Aquaculture and Marine Protected Areas:

Exploring Potential Opportunities and Synergies

To meet the Convention on Biological Diversity's Aichi Target 11 on marine biodiversity protection, Aichi Target 6 on sustainable fisheries by 2020, as well as the Sustainable Development Goal (SDG) 2 on food security and SDG 14 on oceans, by 2030, there is an urgent need to reconcile nature conservation and sustainable development.

It is also widely recognised that aquaculture significantly contributes to sustainable development in coastal communities and plays a vital role in ensuring food security, poverty alleviation, and economic resilience.

In the framework of integrated management, the time has therefore come to identify the potential opportunities and synergies that can enable aquaculture and conservation to work together more effectively.

CONTENT

PRINCE ALBERT II OF MONACO FOUNDATION

Background

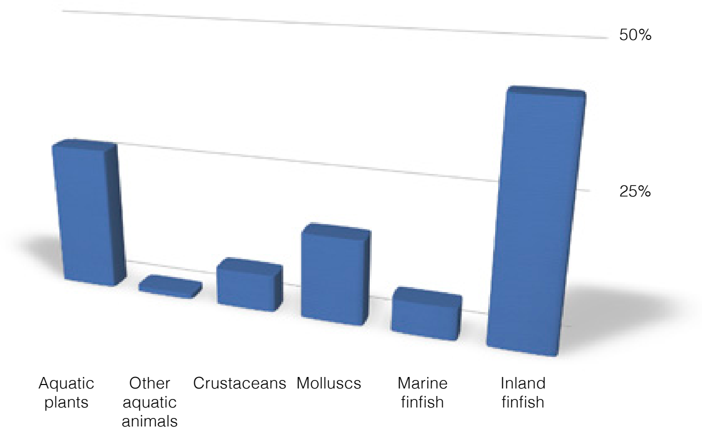
In order to feed the world's growing human population, attention will need to increasingly focus on where the protein needs of the world will be supplied from. While capture fisheries have now reached a plateau of production, marine aquaculture of fish, shellfish and algae has been steadily increasing over the past decades and has become a valid option to make up the protein shortfall. However, one of the major constraints for the aquaculture production sector is the availability of, and access to space. In many coastal areas, competition with other marine activities is already high, mainly because the bulk of marine aquaculture is located close to the shore. Furthermore, water quality in some coastal areas is often not good enough to allow high quality production.

In addition, there is a need for increased ocean protection and the preservation and/or restoration of marine ecosystem health. The establishment of Marine Protected Areas (MPAs) is a key tool essential to meeting the Aichi targets. However, MPAs need to be compatible and integrated within local contexts, acknowledging potential economic activities that are sustainable and in harmony with their conservation objectives. Aquaculture might meet these requirements.

The pressures on MPAs could be reduced by better coordinating the development of marine aquaculture with the establishment and management of MPAs. Promoting synergies between multiple-use MPAs and identified compatible activities, such as sustainable aquaculture production is essential.

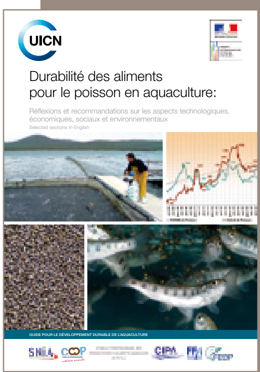
Acknowledging that both aquaculture and MPA may benefit from each other in striving for global sustainable development, the time has now come to explore the following questions: Under what circumstances can MPAs and aquaculture come together? How could MPAs boost aquaculture growth? How could aquaculture activities provide financial support to MPAs? How can we minimize negative interactions? Should we exclude some types of aquaculture (e.g. industrial farms of carnivorous fish cages)? Should we define a frame, a specific approach or just main principles?

Understanding the various types of aquaculture and their potentialities



World aquaculture production distributed among different species categories.

FOCUS: SUSTAINABILITY OF AQUACULTURE FEEDS



The composition of aquaculture feeds is a critical key issue in the sustainability of carnivorous fish and shrimp farming industry, highly dependent on fish meal and oil supply. The aquafeed guide launched by the IUCN (Le Gouvello and Simard, 2017) addresses the sustainability of aquaculture feeds via considerations on the sustainability of the main raw materials used in aquafeeds. Recommendations are made for a more sustainable supply and restricted use of fishmeal and fish oil, to be sourced from responsibly managed industrial small pelagic fisheries.

Due to the very high nutritional quality of these ingredients, it appears difficult to find viable alternatives, but some promising alternative sources have been highlighted such as fisheries and aquaculture co- and by-products, vegetable materials of terrestrial origin, land-based animal by-products or algae, provided that all these raw materials are produced under sustainable practices. A more locally based sourcing strategy for aquafeed ingredients is proposed as a way to improve the overall aquaculture sustainability within a territory.

During the last three decades, global wild-caught fish roughly increased from 69 million to 93 million tons. But 85% of world's fisheries are either being fished at full capacity or already overexploited, depleted or recovering. The world's human population is expected to reach 9.7 billion by 2050 according to the 2015 UN revision of world population prospects. Despite substantial efforts to improve fishery management, global fisheries will continue to experience pressure in order to meet future demand.

In the meantime, aquaculture has grown at an impressive rate. Global aquaculture production rates increased from 5 million to 63 million tons and are expected to grow further with an increase of 38% over the period 2014-2024. Since 2014, it has been contributing more to the supply of seafood[1] for human consumption than capture fisheries. Nevertheless, aquaculture production is highly unbalanced with 25 countries accounting for 97% of total global production, mostly in Asia. Freshwater finfish farming still accounts for the largest proportion of the world's aquatic production, an Asian model originating from very traditional integrated fish-agricultural systems. China alone represents 58% of world's total inland and marine production, and 82% of the world's marine aquaculture production (mainly seaweeds).

Major aquaculture related environmental concerns have been emerging in coastal and marine areas. Recent farming developments of shrimps and carnivorous marine fish of high value, the use of wild pelagic fish as ingredients of aquaculture feeds, and the overall trend to intensification of aquacultural practices have been extensively denounced in the media. However, contrary to many negative perceptions, it should be kept in mind that marine aquaculture production is still widely dominated by the traditional cultures of non-fed species. These include filter-feeding molluscs or seaweeds that are reliant on phytoplancton or on utilizing CO_2 and nutrients as nitrogen and phosphorous naturally present in the environment. The seaweed industry is undergoing a steady growth driven by Indonesia and China and currently accounts for nearly half of the total marine aquatic living productions.

In fact, in contrast with terrestrial livestock farming, aquaculture is very diversified in terms of the number of aquatic species being farmed, the types of technologies used and the degree of intensification, etc. Between the two extreme situations, on one hand intensive industrial fish farming and on the other hand extensive low density aquaculture driven by local communities, there is a wide range of aquaculture practices, types, scales, and situations. The assessment of the sustainability of aquaculture productions is thus a rather complex issue. This means that the farming cost/benefit and impact assessment analysis should be approached on a case by case base. Evaluation parameters should include criteria regarding production objectives, practices, cycles, type of management, environmental conditions, etc.

[1] seafood = fish= all aquatic species, used as a generic term as in the FAO reports.

DESCRIPTION OF THE MOST WIDELY PREVALENT MARICULTURE SYSTEMS IN THE WORLD

SPECIES AND TROPHIC LEVEL

Around 250 of animal or plant species are currently farmed in the World.
The trophic level represents its relative position in the aquatic food chain. These levels can be ranked according to dietary preferences. In the lower ranks, we would find species requiring little to no food or plant based food. The higher ranges would contain species with greater needs like carnivorous species relying mostly on a fish based diet.

% WTP = % of World Total Production

Seaweeds 27% WTP
Seaweeds are autotrophic organisms producing organic matter through photosynthesis. They consume CO_2 and some nutrients such as nitrogen and phosphorous and are located at the basal level of any food chain.

Molluscs 16% WTP
Mollusc cultures are dominated by filter-feeding bivalves such as oysters, mussels, clams…
But it also includes echinoderms such as sea urchins or sea cucumbers, and gastropods such as abalone and cephalopods.

Crustaceans 7% WTP
Mainly penaeid shrimps, crabs, spiny lobster…
High trophic level species.

Finfishes 6% WTP
Farmed fish species are split between:
— Low trophic level species such as milkfish or mullet.
— High trophic level species such as salmon, seabream or seabass.

GROWING PHASES / LIFE CYCLE

For many species, farming techniques and infrastructure are specific and dependant of the growing stage of the species farmed inside their life cycle. Some vertically-integrated farms produce all stages of the life cycle of any particular species, whereas other farms are specialized in one specific growing phase of that particular species.

Hatcheries
Hatcheries are the facilities that take care of culture organisms from broodstock maintenance and spawning to larval rearing.

Broodstock
Adult and mature individuals that are used for breeding purposes. They can be captured from the wild or produced from a selective breeding programme.

Larval rearing
First stages are usually cultured in controlled conditions with high quality waters. Carnivorous fish larvae can be fed with live prey. For shellfish, it includes the metamorphosis and settlement phases.

Nursery
Nurseries for farming of juveniles can be held within a hatchery or in another facility.

Grow-out
Grow out is the longest stage. The transferred juveniles are grown until marketable size, being sorted on a regular basis.

FARMING SYSTEMS

Aquatic organisms can be grown under different culture modes.
Most common farming systems are described hereunder, although, it is not an exhaustive list.

Cages/Pens
Floating or semi-floating enclosed nets for finfish placed in coastal or offshore areas.

Suspended culture
Longlines are ropes vertically set in the sea to support shellfish or seaweed cultures.

Vertical or rack culture
Sticks or posts are staked on the bottom and act directly as a growing medium for shellfish or support racks for seaweeds.

Bottom
Shells, stones, rocks, cement slabs etc., added to the bottom substrate provide attachment sites for shellfish.

Ponds
Ponds are standing water bodies, either natural or artificial, where finfish, crustacean, shellfish or seaweed are produced.

Recycling aquaculture systems (RAS)
Land based tank system which operates with little amount of water. By filtering water and reusing it, those systems enclose fish, shellfish or seaweed, generally in high densities.

Integrated Multitrophic Aquaculture
(see IMTA Focus, p. 14)

INTENSITY

Density is the number of animals or biomass per volume unit.
Intensity combines density and inputs such as supplementary artificial feeds.

Intensive productions involve high density cultures of aquatic species, with regular and nutritionally complete feeding.
Examples: salmon cages in Northern Europe, Canada and Chile, seabream and seabass in Mediterranean countries. Some shrimp cultures in Thailand, in New Caledonia...

Semi-intensive systems involve lower stocking densities than intensive ones, with the enhancement of naturally occurring feed, and some direct artificial feeding.
Examples: mullet farms in Egypt, some shrimp ponds in Asia or Latin America.

Extensive aquaculture involves a low density of cultured species, sometimes with the enhancement of naturally occurring feed.
Examples: seaweed cultures, shellfish, milkfish ponds in the Philippines.

AQUACULTURE SITE

Land-based aquaculture
Aquaculture production facilities with tanks and/or ponds, located along the shoreline.

Inshore
Inshore or coastal aquaculture is generally near the shoreline, in embayments or in sheltered coastal areas.

Offshore
Offshore aquaculture or open ocean aquaculture where farms are located some distance offshore with significant exposure to wind and wave action. The farms are positioned in deeper and less sheltered waters. It is an emerging approach to mariculture or marine farming.

COMMERCIAL OUTLET

The products coming out from aquaculture activities are not restrained to food production. Aquaculture products can be used in various sectors.

Food
Agro-food industry
Agriculture sector (fertilizers)
Medicine components
Cosmetics
Aquariology
Reintroduction/restoration for conservation purposes or stock enhancement

The types of MPAs and matrix of interactions showing aquaculture & sustainability principles

The necessity to protect marine wildlife and ecosystems through area-based approaches like MPAs has been agreed upon by countries, many of whom have signed the UN Convention on Biological Diversity. Underpinning that global Convention, there are 20 targets and one in particular is highly relevant to the trend in increasing ocean protection – the Aichi target 11:

"By 2020, at least 17 per cent of terrestrial and inland water areas, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes."

The term Marine Protected Area actually covers a wide variety of settings within which the conservation of biodiversity and associated ecosystem services can be achieved. In recognition of the fact that it is the substance of the management action that is important, rather than simply the name of an MPA, IUCN issued guidance on the definition of a protected area and the differing types of management categories. This guidance was subsequently expanded to include more detailed information and advice on MPAs.

To qualify for one or more of the IUCN management categories, a site must meet the IUCN definition of a protected area:

"A protected area is a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values".

IUCN has defined six categories of MPAs whereby the two most commonly applied types (Categories V and VI) can allow aquaculture activities. Category VI reflects multi-purpose MPA aiming to both preserve biodiversity and enhance a sustainable economy by managing related impacts and synergies. However, looking into the detail, most MPAs categories may allow some type of aquaculture as discussed later in this paper. Quite how appropriate aquaculture activity is within a MPA category forms the essence of this paper.

Protected Area Category and International Name	Management Objectives
Ia – Strict Nature Reserve	Managed mainly for science
Ib – Wilderness Area	Managed mainly to protect wilderness qualities
II – National Park	Managed mainly for ecosystem protection and recreation
III – Natural Monument	Managed mainly for conservation of specific natural/cultural features
IV – Habitat/ Species Management Area	Managed mainly for conservation through management intervention
V – Protected Landscape/Seascape	Managed mainly for landscape/seascape conservation and recreation
VI – Managed Resource Protected Area	Managed mainly the sustainable use of natural ecosystem

Matrix of activities that may be appropriate for each IUCN management category.

Activities	Ia	Ib	II	III	IV	V	VI
Research: non-extractive	Y*	Y	Y	Y	Y	Y	Y
Non-extractive traditional use	Y*	Y	Y	Y	Y	Y	Y
Restoration/enhancement for conservation (e.g. invasive species control, coral reintroduction)	Y*	*	Y	Y	Y	Y	Y
Traditional fishing/collection in accordance with cultural tradition and use	N	Y*	Y	Y	Y	Y	Y
Non-extractive recreation (e.g. diving)	N	*	Y	Y	Y	Y	Y
Large scale high intensity tourism	N	N	Y	Y	Y	Y	Y
Shipping (except as may be unavoidable under international maritime law)	N	N	Y*	Y*	Y	Y	Y
Problem wildlife management (e.g. shark control programmes)	N	N	Y*	Y*	Y*	Y	Y
Research: extractive	N*	N*	N*	N*	Y	Y	Y
Renewable energy generation	N	N	N	N	Y	Y	Y
Restoration/enhancement for other reasons (e.g. beach replenishment, fish aggregation, artificial reefs)	N	N	N*	N*	Y	Y	Y
Fishing/collection: recreational	N	N	N	N	*	Y	Y
Fishing/collection: long term and sustainable local fishing practices	N	N	N	N	*	Y	Y
Aquaculture	**N**	**N**	**N**	**N**	*	**Y**	**Y**
Works (e.g. harbours, ports, dredging)	N	N	N	N	*	Y	Y
Untreated waste discharge	N	N	N	N	N	Y	Y
Mining (seafloor as well as sub-seafloor)	N	N	N	N	N	Y*	Y*
Habitation	N	N*	N*	N*	N*	Y	N*

Key:

N = No

N* = Generally no, unless special circumstances apply

Y = Yes

Y* = Yes because no alternative exists, but special approval is essential

* = Variable; depends on whether this activity can be managed in such a way that it is compatible with the MPA's objectives

**Illustrative example of a matrix Aquaculture systems and MPAs categories.
Any actual version would need to be developed through extensive discussion and dialogue,
and so accordingly the below table should not be taken to reflect a formal view of IUCN or its Commissions.**

Categories	Ia	Ib	II	III	IV	V	VI
High density fish cage culture	N	N	N	N	*	*	*
High density on-land close system fish culture	N	N	N	N	*	*	Y
Medium density on-land circulating system fish pond culture	N	N	N	N	*	Y	Y
High density shell fish culture (table, long-lines)	N	N	N	N	*	*	Y
Low density pond /lagoon fish culture	N	N	N	N	*	Y	Y
High density seaweed culture	N	N	N	N	*	*	Y
Low density shellfish culture	N	N	N	N	*	Y	Y
Medium density invertebrate (e.g. sea cucumber) culture	N	N	N	N	*	Y	Y
Integrated Multi-trophic culture	N	N	N	N	*	Y	Y
Restoration purpose aquaculture *	*	*	*	*	*	Y	Y

Understanding aquaculture and MPA interactions

This section shows ways to broadly address the interactions between aquaculture and Marine Protected Areas. The attached table presents the main types of marine aquaculture in order to help readers in assessing the potential synergies or challenges between aquaculture and MPAs.

Indeed, to grasp opportunities for positive synergies, MPA management should include an evaluation of the potential impacts of aquaculture on the marine environment as well as the socio-economical factors of those that interact or depend on MPAs for their livelihoods or recreational pursuits. Different aquaculture systems may cause diverse effects on the natural environment, such as habitat deterioration and ecosystem function disturbance. However, some aquaculture systems may have positive effects for the biodiversity of the site and, therefore, their objectives be compatible with MPA targets.

The following benefits and services provided by aquaculture are underlined as follows:

— Aquaculture can play a direct role for wild stock fauna enhancement and flora/conservation. Various examples are provided, such as grouper population restoration in Italy, coral reef farming in Madagascar... However, caution should be exercised, to monitor the impacts on wild stock genetic variations, and assess the overall sustainability of such aquaculture versus other options such as strict conservation rules.

— Aquaculture can be designed for fisheries enhancement and proposed as a valid alternative to overfishing on vulnerable stocks. Restocking for fisheries based on aquaculture has been well developed in many countries for decades such as Japan (all fisheries) and in the USA (salmon fisheries). But these kinds of aquaculture depend on specific national and local traditions, formal governance mechanisms, markets, and rely on appropriate monitoring tools, in order to avoid impacts on wild stocks.

— Aquaculture can play a major role for food security, poverty alleviation and economic resilience of MPA local communities. For instance, in Madagascar (Focus Blue Venture case, p. 12), aquaculture is proposed as an alternative to overfishing in a region of great poverty, although it may be challenging to pursuade traditional fishing communities to switch to aquaculture. Women are often the actors of such transition.

— Aquaculture can provide services to coastal ecosystems such as carbon sequestration, nutrient or phytoplankton biomitigation, benthic biodiversity restoration. These various benefits are mostly achieved with shellfish and seaweed cultures, but also mentioned with finfish cages (Focus Madeira p.9). However, research has to be carried out to better describe these services and point out their limits.

This being the case, it can be said that a controversial aquaculture system, such as an intensive salmon cage farm, may become acceptable for a given marine protected area, provided that it is well placed and cleverly managed. The same farm, however, would be completely incompatible for an MPA hosting another specific marine habitat. In contrast, the cultivation of seaweeds or shellfish, considered a low impact aquaculture activity (with a small ecological footprint), may in fact become detrimental to a coastal socio-ecosystem, if not appropriately planned and managed.

FOCUS:

CURRENT STATUS OF MPAS, MARINE SPATIAL PLANNING AND AQUACULTURE IN MADEIRA AND CANARY ISLANDS

SWOT analysis of Aquaculture production in the archipelagos of Madeira and Canary Islands (C.Andrade - R.Haroun)

S Strengths

— Studies show no significant impact of fish farms,

— Aquaculture industry reaching maturation stage with economic, social and environmental issues integrated into the business,

— Marine Reserves zonation provide an example integration of MPAs and economical activities.

W Weaknesses

— Lack of public awareness of aquaculture as "clean" industry,

— Lack of knowledge and cartography of marine biocenosis in MPAs may introduce a principle of precaution excluding fish farms from MPAs.

O Opportunities

— Marine Spatial Planning as a tool to integrate aquaculture activities in MPAs,

— The establishment of MSP may launch pilot projects of fish farms in marine reserves – testing farms interaction with conservation purposes, local communities, tourism attractions etc.

T Threats

— Implementation of single purpose MPAs (conservation) or other limiting regulations during the MPS process,

— Competition of aquaculture with tourism in MPAs,

— Absence of political will to implement MSP principles.

ULPGC ECOAQUA www.ecoaqua.eu Observatório Oceânico da Madeira

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The islands of Madeira and Canary archipelagos, situated off the Northwestern African Coast support a rich marine biodiversity, protected mainly under the umbrella of the European Habitat Directive and, consequently, with a number of MPAs inside the Natura 2000 Network. The MPAs are scattered along the island's coastlines and present different level of protection, from "no take areas" to marine protected sites where, for example, some human activities are allowed and controlled (commercial and sport fishing, diving, nautical sports, bird- and whale-watching) or banned, such as sand extraction or specific fishing gear (nets and longlines).

Fish farming production (mostly seabass and seabream cages) in Madeira (600 t/year) and Canary Islands (7000 t/year) was originally and successfully established from 1990´s onwards, prior to MPA recognition, and for supporting the local economy. At present time, a first step towards developing a Marine Spatial Planning (MSP) Strategy is underway in Madeira, mapping aquaculture potential sites as well MPAs, other social and economic activities along the coast and maritime area. With only a single exception, aquaculture is being left out of MPAs. The only new fish farm site approved is inside the Network of Marine Protected Areas of Porto Santo and has to comply with organic fish farming regulations. Due to difficult logistics and the nature of production, this site will hardly ever be occupied by fish farming activities. On the other hand, the oldest fish farm and first pilot project in Madeira is due to move out of the limits of a designated marine bird reserve within ten years.

In the case of the Canary islands, the Regional Agency of Fisheries defined in 2010 the Regional Plan of Aquaculture Zonation (PROAC in its Spanish acronym), which designated priority areas for aquaculture production along the coastlines of the Canary islands. Nevertheless, this Plan has not been implemented until now and new licenses have not been awarded for off-shore aquaculture production due to major differences among diverse governmental agencies and the uncertainties related to the implementation of the European Marine Framework Strategy Directive.

Towards MPAs and aquaculture compatibility and sustainability

DEVELOPING THE APPROACH THROUGH A STEP-BY-STEP PROCESS

Among the key questions related to the topic, the clarification of MPA objectives is essential. They should be defined and accepted among the stakeholders of the MPA project as a pre-requisite.

Once the MPA objectives are defined, other issues will need to also be considered and agreed. Undeniably, in order to meet the Aichi objective of 10%, we need the extension of multi-purpose / multi-use MPAs. But more than a debate on MPA categories ("no take" zone or multiple-use zone), the crucial issue is to make sure that the right management tools are in place in order to satisfactorily meet MPA objectives. If both questions upon MPA objectives and the presence of an adequate management have been stated and accepted by the stakeholders (within the MPA and its surroundings), the aim of the aquaculture project should also be, in the same way, clearly questioned and acknowledged.

Three contextual situations related to the MPA/aquaculture interaction have been identified:

Development of a multiple-use MPA in an existing aquaculture area

This relates to situations where aquaculture farms already exist before the MPA is actually declared and set up by the authorities. This context is widespread, well illustrated by Scottish cases, where most salmon or shellfish farms were existing before the MPA declaration (Focus, p. 11). Aquaculture farms are usually not moved out, but an impact assessment of the farms should be conducted in regard to the MPA's objectives, which may lead to the relocation of the farms or to re-definition of the MPA limits in extreme cases.

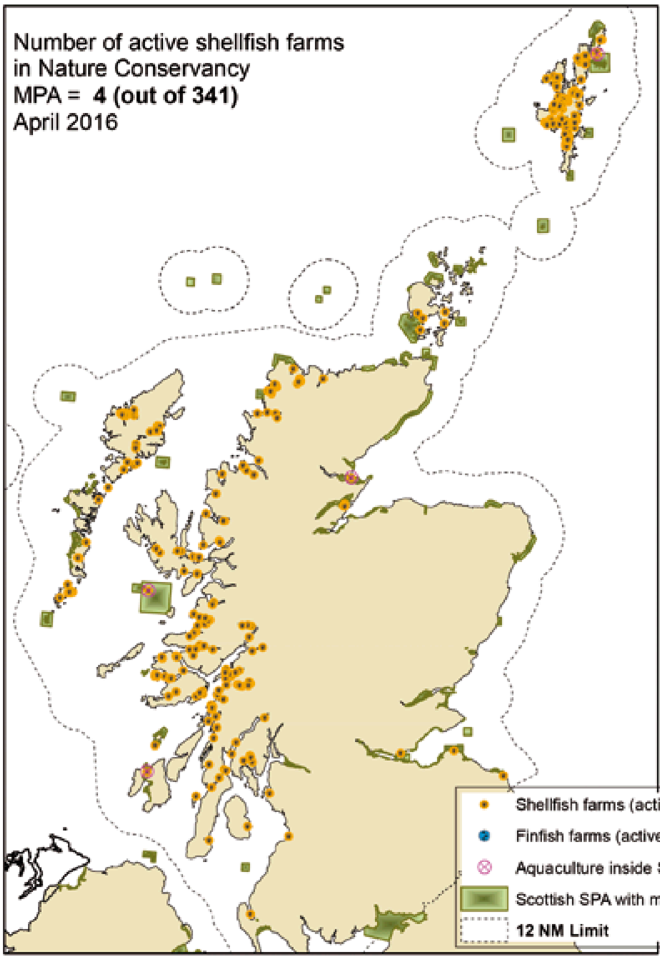
Development of aquaculture farms in multiple-use MPAs

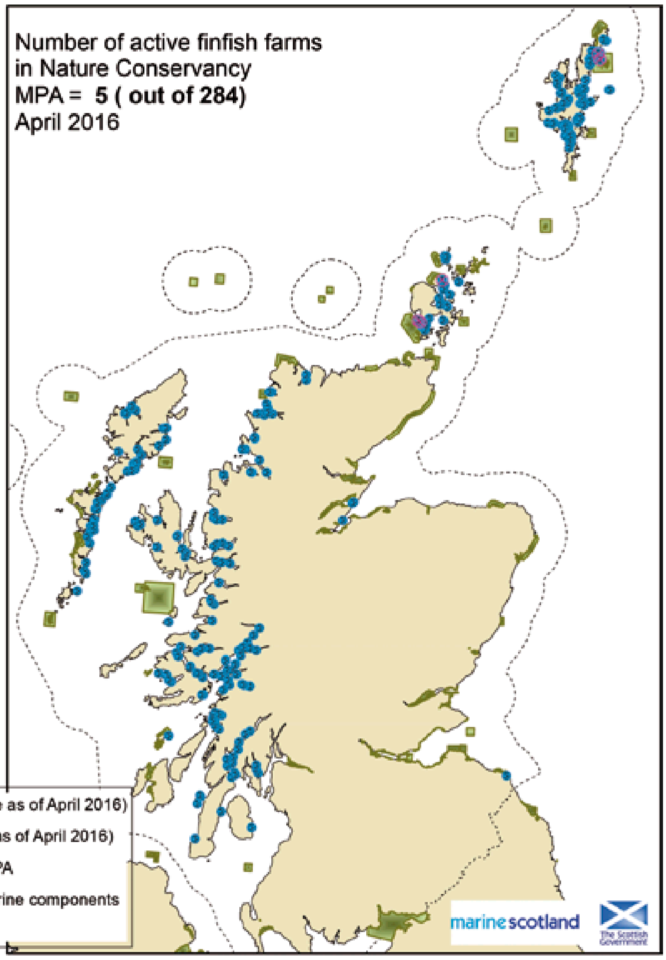
The second situation illustrates the case where there is an existing multiple-use MPA and there is a call to develop aquaculture within the area in order to meet some of the local community's needs. In this situation, the type of aquaculture systems would need careful selection to meet the needs of the community and be compatible with the management objectives for the MPA, as the case study brought by Blue Venture in Madagascar illustrates (p. 12). Some guidance on aquaculture and multi-purpose MPAs has already been developed within the European community and could be helpful in this regard, as well as other general recommendations that already exist on site selection and aquaculture with regard to zootechnical and socio-economic issues.

Joint creation of multiple-use MPAs with aquaculture operations

In the third situation, the MPA is established and the associated aquaculture production(s) are set up as simultaneous developments. This situation is illustrated by the French Mayotte case (Focus, p. 13), although the fact may be argued that some aquaculture productions farming non-native carnivorous fish (at a very small scale) pre-existed in this area, prior to the Mayotte National Marine Park creation. The pre-existing situation of the farm is, in fact, the main reason why such an aquaculture production system was authorized within the multiple-use MPA. The key critical issues are related to how the decisions are made to allow such aquaculture production, how it will be monitored, and what vision the project leaders have for the future.

These two last issues are very similar in the sense that the establishment of an aquaculture farm in the MPA requires a clear rationale and a list of objectives. The choice and advantages of a specific aquaculture project against other economic activities (tourism, fisheries, etc.) should be underpinned and acknowledged by the MPA stakeholders. Comparison between aquaculture and other activities in terms of impacts or risks is necessary to address information on the best choice of economic development within an MPA. Various options of aquaculture types, systems, purposes and scales should be studied to optimally adapt the specificity and needs of each potential site and minimize adverse effects and the overall environmental footprint. The way an aquaculture project interacts with a MPA is related to the characteristics of the project, its design and its management as well as the scale of the operation. Thus, a small-scale aquaculture facility poorly sited in a multiple use MPA (category IV though to VI, though most likely the latter category) may be more damaging to nature conservation than a well thought-through larger scale operation.





FOCUS:
SCOTTISH MPA/AQUACULTURE MANAGEMENT FRAMEWORK

Two different cases are distinguished by authorities:

— If the aquaculture farm came first, then a Partial Business and Regulatory Impact Assessment (PBRIA) is required. The purpose is to evaluate the consequences of a MPA creation for existing aquaculture farms (and other impacted sectors) on a specific site: what are the additional requirements for the farms, and consequently additional costs for them? Aquaculture farms within such new MPAs should display good practices and be able to prove it.

— If MPA came first, then a Habitats Regulation Appraisal (HRA) is required. It should provide, and analyse sufficient information to allow a competent authority to ascertain whether the plan or project will not adversely affect the site's integrity.

In addition, aquaculture sector professionals have developed a voluntary Code of Good Practice in order to address various practical issues such as cage and equipment design, prophylaxis, management and operational practices.

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For the Scottish and French authorities, for instance, fish production is acceptable, provided that "good practices" are applied within the farms and good monitoring of the aquaculture impacts is in place (e.g. Scotland and Mayotte cases).

Similarly, for the location and area of coverage, the location of the sites should be discussed with local stakeholders and aquaculture professionals in a concerted approach binding sustainable development, social integration and environmental considerations. MPA managers should be prepared to exchange ideas and visit diverse types of aquaculture farms to reach a better understanding on aquaculture concerns and limiting factors.

FOCUS:

LOCALLY MANAGED MARINE AREA AND AQUACULTURE, A BLUE VENTURE CASE STUDY

blue ventures
beyond conservation

Locally Managed Marine Areas (LMMA) are protected areas that are largely or wholly managed by coastal communities and/or land-owning groups, with the support of government and partner representatives. Velondriake LMMA was created in 2006 with the purpose to safeguard marine biodiversity essential to local marine livelihoods. As 82% of all household income was generated by the small scale fisheries sector, the community was highly reliant on marine resources making protection of fisheries stock a priority.

A community-based contract for farming of hatchery reared sea cucumbers and carrageenan seaweed was launched with the community in partnership with the private sector, some institutions and with the support of the Blue Venture NPO. Mariculture of both species has little environmental impact, with positive effects on local ecosystems (through reduction of fishing pressure) and on livelihoods resilience through income diversification.

Community based Aquaculture of carrageenan seaweed and sea cucumber in the Velondriake Locally Managed Marine Area, Madagascar (Blue Ventures - A. Harris)

S Strengths

— Increasing market price for sea cucumbers and steady price for seaweed,
— Strong, local commercial partners and experienced NGO,
— Low running costs, low technical expertise and no feed inputs,
— Little environmental impact of farming activities
— Hatchery production: No overfishing for larvae from the wild,
— Diversification reducing local dependence on over-exploited capture fisheries,
— Greater connectedness of previously isolated villages/ financially marginalized community members.

W Weaknesses

— Accessible to impoverished communities only if capital costs covered by donor funding, or through a contract farming agreement with a private partner,
— Few best practice guidelines to inform the development of the model,
— Single provider of sea-cucumber juveniles limits the bargaining power of farmers,
— Profitability not yet high enough to encourage professionalization to full-time farming.

O Opportunities

— High level of interest and desire to participate in farming initiatives from other communities allows for rapid expansion in suitable habitats,
— Profitability of both models increasing yearly,
— Developing community farming associations to increase the bargaining power of farmer.

T Threats

— Storms and cyclonic activity damaging pens and animals,
— Epidemics of a disease with little understood etiology / epiphytic algal infestations,
— Theft and fishermen animosity,
— Negligible policy framework to guide the development of aquaculture activities and contract farming initiatives in Madagascar.

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CAN THE DEVELOPMENT OF A MATRIX ON MPA TYPES AND AQUACULTURE HELP TO IMPROVE SYNERGIES?

A matrix, with a similar format as those used by IUCN in its marine guidelines, is an effective tool to identify major synergies. Table (p. 7) provides an illustrative example of the type of approach in the interaction between MPAs and Aquaculture and should be used for general guidance as many of the specific issues are related to prevailing conditions in the specific site such as stocking densities, conservation objectives, etc. It could, however, provide a flexible frame to further explore potential synergies between aquaculture and MPAs, and help all concerned stakeholders identify specific issues that should be followed up on. Eventual decisions on whether to proceed or not, or to modify the original concept, will all depend on the overall case assessment. In addition, even where the illustrative example of Table (p. 7) shows green compatibility, this does not negate the need for comprehensive discussions and evaluation of siting and impacts.

COULD INTEGRATED MULTI-TROPHIC AQUACULTURE (IMTA) PROVIDE OPPORTUNITIES FOR SYNERGIES WITH MPA MANAGEMENT OBJECTIVES?

By definition, Integrated Multi-Trophic Aquaculture (IMTA) (Focus IMTA) seems an interesting perspective on reducing negative aquaculture externalities and maximizing its production capacity whilst enhancing the associated marine biodiversity and augmenting resilient ecosystems. In this context, some applications of IMTA could be of interest within MPAs by providing enhanced opportunities to secure management synergies. IMTA could be deployed in various cases as in Table (p. 7) (e.g. high density fish cage cultures, shellfish culture, sea cucumber culture...), although a specific assessment of the proposed local IMTA system must be conducted to define what level of compatibility it has regarding the MPA category.

DO NON-NATIVE SPECIES AQUACULTURE OPERATIONS POSE DIFFICULTIES IN ACHIEVING GREATER SYNERGIES WITH MPAs?

The acceptance or non-acceptance of the aquaculture production of a non-native species within an MPA is also a very critical point. For the nature conservation community, it seems quite difficult to accept that an aquaculture production of non-native species within an MPA could be allowed. However, non-native species are widespread, even in marine ecosystems within MPAs. In aquaculture worldwide, it has been a major trend for decades. The global oyster production is based

FOCUS:

MARINE NATURE PARK OF MAYOTTE, A CASE STUDY

A small scale Red Drum production began in 2001 in Mayotte and was supported by a nonprofit organization Aquamay until 2015. Aiming to continue Aquamay missions, a new organization will emerge to train and support new farmers at administrative, technical, economical and biological levels, and define local candidate species for aquaculture diversification.

Mayotte MPA is a marine Nature Park created in 2010 and covering all Mayotte's EEZ. The park pursues several objectives: knowledge of the marine environment, its protection and the sustainable development of marine activities. Within Mayotte's Marine Park management plan, a goal of sustainable aquaculture in Mayotte was recognised by stakeholders and local authorities. Therefore, detailed recommendations have been made for its development.

S

Strengths

— MPA framework for the development of sustainable aquaculture/Marine Spatial Planning,
— Current production compatible with the specifications of organic farming (low density/no antibiotic),
— Sheltered lagoon cyclonic storms.

W

Weaknesses

— Infrastructure development plan in progress (roads)
— Low local investment capacity,
— Low number of species produced, non-native selected species
— Insecurity (installations),
— Low efficient marketing strategy.

O

Opportunities

— Stable political system,
— Growing demand for marine products
— Biodiversity: possibilities of diversification and IMTA.

T

Threats

— Urbanization and demographic change,
— Climate change,
— Cost of labor,
— Availability of shore land and competition with other coastal uses.

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on the introduction of new species of oysters in order to overcome epidemic outbreaks in local oyster species. Even in the situation where the aquaculture production is based on a local species like Atlantic salmon in Scotland and Norway, it may also be argued that the domesticated farmed fish becomes, over time, quite genetically far from the local wild species. Consequently, each case of aquaculture should be contextually analysed, and risk assessed, with regard to this particular issue of non-native species, and whether the species concerned is already farmed in the local or national context. The frame provided by the European Union with regard to risk analysis, provides a very valid approach, as it has been approved and validated by the scientific expert community.

EXPLORING NEEDS AND OPPORTUNITIES: MPA/AQUACULTURE MONITORING, DEVELOPMENT AND PROMOTION

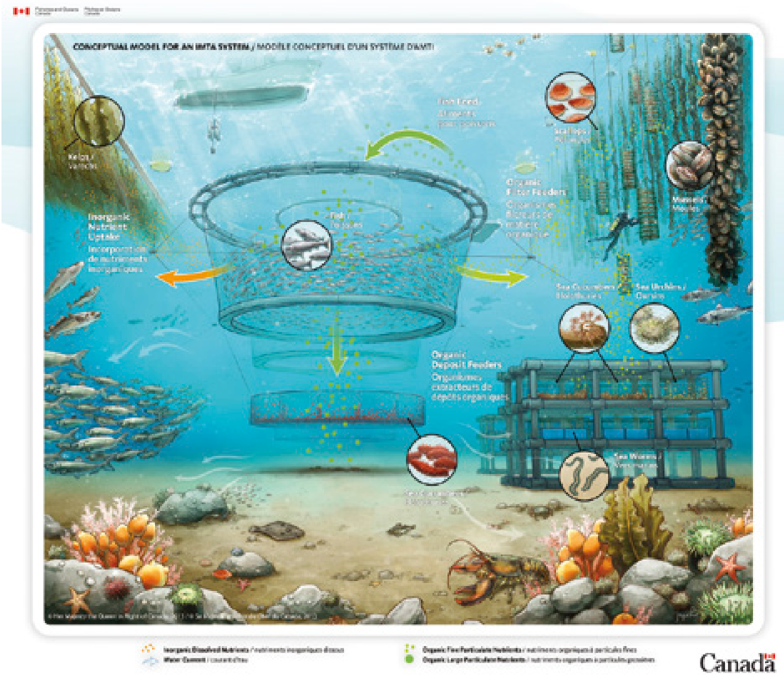
Many potential synergies exist between MPAs and aquaculture and vice versa. In the coming years, stakeholders and MPA managers should come together more often to better understand the aquaculture sector, its constraints for production, and its intrinsic needs for a high-quality environment. At the same time, MPA managers and aquaculture leaders should always work to reduce conflicts, but should also explore optimising advantages, especially in the area of supporting conservation efforts, restocking, and lowering environmental footprints and intensity of production systems. Among available tools and potential approaches/ concepts that should help in reconciling aquaculture and MPAs, the following were identified:

— The concepts of Ecosystem Approach to Aquaculture and Carrying Capacity: they provide very valid tools, integrating human activities within the wider ecosystem (Focus Ecosystem approach and carrying capacity).

— The development and application of Marine Spatial Planning (MSP) together with Integrated Coastal Zone Management (ICZM): They constitute dynamic processes facilitating site selection – with the correct water quality and siting measures – for aquaculture applications.

— SWOT analyses: As illustrated by the case studies, a SWOT analysis may provide a valid analytical tool, shared with stakeholders, to evaluate ongoing aquaculture projects within MPAs and identify the actions to correct weaknesses and prevent failures.

— ‘Other Effective area-based Conservation Measures’ (OECM): Alongside the traditional view of MPAs, more options for cooperation may open in the future through new guidance IUCN will develop for the Convention on Biological Diversity to further elaborate achieving Aichi Target 11.



Conceptual model for an IMTA system by Joyce Hui (www.joycehuiart.com).
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FOCUS:
INTEGRATED MULTI-TROPHIC AQUACULTURE (IMTA)

IMTA uses the principle that in a food chain, what can be considered as waste for one species becomes feed for another. Following this approach, shellfish and marine plants for instance, could benefit from the organic and inorganic waste generated by finfish marine farms. Thus reducing their impact on the environment and, at the same time, diversifying income for the farmers. IMTA has been a traditional aquaculture system for centuries in Asia, associating agriculture-livestock productions to freshwater finfish polycultures. This has drawn attention recently, by some work in Canada and Europe, where seaweed, finfish and shellfish productions are associated within the same coastal area.

FOCUS:
ECOSYSTEM BASED APPROACH AND CARRYING CAPACITY

The Ecosystem approach is a powerful tool for the integrated management of human activities and should be used to address site selection and management. This approach, based on the best available scientific, traditional and local knowledge, gives an equal voice to all stakeholders including the aquaculture community. It aims to optimise the use of an ecosystem without damage, through the management of human impacts and activities.

Carrying capacity is a concept defined (in the case of aquaculture) as the maximum biomass of a farmed species that can be supported by an ecosystem without by-passing the maximum acceptable impacts to the farmed population. Carrying capacity can be broken down into four categories; production, physical, ecological and social.

The views expressed in this document do not necessarily reflect those of IUCN and its partners.

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— Environment Impact Assessment (EIA): It can be required by national authorities and will address most of the key questions addressed in this paper.

— Good practices as a standard and consideration to a certification: In MPAs, aquaculture should be developed on the basis of best practices. Those good practices may be recognised and controlled through a certification process. However existing standards such as organic or ASC (Aquaculture Stewardship Council) may not address the objectives of an MPA. New certification standards could be created ("certified MPA-friendly") but this may lead to an uncertain, costly and time-consuming process, may be questionable regarding MPA and aquaculture diversity cases. In addition, it may create a gap between emerging and wealthy industrial country situations.

— The use of impact assessment tools such as Life cycle analysis or Ecological Footprint: They are being adapted for aquaculture activities. However, due to the diverse and multidisciplinary nature of environment issues and highly variable production processes, implementation so far does not reflect the full diversity of aquaculture activities and often neglects social aspects of sustainability. The costs and difficulty to find the required scientific data is also limiting.

— Further research on ecosystem services: the quantification of either benefits or impacts on MPAs and the discussions have already raised many interesting scientific questions which offer outstanding opportunities to deepen understanding. There is a need for research concerning ecosystem services, dynamics and functions but also considering the socio-economic impacts.

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Conclusions

Undeniably, to meet the Aichi objective of 10% marine protection, countries will need to dramatically expand the designation of MPAs, the bulk of which, based on current experience, will fall into the categories of multiple-use MPAs. However, more than a percentage number, it is far more relevant to attain conservation objectives and to do so, it will be essential that the appropiate types of governance and management system are in place. These are critical issues as MPAs expand to cover greater areas of the oceans. Similarly, the aim of an aquaculture project should also be clearly set out alongside adequate governance frameworks and the selected management system to allow sustainable seafood production under an ecosystem approach.

Understanding the relationship between aquaculture and multiple-use MPAs is critical in developing opportunities for greater synergies. This in turn has the potential to develop a simple matrix of aquaculture systems vs MPAs categories to support broader discussions in both communities. However, this is a demanding task because of significant challenges around setting rigid assumptions and rules on the MPA-aquaculture relationship. The diversity of farming methods using a wide range of technologies and species predicates against this. In most cases, approaches will anyway need to be adapted or applied according to the objectives of specific MPAs. A matrix may be useful for broader discussions but a case by case and stepwise approach will always need to be taken through a participatory approach, using tools appropriate to the circumstances, available data and the specific requirement of the specific MPA - with an equal consideration of ecological, social and economic issues.

Examples do exist though, and include providing alternative livelihoods for small-scale artisanal fisheries to encourage them to shift to low impact aquaculture, such as sea cucumber ranching and rope-based seaweed aquaculture. More broadly, where economic income is needed within a multiple-use MPA and choices can be made, options for properly selected aquaculture sites may be far more preferential and sustainable than other economic options which would involve destruction and/or permanent loss of habitats and species.

In conclusion, there is no simple answer to the issue of how to deliver enhanced synergies between MPAs and aquaculture. It is not a case of 'banning' aquaculture in multiple-use MPAs – except "badly practiced aquaculture" – but which projects do go forward should be compatible with environmental conditions and local settings. The benefits of, and limits to the diverse combination of MPAs and aquaculture types have to be further explored and investigated. Closing these gaps would have measurable benefits – creating a better understanding all around, a better vision of the real impacts of aquaculture, a richer understanding of the role and importance of MPAs, and above all the opportunity to develop new innovative projects and perspectives for the common good.

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