WORKING GROUP 1 - OVERVIEW

GROWTH AND CONSERVATION IN MARINE AND COASTAL FISHERIES AND AQUACULTURE[1]

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1. This overview paper was commissioned by FAO to serve as a background paper for Working Group 1 "Growth and Conservation in Marine and Coastal Fisheries and Aquaculture". It identifies some key issues, actions needed, constraints to be removed, and to be considered by the High Level Segment of the Summit.

INTRODUCTION

2. For centuries, capture fisheries and aquaculture have provided essential livelihoods and healthy food to a large part of the fast-growing world population. Nonetheless, about 850 million people are still undernourished and the environmental impact is already significant. However, human populations are expected to grow further (from 6.8 to 9 billion in 2050, UN-DESA, 2009) and wealthier, requiring additional food supplies from the ocean. The fisheries and aquaculture sector have to meet the growing challenge of sustainable growth, increasing production to satisfy demands of a growing population, use the sector as a springboard to reduce food insecurity and poverty, generating livelihoods where they are most needed while transitioning to practices that are environmentally sustainable. The challenge to translate these goals into practical action will be particularly difficult in less developed countries and in coastal areas (where 60% of the world population will already be living by 2020, UNEP 2007).

3. This overview looks briefly at these strongly interconnected questions in marine capture fisheries and aquaculture, in terms of growth (i.e. of additional production needed and possible) and conservation (i.e. of policies, technologies and practices needed to ensure long-term environmental sustainability). It identifies and discusses a range of actions needed as well as some of the barriers, trade-offs and synergies involved.

1. GROWTH AND CONSERVATION

4. Fisheries growth and conservation are different but interdependent strategic goals, often pursued in different institutions. However, the management of capture fisheries and aquaculture involve a good dose of utilitarian of conservation to maintain the core resources and habitats used for production. In addition, the adoption of the Ecosystem Approach to Fisheries (EAF, FAO 2003) and to Aquaculture (EAA, FAO 2010) has significantly broadened their conventional

[1] The views expressed in this information product are those of the author(s) and do not necessarily reflect the views or policies of FAO.

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conservation scope. In both subsectors achieving sustainable ("Blue") growth requires facing strategic and tactical trade-offs, avoiding negative synergies and looking for positive ones, i.e. through measures with significant conservation benefits for both growth and conservation.

5. The rationale for growth of capture fisheries and aquaculture has a lot in common as the contribution of these subsectors to food supply is interchangeable and complementary. They will therefore be examined together below. The same will be successively done for the rationale for improved conservation as the two subsectors use the same ecosystem albeit differently and have adopted a similar ecosystem approach. The barriers to change and the action needed to remove or circumvent them tends to be more specific and will be treated by subsector aiming, in each of them at a unified agenda covering both growth and conservation.

1.1 GROWTH RATIONALE: DEMOGRAPHY AND FOOD SECURITY

6. Paraphrasing Ekins (2000), "growth" in fisheries and aquaculture could be defined as an increase in: (i) physical production (tonnes), limited by the carrying capacity of the system; (ii) market value of that production, at different levels of the value chain; and (iii) social benefits, different from (ii) but often compounded with it. The latter is important as "*Real progress cannot be measured by money alone [and] we must ensure that economic growth contributes to our quality of life, rather than degrading it*." (Tony Blair, 1999). In this document, taking a food supply and security angle, "growth" is expressed in terms of food production, recognizing however the connection with economic performance, environmental impact and livelihoods.

7. Capture fisheries and aquaculture, both inland and in the oceans, interact in the ecosystem, at policy level, in their quest for space and investments, and in the market, and they will jointly contribute to meeting the growing demands for fish. This future demand has been projected by FAO, OECD, the World Bank, IFPRI, and Worldfish, in cooperation, using different models and for different time horizons (FAO, 2014). The results provide insights into how the sector may develop and, overall, agree in expecting that: (1) Capture fisheries production will return to stability and possibly increase slightly if overexploited/depleted stocks recover; (2) The additional supply will need to be met mainly by continued growth in aquaculture, particularly inland aquaculture; and (3) Population growth outpacing fish production in Africa will result in overall decrease in per capita fish consumption. In the "most likely scenario" of the Fish 2030 analysis undertaken by the World Bank, FAO and IFPRI (World Bank, 2013), the total supply reaches 187.10^6 tonnes[3] in 2030, representing an increase of 33.10^6 tonnes (21%) from the 154.10^6 tonnes reported in 2011 (FAO, 2012) or a growth of about 2.4%/year. Capture fisheries production stabilizes at $90\text{-}93.10^6$ tonnes, aquaculture grows from 64 to 94.10^6 tonnes and each subsector ends up providing about 50% of the total supply. Direct human consumption grows by about 16%, from 131.10^6 tonnes to 152.10^6 tonnes and about 60% of that increase is projected to come from aquaculture. These projections are the main rational for further growth despite the already significant environmental impacts. It should be noted that the projected demand increases substantially when the expected increase in wealth is factored in. These projections do not explicitly consider that continued sequential overfishing may lead to further decline in global catches if management does not significantly improve. They do not integrate either the possibility of an increase in fishing pressure on non-conventional resources (krill and mesopelagics) that have a high production potential, as a direct source of food or as aquaculture feeds. They appear to be globally insensitive to global climate change even though important

[3] Depending on the scenarios, expected total production varies from 185 to 209.10^6 tonnes.

regional-to-local differences are to be expected but they are likely to be quite sensitive to governance and management performance.

8. Aquaculture is rapidly increasing its contribution to growth and food security. It has expanded between 1981 and 2011 with no sign of peaking, at an average annual rate of more than 8 percent, from about 5.10^6 tonnes to 63.10^6 tonnes in 2011 (FAO, 2012). Over this same period, its relative contribution to global food fish supply has grown from 9 to 48 percent. In parallel with this expansion, aquaculture has increased its inter-connection with capture fisheries (e.g. through capture-based culture and culture-based fisheries), in synergy but also competing for investments and markets and increasing pressure on fisheries due to the use of wild fish for feed. It has increased its ecological footprint, facing problems of resources and space scarcity, diseases; uneven product quality, etc. However the sector has committed to improved sustainability following the Code of Conduct and other soft law instruments such as the 1976 Kyoto Declaration on Aquaculture and the 2000 Bangkok Declaration and Strategy[4], reaffirmed in the 2010 Phuket Consensus.[5] It is important to note also that aquaculture can have comparatively less environmental impacts than other terrestrial sources of protein.

9. Mariculture has grown worldwide but not at the same pace as freshwater aquaculture and in many regions there is still untapped potential for its development.

10. The global offshore mariculture potential is apparently large. At present, 44 percent of maritime nations with 0.3 million kilometers of coastline are not yet practicing mariculture. About half of the mariculture nations produce less than 1 t/km of coastline. About half of inshore mariculture production consists of aquatic plants, but there is little plant production offshore. Moving mariculture farther offshore can release pressure on coastal and freshwater ecosystems and increase the volume available for dilution of nutrient loads and, potentially, increase ocean fertilization and carbon sequestration (Lovatelli, Aguilar-Manjarrez and Soto 2013)[6]. Development scenarios in only 5 and 1 percent of the area meeting all of the criteria required for each of the three most likely species, showed that development of relatively small offshore areas could substantially increase overall mariculture production. Improvements in culture technologies allowing for aquaculture in greater depths and increased autonomy (e.g. growing extractive species such as seaweeds and filter-feeders) as well as the further development of free-floating or propelled offshore installations, would add greatly to the area with potential for offshore mariculture development (Kapetsky, Aguilar-Manjarrez and Jeness, 2013). More generally, genetic and technological improvements (e.g. in the production of marine-based feed stuff) can provide a huge potential for its sustainable growth.

11. Additionally the lower growth rate of marine fish farming compared to freshwater farming relates to the fact that marine fish farming is based on carnivorous species with higher feeding costs and infrastructure investments (e.g. sea cages). The results might change substantially if, for example, a new strain of tilapia could be successfully farmed in sea water (with due attention to the potential environmental impact). There is also a significant potential for aquaculture growth

[4] "Aquaculture Development beyond 2000" declaration, adopted at the 2000 Bangkok Conference on Aquaculture in the Third Millennium.

[5] Report of the Global Conference on Aquaculture 2010 –Farming the waters for people and food Phuket, Thailand, 22–25 September 2010. http://www.fao.org/docrep/015/i2501e/i2501e00.htm

[6] http://www.fao.org/docrep/018/i3092e/i3092e.pdf

in other areas such as in North America that is not realized because of environmental concerns and constraints[7] that could be removed.

1.2 CONSERVATION RATIONALE: ECOSYSTEM DEGRADATION

12. Capture fisheries and aquaculture have been developed with a significant and sometimes underestimated or disregarded impact on the ecosystem which could often be minimized if not avoided.

13. In marine capture fisheries, conservation issues relate to the sustainable use of target species as well as the protection of associated and dependent species, of habitats, and of the ecosystem. On target species, capture fisheries: (a) reduce old age classes and large predatory fish and spawning biomass with a consequent reduction of resilience to environmental oscillation and climate change; (b) modify life parameters (age/length at maturity, maximum age, growth, fecundity); and (c) change species community structure (decrease in predators; increases in preys). However, conventional fishery management gave little or no consideration to predator-prey relationships, the needs of forage food by the upper levels of the food chain, the impact and management of non-target or secondary species, and damage to habitat, except if critical for target species production. The CBD norm for the ecosystem approach to sustainable utilization of biodiversity, e.g. the maintenance of the ecosystem structure and function (Malawi Principle 5), embedded in the Ecosystem Approach to Fisheries (EAF, FAO 2003) has been given little consideration (Garcia et al., 2011).

14. In aquaculture, a conspicuous environmental impact, considered particularly severe and/or potentially irreversible may provoke societal reactions, from ENGOs and consumers, may and do represent brakes to aquaculture development. Conservation issues relate to: (a) conversion and degradation of coastal ecosystems, including mangroves; (b) pollution of coastal areas (organic wastes; chemicals, drugs); (c) accidental introduction of new diseases; (d) escape of species of farmed fish, potentially posing a threat to biodiversity goods and services, including genetic threat in the case of highly selected native species and (e) the use of wild marine fish as feeds (potentially increasing bycatch and overfishing) . The use of exotic species in aquaculture is a relevant global conservation issue. Voluntarily or accidentally, aquaculture has introduced exotic species in various aquatic environments, sometimes affecting negatively the local species. Such introductions have increased the contribution of aquaculture to food security and development[8] and may be necessary if there are no alternatives but adequate risk assessment and management must be put in place

15. Other economic activities, marine and land-based have also deeply modified the ocean environment of capture fisheries and aquaculture: (i) using the ocean as ultimate sink for e.g. organic, mineral, natural, synthetic, short-lived or persistent pollutants; (ii) destroying sea-grass beds and coral reefs; (iii) broadly changing ocean climate; contaminating food, making it unsafe for pregnant women or their babies in some enclosed and semi-enclosed seas; creating anoxic zones in many parts of the world. No mechanism exists today to compensate fisheries for the damage it has to bear and much progress is needed in cross-sectoral management.

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[7] Olin, P., Smith, J. and Nabi, R. Regional Review on Status and Trends in Aquaculture Development in North America – 2010. FAO Fisheries and Aquaculture Circular No. 1061/2. Rome, FAO. 2011. 84 p

[8] Tilapia provides the best example. In 2011, its global production approached 4.10^6 tonnes and 84% of it takes place in 94 countries where tilapia is an exotic species. The impact is particularly noticeable in Asia (FAO/NACA 2011) as well as in Egypt (Krouma, 2010).

16. It is obvious that the demand for food and livelihoods cannot be satisfied without any impact and there is a very large agreement that sectors development needs to be managed to maintain the structure and function of the ecosystem. In response to the endorsement of the Ecosystem Approach[9] by the CBD COP (Decision V/6), FAO specified and adopted an Ecosystem Approach to Fisheries (EAF) in 2001. Guidelines have been developed for capture fisheries (FAO, 2003) and guidelines for an Ecosystem Approach to Aquaculture (EAA) have also being completed (FAO, 2010). Their implementation is still slow and constrained by insufficient political will, lack of coordination between ministries, low capacity to implement, and contextual change in environmental social and economic conditions.

2. POLICY CHANGE AND MANAGEMENT ACTION

17. Despite some discording voices (e.g. Sachs, 1997; Gallup and Sachs, 2000; Alexandratos, 2005) most simulations tend to assume that the future fish-for-food demands could be met and require better management of capture fisheries and more investments and R&D in aquaculture, to face its problems regarding water and space scarcity, fish health, feeds alternatives and environmental impacts. Better coordination between the presently largely independent streams of governance of fisheries and conservation is also needed if their respective sets of objectives are to be simultaneously met (Rice and Garcia, 2011).

18. The action aims to reduce anthropogenic stresses through actions such as those foreseen in the CBD Aichi Targets for 2020 (CBD, 2003), the most relevant of which are described below. While a number of actions are foreseen specifically in each subsector, a number of them are common to capture fisheries and aquaculture and relate to the conservation of the ecosystem within which they operate: (a) Eliminate subsidies and promote positive incentives (Target 3); (b) Reduce habitat loss (Target 5); (b) Minimize multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems (Target 10); (c) Conserve 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, 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 (Target 11); (d) Minimize genetic erosion and safeguard genetic diversity (Target 13); (e) Restore and safeguard ecosystem services (Target 14); (f) Restore degraded ecosystems to contribute to climate change mitigation and adaptation (Target 15); (g) Respect and integrate traditional knowledge ...with full participation of indigenous and local communities (Target 18); (h) Improve, share, transfer and apply knowledge, science and technology (Target 19); (i) Promote responsible consumption, e.g. through ecolabels and other means of scientific information and communication to instigate and help fish consumers to choose seafood that comes from healthy populations, fished responsibly and produced sustainably10; (j) International trade controls for threatened species (through CITES) and last but not least (k) reduce food waste and losses through the value chain, at capture (discards), postharvest handling and storage, processing (by-products), distribution and final consumption (Gustavsson et al, 2011).

[9] defined as *a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way*

[10] http://ec.europa.eu/fisheries/inseparable/en/about

2.1 REFORMING MARINE CAPTURE FISHERIES

19. Most conventional marine fisheries resources are exploited at their maximum productivity level or beyond and with significant environmental impact. The sector is already overcapitalized dissipating potential rents and increasing investment risk in a system in which use rights are often unsecure. Illegal fishing, conflicts between small- and large-scale fisheries and between them and other economic sectors, discards. The impact on the ecosystem, by fisheries and marine and terrestrial sectors (such as mining, including oil & gas extraction), coastal development and shipping) are locally significant, affecting productivity and food quality as well as social and economic performance and resilience. Governance need to improve significantly both at national and regional levels. Integration of capture fisheries within multi-sectoral management is also essential to ensure that sustainability objectives are agreed to and addressed by all impacting sectors.

19. Global bio-economic analyses have indicated that most world fisheries were operating beyond the sector size corresponding to the Maximum Economic Yield (MEY, Figure 1), dissipating around 50 billion US$ of annual rent (Garcia and Newton, 1997; World Bank, 2009; Sumaila et al., 2012). This rent could be captured through a reform involving "disinvestment", reducing the number of boats (by about $2.6.10^6$ units) and employment (by $15\text{-}22.10^6$ jobs). While results have been mixed, successful examples exist in the developed world, mainly for large-scale fisheries.

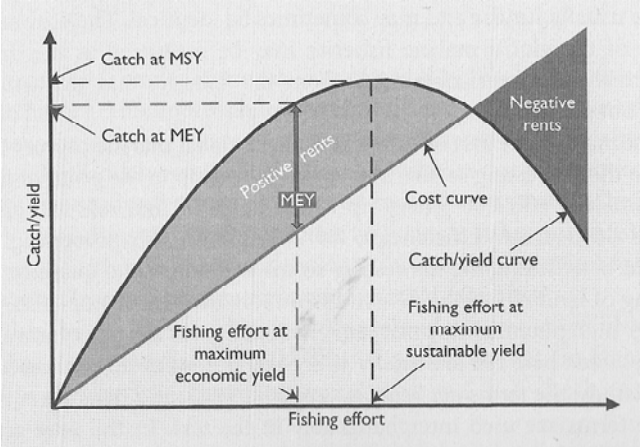

Figure 1. Maximun Sustainable Yield and Maximum Economic Yield (From World Bank, 2009)

20. The action required for improving and better integrating growth and conservation in capture fisheries are defined in many documents, including the FAO Code of Conduct for Responsible Fisheries, its numerous technical and international guidelines and plans of action[11]. The key objectives include: (1) The maintenance or rebuilding of target stocks and improved economic performance and social benefits; (2) The management (for reduction of collateral impact) and rehabilitation of other natural resources such as non-target stocks (reduced bycatch and discards), water and soil resources (pollution, salination), critical habitats (e.g. mangroves, seagrass beds, coral reefs, seamounts); (3) The reduction of waste[12]; and (4) The reduction of the contribution to climate change e.g. GHGs and carbon budget.

21. In facing their part of the growth challenge, marine capture fisheries face two fundamental international requirements: (1) UNCLOS requires maintaining stocks at the level allowing the production of the maximum sustainable yield (MSY); and (2) the CBD requires to maintaining the ecosystem structure and function. MSY should be aimed at to maximize food supplies but uncertainty about its exact value and its inter-annual oscillations make it a risky target. Hence, the 1995 UNFSA qualified MSY as a limit to growth. Aiming instead at the Maximum Economic Yield (MEY) would increase economic profits with a minimum loss of food supplies

[11] http://www.fao.org/fishery/publications/technical-guidelines/en and http://www.fao.org/fishery/code/ipoa/en
[12] Which represents today about 30% of the total production, including discards but also offal, carcasses, and poorly conserved products.

and a major structural adjustment (reform) of the fishery sector with substantial cuts to fleets size and the labor force (**Figure 1**). The CBD requirement is discussed in **Section 2**.

2.1.1 Barriers and constraints

22. The barriers that may block or condition the effectiveness of the action (impeding the needed change) can be related to the various dimensions of sustainability: (1) Environmental: e.g. the ecosystem carrying capacity; its degradation; the sustainable use of goods and services; and the protection of vulnerable species and habitats; (2) Technological: e.g. excessive capacity; non-existent or unaffordable alternative technology; insufficient innovation to use or enhance the ecosystem productivity; (3) Economic: e.g. primacy of short-term economic gains; inadequate incentives; insufficient investment; excessive costs of solutions (cost of compensation, transition and alternative livelihoods, see below); perverse subsidies; (4) Social: e.g. poverty; low capacity to act; marginalization; cultural barriers; violations of traditional rights and, related to it, (5) Governance: e.g. inadequate legal and institutional frameworks; unclear objectives; uncertain tenure and use rights; participation deficit; poor planning; lack of performance assessment; inadequate resolution of conflicts within fisheries and with other sectors. Information plays a central role overall and barriers in this respect come from ignorance or uncertainty; inadequate data; lack of agreed indicators; poor communication; lack of transparency; insufficient science and disregard of informal knowledge (Grafton et al., 2008; 2010).

23. The cost of the reform and its distribution are difficult issues rarely addressed despite their evident strategic importance. More recent preliminary analyses of the problem have concluded that the application of a reform similar to that applied to some industrial fisheries in the developed world to the developing world small-scale fisheries alone (i.e. reducing their labor force by 90%), would cost the developing States in the order to 61-94 billion $/year to maintain just above the poverty line the 95 million people presently directly dependent on these fisheries that would be excluded by a radical reform of use rights distribution, even without accounting for the multiplier effect on the fishery-connected livelihoods (Béné, Hersoug and Allison, 2010) or the aggravating effect of demography. Other analyses conducted at ecosystem level and considering the entire capture fishery sector value chain, concluded that: (i) conventional global models' assumptions used in calculating rents were inadequate in that, in the value chain, costs are not linearly related to effort; (ii) at whole-sector level, the MEY effort level in the value chain is close to the effort at MSY; and most importantly (iii) that, in terms of benefits for the whole society, MSY appears to be a more appropriate target than the single fishery MEY (Christensen, Steinbeck and Failler, 2010; Christensen, 2010). Even more recently, Sumaila et al. (2012) have assessed the cost of the reform to US$ 203 billion, on average, valuing the reform as positive for society and in the long run but as negative for fishing enterprises and fishers, requiring temporary programmes and resources to mitigate its social and economic impact.

24. It is not surprising that a significant change in the scope of the analyses changes the conclusions and the issues raised by these new studies are probably not closed. However, the complete picture of any reform of capture fisheries can only be obtained through analyses conducted at sector/ecosystem level and through the whole value chain looking both at benefits and costs and at their distribution. In addition, solutions that have often worked in the developed world should only be very carefully considered for the developing world, ensuring that inclusive institutions and transparent processes are in place to ensure equity and protect *those who lose in the process of added competition which inevitably accompanies [economic] globalisation* (De Haen, 1998).

2.1.2 Action needed

25. Action is needed, using command-&-control measures and legal, social and economic incentives the mix of which will depend on context, depending on culture, type of fishery and existing governance arrangements. Action in small-scale fisheries in poor and highly fishery-dependent communities is seriously constrained by the fact that, in the absence of alternatives livelihood and "safety nets", trying to narrowly improve economic performance could increase vulnerability and food insecurity, leading to social unrest and disaggregation. The actions prescribed in numerous documents and agreed in principle by Governments include:

1. To ensure good governance explicitly aiming at sustainable growth, conservation and equitable distribution of benefits, apply the ecosystem approach to fisheries (EAF) by establishing a risk-based management cycle at the appropriate level (local, national or regional) that is participatory, uses best available knowledge and explicitly considers and reconciles different objectives including ecological, social and economic. Furthermore, it is essential to ensure that the measures listed below will be accepted and successfully implemented, (Grafton et al. 2010). This requires to: (a) Improve legal frameworks (particularly in the high seas); (b) Clarify rights and responsibilities; (c) Improve institutional frameworks to better integrate growth and conservation, e.g. in Regional Fishery Management Organizations (RFMOs[13]); (d) Adopt and apply good governance principles, e.g.: transparency, participation, rule of law, enforcement, equity, performance assessment, etc.; (e) Modernize scientific support (multidisciplinarity; complexity; uncertainty); (f) Integrate local knowledge; (g) Build capacity for decentralized /participative management; (h) Improve gender equity and working conditions; (i) Confront the externalities of present management systems and of the proposed reform (e.g. on employment and social safety nets); (j) Tailor solutions (the position of the job-profits cursor) to local situations (availability of alternatives, etc.); (k) Promote alliances and synergy between conservation, fishing, tourism and other economic interests;

2. To reduce impact on biodiversity: (a) Redirect investments to environmentally-friendly instruments: by-catch excluder devices; non-destructive fishing practices; accidental mortality limits (e.g. by-catch limits; no-take zones and other MPAs; Payments for ecosystem services (PES) and other economic measures for impact mitigation; (b) Reduce fishing pressure (see 2a); (c) Promote more environmentally-friendly fishing gears at affordable cost;; (d) Create marine/fishing reserves with broad conservation objectives to protect or rebuild vulnerable species and habitats; (e) Consider using the Balanced Harvest approach to meet the CBD requirement to maintain ecosystem structure and function; and (f) Adapt ecolabelling to SSFs.
3. To improve equity: (a) Balance economic and social objectives; (b) Regulate access to resources in an equitable manner: improve tenure systems; (c) Consider community-based rights to maintain social resilience; (d) Improve conflict resolution;
4. To improve the sector performance: (a) Reduce fishing capacity and effort; (b) Close some areas to fishing; (c) Reduce gear collateral impact; (d) Reduce allowable catches; (e) Improve tenure (allocate/confirm user rights) and (f) Eliminate subsidies; (g) Clarify the

[13] The RFMO performance problem relates to, *inter alia:* rigid decision-making; ineffective conflict resolution; poor MCS; reluctance of States to allocate effective management power (e.g. to allocate shares, to enforce management strategies); and reluctance to share with new members.

role of PPPs; (h) Improve MCS (financial support, deterrence, traceability, anti-corruption) (i) Internalize all costs, including management costs; compensation costs, etc.;

5. To reduce conflicts: (a) Allocate fishing rights to sub-sectors; and (b) Integrate planning and management in spatial frameworks (multiple-use MPAs, Marine Spatial Planning, ICAM, etc.);
6. To improve utilization: (a) Redirect fish from fish meals to human consumption, possibly with some negative retro-effects on production of livestock, poultry and culture of predators; (b) Reduce discards and promote full use of catches; (c) Promote further development of by-products[14]; (d) Reduce post-harvest losses; (e) Lobby to reduce pollution and the risk of fish food contamination; (f) develop new products using parts presently discarded; (g) educate customers on better planning of purchase, selection of quality fish and food preparation; and (g) Improve use of fish in emergency food aid.
7. To prepare for /adapt to climate change: (a) Develop foresight and prediction capacity; (b) develop flexibility and resilience; (c) Reduce pressure; (d) Preserve pristine areas.

26. The efficiency of these measures is interdependent and enabling measures (e.g. institutional and legal frameworks, systems of incentives), having a positive impact on many of them simultaneously, should be given priority. Furthermore, the relative importance of different issues, alternative management options and most adequate measures depend on agreed sustainability goals and objectives but also on context, culture, type of fishery and stakeholder perceptions. Finally, there are trade-offs and possible synergies within and between the packages of actions listed above, the identification and solutions of which require a participative process such as the one advocated as part of EAF.

2.2 INCREASING SUSTAINABLE PRODUCTION OF MARINE AND COASTAL AQUACULTURE

2.2.1 Barriers and constraints

27. The further development of mariculture faces a number of difficulties relating to: (i) requirement of fish based feeds specially marine oils, (ii) the costs of feeds, (iii) infrastructures and holding systems; (iv) the access to technology and the markets; (v) the scarcity of good quality space and water; (vi) insufficient investment, and (vii) environmental impacts. Actions to overcome the problems are discussed below.

2.2.2 Action needed

28. Adequate action could enable the oceans to become a major source of food and possibly become the origin of next food revolution in human history (Duarte, Holmer, Olsen et al., 2009). The areas requiring particular attention include:

1. Good governance.is needed to ensure sustainability and avoid misallocation of resources, industry stagnation and irreversible environmental damage. Such governance must provide the enabling environment, with economic incentives promoting long-term consideration, secure property rights, profitability, environmental stewardship, food safety, sustainable technological progress and social acceptability. It should ensure also

[14] Today, about 40% of FM and FO comes from by-products rather than from small pelagics. By-products are also richer in micronutrients (e.g. minerals in bones) compared to the main product (J. Toppe, pers. Comm.; Olsen et al. 2014).

accountability, effectiveness, efficiency, inter-generational equity, and predictability of the rule of law. It requires decentralization, and active participation of the actors and civil society, operating within modern and adapted administrative and legislative frameworks, effective monitoring and enforcement of regulations, and legitimate siting decisions, adjusting itself constantly to both endogenous and exogenous forces (Hishamunda et al., 2014).

2. The feeds environmental and economic challenge. This multi-facetted problem requires multiple solutions: (a) Increased efforts and incentives towards the farming of non-carnivorous species and extractive species are needed as well as consumer education, and reduce the use of wild fish as feed (fish meals, oils, trashfish), increasing the use of vegetal proteins and fishery byproducts; (b) Develop new feed sources. A major breakthrough is expected using new sources originating low in the marine food chain (e.g. krill and mesopelagic species) and safe biotechnologies Alternative marine feed sources can also be explored to replace fish oils for those fish such as salmon that need omega 3s since this is an important value added of marine fish. Progress is underway and most feed companies and private sector are already involved in the search for innovative solutions. Examples include the efforts by Global Salmon Initiative (GSI) to minimize and replace fish meal and fish oil[15] and the experimental Verlasso salmon initiative that has replaced about 70% of the fish oil by yeast that provide omega 3[16]. (c) Adapt new strains of freshwater omnivorous species such as tilapia to the marine environment after appropriate risks assessment; (d) Promote culture of more autonomous species such as edible algae and filter-feeder organisms and improve the markets and the public understanding of the added value in these products; (e) Promote integrated multitrophic aquaculture (IMTA), recycling the by-products (wastes) from one species as inputs (fertilizers, food and energy) for another. Combine the culture of fed species (e.g. finfish/shrimps) with organic and inorganic culture of extractive species (e.g. suspension feeders/deposit feeders/herbivorous fish and seaweeds) (Barrington et al., 2009); (f) Promote other integrated aquaculture systems including agriculture-silviculture (FAO/ICLARM/IIRR, 2001; Soto, 2009) where mangrove growth and management can be practiced in appropriate integration with shrimp farming.

3. Improve access to inputs, technology and access to markets. The problems are particularly important in developing countries where aquaculture is a new sector (e.g. Africa). Some low-investment mariculture systems such as those used for non-fed species and extractive species (e.g. bivalves and seaweeds respectively) could take off with some concerted fostering actions. The economic viability of offshore mariculture is a major challenge and better technologies still need to be developed.

4. Reduce costs, particularly in feeds, offshore developments, infrastructure and holding systems. Most cultured marine fish and shrimp are carnivores using a much higher proportion of fish meal and oil per tonne of fish produced than freshwater species but progress is being made, increasingly using terrestrial feed sources and improving the feed conversion ratio (e.g. in salmon) (Olsen and Hasan 2013). However, marine fish farming usually faces higher exposure to climatic conditions than freshwater system and therefore requires fancier and more expensive infrastructure.

[15] http://www.globalsalmoninitiative.org/areas-of-focus/feed-nutrition/
[16] http://www.verlasso.com/

5. Increase available space, while reducing pollution impacts and reduced exposure to external sources of pollution. Reduced space is already prompting intensification of cultural practices but this is resulting in increased modification of habitats and leakage of nutrients (Bauwman et al 2012). The potential for offshore aquaculture to contribute to growth and food and nutrition security is still poorly understood but will develop in the coming decades (see investment issues below), both in areas beyond national jurisdiction and EEZs (Lovatelli, Aguilar-Manjarrez and Soto, 2013).
6. Increase investments. There is a need to attract more investment in support of R&D and for the development of commercial farms. Limiting factors include competition with freshwater aquaculture which is less costly, produces more affordable products, and has lower environmental costs (e.g. compared to salmon culture). For the latter, in addition, space has become limiting and licences more restrictive. Offshore aquaculture may not yet provide enough incentives to investors and entrepreneurs who will not start investing unless they *expect* it to be profitable, and will not continue to invest in it unless it actually *is* profitable (Knapp, 2013).
7. Prevent introduction of alien species. Increased efforts are required, e.g. using native species and strains in aquaculture (CBD, 2010: target 9) and minimizing the risks of escapement of genetically improved native species (Thorstad et al; 2008).
8. Reduce pollution and impacts due to chemicals and excess nutrients thus reducing eutrophication risks and damage to benthic communities and sensitive habitats. Key actions involve improved feeding systems and technologies, proper biosecurity and considerations to carrying capacity. In general, a wider implementation of the EAA (FAO, 2010) can improve production and earnings while minimizing environmental impacts and maximizing social benefits. One of the key tools within this strategy is the spatial planning of aquaculture with considerations to carrying capacities and main environmental and social risks; this can also facilitate the offshore expansion of the sector (Ross et al 2013; Lovatelli, Aguilar-Manjarrez and Soto, 2013). Moving aquaculture away, off the coasts and offshore, can also reduce many impacts at the cost, however, of increasing governance requirements. The scientific and concerted management efforts should be increased to expand the safe use of culture-based fisheries (CBFs) to increase coastal fishery production, recover some endangered stocks etc. This option can offer huge social and food security impacts and a potential for improving local fisheries, providing that the carrying capacity for the recipient water body to sustain the introduced fish population and the potential environmental impacts (including genetic impacts) are assessed and EAF is implemented (Soto et al 2012).

3. COMMON CONSIDERATIONS

29. A number of considerations are common to the capture fisheries and aquaculture agendas. They relate for instance to the fact that: (a) The status quo is generally not a solution; (b) The role of the State remains fundamental in the ocean, both in the EEZ and in the high seas; (c) Equity is essential to avoid social unrest and illegal activities, ensuring smooth development; (d) Climate change calls for increased attention and adapted solutions, not yet always clearly identified; (e) Better dialogue is required between agencies in charge of growth and conservation (Rice and Garcia, 2011).

3.1 BLUE GROWTH

30. Stemming from the UNEP concept of "green economy[17]" blue growth, its ocean avatar, has been defined) as *smart, sustainable and inclusive economic and employment growth from the oceans, seas and coasts* (EC, 2010). It is (i) grounded in knowledge and innovation (i.e. smart); (ii) more resource-efficient, greener and competitive (i.e. sustainable); and aimed at high employment and social and territorial cohesion (i.e. inclusive). In the FAO fishery context, it has been defined as *the sustainable contribution, and conservation, of living renewable resources in the marine and freshwater ecosystems as well as adjacent coastal and inland ecosystems, to food and nutrition security and poverty alleviation"* (Mathisen, 2014). Both definitions connect implicitly to the concept of sustainable development, putting however more emphasis on the need for socioeconomic growth, potentially reopening the old debate on the likelihood of infinite growth. These definitions, implicitly contain the tension between growth and conservation in both capture fisheries and aquaculture and the translation of the concept in practical terms will call for hard-nosed decisions on trade-offs and efforts to promote synergies.

3.2 IMPACT OF GLOBALISATION

31. Globalization is both a powerful factor of change in policies as well as an outcome of that change. It has opened opportunities for discovery, learning, exchange and socioeconomic transformation as well as wars, migrations, colonization, slavery and economic dislocation. It has certainly contributed to secure global food supplies, improving their availability and accessibility. However, its consequences for people have been quite unevenly distributed (Piketty 2013) confirming that in *the absence of ...conditions for equitable and sustainable benefit sharing of the potential advantages of globalisation could result in the risk that globalization not only misses its opportunities, but would even contribute to the rise of hunger and even lay the ground of conflict... Globalisation may therefore help in spreading lessons from successes and failures, accelerating the needed up-scaling of virtuous initiatives provided safety nets are put in place and financially secured to mitigate and correct its potentially negative impacts (*de Haen, 1998).

32. Approaches intended to limit this risk include: (a) Gradual implementation of global solutions, at a rate adapted to local absorption capacity; (b) Transparent and equitable international mechanism for development of global rules and norms; (c) Development of national institutions' awareness and preparedness to manage the change process efficiently...building on traditional values; (d) Identification and management of the risks of increased marginalization of the disadvantaged, e.g. through social safety nets and participation in decision processes; (e) Use of crises as opportunities to change, paying due attention to the above, e.g. developing institutions for, and capacity to, change; and (f) Caring for livelihoods and food security as well as the environment in addition to economic growth (de Haen, op. cit.).

33. The global analysis undertaken by FAO of the impact of the globalization of international fish trade on food security has concluded on a positive effect on the economy and food security, particularly in the developing world, stressing that the benefits may be sustainable through

[17] Green economy is an economy that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. It can be thought of as one which is low carbon, resource efficient and socially inclusive.
http://www.unep.org/greeneconomy/aboutgei/whatisgei/tabid/29784/default.aspx).

improvement of management capacity and more equitable trade and market policies. The micro-analysis, however, stressed that there could be a range of situations involving different impacts on the rich and poor consumers, calling for particular attention to impacts on disadvantaged strata of the population (Kurien, 2005).

3.3 Other drivers of change

34. Many other drivers of change of policies towards sustainable growth (and the interaction between growth and conservation) are common to fisheries and aquaculture, e.g.: (a) Public opinion (particularly if not directly confronted with costs) enhanced by the action of NGOs. (b) Scientific evidence to increase legitimacy and discover opportunities; (c) Technology to realize existing potentials and open new ones; (d) Oil prices that constrains forms and levels of development; (e) The economic and financial climate which conditions investments; (f) Access to markets which opens opportunities and conditions profits; (g) Climate which conditions performance of present and future developments; (h) Demography, which conditions demands at global and, more importantly, national and local levels; (i) Resources scarcity which affects prices, costs and revenues; (j) International agreements, norms and standards, which affects national policies and sector developments.

3.4 Trade-offs

35. Making trade-offs is the most tangible but difficult aspects of problem solving, particularly in complex social ecological systems. It implies accepting to lose on one side of an alternative in order to gain on the other, stating priority. Nonetheless, the term seems to be progressively tabooed from international political documents to be replaced by "win-win solutions" (the more "wins" in the term, the better!) i.e. solutions that satisfy equally everyone and hence have the lowest political cost. The reality is that "win-win" solutions tend to reflect the composition of the negotiation table and the distribution of power around it and imply trade-offs, within them and between them and other alternatives (see examples below), with some loss to some people and some gain to others. They also tend to emerge only when reducing, by design or ignorance, the number of dimensions considered. Reducing fleet size substantially, for example, is a very systemic measure that should reduce fishing pressure, increase biomass, improve population structure, reduce by-catch and discards, and increase economic performance. It is a "multiple win" solution at the cost, however, of cancelling a substantial number of jobs, with the risk of concentration of harvesting privileges in fewer and richer hands and ensuing social disruption. This reality does not invalidate the measure but it must be faced.

36. The history and present negotiation arenas provide numerous example of trade-offs which cannot be examined in detail here: (i) Maximizing rent vs employment vs food production; (ii) Optimizing throughput vs distribution among actors; (iii) Exploiting forage fish (krill, cephalopods) for humans vs leaving them to predators; (iv) Subsidizing small- or large-scale fisheries, or none of them; (v) Keeping fish for the local communities wellbeing vs selling it away to foreign fleets in exchange of foreign exchange; (vi) Locating MPAs in most ecologically important vs less problematic areas; (vii) Catch quantity vs catch quality and diversity; (viii) Development of local vs export markets. Each of them may have different short and long-term implications and it is important to face them and find ways to overcome the transitional difficulties in order to reach the ultimate goal. There are also important trade-offs between fisheries and other economic sectors with short as well as long-term implications that should be addressed within space-based, cross sectoral, integrated policy and management frames.

3.5 SYNERGIES

37. This often used-term refers to measures that reinforce each other, producing a joint (positive or negative) impact larger than the sum of their impact when used alone. Climate change and overfishing, for example, produce a negative synergy, aggravating each other's impact on the fishery system. Fishing capacity reductions and judiciously placed MPAs, on the contrary, could accelerate stock recovery. Identifying both types of synergies is important to optimize implementation performance and reduce risk of unexpected outcomes.

3.6 INSTITUTIONAL DIALOGUE

38. Many of the examples above converge on the more general tension between growing demands for both more food from, and improved conservation of, the oceans. The problem in dealing with that tension is aggravated when the two terms of the trade are dealt with in two different governance "arenas" at different times[18] with no possibility to have a common debate and solution. The measures foreseen to reduce collateral impact of capture fisheries and aquaculture may often (not always) conflict with those intended to increase food supplies. The trade-offs need to be faced jointly to reconcile solutions and deal explicitly with their distributional and other effects (Rice and Garcia, 2011). Within environmentally sustainable boundaries, the evaluation of social and economic trade-offs and ensuing decisions have to be context-specific and related to local and national objectives. Governments can play a key role in facilitating the necessary stakeholder processes.

Policy or activity	Food security	Biodiversity conservation
Fisheries harvest rate	Maximum sustainable, allowing for major uncertainties	Low (precautionary)
Fishing on lower trophic levels	At sustainable rates; ensure impacts on dependent predators are sustainable	Minimize to avoid impacts on dependent predators
Fishing in high Productivity areas	Fully use at sustainable rates; highest catches at lowest cost and effort	Key areas for inclusion in highly protected MPA networks (EBSA Criterion)
Aquaculture generally	Increase scale and use optimal strains for domesticated growth and integrated facilities	Avoid non-native species and strains, site only where habitat and ecosystem impacts are minimal
Mariculture	Expand in productive coastal areas, use optimal species and strains	Protect productive coastal habitats as priority; use only local strains, promote omnivorous and extractive species

Table 2. Differing directional pulls on policies and activities to address the role of oceans and coasts in addressing global food security and to improve conservation of aquatic biodiversity (From Rice and Garcia, 2011).

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[18] Such as FAO for fisheries and IUCN, UNEP and the CBD for broader ocean and biodiversity conservation.

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