500 tondan fazla sashimi ayarında Kona Kampachi (1 milyon pounddan fazla) elde edilmiştir.

En son olarak Sims, yüksek değerli ılık su deniz balığının küresel olarak ticari yetiştiriciliğini genişletmek ve uzaktan kontrollü açıkdeniz sistemleri, daha sürdürülebilir ve ölçülebilir yemler ve yeni türler geliştirme gibi yeni nesil teknolojileri takip etmek için kurulan Kampachi Çiftliklerinin, LLC, ortak kurucusudur. Ayrıca, deniz kaynaklarının ve yaşam ortamının korunarak rasyonel ve sorumlu açık okyanus üretimini dengelemeyi savunan açık okyanus deniz tarımı ticaret birliği olan Okyanus İdarecileri Enstitüsünün kurucu başkanıdır.

Sims ayrıca Birleşmiş Milletler Gıda ve Tarım Örgütü, bölgesel acenteler ve devletlere danışmanlık hizmeti vermekte ve şu anda Seriola -Cobia Su ürünleri Diyaloğu Yürütme Komitesi'nde ve WWF'nın sponsor olduğu Su ürünleri İdarecilik Konseyi'nin Teknik Danışmanlık Kurulu'nda üye olarak yer almaktadır. Sims Kona Hawaii'de ikamet etmektedir.

ÖZET

AÇIK DENİZ DENİZ ÜRÜNLERİ YETİŞTİRİCİLİĞİNDE BALIK SAĞLIĞI İÇİN BESİN DESTEĞİ

Açık denizde yetiştirilen balıklar değişken ve zor bir çevrede yaşarlar. Aktif beslenme, Avrupa levreğini yazın yüksek sıcaklıkta yaşaması gibi zor koşullar için özel besin sağlamak ya da çipurayı kış koşulları gibi stresli durumlara hazırlamak için, balık sağlığını destekleyici güçlü bir araçtır. Bağışıklık sistemi uyarımı, iç organların sağlığı ve mikrobiyoloji, balık sağlığını desteklemek için beslenme çözümlerinin parçaları olmalıdır.

5 - OTURUM

YETIŞTIRICILIKTE YENI YAKLAŞıMLAR VE DIĞER TEKNOLOJILERLE ENTEGRASYONU

Açık deniz su ürünleri yetiştiriciliği ve rüzgâr enerjisi projelerinin ortak yerleşimi – fizibiliteler ve kısıtlamalar

Michael W Ebeling
Bela Buck Alfred-Wegner Deniz Balıkçılığı Enstitüsü

ÖZGEÇMIŞ

Michael W. Ebeling works at the Institute of Sea Fisheries, which is part of the Johann Heinrich von Thünen-Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries. Mr. Ebeling is dealing with fisheries, fish processing and aquaculture economics, in particular in the realm of offshore aquaculture. He is also affiliated to the University of Applied Sciences Bremen, where he is lecturer for quantitative methods and economics. Since several years Mr. Ebeling is also involved in the European Fisheries Policy and just recently he has become chairman of the STECF Sub-group on Research Needs.

Michael W. Ebeling has studied Economics, Economic History, Economic Teaching, Political Science and Philosophy at the Johannes Gutenberg University Mainz, the Westfälische Wilhelms University Münster and the Carl von Ossietzky University Oldenburg where he made his Diploma.

After his Diploma he worked at the University of Kassel on Institutional Economics, especially about the role of law and legal institutions in Economic Development and in a project dealing with modelling of Regional Innovational Systems. Turning back to Oldenburg University he was engaged in an empirical project on Management Accounting in the German banking sector. Since 2007 he is now affiliated with the Institute of Sea Fisheries.

Since his Diploma he is also working as a private consultant and has dealt with a variety of issues ranging from the modeling of regional economic impact of changes in fishery in Northern Norway due to climate changes, the evaluations of studies dealing with regional economic impacts of airports to the evaluation of reports concerning national data collection actions under the European Fishery Framework. Furthermore he is assessing the commercial feasibilities of aquaculture recirculation systems.

ÖZET

Açık Deniz Su Ürünleri Yetiştiriciliği- Fizibiliteler ve Kısıtlamalar

Deniz ve tatlı su ürünleri yetiştiriciliği üretimi küresel ölçekte artmaktadır. Ancak, Avrupa'da durum farklıdır. Mevzuatlar ve yönetimsel prosedürler su ürünleri yetiştiriciliğinde artışı engelleyen önemli sebeblerden bir tanesidir. Son zamanlardaki araştırma ve ticari ilgi odağı, açık okyanus su ürünleri yetiştiriciliği için kıyıdan uzak alanlardır. Bir de yeni bir konu vardır ki – açık deniz rüzgar üretim endüstrisi- o da sinerjetik ortak olarak rol oynayacaktır.

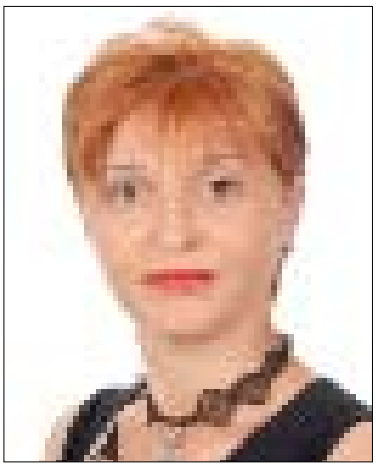
Çalışmanın yazarları açık deniz rüzgâr çiftliklerinde ya da yakınlarında balık, midye ve alg üretimi yapılan deniz ürünleri yetiştiriciliği ile bir kaç proje ile çalışmışlar ve çalışmaktadırlar. Bu sunum çeşitli projelerin sonuçlarına dayanılarak açık deniz rüzgâr üretim alanlarında balık, midye ve makroalg yetiştiriciliğinin biyolojik, fiziksel ve

ekonomik değerlendirmesini içermektedir. Ürünlerin farklı kullanımları tartışılacak ve ekonomik karlılık üzerine etkileri odak noktası olacaktır. Rüzgar üretme çiftliği alanlarının su ürünleri için ortak kullanılması ile ilgili olası ekonomi alanı da değerlendirilecektir.

Açık okyanus makro alg yetiştiriciliği. Deniz balıklarının beslenmesinde algözütlerinin ve makro alglerin biyo enerji amaçlı kullanımı

Dr. Gamze Turan
Ege Üniv. Su Ürünleri Fakültesi,
Su ürünleri Yetiştiriciliği Bölümü

Dr. Amir Neori
İsrail Oşinografik veLlimnolojik
Araştırma Ltd.





ÖZGEÇMIŞ

Dr. Gamze Turan (1991) Ege Üniversitesi Su ürünleri balıkçılık Fakültesi Su Ürünleri Bölümünden Lisans, (1999) ABD, Orono, Maine Üniversitesi Su Bilimleri Bölümünden yüksek lisans, (2007) Ege Üniversitesi Fen Bilimleri Enstitüsünden Su Ürünleri yetiştiriciliği konusunda doktora almış fakülte üyesidir. Kariyeri özel şirketlerde (Southland Fisheries Coorporation Ltd. and Island Fresh Seafood, Inc., USA)mikroalg üretimi ile başlamış ve Türkiye'de deniz yosunu kaynaklarında üretim ve endüstriyel uygulama çalışmalarıyla devam etmiştir. Dr Turan'ın bilimsel ilgi alanları karada ve denizde deniz yosunu üretimi, deniz yosunu temelli IMTA(entegre multitrofik su ürünleri yetiştiriciliği) ve deniz yosunları ve özütlerinin kozmetikte, farmasötiklerde, nutrasötiklerde, insan besin kaynaklarında, hayvan besinlerinde, balık yemlerinde, gübrelerde ve toprak düzenleyicilerde, algsel yakıtlarda vs kullanımıdır. 50 nin üzerinde ortak yazarlı yayını ve 2 kitap bölümü yayınlanmıştır.

Dr. Amir Neori deniz biyoloğudur. (1976)İsrail , Kudüs Musevi Üniversitesi'nde Ziraat bölümünden lisans, (1979) İsrail, Rehovot, Weizmann Bilim Enstitüsünden Yaşam Bilimleri konusunda Yüksek Lisansı, (1986) ABD, Kaliforniya San Diego Üniversitesi-Scripps Oşinografi Enstitüsünden Deniz Biyolojisi konusunda Doktorası vardır. 1986'dan beri İsrail Oşinografik ve Limnolojik Araştırma Ltd., İsrail Ulusal Deniz ürünleri yetiştiriciliği Merkezi'nde sürdürülebilir deniz ürünleri yetiştiriciliğini araştırmış ve geliştirmiştir. Dr Neori merkezde Algler, Su Kalitesi ve Biofiltreler bölümlerine başkanlık yapmıştır. 1991-1992'de Gainesville, Florida Üniversitesi'nde misafir profesör olarak görev yapmıştır.

2000'den 2001'e kadar her ikisi de İsrail'de olan Bar Ilan ve Tel Aviv Üniversiteleri'nde misafir bilimadamı olarak çalışmıştır. 2010-2011 arasında Kaliforniya San Diego Üniversitesi- Scripps Oşinografi Enstitüsünde misafir araştırmacı biyolog olarak, 1990'larda aralıklı olarak Çek Cumhuriyeti Bilimler Akademisi'nde Mikrobiyoloji Entitüsü'nün Fototrofik Mikroorganizmalar Bölümü'nde misafir bilim adamı olarak çalışmıştır. Bilimsel ilgi alanları sürdürülebilir su ürünleri yetiştiriciliği , alg yetiştiriciliği,

entegre multi-trofik su ürünleri yetiştiriciliği (IMTA), su ürünleri yetiştiricliğinde biofiltreler ve alglerden biyo yakıt üretimidir. 80'in üzerinde hakem denetimli yayını bulunmaktadır.

ÖZET

AÇIK OKYANUS MAKROALG YETİŞTİRİCİLİĞİ, DENİZ BALIKLARININ BESLENMESİNDE ALG ÖZÜTLERİNİN KULLANIMI VE MAKROALGDEN BİOENERJİ ELDE ETME

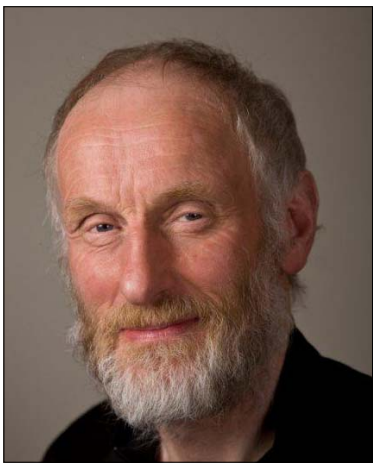
Hem diğer endüstriyel uygulamalar için bileşenlerin kaynağı, hem de sağlıklı ve besleyici bir besin olmasının yanı sıra, makroalgler (ya da deniz yosunları) büyüyen bir teknoloji olan Entegre Çok Besleyicili Su Ürünleri Yetiştiriciliğinin (IMTA) ana elementidir. Bu sunum deniz yosunlarının günümüz üretimini, deniz balıklarının beslenmesinde ve bioenerji üretiminde kullanımını incelemekte olup, deniz yosunu temelli IMTA 'nın sürdürülebilir deniz ürünleri yetiştiriciliğinde temel rol oynadığını belirtmektedir.

6 – OTURUM

YENILIKÇI KAFES TEKNOLOJILERI

Kafes bileşenlerini güçlendirme

Doç. Dr. Ludvig Karlsen
NTNU Marin Teknolojisi Bölümü



ÖZGEÇMIŞ

İsim: Ludvig Carlsen
Doğum tarihi: 25. 08.1945
Milliyet: Norveç
Şu anki pozisyonu: Doçent
Dereceleri: Yüksek lisans, Deniz Kuvvetleri Mimarisi İnşaat Mühendisliği ve Deniz Mühendisliği, NTH, 1971

İş tecrübesi:
1972 – 73: Askeri hizmet, Denizci, HAS (Gemi tahribat kontrol okulu), Haakonsvern, Bergen

1973 – 74: SFI (Bugün Marintek), Trodnheim'de bilim adamı

1975 – 1981: (FTFI)Balıkçılık Teknolojisi Araştırma Enstitüsünde kıdemli bilim adamı, Avcılık Bölümü (Bugün IMR), Bergen

Esas çalışma alanları: Seçici (karides) trolleri, dip parakete teknolojisi

1981 – 1985: Doçent, Tromsø Üniversitesi, Balıkçılık Bölümü/Norveç Balıkçılık Koleji, Tromsø: Esas öğretim ve araştırma sahası – balıkçılık malzemesi ve balıkçı teknesi teknolojisi

1985 – … : Şu anda NTNU, Trondheim Deniz Ürünleri teknolojisi bölümündedir.
Son günlerdeki araştırma ve öğretim faaliyetleri ve ilgi alanları: balık avlama ve balık üretme teknolojisi, sualtı teknolojisi

ÖZET

Olanaklar, kontrol ve sertifikasyon açısından açık deniz kafeslerinde balık yetiştiriciliği

Açık denizde kafeste balık yetiştiriciliği daha korunaklı sularda yapılan yetiştiricilikten daha fazla zorluk içerir. Açık deniz terimi kitaplar, bölümler, yazılar gibi birçok yerde başlıklarda kullanılmakta ancak yazılı içeriği gerçek anlamını çok da desteklememektedir. Norveç'te olduğu gibi diğer Kuzey Atlantik ülkelerinde de gerçek 'açık deniz' somon balığı yetiştiriciliği, açık deniz petrol endüstrisinde olduğu gibi bugün sadece 'hayal edebileceğimiz' bir şeydir. Bu kötümser ifadeyi desteklemek için Norveç'in batı sahilinde 'dış sahil alanı' diye açıklayabileceğimiz (balıksız) büyük bir kafesle yapılan bir denemenin anlatımıyla bir örnek verilmiştir. Ancak biraz daha 'açık deniz' olabilme mücadelesinde en büyük zorluk kafes ağları, yüzen yapılar, yuvarlak halka ya da çelik platform tasarımlar ve demirleme sistemi gibi çiftliğin ana bileşenlerinin gücü ve dayanıklılığı ile bağlantılıdır. 2004'ten beri, birçok çiftlikte balık kaybından dolayı Norveç'in tüm yüzen somon balığı kafes çiftlikleri için 9415 NS (Norveç Standardı)na dayanarak yukarıda verilmiş olan ana çiftlik bileşenlerini kapsayan zorunlu bir sertifikasyon sistemi vardır. Sertifikasyon için ana belirleyici parametreler, çiftlik bölgesinde belirli dalga boyu ve okyanus akıntı hızı ve kafeslerin boyutu/derinliğidir, ayrıca su derinliği, dip tipi ve topografisi de demirleme sistemi ile ilgili önemli kontrol parametreleridir. Sertifikasyon sistemi ile ilgili deneyim hem yüzey alanı hem de net derinlikte sürekli artan boyutları ile kafes malzeme ve tasarımlarının güçlendirilmiş koşulları olarak anlatılmıştır. Daha korunmasız yetiştirme alanları için açılmış ana problem alanları anlatılmış ve tartışılmıştır. Özellikle nokta ağırlıklar ya da dip ağırlık halkaları kullanımıyla kafeslerin dip ağırlıkları incelenmiş ve anlatılmıştır. Sonuçta açık deniz yetiştiriciliği için geliştirilmiş çözümler ve teknolojileri, açık deniz kötü hava koşullarında balık yaşam koşulları, nakliye ve besicilikle ilgili sorunlar tartışılmıştır.

Köpek balığına dirençli su ürünleri muhafaza ağlarının geliştirilmesi

Margot van Wunnïk
DSM Dyneema B.V. Uygulama Geliştirme Uzmanı



Felipe Ramïrez
DSM Dyneema B.V.
Pazarlama Müdürü



ÖZGEÇMIŞ

Lisans derecesini Uluslararası İlişkiler konusunda 2003 yılında alan Miami, FL, Florida Uluslararası Üniversitesi mezunu Felipe kariyerinin çoğunu ticari deniz ve endüstriyel pazarlarda geçirmiştir. Kariyeri onu Kanada'nın en kuzeyinden Şili'nin en güney ucuna kadar götürmüştür. Oralarda nefes kesici manzaralar ve yaşamın her yerinden şaşırtıcı ilginçlikte insanlar görmüştür.

'Ticari Balık' takımıyla, tüm paydaşlar için sürdürülebilir ve sorumlu bir yolla su ürünleri yetiştiriciliğinin gelişmesini geciktirecek engelleri aşmak için yenilikler kullanarak dünyayı balıkla besleyebilmek için daha iyi ve sürdürülebilir yollar aramaktadır.

ÖZET

KÖPEK BALIĞINA DİRENÇLİ SU ÜRÜNLERİ MUHAFAZA AĞLARININ GELİŞTİRİLMESİ

Bütün ılık su ve bazı soğuk su su ürünleri yetiştiriciliği alanları köpekbalığı saldırılarına yatkındır. Köpekbalıkları ve diğer yırtıcılar nedeniyle oluşan kayıplar önemli oranda ölüm ve kaçakla sonuçlanmakta ve pahalı ve iş gücü gerektiren onarımlar gerektirmektedir. Köpekbalığı dişinin kesme kapasitesi güçlü çeneleri ve koparma hareketi ile birleştiğinde ağları koparmadaki becerisi onu diğerlerinden farklı hale getirir. Ağda köpekbalığı ısırığı simulasyonu ve okyanustaki net performansı öngörebilmek için laboratuarlarda yeni testler gerekmekteydi. Yeni testleri kullanıp ve köpekbalığı olan sulardaki denemelerden gelen verileri toplayarak Ultra Çapraz Düğümsüz Örgü yapı içinde Dyneema fiber kullanılan hibrid ağ oluşturulmuştur. Bu yeni ağ, balık yetiştiricisinin köpekbalığı ve foklara karşı hafif bir çözüm kullanmasını ve ikincil anti-predatör ağlara gerek kalmamasını sağlar.

Bu sunum köpekbalığı saldırılarının şiddetini, ağ çözümü yaratmanın zorluklarını ve projenin başarısını bol miktarda fotoğraf ve videolarla anlatacaktır.

Pirinç ağ kurma/ Uluslararası Bakır Birliği Çanakkale Boğazı'nda ağıl montajı

Dr. Murat Yiğit
Çanakkale Üniversitesi, Su Ürünleri Fakültesi



ÖZGEÇMIŞ

Prof. Dr. Murat Yiğit
Yüksek Lisans: Ondokuz Mayıs Üniversitesi , Doğa ve Uygulamalı Bilimler Birimi, Türkiye (1996)
Doktora: Ondokuz Mayıs Üniversitesi, Doğa ve Uygulamalı Bilimler Birimi, Türkiye (2001)
Araştırma Görevlisi: Kagoshima Üniversitesi, Balıkçılık Fakültesi, Suda yaşayan hayvanların Beslenmesi, Kagoshima, Japonya (1998 – 2001)
Misafir Bilimadamı : New Hampshire Üniversitesi, Okyanus Mühendisliği Enstitüsü, Durham NH, ABD. (2005)
• Su Ürünleri Yetiştiriciliği ve Balık Beslenmesi Profesörü

Biyografi: Dr Murat Yiğit , Çanakkale Onsekiz Mart Üniversitesi'nde Su Ürünleri Fakültesi'nde 2003'den beri görev yapmaktadır ve Doğa ve Uygulamalı Bilimler Birimi Müdür Yardımcılığı ve Üniversite Eğitim Komisyonu, Yönetim Kurulu üyeliği gibi saygın pozisyonlarda bulunmuştur. Dr Yiğit şu anda Su Ürünleri Yetiştiriciliği Bölüm Başkanıdır. Açık deniz Su ürünleri yetiştiriciliği sistemleri ve Balık Beslenmesi konusunda uzmandır. ABD, New Hampshire Üniversitesi, Okyanus Mühendisliği Enstitüsünde misafir Yardımcı Doçent olarak görev yapmıştır. Çanakkale Onsekiz Mart Üniversitesi'ne gelmeden önce Balık Besleme konusunda araştırma için Japonya'da Kagoshima Üniversitesi'nde bulunmuştur. Dr Yiğit Dünya Su Ürünleri Endüstrisinin sürdürülebilirliğini desteklemek amacıyla kendi bilgi ve deneyimlerine dayanarak birçok bildiri ve makale yayınlamıştır.

Araştırma alanları:
Açıkdeniz Akvakültür Sistemleri, balık besleme (alternatif kaynaklar ve besin optimizasyonu)

Araştırma ilgi alanları
Dr Yiğit'in ilgi alanları Açık Okyanus Su Ürünleri yetiştiriciliği ve Su Ürünleri Beslenmesidir ve araştırma ilgi alanları Açık deniz Akvakültür Sistem gelişmeleri , su ürünleri endüstrisinin sürdürülebilirliğini destekleyen çevre dostu diyetlerdir. Son günlerdeki araştırma projeleri : Açık okyanus su ürünleri yetiştiriciliği: Çevre dostu açık deniz akvakültür sistemleri ; Entegre Çoklu Trofik Su ürünleri Yetiştiriciliği Sistemleri (IMTA) ; Balık Besleme: Diyetlerde balık yeminin yerini alabilecek alternatif protein kaynakları.

Verdiği dersler
Deniz Akvakültür III SU314; Kafes Yetiştiriciliği ve Teknolojisi SY5006; Alabalık ve Somon Yetiştiriciliği SY5007; Yassıbalık Yetiştiriciliği SY6014; Sindirim Fizyolojisi ve Metabolizma SY6003; Su Ürünleri Yetiştiriciliği Politikası SY6015.

ÖZET:

Deniz çiftlik sistemlerinde organik madde büyümesi su ürünleri yetiştiricileri için bir çok zorluk yaratır. Meşin tıkanması su akışını engeller ve kafes ortamında oksijen miktarını azaltır, bu , daha az besin alımına dolayısıyla da balıkların daha yavaş gelişmesine sebep olur. Sağlıklı bir ortam daha seyrek ağ değişimi ve temizlik işinin azalmasından dolayı balığın stresinin azalmasına yardımcı olur. Bu çalışmada, açık deniz tipi HDPE kafeslerde bakır alaşımlı ağlar kullanılmış ve çiftlik koşullarında bu ağların dayanıklılık ve kuvvetini incelemek için çalışmalar yapılmıştır. Çanakkale Boğazı'nda , 387 günlük bir süreyle 2 bölmeli gride yayılmış bakır alaşımlı meş'e konulan çipura ve levrekler üzerinde büyüme performansı ve besin kullanım deneyleri uygulanmıştır. Açık deniz test alanındaki zorlu hava koşulları düşünüldüğünde bakır alaşımlı ağ kafeslerdeki büyüme hızları ve ortalama besin dönüşüm oranları umut vericidir.

Genel olarak bakır alaşımlı ağ materyali Su Ürünleri Yetiştiriciliği'nde kullanım için uygunluğu açısından iyi performans göstermiştir. Çalışma süresince, çok sınırlı biyolojik kirlilik kaydedilmiş ve bakır alaşımlı materyalde çok sınırlı ağ deformasyonu gözlenmiştir, bu da kafes yetiştiriciliği endüstrisinin sürdürülebilirliği için umut vaat eden alternatif bir ağ materyali olduğunu göstermektedir.

Açık deniz su ürünleri yetiştiriciliği için tek nokta üzeri demirli kafesolasılığı

Mohamed Shainee
NTNU, Deniz Teknolojisi Bölümü Doktora Öğrencisi



ÖZGEÇMIŞ

Mohamed Shainee, Lisans (Onur derecesi), yüksek lisans, Ordu Liyakat Derecesi sahibidir ve vatanı olan Maldivler'de balıkçılık ve deniz kaynaklarında teknik, ticari ve idari alanda 10 yılı aşkın tecrübesi vardır. Balıkçılık Bakanlığı'nda danışman, Maldivler Endüstriyel Balıkçılık Şirketi'nde (Maldivlerin en büyük kamu şirketi) idari müdür ve Maldivler Balıkçılık ve Tarım Bakanlığı'nda balıkçılık ve deniz teknolojisinden sorumlu memur olarak görev yapmıştır. Akademik olarak şu anda Norveç, NTNU'da açık deniz balık kafesi tasarımı konusunda doktora yapmaktadır. Kanada Dolhousie Üniversitesi'nde deniz yönetimi konusunda master derecesi, Norveç NTNU'dan deniz teknolojisi konusunda yüksek lisans, İngiltere Plymouth Üniversitesi'nden Deniz Teknolojisi konusunda Mühendislik lisans şeref derecesi vardır. Maldivler kıyı geliştirme gibi çevre etkisi değerlendirme çalışmalarının en büyüklerinden olan proje de olmak üzere çevre projelerinde ulusal ve uluslararası danışman olarak aktif bir şekilde çalışmaktadır.

ÖZET

Açık deniz su ürünleri yetiştiriciliği için SPM Kafeslerinin geleceği

Besin talebini karşılamak sosyo-politik olduğu kadar teknolojik bir zorluktur. Teknolojik zorluk, hareketli açık deniz sularda denzi ürünleri yetiştiriciliği gelişimi için uygulanabilir bir çözüm bulmaktır. Şu anda açık deniz koşullarında çalışabilir sadece birkaç başarılı kafes tasarım kavramı vardır. Yazarlar tarafından yapılan bir seri çalışmada, (SPM) tek nokta demirli kafes kavramı açık deniz sularda potansiyel deniz ürünleri yetiştiriciliği kafes kavramı olarak belirlenmiştir. Son günlerde açık deniz balık yetiştiriciliği için SPM balık kafes sistemleri çevre dostu ve ekonomik olarak tercih edilme özellikleri nedeniyle desteklenmektedir. Kendi batabilir SPM kafes kavramının başarısı açık deniz ortamında çalışma performansına dayanmaktadır. Tek noktada demirli yapının üzerindeki aşırı akıntı sistemdeki sürüklenme arttıkça batmayı tetikleyeceği bilinmektedir. Ancak, balık üretimi amacıyla, kafes içinde hacim azalmasından kaçınmak için ve dalga tepesi veya dalga çukuru altında oluşan yüksek dairesel veya orbital su hareketinden kaçınmak için kafes sisteminin artan dalga boyu esnasında batabilir olması önemlidir. Bu nedenle, çalışma, numerik bir kod kullanarak, AquaSim, SPM kafes sisteminin çeşitli dalga ve akım rejimlerinde batma özelliklerini açık denizde etkin bir biçimde kullanmak için umut verip vermediğini araştıracak ve saptayacaktır.

Tek noktada demirlenmiş açık okyanus ağ ağıllarda karides yetiştirme

Steve Page
Okyanus Çiftliği Teknolojileri Başkanı



ÖZGEÇMIŞ

Steve Page, Aquapod ağ kafes sistemlerinin mucidi ve Okyanus Çiftlik Teknolojileri Şirketinin genel müdürüdür. Page'in profesyonel geçmişi, Stanford Üniversitesi ve Michigan Üniversitesi eğitimine dayanarak, 1976'da bir çevre tasarım ve danışmanlık işi kurmasıyla başlamıştır. Bu şirketi 1988'de satmış ve Maine Çevre Koruma Departmanında çalışmaya başlamış, daha sonra da Atık Yönetimi Şirketi'nde Bölgesel yönetici olarak çalışmıştır. Tüm yaşamı boyunca kara tarımı yapmasına rağmen, balık yetiştiriciliği deneyimi 1999'da Maine somonu (ASM) ve Ducktrap nehri Balık Çiftliği'nde (Fjord deniz ürünleri ABD) çevre uyum görevlisi olarak işe alındığında başlamıştır. 2003'te Page ASM'nin genel müdürlüğüne terfi ettirildi. Fjord Deniz ürünleri ASM'yi sattığında Steve açık okyanus su ürünleri yetiştiriciliği ekipmanı imal etmek için, Okyanus Çiftlik Teknolojileri Şirketi'ni kurdu. Page ve ailesi kıyı Maine'de elma yetiştiriciliği ve sığır yetiştiriciliği yapmaktadır.

ÖZET

Tek nokta demirli açık okyanus ağ kafeslerinde karides yetiştiriciliği

2009'dan beri Okyanus Çiftlik Endüstrileri A.Ş. L. vannamei, beyaz karides yetiştiren müşterilerine Aquapod™ağ kafeslerini sağlamaktadır. Bu kafesler farklı tiplerde demirlenmiş noktalara kurulmuştur, ancak son zamanlarda kurulanların hepsi, başarısı kanıtlanmış çekme kazıklı tek nokta demirlemelere yapılmıştır. Biyoloji ve mühendisliğin birleşiminde açık okyanus karides yetiştiriciliğindeki zorluklar ve başarılar, tek nokta üzeri demirli sistemlerin detaylı anlatımıyla sunulacaktır. Farklı ortamlar için yetiştirme tekniklerinin uyarlamaları ve çeşitli balık türleri için tek nokta üzeri demirlemenin kullanımı anlatılacaktır. Tek nokta üzeri demirlemeyle, grid demirlemenin ekonomik ve operasyonal avantaj ve dezavantajları, farklı ölçekte kullanımlara uygulanabilirliği açısından karşılaştırılacaktır.

PoKi Ağı, Velella Projesi ve diğer adımlar

Neil Anthony Sims
Kampachi Çiftlikleri



ÖZGEÇMIŞ

Neil.Anthony Sims Kona, Hawaii'de ve La Paz , Mexico'da kurulmuş LLC, Kampachi çiftliklerinin ortak-kurucusu ve eş-CEO'sudur. Son 20 yılda, Sims inci istiridyesi üretiminde, açık deniz su ürünleri yetiştiriciliği mevzuatı ve düzenlemeleri, deniz balığı kuluçka teknolojisi ve son olarak da, bağlanmamış açık deniz 'sürükleyen (drifter) tekne ağıllar ' : Velella Projesi gibi çığır açan gelişmeleri başaran takımları yönetmiştir.

Sims 2001 yılında kurulan Kona Blue Water Çiftliklerinin ortak kurucusudur, çiftlik ileri kuluçka teknolojileri kullanarak 'yetiştirilmesi zor olan' kapan levrek, lağos, sarıkuyruk balığı larvalarını üretmiştir. Bu üretim darboğazını aşmak, Amerika Birleşik Devletleri'ndeki ilk entegre deniz balığı üretim istasyonları ve açık okyanus balık çiftliğinin oluşmasına yol açmıştır. 2008 yılı itibariyle Kona açık deniz sahasındaki sualtı ağıllarından yıllık 500 tondan fazla sashimi ayarında Kona Kampachi (1 milyon pounddan fazla) elde edilmiştir.

En son olarak Sims, yüksek değerli ılık su deniz balığının küresel olarak ticari yetiştiriciliğini genişletmek ve uzaktan kontrollü açıkdeniz sistemleri, daha sürdürülebilir ve ölçülebilir yemler ve yeni türler geliştirme gibi yeni nesil teknolojileri takip etmek için kurulan Kampachi Çiftliklerinin, LLC, ortak kurucusudur. Ayrıca, deniz kaynaklarının ve yaşam ortamının korunarak rasyonel ve sorumlu açık okyanus üretimini dengelemeyi savunan açık okyanus deniz tarımı ticaret birliği olan Okyanus İdarecileri Enstitüsünün kurucu başkanıdır.

Sims ayrıca Birleşmiş Milletler Gıda ve Tarım Örgütü, bölgesel acenteler ve devletlere danışmanlık hizmeti vermekte ve şu anda Seriola -Cobia Su ürünleri Diyaloğu Yürütme Komitesi'nde ve WWF'nın sponsor olduğu Su ürünleri İdarecilik Konseyi'nin Teknik Danışmanlık Kurulu'nda üye olarak yer almaktadır. Sims Kona Hawaii'de ikamet etmektedir.

ÖZET

POKİ AĞ KAFESLERİ, VELELLA PROJESİ VE SONRAKİ ADIMLAR

Bu sunum Kona Blue Water çiftlikleri ve Kampachi Çiftliklerinin yeni teknolojiler geliştirmek ve sürdürülebilir, ölçülebilir ve karlı açık okyanus ürünleri yetiştiriciliğinde henüz çözülmemiş sorunları çözmek için son araştırma ve gelişmeleri incelemektedir.

PoKi ağ kafesleri projesi Norveç HDPE yüzdürme sistemi, sert çelik ağırlık halkası ve mort geri çekme sistemi ve Kikkonet – Japonya'dan dayanıklı, monofilament meş'ten oluşan birçok yeniliğin entegre edildiği tek yüzey ağ kafeslerin tasarımını araştırmıştır. Amaç PoKi ağ kafeslerinin yeterliğini ve etkinliğini kontrol etmek ve balık sağlığı ve kaçakları, deniz memeli etkileşimleri ve besleme verimliliklerini incelemekti. PoKi ağ kafeslerinin genel performansı, ana tasarım iyileştirmeleri ve bulguların önemi tartışılacaktır.

Velella beta-deneme Hawaii Büyük Ada'nın kuytu kısmında bölgesel okyanus akıntılı girdabın içine yerleştirilmiş demirlenmemiş bir ağ kafes dizisini denedi. Bu deneme ABD federal sularında ilk balık yetiştiriciliğini ve dünyanın ilk demirlenmemiş balık ağ kafes denemesini temsil etmektedir. Velella sürüklenme izi Kona'nın 3 deniz mili ila 75 deniz mili açıklarında, ortalama 4000 metre derinlikte sularda, 45 kts den fazla rüzgara ve 20 ft yüksekliğindeki dalgalara dayanır durumdaydı. Büyüme performansı, yem dönüşüm oranları, balık sağlığı ve hayatta kalımı gibi sonuçlar çok yüreklendirici idi. Şimdiki görev teknolojik zorlukları çözmek (iş maliyetlerini otomasyonla azaltmak ya da daha da iyisi uzaktan kumanda-ve-kontrol etmek, dizel tüketimini azaltmak ve çekici ağ kafesleri sürüklemek), fakat yine de balıkların etkileyici biyolojik performanslarını muhafaza etmektir. Velellla gama-testi olarak Kona, Hawaii'nin 6 deniz mili açığında 2000 metre derinlikte suda bir derin-su tek nokta demirli denemesi planlanmaktadır.

7 – OTURUM

İMALATÇILAR TARAFINDAN MALZEMELERIN TANITIMI

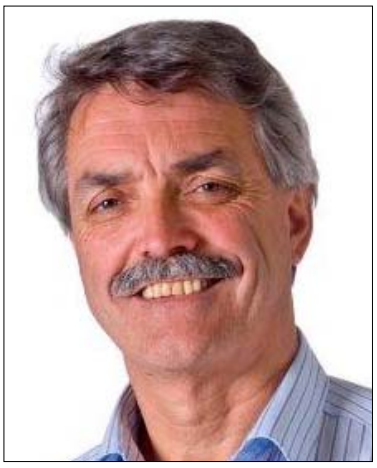
8 - OTURUM

BESICILIK VE ALAN HIZMETLERI

Açık deniz endüstriyel somon balığı yetiştiriciliği – deneyim ve gelişme içinihtiyaçlar

Finn Victor Willumsen

Su ürünleri Yetiştiriciliği Mühendisliği Şirketi (ACE) Yönetim Müdürü



ÖZGEÇMIŞ

İsim: Finn Victor Willumsen
Doğum tarihi: 20. Aralık. 1950
Milliyet: Norveç

Eğitim:
1978 – Deniz Biyolojisi üzerine Yüksek Lisans(Mat. ve Doğa Bilimleri)
1978 – 2005 Yöneticilik, ekonomi, pedagoji, psikoloji ve su ürünleri yetiştiriciliği eğitimi

Önceki işleri:
2006 – Büyük ölçekli araştırma tesislerinde idari müdür(Su Ürünleri Yetiştiriciliği Mühendisliği – ACE)
2004 – 2006 Hizmet şirketleri geliştiricisi ve genel müdür (Intrafish hizmetleri)
2002 – 2003 Deniz balığı yetiştiriciliği danışman ve iş geliştirici (A-Pro – Pos)
2001 – 2002 Su ürünleri yetiştiriciliği için IT (bilgi teknolojileri) sistem malzemelerinin müşteri çözüm yöneticisi (AKVASmart)
1999 – 2001 Pazarlama ve Uluslar arası pazarlama ve Satış Müdürü (Superior Sistemler)
1998 – 1999 Asya'da iş geliştirici (MaqSEA)
1996 – 1998 Endonezya Deniz Gözlemleme Proje Müdürü (OCEANOR)
1990 – 1995 Kalite Müdürü, Bölüm yöneticisi ve danışman (OCEANOR)
1986 – 1990 Balık çiftlikleri Koordinatörü ve Kuluçkalar genel müdürü (TiMar)
1984 – 1986 Su Ürünleri Yetiştiriciliği Danışmanı (Norveç Balıkçılık Müdürlüğü)
1979 – 1984 Okutman (Üniversite, lise ve meslek okullarında)

Ana Çalışma Alanları:
Oraganizasyon geliştirme ve değişim süreçleri yönetimi
Norveç'te şirket ve organizasyon kurma , uluslararasılaştırma
İşe alma, hizmet geliştirme , pazarlama ve yönetimi
Su ürünleri yetiştiriciliği geliştirme ve entegre kıyı bölgesi yönetimi
Su ürünleri endüstrisinde risk analizi ve yer seçimi
Deniz gözlemi ve deniz çevre etkisi değerlendirme çalışmaları
Teknoloji transferi, öğretim ve eğitim
Farklı türlerle çalışma (somon, trança, morina balığı, kabuklular)

Verdiği dersler:
Su ürünleri yetiştiriciliği, büyük ölçekli araştırmalar, deniz ekolojisi, deniz gözlemi

Raporlar:
Su ürünleri yetiştiriciliği, deniz çevresi, deniz gözlemi gibi konularda farklı raporlar

Yayınları:
Su ürünleri yetiştiriciliğinin farklı yönleri ve denizle ilgili çevresel çalışmalarla ilgili 20 yayın.

ÖZET

Z ENDÜSTRİYEL AÇIK DENİZ SOMON BALIĞI YETİŞTİRİCİLİĞİ- DENEYİMLER VE EN ÇOK İHTİYAÇ DUYULAN GELİŞME

ACE'deki büyük ölçekli tesisler açık deniz çiftliklerde araştırma, geliştirme ve yeni çözümlerin denemesi için kullanılmaktadır. 3 yıldır zor koşullarda çalışmaktadır. Hs 3,0'de dalgalar yüksek rüzgar ve düşük ısılarla birleştiğinde hem çalışma hem de üretim için özel zorluklar yaratmaktadır.

Daha açık deniz alanlarında su ürünleri yetiştiriciliği üretimi için teknolojik çözümler arayan ACE, Orta-Norveç'te en açık çiftliklerin bazılarından veri toplayıp, analiz ederek 2011''de bir bilimsel çalışmayı desteklemiştir. Çalışma teknoloji, güvenlik ve balık sağlığına adoklanmıştı. Çalışma, saha yöneticileriyle görüşmeler ve sahalardan çevresel verilere dayanmaktaydı. Daha sonra bir çalıştay, Faeroes'e çalışma turu ve çiftçilere, tedarikçilere, araştırma kurumlarına ve devlet organlarına verilen anketler ilave edildi. Çalışma böylesi açık deniz koşulları için en çok geliştirilmesi gereken operasyonların ve tekniklerin önem sırasına gore listesini vermiştir. Sonuçlar yeterlik ve tecrübenin, tekneler ve kafesler arayüzü, ağlar, balıkların takibi, insan, yapılar ve güvenilir hava tahminlerinin listenin en önemlilerinden olduğunu göstermiştir.

Korunmasız somon balığı alanlarının işletmesinde hizmet araçları

Mats Augdal Heide
Sintef Balıkçılık ve Su Ürünleri Şirketi Ürün Tasarımcısı



ÖZGEÇMIŞ

Mats Augdal Heide SINTEF Balıkçılık ve Su Ürünleri yetiştiriciliği'nde bilimadamı olarak 10 yıldan fazla bir süredir su ürünleri yetiştiriciliği teknolojisi konusunda çalışmaktadır. Ürün tasarımı konusunda eğitim almış olup ana konusu kullanıcı-merkezli teknik çözümler geliştirmektir. Çiftlik tasarımı, sağlık ve güvenlik konuları da dahil olmak üzere hem kara hem de su temelli su ürünleri yetiştiriciliği konusunda tecrübesi vardır fakat son zamanlarda özellikle wellboats ve hizmet tekneleri gibi su ürünleri kullanımı için tekneler üzerinde çalışmaktadır.

ÖZET

AÇIK DENİZ SOMON BALIĞI YETİŞTİRİCİLİK ALANLARI İÇİN HİZMET TEKNELERİ

Birçok Norveç somon balığı çiftliği açık deniz alanlarında kurulmuştur ve büyük kafeslerin kullanımı fırtınalı hava koşullarıyla birleştiğinde demirleme, ağların temizlenmesi ve değiştirilmesi gibi çalışmalar zorlaşmaktadır. Büyük kafesler için tasarımlar geliştirilmesine rağmen daha kabiliyetli hizmet tekneleri geliştirilmemiştir. Bu ihtiyaçları karşılamak için, endüstri yeni nesil hizmet araçları için tasarım spesifikasyonlarını geliştirecek 'Hizmet teknesi 2010' projesindeki Ar-Ge ile güçlerini birleştirmiştir

Projenin endüstirinin ihtiyaçlarıyla tanımlanmış ana odak alanları:
1. Personel güvenliği ve kaçaklar açısından güvenli işletim
2. Verimli ve rekabetçi tasarım
3. Güvenirlik ve fırtınalı sularda çalışma zamanı

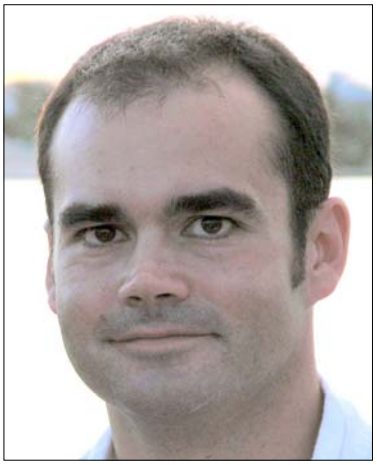
Bu proje yoluyla üç farklı alanda yeni özellikler ve kavramlar geliştirilmiştir:

1) Tekne tasarımı: Aracın kendisi operasyonlar için platform olarak kullanılmaktadır ve projede iki yeni tekne tasarımı sunulmuştur.
2) Güverte malzemesi: Geliştirilmiş ve daha özel malzeme geliştirilmiştir.
3) Mevzuat: Norveç Denizcilik yetkilileriyle işbirliği içinde var olan mevzuata yeni düzenlemeler önerilmiştir. 2013'e kadar yeni düzenlemeler beklenmektedir.

Sunuda proje sonuçları ve geliştirilen tekne tasarımları sunulacaktır.

Su Ürünleri canlı hayvan sigortası

Cédric Audor
Guian Su Ürünleri Canlı Hayvan Sigortacılar



ÖZGEÇMIŞ

1973'te doğan Cédric Audor hep su ürünleri yetiştiriciliği işinde olmuştur. Kültür balıkçılığı konusunda teknisyenlik diploması edindikten sonra, Fransa'da ziraat mühendisliği ve su kaynakları yönetimi diploması almıştır.

Fransız Tarım Bakanlığında su ürünleri yetiştiriciliği projelerinde 3 yıl çalışmış ve ayrıca Fransa'da su ürünleri konusunda uzman bir okulda öğretmenlik yapmıştır. Cédric Audor, Kültür Balıkçılığı Hayvan Sigortası üzerinde çalışmaya karar veren GUIAN S.A.da 3 yıldan fazla süredir denizcilik broker'ı olarak çalışmaktadır. Kendisi bu bölümden sorumludur. İki yıl önce Aquasecure adı verilen özel bir poliçe yaratmıştır ve bu pazarın gelişmesinden sorumludur. GUIAN S.A. bu gelişmeler sayesinde tüm dünyada 100.000.000 dolar değerinde balığı sigorta kapsamına almıştır.

9 - OTURUM

TÜRK AÇıK DENIZ SEKTÖRÜ- PLANLAMA, UYGULAMA VE BAŞARı



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Türkiye'nin açık deniz su ürünleri yetiştiriciliğinde krizleri avantajadönüştürmeyi de içeren başarılı alansal planlama politikası öyküsü

Hayri Deniz
T.C. Gıda Tarım ve Hayvancılık Bakanlığı, Balıkçılık ve Su Ürünleri Genel Müdürlüğü



ÖZGEÇMIŞ

Akdeniz Üniversitesi Su Ürünleri Fakültesinden 1987 yılında mezun oldum. Dokuz Eylül Üniversitesi, Deniz Bilimleri ve Teknolojisi Enstitüsünde "çipura ve levrek yetiştiriciliği" konusunda Doktora yaptım.

Halen Gıda Tarım ve Hayvancılık Bakanlığı, Balıkçılık ve Su Ürünleri Genel Müdürlüğü, Yetiştiricilik Daire Başkanlığında "Deniz Ürünleri Yetiştiricilik Uzmanı" ve "Proje Koordinatörü" olarak görev yapmaktayım.

Daha önce sırasıyla; 1988-1991 yıllarında Tarım ve Köyişleri Bakanlığı (TKB), Bodrum Su Ürünleri Araştırma Enstitüsünde "Araştırmacı" olarak, 1992-1993 yıllarında Konya Tarım İl Müdürlüğünde "Su Ürünleri Yetiştiricilik Uzmanı" olarak, 1993-1994 yıllarında Akdeniz Su Ürünleri Araştırma, Eğitim ve Üretim Enstitüsünde "Araştırmacı" olarak, 1995-2011 yıllarında Tarımsal Üretim ve Geliştirme Genel Müdürlüğünde "Deniz Ürünleri Yetiştiriciliği Şube Müdürü" olarak görev yaptım.

Yine aşağıda belirtilen uluslararası ve ulusal projelerde "Ulusal Proje Koordinatörü" olarak görev yaptım:

- *Ekosistem Esaslı Yönetim Modeli Kullanılarak Deniz Balıkları Yetiştiriciliğinde Yer Seçimi için Yol Haritasının Oluşturulması Projesi (FAO TCP)*
- *Balık Çiftliklerinin Denizel Ekosisteme Olan Etkilerinin Belirlenmesi (TUBITAK)*
- *Su Ürünleri Yetiştiricilik Ürünlerinin Hasat Sonrası Kalite, İzlenebilirlik ve Güvenilirliği Açısından Sürdürülebilir Sektörel Gelişimi Projesi (FAO Bölgesel TCP)*
- *Mersin Balığı Stoklarının Belirlenmesi, Yaşam Ortamlarının Araştırılması ve Doğal Stokların Zenginleştirilmesi (FAO TCP)*

Ayrıca; Akdeniz Genel Balıkçılık Komisyonu (GFCM) Yetiştiricilik Komitesi, Avrupa Balıkçılık Organizasyonu (EUROFISH), Akdeniz Kıyı Vakfı (MEDCOAST) ve Kıyı Alanları Yönetimi Türkiye Milli Komitesi (KAY) gibi uluslararası ve ulusal organizasyonların görev yapmaktayım.

Uzmanlık alanlarım deniz ürünleri yetiştiriciliği ve yönetimi, açık deniz balık yetiştiriciliği, yetiştiricilik ve diğer kıyısal sektörlerin etkileşimi, bütünleşmiş kıyı alanları yönetimi ve lagün yönetimidir.

Üyesi bulunduğum sivil toplum kuruluşları ise Avrupa Su Ürünleri Yetiştiriciliği Derneği (EAS) MEDCOAST, WWF Türkiye, Dünya Mersin Balıklarını Koruma Derneği (WSCS), JICA Derneği ve Balkan Çevre Koruma Derneğidir (B.EN.A).

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ÖZET

Türkiye bir yarımadadır ve su ürünleri yetiştiriciliği için önemli bir potansiyeli olan göller, göletler, rezervuarlar, nehirler ve su kaynaklarına sahiptir. 8,333 km lik deniz kıyısı ve 177,714 km uzunluğundaki nehirleriyle, balıkçılık ve su ürünleri yetiştiriciliği için uygun olan 26 milyon hektarlık deniz ve iç su kaynakları vardır.

Resmi rakamlar 2010 da balık üretiminin 653.080 ton olduğunu ve bunun 167.141 tonunun kültür balıkçılığından geldiğini göstermektedir. Su ürünleri yetiştiriciliği çok genç bir sektör olmasına rağmen, hızla yayılmaktadır ve Türkiye'nin toplam balık üretiminin %26sını oluşturmaktadır. Balık ürünleri Avrupa Birliği'ne ihraç edilebilen tek hayvansal kaynaklı ürün olduğu için, su ürünleri yetiştiriciliği Türk ekonomisinde artan öneme sahip bir rol oynamaktadır.

Ancak günümüzde çoğu Ege Bölgesi'nde olan ve diğer aktivitelerle rekabette oldukları kapalı koylarda veya kıyı sulardaki deniz çiftliklerinin yayılışı bir sınırlama ve sektörün gelecekteki büyümesi için esas problem olarak düşünülmektedir.

Hem hükümet hem de özel sektör yıldan yıla ciddi problemlerle karşı karşıya kaldıkça durumdan dersler almışlardır. Yeni Çevre Yasası yürürlüğe girdikten sonra Gıda, Tarım ve Hayvancılık Bakanlığı diğer ilgili paydaşlarla birçok eylemi uygulamaya koymuştur.

Türk hükümeti 2008'de, anlaşmazlıkları azaltmak ve deniz su ürünleri yetiştiriciliğinin gelecekteki gelişimi için istikrarlı zemin sağlamak amacıyla Ulusal Deniz ürünleri Yetiştiriciliği Gelişme Planını geliştirmiştir. Tüm ilgili kurumların ve paydaşların görüş birliğiyle entegre kıyı bölgesi yönetimi modelleri geliştirilmiş ve uygulanmıştır ve 2009'da kıyılardaki balık çiftlikleri kendilerine tahsis edilen açık deniz alanlara taşınmıştır. Ayrıca problemleri çözmek ve sektörü sürdürülebilir bir şekilde geliştirmek için ulusal ve uluslar arası projeler vardır.

Çok genç olmasına karşın, su ürünleri yetiştiriciliği sektöründe çok önemli ilerlemeler görülmektedir: 2002- 2011 arasında su ürünleri yetiştiriciliği üretiminde hacim olarak artış % 209 dur. Türkiye Avrupa levrek ve çipura pazarının %25 payına sahiptir ve dünyada su ürünleri yetiştiriciliğinde 3. en hızlı büyüyen ülkedir. Dahası , su ürünleri yetiştiriciliği Türkiye'de son iki yılda en hızlı büyüyen sektör olarak kaydedilmiştir. Avrupa ülkeleri arasında Türkiye, alabalıkta ilk sırayı, levrek ve çipurada ikinci sırayı almaktadır. Sektörde yaklaşık 25.000 kişi istihdam edilmektedir.

Su ürünleri yetiştiriciliği sektöründeki son gelişmeler Türkiye'yi hem Akdeniz havzasında hem de Avrupa ülkeleri arasında önemli bir pozisyona getirmektedir.

Örnek Çalışma 1: Türkiye Açık deniz Sektöründe Kılıç Deniz'in Başarı Öyküsü

Oznur Yildiz Basruh
Kılıç Holding, Deniz Ürünleri Proje ve Kalite Sistemleri Müdürü



ÖZGEÇMIŞ

Öznur Yıldız ziraat mühendisidir (Ziraat Bölümü) ve yüksek lisansını tamamlamıştır. Kılıç Holding'de kalite yönetim sistemleri müdürü ve proje müdürüdür. Şirketin tüm balık çiftlikleri ve yeni araştırma projeleri, besin sertifikasyonu, çevre ve kalite yönetim sistemlerini yönetmekle sorumludur. Su ürünleri yetiştiriciliği sektöründe özellikle levrek, çipura ve alabalık yetiştiriciliği ve işleme konusunda 18 yıldan fazla deneyimi vardır.

Örnek Çalışma 2: Pınar Balık Çiftliği

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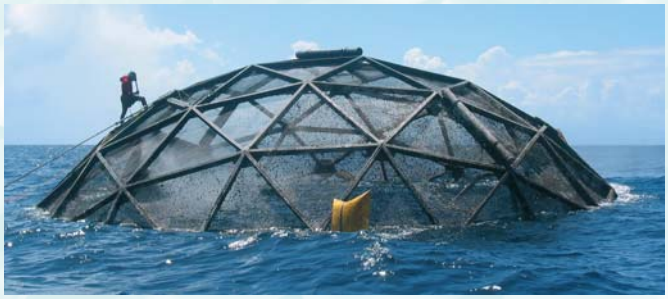
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