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Sustainable Development in Aquaculture and Fisheries: International Legislation, Technical Aspects, Present situation and Future Perspectives

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Finally, I would like to dedicate this work to my family: Silvia, and my children Giovanni Paolo and Marianna.

TRANSPARENCY STATEMENT

The present work is a theoretical dissertation on Sustainable Aquaculture on Fisheries, compiled by gathering information, definitions and figures from the major international publications and websites concerned with Sustainability, Aquaculture and Fisheries.

Being a Ph.D. part-time student-worker, I elaborated the information and bibliographic research in about two years.

The dissertation is structured as follows:

Abbreviations and acronyms have been extrapolated from the major reference texts and websites.

The glossary containing the main definitions have been extracted from the main texts published by the major International Organizations concerned with Aquaculture and Fisheries.

The list of Figures is composed by already existing pictures that I re-elaborated and by photographs I personally and purposely took.

Most of the Graphs and Tables are part of FAO Globefish Research Programme Volume 114 I authored. The last three Tables have been specifically elaborated for this work. In any case, all data contained in the Graphs and Tables have been gathered and elaborated by the author.

All the texts and references listed in the Bibliography are part of my personal collection or have been kindly made available by FAO Fisheries and Aquaculture Library in Rome, or downloaded from the various international organizations' websites.

Signature

INTRODUCTION

The object of this thesis is to sustain that achieving Sustainable Development in Aquaculture and Fisheries is not only possible, but also strongly recommendable. Fishing and Aquaculture products are a highly valuable source of protein that remarkably contribute to food security at a global level. They also constitute a source of income and employment, but when ill managed, can cause irreversible depletion of natural aquatic resources.

In order to support our thesis, we started by providing a Glossary of terms and a list of Acronyms and Abbreviations. Then, in Chapter 1, we illustrated the basic principles and concepts of sustainability that can be achieved only if Social and Economic Development and Environmental Safeguard are harmoniously integrated. Sustainability also includes a series of different approaches that, in their turn, introduce the methodologies and tools applied to analyze the single situations from a sustainable point of view.

Subsequently, in Chapter 2, we reviewed the most recognized international agreements on Sustainability in general, those on endangered species in particular, and the adoption of institutional agreements within the ecosystem approach on Fisheries and Aquaculture. The chapter includes a second section dedicated to international regulations aiming to safeguard consumers' health and food standards. Chapter 3 briefly describes the statistical database utilized in the three Case Studies that are contained in Chapter 4. This chapter is therefore divided in three sections, each dedicated to investigate respectively: Anguilla spp., Market, Production and Trade[1]; Nile Perch and Lake Victoria: Invasion, Decline, Market Trends and Sustainability; By-catch and Discards: Sustainability in Major FAO Fishing Area 37.

From the analysis of all elements contained in the chapters, we can deduce that the first step towards Sustainable Aquaculture and Fisheries could be an effective enforcement of the already existing international agreements and a more precise application of them at all levels: international, national, regional and local. This can happen with a greater involvement of International Bodies, such as FAO, in supporting developing countries in enhancing the role of Aquaculture and Fisheries in their National Development Programmes.

Secondly, all along our excursus, we noticed and highlighted how a smaller scale of Fishing and Aquaculture facilities could be extremely helpful to minimize the environmental impact and improve monitoring and control of operational procedures. Although Small-scale Fisheries could provide lower revenues in the short term, they could supply a more equal distribution of the income and secure long-term benefits thanks to their lower environmental impact.

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[1] This Case Study is a part of FAO Globefish Research Programme, Vol. 114, by the same author of the present work.

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EXECUTIVE SUMMARY

In 1987 the Bruntland Commission introduced the concept of Sustainable Development that is at the base of this work.
Sustainability or the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs", was later formally accepted and ratified by the 1992 Rio Declaration and opened the way to a new vision of all human activities.

Despite the accordance on the principles and the subscription of numerous International Agreements by most of the governments, NGOs, international organizations and civil society, sustainable development is still far to be accomplished at a global level.

This work aims to evaluate how Fishing and Aquaculture could fit in this picture, and how could they contribute to improving a future Sustainable Development.

In order to do so, we examined the principles and concepts of Sustainability, focusing on the three pillars that constitute its core. Then we analyzed the most significant international agreements and legal instruments that are meant as a support of Sustainable Development.

We conducted a through bibliographical research and gathered information from the already existing researches and studies, visited numerous websites on Sustainability, International Organizations and more specific websites concerned with Fisheries, Aquaculture and the major bodies involved in the three case studies. All relevant statistical data found while collecting the information, has been re-elaborated and then reported in the graphs, figures and tables.

Each of the three case studies reported in the work, constitutes a picture of the environmental risks and damages occurring when the principles of Sustainability are not respected. Eel is threatened by a series of factors that interfere with the completion of its long life cycle such as climate change, overexploitation, anthropic impact and pollution. Nile Perch in Lake Victoria is an example of artificial introduction of an alien species that caused irreversible environmental damage and social alterations. Finally, By-catch and Discards in FAO Major Fishing Area 37 represents one of the greatest threats for sensitive and non-target species of the Mediterranean and Black Sea area and one of the most difficult to mitigate due to the complexity of the factors and stakeholders involved, exacerbated by overexploitation, use of unselective or detrimental fishing gear and the numerous national jurisdictions that lead to a lack of legal homogeneity.

Aquaculture is a fast growing sector both in developed and developing countries. Its growth responds to the ever-increasing world's food security demand. It could also contribute to poverty alleviation and prevention as a source of food and income, but in order to achieve a long-term result and prevent further environmental damages it must align with sustainable requirements.

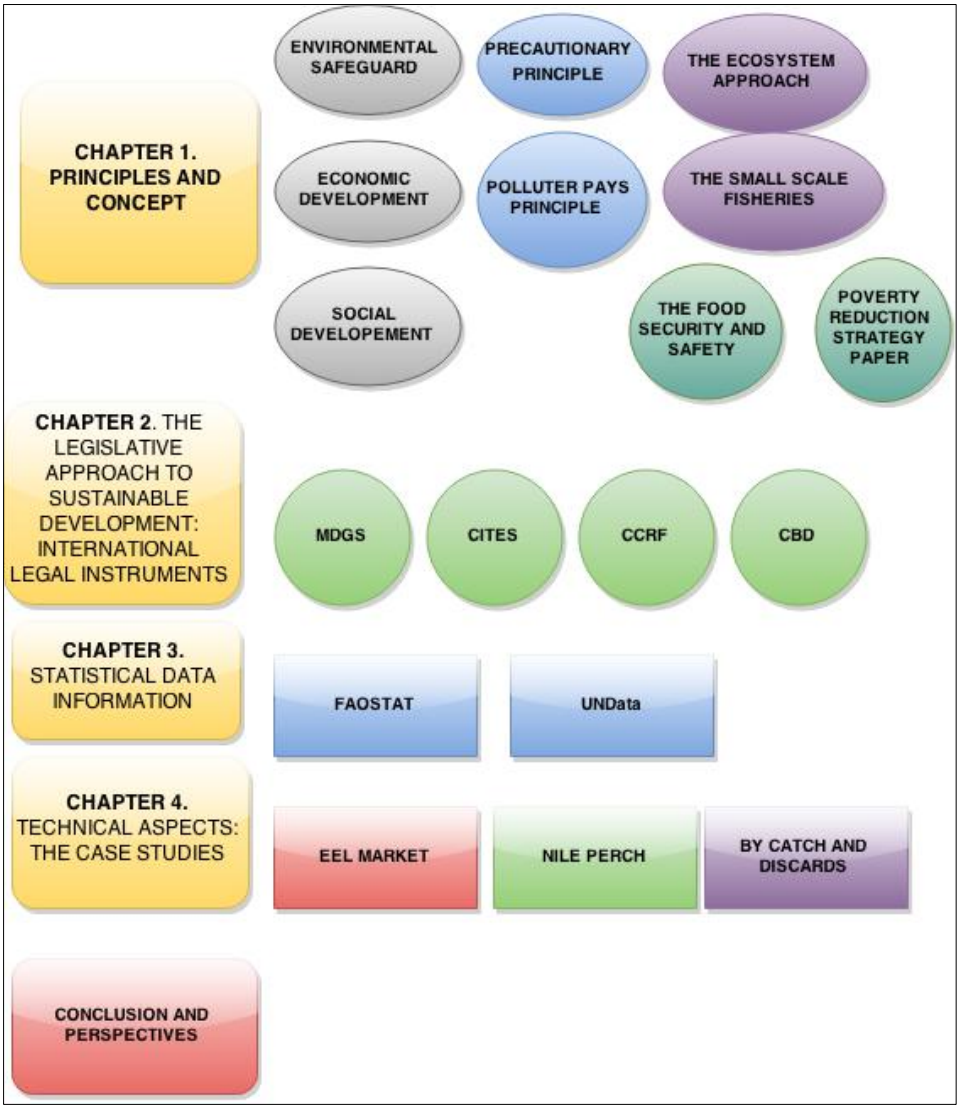


Figure 1. Dissertation Structure Flow Chart

Sustainable Aquaculture can be achieved by applying the principles of sustainable development, but the analysis of our three case studies and the information gathered from our resources, led us to suppose that a reduction of over-exploitation and preservation of aquatic biodiversity is more easily attained when fisheries and aquaculture facilities are of smaller size.

Small-scale fisheries, in fact, could effectively enhance human wellbeing by producing higher employment opportunities while minimizing the impact on the environment. Moreover, they can be more easily monitored and have lower possibilities of biohazard spread.

Their advantages when compared with large-scale facilities and past practices make small-scale and artisanal fisheries a true potential contributor to Sustainable Development.

1. PRINCIPLES AND CONCEPTS

1.1. SUMMARY

In this Chapter we will report the most common shared definitions of the principles and concepts of Aquaculture and Sustainability.
This will allow us to have a larger general framework of what Sustainability implies at global, national and local level, in terms of goals and tools. At the same time it will provide us with the specific terminology related to Aquaculture, Fisheries and Sustainability that will be used all along our work, and more specifically in the three case Studies. The Ecosystem Approach to Fisheries and the Small Scale/Artisanal Fisheries Approach are the two main methodologies considered, that constitute the milestones on Sustainable Aquaculture feasibility. These two approaches, in their turn, are based on Code of Conduct for Responsible Fisheries, whose main articles are reported in this chapter.

Among the tools necessary to achieve Sustainability, we report the general concepts of the IMF and WB Poverty Reduction Strategy Paper. A specific examination of National PRSPs will then be carried out in Chapter, Case Study 2.
Finally, we will examine Climate Change and its interactions with Sustainable Aquaculture and Fisheries.

1.2. AQUACULTURE

According the latest FAO Booklet "*Food and Nutrition in Numbers*" (FAO, 2014), Capture Fisheries continue to dominate the global supply of fish. Nevertheless Aquaculture products, contribute directly to food security[2] as nutrition facts, protein source, essential amino acids, vitamins, mineral and trace elements in all countries. Moreover, fishery products indirectly improve food security by increasing stakeholders' income and farm employers' livelihoods. Therefore, proteins from aquatic origin remain fundamental for human wellbeing in many parts of the worlds (Bardach, 1997), and the fishery sector represents an important source of food and livelihood in Developing Countries.

According to Food Agriculture Organization of the United Nations (UN-FAO), the word Aquaculture was defined in 1995 as:

"*... is the farming of aquatic organisms, in inland and coastal areas, including fish, mollusks, crustaceans and aquatic plants. Farming implies some sort of human intervention and the individual or a corporate ownership in the rearing process, to promote production, such as stocking, feeding and protection from predators"* (FAO, 1995).

FAO also confirmed its view on Aquaculture in the State of World Fisheries and Aquaculture 2000 with this declaration:

"*Fish are and integrated part of aquatic ecosystem, a system in which modification in one area have the potential to affect other area. Thus it is increasingly regarded as necessary, to monitoring the state of the aquatic ecosystem, and also to manage human interventions within that ecosystem. Only within such a framework will be possible for capture fisheries to continue to be a source of food and income for future generations" (*FAO, 2000*).*

Aquaculture involves under controlled environment[3], cultivating marine, freshwater and brackish organisms. This principle allows a substantial distinction between fishing and fish farming (Bunting, 2013; Romanowski, 2007).

[2]**Food security**: when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary basic needs and food preferences for an active and healthy life (FAO, 1993).

[3]**Controlled or semi-controlled environment**: where farmers grow various types of aquatic organisms in an altered condition. The parameters of control can be managed at significantly different levels (Stickney, 2009).

Aquaculture can be also classified:

- By species: around 179 species are used for food and commercial aquaculture and more than 1980 species for ornamental purpose (Bardach, 1997), although numbers are continuously increasing. More recent reports show that more than 200 species are currently farmed (Bilio, 2007). This number includes all the four major taxonomic groups: fish, crustaceans, mollusks, algae and other marine organisms, mainly echinoderms and jellyfish, (Barnabe', 1989).
- By methodologies: freshwater aquaculture, marine aquaculture[4], aquaponics[5], and integrated multi-trophic aquaculture[6].
- By typologies: extensive, semi-intensive and intensive.

Aquaculture is a fast growing sector, both under quantitative and technological aspects. It contributes to food security and poverty alleviation by means of providing protein and income. It also reduces over-exploitation of natural living resources and preserves aquatic biodiversity.
The three crucial developing factors for aquaculture are: managing the breeding process in nursery, growth managing, control and eradication of risk mortality factors (e.g. pollution, predation, etc.)

1.3. SUSTAINABLE DEVELOPMENT

The Bruntland Commission, in its 1987 report Our Common Future, was the first to use the frequently quoted definition of sustainable development as a "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Jana *et al*. 2003). Sustainable development is also the process by which the long-term goal of "sustainability" is achieved (VanderZwaag, 2012; Howarth, 1999).

One of the most important parts of the definition is highlighting the basic needs of the poor, to which should be given priority. This aim can be achieved by limiting the use of non-renewable resources while planning long-term interventions adopting a precautionary approach in order to prevent negative impacts on biodiversity.
In relation to the purpose of this work, the definition adopted by FAO in 1995 and 1997 is particularly appropriate:

[4]**Marine aquaculture,** the breeding of the end products takes place in seawater, whereas earlier stages of the life cycle may be spent in freshwater or brackish waters.
[5]**Aquaculture** linked to **hydroponic** crop production; aquaculture, providing nutrients for plants, (FAO, 2008).
[6]**Integrated multi-trophic aquaculture:** an aquaculture system sharing resources with other activities mainly agricultural, agro-industrial or infrastructural (FAO, 2008)

"Sustainable development is the management and conservation of the natural research base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such sustainable development (... and fisheries sectors) conserves land, water, plant and animal genetic resources, is environmentally equitable, non-degrading, technically appropriated, economically viable and socially acceptable".

The milestones of sustainability can be thus summarized:

- Social development;
- Economic development;
- Environmental safeguard;

Potential actions to achieve these goals are:

- Livelihoods, poverty alleviation through employment;
- Management of natural resources;
- Wellbeing and food security oriented interventions;
- Remuneration for environmental and ecosystem services;

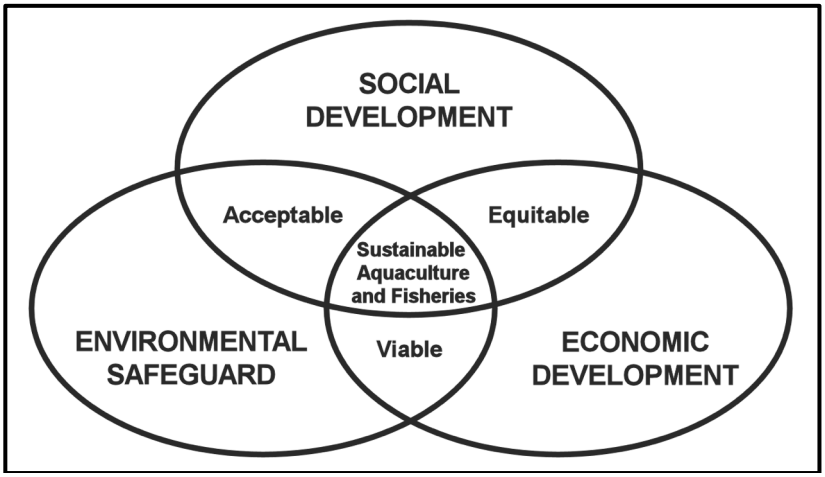


Figure 2. Three dimension of sustainability

The 2000 Millennium Declaration and its MDGs that we will later illustrate, underlined the interdependence of social, economic and environmental development

and also that, in order to attain the achievement of its Goals by 2015, these factors had to be integrated. To date the goals are yet to be fulfilled.
Hereby we report an illustration of the previous milestones and potential action necessary to achieve a balance among social, environmental and economic issues (Weybrecht, 2014).

1.4. SOCIAL DEVELOPMENT

Social equity and development are consolidated concepts that can be applied to any economic activity. Intra-generational consequences must be always taken into account, allowing future generations to have access to the same social resources of their predecessors (GFCM, 2013).
Aquaculture, as well as any other economic activity can contribute to social and economic development, but can also generate social ruptures, inequalities and conflict over resources (Brugère, C. *et al*, 2010). In order to avoid negative outcomes, the major actors involved in the economic process need contribute to reach a social balance. Government agencies, traders, customers, communities, NGOs and all other stakeholders must collaborate both during the preliminary planning phase through the completion of the economic process.
When applied to aquaculture, the above concept implies that of social acceptability, since Aquaculture industry is often surrounded by a negative perception from a social, environmental and economic point of view. In fact it is very common to see industries totally detached from the social environment where they are located.
This is particularly true in developing countries where local workers seldom benefit from the development of the industry, because revenues are not allocated or invested in situ. Summarizing we could say that natural public resources are exploited, but benefits are shared only among few actors.
Current and future generations could have access to the same resources only through a series of provisions and guidelines supporting national policies for responsible development of aquaculture (FAO, 1995).
Increasing the participation of local communities and aquaculture farmers' organizations in promoting sustainable aquaculture, decision-making and site selection could prevent negative behaviors by owners and also create other positive effects, such as reducing migration, contributing to social stability and enhancing woman empowerment (especially in small scale fisheries).

1.5. PARTICIPATION FOR SOCIAL AND ECONOMIC SUSTAINABILITY

A project can be defined sustainable when it provides long-term benefits, so that the receiver will continue to perceive the benefits even once the external contribution has ceased.

In order to achieve this goal, in 2001 the European Commission established a list of basic requirements that a project should fulfill:

- Beneficiaries' ownership;
- Supporting policies;
- Adequate technologies;
- Environment safeguard;
- Social and cultural aspects;
- Gender equality;
- Institutional management capacity;
- Financial and economic viability;

UNDP[7] too, identified similar monitoring areas apt to establish the sustainability of a project, underlining how eradication of poverty, gender considerations, healthy management of natural resources and sound governance, can contribute to a successful sustainable project.
All these requirements lead to a greater participation of the beneficiaries that is the one of the crucial keys of sustainability (UNDP, 2002).

Hereby we will report three of the main tools utilized to evaluate the rate of the beneficiaries' participation:

- *Stakeholder analysis;*
- *Participatory Rural Appraisal;*
- *SWOT analysis.*

Stakeholder analysis

For a social and economic evaluation of fisheries and aquaculture sustainability, we need to define the fundamental components involved.
This brings us to the introduction of the stakeholder[8] concept.
Stanford Research Institute (SRI) elaborated the first definition of stakeholders in 1963 as *those groups without whose support the organization would cease to exist*.
Edward Freeman further elaborated by introducing the concept of the various actors involved in a business that not necessarily share the benefits or directly participate in

[7]**UNDP**, United Nations Development Programme, his main goals is helping countries build and share solutions to achieve Poverty Reduction and the Millennium Development Goals, Crisis Prevention and Recovery, Environment and Energy for sustainable development,(www.unpd.org).
[8]**Stakeholder:** according to FAO Glossary of Aquaculture: a stakeholder is any person o group with a legitimate interest, in the utilization, conservation and management of resources.

it, but who benefit or suffer the consequences of the specific business or economic activity (Weybrecht, 2014; Welcomme, 2001; Sevaly, 2001)

The term stakeholder has acquired numerous definitions along the years and by different organizations operating in various sectors. In particular the World Bank in 1996 defined two types of stakeholders:

- **Primary Stakeholders**: all those directly affected (positively or negatively) by businesses, policies or any other intervention. In this list we find aquaculturists[9], wholesalers and retailers, feed manufacturers and suppliers, fish farmers and other local residents as well as government planners, aquaculture researchers, financial and technical contributors;
- **Secondary Stakeholders**: all those who are indirectly involved like consumers, exporters, tourism and forestry organizations, fishers for juvenile specimens according to capture-based aquaculture, and all those who represent public interests thanks to their expertise (e.g. NGOs and/or technical bodies).

The boundary between directly and indirectly affected is not always clearly marked, and often depends on the perception of the actors involved. In the case of fisheries and aquaculture in general, this lack of specification can be the leeway to conflicts and inequality among the actors involved.

It is clear how the identification of the stakeholders involved is the key tool for a good social and economic evaluation, that is at the base of an effective policy-making towards sustainable aquaculture.
According to Rietbergen-McCraken & Narayan, stakeholder analysis can be divided in four steps:

- Identify key stakeholders: assess potential beneficiaries as well as all those who might be negatively affected; identify vulnerable groups, and the relationships among the stakeholders;
- Assess stakeholders interests and the potential impact of fisheries management on their interests;
- Assess stakeholder influence and importance: for each group assess its social, economical and political status and power relation with other stakeholders, degree of structuration and weight of the stakeholders on the management plan;

[9]According to the FAO's Glossary of the Aquaculture an **aquaculturist** is a person engaged in aquaculture.

- Outline a stakeholder participation strategy: plan each beneficiary group involvement according to its importance, influence and capacity.

Once the stakeholder analysis and social economic evaluation are completed, the next objective should be to increase stakeholders' involvement at all levels.
Stakeholders' involvement can be classified in three categories:

- Instructive, a top down approach with information exchange;
- Consultative, a top down approach with an effective influence of stakeholders over decision making;
- Cooperative, where stakeholders act as partners with government in the decision making process;

Stakeholders' involvement is obviously a two way process which implies political structures which encourage and regulate participation in policy-making, planning and management process. Agenda 21, too affirmed the necessity for a greater involvement of individuals and communities in 1992, but unfortunately the participation so often advocated has not been sufficiently and correctly applied.

The weaknesses of such involvement are the scarce institutional capacity and legitimacy of stakeholders, the costs of their involvement, the degree of the involvement and their eventual conflicts.

Participatory rural appraisal (PRA)

The Participatory Rural Appraisal (PRA) is methodological diagnosis that allows an intense and rapid understanding of the local communities' level of participation and knowledge applied to the rural milieu.

This too is an important means for a further assessment of stakeholder involvement and consequently a deeper social and economic evaluation.
It utilizes various tools like interviews, focus group discussions, wealth ranking, and other evaluation methods.
Validity and credibility of the results depend on appropriate choice of the methods as well as good timing for the evaluation. In relation to this point various authors and agencies (e.g. The World Bank) have produced publications containing the guidelines for a correct participation Analysis.

In relation to this work, therefore, a deep social economic analysis, obtained by using tools such as stakeholder and rural appraisal, should outline the path for governments

to set policy guidelines apt to achieve sustainable aquaculture projects and environmental safeguard.

SWOT analysis

SWOT analysis is a strategic tool that is often used by the private sector and non- governmental organizations. It usually consists in a matrix composed by four sections: **Strengths, Weaknesses, Opportunities** and **Threats** (SWOT). These elements represent internal and external factors, favorable or unfavorable to the achievement of the project's objective in the present and in the close future.

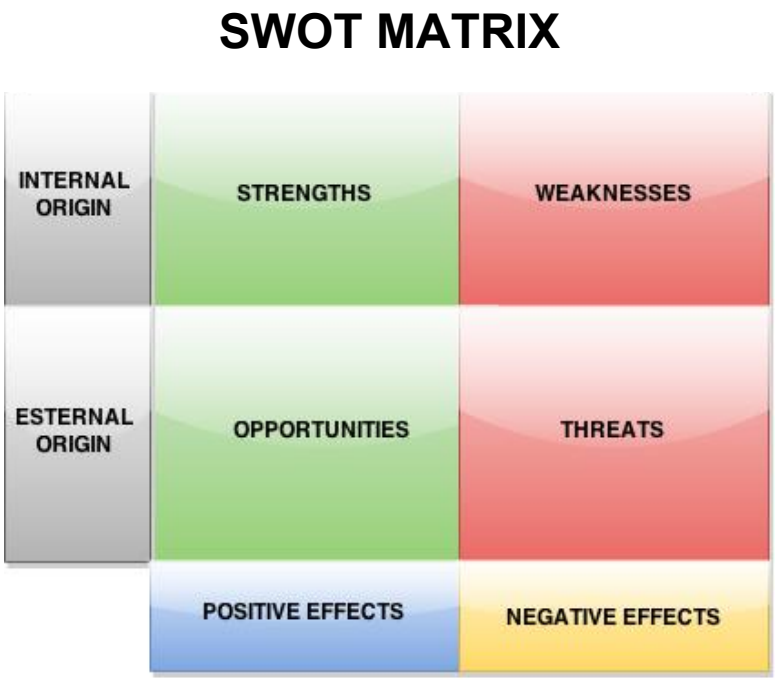


Figure 3. The SWOT Matrix.

Internal origin:

- ***Strengths****:* resources of the system that can be used to reach the system's objectives (in the present);
- ***Weaknesses****:* internal limits of the system that impede reaching the system's objectives (in the present).

External origin:

- ***Opportunities:*** favorable situations external to the system that favor the strategy (environment in the future);
- ***Threats***: unfavorable environmental situations, which may hinder the system's strategy (environment in the future).

Once the SWOT analysis has been performed, it is possible to set the objectives of the project/context. The identification of the objectives is crucial for the subsequent strategic choices and decision-making.
The standardization of SWOT is attributed to Albert Humphrey, who organized a type of analysis that could help companies to evaluate risks and opportunities in their business ventures. This technique was later widely adopted by other organizations and sectors, especially non-profit organizations and international bodies that applied it to the intervention fields.
Sustainability has been therefore incorporated in traditional SWOT analysis, and it has included environmental challenges both as opportunities and threats.
SWOT analysis will be adopted in our Case studies, in order to evaluate future trends and opportunities of each case.

1.6. POVERTY REDUCTION STRATEGY PAPER (PRSP)

The Poverty Reduction Strategy paper is a document required by World Bank (WB) and International Monetary Fund (IMF), as an instrument that enables low-income countries (Heavily Indebted Poor Countries - HIPC) to apply for debt relief and receive aid by major international donors.
The document should be regarded as a participatory process involving all national stakeholders such as NGOs and civil society:
"(*This*) *enhanced framework for poverty reduction (…) seeks to ensure a robust link between debt relief and poverty reduction by making HIPC debt relief and integral part of broader effort to implement outcome-oriented poverty reduction strategies using al available resources"* (World Bank web page, September 1999).
The PRSP or PRSPs, therefore, are documents created to help developing countries to adopt and implement the Millennium Development Goals (MDGs).

The aim

The PRSP, formulated by each developing country, is updated every three years and followed by an annual evaluation paper by IMF and WB (Zupi & Mellano, 2007). The PRSP should outline a national development plan apt to promote the economic growth and poverty reduction, through the implementation of specific

social and economic policies. The PRSP is therefore an essential tool to receive funds from donors, international agencies and lenders.

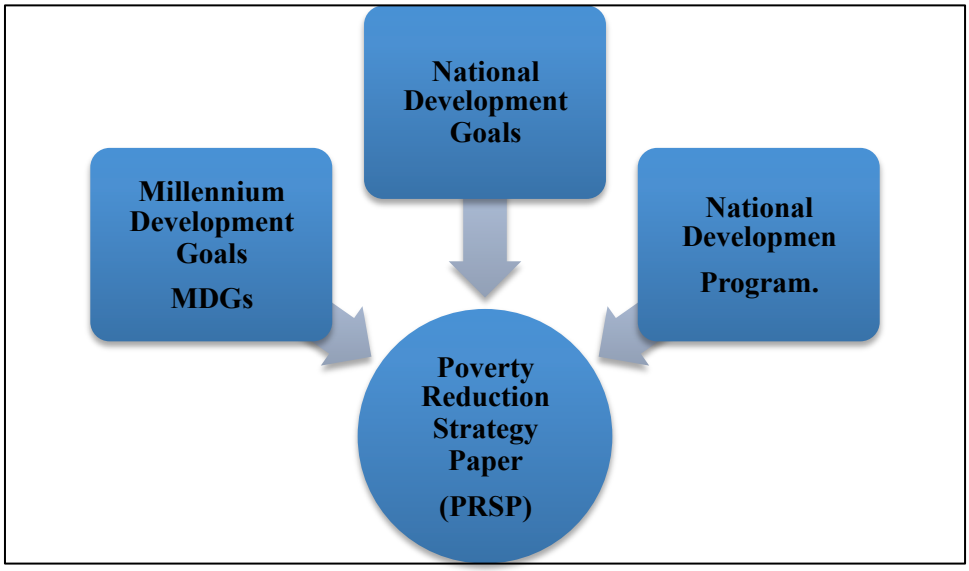


Figure 4. The Strategic rule of PRSP
(Zupi & Mellano, 2007, *modified and elaborated by Pierluigi Monticini*)

The Goals

The five fundamental principles outlined and elaborated by IMF specify that PRSP should be:

- Country-driven;
- Result-Oriented;
- Comprehensive;
- Partnership-oriented;
- Long-term perspective based.

These five core principles are central to the three goals of the national PRS (Poverty Reduction Strategy) process:

- Poverty and Vulnerability focused on government;
- Civil society and Stakeholder involvement;
- Ownership.

The formulation phase

The Poverty Analysis is an essential initial stage of the formulation process that enables to have both a quantitative and qualitative vision of the poverty within a country. It also constitutes the basis to set priority issues and initiate civil participation.
Participation, in fact, is an essential feature of PRSP, which enhances a country ownership while promoting its accountability. It includes different participatory levels:

- Government participation, which include national and local authorities;
- Stakeholder participation, at social, educational and private level;
- External participation of bilateral or multilateral partners;

Weaknesses of PRSP

In contrast with its innovative vision, the main problems of PRSP are the result of excessive ambition. Developing countries are seldom ready to undertake such high standards of participation and linearity in policy making.
Other criticisms of PRSP arise when considering aid dependency and the donors' influence on the country.
Moreover there is a lack of attention on distribution and equity, and there is no relation between the achievement of the Millennium Development Goals and a consequent redistribution of wealth.

PRSPs Conclusion

As regards the specificity of this work, we must underline the small consideration of fisheries and aquaculture in PRSP.

Despite the acknowledged contribution of fisheries and aquaculture in terms of food security for the National economies, in most cases these rural core activities have been rarely mentioned. Unfortunately, the implementation of the Fisheries policies as a sub-sector of Rural Development is marginalized when compared with other key sector such as Agriculture and Livestock (Horemans, 2004).

In relation to this aspect, we will examine the latest PRSP of Tanzania, Uganda and Kenya concerned in Case Study 2-The Nile Perch, and its implication on fisheries in Lake Victoria.

1.7. SUSTAINABLE AQUACULTURE

The application of sustainable development principles to aquaculture may constitute a tool to attain environmental sustainability.
As WorldFish[10] noted, *"Sustainable aquaculture technologies focus on increasing aquaculture production and productivity to maximize impacts on poverty and hunger without compromising the environment"*.
Nevertheless it must be taken into account that aquaculture may develop the same risk of impact on environment as any other form of industrial activity, which can be profitable for a short period, but that can result in serious disease and pollution problems in the long-term.
Strategic plans can be the answer to ensure sustainability, in order to limit disease, pollution and the consequent abandonment of fish farming operations (Jana, 2003; Howarth, 1999).
Therefore, in order to effectively enhance human conditions while minimizing the impact on environment, aquaculture must focus on operating on limited number of geographic areas and, most important, on small-scale fisheries.

FAO Glossary of Aquaculture defines Small-Scale Aquaculture as: *"Aquaculture system with a small annual production (max one tonne per unit and 10 tons in total), made of one or small production units; family or communally run; low to moderate input level and limited external labor. Own food supply, may be a motive"*.

Sustainable Aquaculture key tools:

- Improvement of genetic breeding programs to support the continuous development of new fish strains useful for fishermen and consumers;
- Reduction of risks of disease spread through prevention, rapid diagnosis and adequate treatment;
- Promotion of sound feed and fertilizer management program to maintain full health and vigor;
- Adoption of sustainable production technologies and development of effective supply and chain to produce a valuable outcome for the poor beneficiaries;
- Strengthening access to affordable credit and support of sustainable monetary policy;

[10]**WorldFish,** is an international, non-profit organization, it's a member of the **CGIAR Consortium**. Its mandate is to promote food security, reducing poverty and ensuring sustainable management of the natural resources. Its beneficiaries are the extremely poor and vulnerable who live where fisheries and aquaculture can make a difference, supported while aiming to large scale and long term environmentally sustainable goals.

- Promotion of livelihood strategies in order to increase income, well-being and food security while reducing vulnerability;

Poverty alleviation and vulnerability[11]: reduction and prevention

Poverty alleviation and food security are fundamental components of the Millennium Development Goals (MDGs).
The OECD adopted the following definition of Poverty in 2001:

"Poverty encompasses different dimension of deprivation that relate to human capabilities including consumption and food security, health education, right voice, personal security, dignity and decent work".

In relation to this work, we want to highlight how fisheries could contribute to poverty alleviation on developing countries.
Poverty alleviation can be divided in two components:

- *Poverty reduction*: this can be obtained by generating or strengthening sources of income, creating long term investment, increasingly involving local populations in fishery activities;
- *Poverty prevention:* fisheries can have an effective role in prevention by helping people to maintain a minimum standard of living however low, and thus reducing the risks and increasing safety (Adger, 2004).

Poverty prevention introduces the concept of *vulnerability*. Vulnerability, in turn, can be expressed as:

- Risk exposure of a group (family, community, area) to natural disasters, conflicts, market fluctuations and climate change;
- Sensitivity to risk, that is the grade of dependence of the above groups on fisheries for their subsistence, may be it food security, source of income or both;
- Adaptive capacity of the groups to cope with threats and changes.

[11]**Vulnerability**: according to FAO's Glossary of Aquaculture, vulnerability can be defined as dependency or fragility as well as insecurity complexity (e.g. income, food), the absence of effective regulation and low resilience. In a household context: exposure to contingencies and stress, and difficulty of coping with them.

Vulnerability is strictly related to poverty, as poor people are more vulnerable. By enhancing the level of health, education, involvement, gender empowerment, we could reduce the level of risk and vulnerability, thus alleviating poverty.

Fisheries could contribute to alleviate poverty by offering opportunities for poor people to increase their income and overall growth. Moreover, increasing food security reduces vulnerability to socio-economic shocks, triggering a virtuous cycle towards a better livelihood (Willmann, 2004).
As regards to this work, and to Case Study 2 in particular, the presence of small scale Nile Perch fishing activities on Lake Victoria had created a favorable situation and economic balance and contributed to poverty alleviation. On the contrary, when the same fisheries became large-scale activities, social conflicts and inequality appeared in the local communities. Moreover, the overexploitation of the natural resources created environmental sustainability unbalances.

1.8. ENVIRONMENTAL SAFEGUARD

Environmental safeguard refers to the protection of the whole environment including water, energy, agriculture, biodiversity, fish, plants, forests and air (Weybrecht, 2014).
As for social development, this too is a consolidated concept that should be applied to any human activity and industry.
Both capture fisheries and aquaculture have strong interactions with the environment. One of the most potentially serious effects on environment is the introduction of alien species, which can compete or replace native species. Either the introduction is unintended or deliberate; its diffusion is mostly uncontrolled and has irreversible effects on ecosystems. Alien species, also called exotic or non-indigenous species are species that are not native to a specific area or ecosystem. They represent all phyla including fish (Nuov. *et al,* 2005). One of the most emblematic examples of negative impact on biodiversity is the introduction of Nile Perch in Lake Victoria around the '60s. Although it is not clear if the introduction was accidental or had capture purposes, the spread of this highly predatory species in the lake was devastating on indigenous species. This fish occupied all lake ecosystems and, due to its size and high reproductive rate, it threatened the extinction of native species and the consequent alteration of the trophic chain of the lake. Nile Perch will be later illustrated as case study, underlining how the environmental impact can be combined with social and economic issues on local populations.
The last case study we will report later will examine another potential damage of capture-fisheries that is the By-catch[12] and Discards of Non-Target species.

[12] **By-Catch,** according to the FAO Technical Guidelines for Responsible fisheries, "*The Ecosystem Approach*" is defines as a species non-target (other species), or in a different size range of the target

Aquaculture's negative image derives from the environmental damages caused in the past and its potential future risks. Pollution, damage of sensitive ecosystems, coastal erosion, loss of biodiversity, environmental contamination, introduction of exotic species, introduction of drug resistant pathogens, as well as land water conflicts are the main negative consequences often attributed to aquaculture (GFCM, 2013; Phillips & Subasinghe, 2008).
From a sustainable perspective, monitoring the interactions between human activities and their ecosystems has a crucial role to prevent potential negative impacts on the environment.
According to Herman Daly[13], ecological sustainability, can be safeguarded by introducing three broad criteria:

- Renewing natural resources;
- Develop renewable substitutes for non renewable natural resources;
- Reducing and controlling waste generation.

Therefore both national and international legislation can play a fundamental role in protecting the environment from aquaculture's potential damages.
Policies should focus on combining aquaculture development and ecosystem approaches.
The most important international environmental conventions are: Convention on Biodiversity (CBD)[14]and Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).
These establish international guidelines, which effect legislations and regulations at a national level.
As we will illustrate in the Eel Case Study, the reception of EU of CITES regulations on endangered species, has produced some relevant effects on EU legislation: Council Regulation (EC) 338/1997 which carries out CITES within European Union and Council Regulation (EC) 1100/2007, the last specifically related to the protection of European Eel through implementing a management plan.

species. Part of the by-catch has no economic value and then is discarded and return to the sea, usually dead.

[13] http://en.wikipedia.org/wiki/Herman_Daly, Date accessed, 3 October 2014.

[14]**The Convention on Biodiversity (CBD),** is a multilateral treaty, it was open by the Earth Summit in Rio de Janeiro in 1992 and entered into force on December 1993, has many objectives such as the conservation biodiversity, the sustainable use of the components of biological diversity and the equitable sharing of the benefits arising out of the utilization of genetic resources. The agreement covers all ecosystems, species, and genetic resources

Precautionary principle

The precautionary approach was first stated by *Principle 15* of Rio Declaration on Environment and Development in 1992.
"In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environment degradation" (www.pprinciple.net).
This principle is part of a larger group of terms, concepts, principles and issues, which define the wider idea of Sustainability (Weybrecht, 2014; VanderZwaag D.L & Chao G. 2012; De Young, 2008; Garcia, 2003 &1994).
Its application to Fisheries management is particularly important. In fact Fishery planning and management are frequently surrounded by uncertainty and ignorance of the potentially irreversible damages caused by unscrupulous decisions.
Therefore, higher the level of risk, higher should be the degree of precaution employed in decision making.
Although Fisheries management still suffers from lack of scientific certainties of potential consequences, making the precautionary Principle often hard to apply, FAO offers some precious guidelines through its Code of Conduct for Responsible Fisheries.
Article 6.5 of General Principles, and 7.5 of Fisheries Management, in particular, stress again on the need of never postponing conservation in case of absence of sufficient scientific information.
If these guidelines were applied on both target and non-target species, through an international reinforcement of pre-existing regulations, there would be many beneficial consequences for biodiversity and environment conservation.

Polluter-pays principles (PPP)

The PPP is a widely recognized principle that establishes that who is responsible for any environmental damage should cover its costs (Weybrecht, 2014).
It is evident how this principle can be relevant for capture fisheries and aquaculture, where all the activities can be a source of pollution, from fish processing to loss of fishing tools and gear.
This is particularly true in developing countries where the use of obsolete technologies represents one of the main obstacles for the attainment of environmentally friendly fisheries (Shawkat, 2008)
The principle should be implemented by establishing strict standard rules that would regulate fish processing, capture fisheries, waste, potential habitat damage by the application of laws and taxes.

Unfortunately it must be noted that this principle has not been enforced by any binding international regulation, although it was originally recommended by the Organization for Economic Cooperation and Development (OECD) in 1972 and then confirmed in 1992 by the Rio Declaration:
"National authorities should endeavor to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment."

1.9. THE ECOSYSTEM APPROACH

Principles and concept

This approach conventionally indicates a management of human and natural resources in a way to *"meet human requirements to use natural resources, whilst maintaining the biological richness and ecological processes necessary to sustain the composition, structure and function of the habitats or ecosystem concerned"* (UN, Convention on Biological Diversity, 1992).

Ecosystems are multiform bodies with many interactions, these can be defined as "*a system of complex interaction of populations between themselves and with their environment*" or as "*the joint functioning and interaction of these two components, populations and environment, in a functional unit of variable size*" (Scialabba, 1998; Nybakken, 1982; Odum, 1975; Ellenberg, 1973).

Aquatic environments include rivers, streams, lakes, agriculture (e.g. floodplains), forestry (e.g. mangroves) and sea with off shore, estuaries and coastal areas. They are the source for fishing and aquaculture. These activities exploit largely diversified organisms, both marine and freshwater; ranging from algae to mollusks, from fish to marine mammals. In most cases, undesirable fishing practice (e.g. by use of explosive or by use of cyanide) and overfishing, threaten seriously the fragile aquatic ecosystem. However, aquatic ecosystems often represent the waste yard of human pollution, caused by industrial discharges and human settlements. It is therefore urgent to take action to prevent further loss of biodiversity. The Ecosystem Approach (EA) may help providing potential solutions. Moreover, the application of the EA, in all its forms of ecosystem management or ecosystem-based management, could help reaching a balance among the three objectives of the Convention on Biological Diversity (CBD): conservation, sustainable use and equitable sharing of benefits (Vierros, 2008).

The principles that characterize the Ecosystem Approach are contained in the previous definition. Most of them are the same key principles of international

agreements such as the Convention on the Laws of the Sea (UNCLOS), the UN Fish Stock Agreement (FSA) and the Code of Conduct of Responsible Fisheries (CCRF). According to Mrs. Gabriella Bianchi *et al*. (FAO, 2008), these principles are re-classified in three frameworks: normative, operational and cognitive.

The normative framework of Ecosystem Approach

The *normative framework* of EAF consists in the two main high-level goals:

- Maintaining *ecosystem integrity* through the sustainable use of aquatic resources (species, habitat), while improving livelihood and human well-being;
- Promoting the *principle of equity*, through a distribution of benefit from the exploitation of aquatic ecosystem.

The operational framework of Ecosystem Approach

The *operational framework* regards the institutional bodies, to the processes and all the resources implied in the achievement of the high-level objectives. It therefore relates to:

- Adoption of the precautionary approach;
- Adaptive management system;
- Compatibility;
- Participation;
- Incentives;
- Sectorial Integration;

The operational framework is certainly the most challenging of the three frameworks, as it requires a true share of objectives by society, stakeholders, NGOs and government.

The cognitive framework of Ecosystem Approach

The *cognitive framework* regards the acquisition of scientific knowledge apt to achieve the application of EAF and consists in:

- Improving *scientific understanding* of ecosystems;
- Promoting research on *selective safe fishing gear and practice*;
- Moving *from a predictive to an adaptive science framework*;

The objects and principles described by Bianchi are not new, as they all recall earlier

agreements, and frameworks. Despite they are widely recognized, these instruments have been often ineffective, as they require a shared vision by all the actors involved.

Institutional agreements

In relation to this work, the most relevant institutional agreements that contributed to the creation of the concept of Ecosystem Approach concerning aquatic ecosystems are:

- **1973** Convention on International Trade of Endangered Species of Wild Flora and Fauna (CITES);
- **1982** UN Convention on the Laws of the Sea (UNCLOS);
- **1995** Code of Conduct for Responsible Fisheries (CCRF);
- **1995** UN Fish Stock Agreement (FSA);
- **1995** Convention on Biological Diversity (CBD);
- **2001** Reykjavik Declaration on Responsible Fisheries in Marine Ecosystem.

In particular, the Reykjavik Declaration included a specific declaration of intentions about fisheries management. Despite the application of Reykjavik Declaration by 2001 has been called for by the Plan of Implementation of the World Summit in 2002 and the efforts spent by NGOs to raise awareness of governments and society, much is still to be done in many parts of the world in order to accomplish sustainable fisheries management.

Hereby we report the most widely recognized ecosystem based approaches related to fisheries, that are often interchangeably used.

Ecosystem-based Fisheries Management (EBFM)

The concept of ecosystem-base fisheries management was adopted by Larkin in 1996 and the applied to marine fisheries.

The term has been also defined by the US National Research Council in 1998 as: "*An approach that takes major ecosystem components and services - both structural and functional - into account in managing fisheries... It values habitat, embraces a multispecies perspective, and is committed to understanding ecosystem processes... Its goal is to rebuild and sustain populations, species, biological communities and marine ecosystems at high levels of productivity and biological diversity so as not to jeopardize a wide range of goods and services from marine ecosystems while providing food, revenues and recreation for humans*".
EBFM is a strictly conservative perspective based on holistic and integrated principles, with explicit considerations towards the protection of marine mammals

and protected, endangered and non-targeted species. The precautionary principle strongly emphasizes the need to consider the integration among species and the environment. It provides a vision for improving short- and long-term participation, equity and sustainability (Jason S. Link, 2010).
This term was not internationally accepted at 2001 FAO Reykjavik Conference as it seemed to imply a priority of environmental over socio-economic and cultural considerations, thus causing concerns about costs and practicability (Garcia, 2003).

Ecosystem Approach to Fisheries (EAF)

Although EAF and EBFM share numerous similarities and could be used interchangeable, EAF seems to be more in line with FAO Code of Conduct, being less conservative and more flexible.
According to FAO, EAF introduces a series of modifications in traditional fisheries governance. Furthermore it is also useful for the implementation of the Code of Conduct for Responsible Fisheries (CCRF) in all its aspects.
The main difference with the previous approach seems to be the fact that EAF starts with a fish stock and tries to reach a balance between the human activity and the environment, whereas the EBFM starts with an ecosystem that humans need to preserve while conducting their fishing activities.

The Ecosystem Approach to Fisheries was defined by Ward *et al.* (2002) as "*an extension of conventional fisheries management recognizing more explicitly the interdependence between human well-being and ecosystem health and the need to maintain ecosystem productivity for present and future generation, e.g. preserving critical habitats, reducing pollution and degradation, minimize waste, protecting endangered species*".

In 2003 FAO, agreed that: "*The purpose of an ecosystem approach to Fisheries in to plan, develop and manage fisheries in a manner that addresses the multiplicity of societal needs and desires, without jeopardizing the options for future generation to benefit from a full range of goods and service provided by marine ecosystem".*
FAO also reaffirmed the definition of EAF as follows: "*An ecosystem approach to fisheries strives to balance diverse societal objectives, by taking into account the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries*" (FAO, 2003).
FAO and CBD share a series of guiding principles that constitute the conceptual base and objectives of EAF. Most of them are widely agreed and already established by other international conventions and agreements. Hereby we report the most relevant in relation to our work:

- Equity;
- Decentralization and Participation;
- Precautionary Principle and Precautionary Approach;
- Polluter Pays Principle (PPP);
- User Pays Principle (UPP);
- Compatibility of Management Measures;
- Uncertainty, Risk and Precaution;
- Species Interdependence;
- Ecosystem Integrity and Well-being;
- Rebuilding living Aquatic Resources;
- Impact Reversibility and Minimization;
- Maximum Acceptable Fishing Level and Biological Productivity;
- Resource Scarcity;

Ecosystem Approach to Aquaculture (EAA)

In order to better contribute to sustainable development, in 2005 FAO Fisheries and Aquaculture Department, developed a further framework for an Ecosystem Approach to Aquaculture (EAA):

"*An ecosystem approach to aquaculture (EAA) strives to balance diverse social objectives by taking in account of the knowledge and uncertainties of biotic, abiotic and human components of ecosystems including their interactions, flows and process and applying an integrated approach within ecologically and operationally meaningful boundaries*".

This approach is relevant both at a farm level, close to aquaculture area, and at an industry and commodity level. EAA should improve sustainable aquaculture while minimizing the negative impacts on environment through the utilization of alternative activities such as recycling organic matter, integrate aquaculture/agriculture, rice fish farming and aquaponics.

EAA comprises a part dedicated to the responsible use of alien species. The introduction of alien species is an acknowledged method to increase productivity, but it is also widely recognized as a major potential threat to biodiversity and its uncontrolled modification (see case Study, nr. 2). FAO produced a framework for the responsible use of alien species[15] that contains, among others regulating instruments, the CCRF and the Precautionary Approach.

The principles that characterize the Ecosystem Approach are contained in the previous definition. Most of them are the same key principles illustrated above in

[15] In English literature, non-indigenous, exotic, and **alien** are terms often used for the same concept. Their use means that a certain species is *not native* to that particular area (Lockwood *et al*. 2013). http://www.fao.org/fishery/topic/13532/en. Date accessed: June 20, 2014.

relation to EAF and contained in many international agreements such as the Convention on the Laws of the Sea (UNCLOS), the UN Fish Stock Agreement (FSA) and the Code of Conduct of Responsible Fisheries (CCRF).

Integrated Ecosystem Evaluation

EAF and EAA require a solid knowledge of the status of the ecosystem where they are to be applied.
In order to reach a reliable evaluation, assessments need to examine the following factors:

- Productivity Module Indicators (*Photosynthetic activity; Zooplankton biodiversity and biomass; Oceanographic variability; Ichthyo-plankton biodiversity*);
- Pollution and Ecosystem Health Module Indicators (*Eutrophication; Bio-toxins; Pathology; Multiple aquatic ecological disturbances*);
- Fish and Fisheries Module Indicators (*Biodiversity; Finfish; Shellfish; Demersal and Pelagic species*);
- Governance Module Indicators (*Stakeholder involvement*);
- Socio-Economic Module Indicators (*Integrated Assessment; Sustainability of long-term socio-economic benefits*).

As we can see, the same macro-principles that we found for Sustainability may be applied to evaluate ecosystem conditions of fisheries and aquaculture, by starting from specific micro-indicators.

EAF and EAA: social and economic considerations

Implementation of EAF and EAA cannot avoid examining their social and economic consequences, either positive or negative they may be.
EAF and EAA are undoubtedly indispensible tools for long-term sustainable development, nevertheless their "side-effect" may appear negative in the short-term, especially by those local populations who must revolutionize their fishing and aquaculture methods, not only in terms of quantity of fish captured/produced, but also in terms of management (based on capture-fisheries) and tools employed.
We have previously illustrated the advantages of EAF and EAA that aim to preserve natural resources that will be able to represent a source of income for local populations in the long-term (De Young *et al.* 2008).
To summarize, we could say that EAF and EAA effect:

- Employment and livelihood;
- Poverty and employment levels;

- Food security;
- Cultural and traditional practices and knowledge;
- Distribution of benefits.

As we can easily deduce from these aspects, most of the positive effects are long-term benefits deriving from the preservation of the environment that allows a maybe lower, but more equal distribution of employment and revenues. They can also avoid fisheries or aquaculture collapses (see Case Study n. 2) and degradation
On the other side, implementing EAF and EAA involves financial and social costs. Increased management costs are the first potential threat to a successful implementation, but a greater obstacle is the perception of EAF by local communities, that could experience a reduction of employment and revenues in the short-term, and potential radical modifications of traditional fishing practices.
Therefore it appears clear that EAF and EAA necessitate not only of a solid political support, but also of a cultural one, capable of leading poor communities to a long-term vision of the advantages of sustainable development.

Productivity susceptibility assessment (PSA)

PSA[16] is semi-quantitative tool that can be used to determine the status of a specific stock, thus allowing the formation of a strategy for a potential intervention. PSA could be particularly interesting for our work in relation to our Case Studies.

PSA was first used to assess the sustainability of by-catch in Australian Prawn fishery in 2001, and then was extended to other fishing sectors.
Susceptibility and productivity of stocks, are determined by a score ranging from 1 (low) to 3 (high).
Susceptibility is calculated by evaluating four independent aspects: availability; encounter-ability, selectivity and post-capture losses. The result of such evaluation can be graphically displayed.
PSA is a widely recommended instrument of evaluation and the National Oceanic Atmospheric Administration (NOAA)[17] adopted an extended version of PSA that includes four additional components: management strategy, fishing mortality and biomass spawners and survival of released fish.

[16] **Productivity susceptibility assessment (PSA),** http://nft.nefsc.noaa.gov/PSA_pgm.htm Date accessed: June 26, 2014.
[17] **National Oceanic Atmospheric Administration** (NOAA), http://www.noaa.gov Date accessed: June 26, 2014.

EAF and the management process: the Marine Protected Areas (MPAs)

The Main Goal of Fisheries Management is to achieve an optimal and sustainable utilization of marine and freshwater living resources**.** The management of fishing involves not only the international, national and regional regulation, but also a number of environmental and human factors, which appeal to the Ecosystem Approach (EA). In fact, the Ecosystem Approach to Fisheries represents an interaction among fisheries, environment protection and human management. Another crucial factor for the management of living resources is the Precautionary Approach, which contains one of the main principles of the Code of Conduct of Responsible Fisheries (CCRF) and has great relevance for the EAF.

There are many tools to manage fishing activities:

- Establishment of Quota Management System;
- Fishing effort limits (e.g. number of fishing gears);
- Size of fish that can be caught;
- Assignment of Territorial Use Rights in Fisheries (TURFs[18]), (Bianchi *et al*. 2008);
- Institution of MPAs, Marine Protected Areas.

In 2008 the World Conservation Union (IUCN) defined MPAs as: "*any area of intertidal or sub tidal terrain together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all the enclosed environment*".
The FAO CCRF does not explicitly mention MPAs, however its Technical Guidelines reports that "*marine protected areas can have a critical role to play sustainable fishing* (….) *can also play and important role in preserving critical habitats or sensitive life stage of species*".
According to FAO Aquaculture and Fisheries Department[19], MPAs are one of the best multilevel fishery management tools in accordance with the Ecosystem Approach. MPAs can be set up with varying degrees of protection: from totally protected areas to areas with the only limitation relative to the regulation of the fishing season. Another option is to establish MPAs to protect certain endangered fish species. In general, MPAs can be utilized for the following reasons: to protect environment and biodiversity, to preserve endangered species, to serve as a reservoir

[18] **TURFs** are part of a larger strategy to conserve marine biodiversity, protect and restore marine habitats and promote the sustainable use of marine resources by local people. Fish and invertebrates harvested from the TURFs are used in programs to restore marine habitats and to generate income, http://link.springer.com/article/10.1023%2FA%3A1011384207934, Date accessed: June 18, 2014.
According to the EAF Fisheries Management Guidelines, TURFs are a type of fisheries management method that assigns rights to individuals or groups to fish in certain locations.

[19] http://www.fao.org/fishery/topic/4400/en, Date accessed: June 28, 2014.

of fish eggs and spawning site, to reduce by-catch, and finally to allow a sustainable exploitation of fish stock.

The Management Strategy Evaluation (MSE)

Among the various evaluation instruments utilized within EAF, MSE is the one that intends to assess the consequences of fisheries management strategies (Valdimarsson *et a*l. 2003; Sainsbury *et al.* 2000). This technique has been adopted by a large number of countries. MSE was used for the first time in 1992 by the International Whaling Commission[20], and in 1996 for the Conservation of Antarctic Marine Living Resources.[21]

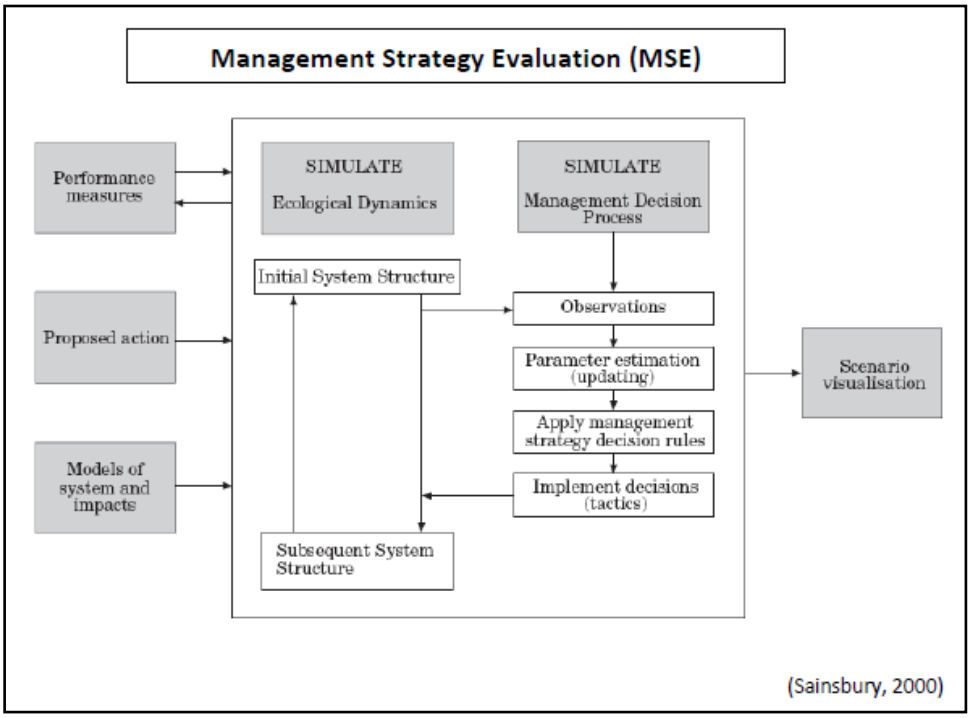


Figure 5. Management Strategy Evaluation (MSE) – (*from Sainsbury, 2000)*
http://icesjms.oxfordjournals.org/content/57/3/731.full.pdfion Date accessed: June 24, 2014.

MSE is an evaluating process that starts by clearly specifying the objective of a plan, then by developing quantifiable performance measures that serve as evaluating criteria when comparing the possible alternative management strategies. The results are then to be communicated to decision-makers. Observation and simulation are

[20] http://iwc.int/iwcmain, Date accessed: June 28, 2014.
[21] https://www.ccamlr.org/en/search/site/MSE, Date accessed: June 28, 2014.

therefore the fundamental tools of MSE that analyses also under variations and potential uncertain circumstances.

The EAF and the comparison with other Approaches

As we have earlier illustrated, there are several type of approaches to manage fisheries and aquaculture. In particular we have mentioned as most relevant: TURFs, SLA, Ecosystem-based management (EBM) and EAF. Each one has its own pros and cons and advantages in relation to the Ecological, Institutional and Human factors **(**Bianchi *et al***.** 2008).

TURFs seems to be more institutional oriented, SLA more inclined towards the Human factor, whereas EBM is more ecologically conservative. EAF seems to be the most integrated approach that reaches a fair balance among the three factors.

EAF therefore seems to be the most suitable to analyze and evaluate our three case studies, which all imply the involvement of the three factors. In fact they all constitute a potential source of income, as well as a potential environmental threat, and thus they all need a decisive institutional legal intervention.

1.10. ECONOMIC DEVELOPMENT

Economic Development is a widely recognized principle that refers to an economic growth that should take into account "issues like poverty reduction, responsible consumption, corporate responsibility, energy efficiency and conservation, waste management, employment and education" (Weybrecht, 2014).
Therefore long-term economic growth appears inextricably related with its social and ecological consequences. That is, aiming to poverty alleviation and long-term profit implies treating the environment as part of the economic process, improving the quality of management and conservation of ecological commons.
This is particularly true for aquaculture that too often has disregarded this aspect, seeking profit at biodiversity loss expense.
Aquaculture is recognized as a potential economic trigger at a local level, creating job opportunities and subsidiary activities. This potentiality, though, can become a lasting benefit only if the parameters of sustainability are respected.
Once again, the enforcement of laws that regulate the exploitation of water resources plays a crucial role. The absence of rules produces only short-term profit and long-term negative effects.

1.11. FOOD SECURITY VS FOOD SAFETY

Security and safety are two terms often related to food, which are included in the UN mandate for nutrition and food supply.
A definition of Food Security was elaborated at the World Food Summit in 1996.

"Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preference for an active and healthy life" (FAO World Food Summit, 1996).

Food Security is a complex and flexible concept that can be subject to different interpretation in the numerous publications dedicated to it.
Poverty Alleviation can be achieved through Food Security in accordance with MDGs standards. The Millennium Development Goals are eight milestones established during the Millennium Summit of United Nations in 2000. Each goal has a target for which MDGs set a specific deadline. Aquaculture can effectively contribute to the accomplishment of two of these goals – specifically goal 1: *To eradicate extreme poverty and hunger*; and goal 7: *To ensure environmental sustainability*. Supplying a most important source of animal protein, as well as providing employment and income by which food can be obtained and sold can alleviate extreme poverty. Aquaculture, at the same time, is obliged to assess environmental risks in its planning in order to avoid long-lasting detrimental impacts and biodiversity losses (Brugère, C. *et al*, 2010; Béné, C. *et al*, 2007).
The continuing evolution of Food Security as both operational tool and goal in policy, has led to a substantial re-definition of the concept over the years. While the initial focus was primarily on food supply problems, the attention was later moved to long-term considerations that included concerns about resources depletion, pollution and biodiversity reduction.
This change of focus highlighted the need of combining Food Security with Food Safety.
Food Safety is a scientific discipline contemplating handling, preparation and storage of all food, including seafood and other fishery products, in a way to prevent foodborne illness.
In the past, when Food Security represented the main goal – that is quantity versus quality - it often contrasted Food Safety.
Moreover, the stringent trading standards imposed by developed countries reduced the amount of possible economic trades. As a consequence, the poor countries had to improve their safety standards in order to maintain their international market partnerships.

Today (FAO, 2014) Food Security is considered a complex concept that include a series of indicators which do not exclude Food Safety, but rather, they include it as part of long-term factors. Food Security indicators can be summarized as follows:

- *Availability* concerns the quantity and quality of food;
- *Access* indicates physical access as well as infrastructure and distribution;
- *Stability* evaluates political and market factors;
- *Utilization* refers to the ability to utilize food and the outcomes of poor utilization.

The *Codex Alimentarius* (CA) has played a fundamental role in this evolution, defining the requirements for developing countries. Consequently environmentally integrity, aquaculture certification and labeling have become common international features (Subasinghe, R.P *et al*, 2012).
Therefore Food Safety has become an integral part of Food Security contributing to prevent and reduce foodborne diseases for vulnerable rural communities, limiting food losses but increasing available food, enlarging market access and enhancing purchasing possibilities.

1.12. SMALL SCALE/ARTISANAL FISHERIES

Small-scale fisheries play an important role in human nutrition, food security sustainable development and poverty reduction/prevention. The great importance of Small-scale fisheries was reiterated by FAO which recognized and reaffirmed the intake of Small-scale fisheries in sustainable development, stating that the numerous stakeholders involved (mainly in developing countries) in fisheries/artisanal fisheries are not marginalized, and finally valued the impact of these activities in food security at local, regional and national level.
The importance of Small-scale fisheries is recognized by national Governments that adopted new development policy to enhance national economies.
Nevertheless the acknowledgement of the value of Small-scale fisheries should be supported by an increasing participation of the stakeholders through an integration of social, economic and ecological factors, which represent the three main pillars of sustainability.

Definitions

The most widely accepted definitions of Small-Scale fisheries are the following:

"Small-scale fisheries can be broadly characterized as a dynamic and evolving sector employing labour intensive harvesting, processing and distribution

technologies to exploit marine and inland water fisheries resources. The activities of this sub sector, conducted full-time or part-time, or just seasonally, are often targeted on supplying fish and fisheries products to local and domestic market, and for subsistence consumption. Export- oriented production, however, has increased in many small-scale fisheries during the last decade because of greater market integration and globalization. While typically men are engaged in fishing and woman in fish processing and marketing, woman are also know to engage in near shore harvesting activities and men know to engage in fish marketing and distribution. Other ancillary activities such as net-making, boat-building, engine repair and maintenance, etc. can provide additional fishery-related employment and income opportunities in marine and inland fishing communities. Small-scale fisheries operate at widely differing organizational level ranging from self-employed single operators through informal micro-enterprise to formal sector businesses. This sub-sector therefore is not homogenous within and across countries and region and attention to this fact is warranted when formulating strategies and policies for enhancing its contribution to food security and poverty alleviation" (FAO, 2004).

While trying to combine all the characteristic dimensions of these fisheries, the FAO Glossary of aquaculture indicates that artisanal fisheries are:

"Traditional fisheries involving fishing households (as opposed to commercial companies), using relatively small amount of capital and energy, relatively small fishing vessels (if any), making short fishing trips, close to shore, mainly for local consumption. In practice, definition varies between countries, e.g. from gleaning or a one-man canoe in poor developing countries, to more than 20-m. trawlers, seiners, or long-liners in developed ones. Artisanal fisheries can be subsistence or commercial fisheries, providing for local consumption or export. They are sometimes referred to as small-scale fisheries".

The Glossary tends to identify Small-scale with "artisanal" fisheries. This could derive from the fact that "Small-scale" is and Anglophone adjective whereas the term "artisanal" is more frequently used in French and Spanish-speaking countries. Nevertheless, since the term Small-scale mainly refers to the size of the vessel, whereas artisanal refers to the level of the technology involved, when trying to determine is a fishery can be defined Small-scale, artisanal or industrial, we need to evaluate and combine the vessel size, the degree of technology and the geographical area where the fishery is located.

TietzeGroen & Marcoux (2000) for instance remind that:

"In technological terms, marine artisanal and small-scale fisheries are characterized in most cases by fishing craft with non-mechanized propulsion systems (sails and

oars) or low-horsepower outboard or inboard engines; use of passive fishing methods, manual operation of fishing gear (setting, shooting and hauling) and the absence of electronic fish-finding and navigational devices".

Likewise McGoodwin (2002) indicates that:

"[While] In temperate or colder waters, small-scale fishing communities generally exploit only a few species, ... in tropical waters a greater variety of species are typically exploited. Moreover, small-scale fishers in tropical regions typically utilize a greater variety of fishing gear."

Finally, other important concept is that of rural aquaculture, where its main purpose is to improve the livelihood of the rural people and to enhance the food security, income and stakeholder occupation.
The definition, according to Edwards *et al*. (2006), of *Rural aquaculture implies the definition of the beneficiaries, the "the poor". In any case, technically, rural aquaculture, refer to Small-scale fisheries with low technological intake*.

Advantages Disadvantages of Small-scale fisheries

Although it is evident how Small-scale fisheries could play a crucial role in supporting socially and economical rural communities in developing countries, we intend to examine the possible disadvantages and weaknesses of this type of activity, bearing in mind that it is impossible to generalize any kind of conclusion, as pros and cons always depend on the contexts.

Advantages

- Lower ecological impact;
- Higher employment opportunities;
- Higher versatility;
- Lower construction, running and technology costs;
- Low post-harvest losses;
- Utilization of fisheries by-products

Disadvantages

- Overfishing: although the impact of artisanal/small-scale fisheries is always lower than industrial size fisheries, overfishing represents one of the main risks, caused by lack of knowledge and short-term vision;

- Lack of control: the lack of control on scattered or inaccessible areas, does not allow controlling the use of destructive methods or gear. This too can be caused by ignorance on long-term consequences;
- Lack of technology: the use of technology instead of old destructive methods could help to increase the sustainability of artisanal fisheries;
- Low participation in decision-making: single Small-scale fisheries have scarce economical weight and are often excluded from policy making. This obstacle could be removed by improving the level or organization among fishers;

Despite the disadvantages, the advantages of Small-scale fisheries make it a crucial resource for food security and Poverty eradication. As underlined by FAO in The State of World Fisheries and Aquaculture 2014, that also highlighted the importance of aquaculture in meeting future fish demands.

Vulnerability and threats

Small-scale/artisanal fisheries are subject to some external menaces that could impede their growth, thus reducing the level of food security provided in developing countries.

- Marginalization: inappropriate and ineffective policies and management, combined with their isolated geographical position, often determine the socio-political marginalization of Small-scale/artisanal fisheries;
- Water competition: inland fisheries frequently compete with agriculture for use of water. Modification of river basins, as well asa greater urbanization of coastal areas has led to the depletion of biodiversity and pollution, with a subsequent impact on fish stock productivity;
- Reduced fish stock levels: overfishing and an increasing number of world's fisheries, contribute to the deterioration of fish stock numbers and quality;
- Global warming: climatic fluctuations have a negative impact on natural fish stock, with a high level of unpredictability that contribute to vulnerability of rural people and fuelling migration;
- Globalization: the involvement of Small-scale fisheries in the global market, make them subject to market fluctuations and decrease food security;

Sustainable livelihood approach (SLA)

A livelihood is sustainable "when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resources base" (Carney, 1998). This approach was adopted by the UK Department for Development (DFID), after

numerous experiences from international NGOs, such as CARE and Oxfam UK. The SLA is strongly based on participation and observation, during the implementation and evaluation phases (Lewins, 2004).

IFAD[22] defines the SLA "*a way to improve the knowledge of the livelihoods of poor people and the relationship between the different factors involved*".

Moreover, SLA may facilitate the formulation of a new poverty reduction programme, and serve as a basis for the evaluation phases (Failler & Kane, 2004). According to FAO Fisheries Department, the SLA is an important tool to identify the fishing communities, their level of dependence on wild fish stock and if there are alternative livelihoods. It is a multifactorial approach based on a high level of participation of the relevant stakeholders involved in Small-scale/artisanal fisheries.

The Sustainable Livelihood Approach has two basic components:

- *The Sustainable framework*;
- *The seven guiding principles*.

The Sustainable framework
The SL framework provides on analytical body for organizing and understanding livelihood. It is composed of five structural elements that aim to examine and understand the livelihoods of rural people involved in Small-scale fisheries.

- Vulnerability context: taking account socio-economical factors, seasonality and shock events;
- Livelihoods assets: examining rural people's **N**atural, **P**hysical, **S**ocial, **H**uman and **F**inancial resources;
- Policies, Institutions and policies: analyzing how governments, laws and processes affect rural people's lives;
- Livelihood strategies: examining each strategy adopted by a rural community to face poverty and vulnerability;
- Livelihood outcomes: analyzing the outcomes they achieve or they aspire to, such as increased income and improved well-being, reduction of vulnerability, more sustainable use of natural resources.

[22]The International Fund for Agricultural Development (IFAD), a specialized agency of the United Nations, was established as an international financial institution in 1977. http://www.ifad.org/governance/index.htm

The IFAD SLA framework schematized below shows the main components of SLA, which may help identifying more effective ways to support livelihoods and reduce poverty (ref. IFAD web page).

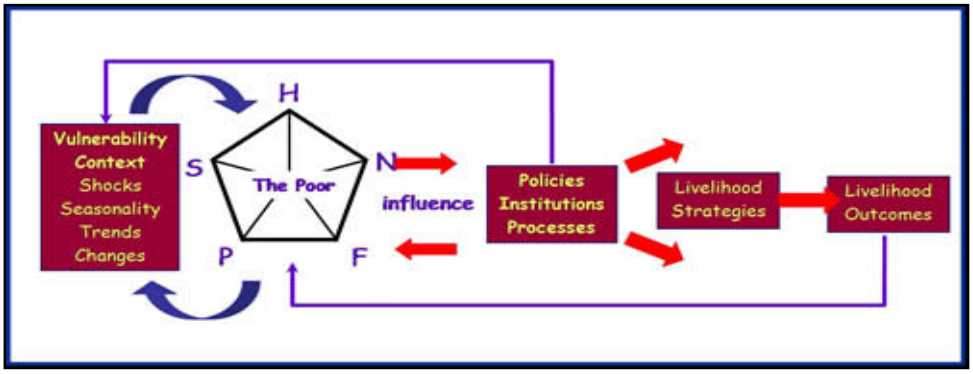


Figure 6. The SLA matrix
http://www.ifad.org/sla/ Date accessed: June 10, 2014.

The seven guiding principles

The seven Livelihoods guidelines are flexible and adaptable principles, focused on poverty and how development strategies to reduce poverty should be implemented. They are addressed to NGOs and any other body involved in the implementation and evaluation of development project. They are an encouragement to:

- Be people-centered and stakeholder oriented;
- Be Holistic;
- Be dynamic and flexible;
- Build on strengths;
- Promote micro-macro links;
- Encourage public and private partnership;
- Be socially, economically and environmentally sustainable;

Combining SLA (Sustainable Livelihood Approach) with other participatory field methods such as PRA (Participatory Rural Appraisal) can be particularly helpful both to examine and to operationalize the above principles, especially the participatory, holistic and conducted partnerships ones (Horemans, 2004).

Implications with Code of Conduct for Responsible Fisheries (CCRF)

Good fisheries management can assist the fishing communities involved in small-scale/artisanal fisheries in poverty alleviation.

For this purpose the Code of Conduct for Responsible Fisheries (CCRF) is a formidable tool to achieve these main goals.
Many articles of the Code have strong implications with Small-scale fisheries improving fisheries management, the decision-making and the fish utilization:

Fisheries Management:

Article 2 (f), Objectives of the Code
Promote the contribution of fisheries to food security and food quality, giving priority to the nutritional needs of local communities

Article 6.2, General principles
Fisheries management should promote the maintenance of the quality, diversity and availability of fishery resources in sufficient quantity for present and future generations in the context of food security, poverty alleviation and sustainable development. Management measures should not only ensure the conservation of target species but also of species belonging to the same ecosystem or associated with of depend upon the target species.
This article is one of the most important ones for the Small-scale fisheries, not only for the maintenance and safeguard of the environment, but also for its clear long-term implications in sustainability under the social aspect and for its strong references to food security and poverty alleviation.

Article 6.18, "*Recognizing the important contribution of Small-scale/artisanal fisheries to employment, income and food security, States should appropriately protect the right of fishers and fish-workers, particularly those engaged in subsistence, Small-scale and artisanal fisheries, to a secure and just livelihood, as well as preferential access, where appropriate, to traditional fishing grounds and resources in the water under their national jurisdiction".*
Once again it is underlined the fundamental contribution of governments in fostering and regulating this kind of activities, in order to make them stable and sustainable.

Decision-making:

Article 6.13,"*States should, to the extent permitted by national laws and regulations, ensure that decision-making processes are transparent and achieve timely solution to urgent matters. States, in accordance with appropriate procedures, should facilitate consultation and the effective participation of industry, fish-workers, environmental and other interested organizations in decision-making with respect to the development of laws and policies related to fisheries management, development, international lending and aid*".

Article 6.16, "*States, recognizing the paramount importance to fishers and fish-farmers of understanding the conservation and management of the fishery resources on which they depend, should promote awareness of responsible fisheries through education and training. They should ensure that fishers and fish-farmers are involved in the policy formulation and implementation process, also with a view to facilitate the implementation of the Code*".
Both articles refer to participation to decision-making of all stakeholders as a key element for successful fisheries.

The Fish utilization

Article 6.7,"*The harvesting, handling, processing and distribution of fish and fishery products should be carried out in a manner, which will maintain the nutritional value, quantity and safety of the products, reduce waste and minimize negative impacts on the environment"*.

Article 6.14, "*International trade in fish and fishery products should be conducted in accordance with the principles, rights and obligations established in the World Trade Organization (WTO) Agreement and other relevant international agreements. States should ensure that their policies, programmes and practices related to trade in fish and fishery products do not result in obstacles to this trade, environmental degradation or negative social, including nutritional, impacts"*.
Both articles imply good handling, processes and trading practices to help minimize fisheries' negative environmental impact. As we will illustrate when examining the advantages of Small-scale/artisanal fisheries, their small size can facilitate the reduction of negative impacts when compared to large-scale/industrial fisheries.

Article 11 (all paragraphs), Post Harvest practices and trade:
According to the FAO Technical Guideline for Responsible Fisheries n.10 "*Increasing the contribution of Small/scale fisheries to poverty alleviation and food security*", all paragraphs contained in Article 11, related to post-harvest practices and trade have strong implications on Small/scale fisheries.
In relation to this work, the most important is probably:
11.1.8 *States should encourage those involved in fish processing, distribution and marketing to:*

a) Reduce post-harvest and waste;
b) Improve the use of by-catch to the extent that this is consistent with responsible fisheries management practices;

The last section of the paragraph is strongly related to our third Case Study, which will examine the situation of by-catch in general.

After examining the pros and cons of Small-scale fisheries, the approaches needed to analyze and improve the status of fishers' livelihood, it is evident how good information can make the difference in a long-term vision.
Good information is needed to inform fishers of the possible damages of ill management of fisheries and help them implement sustainable fishing practices. Good information is also needed by governments and organizations to be informed about the presence and the weight of Small-scale fisheries in developing economies, in order to involve stakeholders in decision-making and include Small-scale fisheries in policy-making.

1.13. CLIMATE CHANGE AND INTERACTION WITH SUSTAINBLE AQUACULTURE.

The importance of climate change in the environment

The climate change is a natural process that implies a significant variation of weather in a certain period of time. Climate change can be caused by different natural factors such as solar and terrestrial radiation, volcanic activities or atmospheric circulation. When the climate change refers to the anthropogenic influences, it is defined Global Warming and considered separately from the natural causes of climate change. The Global Warming, in any case, occurs in a much shorter period of time (Burroughs, 2007).
The most relevant anthropogenic causes of Global Warming are:

- Greenhouse gas emissions;
- Dusts and aerosols;
- Desertification, deforestation – depletion of natural environment;
- The Ozone hole.

Among the most relevant human-induced emissions contributing to the Greenhouse effect are the gasses deriving from agriculture and its relates sub sectors such as livestock, forestry and aquaculture, which are responsible of approximately 20-25 percent of emissions at global level (FAO, 2014).

All the international development agencies such as FAO and IFAD have recognized that the climate change is one of the most serious threats not only for the natural ecosystem, but also for human society, especially in developing countries.
The Climate change is closely related to the various dimensions of food security:

- Availability
- Stability;
- Access;

- Utilization.

As concerns fishing and aquaculture activities, Small-scale/artisanal fisheries have low responsibility in climate change, but they are among the primary sectors that have most suffered its impact (Cochrane K. *et al*, 2009).
As the Greenhouse Gas (GHG) increase, there are a series of consequences that modify seas and inland waters and directly effect fisheries and aquaculture:

- Increase of seas surface temperature;
- Variation of primary productivity;
- Intensification of extreme weather events;
- Decrease of subtropical rainfall and consequent demand for irrigation.

According to IFAD, most of the negative consequences of climate change for fisheries and aquaculture will be perceive at low latitudes (Williams, 2010) because of their dependency to natural environment.
As regards to the Mediterranean Sea, this area is undergoing a constant and linear increase of temperature since 1990s (Bethoux *et al.* 1990). According IUCN, the temperature is expected to rise by about 3.5 ^{o}C before year 2050. By year 2100, the forecast provides a variation ranging from 2.0 to 6.0 ^{o}C. At the same time, CO_2 is estimated to double its concentration in the next 25 years. As a consequence, the sea level is expected to rise by 5 cm/decade[23].

Climate change and Fisheries

Climate's elements that are essential for fisheries are temperature, seasonal weather events (rain, droughts, currents, etc.) and extreme weather events (storms, typhoon, etc.).
As climate changes, the most important consequences can be summarized as follows:

- Reduced productivity;
- Fish species migration;
- Localized extinctions;
- Coral reef damage;
- Damage of mangroves ecosystem.

Fisheries activities and their ecosystems are closely related (FAO, 2008). Fish species, and wild specimens in particular, tend to live close to their tolerance limits

[23] www.climate.noa.gr/Reports/Executive_summary_Eng.PDF in IUCN 2010, Mediterranean Pelagic Habitat, Oceanographic and Biological Processes, An Overview (in Bibliography).

of various factors, such as temperature variation, pH value and oxygen concentration that can have negative effects on their physiology (Roessig *et al*, 2004).
Climate change has negative effects on capture fisheries, especially for highly migratory fish, anadromous and catadromous fish species, like Eels.
In fact, Anguilla has a very long multi-stage development with a remarkable long life cycle (up to 20 years). These particular features, expose Eels to significant environmental threats exacerbated by abrupt climate changes (for further details see the Case study nr. 1 on Eels and its SWOT analysis).

As for the most threatened geographical areas and the most vulnerable countries involved in capture fisheries, IFAD indicates that many African countries are highly exposed to the impact of climate change. Among them we can mention: Mozambique, Malawi and Uganda (see Case study nr. 2 on the Nile Perch).

As regards to Case Study 3 on By-catch and Discards, the influence of global warming on the Mediterranean Sea (FAO Major Fishing Area 37), Global Warming has some direct effects on various aspects (Perez, 2008). The top predator and small pelagic fish species will undergo metabolic functions and genetic modifications. Growth, reproductive rate and physiological modifications at early fish life stages represent further consequences of climatic change.
Finally, climate change could strongly effect phytoplankton dynamic and primary production through the modifications of upwelling processes (Olita *et al*., 2006)

Climate change and aquaculture

Aquaculture is subject to human control and is therefore less affected by external environmental factors (Brander, 2007).
The importance of climate change has therefore a lower impact than in capture-fisheries. However, many fish facilities as a Small-scale/artisanal aquaculture in developing countries depend on their ecosystem.
A reduction of wild stocks may have a negative effect only on those types of aquaculture dependent on wild specimens exploitation, such as Capture-base aquaculture. As regards water's chemical and physical factors, temperature seems to be the most limiting parameter, both for the concentration of oxygen and for the possible modification of fish metabolism (e.g. growth, spawning and disease resistance).
The major threats of climate change that could impact on aquaculture can be summarized as follows:

- Change in water availability;
- Reduced level of oxygen level;
- Sea level and rivers flows;
- Substantial temperature variations;

- Algal blooms (e.g. Red tide[24]);
- Ocean acidification;
- Spread of Diseases.

Coastal aquaculture can be also affected by extreme events such as typhoons, hurricanes and red tides, which occur with increasing frequency and gravity. (Roessig *et al*., 2004).
The impact on aquaculture cannot be attributed to one single factor, but it usually derives from a set of causes and their potential combination.
According to Subasinghe *et al*. (2012), the impact on aquaculture by climate change manifestation can be direct or indirect.

Direct impact manifestation:

- Variation in productivity;
- Impossibility of farming;
- New potential plague;
- Physical and chemical damage;
- Variation on breeding rates;
- Increased of fish losses in farm;
- New disease.

Indirect impact manifestation:

- Loss of potential farming sites;
- Increase in prices of raw materials for feed.

The Ecosystem approach to Fisheries (EAF) and to Aquaculture (EAA) should be adopted to support the precautionary approach in order to increase the resilience to climate change impact. In fact, improving aquaculture management and sustainable fisheries measures can contribute to mitigate the effects of climate change and increase resilience of aquaculture.

[24] **Red tide** is a common algal bloom caused by the spread of a certain species of *Dynoflagellates*, which assumes a red or brownish color. This algal bloom is often caused by the high concentration of Nitrate and Phosphate in the water as a result of agricultural activities. Temperature is both the triggering and the limiting factor of the spread of Red tides, which are usually found near the coastal areas. Some red tide algal blooms are associated with the production of bio-toxin, low oxygen concentration and high mortality rate of living marine organisms. http://en.wikipedia.org/wiki/Red_tide Date accessed 20 June 2014.

1.14. RISK ANALYSIS IN AQUACULTURE

According to FAO "Risk" has been defined as "*a combination of the severity of consequences and likelihood of occurrence of undesired outcomes*", and "hazard" as "*the presence of a material or condition that has the potential for causing loss or harm*". No matter how well managed a system is, there will always be associated hazards and risks. Another important factor needed to assess risk, is the "*specific period of time*" (Arthur *et a*l. 2004). Risk analysis is a structured process apt to determine what event can occur, the probability that the same event will occur again, assessing the potential impact once it occurs, identifying the potential management process and finally communicating the elements featuring the identified risks (Melba Bondad-Reantaso *et al*. 2009).
Risk analysis is generally defined by the following key words and their definitions (see also OIE, 2001):

- ***Hazard identification***: it is the process that identifies actions and/or events, which can potentially cause negative consequences in a context. As regards to aquaculture and fisheries, it is the process that identifies pathogenic microorganisms that could potentially affect aquatic animals such as fish, crustaceans or other invertebrates.
- ***Risk assessment***[25]: it is defined as the evaluation of the likelihood and possible consequences of biological, socio-economic spread of certain hazard. This step includes the release assessment, the exposure assessment and the consequence assessment. The risk assessment can be determined both by the quantitative and the qualitative point of view. Methods for assessment of risk may differ in different areas of interest such as environment or fisheries. This phase of risk analysis requires very specialized knowledge and skills such as veterinary, epidemiologic, and ecologic competences. Risk assessment is also the overarching term regarding risk definition for the World Health Organization.
- ***Risk Management***: it is defined as the design technique to manage risk and reduce its effects. Its steps are identification, selection and implementation of a series of measures that can be applied to reduce or mitigate the level of risk. It's a decision-making process. As regard to the aquaculture and fisheries sectors, it requires the expertise and knowledge of pathologists, epidemiologists and aquaculturists.
- ***Risk Communication***: it is the process by which information about risk is provided. The OIE, through the 1999 Aquatic Animal Health Code, defines risk communication as "*an interactive exchange of information on risk among risk assessors, risk managers and other interested parties*". An

[25] http://en.wikipedia.org/wiki/Risk_assessment, Date accessed: July 1, 2014.

effective risk communication is crucial both for the stakeholders involved in the process and for those affected by decision-making. The perception of risk may change depending on the type of communication and information presented.

- ***Risk Evaluation***[26]: it determines the risk management priorities through the establishment of qualitative and/or quantitative relationships between benefits and associated risks.

FAO defines Risk analysis as an overarching term that covers the activities of the following terms: ***Hazard identification, Risk assessment, Risk Management*** **and** ***Risk Communication*** (OIE, 2009; Arthur *et al*. 2004).

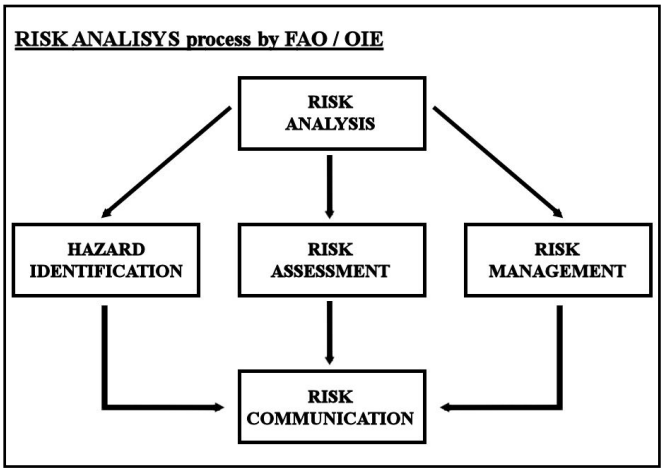


Figure 7. FAO Risk analysis.

In contrast with FAO, the World Health Organization (WHO) has provided his definition of risk, using the overarching term *Risk assessment* that encompasses some of the previous key words**:** ***Hazard identification, Risk analysis*** **and** ***Risk Evaluation*** (Aven, 2003).

[26] http://www.businessdictionary.com/definition/risk-evaluation.html, Date accessed: July 1 2014.

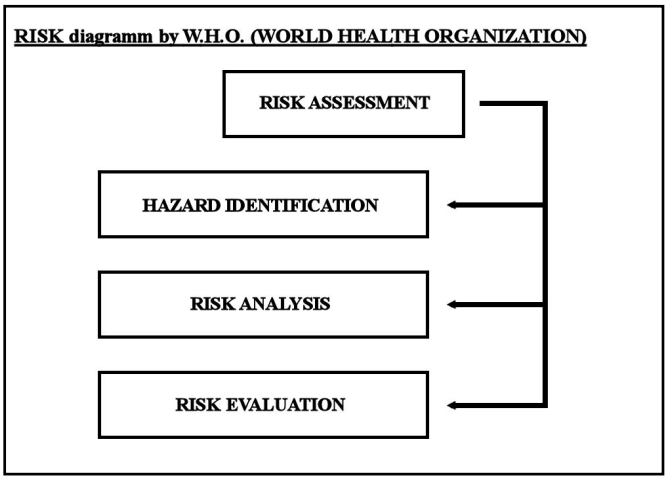


Figure 8. World Health Organization Risk assessment.

According to FAO/NACA[27], Risk analysis, in all forms of aquaculture and fisheries, can be categorized as follows:

- Pathogen/micro-organisms risk;
- Food Safety risk;
- Environmental/Ecological risk;
- Economic/Financial risk;
- Social risk;

The Pathogen risk and Ecological risk (such as invasive species spread) are covered by the OIE by the Aquatic Animal Health Code, the Food Safety risk is ruled by the *Codex Alimentarius* and its standards, finally, the last three points are the pillars of sustainability and they represent the transversal areas that indirectly affect aquaculture and fisheries. CCRF is a very important Code, which covers all points except the Economic/Financial and Social risk.
Risk analysis in aquaculture is generally widely used. It is supposed to operate according the precautionary principle as provided in the Convention on Biological Diversity (CBD) and its agreements, and subsequently by the FAO Code of Conduct of Responsible Fisheries (CCRF).
Unfortunately, risk analysis in Sustainable Aquaculture is less used in order to achieve best result; this is probably due to the lack of scientific information, and the inadequacy of appropriate methodologies.

[27] The Network of Aquaculture Centers in Asia-Pacific (NACA) is an Intergovernmental Organization that promotes rural development through sustainable aquaculture.
http://www.fao.org/fishery/rfb/naca/en, Date accessed: July 3 2014.

However, building a core value framework can support risk analysis in Sustainable Aquaculture by providing useful guidelines such as (Melba Bondad-Reantaso *et al*. 2009):

- *Environmental values*;
- *Economic values;*
- *Social values*.

Risk analysis, if applied to our case studies, could avoid depletion and overexploitation of natural resources while increasing potential future production and securing acceptable natural stock levels.
Anticipating the considerations about case studies, it is evident how a careful risk analysis would have allowed maintaining the amount of eel captured at a constant and acceptable level (See Case Study n. 1). In the case of the Nile Perch, foreseeing the consequences of the diffusion of an invasive species like Nile Perch, could have avoided the present environmental and social damages. As for our third case study, risk analysis could represent a fundamental tool to avoid the capture of non-target, under or over-size target, and target-related species.
Risk analysis is therefore indispensable to prevent environmental, social and, in the long-term, economic losses.
In the legislative section of this work, we will see how the international agreements have taken in consideration the relations among risk factors and sustainability.

BIBLIOGRAPHY

AA.VV. 1992**,** Earth Summit: Rio Declaration & forest principles, Parte 3 di Earth Summit: United Nations Conference on Environment and Development, Rio De Janeiro, Brazil, 3 – 14 June 1992; Department of Public Information, United Nations, 1992, Indiana University Press.

Adger N. ***et al.*** 2004, New Indicator of vulnerability and adaptive capacity, Centre for Social and Economic Research in the Global Environment School of Environmental Sciences University of East Anglia Norwich NR4 7TJ.

Arthur J.R. ***et a*****l**. 2004, Manual on Risk analysis for the safe movement of aquatic animals (FWG/01/2002), APEC/NACA/FAO Publ. No. APEC, p. 59.

Aven T. 2003, Foundation of risk analysis, a knowledge and decision oriented perspective, John Wiley & Sons. p. 190.

Bardach J.E. 1997, Sustainable Aquaculture, John Wiley & Sons, Inc. New York, pp. 1-5.

Barnabe G. 1989, Aquaculture Vol.1, Ellis Horwood Publishing, New York USA, pp. 25-29.

Béné, C. ***et al***, 2007, increasing the Contribution of Small Scale Fisheries to Poverty Alleviation and Food Security, FAO Fisheries and Technical Paper, 481, FAO, Rome, Italy, 2007, p. 11-14.

Bethoux J.P. ***et al.*** 1990, Warming trend in the Western Mediterranean deep water. Nature 347 pp. 660-662 *cited in* **IUCN-Med.** 2010, Mediterranean Pelagic Habitat, Oceanographic and Biological Processes. An Overview, IUCM-MED.

Bianchi G. ***et al.*** 2008, The Ecosystem approach to Fisheries, published by Food and Agriculture Organization of the Unites Nations, CABI publishing, p. 22-25, 26-28, 30-32, 147-148.

Biblio M. 2007, Controlled reproduction and domestication in aquaculture: the current state of the art, Aquaculture Europe, vol. 32 nr. 3, pp. 5-23.

Brander K.M. 2007, Global fish production and climate change. *Proceeding of the National Academy of Sciences* 104(50), 19704-19714.

Brugère, C. ***et al***, 2010, Aquaculture Planning, Policy Formulation and Implementation for Sustainable Development, FAO Fisheries and Aquaculture Technical Paper 542, FAO, Rome, Italy, 2010, p. 14.

Bunting W.B. 2013**,** Principles of Sustainable Aquaculture, promoting social, economic and environmental resilience, Earth-scan Food and Agriculture Series, Routledge London, pp. 2-3, 14-15, 17.

Burroughs W.J. 2007, Climate change: a multidisciplinary approach, 2nd edition, Cambridge University press UK, pp. 33, 54, 159, 200, 282.

Carney D. 1998, "*Implementing the sustainable rural livelihood approach*" in D. Carney Ed. Sustainable Rural Livelihood: what Contribution Can We Make? Dep. For International Development UK London *cited* in **Bunting W.B.** 2013**,** Principles of Sustainable Aquaculture, promoting social, economic and environmental resilience, Earth-scan Food and Agriculture Series, Routledge publishing London, p. 18.

Cochrane K. ***et al*****,** 2009, Climate change implications for fisheries and aquaculture, an overview of current scientific knowledge, FAO Fisheries and Aquaculture Technical paper 530, FAO, Rome, Italy.

Crespi V. ***et al*** 2008, Glossary of aquaculture, Food and Agriculture Organization of the United Nations, FAO Rome, pp. 15, 20, 199, 296-297.

De Young C. ***et al.*** 2008, Human dimension of the ecosystem approach to fisheries, an overview of context concepts, tools and methods, FAO Fisheries and Technical Paper, 489, FAO, Rome, Italy, 2008, p. 26, 35-47.

Edwards ***et al.*** 2006, Rural Aquaculture, CABI Publishing, UK, P. 323.

Ellenberg, 1973, Berlin, Okosystemmforchung, Ziele und Stand der Okosytemforschung.

European Commission, 2001, *Project Cycle Management* – Training Handbook, Brussels, p.25.

Failler P. & Kane A. 2004, the sustainable livelihoods approach and the improvement of the living conditions of fishing communities: relevance, applicability and applications *cite*d in **Neiland E.** ***et al***. 2004, Poverty and Small-scale fisheries in West Africa, Kluwer Academic Publishers, p.125.

FAO 2014, Food and Nutrition in Numbers, Economic and Social Development Department – Statistic Division FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, Italy pp. 18, 34, 50.

FAO 1995, Code of Conduct for Responsible Fisheries, Rome, FAO, p. 41.

FAO 2000, State of World Fisheries and Aquaculture, 2000, Rome FAO.

FAO 2003, The Ecosystem Approach to Marine Capture fisheries. FAO Technical Guidelines for Responsible Fisheries, No 4 (Suppl. 2), p. 231.

FAO 2004, Research Agenda for Small-Scale Fisheries, by C. Benè. Document presented as information paper ACFR/V/2004/ INF. 9 at the fifth session of the Advisor Committee on Fisheries Research (Rome, 12-15 October 2004).

FAO 2008, Climate changes for fisheries and aquaculture. Technical background document from the Expert Consultation, 7 to 9 April 2008, FAO Rome, paper presented at "climate change, energy and food" High level conference on food security: The challenges of climate change and bioenergy, 3-5 June 2008, Rome Italy.

FAO 2014, The State of World Fisheries and Aquaculture, Opportunities and challenges, 2014 FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, Italy.

Freeman, R. Edward; Reed, David L., 1983, Stockholders and Stakeholders: A new perspective on Corporate Governance, California Management Review, Vol. 25 Issue 3, pp. 88-106.

Garcia S.M. 1994, the precautionary principle, its implications in capture fisheries management, Ocean and Costal Management, 22, 99-125.

Garcia S.M. ***et al*** 2003, The Ecosystem approach to fisheries, Issue, terminology, principles, institutional foundations, implementation and outlook. FAO, Fisheries Technical paper 443, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, Italy pp. 6, 17-18, 25.

General Fisheries Commission for the Mediterranean 2013, Studies and Reviews No. 93, Indicators for Sustainable Aquaculture in Mediterranean and Black Sea Countries, FAO, Rome, p. 11.

Hoanh C.T. ***et al,*** 2006, Environment and Livelihoods in Tropical Coastal Zones: Managing Agriculture-Fisheries Conflicts, Comprehensive Assessment of Water Management in Agriculture Series, CABI publisher UK.

Hoggarth ***et al***. 1999, Management guidelines for Asian floodplain river fisheries, FAO Fisheries Technical paper nr. 348/1 - 348/2 FAO Rome.

Horemans B. 2004, The Work of the Sustainable Fisheries Livelihoods Programme (SFLP) in West Africa *cite*d in **Neiland E.** ***et al***. 2004, Poverty and Small-scale fisheries in West Africa, Kluwer Academic Publishers, pp. 232-234, 236-237.

Howarth W. cited in **Niels Svennevig** ***et al.*** 1999, Sustainable Aquaculture: Food for the Future? Proceedings of the Second International Symposium on Sustainable Aquaculture: Oslo, Norway, 2-5 November 1997, pp. 319-320, 322.

IUCN-Med. 2010, Mediterranean Pelagic Habitat, Oceanographic and Biological Processes. An Overview, IUCM-MED, pp. 64-65.

Jacobs P. ***et al.*** 1987, Sustainable and Equitable development *cited* in **Jabobs** and D.A. Munro ed. Conservation with Equity IUCN Cambridge England.

Jana B.B. ***et al.*** 2003, Sustainable aquaculture: a Global perspective, Food Products Press The Haworth press. Inc. Oxford, pp. 288-291.

Jana ***et al***. 2003, Sustainable Aquaculture, Global Perspective, Food products Press Oxford UK pp. 303-304, 288-289.

Jason S. Link, 2010, Ecosystem-Based Fisheries Management, Confronting Tradeoff, National Marine Fisheries Service, Woods Hole, MA USA, Cambridge University Press, p. 22-23, 31.

Larkin P.A. 1996, Concept and issue in marine ecosystem management. Review in Fish Biology and Fisheries, pp. 134-164.

Lewins R. 2004, *The Sustainable Livelihood approach*: the importance of Policies, Institutions and Process *cite*d in **Neiland E.** ***et al***. (2004), Poverty and Small-scale fisheries in West Africa, Kluwer Academic Publishers, pp. 37- 44.

Lockwood J. ***et al***. 2013, Invasion Ecology, 2nd Edition, Wiley-Blackwell

Publications, pp. 7-8.

McGoodwin, J. 2001. Understanding the cultures of fishing communities - a key to fisheries management and food security. FAO Fisheries Technical Paper No.401, Rome: Food and Agriculture Organization, p. 287.

Melba G. Bondad-Reantaso *et al*. 2009, Understanding and applying risk analysis in aquaculture. A Manual for decision makers. FAO Fisheries Technical Paper No. 519/1 Rome: Food and Agriculture Organization, p. 4.

Mitchell, R. *et al.* 1997, Toward a Theory of Stakeholder Identification and Salience: Defining the Principle of Who and What Really Counts, Academy of Management review. Vol. 22, No. 4, pp. 853-886.

Moran F. 2010**,** Environmental, social science human-environmental interactions, and sustainability, Blackwell Publishing.

Neilland E. *et al*, 2004, Poverty and Small-scale Fisheries in West Africa, Kluwer Academic Publisher and FAO Rome.

Nuov *et al.* cited in **AA.VV.** 2005, International mechanisms for the control and responsible use of alien species in aquatic ecosystems, Report of Ad Hoc Expert Consultation, August 2003, FAO Rome, pp. 75-77.

Nybakken J.W. 1982, Marine Biology: an ecological approach. New York Harper and Row.

Odum E.P. 1975, Ecology. New York. Rinehardt and Wilson.

OECD, 2001, Development Action Committee's Guidelines on Poverty Reduction, Organization for Economic Co-operation and Development, 2001 Paris (www.oecd.org).

OIE 2001, Risk analysis in aquatic animal health, Proceeding of an International Conference held in Paris, France 8-10 February 2000, pp. 4-5.

OIE 2009, Aquatic Animal Health Code 12th edition OIE, Paris.

Olite A. *et al.* 2006, Effects of the 2003 European heat-wave on the Central Mediterranean Sea surface layer: a numerical simulation. *Ocean Sci Discuss*, **3** pp. 85-125 *cited in* **IUCN-Med.** 2010, Mediterranean Pelagic Habitat,

Oceanographic and Biological Processes. An Overview, IUCM-MED.

Perez T. 2008, Impact of climate change on biodiversity in the Mediterranean sea. UNEP-MAP-RAC/SPA Edit. Tunis *cited in* **IUCN-Med.** 2010, Mediterranean Pelagic Habitat, Oceanographic and Biological Processes. An Overview, IUCM-MED.

Phillips, M. & Subasinghe, R. 2008**,** Application of risk analysis to environmental issues in aquaculture, cited in **Melba Bondad-Reantaso, J. Arthur & Subasinghe, R.,** Eds. *Study on understanding and applying risk analysis in aquaculture production*, pp. 101-120. FAO Fisheries and Aquaculture Technical Paper, No. 519, Rome, FAO, p. 304.

Pillay T.V.R, & Dill Wm. A, 1976, Advances in Aquaculture, Papers presented at the FAO Technical Conference on Aquaculture, Kyoto, Japan 26 May-2 June 1976, FAO Rome.

Rietbergen-McCracken & Narayan, 1998, Participation and Social Assessment: Tools and Techniques, World Bank, Washington D.C.

Roessig J. M. *et al*, 2004, Effects of global climate change on marine and estuarine fishers and fisheries. Reviews in Fish Biology and Fisheries, pp. 14, 251-275.

Romanowski N. 2007, Sustainable Freshwater Aquaculture, The complete guide from backyard to investor, University of New South Wales Press. Ltd. P. 9-15.

Rossi M. 2007, I Progetti di sviluppo, Metodologie ed esperienze di progettazione partecipativa per obiettivi, seconda edizione, Franco Angeli Editore, pp. 123-140.

Sainsbury K.J. *et al.* 2000, Design of operational management strategies for achieving fishery ecosystem objectives. ICES Journal of Marine Science, pp. 57, 731-741.

Scialabba N. 1998, Integrated coastal area management and agriculture, forestry and fisheries. FAO Guidelines, p. 256.

Selavy S. 2001, Involving stakeholders in aquaculture policy-making, planning and management cited in **Subasinghe R. *et al*** 2000, Aquaculture in the Third Millennium, Bangkok, Thailand, 20-25 February 2000. NACA, Bangkok and FAO Rome pp. 83-93.

Shawkat A., 2008, Sustainable Development and Free Trade, Institutional Approaches, Rutledge Studies in Development Economics, pp. 27-28.

Shiva V. *et al.* 2002, Sustainable Agriculture and Food Security, The impact of Globalization, Sage Publications New Delhi India.

Stickney R. 2009, Aquaculture an introductory text, 2nd Edition Cambridge University Press, p. 1.

Subasinghe R.P *et al*, 2012, farming the Waters for People and Food, Proceedings of the Global Conference on Aquaculture 2010, Food Agriculture Organization of the United Nations, Rome, Italy, 2012, p. 27, 75-102.

The World Bank. 1996, Participation Source-book, Washington D.C. pp. 276.

Tieze, U., Groenewold, G. & Marcoux A. 2000, Demographic change in coastal fishing communities and its implications for the coastal environment, FAO Fisheries Technical Paper No. 403, Rome, FAO. p. 151.

UNDP, 2002, Result Oriented Monitoring and Evaluation, United Nation Development Programme, New York, p. 5.

Valdimarsson G. *et al*., 2003, Responsible Fisheries in the Marine Ecosystem, Published by FOOD AND AGRICULTURE ORGANIZATION of THE UNITED NATIONS, Rome, Italy and CABI Publishing, pp. 312, 348-350.

Vander Zwaag D.L & Chao G. 2012, Aquaculture Law and Policy, towards principles access and operations, Rutledge Advances in Maritime Research, pp.16, 62-65.

Vierros M. 2008 The Ecosystem Approach of the Convention on Biological Diversity cited in **Bianchi G. *et al.*** 2008, The Ecosystem approach to Fisheries, published by Food and Agriculture Organization of the Unites Nations, CABI p. 39.

Ward T. *et al*. 2002, Ecosystem Based Management of marine capture fisheries. World Wide Fund for Nature Australia, p. 80.

Welcomme R. L. 2001, Inland Fisheries, Ecology and Management, FAO by Blackwell Science, p. 12, 160-163.

Weybrecht G. 2014**,** The Sustainable MBA, a Business Guide to Sustainability, John Wiley & Sons Ltd., pp. 14-22.

Williams L. & Rota A. 2010, Impact of climate change of fisheries and aquaculture in the developing world and opportunities for adaptation. Fisheries Thematic Paper, IFAD International Fund for Agricultural Development Rome, Italy.

Willmann R. 2004, Poverty in Coastal Fishing Communities *cite*d in **Neiland *et al***. 2004, Poverty and Small-scale fisheries in West Africa, Kluwer Academic Publishers, pp. 248-249.

World Resources Institute, 1998, Cultivating Diversity, Agro-biodiversity and Food Security, World Resources Institute Washington DC, pp. 6-7.

Zupi M. & Mellano M. 2007, Economia e politica della cooperazione allo sviluppo. Editore Laterza, pp. 223, 237, 240-243.

2. THE LEGISLATIVE APPROACH TO SUSTAINABLE AQUACULTURE (THE INTERNATIONAL LEGAL INSTRUMENTS).

2.1. SUMMARY

This chapter relates on the International Agreements and legal instruments on Sustainable Aquaculture and Fisheries.

We start with the examination of non-legally and legally binding International Agreements, but we also examine the institutional agreements applying the Ecosystem Approach to Fisheries.

As far as non-legally binding instruments are concerned, UNCED, Agenda 21 and MDGs, constitute the main reference for Sustainable Development, whereas among the legally binding agreements, the Washington Convention and the UN Conventions on Biological Diversity (CBD), are the Multilateral Environment Agreements that regulate national Biodiversity and Endangered Species Legislation.

UNCED and Agenda 21 also represent the base for the elaboration of Code of Conduct for Responsible Fisheries.

An important section of the legal instruments regards Food Safety as a part of Food Security, and particular attention is dedicated to the *Codex Alimentarius* and the Code of Practice for Fish and Fishery products; here are described in detail the Commodities used in case Studies 1 and 2.

The final part provides a framework of the European Legislation on Sustainable Aquaculture and Food Safety for Fish and Fishery Products.

2.2. LEGALLY AND NON-LEGALLY BINDING LEGISLATION ON SUSTAINABLE AQUACULTURE

Soft law tools are not legally binding documents, which constitute an important instrument for aquaculture activities; these include the Kyoto Declaration (Conference on Aquaculture held in Kyoto, Japan in 1976), the Bangkok Declaration and Strategy (Aquaculture Development beyond 2000) and the Agenda 21 (discusses below). Rio Declaration and Agenda 21 have also provided the basis for the implementation of the 1995 Code of Conduct for Responsible Fisheries (Code of Conduct).
Here is a list of the main International Agreements:

Non-legally binding Environmental instruments:

- **Rio Declaration on Environment and Development**, 1992;
- **Agenda 21, UN Conference on Environment and Development**, 1992;
- **UN Millennium Declaration (MDGs**), 2000.

Legally Binding Multilateral Environmental agreements:

- **Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES),** entered in force in 1975;
- **UN Convention on Biological Diversity (CBD)**, Rio de Janeiro, 1992.

2.3. THE UNITED NATIONS CONFERENCE ON ENVIRONMENT AND DEVELOPMENT (UNCED)

The United Nations Conference on Environment and Development took place in Rio in 1992.

UNCED provided a formal and general acceptance of the term *Sustainable Development* that had been already defined in 1987 by the World Commission on Environment and Development (the Brundtland Report).

The Conference produced the Declaration on Environment and Development, which reaffirmed the principles of the Declaration of the United Conference on the Human Environment adopted in Stockholm 1972, and an action plan: the Agenda 21 (Hempel, 1998).

The main goals of the Declaration were "…*establishing a new and equitable global partnership through the creation of new levels of cooperation among States, key sectors of society and people*" and "*Working towards international agreements which respect the interests of all and protect the integrity of the global environmental and developmental system*", while "*recognizing the integral interdependent nature of the Earth*" (www.unep.org).

Rio Declaration was declaratory in nature and never legally binding upon states. It interpreted the aspiration of both developed and developing countries for a Sustainable Development and included poverty alleviation as an indispensable requirement to achieve it (Shawkat**,** 2008).

It is composed of 27 principles: Principles **15**, **16** and **22** are the most interesting in relation to this paper.

Principle 15

"In order to protect the environment, the precautionary approach shall be widely applied by States, according to their capability. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation".

Principle 16

"National authorities should endeavor to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment".

Principle 22

"Indigenous people and their communities and other local communities have a vital role in environmental management and development, because of their knowledge and traditional practices. States should recognize and duly support the identity, culture and interests and enable their effective participation in the achievement of sustainable development".

As we illustrated earlier, the precautionary approach and the polluter-pays principle introduced by Principle 15 and 16 are fundamental in sustainable aquaculture.

We have also underlined the importance of local communities both from an economic and environmental point of view.

2.4. AGENDA 21

Agenda 21 represents the basic source of principles of different nature and different application (Shawkat**,** 2008; Welcomme, 2000), elaborated during the Earth Summit held in Rio de Janeiro in 1992 and then assumed by the panel of the 178 participant countries. Its main Goal is to promote Sustainable Development both in Developed and Developing countries.
It is divided in 4 sections and 40 Chapters, most of which are relevant for this paper (Welcomme, 2000).

The most important Chapters concerning Fisheries and Aquaculture examined by this work are the following:

Section I: Social and Economic dimension (from Chapter 2 to 8)

Chapter 2*, International Cooperation to promote sustainable development in developing Countries and related domestic policies*.
This Chapter concerns the social and economic dimension of sustainability. Its most important features are the four areas, which introduce the actions to be taken against poverty and hunger by improving the level of decision making of beneficiaries (stakeholders**).**

The four areas of intervention are:

- Promotion of sustainable development through trade liberalization,
- Making trade and the environment mutually supportive,
- Provision of adequate financial support to developing countries,
- Encouragement of policies conducive to environment and development (Shawkat**,** 2008).

These pillars are drawn in terms of actions, objectives, activities and means of implementation.

Section II: Conservation and Management of Resources for development

It include the Chapter relevant to fisheries, (**from Chapter 9 to 22**.)

Chapter 15, *Conservation of Biological Diversity*.

The objectives and activities of this chapter are intended to promote the conservation of biodiversity and the sustainable exploitation of natural resources, as well as the support the Convention in Biological Diversity (CBD). Consequently it is of highest importance in relation to this work as natural ecosystems such as rivers, lakes, rainforest, coral reefs and seas contain most of World's biodiversity. Moreover, decline and depletion of biodiversity is mainly imputable to anthropic activity, and it represents a serious problem for future generations.

The objectives and activities of Chapter 15 are introduced by the encouragement to involve a series of actors: not only governments, but also UN bodies, regional governmental organizations and NGOs, private sector, financial bodies, as well as indigenous populations and their social factors.

The actors should mainly operate to develop and integrate strategies fostering the conservation of biological diversity and sustainable use of natural resources.

Maybe the lack of fulfillment of Chapter 15's objectives and activities could be imputed to a top down approach that did not start from the long-term beneficiaries of Conservation of Biodiversity, that is the indigenous communities. Being only declaratory and non-legally binding, is probably another crucial factor for incompleteness.

In the past two decades, the loss of biodiversity has been perpetuated in different forms: pollution, overexploitation and habitat depletion. Therefore and effective and efficient action plan would be required, not only a national level, but also at an international level in order to protect all fragile natural ecosystems.

Moreover, in order to promote a sustainable human development, this plan should include an enhancement of sustainable exploitation of natural resources, through the involvement and empowerment of the rural communities living in their respective ecosystems.

Chapter 15 is also fundamental both for Capture fisheries and Aquaculture activities and indicates conservation and sustainable utilization of the wild fish stock as advisable tools for a long period vision policy.

Chapter 17, *Protection of the Oceans, all kinds of seas, including enclosed and semi-enclosed seas, coastal areas and the protection, rational use and development of their living resources*.

Chapter 17 focuses on the protection of marine resources and their sustainable exploitation by developing sustainable aquaculture activities and capture fisheries.

Here we report the Chapter's Programme Areas:

a. Integrated management and sustainable development of coastal areas, including exclusive economic zones (EEZs);

b. Marine environmental protection;

c. Sustainable use and conservation of marine living resources of the high seas;

d. Sustainable use and conservation of marine resources under national jurisdiction;

e. Addressing critical uncertainties for the management of the marine environment and climate change;

f. Strengthening international, including regional, cooperation and coordination;

g. Sustainable development of small islands;

All areas of this Chapter are highly relevant in relation to this work as fisheries and aquaculture can effect and be affected by the degradation of coastal areas and marine environment in general.

Here's a list of the most relevant actions to be taken relatively to the above areas:

- Implementation of integrated coastal and marine management and sustainable development plans and programmes at appropriate levels;

- Contingency plans for human induced and natural disasters, including likely effects of potential climate change;

- Locating coastal outfalls so as to maintain an acceptable level of environmental quality to avoid exposing shell fisheries;

- Promoting risk and environmental impact assessment to help ensure an acceptable level of environmental quality;

- Cooperating with developing countries, through financial and technological support to maximize the best practicable control and reduction of pollution;

- Prohibiting poisoning and other comparable destructive fishing practices;

- Implement strategies for sustainable use of marine living resources, taking into account the special needs and interest of small-scale fisheries;

- Enhance the productivity and utilization of marine living resources for food and income;
- Promote the contribution of marine living resources to reduce malnutrition and achieve food self-sufficiency in developing countries;
- Develop agreed criteria for the use of selective fishing gear and practices to minimize waste and the catch of target species and minimize By-catch of non target species (see Case Study n. 3);
- Study of special environmental and developmental characteristics of small islands, producing an environmental profile and inventory of their natural resources critical marine habitats and biodiversity;
- Prepare Medium and long term plans that emphasize multiple use of resources, integrate environment and economic sector planning and policies, define measures for maintaining cultural and biological diversity and conserve endangered species and critical marine habitats;
- Implement sustainable development plans, including the review and modification of the existing unsustainable policies and practices;
- Based on precautionary approach, design and implement response strategies to address the environmental, social and economic impacts of climate change;

Chapter 18, *Protection of the Quality and supply of freshwater resources: application of integrated approach to the development, management and use of water resources.*

Chapter 18 focuses on freshwater resources that are essential components of the whole Earth's hydrosphere and ecosystem.

The protection of the freshwater aquatic ecosystem is based on the following programme areas:

a. Integrated water resources development and management;
b. Water resources assessment;
c. Protection of water resources, water quality and aquatic ecosystems,
d. Drinking-water supply and sanitation;
e. Water and sustainable urban development;

f. Water for sustainable food production and rural development;

g. Impacts of climate change on water resources.

The areas most closely related to this work are certainly a., c., f. and g., that is the necessity of integrating protection with human economic activities that could both endanger and be endangered by pollution.

The section of the Chapter 18 that best summarizes the series of actions that could be taken by states, local actors and relevant organizations such as United Nations, is Part 40.

Here we report a list of the main activities to be implemented by the above actors:

- Water resources protection and conservation; this includes the preparation of national plans for water resources protection and conservation. The Eel Management Plan, object of Case Study nr. 1 which carries out CITES within European Union (EU) and Council Regulation (EC) 1100/2007, is certainly one of the means of implementation of this protection activities.

- Water pollution prevention and control; this applies both the "polluter pays" principle and the precautionary approach in water quality management. It focuses on pollution minimization and risk assessment and risk management.

- Development and application of clean technology; this activities seeks the development of appropriate methods of control of water pollution while taking into account traditions and indigenous practices.

- Groundwater protection;

- Protection of aquatic ecosystem; this aims to the rehabilitation of polluted and degraded water, conservation and protection of wetlands while taking into account social and economic factors. It also aims to control the spread of noxious endemic and non-endemic species. This concept is better investigated in Case Study nr. 2, about Nile Perch spread in Lake Victoria and its social and environmental implications.

- Monitoring and surveillance of water resources and water receiving wastes;

- Development of national and international legal instruments in order to monitor and control pollution and its effects; this includes environmental impact assessment.

Section III: Strengthening major and local actors

(From Chapter 23 to Chapter 32) - In order to achieve an effective transition to Sustainable Fisheries - (FAO, Fisheries and Aquaculture Department).

Section IV: Means of implementation

(From Chapter 33 to 40) To rationalize sustainable exploitation of natural resources. This includes the use of financial resources, technologies, science for sustainable development, public awareness, capacity building in developing countries and international legal instruments (FAO, Fisheries and Aquaculture Department).

Conclusion on Agenda 21

Despite its comprehensive areas of intervention and list of actions, Agenda 21 has been inadequately implemented. This is largely due to the lack of political will in actively trying to solve fundamental issues such as trade, debt, poverty and inequities and the role of actors such as multinational corporations and NGOs (Shawkat, 2008).
Even the numerous conferences that followed Rio 1992 was not able to give and significant contribution toward sustainable development. One of the most important of these international conferences was the Millennium Summit, which took place in New York in 2000.

2.5. UN THE MILLENNIUM DECLARATION (MDGs).

The 2000 Millennium Summit‘s main outcome was the adoption of the Millennium Declaration that, like Rio Declaration, is only declaratory and therefore not legally binding for the 193 Member Parties and the over 20 international organizations (De Young C.*et al.*2008).

The Millennium Declaration brought to the elaboration of the Millennium Development Goals (MDGs). These eight Goals contain 21 targets that were established directly by the Millennium Declaration. The Goals should be achieved by 2015 and could be verified by a series of measurable, specific and economic indicators.

Hereby we report the eight goals:

1. **Eradicate extreme poverty and hunger;**
2. **Achieve universal primary education;**

3. **Promote gender equality;**
4. **Reduce young mortality rates;**
5. **Improve maternal health;**
6. **Combat HIV/AIDS, *Malaria* and other diseases;**
7. **Promote environmental sustainability;**
8. **Develop a global partnership development.**

As regards to this paper, we will focus mainly on Goal 7: *Promote environmental sustainability*.

This goal has four targets:

- 7A: Integrate the principles of sustainable development into country policies and programs; reverse loss environmental resources;
- **7B: Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss**;
- 7C: Have, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation;
- 7D: By 2020, to have achieved a significant improvement in the lives of at least 100 million slum-dwellers.

Target 7B, in particular, stresses on the necessity to promote wild fish stock within safe biological limits, expand terrestrial and marine protected areas; protect the endangered species (Shawkat, 2008).

2.6. CONVENTION ON INTERNATIONAL TRADE OF ENDANGERED SPECIES OF WILD FAUNA AND FLORA (CITES)

The Washington Convention on International Trade of Endangered Species (CITES) regulates trade in terms of exportation, re-exportation, importation, transit, transfer and detention for any reason, of some endangered animal and plant species.

Established in 1975 and administered by UNEP, currently composed by 169 member countries (*Parties*). CITES regulates the international trade of approximately 30 thousand species, 25 thousand of which are plant species. These

species are listed in 3 Appendices. Each country has its own Management Authority.
On January 1st 1984, the EU implemented the CITES regulations. In some cases, the EU's legislation has become stricter that CITES itself.
Regulation (EC) 338/1997 (Protection of wild flora and fauna species through trade control) was followed by other regulations and significant modifications to define the species to protect in detail, classifying the same in various annexes.

Protected Species

The list of CITES protected species (formally referred to as *Specimens*) are periodically revised (dynamic lists).
The various species are listed in three appendices on the basis of the level of protection required:

- **Appendix I** includes protected species in the strictest sense, actually in danger of extinction. Trade is forbidden, use may be allowed in exceptional circumstances.
- **Appendix II** includes protected species, which are not in imminent danger of extinction. These species are subject to control (trade must be compatible with survival of the same and is subject to authorization through CITES certification).
- **Appendix III** includes species protected by single member states (generally in states that attempt to protect special endemic species and or sub-species).

Various species can be added or cancelled from *Appendices I* and *II* or moved from one appendix to another only after joint parties decisions in conferences held by member states using proposal procedures (CoPs).
Species in *Appendix III* can only be included or cancelled from the list by unilateral decision of the relevant Country.

APPENDIX I
Permission to import must be requested from the state authorities. This is only given if the species in question is not traded for commercial purposes but for the purpose of protecting the species – the same is valid for re-exportation requests.
Permission is only given if the animal was obtained with legal means.
In the case of live animals or plants, the effects of stress during transportation must be kept to a minimum.

APPENDIX II
An export or re-export certificate is required from the state authorities.
The certificate can only be issued if the species in question was obtained legally, through acknowledged channels and the marketing of the same cannot endanger the species.
The re-exportation certificate can only be issued if the species was imported in compliance with Convention regulations. In the case of live animals or plants, transportation must be organized to limit risks for survival, and in consideration of the wellbeing of the same.

CLASS ACTINOPTERYGII (FISHES)		
ANGUILLIFORMES		
Anguillidae Freshwater eels		
	Anguilla anguilla (Entry into force delayed 18 months, i.e. until 13 March 2009)	

Figure 9. Eel Annex II
www.cites.org[28]

APPENDIX III
In the case of trade from a state, which has included animals or vegetable species in *Appendix III*, permission must be given by the Authorities of said state.
This permission will only be given if the species were obtained through legal and authorized channels and again trying to minimize the risk of injury or damage during the various phases of shipment. Exceptions to the above articles can be summed up as follows:

- Species in transit and shipped using transshipping;
- Species acquired before inclusion in the CITES lists;
- Species which are part of private collections;
- Animals bred in captivity;
- Plants grown using artificial techniques;
- Organisms used in scientific research;
- Circus animals;

Approximately 5,000 animals species and 2,800 plant species are protected by CITES against exploitation and trade.

The various species are listed in the *Appendix*; these include taxonomic groups such as primates, cetaceans, turtles, parrots, coral, and orchids. In certain cases are included subspecies, or the same species from different geographical areas (for example the population of a certain species present only in one country).

[28] http://www.cites.org/eng/app/appendices.php. Date accessed: June 20, 2014.

There are roughly 15 fish species (*Specimens*) in *Appendix I,* and 71 species in *Appendix II*.

Of these, the European Eel, *Anguilla anguilla,* Linnaeus 1758 is listed in *Appendix II*.

Lates niloticus, Linnaeus 1758, or Nile Perch object of Case Study n. 2*,* is not included on the list of endangered species. More so, it is considered a noxious species whose number is to be contained.

As for Case Study 3 on By-catch and Discards in FAO Major Fishing Area 37, CITES is a fundamental instrument for the safeguard of Marine Mammals, Seabirds, Sharks and Turtles that are all defined as *sensitive species*, and whose largest part is included in the Annex I and II.

2.7. UN CONVENTION ON BIOLOGICAL DIVERSITY (CBD), RIO DE JANEIRO, 1992

It is an international agreement come into force in 1993. It constitutes in 42 articles and 3 annexes.

The Convention on Biological Diversity is a Multilateral Environmental agreements is also an International legally binding treaty with few main goals (Garcia, 2003; Welcomme, 2000):

- Conservation of biological diversity;
- Sustainable use of its natural resources;
- Fair and equitable sharing of benefit arising from genetic resources.

It elaborates and emphasizes all aspects of biodiversity, defining it "the variability among living organisms" including "diversity within species and of ecosystems" (Article 2).

The Conference of the Parties (COP) has adopted several decisions that implement the principles of CBD. In particular it invites the parties to adopt the "ecosystem approach". It defines the ecosystem as a *functional unit at any spatial scale… that humans are an integral part of many ecosystems and requires adaptive management techniques* (Secretariat of the Convention on Biological Diversity, 2000). Ecosystem management is also necessary *…to meet human requirements to use natural resources, whilst maintaining the biological richness and ecological processes necessary to sustain the composition, structure and function of the habitats of the ecosystems concerned. Important within this process is the setting of explicit goals and practices, regularly updated in the light of the results of monitoring and research activities".* This approach ahs also been defined as *a strategy for the integrated management of land water and living resources that promotes the*

conservation and sustainable use in an equitable way and *a strategy to reach a balance between ... conservation, sustainable use, and fair and equitable sharing of the benefits arising from the utilization of genetic resources* (Fifth Meeting of the COP, Decision V/6, 2000).

In this context, given the right of parties to exploit biological resources, some very important measures are called for to prevent depletion of biodiversity and allow the resilience[29] of natural habitats. Among these one of the most important is the creation of land and marine protected areas that serve the purpose of maintaining habitats as well as prevent future degradation and negative economic externalities.

Article 8, *In-Situ Conservation*, emphasizes the role of parties not only in the creation of such protected areas, but also in the regulation and management of biological resources. Furthermore parties are required to restore degraded areas and prevent depletion as well as the introduction and spread of alien species **(**VanderZwaag**,** 2012).

Article 9, *Ex-Situ Conservation*, establishes that, for the purpose of completing in-situ conservation, parties shall take a series of conservation measures in those areas interacting with the protected ones. Among these, measures "c" has a crucial role for the *recovery and rehabilitation of threatened species and for their reintroduction into their natural habitats under appropriate conditions.* This measure is directly related to the Washington Convention of 1975 and with the more recent EU legislation regarding the European Eel Management Plan of 2007.

Despite universally agreeing with the rightness of the principles introduced by the CBD, parties have been slow in effectively applying the measures. The late application is mainly due to the consciousness of the irreversibility of the negative consequences of biodiversity loss. Doubtlessly these consequences would have not occurred with a more solicitous adoption and an international legal enforcement.

2.8. FIRST PILLAR: CODE OF CONDUCT FOR RESPONSIBLE FISHERIES

On 31 October 1995, during the Twenty-eighth Session of the FAO Conference, more then 170 FAO Member parties adopted unanimously the Code of Conduct of Responsible Fisheries. The continuing implementation of the Code is strongly supported and financed by FAO through Regular Programmes and numerous Projects, such as FishCode[30]. The Code is organized in 12 Articles, and 2

[29]**Resilience** is intended as the capacity of an ecosystem to resist to disturbances and recover to original conditions once the impact is mitigated or removed.

[30]The **FishCode** is an Interregional Assistance Programme for the implementation of the Code in

Annexes (all referring to the original elaboration of the Code and Resolution 4/95).

About the Code

The (CCRF) or simply the Code, is a non-legally binding, voluntary set of principles;
However, according the many international Organizations such as the GFCM it is "*an overarching document comprising a set of principles and criteria*". Its goal is to promote the formulation and the implementation of policies for responsible fisheries at global level. In fact, the Code set the standard at international level (with Global coverage and continuous implementation), for an effective conservation, management and development of aquatic resources, while continuously respecting the ecosystem and biodiversity. Moreover, the Code is intended to cover all different aspects of marine fisheries and high sea fishing (Ederson, 1996). It is therefore an important tool for fisheries management and decision-making. The actors involved are the Representative Members States, Regional Fisheries Management Organizations (RFMOs) and all the other stakeholders implicated in fisheries and aquaculture activities. All are encouraged to apply the Code, implement and improve it and give it legal and practical effect.

Code of Conduct (CCRF) - Framework

FAO Code of Conduct for Responsible Fisheries could represent a most valuable instrument for environmentally safe fishing practices. Although it is not legally binding, FAO has been disseminating the Code in various languages in order to promote its implementation as widely as possible by States, industry, NGOs and other concerned organizations.
UN Resolution 4/95, contained in Annex 2 of the Code, *urges* developing countries to upgrade their fishing capabilities in order to meet the Code's provisions. For this purpose, FAO should elaborate an Inter-Regional Programme (FishCode) to assist them in the implementation of the Code.

The Code is effectively acknowledged in many countries, which have used its guidelines as a basic text to elaborate national legislative measures for Fishing, Aquaculture and certification.

International Plan of Actions (IPOAs) – Code of Conduct (CCRF)

response to the special requirements of developing countries. The main mission of FishCode Programme is to raise the economic, social and nutritional benefits obtained from the fisheries and aquaculture, through the adoption of responsible development, management and conservation practices, http://www.fao.org/fishery/fishcode/en. Date accessed: June 21, 2014.

The four IPOAs are voluntary instruments strictly related to the Code of Conduct for Responsible Fisheries. These are applied to all FAO Member States and all the other bodies involved in fisheries activities such as fishermen, processing facilities or other stakeholders involved in the exploitation of the aquatic environment.
Here below we report the four IPOAs currently acknowledged and implemented:

- International Plan of Action for the Conservation and Management of Shark;
- International Plan of Action for the Management of Fishing Capacity;
- International Plan of Action for Reducing Incidental Catch of Seabird in Long-line Fisheries:
- International Plan of Action to stop illegal unreported and unregulated IUU fishing.

Their mandate is to follow the rules designated to preserve the marine ecosystem through various activities: restrictions on the fishing of juveniles, gear regulation, reduction of by-catch and discards of non-target species and, finally, prohibition of fishing in spawning areas.
All IPOAs are relevant in relation to the purpose of this work. The first and the third, in particular, play an important role in Case Study 3, as Sharks and Seabirds are both sensitive species involved in By-catch.

The Code of Conduct and the three Case Studies

CCRF constitutes a valuable instrument to evaluate of Sustainability for our three Case Studies. In fact, by using its guidelines as a paradigm of correct conduct of fisheries, we can weigh how close or far each of our Cases is to its application.
Eel, the subject of our first Case Study, is a species that is bred according to the ***capture-based aquaculture*** which is the practice of "*collecting seed material from early life stages to adults from the wild, and on-growing these to market- able sizes using conventional aquaculture techniques*" (Lovatelli *et al.* 2004).

Capture-based aquaculture should not be confused with culture-based fisheries that is defined by FAO as follows: ***culture-based fisheries*** *"increase production in natural environments by controlling a part of the life history of certain species and transplanting or releasing their seed or fry into the open waters. The juvenile fish, which are produced in hatcheries and are released into fresh- brackish- or marine waters, are allowed to propagate or grow on natural foods until they reach harvestable size".*

Both culture and capture-based practices, however, are regulated by Article 9 of the Code of Conduct, which aims to a responsible development of aquaculture in

national and trans-boundary waters as well as the rehabilitation and enhancement of endangered fish stocks. European Eel, having been recognized as a critically endangered species by the Washington Convention (CITES), is currently strictly regulated by the principles of the Code of Conduct. It is therefore evident how the Code of Conduct, when applied, positively affected the conservation of this species.

Nile Perch, on the contrary, shows how, when any Code or Law does not regulate fisheries, can be extremely environmentally destructive. As we will illustrate in Chapter 4, Case Study 2, the uncontrolled invasion and capture of this species in lake Victoria, produced short-term benefits and irreversible environmental damages of aquatic fauna. Had the precautionary approach (Art. 6.5 and 7.5.1) and the alien species limitation (Art. 9.2) contained in the Code been applied in past, they could have largely limited the lake's natural resources depletion. Now, only the future strict application of the Code of Conduct could perhaps limit the damages and rehabilitate the endemic fish fauna stock.

As we previously anticipated, Case Study 3 concerns By-Catch and Discards in Major FAO Fishing Area 37. It is evident how this is the issue where the application of the Code of Conduct appears more relevant. Article 7.2.2, in particular, includes a list of measures aiming to achieve long-term sustainable use of fisheries resources. Among these, paragraph "g" specifically mentions those measures providing that: *pollution, waste, discards, catch by lost or abandoned gear, catch of non-target species, both fish and non-fish species, and impacts on associated or dependent species are minimized, through measures including, to extent practicable, the development and use of selective, environmentally and safe and cost-effective fishing gear and techniques*.

In the Code there are other relevant articles that involve By-Catch and Discards that we will examine later on and in detail in Case Study 3. Here, we can add that CCRF could alone constitute the basic guideline to reduce By-Catch and minimize Discards, if only it were applied by all the countries involved in Area 37, or even by all countries at a global level.

Code of Conduct (CCRF) - Relevant Articles

Article 3, *Relationship with other international instruments:*

- 3.2 c)…In the light of the 1992 Rio Declaration on Environment and Development, and Agenda 21 adopted by the United Nations Conference on Environment and Development (UNCED), in particular Chapter 17 of Agenda 21.

Article 6, *General principle*:

- **6.2** Fisheries management should promote the maintenance of the quality, diversity and availability of fishery resource in sufficient quantity for present and future generation in the context of *food security, poverty alleviation and sustainable development.*

- **6.5** States and regional fisheries management organization should apply a *precautionary approach* widely to conservation, management and exploitation of living aquatic resources in order to protect them and preserve aquatic environment**.**

- **6.6** States and user of aquatic ecosystem should minimize waste, *catch of non-target species,* both fish and non-fish species.

- **6.1.8** Recognizing the important contributions of artisanal[31] and small scale fisheries to employment, income and food security, States should appropriate protect the right of fisheries and fish worker, particularly those engaged in subsistence, small scale fisheries and artisanal fisheries, to a secure and just livelihood, as well as preferential access, where appropriate, to traditional fishing ground and resources in the water under their national jurisdiction.

Article 7, *Fisheries Management*:

- **7.5.1** and subsequent (Precautionary approach), *States should apply the precautionary approach widely to conservation, management and exploitation of living aquatic resources in order to protect them and preserve aquatic environment.*

The Code has proven to be forward-looking and helped shape policies according to concepts such as the precautionary, participatory and ecosystem-based principles. These concepts today are internationally integrated in the management of fisheries and aquaculture policies.

Article 9, *Aquaculture development*: it encourages member parties to promote sustainable practices in aquaculture through the use of strategic policies, to take account of harmful environmental and socio-economic impacts and to adopt a participatory approach over borderline impacts (VanderZwaag, 2006).

- **9.1.1** States should establish, maintain and develop and appropriate legal and administrative framework, which facilitate the development of responsible aquaculture.

[31]According to FAO web page, term "**artisanal fisheries**" is often used in French and Spanish-speaking areas to mean relatively low levels of technology, sometimes paired with low levels of organization and industrialization, but with little reference to size.

- **9.1.2** States should promote responsible development and management of aquaculture, including an advance evaluation of the effects of aquaculture development on genetic diversity and ecosystem integrity, based on the best available scientific information.

- **9.1.3** States should produce and regularly update aquaculture development strategies and plans, as required to ensure that aquaculture development is ecologically sustainable.

Article 11, *Post-harvest practice and trade*:

- **11.1.3** Responsible fish utilization – States should set minimum standards for safety and quality assurance and make sure that these standards are effectively applied throughout the industry. They should promote the implementation of quality standards agreed within the context of the FAO/WHO *Codex Alimentarius Commission*.

- **11.1.8** States should encourage those involved in fish processing, distribution and marketing to: reduce post harvest losses and waste; improve the use of by-catch to extend that this is consistent with responsible fisheries management practice;

Code of Conduct (CCRF) – Technical Guidelines

The purpose of the Technical Guidelines of the Code is to encourage its application in Capture fisheries and aquaculture. Subsequently, the practical elaboration of the general principles of the Code has produced numerous FAO Guidelines for responsible fisheries, some of which are relevant to the topics covered in this paper's case studies (VanderZwaag, 2006). The Guidelines report below however, do not have a formal legal status:

- Aquaculture development. Use of wild fishery resources for capture-base aquaculture; *FAO technical Guidelines for Responsible Fisheries N. 5 Suppl. 6.*

- Fishing operation. Best practice to reduce incidental catch of seabird in capture fisheries; *FAO technical Guidelines for Responsible Fisheries N. 1, Suppl. 2.*

- Fisheries Management. The Ecosystem approach to fisheries, the human dimension of the ecosystem approach to fisheries. *FAO technical Guidelines for Responsible Fisheries N. 4 Suppl. 1 & 2.*

- Increasing the contribution of small-scale fisheries to poverty alleviation and

food security; *FAO technical Guidelines for Responsible Fisheries N. 10.*

- Indicators for sustainable development of marine capture-fisheries; *FAO technical Guidelines for Responsible Fisheries N. 8.*
- Aquaculture Development; *FAO technical Guidelines for Responsible Fisheries N. 5.*
- Inland Fisheries; *FAO technical Guidelines for Responsible Fisheries N. 6.*
- Precautionary approach to capture fisheries and species introductions; *FAO technical Guidelines for Responsible Fisheries N. 2.*

Other Guidelines are under development or in preparation.

Final Comment – Code of Conduct (CCRF)

CCRF remains the main overarching document on Responsible Fisheries at a global level. Its effectiveness would be much greater not only if it were a legally-binding instrument applied by all FAO member states, but also if it were combined with education and diffusion of culture on sustainable fishing practices.
The main obstacles to its effective application are the cultural differences among the countries and diversity of short-term economical interests.
Other major obstacles are the difficulties of monitoring illegal fishing and poaching, especially in developing and in politically unstable countries.
All these elements, combined with the scarcity of data provided by some States, contribute to a weaker control over fishing practices.

2.9. INSTITUTIONAL AGREEMENTS APPLYING THE ECOSYSTEM APPROACH IN FISHERIES

The bodies that elaborate international governance for sustainable and responsible fisheries and aquaculture are mainly two: the UN General Assembly and UN FAO and its Committee on Fisheries.
These two bodies have elaborated two relevant instruments establishing the rules for exploitation and conservation of natural resources of fresh and marine waters: the 1982 UN Conventions on the Law of the Sea, and the previously mentioned 1995 Code of Conduct for Responsible Fisheries.
There are also other agreements deriving from the above agreements that will be later illustrated. These are all correlated to the implementation of the Ecosystem Approach to Fisheries, but each one has its own specific characteristics and area of intervention.

2.10. UN CONVENTION ON THE LAWS OF THE SEA (UNCLOS)

The UN Convention on the Law of the Sea was adopted on December 1982 and came into force on November 1994[32], by 138 Member Parties (Bianchi *et al*., 2008; Garcia *et al*., 2003; Valdimarson *et al*., 2003). The Convention establishes the basic legal agreement that oversees all aspects of the oceans and seas. UNCLOS (or LOSC) also establishes a framework for conservation, management and development measures regarding living marine resources. It also provides the responsibility of coastal States and the management of the fishery resources in their **Exclusive Economic Zones (EEZ[33]).** The main goal of this right is to preserve the fish stock, including breeding area close to EEZ and different types of fish species (highly migratory species, marine mammals, anadromous and catadromous species). However, the living resources of the high seas are managed and protected **(**HLPE Steering Committee members & FAO, 2014). The main factors are:

- Preservation of Marine ecosystem;
- Conservation of the living resources within EEZ;
- Conservation of the living resources of the high seas.

As regards to this work, the most relevant articles can be summarized as follows:

PART V – EXCLUSIVE ECONOMIC ZONE EEZ

Article 55. *Specific legal regime of the Exclusive Economic Zone;*
The exclusive economic zone is an area beyond and adjacent to the territorial sea, subject to the specific legal regime established in this Part, under which the relevant provisions of this Convention govern the rights and jurisdiction of the coastal State and the rights and freedoms of other States

Article 61. *Conservation of the living resources*; (2) The coastal State, taking into account the best scientific evidence available to it, shall ensure through proper conservation and management measures that the maintenance of the living resources in the exclusive economic zone is not endangered by over-exploitation. (4) In taking such measures the coastal State shall take into consideration the effects on species associated with or dependent upon harvested species with a view to maintaining or restoring populations of such associated or dependent species above levels at which

[32] http://www.un.org/Depts/los/convention_agreements/convention_overview_convention.htm
Date accessed: June 17, 2014.
[33] According to the UNCLOS the EEZ are zones not beyond 200 nautical miles from the border. The State oversees the exploitation of fisheries and its regulations.

their reproduction may become seriously threatened.

Article 64. *Highly migratory species*; (1) The coastal State and other States whose nationals fish in the region for the highly migratory species listed in **Annex I** shall cooperate directly or through appropriate international organizations with a view to ensuring conservation and promoting the objective of optimum utilization of such species throughout the region, both within and beyond the exclusive economic zone.

Article 65. *Marine mammals*; (….) States shall cooperate with a view to the conservation of marine mammals and in the case of cetaceans shall in particular work through the appropriate international organizations for their conservation, management and study.

Article 66. *Anadromous stocks*; (1) States in whose rivers anadromous stocks originate shall have the primary interest in and responsibility for such stocks (…).

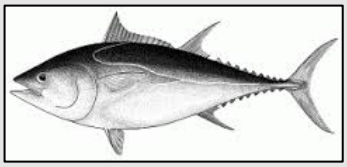
Article 67. *Catadromous species*; (1) A coastal State in whose waters catadromous species spend the greater part of their life cycle shall have responsibility for the management of these species and shall ensure the ingress and egress of migrating fish (…).

PART XII – PROTECTION AND PRESERVATION OF THE MARINE ENVIRONMENT

Article 192. *General obligation*; States have the obligation to protect and preserve the marine environment.

Article 194. *Measures to prevent, reduce and control pollution of the marine environment;* (5) The measures taken in accordance with this Part shall include those necessary to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life.

According to the Convention, the *Highly Migratory Species* included in ANNEX I are the following:

UNCLOS - ANNEX I. HIGHLY MIGRATORY SPECIES
Albacore tuna: *Thunnus alalunga.*
Bluefin tuna: ***Thunnus thynnus*** (also present in FAO Major Fishing Area 37). 
Big-eye tuna: *Thunnus obesus*.
Skipjack tuna: *Katsuwonus pelamis.*
Yellow-fin tuna: *Thunnus albacares*.
Blackfin tuna: *Thunnus atlanticus*.
Little tuna: *Euthynnus alletteratus; Euthynnus affinis*.
Southern bluefin tuna: *Thunnus maccoyii*
Frigate mackerel: *Auxis thazard; Auxis rochei*.
Pomfrets: Family Bramidae.
Marlins: *Tetrapturus angustirostris*; *Tetrapturus belone; Tetrapturus pfluegeri; Tetrapturus albidus; Tetrapturus audax; Tetrapturus georgei; Makaira mazara; Makaira indica; Makaira nigricans.*
Sailfishes: *Istiophorus platypterus*; *Istiophorus albicans.*
Swordfish: ***Xiphias gladius***, (also present in FAO Major Fishing Area 37)

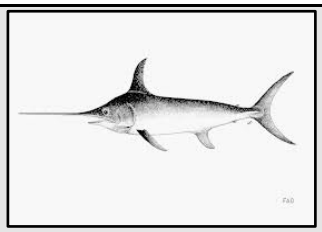
. 
Sauries: *Scomberesox saurus; Cololabis saira; Cololabis adocetus; Scomberesox saurus scombroides*
Dolphin: *Coryphaena hippurus; Coryphaena equiselis.*
Oceanic **Sharks**: Hexanchus griseus; Cetorhinus maximus; Family *Alopiidae*; *Rhincodon typus*; Family *Carcharhinidae*; Family *Sphyrnidae*; Family *Isurida*, (also present in FAO Major Fishing Area 37 some species).
Cetaceans: Family *Physeteridae*; Family *Balaenopteridae;* Family *Balaenidae*; Family *Eschrichtiida*e; Family *Monodontidae*; Family *Ziphiidae*; Family *Delphinidae*, (also present in FAO Major Fishing Area 37 some species). .

Figure 10. Annex I Highly Migratory Species, (UNCLOS).

2.11. UN FISH STOCK AGREEMENT (FSA)

The UN Fish Stock Agreement[34] was adopted at a global level on September 5, 1995 and came into force on 11 December 2001. The FSA provides a higher level of details compared to the Convention (UNCLOS).

The main goal of FSA is to promote and strengthen the management and conservation of highly migratory fish stocks. Furthermore, UN Fish Stock Agreement has a strong long-term vision through the implementation of the articles of UNCLOS.

The terms "conservation" and "sustainable" are at the core of this agreement, in order "*to avoid negative effects on the marine environment and preserve bio-diversity*".

Its main points are:

- Precautionary approach;
- Protection and conservation of biodiversity;
- Sustainable use of marine resources;
- Adopt an Ecosystem Approach.

[34] http://www.un.org/depts/los/convention_agreements/texts/fish_stocks_agreement/CONF164_37.htm. Date accessed: June 17, 2014.

The most relevant articles for the Ecosystem Approach to Fisheries (EAF) are:

PART I – GENERAL PROVVISION

Article 1. Use of terms and scope;
(b) "*Conservation and management measures*" means measures to conserve and manage one or more species of living marine resources that are adopted and applied consistent with the relevant rules of international law as reflected in the Convention and this Agreement; (c) "*fish*" includes mollusks and crustaceans except those belonging to sedentary species as defined in article 77 of the Convention;

PART II – CONSERVATION AND MANAGEMENT OF STRADDLING FISH STOCKS AND HIGHLY MIGRATORY FISH STOCK

Article 5. General principles;
(c) Apply the "*precautionary approach*" in accordance with article 6; (f) Minimize pollution (…) catch *by lost or abandoned gear, catch of non-target species, both fish and non-fish species* (…) and impact on associated or dependent species *in particular endangered species*; (g) Protect biodiversity in the marine environment.

Article 6. Application of the *precautionary approach*;

- States shall apply the precautionary approach widely to conservation, management and exploitation of straddling fish stocks and highly migratory fish. Stocks in order to protect the living marine resources and preserve the marine Environment.
- States shall be more cautious when information is uncertain, unreliable or inadequate. The absence of adequate scientific information shall not be used as a reason for postponing or failing to take conservation and management measures.
- In implementing the precautionary approach, States shall:

  (a) Improve decision-making for fishery resource conservation and management by obtaining and sharing the best scientific information available and implementing improved techniques for dealing with risk and uncertainty;

  (b) Apply the guidelines set out in Annex II and determine, on the basis of the best scientific information available, stock-specific reference points and the action to be taken if they are exceeded;

  (c) Take into account, inter alia, uncertainties relating to the size and

productivity of the stocks, reference points, stock condition in relation to such reference points, levels and distribution of fishing mortality and the impact of fishing activities on non-target and associated or dependent species, as well as existing and predicted oceanic, environmental and socio-economic conditions; and

(d) Develop data collection and research programmes to assess the impact of fishing on non-target and associated or dependent species and their environment, and adopt plans, which are necessary to ensure the conservation of such species and to protect habitats of special concern.

- States shall take measures to ensure that, when reference points are approached, they will not be exceeded. In the event that they are exceeded, States shall, without delay, take the action determined under paragraph 3 (b) to restore the stocks.
- Where the status of target stocks or non-target or associated or dependent species is of concern, States shall subject such stocks and species to enhanced monitoring in order to review their status and the efficacy of conservation and management measures. They shall revise those measures regularly in the light of new information.
- For new or exploratory fisheries, States *shall adopt as soon as possible cautious conservation and management measures,* including, inter alia, catch limits and effort limits. Such measures shall remain in force until there are sufficient data to allow assessment of the impact of the fisheries on the long-term sustainability of the stocks, whereupon conservation and management measures based on that assessment should be implemented. The latter measures shall, if appropriate, allow for the gradual development of the fisheries.
- If a natural phenomenon has a significant adverse impact on the status of straddling fish stocks or highly migratory fish stocks, States shall adopt conservation and management measures on an emergency basis to ensure that fishing activity does not exacerbate such adverse impact. States shall also adopt such measures on an emergency basis where fishing activity presents a serious threat to the sustainability of such stocks. Measures taken on an emergency basis shall be temporary and shall be based on the best scientific evidence available.

The UN Fish stock Agreement is the starting point for the species-based approach to fisheries Management and its application will develop the application and implementation of ecosystem-base fisheries management (EBFM) (Valdimarson *et al. 2*003).

2.12. REYKJAVIK DECLARATION ON RESPONSIBLE FISHERIES IN MARINE ECOSYSTEM

The Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem was held in Reykjavik, Iceland on first October 2001[35]. The Conference can be considered a milestone in terms of consideration and prominence of the ecosystem approach in the fisheries management (Bianchi *et al*. 2008). The main focus was a serious analysis of the global issues relating fisheries and the complete adoption and implementation of the Code of Conduct of Responsible Fisheries. According to Valdimarsson G. *et al,* (2003) the three main objectives were:

- To obtain and reclassify the best available knowledge on marine ecosystem;
- To clearly identify means by which ecosystem approach considerations can be included in fisheries management;
- To identify future challenges and objectives for relevant operational strategies.

As a result a Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem was produced and adopted by the *Member Parties* of the Conference.
The most important focus points are:

- *Recalling* (….) the relevance of the Rio Declaration on Environment and Development and Agenda 21 (Chapter 17);
- *Reaffirming* the principles of the FAO Code of Conduct for Responsible Fisheries;
- *Recognizing* that sustainable fisheries management incorporating ecosystem consideration entails taking into account the impacts of fisheries on the marine ecosystem and the impacts of the marine ecosystem on fisheries;
- *Confirming* that the objectives of including ecosystem consideration in fisheries management is to contribute to long-term food security and to human development and to assure the effective conservation and sustainable use of the ecosystem and its resources.
- *Article 2.*
  " (….) It is clear need to introduce immediately effective management plans with incentives that encourage *responsible fisheries and sustainable use of marine ecosystems*, including mechanisms for reducing excessive fishing efforts to sustainable levels";
- *Article 5*.
  While it is necessary to take immediate action to address particularly urgent problems on the basis of the precautionary approach;
- *5 (d)* Improve the monitoring of by-catch and discards in all fisheries to obtain better knowledge of the amount of fish actually taken;

[35] http://www.fao.org/docrep/meeting/004/Y2211e.htm, Date accessed: June 29, 2014.

2.13. UNCLOS, FSA AND REYKJAVIK AND THE THREE CASE STUDIES

The three previously illustrated agreements can be correlated with our three case Studies. Case Study 1 and 3 are strongly affected by the measures and policies deriving from the application of all the agreements, as they all try regulate all aspects of marine conservation and fishing.
Case Study 2, being circumscribed in an inland fresh-water lake, is only partly affected by the "principles" of UNCLOS and REYKJAVIK, whereas it could benefit from the effective application of the Precautionary and Ecosystem Approaches, contained in FSA.

In the next section of this chapter, we will illustrate another branch of Sustainability concerned with Food Security, whose core is constituted by the *Codex Alimentarius*.

2.14. WORLD ORGANIZATION FOR ANIMAL HEALTH (OIE)

The OIE[36] (or Office International des Epizooties) is an international organization established in 1924 in Paris-France and ratified by more than 160 countries. Its main goals are:

- Protect global animal trade by diffusing publications on health animal standard for live animals and animal products;
- Provide practical knowledge about epizootic controls;
- Guarantee the health and safety of products of animal origin by producing a list of diseases that require health measures at international level;
- Promote animal welfare through a scientific approach.

OIE also provides member states with the instruments for preventing, controlling the spread of diseases in aquatic organisms; indicating effective measures (preventive treatments, risks associated with imports), and specific measures such as international certification (Monticini, 2010).

Regulations are based on the following publications:

- Aquatic Animal Health Code 2014, (The Aquatic Code), which aims to guarantee the healthy trade of aquatic organism (fish, mollusks, amphibians

[36] http://www.oie.int/about-us/, http://en.wikipedia.org/wiki/World_Organisation_for_Animal_Health, Date accessed: July 2, 2014.

and crustaceans), without limiting the trade within member countries;

- Manual of Diagnostic Tests for Aquatic Animals 2014, 7th edition (The Aquatic Manual), which provides scientific and laboratory knowledge useful to diagnose the diseases listed in the Aquatic Code.

Currently, other OIE's relevant scientific publications concerning aquatic animals are:

- Risk analysis in Aquatic Animal Health;
- OIE Global Conference on Aquatic Animal Health, 2011.

The relevance of OIE, in this work is mainly associated with two factors:

- Food Safety as a part of Food Security and the consequent management of associated risks;
- Risk analysis related with the spread of invasive species both in aquaculture (e.g. *Anguillicola crassum* in eel farming) and in ecosystem (invasion of *Lates niloticus* in Lake Victoria).

2.15. WORLD TRADE ORGANIZATION (WTO) – AGREEMENT ON THE APPLICATION OF SANITARY AND PHYTOSANITARY MEASURES (SPS AGREEMENT)[37]

One of the final results of the Uruguay Round[38] was the production of the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement). SPS Agreement entered into force with the institution of the World Trade Organization (WTO)[39] on the first January 1995. Its 14 Articles and 3 Annexes organize it.

According to FAO and WTO the main purpose of SPS, which has important implications in food safety and quality, is to "*guarantee measures established by governments to protect human, animals and plant life and health, in the agricultural sector, including fisheries*", furthermore, the Agreement applies to " *all sanitary and phytosanitary measures which may, directly or indirectly, affect international trade*" (Shawkat, 2008). Furthermore SPS Agreement provides a framework for the laying of the SPS measures. Member countries are also encouraged to adopt the

[37] http://www.wto.org/english/tratop_e/sps_e/spsagr_e.htm, Date accessed: July 4 2014.
[38] The Uruguay Round was one of the multilateral trade negotiations; http://en.wikipedia.org/wiki/Uruguay_Round, Date accessed: July 3 2014.
[39] http://www.gatt.org, Date accessed: July 3 2014.

international standards and recommendations (**Article 3.1**).

For this reason, WTO has the support of three International Organizations to cover and implement his SPS standards:

- The *Codex Alimentarius* Commission (Codex or CAC);
- The World Organization for Animal Health (OIE);
- The Secretariat of the International Plant Protection (IPPC).

In relation to this work only the first two Organizations are taken into consideration. The most important Articles, concerning Fisheries, Aquaculture and Food Safety/Security examined by this paper are the following:

- **Article 2.1** Basic Right and Obligations: "*Members have the right to take sanitary and phytosanitary measures necessary for the protection of human, animal or plant life and health";*

- **Article 5.7** Assessment of *Risk* of the Appropriate Level of Sanitary or Phytosanitary Protection: "*In cases where relevant scientific evidence is insufficient, a Member may provisionally adopt sanitary or phytosanitary measures on the basis of available pertinent information, including that from the relevant international organizations as well as from sanitary or phytosanitary measures applied by other Members States. In such circumstances, Members shall seek to obtain the additional information necessary for a more objective assessment of risk and review the sanitary or phytosanitary measure accordingly within a reasonable period of time*".

In this case it is the "**precautionary principle**", already extensively covered and discussed as one of the milestone of sustainability.

- **(SPS Agreement) ANNEX A Definitions**: *International standards, guidelines and recommendations;* **(a)** for food safety, the standards, guidelines and recommendations established by the FAO/WHO *Codex Alimentarius Commission* relating to food additives, veterinary drugs and pesticide residues, contaminants, methods of analysis and sampling, and codes and guidelines of hygienic practice; **(b)** for animal health and zoonoses, the standards, guidelines and recommendations developed under the auspices of the World Organization for Animal Health (OIE).

2.16. CONCLUSION

International Food Safety is regulated by a complex series of international organizations and agreements, subscribed by numerous countries worldwide.

Member states are both developing and developed countries that adhere to a series of common standard regulations in order to access the international animal food trade.

The weakest point of this framework is probably the lack of knowledge and means of developing countries that is necessary to maintain a high level of food security and safety.

Very often, in fact, only a few large-scale fisheries and processing facilities operate within international food safety directives and only a few chains apply a strict control system from "fishery to fork". On the other hand, large-scale fisheries do not represent the countries as a whole, and are often owned by foreign investors who produce almost only for export.

Once again, this problem could be alleviated by a Small-scale fisheries system that could be coordinated by cooperatives or other organisms in order to limit over-fishing and, most of all, better aligning to international regulations. In this context, FAO and WHO could provide an additional support to help the fishery sector to match up to international safety requirements.

Here below we will describe the structure of the Codex Alimentarius Commission (CAC), with a particular attention to the fishery sector food standards, contained in the Code of Practice for Fish and Fishery Products.

2.17. SECOND PILLAR: *THE CODEX ALIMENTARIUS* COMMISSION

The *Codex Alimentarius* Commission (CAC) is an international and intergovernmental body with more than 180 Members[40] founded it in 1963 by the Food Agriculture Organization (FAO) and the World Health Organization (WHO). The main goal of the Commission is to protect human health and to promote a coordination of all food standards. It oversees the food standards and their international harmonization with more than 300 Food Standards recognized at global level.

[40] http://www.codexalimentarius.org, http://www.codexalimentarius.org/about-codex/en/, The *Codex Alimentarius*, international food standards, guidelines and codes of practice, contribute to the safety, quality and fairness of this international food trade. Date accessed, July 21 2014.

The history of the Codex can be summarized by the following timeline:

- **1945**, Foundation of the Food Agriculture Organization;
- **1948**, Foundation of the World Health Organization;
- **1961**, First resolution FAO/WHO by the Codex Alimentarius Commission;
- **1963**, FAO and WHO Food Standards Programme jointly officially found the *Codex Alimentarius* Commission.
- **1995**, Codex Standards, guidelines, recommendations and Code of Practice become a reference for food safety in the Sanitary and Phytosanitary Measures (SPS agreement). The other international Organizations involved are the World Organization for Animal Health, (OIE) and the International Plant Protection Convention (IPPC), (not examined in this work);
- **2002,** Codex standards and measures become an integral part of the European Food Safety Legislation with the EU Regulation 178/2002;
- **2009 and 2012**, Publication of the Code of Practice for Fish and Fishery Products, 1st and 2nd Edition by FAO and WHO.

For the first few years after its entry into force, *Codex Alimentarius* was scarcely considered because of its lack of legally binding effectiveness (Masson-Matthee D. M, 2007). This situation persisted until 1995, when WTO Agreement approved the SPS and the TBT Agreements. These are legally binding and refer to the principles contained in the Codex Alimentarius Standards.

In 2002 the Codex Standards were included in the European Legislation on Food Safety with the adoption of EU Regulation 178/2002 and the subsequent regulations included in the "Hygiene Package" (Regulation CE 852, 853, 854, 882/2004). Its incorporation into European food safety legislation has certainly led to greater uniformity harmonization of the international food.

Codex Alimentarius Commission plays a subsidiary role for the implementation of international food standards and cannot be considered an independent international body with its own legal powers. These derive from FAO/WHO and not from the individual Member States (Masson-Matthee D. M, 2007).

Here below we report **Article 1,** of the *Codex Alimentarius* Commission that

states[41]:

The Codex Alimentarius Commission shall... be responsible for making proposals to, and shall be consulted by, the Directors-General of the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) on all matters pertaining to the implementation of the Joint FAO/WHO Food Standards Programme, the purpose of which is:

(a) Protecting the health of consumers and ensuring fair practices in the food trade;

(b) Promoting coordination of all food standards work undertaken by international governmental and non-governmental organizations;

(c) Determining priorities and initiating and guiding the preparation of draft standards through and with the aid of appropriate organizations;

(d) Finalizing standards elaborated under (c) above and, after acceptance by governments, publishing them in a *Codex Alimentarius* either as regional or worldwide standards, together with international standards already finalized by other bodies under (b) above, wherever this is practicable;

(e) Amending published standards, after appropriate survey in the light of development".

At the same level of competence of the Codex Alimentarius Commission there are three expert committees, which do not have official part in the structure of the Codex Alimentarius (not shown in the Figure 10):

- JEFCA
- JMPR
- JEMRA

The Joint FAO/WHO Expert Committee on Food Additives (JECFA)[42]

It is an international expert scientific committee jointly administered by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO). JECFA serves as an independent scientific committee which performs risk assessments and provides advice to FAO, WHO and the member countries of both

[41] http://www.fao.org/docrep/008/y7867e/y7867e05.htm, the Codex system: the Codex Alimentarius Commission and how it works, Data accessed: July 23, 2104.
[42] http://www.codexalimentarius.org/scientific-basis-for-codex/jecfa/en/, Date accessed: August 1 2014.

organizations.

The Joint FAO/WHO Meetings on Pesticide Residues (JMPR)[43]

The Joint FAO/WHO Meetings on Pesticide Residues provide independent scientific expert advice to the Commission and its specialist Committee on Pesticide Residues.

The Joint FAO/WHO Expert Meeting on Microbiological Risk Assessment (JEMRA)[44]

While not officially part of the Codex Alimentarius Commission structure, the Joint FAO/WHO Expert Meeting on Microbiological Risk Assessment provide independent scientific expert advice to the Commission and its specialist Committees.

At the lower level of the Codex Alimentarius structure, there are numerous bodies which can be summarized as follows: The Executive Committee, The Secretariat, the General Subject Committees, the Commodity Committees, the *Ad Hoc* Intergovernmental Task Forces and the FAO/WHO Co-coordinating Committee. Below a brief description with particular attention to what concerns the focus of this paper.

[43] http://www.codexalimentarius.org/scientific-basis-for-codex/jmpr/en/, Date accessed: August 1 2014.
[44] http://www.codexalimentarius.org/scientific-basis-for-codex/jemra/en/, Date accessed: August 1 2014.

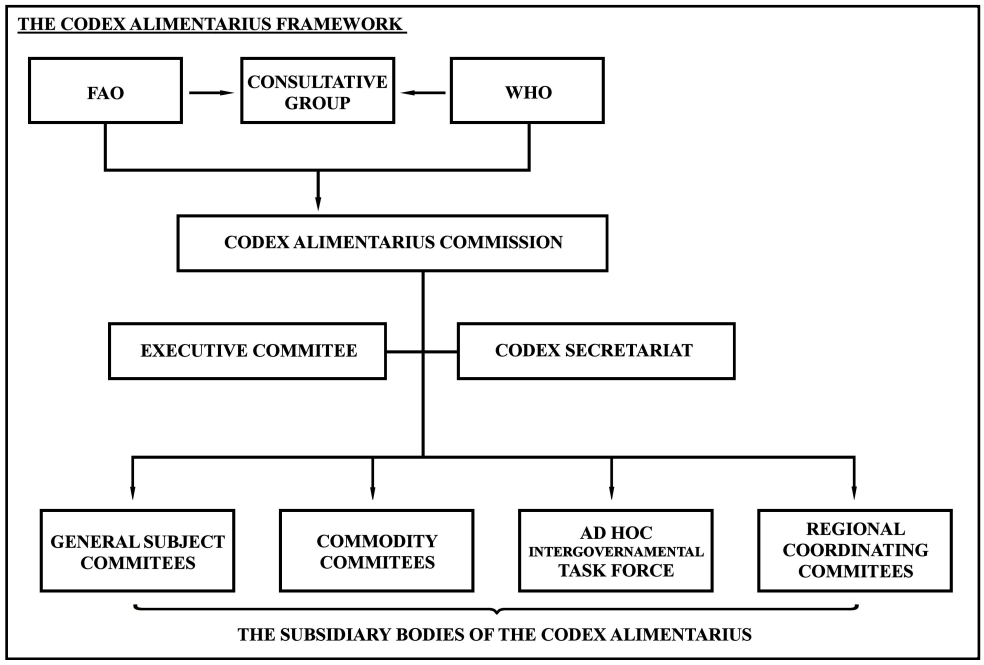


Figure 11. The Codex Alimentarius framework

The Executive Committee

The Executive Committee was established in accordance with the **Article 6** of the Codex Alimentarius Commission that provides that:

"*The Commission shall establish an Executive Committee whose composition should ensure an adequate representation of the various geographical areas of the world to which the Members of the Commission belong. Between sessions, the Executive Committee shall act as the Executive organ of the Commission".*

The main function of the Executive Committee is to act as the executive organ of the Commission between the sessions. However, the power of the Executive Committee is limited to a consultative function, and it has no decisional power to concerning the standard procedures (Masson-Matthee D. M, 2007):

The Executive Committee shall consist of the Chairperson and the Vice-Chairpersons of the Commission, and the Coordinators appointed on the basis of Rule IV together with seven further Members elected by the Commission at regular sessions from among the Members of the Commission, one each coming from the following geographic locations: Africa, Asia, Europe, Latin America and the

Caribbean, Near East, North America, South-West Pacific. Not more than one delegate from any one country shall be a member of the Executive Committee[45]. The Committee is currently active.

The Secretariat

The Secretariat is an integral part of the FAO Nutrition Division of the Economical and Social Development Department[46] and it is located in FAO HQ in Rome. The Secretariat currently carries on its activities exclusively to the Codex Alimentarius Commission.

The first level of subsidiary bodies is formed by two categories of Codex Committees:

- The General Subject Committees;
- The Commodity Committees.

The second level of subsidiary bodies is formed by two categories of Codex Committees:

- The *Ad Hoc* Intergovernmental Task Forces;
- FAO/WHO Regional Co-coordinating Committee**.**

The General Subject Committees

The General Subject Committees are subsidiary bodies, are responsible for the elaboration of the issues in the following area of interest. All the General Subject Committees are presently active, and only the Codex Committee on Food Additives and Contaminants has been renamed:

- Codex Committee on Contaminants in Foods (Netherlands);
- Codex Committee on Food Additives (China);
- Codex Committee on Food Additives and Contaminants (Netherlands);
- Codex Committee on Food Hygiene (United States of America);
- Codex Committee on Food Import and Export Inspection and Certification Systems (Australia);
- Codex Committee on Food Labeling (Canada);
- Codex Committee on General Principles (France);
- Codex Committee on Methods of Analysis and Sampling (Hungary);
- Codex Committee on Nutrition and Foods for Special Dietary Uses (Germany);

[45] http://www.codexalimentarius.org/committees-and-task-forces/en/?provide=committeeDetail&idList=2, the Executive Committee. Date Accessed: July 25, 2014.

[46] http://www.fao.org/economic/es-home/it/#.U89snv10k9c, Date accessed: July 23 2014.

- Codex Committee on Pesticide Residues (China);
- Codex Committee on Residues of Veterinary Drugs in Foods (United States of America).

Their duties and responsibilities are horizontal, or related to more than one Commodity. At present 11 General Subject Committees are active.

The Commodity Committees

They are in charge of the organization and elaboration on Commodity Standards. They are divided in three categories: Active Commodity Committees (6), Adjourned *sine die* Commodity Committees (6) and Abolished Commodity Committees (4):

Active Commodity Committees:

- Codex Committee on Fish and Fishery Products (Norway);
- Codex Committee on Fresh Fruits and Vegetables (Mexico);
- Codex Committee on Fats and Oils (Malaysia);
- Codex Committee on Sugars (Colombia);
- Codex Committee on Spices and Culinary Herbs (India);
- Codex Committee on Processed Fruits and Vegetables (United States of America).

Adjourned *sine die* Commodity Committees:

- Codex Committee on Cocoa Products and Chocolate (Switzerland);
- Codex Committee on Cereals, Pulses and Legumes (United States of America);
- Codex Committee on Milk and Milk Products (New Zealand);
- Codex Committee on Meat Hygiene (New Zealand);
- Codex Committee on Natural Mineral Waters (Switzerland);
- Codex Committee on Vegetable Proteins (Canada);

Abolished Commodity Committees (not shown in Figure 11):

- Codex Committee on Edible Ices;
- Codex Committee on Meat;
- Codex Committee on Processed Meat and Poultry Products;
- Codex Committee on Soups and Broths.

The most important Commodity Committee in relation to this work is the Committee on Fisheries and Fishery Products located in Norway as a host Country.

The Ad Hoc Intergovernmental Task Forces

The *Ad Hoc* Intergovernmental Task Forces belong to the second level of subsidiary bodies. The Codex Alimentarius Commission instituted them in 1999 as a new type of subsidiary organisms. Their mandate is temporary bodies by definition (only the last five Task Forces are reported in the Figure 11):

- Committee of Government Experts on the Code of Principles Concerning Milk and Milk Products;
- Joint CODEX/IOOC Meeting on the Standardization of Table Olives;
- Joint ECE/Codex Alimentarius groups of experts on standardization: Fruit Juices;
- Joint ECE/Codex Alimentarius groups of experts on standardization: Quick Frozen Foods;
- Ad Hoc Intergovernmental Task Force on Animal Feeding;
- Ad Hoc Intergovernmental Task Force on Fruit and Vegetable Juices;
- Ad Hoc Intergovernmental Task Force on Foods derived from Biotechnology;
- Ad Hoc Intergovernmental Task Force on Antimicrobial Resistance;
- Ad Hoc Intergovernmental Task Force on Processing and Handling of Quick Frozen Foods.

All Committees of this second level of subsidiary bodies are currently abolished or dissolved, only the Committee of Government Experts on the Code of Principles Concerning Milk and Milk Products has been reestablished and renamed.

The FAO/WHO Regional Co-coordinating Committee

The Co-coordinating Committees improve the exchange of information and acquired knowledge among the regional members**.**

All Committees of this subsidiary body are currently active, below is their list with the host countries:

- Regional Co-ord. Committee for Africa (Cameroon);
- Regional Co-ord. Committee for Asia (Japan);
- Regional Co-ord. Committee for Europe (Netherlands);
- Regional Co-ord. Committee for Latin America and Caribbean (Costa Rica);
- Regional Co-ord. Committee for Near East (Lebanon);
- Regional Co-ord. Committee for North America and South West Pacific (Papua New Guinea).

According to Masson-Matthee, the most important terms of references of these bodies can be defined as follows:

- Definition of problems and needs at regional level regarding food standards;
- Promotion of exchange of information concerning food standards and its control;
- Promotion of food standards at Regional level;
- Promotion and coordination among all Regional food standards.

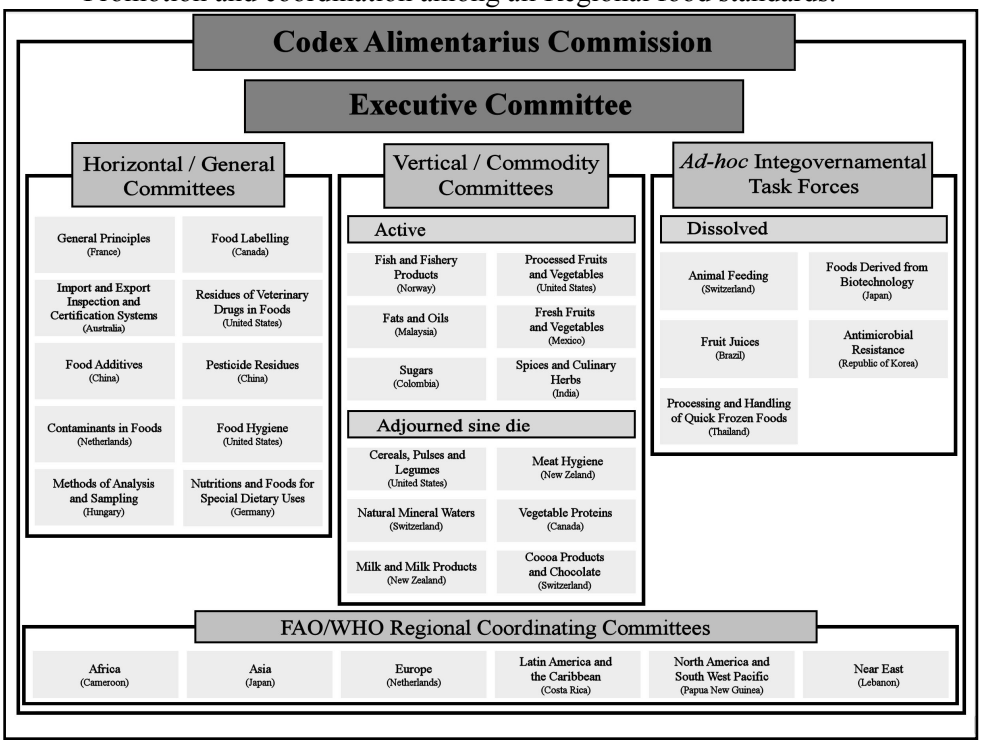


Figure 12. The *Codex Alimentarius* Subsidiary bodies.

2.18. THE CODEX ALIMENTARIUS – THE PROCEDURAL MANUAL

The *Codex Alimentarius* is the outcome of the Codex Alimentarius Commission; in fact the main purpose of the joint FAO/WHO is the publication of a set of Food standards, which are commonly called *Codex Alimentarius*. They are a set of recognized and adopted international food standards: General Principles, Guidelines, some Codes of Practice, individual maximum residue levels (MRLs) and recommendations which are published separately from the Codex standards and procedural manual**.**

Fundamental is the statement of the Procedural Manual concerning the first two Codex General Principles**:**

- Purpose of the *Codex Alimentarius*;
- Scope of the *Codex Alimentarius*.

The Purpose of the Codex Alimentarius

"The Codex Alimentarius is a collection of internationally adopted food standards and related texts presented in a uniform manner. These food standards and related texts aim at protecting consumers' health and ensuring fair practices in the food trade. The publication of the Codex Alimentarius is intended to guide and promote the elaboration and establishment of definitions and requirements for foods to assist in their harmonization and in doing so to facilitate international trade".

Scope of the Codex Alimentarius

"*The Codex Alimentarius includes standards for all the principle foods, whether processed, semi-processed or raw, for distribution to the consumer. Materials for further processing into foods should be included to the extent necessary to achieve the purposes of the Codex Alimentarius as defined. The Codex Alimentarius includes provisions in respect of food hygiene, food additives, residues of pesticides and veterinary drugs, contaminants, labeling and presentation, methods of analysis and sampling, and import and export inspection and certification".*

In this paper, updated regularly, are reported all the information regarding the *Codex alimentarius* procedures: Principles and concepts, elaboration of Codex Standards, Guidelines for subsidiary bodies and their analysis, Risk Analysis principles and finally external relations with other International Organizations.

2.19. CODEX COMMITTEE ON FISH AND FISHERY PRODUCTS (CCFFP)

According to the Codex Alimentarius statement, the mandate and the terms of reference of the Codex Committee on Fish And Fishery Products (CCFFP) are the following:

"*Elaborate worldwide standards for fresh, frozen (including quick frozen fish products) or otherwise processed fish, crustaceans and mollusks*".

The Codex Committee on Fish and Fishery products is one of the first level subsidiary bodies of the Codex Alimentarius and is part of the vertical / Commodity Committees. The current "Host Government" is Norway.

This committee is responsible for numerous standards related to the fisheries sector such as the post harvest and the quality of seafood. Numerous scientific publications are available on this subject (we report only a few):

- Code of Practice for Fish and Fishery Products (last version available 2013, amended);
- Model Certificate for Fish and Fishery Products (last version available 2004);
- Standard for Sturgeon Caviar (last version available 2010);
- Standard for Smoked Fish, Smoke-Flavored Fish and Smoke-Dried Fish (last version available 2013);
- Standard for Sardines and Sardine-Type Products (last version available 2013).

In relation to the purpose of this work, we will investigate only the last two versions of the Code of Practice for Fish and Fishery Products with a particular focus on the Commodity code of the Case study n.1, on the Eel Market and on the Case study 2 only for one Commodity Code.

Figure 13. Italian seafood Market in the early morning (Venice, 2011).

2.20. THE CODE OF PRACTICE FOR FISH AND FISHERY PRODUCTS

The Code of Practice is mainly concerned with Hygiene practices and indicates the basic requirements to guarantee the food safety in the chain production, process, handling, storage and food distribution. The basic text is the General Principles of Food Hygiene (2003). This paper overarches the important hazard analysis and the HACCP, their use in member countries as the references for regional

and their national regulations to guarantee Food Safety. The beneficiaries of these Codes are all the stakeholders involved in the application of the hygiene practices. This Code of Practice has been developed by the Codex Committee on Fish and Fishery Products.

According to FAO, the Code of Practice for Fish and Fishery Products is addressed to all those involved in the production, storage, handling sell, import export of fish and fishery products. The Code is currently under the development (at the moment the second edition is being printed), and is to be considered integral part of the *Codex Alimentarius***.**

The Code of Practice for Fish and Fishery Products is divided in many sections:

- Definitions;
- Prerequisite programme;
- General considerations for the handling of fresh fish, shellfish and other aquatic invertebrate;
- Hazard Analysis and Critical Control Point (HACCP) and Defect Action Point (DAP) analysis;
- Aquaculture production and Live and raw bivalve mollusks;
- Processing of fresh, frozen and minced fish;
- Processing of specific fish and shellfish products;
- Transportation and Retail;
- Additional information will be found in the Appendixes.

In section one is reported the purpose of the Code of Practice:

"This Code applies to the growing, harvesting, handling, production, processing, storage, transportation and retail of fish, shellfish and aquatic invertebrates and products thereof from marine and freshwater sources that are intended for human consumption"

The part of the basic definition was used to identify the commodity code of Case Study nr. 1 on the Eel Market, we have also used the definition given in the first version of the code.

Commodity Code 30266 (Eels, fresh or chilled, whole)

Commodity Code 30266 (Eels, fresh or chilled, whole) is defined as follows: "*products that have received no preserving treatment other than chilling. The chilling facility should be capable of maintaining the temperature of the stock between 0 and 4 °C*". In the 2012 version of the Code, the definition of chilling is stated as follows " *The process of cooling fish and shellfish to a temperature approaching that of melting ice*".

The chilled product must meet the requirements for preventing development of pathogens in foodstuffs for several days. This system is a discrete limiting factor against the proliferation of bacteria, preventing also enzyme activity. The available free water activity (a_W) value is decreased, and temperatures are maintained at a few Celsius degrees (°C) above zero, as lower temperatures would freeze the product. The fish must be healthy and chilled as soon as possible after being caught, entering a continuous, uninterrupted cold-chain process, which is a technique used to keep foodstuffs for short periods of time (Monticini, 2014).

As regards to Case study 2, the Nile Perch is marketed almost exclusively fresh / chilled or frozen fillets according to the **Commodity Code 030410** Fish fillet or meat, fresh or chilled, not liver, roe (fillet, fresh or chilled).

Commodity Code 30376 (Eels, frozen, whole)

The following is the definition of frozen fish, in accordance with FAO Code of practice for Fish and Fisheries Products (first edition): "*products subject to a freezing process sufficient to reduce the temperature of the whole products to a level low enough to preserve the inherent quality of the fish"*.

The facility should be capable of maintaining the temperature of the fish below -18°C. Frozen products are usually kept at a temperature of -10°C (-18 °C seafood). This long-term preservation process maintains the sanitary and an organoleptic characteristic of the foodstuff unchanged and delays the oxidation of fats. Bacteria cannot proliferate at such low temperature and at low a_w value. At -10°C the percentage of residue water is 18 percent, while at -18°C, it is equal to 14 percent with a_w of 0.84 – bacteria growth is inhibited to a great extent at a_w values of less than 0.90.

An increase in the length of preservation time results in an increase in bacteria destruction. The sensitivity of microorganisms to the freezing process therefore depends on various factors: the bacteria strain, the temperature at which the product is frozen, the efficiency and speed of the freezing process, chemical factors of the foodstuff and the health and wholesomeness of the fish stock (Monticini, 2014).

According to the second edition Code the definition of Frozen storage facility is the following*:* "*A facility that is capable of maintaining the temperature of fish at –18°C"*.

Commodity Code 30549 (Eels, smoked)

The definition of smoked fish, in accordance with FAO Code of Practice for Fish and Fisheries Products last edition is the following: "*a process of treating fish by exposing it to smoke from smoldering wood plant materials. This process is*

usually characterized by an integrated combination of salting, drying, heating and smoking steps in a smoking chamber".

Smoking is not exactly a method of preserving food, but rather a complementary method used with other foodstuffs preservation technologies. It is widely used to add flavor to foodstuffs, and involves leaving the product in smoke produced by burning various types of wood (also aromatized).

The smoking process modifies the organoleptic properties of the foodstuff, leaving the surface of the product dry. This type of procedure can have consequences at a toxic-health level, as the combustion produces polycyclic aromatics (IPA or PHA) with a lipophilic action, and therefore potentially oncogenic. The water activity value for smoked products is around 0.95 a_w (Monticini, 2014).

Commodity Code 30192 (Eels, live)

Definition in accordance with FAO Code of practice for Fish and Fisheries Products has not been finalized yet. The live product must be caught and stored, in order to be sent to markets or distribution centers as quickly as possible, without causing excessive stress for the fish. The product must be in a good state of health without injuries to the skin or the evident presence of ectoparasites. Eels are usually sold live, as they can live for a long time out of water (Monticini, 2014).

2.21. EUROPEAN LEGISLATION ON SUSTAINABLE AQUACULTURE AND FOOD SAFETY FOR FISH AND FISHERIES PRODUCTS

In order to examine Sustainable Aquaculture and its relation with Food Security and Food Safety from a global point of view, we will report a general outline of European Legislation, although its detailed description does not represent the object of this study.

The Hygiene Package deriving from EU Regulation 178/2002 is probably the most significant group of rules that imply the application of *Codex Alimentarius*, as they align with its core principles and guidelines thus formalizing its official status.

Hereby we report a brief description of the main European Laws on Sustainable Aquaculture and Fisheries and European Legislation on Food Security and Safety.

European Guidelines for sustainable aquaculture development

The following Strategic Guidelines and Regulations have been selected from the vast Legislation present on the European Commission's Aquaculture and Fisheries webpage. The ones we report are the most recent and significative ones for

the object of this work. The regulations are legally binding for the member countries of the European Union, whereas others Communications and Recommendations have only an informative and strategic purpose.
Being impossible to report every single regulation in detail, we could summarize their contents saying that they are all concerned with a sustainable development of all aquaculture and fisheries practices, and they all refer to the above illustrated international guidelines and regulations (e.g. Code of Conduct for Responsible Fisheries):

- ✓ **COMM/2013/229 Strategic Guidelines for the sustainable development of EU aquaculture,** Communication to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions.

- ✓ **Regulation (EU) No 304/2011** of the European Parliament and of the Council of 9 March 2011 amending Council Regulation (EC) No 708/2007 concerning use of "***alien and locally absent species in aquaculture*".**

- ✓ **Commission Regulation (EC) No 710/2009** of 5 August 2009 amending Regulation (EC) No 889/2008 laying down detailed rules for the implementation of Council Regulation (EC) No 834/2007, as regards laying down detailed rules on "***organic aquaculture animal and seaweed production*".**

- ✓ **COM/2002/0511 final** Communication from the Commission to the Council and the European Parliament: "***A strategy for the sustainable development of European aquaculture*".**

European Food Safety Legislation for Fisheries Products

At the basis of the European Legislation on Food Safety, there is Regulation (EC) 178/2002, which lays the European Safety core principles and procedures for all Food, including Fishery Products.

Following this most important founding act, a series of regulations have been issued in 2004. These specifically regulate each sector of animal food, including:

- Hygiene of foodstuff;

- Hygiene of food of animal origin;

- Official controls on products of animal origin intended for human consumption;

- Feed and food law, animal health and animal welfare rules.

All these regulations can be fully examined on Euro-Lex website, which is directly linked to Globefish webpage.

Hereby, we report the aim and scope of the regulations that are directly applicable by the member states.

- **Regulation (EC) 178/2002** of the European Parliament and of the Council of 28 January 2002, laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matter of food safety.
  The **Art. 1** affirm: "*This Regulation provides the basis for the assurance of a high level of protection of human health and consumers' interest in relation to food, taking into account in particular the diversity in the supply of food including traditional products, whilst ensuring the effective functioning of the internal marke*t" also it "establishes the European Food Safety Authority (EFSA).

- **Regulation (EC) 852/2004** of the European Parliament and the Council of 29 April 2004, on the hygiene of foodstuff.
  The **Art. 1** affirm: "This Regulation lays down general rules for food business operators on the hygiene of foodstuffs; also shall apply to all stages of production, processing and distribution of food and to exports, and without prejudice to more specific requirements relating to food hygiene".

- **Regulation (EC) 853/2004** of the European Parliament and of the Council of 29 April 2004, on the hygiene of food of animal origin.
  The **Art. 1** state: "*This Regulation lays down specific rules on the hygiene of food of animal origin for food business operators. These rules supplement those laid down and processed products of animal origin*", moreover "*this Regulation shall not apply to food containing both products of plant origin and processed products of animal origin. However, processed products of animal origin used to prepare such food shall be obtained and handled in accordance with the requirements of this Regulation*".

- **Regulation (EC) 854/2004** of the European Parliament and of the Council of 29 April 2004, laying down specific rules for the organization of official controls on products of animal origin intended for human consumption.

- **Regulation (EC) 882/2004** of the European Parliament and of the Council of 29 April 2004, on official controls performed to ensure the verification of compliance with feed and food law, animal health and animal welfare rules.
  The **Art. 1** state: "*This Regulation lays down general rules for the performance of official controls to verify compliance with rules aiming*", in particular, at:
  (a) Preventing, eliminating or reducing to acceptable levels risks to humans and animals, either directly or through the environment; and
  (b) Guaranteeing fair practices in feed and food trade and protecting consumer interests, including feed and food labeling and other forms of consumer information.
  This Regulation shall not apply to official controls for the verification of compliance with the rules on common market organizations of agricultural products.

BIBLIOGRAPHY

AA.VV, (?), Sustainable Development, including: Convention On Biological Diversity, Earth Summit 2002, Rio Declaration (…), Hephaestus Books, pp.1, 7, 21, 35-37, 41.

Bianchi G. *et al.* 2008, The Ecosystem approach to Fisheries, published by Food and Agriculture Organization of the Unites Nations, CABI Publishing, pp. 18, 22, 149, 185, 202, 205, 248-249.

Cataudella S. & Bronzi P. 2001**,** Acquacoltura responsabile, verso le produzioni acquatiche del terzo millennio, Unimar – Uniprom, Roma, pp. 632-655.

De Young C. *et al.* 2008, Human dimension of the ecosystem approach to fisheries, an overview of context concepts, tools and methods, FAO Fisheries and Technical Paper, 489, FAO, Rome, Italy, 2008, p. 25.

EC No. 852/2004. 2004, Regulation (EC) No. 852/2004 of the European Parliament and of the Council on the Hygiene of foodstuffs. Official Journal of the European Union L 139 of 30 April 2004.

Ederson, W. 1996, The Code of Conduct for Responsible Fisheries: an introduction, 11 International Journal of Marine and Coastal Law.

FAO & WHO, 2009, *Codex Alimentarius*, Code of Practice for Fish and fisheries products, 1st edition, Full text (English edition), World Health Organization and FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, Italy.

FAO & WHO, 2012, *Codex Alimentarius*, Code of Practice for Fish and fisheries products, 2nd edition, Full text (English edition), World Health Organization and FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, Italy.

FAO 2011, CODE of CONDUCT for RESPONSIBLE FISHERIES (CCRF), Full Text (English Edition), FOOD AND AGRICULTURE ORGANIZATION of THE UNITED NATIONS, Rome, Italy.

FAO, (?), Law and sustainable development since Rio, Legal trends in agriculture and natural resources management FAO Legislative Study 73, FAO Rome p. 169, 170.

FAO/WHO 2003, CODEX ALIMENTARIUS, THE GENERAL PRINCIPLES OF FOOD HYGIENE 4th edition, Secretariat of the Codex Alimentarius Commission joint FAO/WHO Food Standards Programme Food and Agriculture Organization of the United Nations Viale delle Terme di Caracalla 00153 Rome, Italy.

FAO/WHO 2014, CODEX ALIMENTARIUS COMMISSION, Procedural Manual, Twenty-second edition, Secretariat of the Codex Alimentarius Commission joint FAO/WHO Food Standards Programme Food and Agriculture Organization of the United Nations Viale delle Terme di Caracalla 00153 Rome, Italy.

Garcia S.M. ***et al*** 2003, The Ecosystem approach to fisheries, Issue, terminology, principles, institutional foundations, implementation and outlook, FAO Fisheries Technical paper 443, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, Italy pp. 5, 16-17.

Hempel L.C. 1998, Environmental Governance: The Global Challenge, Affiliated East West Press Ltd, New Delhi India.

HLPE Steering Committee Members & FAO 2014, Sustainable fisheries and aquaculture for food security and nutrition, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, Italy p. 76.

Jana ***et al.*** 2003, Sustainable Aquaculture, Global Perspective and Food products. Press Oxford UK pp. 307.

Lovatelli A. ***et al*****.,** 2004. Capture Based Aquaculture, Food Agriculture Organization ROME, p. 66.

Masson-Matthee D. M. 2007, The Codex Alimentarius Commission and Its Standard, T.M.C. Asser Press The Hague Netherlands pp. 1, 20, 31.

Melba G. Bondad-Reantaso ***et al***. 2009, Understanding and applying risk analysis in aquaculture. A Manual for decision makers. FAO Fisheries Technical Paper No. 519/1 Rome: Food and Agriculture Organization, p. 11-12.

Monticini P. 2010**,** "*The Ornamental Fish Trade, Products and Commerce of Ornamental Fish: technical, managerial and legislative aspects* "GRP Globefish Research Programme Vol. 102, FAO Food Agriculture Organization of the United Nations, GLOBEFISH, Products, Trade and Marketing Service and Aquaculture Policy and Economic Division (FIPM), pp. 80-81.

Monticini P. 2014, the Eel (*Anguilla* spp.): Production and trade according to Washington Convention Legislation, GRP Globefish Research Programme Vol. 114, FAO Food Agriculture Organization of the United Nations, GLOBEFISH, Products, Trade and Marketing Service and Aquaculture Policy and Economic Division (FIPM), pp. 23, 34,

OIE 2006, Manual of diagnostic test for aquatic animals, Fish Edition. Paris. The World Organization for Animal Health, OIE.

OIE 2008, Aquatic Animal Health *Code*, 11th edition Full Text (English Edition) Paris, The World Organization for Animal Health, OIE.

OIE, 2001, Risk analysis in aquatic animal health. Proceeding of an International Conference held in Paris, France 8-10 February 2000.

OIE, 2011, Proceeding OIE Global Conference on Aquatic Animal Health, Aquatic Animal Health Programmes: their benefits for global food security, Panama, 28-30 June 2011, Full Text (English Edition), OIE, Panama, pp. 103, 171.

Shawkat A. 2008, Sustainable development and Free Trade, an Institutional Approach, Routledge Press, London UK, pp. 38-46; 47-49, 78-82.

Tips C. Scott. 2007, *Codex Alimentarius*, A Global Food Imperialism, a compendium on articles on codex, Foundation for Health Research, California US.

United Nations 1992, Convention on Biological Diversity, (CBD), Full text (English Edition), Unites Nations.

United Nations 1992, United Nations Conference on Environment & Development Rio de Janeiro, Brazil, 3 to 14 June 1992, AGENDA 21 Full text (English Edition), United Nations Sustainable Development.

Valdimarsson G. *et al*., 2003, Responsible Fisheries in the Marine Ecosystem, Published by FOOD AND AGRICULTURE ORGANIZATION of THE UNITED NATIONS, Rome, Italy and CABI Publishing, p. 27-31, 394-395, 409-411.

VanderZwaag D.L & Chao G. 2012, Aquaculture Law and Policy, Towards principles access and operations, Routledge Advances in Maritime Research, p. 17, 428.

Welcomme R. L. 2001, Inland Fisheries, Ecology and Management, FAO by Blackwell Science, p. 160-163, 314-317.

3. STATISTICAL DATA

3.1. SUMMARY

The statistical data present in this work have been gathered from a few major databases. As regards Case Study 1, *Anguilla spp.*, Market Production and Trade, and Case Study 2, Nile Perch and lake Victoria: Invasion, Decline, Market Trends and Sustainability, our sources are:

- UNData, The United Nations Commodity Trade Statistic Data Base[47];
- FAO FishStatPlus[48];
- UN Comtrade, International Trade Statistics Database[49];
- EuroStat[50].

As regards to Case Study 3, By-Catch and Discards Sustainability in FAO Major Fishing Area 37, exact statistical data are currently unavailable, as all information on discards are based on range estimation. Therefore we will not provide Tables and Figures as in the previous Study Cases, but only projections of the trends.
Both statistical and provisional data of each Case Study will be reported at the in Chapter 4, whereas we will briefly describe our sources here below.

[47] http://data.un.org/Default.aspx, The United Nations Statistics Division (UNSD) of the Department of Economic and Social Affairs (DESA). Date accessed: July 9 2014.
[48] http://faostat.fao.org, by the Statistics Division of FAO. Date accessed: July 9 2014.
[49] http://comtrade.un.org/db/default.aspx, The United Nations Commodity Trade Statistics Database (UN Comtrade). Date accessed: July 9 2014.
[50] http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home/. Date accessed: July 9 2014

UNData: United Nations Commodity Trade Statistic Data Base

UNData contains over one million entries on the commercial exchange of the various Commodity Codes dating back to 1962.

Every year, more than 140 UN Member States provide statistical data to calculate the figures of international trade. Data are also updated at regular intervals. This can determine a retrospective update of data, especially for the last provided year.

The Commodity Codes report data about homogeneous product categories: fish, mollusks and aquatic invertebrates (Cod. 03); fresh or chilled eels (Commodity Code 30266), frozen eels (Commodity Code 30376), live eels (Commodity Code 30192). As for Case Study 2, there aren't any specific Commodity Code about Nile Perch, but only some generic information about the "Fish fillet or meat, fresh or chilled" (Commodity Code 30410).

FAO FishStat Plus

FAOSTAT is part of FAO's mission to improve statistical data collection and dissemination in order to foster development and fight global hunger and malnutrition.

Member States and regional areas have been involved in gathering and sharing data since 1961.

The FAO Fisheries and Aquaculture Department compiles fisheries and aquaculture statistical data using FishStat Plus as a part of FAOSTAT.

FishStat Plus statistical data have been used to present an overview of the Eel trend market at global level, including: Global production, Aquaculture production and Capture production (in tonnes).

Data on global Eel trade have been aggregated and processed for live eels, fresh or chilled eels, frozen eels, smoked eels, moreover FAO FishStat Plus does not use Commodity Codes. Data on Nile Perch are available in FAOSTAT as Capture Production among the World 70 By Principal Species in 2012 (for the period 2008 – 2012).

UNComtrade, International Trade Statistics Database

Data from United Nations Commodity Trade Statistics Database (UN ComTrade) were obtained from the major global importing and Exporting Countries in Value (USD) for the years 2008-2011.

Only Case study 1 has been investigated in the following Commodity Code: 030266 Eels (*Anguilla spp*. fresh or chilled), 030376 Eels (*Anguilla spp*. frozen), 030549 Eels

(*Anguilla spp*. Smoked - Other fish, including fillets, smocked – not only Eels) and030192 Live Eels (*Anguilla spp*.).

Eurostat

Eurostat provides statistical details on the European Member States and candidate countries, through various statistical publications.

This study extracted Eurostat data only on the Smoked Eel trade from the 2010 TRAFFIC Report on *Trade in Anguilla species* (Crook, 2010).

BIBLIOGRAPHY

FAO Fisheries Aquaculture Department, 2012, State of World Fisheries and Aquaculture 2012, FOOD AGRICULTURE ORGANIZATION Rome Italy, http://www.fao.org/3/a-i3720e.pdf, Date accessed September 11, 2014.

FAO Fisheries Aquaculture Department, 2014, State of World Fisheries and Aquaculture 2014, FOOD AGRICULTURE ORGANIZATION Rome Italy, http://www.fao.org/3/a-i3720e.pdf, Date accessed September 11, 2014.

FAO FISHSTAT Plus (2012), http://faostat.fao.org, by the Statistics Division of FAO. Date accessed: July 9 2014.

FAO, Globefish, 2014 GLOBEFISH, Products, Trade and Marketing Service and Aquaculture Policy and Economic Division http://www.globefish.org/market-reports.html, Date accessed September 11, 2014.

Josupeit E. 2006, The Market for Nile Perch, GRP Globefish Research Programme Vol. 84, FAO Food Agriculture Organization of the United Nations, GLOBEFISH, Products, Trade and Marketing Service and Aquaculture Policy and Economic Division (FIPM).

Monticini P. 2014, the Eel (*Anguilla* spp.): Production and trade according to Washington Convention Legislation, GRP Globefish Research Programme Vol. 114, FAO Food Agriculture Organization of the United Nations, GLOBEFISH, Products, Trade and Marketing Service and Aquaculture Policy and Economic Division (FIPM).

UNData, The United Nations Commodity Trade Statistic Data Base, 2014, http://data.un.org/Data.aspx?q=eel&d=ComTrade&f=_l1Code%3a4%3bcmdCode%3a030192, Date accessed September 11, 2014.

United Nations Commodity Trade Statistic Database (COMTRADE), 2014 http://comtrade.un.org/db/default.aspx, Date accessed September 11, 2014.

4. TECHNICAL ASPECTS: VERIFICATION OF SUSTAINABILITY NEEDS

After a description of the principles and concepts, followed the by the legislative approach of Sustainable Aquaculture and Fisheries, we chose our three Case Studies as representative examples of the unsustainable consequences of overexploitation, lack of past years' environmental control over fishing activities and gears.

All Case Studies concerns mainly the environmental pillar of sustainability, but each one also involves either the social more than the economic pillar or vice versa:

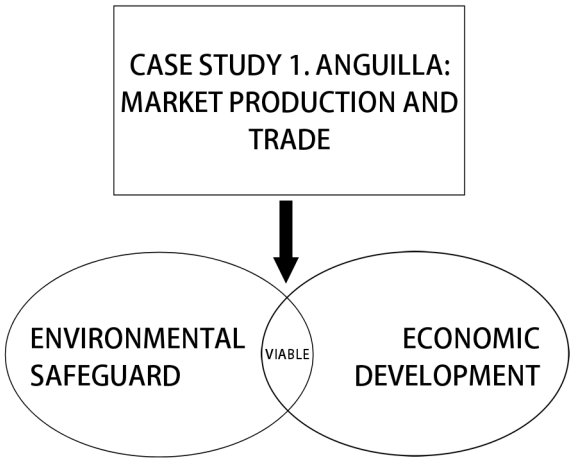


Figure 14. Case Study 1. Flow Chart

Anguilla's overexploitation and scarcity of wild stock has environmental implications that consequently affect the economic aspects of the market.

Nile Perch artificial introduction as alien species, combined with its uncontrolled proliferation, has produced irreversible environmental damage of flora and fauna of Lake Victoria. The rapid and, once again, uncontrolled economic growth that converted small-scale artisanal fisheries into large-scale industries capturing and processing fish for foreign markets, produced radical social changes that impoverished the local communities.

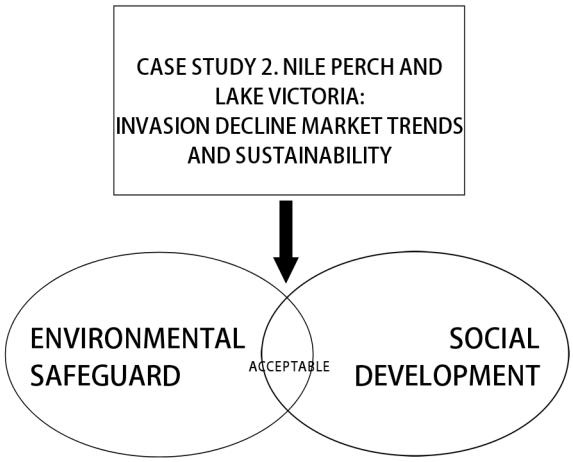


Figure 15. Case Study 2 Flow Chart

By-catch and Discards in FAO Fishing Area 37 is an important environmental issue, that concerns not only sensitive species (marine mammals, turtles, seabirds and sharks), but also all the fish species non suitable for the market that interact with both marketable and sensitive species. Unfortunately the lack of data on By-catch and Discards, does not allow of have a veritable picture of the present situation in this area.

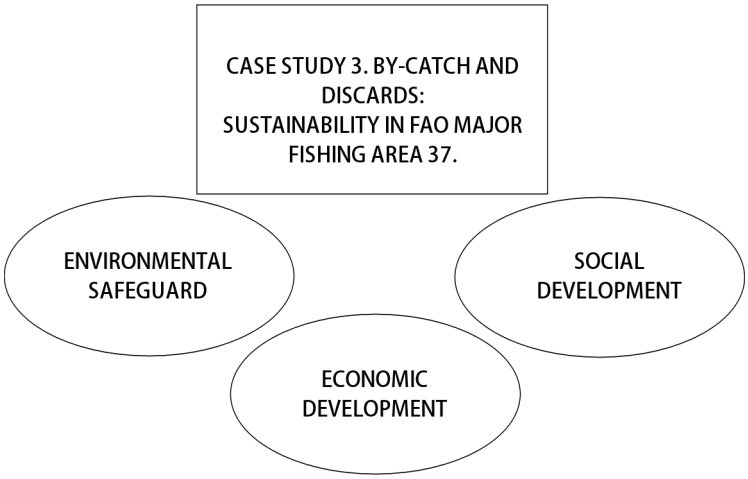


Figure 16. Case Study 3. Flow Chart

4.1. Case study n.1: *ANGUILLA spp.*: MARKET, PRODUCTION AND TRADE

This section is dedicated to the case study of Eel (*Anguilla spp.*), a species particularly sensible to climate changes and overfishing. The present work has already been published as a part of FAO Globefish Research Programme Report No. 114 during 2014.

The Genre Anguilla includes about 15 species and numerous sub-species diffused worldwide. All Eel species and sub-species feature a long life cycle and a low resilience, which makes them extremely vulnerable to external events, both natural and human induced ones. Due to the peculiarities of its physiology, half of its metamorphosis (from Elver to Silver Eel through migration in fresh water) is strongly conditioned by human impact, whereas the other half of the life cycle is more influenced by climate modifications (from Silver Eel to Glass Eel through the breeding phase).

Eel is currently exploited worldwide, but it is considered particularly valuable in some Asian countries (Japan, China, Taiwan Republic of China) and in Europe (France, Italy Spain and some Northern European countries). It is commercialized in various commodities: live, fresh or chilled, frozen and smoked.

Eel has been chosen as a Case Study in relation to Sustainability because of the outcomes of past indiscriminate exploitation, which has resulted in the drastic reduction of wild stock.

While the European eel appears to be the most endangered among the species as far as numbers are concerned, it is probably the most protected by an effective legal regulation, whereas the Japanese eel, whose numbers are not clearly defined, has not been yet included in protection programmes.

Through the illustration of Eel biological, technical, market production and trade, we will see how by protecting the fragile eel environment and allowing this species to complete their life cycle, we could effectively support the increase of wild stock.

4.2. THE SUMMARY

Eels have traditionally been caught, bred for trade and consumed in quite distant geographical areas: from Eastern Asian countries such as China and Korea where we find *Anguilla japonica*, to the Southern European countries such as Italy and France where, the European eel market represents a segment of economic relevance for fisheries and aquaculture.

As a first consideration, the report underlines that only a few of the approximately 15 species and subspecies are relevant from an economic point of view. These include the European eel (*Anguilla anguilla*) and the Japanese eel (*Anguilla japonica*), as well as the American eel (*Anguilla rostrata*), and the short-finned Eel (*Anguilla australis australis*). Among them, in particular, the European eel is subject to specific protection Programmes, which regulate the measures for wild eel stock and recovery. Its relatively long biological cycle, along with numerous pathologies, anthropic threats such as over-fishing, pollution and habitat modification, caused a drastic drop in the number of wild eels since 2009. These reasons brought to the implementation of an Eel Management Plan through the Council Regulation (EC) 338/1997, which carries out CITES within the European Union (EU) and the Council Regulation (EC) 1100/2007.

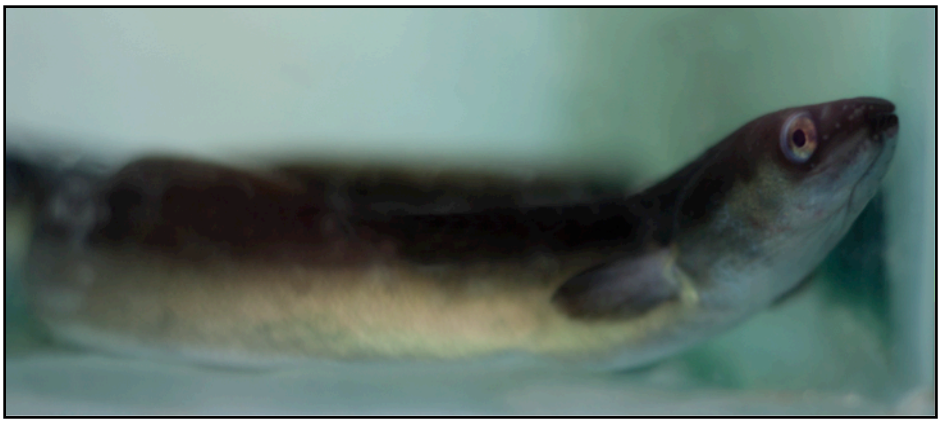


Figure 17. Live *Anguilla anguilla*, Linneo 1758,

Being the most endangered of the main species, we will focus on the European Eel. With numbers decreasing drastically, *Anguilla anguilla* is now featured on the list of protected species in Annex II of the Washington Convention on International Trade of Endangered Species (CITES). The report examines the statistical data of the last years, which represent a significant period for an economic evaluation and for assessing the availability and resilience of the various species, particularly of the European eel.

Unfortunately, the current international discourse on eel trade appears to be limited to recording a decline in the numbers, without offering a solution to the present situation. The development of the strong points of the trade while establishing new opportunities for the future (full lifecycle completed in captivity and mass indoor reproduction for commercial purposes) together with greater awareness at an international level, could help protect the species from an inexorable decline and reap the benefits from sustainable production for future generations.

For statistical reference, see data reported in Chapter 4.14 concerning the United Nations Commodity Trade Statistics Data Base (UNData), FAO FishStat Plus system, Eurostat 2010 data (Traffic report on the Trade in *Anguilla spp.,* Crook, 2010).

As for Commodity Code definitions, see Chapter 2 (section 20), *Codex Alimentarius* Section reporting the FAO Code of Practice for Fish and Fishery Products **(**first and second edition).

Case Study Structure:

- Biology;
- Technical aspects of Eel Farming;
- Regulations;
- Statistical Data;
- SWOT ANALYSIS;
- Conclusion.

4.3. BIOLOGY

CLASSIFICATION

Anguilla or eel: teleost species, *Anguilliformes* Order, easily recognizable by snake-shaped elongated body, with no ventral fins, small pectoral fins to allow swimming along river bottom, no pelvic cirdle, small cycloid-type scales, greenish brown or black color depending on their habitat, with lighter ventral part, and an average length around one meter.

Systematic (common in all species)

Class: Teleostomi, **Subclass**: Actinopterygii

Order: Anguilliformes, **Suborder:** Anguilloidei

Family: Anguillidae

Genus: *Anguilla*

Species: More than 15 species and 5 subspecies – depending on different reports and authors – with only a few species of economic interest.

Eels have some characteristics in common with all the other *Anguilliformes,* namely; cycloid scales, no spiny fins, long dorsal and anal fins, multi-stages development, demersal species, **catadromous.**

The remarkably long lifecycle, which can extend up to 20 years, can be divided in different stages:

- Egg (Pelagic);
- Larvae (*Leptocephalus);*
- Glass Eel;
- Elver;
- Yellow eel;

- Adult or Silver eel.

The first two phases take place in salt water and last around 2 years. The transition from salt to fresh water is carried during the glass eel stage. Here they become elvers, Yellow Eel and finally Silver Eel when they reach sexual maturity and therefore move back to salt water for breeding and start again their life cycle.

The longest is the Yellow Eel phase, lasting from 5 to 9 years, depending on species and habitat. Sexual maturity is reached between 3 to 9 years for male and 5 to 18 years for female. Adult eels measure up to one meter in length and a weigh of averagely 4–6 kg.

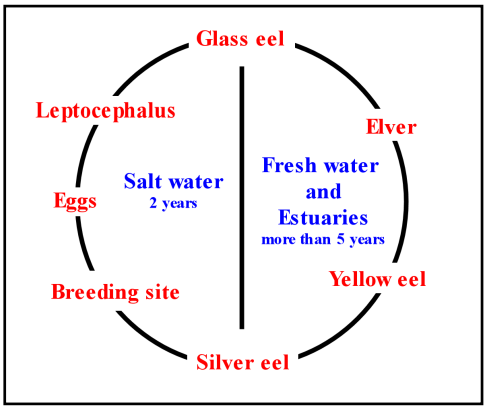


Figure 18. Eel life cycle

The specimens live around 20 years. Some of them spend most of their lives in freshwater before going back to the sea for breeding season, while others remain all their lives in saltwater. All eel specimens die after the breeding season.

Eel has a high commercial value and it is sold in markets all over the world – live, fresh or chilled, frozen, marinated, smoked, whole or in pieces.

Although it has already been bred successfully, progress is still needed in order to breed this species in a controlled environment for commercial purposes. Exclusively specimens are captured in the wild, during the morphological stage; when glass eels change into elver's eel, supply international fish markets.

Due to the biological and physiological characteristics and intensive exploitation, particularly in Easter Asia, the numbers of wild eel populations migrating upstream from river mouths to inland water has dropped considerably. In Italy, eels are one of the most important products for the fish market and the

reduction in the number of young adults in the larvae stage is mainly due to the human impact and morphological changes in freshwater courses.

Figure 19. Refrigerated *Anguilla anguilla*, (Linneo 1758),

According to the United Nations Food and Agriculture Organization (FAO) only four of the 15 eel species are to be considered relevant from a commercial point of view:

- European eel (*Anguilla anguilla*);
- American eel (*Anguilla rostrata*);
- Japanese eel (*Anguilla japonic*a);
- Short-finned eel (*Anguilla australis australis*).

4.4. TECHNICAL ASPECTS OF EEL FARMING

CAPTURE-BASE AQUACULTURE DEFINITION: is the practice of collecting seed material – from early life stages to adults from the wild, and its sub-sequent on-growing in captivity to marketable size, using aquaculture techniques **(Lovatelli *et al*., 2004**).

Biologically, eels have a high rate of survival in captivity, better tolerance to different water parameters, good growth rates and high productivity, thanks to well-tested rearing methods. Eel aquaculture is based solely on glass eels (elvers) caught in the wild and grown in captivity. The most widely used farming techniques worldwide are: extensive systems such as "*valliculture"* in Italy, intensive rearing in open recirculation systems and intensive rearing in closed systems.

- **Extensive rearing** is the traditional form of eel aquaculture in Europe. Fish are reared in large earth ponds, characterized by very low density stock, using no particular technical equipment or artificial oxygen, at a temperature ranging from 18 to 25 °C.
- **Intensive closed system** calls for artificial tanks of different sizes, each used for a specific purpose, (for different purposes: nursery, quarantine, growing or, treatment), and which and can be either different shapes (circular or

rectangular). Usually the tanks are made of PVC, fiberglass or concrete. The technical equipment is complete and controls all the water parameters and flow rate. An efficient recycling system can increase Eel biomass in the system with a relatively small quantity of water.

- **Intensive open system** is set in medium size earth ponds, with medium to low density of elvers biomass. This technique is similar to *valliculture*, but less available surface area and water is required.

4.5. WATER QUALITY CONTROL

The Eel species are robust fish and can endure high-density (intensive) farming. However, their high growth rate and survival requires close attention to physical and chemical parameters, such as:

- **Temperature** is the most important factor for eel production. In *valliculture*, 25 °C is an optimal temperature for the rearing system, although temperature can range from 18 to 26 °C. In a closed system, water must be heated, with optimal results, at to 24–26 °C, since eel growth ceases at 12 °C, while water temperature is not a problem during eel migration because, during the yellow stage, eel can tolerate a high temperature fluctuation.
- **Salinity** is an extremely variable parameter, ranging from freshwater to around 36 percent saltwater. Eels are euryhaline fish and adapt to different environmental conditions. Nevertheless elvers prefer freshwater or brackish water with a low saline concentration, while silver eels prefer high salinity.
- **Oxygen** concentration must be high. The level depends on the rearing methods – whether it is a saltwater or freshwater environment, open or closed system. Eels can survive in a low oxygen concentration, but the best concentration is a saturation of 40 to 50 percent. Oxygen consumption is affected by many behavior and environmental factors such as temperature, eel size and biomass, quantity of food, and health conditions. In an intensive closed system, oxygen level can easily be monitored and regulated by electronic instruments and aerators.
- **Nitrogen compounds** such as ammonia are highly toxic. However, *Anguilla spp.,* is tolerant to nitrites and to the less toxic nitrates. Free ammonia is extremely toxic and harmful, especially for gill epithelia in certain situations, such as water with high pH value and high fish density. A high concentration of ammonia in the gills makes the fish susceptible to secondary infections and to fungi, such as *Saprolegna spp.* Thus, recycling, biological filters and frequent water changes are often used to remove harmful substances from the water.
- **pH value** for eel farming is around 7–8 pH. The ideal situation is the availability of freshwater and saltwater to obtain an optimal mix and regulate

the pH value as required. Achieving this value is closely related to temperature, salinity and oxygen concentration.

4.6. FEEDING AND GROWTH RATE

Diet on eel farming depends on the type of rearing methods and eel size.

- **Natural food diets** call for frozen or fresh fish (whole or chopped) such as shrimp and sardines. This use is now decreasing.
- **Artificial diets** call for pellets and extruded food, which contain a high level of protein (40–50 percent) and a variable level of fats (7–20 percent).

Most intensive farming sites use moist paste or an artificial diet.

The composition of the food gives good results with a suitable level of crude proteins and fats.

The amount of food administered depends on many factors such as type of diet, body weight, biomass and number of daily meals.

Silver eels stop eating before migration with a consequent reduction in stomach size.

Eels reach commercial size after about two years of maintenance.

4.7. DISEASES AND DISORDERS

Many eel diseases are problematic in both wild and farm environments, either freshwater or saltwater. Commercial harvesting of live eels has contributed to an ever, increasing spread of various pathogens (not all endemic): parasites, bacteria, fungi and viruses. The growth of eel diseases can be due to incorrect fishing methods, bad management, environmental factors such as inadequate temperature, high salinity or high level of free ammonia and infectious biological agents.

Parasitic diseases

In nature, parasites are usually not pathogenic, but can become so due to overcrowding and high-density biomass, associated with low water exchange and in general to bad water conditions. The parasites most frequently found in eel farming are:

- Crustacean: *Argulus spp.*; *Learnea spp.*; *Ergasiluss spp;*
- Trematodes: *Gyrodactylusspp; Dactylogyrus spp.*;
- Nematodes: ***Anguillicola spp***. (Swim Bladder Disease);
- Fungi: *Saprolegna spp*; *Ichthyophonus spp.*;
- Protozoa: *Ichthyophthirius multifilis*; *Tricodina spp.*;

Bacterial and Viral diseases

The main infectious diseases, which occur in the presence of the bacterial agents, are:

- *Aeromonas spp.*–red fin disease;
- *Pseudomonas hydrophila*– fin rot disease;
- *Vibrio anguillarum*– red eel pest.

The three viral diseases known to affect eels are:

- *Cauliflower disease* (**EV2**) – an Orthomyoxovirus group, specific to *Anguilla anguilla;*
- *Viral kidney disease* (**EVE**) – an IPN-like Birnaviridae that occurs in European and Japanese eel with a high mortality rate, especially for juveniles;
- *Eel virus American* (**EVA**) – occurs in European and American eel, with the specimens showing signs of hemorrhages and necrosis in the muscle tissue.

However, the major diseases caused by primary and secondary bacterial infection as well as viral infections could be eradicated by maintaining good farming conditions such as: controlling stress factors, eliminating poor farming practices, following valid quarantine protocol, and having correct diagnosis and effective treatment.

4.8. REGULATIONS

The following EU regulations are currently in force:

- **Council Regulation (EC) 338/1997** on the Protection of Species of Wild Fauna and Flora;
- **Commission Regulation (EC) 407/2009** (annexes of Regulation 338/97 with the lists of the protected wild flora and fauna species), that repealing and replacing the (EC) 318/2008;
- **Commission Regulation (EC) 865/2006** (indicating the method of application of the Council Regulation (EC) 338/97;
- **Commission Regulation (EC) 100/2008** (with modifications and integrations of Regulation (EC) 865/2006);
- **Commission Regulation (EC) 359/2009** (suspending the introduction in the EU of some wild fauna and flora species and annulling Commission Regulation 1037/2007 and Regulation 811/2008.
- **Council Regulation (EC) 1100/2007** (establishing measures for the recovery of the stock of the European Eel on 18 September 2007.

4.9. COUNCIL REGULATION (EC) 1100/2007

The EU Member States adopted Council Regulation (EC) No. 1100/2007, establishing measures for the recovery of European eel stock *(Anguilla anguilla*, Linnaeus, 1758). This rule includes measures for the EU Member States concerning the restocking of European Eels in the wild, and in particular special requirements to increase the number of Eels measuring less than 12 cm in length through the implementation of an Eel Management Plan. This Regulation established some guidelines for the exploitation of the European Eel in Community and Trans-boundary water, in costal lagoons, in estuaries and rivers that flow into the Sea (art. 1).

All the member States shall identify the river basins (in their national territory) that can constitute natural habitats for the Eels (freshwater Eel in natural habitat). Also for each habitat, Member States need to prepare an **Eel Management Plan**. The main goal of the Eel Management Plan is to reduce anthropogenic mortalities to let around 40 percent of the Silver Eel biomass escape to the sea. Each document shall contain a detailed description of the present Eel population situation in the river basin. In the Eel Management Plan, each Member State shall also implement measures to decrease Eel losses caused by non-fishery factors, including hydroelectric turbines, dams and biological predators. An Eel Management Plan may contain the following measures: restocking of specimens, reducing commercial fishing activity (legal and illegal), certain measures related to aquaculture, and the reduction and or eradication of natural predators (art. 2). The reduction in catches may be replaced in whole or in part by immediate measures concerning other anthropogenic loss factors (art. 5). The measures concerning restocking Eels of less than 12 cm in size are in art. 7.

4.10. IUCN RED LIST OF THREATENED SPECIES

IUCN Red List of Threatened Species was established in 1948 and represents the most extensive database of information and data on the conservation status of plant and animal species around the world.
The **International Union for the Conservation of Nature and Natural Resources** (IUCN) is the agency in charge of compiling this annual list, which is based on precise criteria that allow assessing the rate of extinction risk of thousands of species and subspecies.

Some 30 percent of all fish species recently assessed by the World Conservation Union were designated to threatened categories.

Species are classified as follows:

- Extinct (**EX**);
- Extinct in the wild (**EW**);
- Critically endangered (**CR**);
- Endangered (**EN**);
- Vulnerable (**VU**);
- Lower risk/conservation dependent (**LR/CD**);
- Near threatened (**NT**);
- Least concern (**LC**);
- Data deficient (**DD**), when data are inconclusive.

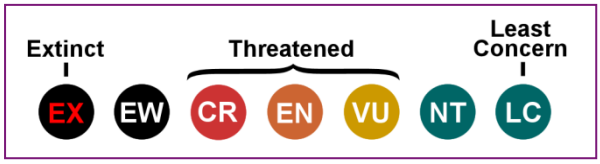


Figure 20. IUCN Red List scale

Freshwater fish are particularly vulnerable due to their habitat degradation, while marine fish (excluding anadromous species) appear to be less at risk (Akcakaya, 2004).
Although there are no documented cases of saltwater species become extinct as a result of human activities (Robert and Hawkins, 1999), over fishing has caused the local extirpation and some marine fish populations whose numbers have declined within a few generations (Reynolds *et al*., 2001).

The European eel*, Anguilla anguilla* has been included in the 2008 IUCN Red List of Threatened Species and classified **as critically endangered (CR)** because its small population has recently suffered a dramatic decline (around 90 percent of wild juvenile stock) due to human impact.

According the IUCN Red List, he other eel species suitable for commercial purposes are currently listed as a follow:

- *Anguilla japonica*, Endangered (En);
- *Anguilla rostrata*, Endangered (En);
- Anguilla australis, Near threatened (Nt).

4.11. UNITED STATES OF AMERICA LEGISLATIVE ASPECTS

Aquaculture Regulation in United Stated of America

In the USA aquaculture is regulated both at state and federal level.

The most important federal agencies are the Food and Drug Administration (FDA), the Department of Agriculture (USDA) and the Environmental Protection Agency (EPA). Each of these regulates a specific part of the aquaculture sector. FDA, in particular, covers all matters concerning food and safety regulations and drug approval.
Other federal agencies are also involved in aquaculture activities: Centre for Veterinary Medicine in the FDA, the Animal and Plants Health Inspection Service (APHIS) in the USDA and the US Fish and Wildlife Service (FWS) of the Department of the Interior.

The National Aquaculture Act of 1980 defines aquaculture at federal level. As far as the eel market is concerned, some laws have specific purposes. This study intends to analyze two of them: **the Lacey Act** and **the Endangered Species Act** (ESA).

Wildlife – Fish Regulation: The Lacey Act

The Lacey Act is a conservation law that prohibits the transportation of illegally captured or endangered animals across state borders. It was the first federal wildlife protection law, and it is still effective although severally revised and amended in 1969, 1981, 1989 and 2008.

The Lacey Act is administered by the U.S. Departments of the Interior, Commerce and Agriculture through their respective agencies and is mainly applied to prevent the importation or spread of potentially dangerous and non-native species, such as the Eel Swim Bladder Parasite *Anguillicola crassum*.

Prohibitions on activities: This Act makes it illegal to import, export, transport, sell, receive, acquire or purchase fish, wildlife or plants taken, possessed, transported or sold in violation of a federal law, treaty, regulation or Indian tribal law. It is also illegal for a person to import, export, transport, sell, receive, acquire or purchase in interstate or foreign commerce: fish or wildlife taken, possessed, transported or sold in violation of a state law, state regulation or foreign law; plants taken, possessed, transported or sold in violation of a state law or regulation. The Act also renders illegal to possess within the special maritime and territorial jurisdiction of the U.S.: fish or wildlife taken, possessed, transported or sold in violation of a state law, state regulation, foreign law or Indian tribal law; plants taken, possessed, transported or sold in violation of a state law or regulation.

The Lacey Act introduced some fundamental definitions:

Fish or wildlife which defines all wild animals dead or alive: wild mammals, birds, reptiles, amphibians, fish, mollusks, crustacean, arthropods, coelenterates or other invertebrates, including any part, product, egg or offspring.

Import includes: land on, bring into or introduce into any place subject to U.S. jurisdiction plants or any wild member of the plant kingdom, including roots, seeds and other parts indigenous to a state and either listed on an appendix to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), or under a state conservation status.

Federal laws related to wildlife control: Endangered Species Act (ESA)

The main agencies involved in wildlife protection are:

- U.S. Fish and Wildlife Service (FWS);
- U.S Environmental Protection Agency (EPA);
- Department of Agriculture, Animal and Plant Health Inspection Service (APHIS).

All the U.S agencies cooperate to reduce the potential damages produced by wildlife to agriculture and natural resources, minimize risks to human health and safety, and help protect endangered and threatened species.

The Endangered Species Act

Protects animal species that are listed by the federal government as "endangered" or "threatened". As a result, these species cannot be killed, harmed or collected except under some carefully described circumstances, and consequently, only with permits.

The most important sections are 7 and 9.

Section 7 applies not to private parties but to federal agencies and Section 9 makes it illegal for anyone to "take" a listed animal or significantly modify its habitat.

The process necessary for listing a species are contained in Section 4, which also defines an "endangered" species as a species that is "in danger of extinction" throughout all or a significant portion of its range. Congress refined these definitions into five criteria, any of which will justify listing: impacts to the species' habitat or range, overuse of the species by humans, disease or predators, inadequacy of existing legal protection, or "other natural or man-made factors" affecting the species' continued existence. When the agency determines that a species is endangered or threatened, it must designate the species' "critical habitat". The critical habitat includes the areas within the geographic area occupied by the species, whose physical or biological features are "essential to the conservation of the species" and which may require special management considerations or protection. Most states

have their own state endangered species laws and their lists of species based on state law, and there are many specific-state lists on endangered species.

The Fish and Wildlife Service (FWS)

Reviewed the status of the American eel (*Anguilla rostrata*) in 2007 and found that all available information about the eel population from Greenland south along the North America coast to Brazil in South America was somehow controversial. In fact although data showed a decline of the wild stocks of American eel in some areas, the overall population did not seem not in danger of extinction.
The FWS received another more comprehensive document in 2010 that brought to the extension of the protection of the *Anguilla rostrata* at a federal level.

At a regional level, the Government of Ontario, Canada, also banned commercial American eel fishing in Lake Ontario and the upper St. Lawrence River, whereas other eel fisheries activities (maybe *Anguilla anguilla*) continue in various parts of Canada.

This paper reports new and substantial environmental data, which indicate that changes in ocean conditions and the correlation of the climate change may be negatively impacting the *Anguilla rostrata* breeding rates.

4.12. JAPANESE LEGISLATION FOR *ANGUILLA SPP.* MARKET

There is no legal definition of aquaculture in Japan. However, its Fisheries Law defines fishery as "*an industry, which carries on gathering, taking or culturing of aquatic animals and plant*s".
The Japanese Government is a member of the following international organizations: World Trade Organization (WTO), Southeast Asian Fisheries Development Center (SEAFDEC), Convention on Biological Diversity (CBD) and Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Japanese law concerning the Eel market (mainly European and Japanese eels) defines different levels and involves different agencies. It depends on whether the issues are related to trade or are related to health regulations and the protection of endangered species. Japan's Ministry of Agriculture, Forestry and Fisheries (MAFF) and the Ministry of the Environment (MOE) is in charge of any other aspects (Animal Health Legislation, Welfare and Wildlife Legislation) are the two Government bodies involved.

Law on the Protection of Fisheries Resources (Act No. 78 of 1996)

This Law is primarily aimed at preventing the spread of fish disease to Japan

through the import of marine aquatics animals for use in aquaculture. The Ministry of Agriculture, Forestry and Fisheries (MAFF**),** has the necessary expertise regarding this law. The most interesting section of this law covers Import Quarantine of Aquatic Animals for different purpose (Article 13-2 – 13-5).
Other laws include the Fisheries Basic Act (Act No. 89 of 2001), and the Law of Maintenance of Sustainable Aquaculture Production (Act No. 51 of 1999).

Fisheries Basic Act (Act No 89 of 2001)

The aims of this Act are to control water quality, and protect and provide nursery grounds of aquatic animals, in order to conserve and improve the environment for fish. The Fisheries Basic Act provides measures for the conservation and management of living aquatic resources, research and study of living aquatic resources, and promotion of production of aquatic animals.

Law of Maintenance of Sustainable Aquaculture Production (Act No. 51 of 1999)

This Act aims to assure sustainable aquaculture production by taking measures to promote the improvement of aquaculture areas, and by taking measures to prevent the spread of certain infectious diseases in farm-raised aquatic organisms.
The MAFF establishes the basic policy for the sustainable aquaculture production. This Act also provides for: obligations of persons engaged in aquaculture to report specified diseases, restrictions on the movement of farm-raised aquatic animals, and compensation for losses caused by specified diseases.

Wildlife protection system

There are still many problems regarding wildlife trade in Japan, mainly because the present laws regulating wildlife trade are insufficient to curb illegal trade and do not provide sufficient deterrents, even if many laws have been revised. Law No. 75 of 1992 remains defective and ineffective (www.panda.org).

To protect wildlife and preserve endangered species, it is important to protect habitat, regulate hunting, prevent illegal killing and implement any other measures necessary. The wildlife protection system of Japan preserves wildlife by enforcing the Wildlife Protection and Hunting Law and the Law for the Conservation of Endangered Species of Wild Flora and Fauna.

Law for the Conservation of Endangered Species of Wild Fauna and Flora (LCES) in Japan (1992, Law No 75)

Japan became a member of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1980. In Japan, the

Ministry of International Trade and Industry is the Management Authority, while the Environment Agency and the Ministry for Agriculture, Forestry and Fisheries (MAFF) are the Scientific Authorities. The Japanese Government applies the Customs Law and the Foreign Exchange and Foreign Trade Control Law for border control relating to CITES. Japan also controls the transfer of CITES Appendix I specimens within the country under the Law for the Conservation of Endangered Species of Wild Fauna and Flora (1992, Law n. 75).

Objectives. The Law for the Conservation of Endangered Species of Wild Fauna and Flora recognizes the importance of wild fauna and flora as essential to life. Its objectives are to ensure the conservation of endangered species of wild fauna and flora and as a result contribute to the conservation of natural surroundings for present and future generations.

Definitions. "National endangered species" (NES) refers only to the endangered species that are native to Japan, while "international endangered species" (IES) are those species listed in Appendix I of CITES or species listed as protected species in any of the bilateral migratory bird agreements/conventions with the United States of America, Australia, China or the Russian Federation. At the moment, Japanese eel (*Anguilla japonica*) or other Indo-Pacific eel species are not included in this list.

The National Guidelines for Conservation of Endangered Species.

Adopted by the Japanese Government, the National Guidelines for the Conservation of Endangered Species include the fundamental concept of and basic methodology for protection of organisms, protection and rehabilitation of natural habitats, and maintenance of viable population for the conservation of endangered species.

Prohibition on Acquisition and Transfer of Endangered Species.

Hunting, taking, killing or injuring any living NES specimens is prohibited unless the Director-General of the Environment Agency has granted a permit. The transfer of NES or IES organisms, whether dead or alive, for commercial or non-commercial purposes, and including whole organisms, parts or derivatives, is forbidden except in the following cases: a) when permission to transfer for specific purposes has been granted by the Director-General of the Environment Agency; b) if the NES is exempt from the provisions of the law; c) if the specific IES parts or products (manufactured in Japan) are exempt from the provision of the law; and d) if the IES organisms have been designated or when specific materials have been previously registered.

Regulations on Transfer of IES Parts

Parties that intend to transfer certain IES parts (non-processed) within the country must first register these at the Japan Wildlife Research Centre. The IES parts can be registered if a) they have been produced from captive-bred animals or artificially propagated plants or b) they were obtained before the CITES measures came into force. If the IES parts have not been registered in this manner, the Director-General of the Environment Agency must issue permission to transfer the IES parts for specific purposes. Registered entities may issue management cards to indicate the legality of the parts they handle. Furthermore, entities engaged in manufacturing final products made of specified materials with properly filed management cards may place on each product a mark issued by the Director-General of the Agency, relevant ministers, or designated public organizations.

4.13. OTHER INDO-PACIFIC LEGISLATION ON EEL (AUSTRALIA AND NEW ZEALAND)

Australia: according to Queensland authorities that have managed the eel fishery since 1990, freshwater eels are the only eel species that may be taken for trade in Queensland freshwaters. The targets are two Indo-Pacific eel species:

- Long-finned eel (*Anguilla reinhardtii*);
- Short-finned eel (*Anguilla australis australis*).

There is a minimum size limit of 30 cm for each adult specimen, and juvenile eels may be sold to authorized aquaculture enterprises for growing only. Exporting juvenile eels is not permitted. Adult eel catch is exported as live product to Southeast Asia – mainly to China and Taiwan Republic of China (almost certainly Long-fin eels, *Anguilla reinhardtii*).

The Queensland commercial eel fishery is operated in accordance with the Fisheries Act, 1994 and the Fisheries Regulation 2008.

New Zealand: New Zealand's freshwater environment supports a number of species that are used and valued in different ways. For this reason, the Ministry of Fisheries has developed a National Fisheries Plan (NFP) for Freshwater.

All native freshwater eel species (*Anguilla dieffenbachiii* and *Anguilla australis*) are under the **Quota Management System**, which establishes a catch limit for certain fish species.

Short-finned eel has been recently successfully spawned in captivity in New

Zealand. At the moment this has only a scientific relevance and not a commercial one (Romanowski, 2007).

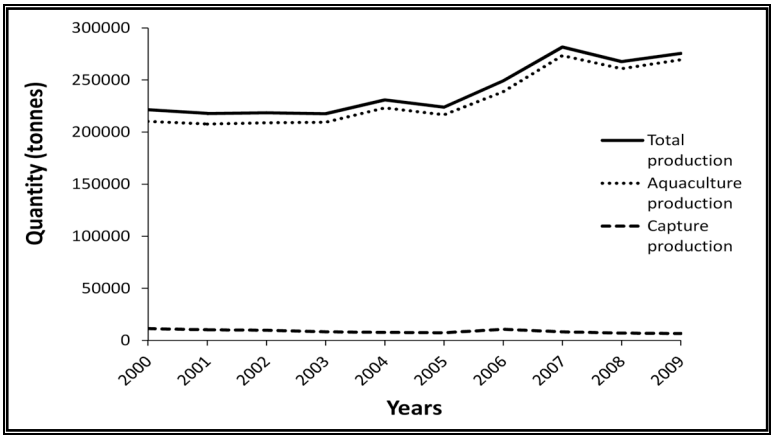
The Fisheries Act of 1996 is the relevant legislation in force and the NFP role includes the stock and fishing activities that are managed under this Act. The primary fisheries are for two freshwater eel species: short-fin eel (*Anguilla australis*) and long-fin eel (*Anguilla dieffenbachii dieffenbachii*). The Australasian long-fin (*Anguilla reinhardtii)* is relatively uncommon and not particularly popular in Australia, but is exported in Asia where it is highly requested.

4.14. STATISTICAL DATA: *ANGUILLA spp.*: MARKET, PRODUCTION AND TRADE.

The statistical data contained in the following paragraph have been selected among the data supplied by Globefish Research Programme, Vol. 114, which gathered the information from FAO FISHSTAT Plus, United Nations Commodity Trade Statistic Database (COMTRADE), EUROSTAT and the United Nations Statistic Division, Commodity Trade Statistics (UNdata).
The first part concerns the amount (in tonnes) of Eel Global, Aquaculture and Capture production, whereas the second part illustrates the various Commodity Codes that regulate Eel commercialization and trade (Fresh or Chilled, Frozen, Live and Smoked).
As far as amount of Production, Graph 1 shows how the largest part is provided by Aquaculture, whereas Capture has a marginal role. China represents the world's major player in Aquaculture production and consumption (see Graph 7).
As regards the import and export data, we experience a negative trend started around 2000. In those years, the abrupt decrease of European Eel wild stock strongly influence the trade and induced the introduction of *Anguilla anguilla* in the Annex II of Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES) in 2009.

EEL Global Production

Graph 1. Eel Global, Aquaculture and Capture Production



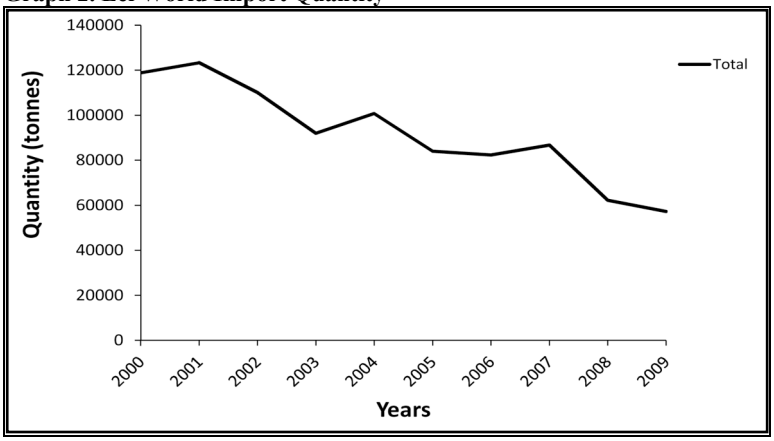
Source: FAO FISHSTAT Plus (2012).

Table 1. Global Aquaculture and Capture Production

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total production	221 452	217 875	218 583	217 701	230 901	223 981	249 121	281 569	267 709	275 557
Aquaculture production	210 228	207 708	208 897	209 470	223 238	216 616	238 697	273 449	260 835	269 397
Capture production	11 224	10 167	9 692	8 235	7 676	7 375	10 616	8 279	6 899	6 679

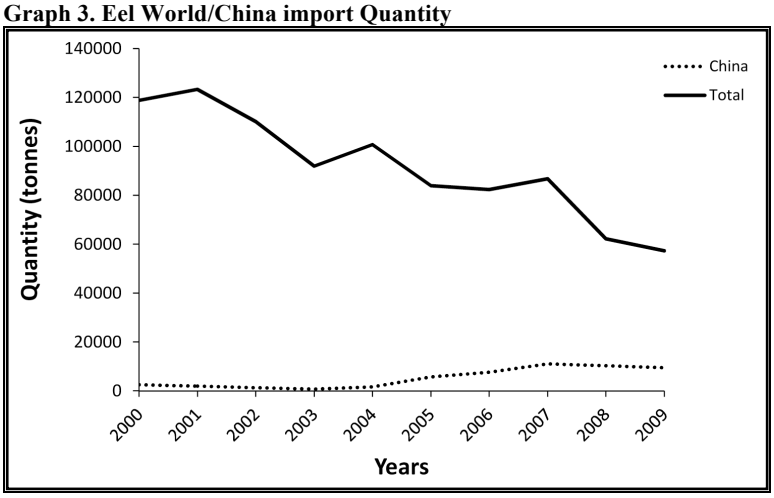
Source: FAO FISHSTAT Plus (2012).

Graph 2. Eel World Import Quantity



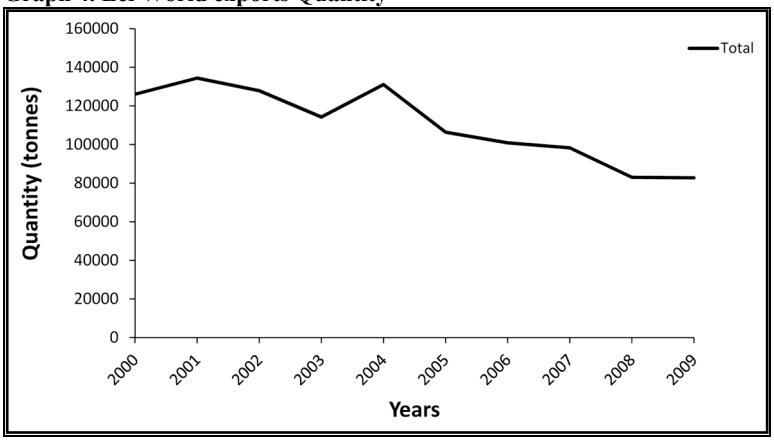
Source: FAO FISHSTAT Plus (2012).

Graph 3. Eel World/China import Quantity



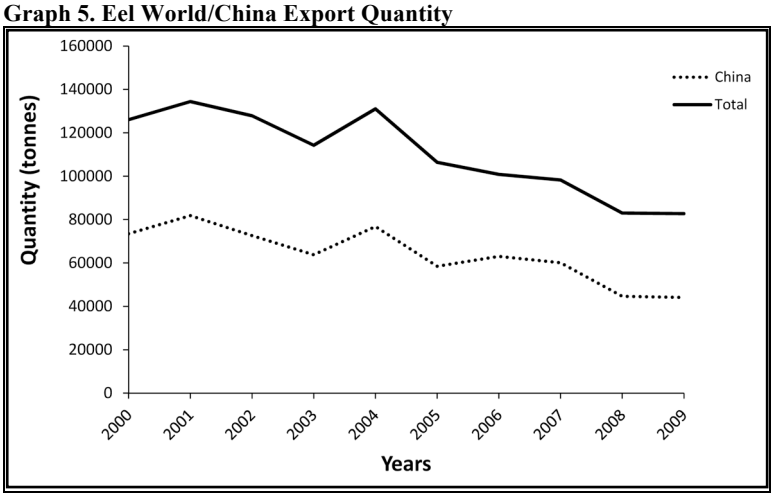
Source: FAO FISHSTAT Plus (2012).

Graph 4. Eel World exports Quantity



Source: FAO FISHSTAT Plus (2012).

Graph 5. Eel World/China Export Quantity



Source: FAO FISHSTAT Plus (2012).

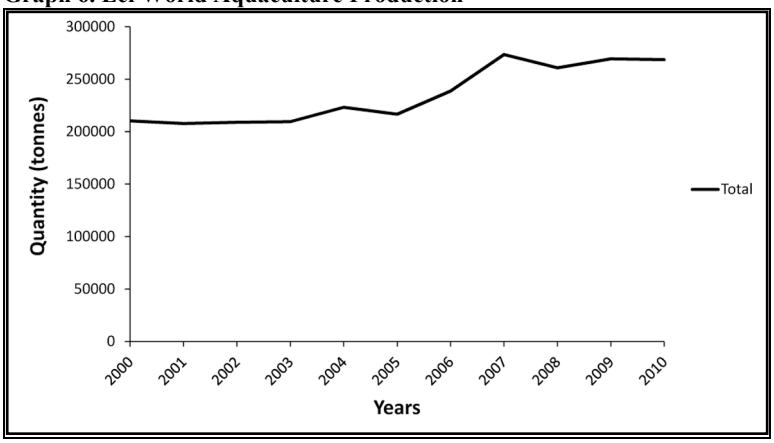
Table 2. Eel World global production by Species group

Species group		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
River eels	Quantity tonnes	210 303	209 823	209 963	223 672	217 185	238 831	273 479	265 114	275 174	271 536
	Value ('000 USD)	800 372	773 281	690 782	740 090	969 803	1 044 383	1 270 489	1 324 802	1 395 645	1 526 197

Source: FAO FISHSTAT Plus (2012).

EEL Aquaculture Production

Graph 6. Eel World Aquaculture Production



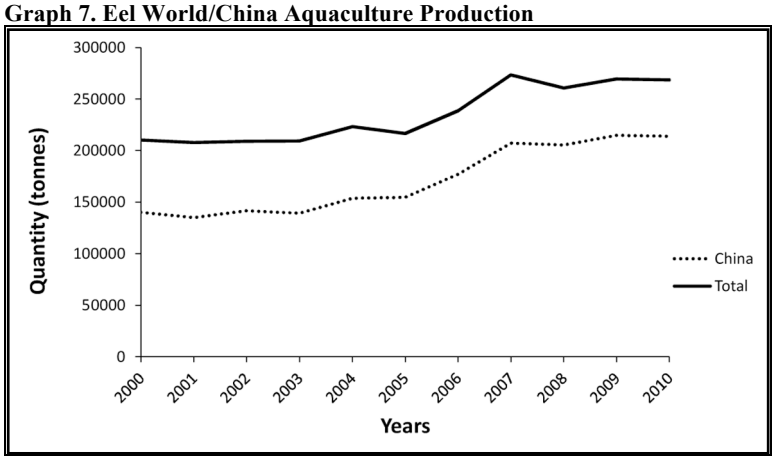
Source: FAO FISHSTAT Plus (2012).

Table 3. World Aquaculture Production By species group

Species group		2002	2003	2004	2005	2006	2007	2008	2009	2010
Anguilla Japonica	Quantity tonnes	200 732	200 298	214 053	208 254	229 506	264 952	253 795	262 729	261 617
	Value ('000 USD)	718 240	619 366	649 018	879 906	940 326	1 170 440	1 242 023	1 320 056	1 441 566

Source: FAO FISHSTAT Plus (2012).

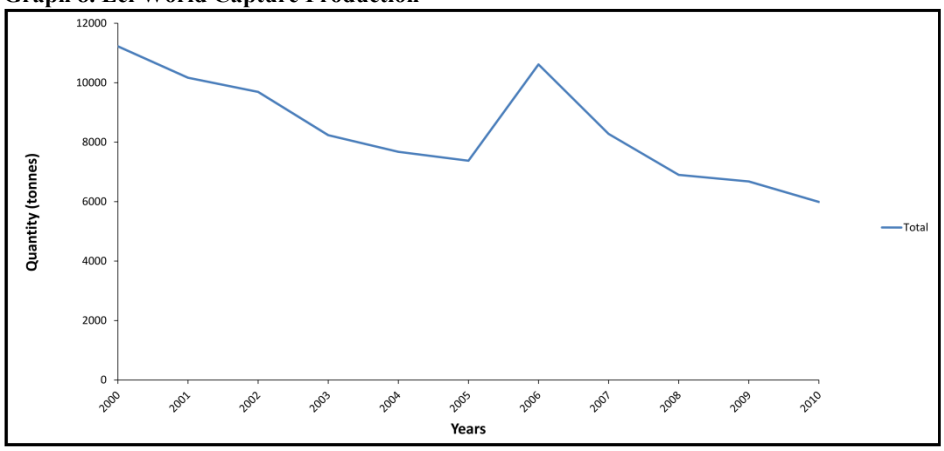
Graph 7. Eel World/China Aquaculture Production



Source: FAO FISHSTAT Plus (2012).

Eel Capture Production

Graph 8. Eel World Capture Production



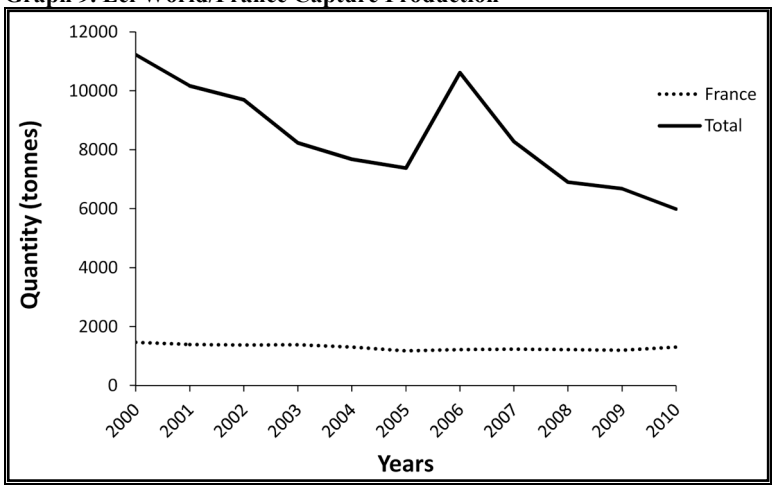
Source: FAO FISHSTAT Plus (2012).

Table 4. World capture production (tonnes)

Species group	2004	2005	2006	2007	2008	2009	2010
River eels	11 791	9 578	13 643	10 917	8 845	8 938	8 440

Source: FAO FISHSTAT Plus (2012).

Graph 9. Eel World/France Capture Production



Source: FAO FISHSTAT Plus (2012).

4.15. EEL COMMODITY CODE 30266 (EELS, FRESH OR CHILLED, WHOLE)

Table 5. 030266 Eels (Anguilla spp. fresh or chilled) – International export of Fishery Commodities by FAO

Year	2007	2008	2009
Quantity (tonnes)	3 211	3 547	5 233
Value ('000 USD)	25 711	27 509	28 630

Source: FAO FISHSTAT Plus (2012).

Data from United Nations Commodity Trade Statistics Database (UN ComTrade) was obtained from the major global importers with the value of imports and exports for the four years: 2008 to 2011.

Table 6. 030266 Eels (Anguilla spp. fresh or chilled) Major Importer Countries (30266–COMTRADE)

Country	Value (USD)
Germany	8 729 000
Italy	6 256 000
Spain	4 824 000
United Kingdom	3 884 000
China, Hong Kong SAR	1 968 000
Other Reporters	13 206 000
Total	38 869 000

Source: United Nations Commodity Trade Statistic Database (COMTRADE).

Table 7. Eels (Anguilla spp. fresh or chilled) Major Exporters Countries (30266 –COMTRADE)

Country	Value (USD)
Indonesia	39 538 000
Denmark	17 789 000
Sweden	4 501 000
Netherlands	3 344 000
France	3 264 000
Other Reporters	12 693 000
Total	81 129 000

Source: United Nations Commodity Trade Statistic Database (COMTRADE).

4.16. EEL COMMODITY CODE 30376 (EELS: FROZEN, WHOLE)

Table 8. 030376 Eels (Anguilla spp. frozen) - International export of Fishery Commodities by FAO

Year	2007	2008	2009
Quantity (tonnes)	11 239	10 730	10 940
Value ('000 USD)	46 854	39 210	39 923

Source: FAO FISHSTAT Plus (2012).

Data from United Nations Commodity Trade Statistics Database (UN ComTrade) was obtained from the major global importers with the value of imports and exports for the four years: 2008 to 2011.

Table 9. 030376 Eels (Anguilla spp. frozen) Major Importer countries (030376 – COMTRADE)

Country	Value (USD)
China	31 381 000
USA	31 155 000
Poland	30 387 000
Germany	26 905 000
China, Hong Kong SAR	21 256 000
Other Reporters	82 495 000
Total	223 581 000

Source: United Nations Commodity Trade Statistic Database (COMTRADE).

Table 10. 030376 Eels (Anguilla spp. frozen) Major Exporter countries (030376 – COMTRADE)

Country	Value (USD)
China	65 108 000
Canada	16 088 000
Denmark	15 160 000
USA	14 044 000
India	11 234 000
Other Reporters	55 631 000
Total	177 267 000

Source: United Nations Commodity Trade Statistic Database (COMTRADE).

4.17. EEL COMMODITY CODE 30549 (EELS, SMOKED)

Table 11. 030549 Eels (Anguilla spp. Smoked) - International exports of fishery commodities by FAO

Year	2007	2008	2009
Quantity (tonnes)	277	335	326
Value (‘000 USD)	7 902	7 784	7 281

Source: FAO FISHSTAT Plus (2012).

Table 12. 030549 Eels (Anguilla spp. Smoked) SMOKED EELS WITHIN THE EU MEMBER STATES

Country or Area	Year	Comm. Code	Commodity	Trade ('000 Euro)	Weight (kg)
EU-27	2001	030549	Eels, smoked	5 600	553 800
EU-27	2002	030549	Eels, smoked	8 200	726 500
EU-27	2003	030549	Eels, smoked	8 000	745 400
EU-27	2004	030549	Eels, smoked	9 700	644 600
EU-27	2005	030549	Eels, smoked	9 600	530 500
EU-27	2006	030549	Eels, smoked	7 500	406 300
EU-27	2007	030549	Eels, smoked	5 600	263 700
EU-27	2008	030549	Eels, smoked	5 200	324 600

Source: EUROSTAT (2010).

Data from United Nations Commodity Trade Statistics Database (UN ComTrade) was obtained from the major global importers with the value of imports and exports for the four years: 2008 to 2011. (Other fish, including fillets, smocked – not only Eels):

Table 13. 030549 Eels (Anguilla spp. Smoked) Major Importer countries (030549 – COMTRADE)

Country	Value (USD)
Germany	410 235 000
Japan	199 047 000
USA	170 065 000
Belgium	82 241 000
Italy	78 255 000
Other Reporters	474 566 000
Total	1 414 413 000

Source: United Nations Commodity Trade Statistic Database (COMTRADE).

Table 14. 030549 Eels (Anguilla spp. Smoked) Major exporters countries (030549 – COMTRADE)

Country	Value (USD)
Denmark	289 806 000
Poland	220 854 000
Chile	168 721 000
Turkey	109 095 000
Thailand	76 628 000
Other Reporters	547 950 000
Total	1 413 056 000

Source: United Nations Commodity Trade Statistic Database (COMTRADE).

4.18. EEL COMMODITY CODE 30192 (EELS, LIVE)

Table 15. 030192 Eels (Anguilla spp. Live) - International export of Fishery Commodities by FAO

Year	2007	2008	2009
Quantity (tonnes)	32 133	37 004	32 692
Value ('000 USD)	379 855	454 009	307 677

Source: FAO FISHSTAT Plus (2012).

Data from United Nations Commodity Trade Statistics Database (UN ComTrade) was obtained from the major global importers with the value of imports and exports for the four years: 2008 to 2011.

Table 16. 030192 Eels (Anguilla spp. Live) Major Importer countries (030192 – COMTRADE)

Country	Value (USD)
Japan	1 367 852 000
Rep. of Korea	257 619 000
China, Hong Kong SAR	95 383 000
Netherland	70 251 000
Germany	54 177 000
Other Reporters	177 358 000
Total	2 022 644 000

Source: United Nations Commodity Trade Statistic Database (COMTRADE).

Table 17. 030192 Eels (Anguilla spp. Live) Major exporters countries (030192 – COMTRADE)

Country	Value (USD)
China	593 784 000
Other Asian countries	344 811 000
France	104 174 000
Denmark	67 441 000
Netherlands	53 993 000
Other Reporters	299 113 000
Total	1 463 319 000

Source: United Nations Commodity Trade Statistic Database (COMTRADE).

Table 18. 030192 Eels (Anguilla spp. Live) Import China (030192 – UNdata)

Country or Area	Year	Comm. Code	Commodity	Trade (USD)	Weight (kg)
China import	2001	30192	Eels, live	5 478 214	73 931
China import	2002	30192	Eels, live	10 506 517	112 557
China import	2003	30192	Eels, live	5 373 071	64 191
China import	2004	30192	Eels, live	5 062 546	155 294
China import	2005	30192	Eels, live	7 314 737	226 275
China import	2006	30192	Eels, live	6 369 152	249 799
China import	2007	30192	Eels, live	7 529 198	252 139
China import	2008	30192	Eels, live	6 563 631	229 052
China import	2009	30192	Eels, live	2 319 766	218 834
China import	2010	30192	Eels, live	4 190 971	256 220

Source: UNdata, United Nations Statistic Division, Commodity Trade Statistics Database.

4.19. SWOT ANALYSIS TOOL ON THE EEL MARKET

We decided to use this tool to explore the eel situation, under all aspects other than biology, resilience, human impact, environment and the future concerning the sustainability of the international market.

- ***Strengths***: strong adaptability and tolerance to different water parameters, adaptable to artificial diet, high rate of survival in captivity, good growth rate;
- ***Weaknesses***: only few species have commercial interest, particularly vulnerable due to their very long life cycle, susceptibility to many diseases and high farming temperature. Significant differences in the growth rates of specimens, high cost of the artificial food, cases of cannibalism among specimens, escapes from farm;
- ***Opportunities***: potential new controlled reproductive technologies, life cycle is not yet fully investigated, if regulated at international level the trade becomes sustainable, international legislation;
- ***Threats*****:** essential food for many natural predators, trade in eels provide a source of income for people mainly in Asian and European countries, over fishing, pollution, natural mortality, modified natural habitats due to human impacts, natural parasites, impact of invasive species, illegal trade, poaching.

SWOT MATRIX

INTERNAL			
Strengths	• Strong adaptability and tolerance to different water parameters; • Easy to keep; • Adaptable to artificial diet; • High rate of survival in captivity; • Good growth rate; • Highly productive and well-tested rearing methods.	• Only few species of commercial interest; • Particularly vulnerable due to their very long life cycle; • Susceptible to many diseases; • High farming temperature; • Significant differences in the growth rates between specimens; • High cost of artificial food; • Cases of cannibalism among specimens; • Escapes from farm.	Weaknesses

EXTERNAL			
Opportunities	• Potential new reproductive controlled technologies; • Lifecycle is not yet fully investigated; • If regulated at international level, the trade becomes sustainable; • International legislation.	• Essential food for many predators; • Eel trade provides a source of income for people, mainly in Asian and European countries; • Over fishing; • Pollution, natural mortality; • Modified natural habitats due to human impacts; • Parasites; • Impact of invasive species; • Illegal trade; • Poaching; • Climate change.	Threats

SWOT ANALISYS SUMMARY

From an analysis of the SWOT matrix, it is clear that at present, the *threats* due to the external pressure are very important. The increased human activities, and the increasing demand for the international market are the causes of the dramatic decline of wild population of Japanese as well as European eels.

At the moment, the international legislation seems unable to reverse the negative trend. Law currently regulates only European eel.

Only new breeding techniques (without use of wild stock), and a greater compliance and enforcement against illegal trade, such as through an international agreement, can resolve this situation.

Developed by Pierluigi Monticini

4.20. CONCLUSION

If we analyze the case of Eel in relation to the basic principles of sustainability, we could affirm that the pillars involved are mainly two: environmental and economical. Eel is economically relevant, but it is not numbered among the most captured and traded fish species. Therefore, from a social point of view, only few communities base their economy exclusively on eel management, and if they do, it is only during a limited fishing season.
The environmental sustainability can be divided in two fundamental aspects:

- Anthropic impact;
- Climate change.

Both aspects remarkably affected the global reproduction and diffusion of this species (despite the large number of classified eels, only a few are commercially relevant).

Eel's long life cycle depending on the environmental conditions of both marine and freshwater biotopes, make this species easily endangered by human activity (dams, modifications of river basin, pollution, overfishing, introduction of alien species, etc.) or changes of water environmental parameters (temperature, currents, food availability, pH modification, etc.). The mix of anthropic and climate potential modifications constitute themselves substantial limiting factors to eel diffusion, that made necessary the implementation of protection measures. At the moment, European Eel has been included in Annex II of CITES, whereas the rest of protection measures are applied at regional or national levels, such as the previously mentioned US legislation on American Eel (*Anguilla rostrata*) and the institution of fishing Quota Management System by the New Zealand Government for their tropical Eel species.

Unfortunately, not all eel species are protected by national or international legislation. This has created an imbalance at international level. While some species, like European and American, are subject to restrictions, others are completely ignored from legislation and protection point of view (Japanese Eel).

Consequently, important economic advantages and disadvantages arose and will arise for those who are, or aren't, subject to legal bindings.

A potential solution of environmental and economic imbalances would be the international protection of all Eel species, not only those economically relevant, in order to safeguard species from extinction and obtain minor, but long-term economic benefit.

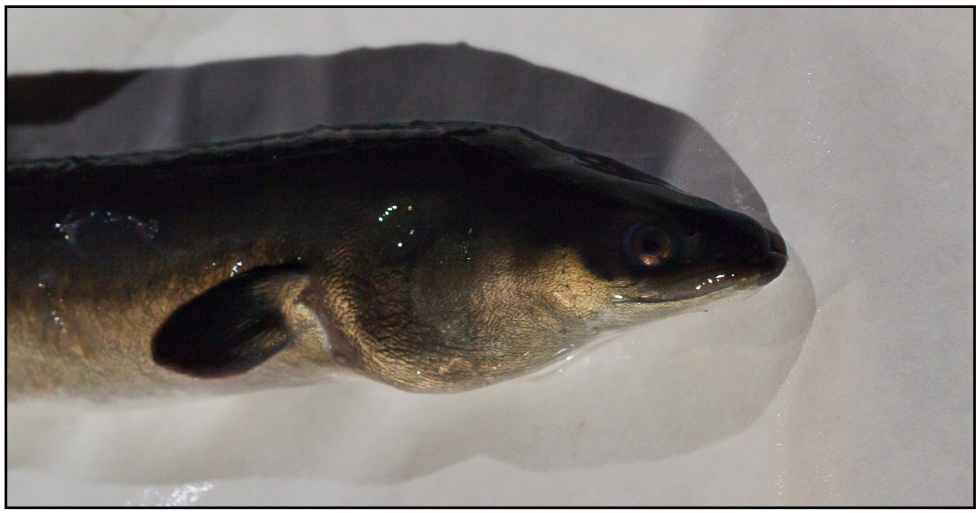


Figure 21. European eel (*Anguilla anguilla*).

BIBLIOGRAPHY

Akacakaya H.R. 2004, Species Conservation and Management, Oxford University Press Inc.

Barnabe G. 1989, Aquaculture Vol.2, Ellis Horwood Publishing, New York USA, pp. 756–785.

Cataudella S. & Bronzi P. 2001**,** Acquacoltura Responsabile, verso le produzioni acquatiche del terzo millennio, Unimar – Uniprom, Roma, pp.508-517.

Cockum E. 1980**,** Zoologia 2nd Italian Edition, Piccin Editore Padova, ITALY, pp. 330, 601–610.

Colavita G. 2008, Igiene e Tecnologie degli alimenti di Origine animale, Le Point Veterinarie. ITALIE SRL, Milan pp. 80-83, 269–272.

Costa F. 1991**,** Atlante dei pesci dei Mari Italiani, Mursia Editore spa, pp. 24–25.

Crook V. 2010**,** Trade in Anguilla species, with a focus on recent trade in European Eel, *A. anguilla*, A TRAFFIC Report for the European Commission.

D'Acona U. 1960, *Trattato di Zoologia* 2nd Italian Edition, UTET, Torino ITALY, pp. 382, 959.

FAO-FIPS. 2009. Food balance sheet of fish and fishery products in live weight and fish contribution to protein supply, World by continent, FAO Rome.

Ghittino P. 1983. *Tecnologia e Patologia in Acquacoltura* Vol. 1,Tipografia Emilio Bono Torino, pp. 53, 71, 350, 408.

Globefish. 2004, Fishery Industry in China, Globefish Research Programme FAO Rome.

Globefish. 2008, The Seafood Market in Spain, Globefish Research Programme FAO Rome.

Jordan D. 1923.A Classification of Fishes, Including Families and Genera, Stanford University, California USA, p. 130.

Lovatelli A. *et al*., 2004. Capture Based Aquaculture, Food Agriculture Organization ROME, pp. 3, 23-66.

Manzoni P. & Tepedino V. 2008. *Grande Enciclopedia illustrata dei pesci*, Euro-fishmarket srl, Trebbo di Reno Bologna, pp. 121–122.

Melotti P. & Giordani G. 1984. Elementi di Acquacoltura Edizioni Agricole Calderini Bologna, pp. 337–351.

Monticini P. 2012. Commercial values of *Anguilla anguilla* at a European and national level, IL PESCE Magazine N. 3/2012 Edizioni Pubblicità Italia srl, 41100 Modena (MO), pp. 83–91.

Noga J. 1999, Fish Diseases, Diagnosis and Treatment, Blackwell Publishing, USA pp.166–168.

Paperna I. 1996.Parasites, Infections and Diseases of Fishes in Africa, an Update. CIFA Technical Paper 31, Food Agriculture Organization Rome Italy, pp.157–159.

Reynolds J.D. & Jennings S. & Dulvy N.K. 2001, *Cited in* **Akacakaya H.R.** 2004.Species Conservation and Management, Oxford University Press Inc. p.195.

Richard D. 2005. Fisiologia degli Animali, Zanichelli Editore spa, Bologna ITALY, pp. 159–490.

Robert & Hawkins. 1999. Cited in **Akacakaya H.R.** 2004, Species Conservation and Management, Oxford University Press Inc.p.195.

Romanowski N. 2007, Sustainable freshwater aquaculture, the complete guide from backyard to investor, UNSW PRESS, p.p. 148,149.

Saroglia M. & Ingle E, 1992.Tecniche di Acquacoltura Edizioni Agricole Calderini Bologna, pp. 150–156.

Thorpe J.E. 2003, The Eel, Fifth Edition, Blackwell Science and The Fisheries Society of the British Isles, Blackwell Publishing Ed. UK.

Tortonese E. 1970.Fauna d Italia, OSTEICHTHYES (pesci ossei) parte prima, Edizioni Calderini Bologna, pp.303–307.

Trentini M. 1997. Appunti di zoologia generale e speciale veterinaria. Bologna Edizioni Nautilus, pp. 71–76, 198–203.

Van den Thillart G. & Rankin C. & Dufour S. 2009. Spawning Migration of the European Eel: Reproduction Index, a Useful Tool for Conservation Management, Springer Verlag.

4.21. Case study n.2: NILE PERCH AND LAKE VICTORIA: INVASION, DECLINE, MARKET TRENDS AND SUSTAINABILITY

SUMMARY

Nile Perch has been enumerated among the 100 most invasive species and its artificial introduction in Lake Victoria between the '50s and the '60s, has generated traumatic and irreversible upsetting from ecological and social point of view.
The present case study starts from a description of the geographical and social context of Lake Victoria, including the evolution of fishing practices. We then provide an overview of the biology, classification and protection status of the species. Next we analyze the market trends of Nile Perch, and finally we investigate Uganda, Tanzania and Kenya's **Poverty Reduction Strategy Papers** (PRSPs), in order to verify the possible development of Sustainable Aquaculture in Lake Victoria.

Case Study Structure

- Context;
- Biology of Nile Perch;
- Impact of Nile Perch on Lake Victoria;
- Market Trends;
- Statistical Data;
- Detailed country case study;
- SWOT analysis;
- Conclusion.

4.22. THE CONTEXT

Lake Victoria is one of the big tropical Lakes, the third of the Earth, together to Lake Malawi and Lake Tanganyika form the Great Lake region in Africa. Its surface area is around 68,500 km^2 and its maximum depth is around 80 meters with and with an average of 45 meters. It is situated on a plateau in the western part of the Rift Valley at 1,134 meters above the sea level, with a surface of 68 870 Km^2, include three African countries: Tanzania (around of 50% of lake surface and 60% of shoreline), Uganda (around 45% of surface and 30% of shoreline), and Kenya (6% of surface and 10% of shoreline). The Lake has a very large catchment area between 184,000 and 194,000 km^2 with a shoreline length 3,440 Km (Balirwa, 1998; Seehausen, 1996).

Figure 22. Lake Victoria, Satellite overview by Google Maps

The Victoria Lake has many rivers drain to in, such as Kagera (the most important to flow), Nzoia and Mara. The weather is tropical, with two distinct seasons, which are different and depending on latitude. The annual Lake level fluctuation is negligible, around 0.4 and 1.5 meters, however Lake Victoria receives 80 percent of its water from direct precipitation (Hickling, 1961).

Due to the altitude the air temperature is temperate with a range between 16 and 28 Celsius degree. The water temperature, influenced by deep and season, range between 21 and 27°C Celsius degree. The pH value is less basic than the two other great lakes (Malawi and Tanganyika), and range between 7 and 8. The water hardness is very variable with some fluctuations, between 3 to 7 ^{o}dH, and the conductivity is around 100-200 mS.

Due to of the Nile Perch invasion (an exotic predator fish species introduced before 1970), the endemic population of *Haplochromis spp.,* has suffered a significant decline. According to different authors many fish species (many of scientific interest also suitable as Ornamental Fish Market), have disappeared from the lake without being classified (Goldschmidt, 1998). Besides, the biology of the lake has undergone considerable modifications, both as regards the primary production (with a remarkable algae bloom and consequent formation of anoxic zones), both as regards the sympatric species and their habitats. Some species have evolved, adapting to new living conditions, others (the majority) have undergone a dramatic decline or become extinct.

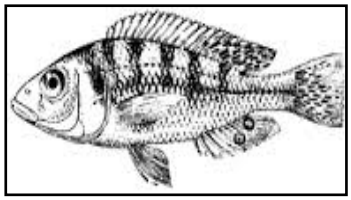


Figure 23. *Haplochromis spp.* (the "*furu*") from Goldschmidt, 1998

4.23. BIOLOGY OF NILE PERCH

Short description

***Lates niloticus* or Nile Perch** is a Top-level piscivourous predator, according to the *IUCN's Red List of Threatened Species* is consider one of the world's 100 worst invasive species (**IUCN**).

Lates niloticus* or Nile Perch*: teleost freshwater species, belonging to the Order of the Perciformes, easily recognizable by the lateral compressed elongated body (Manzoni, 2008). Gill operculum with one spine, the lateral line is extended until caudal peduncle. The dorsal fin is divided into two parts, the anterior with seven-eight spines, and the second on the posterior, with some soft rays. The anal fin has both spines and soft rays. The caudal fin is rounded. The color is dark greyish on the dorsal and silver ventrally. The maximum size is around 200 cm in length and 220 Kilos. Sexually it spawns at size between 60 and 90 cm in length. The sexual dimorphism in not evident. The Nile Perch has also a high breeding rate without care of offspring. The time of resilience is in a range between 1.5 and 4.5 years. It is a Top-level predator, according to The *IUCN's Red List of Threatened Species* is consider one of the world's 100 worst invasive species.

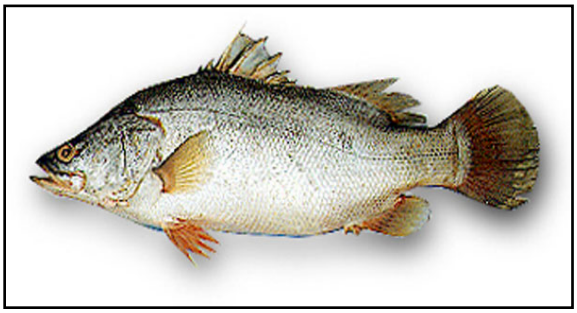


Figure 24. Nile Perch, *Lates niloticus* (FAO)

4.24. CLASSIFICATION

Class: Teleostei, **Subclass**: Actinopterygii;

Order: Perciformes;
Family: Latidae;
Genus: *Lates*;
Species: *L. niloticus,* Linnaeus, 1758 (original description);

FAO name: En common name – Nile Perch.
Other similar species is the *Lates calcarifer* (Bloch, 1790) - the native Australian barramundi (Romanowski, 2007).

Environmental and Geographical distribution

Tropical freshwater fish species, demersal and potamodromous, water range between 10 to maximum 60 meters in deep.
Inland water habitats, fish species widespread in all major river basin in horn of Africa such as Ethiopia also in Chad and Senegal. Widespread occur in Nile and many other African Lake such as Lake Tana in Ethiopia and Lake Victoria. Introduced as an alien species in north of America, it is also present in brackish water.

The Nile Perch occupies the cannels, streams and irrigation channels. The adult specimens live and prey in deep water, while young remaining in shallow water. Normally, juvenile specimens are planktivourous while adult specimens became carnivorous. Many African Countries such as Tanzania, Uganda and Kenya have reported adverse ecological impact after the introduction of Nile Perch in their own inland water.

4.25. ENDANGERED SPECIES STATUS (DATA FROM IUCN)

- *IUCN Red List of Threatened Species:* Least concern (**LC**);

Figure 25. IUCN Red List. Least Concern (LC),

- *Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) status*: **NOT EVALUATED.**

According to the Global Invasive Species Database (GISD), the Nile Perch is one of the hundred of the most global harmful alien species (The GISD is managed by the Invasive Species Specialist Group (ISSG) of the IUCN Species Survival Commission[51].

[51] The Invasive Species Specialist Group (ISSG) is a global network of scientific and policy experts on invasive species, organized by the IUCN/Species Survival Commission (SSC). http://www.issg.org/about.htm, Date accessed July 7 2014

The socio-economic impact and the environmental assessment can be summarized in the following four points:

- *Live food competition*: Direct competition with other fish species, altering the food chain of the endemic fauna;
- *Livelihoods status*: traditional fishing system and distribution of income, completely altered, from Small Scale/Artisanal fisheries to Industrial Large Scale fisheries;
- *Habitat modification*: the spread of Nile Perch is at the base of a significant biological impact on the fragile and complex ecosystem of the Lake Victoria (e.g. eutrophication);
- *Modification of predation*: distortion of the food chain, resulting in the decimation of endemic fish fauna consists mainly of *Haplochromis spp.*

Numerous works and approaches are, several times quoted the relevance of the spread of alien species. The Ecosystem Approach of Fisheries (EAF) as defined by the Convention on Biodiversity (CBD), with regard to the prudent choice of whether to use alien species for fisheries and aquaculture. The Code of Conduct for Responsible Fisheries (CCRF) in the Article 9 (Aquaculture development), reiterates the importance of adequate and comprehensive information in relation to the use of genetic material. In particular: Article 9.3.3 "*States should, in order to minimize risk (...) and other adverse effects on wild and cultured stocks, encourage adoption of appropriate practices (...), the introduction of non-native (alien) species* (…)".

4.26. DISEASES AND DISORDERS

Bacterial and viral diseases naturally affect the Nile Perch. The manual "*Parasites, infections and diseases of fishes in Africa. An update*" (Paperna, 1996), is been used as a reference to identify the major parasitic diseases in *Lates niloticus:*

- Myxosporea*: Henneguya spp*.;
- Monogenea: *Gyrodactylus spp.;*
- Monogenea: *Diplectanum spp.;*
- Ergasilidae (Copepoda): *Ergasilus spp.*

Other references can be obtained from the analysis of fish species close to Nile perch such as *Oreochromis niloticus niloticus*, which occupies the same ecosystems. For more information, please refer to the following work, "*Veterinary and public health aspects in tilapia aquaculture in Kenya, Uganda and Ethiopia*," published in

2009, by SIPI Italian Society of Fish Pathologists[52], and University of Bologna, Dept. Veterinary Public Health and Animal Pathologies (in Bibliography).

Natural predators

The few predators that can undermine the Nile Perch can be summarized as follows:

- Threatened by humans for commercial purposes;
- Reptiles such as Crocodiles, *Crocodylus niloticus*, (Laurenti, 1768);
- Piscivourous birds;
- Phenomena of cannibalisms.

4.27. THE IMPACT OF NILE PERCH ON LAKE VICTORIA

Lake Victoria, in the past, has undergone two invasions by non-endemic invasive organisms: the South American water hyacinth and the Nile Perch spread (Elton, 2000). This paper examines' the problems related to the diffusion of Nile Perch, its environmental and social implications. The Nile Perch is not at the most voracious piscivore, but it is has predatory behavior unlike any encountered by *Cichlidae* family in Lake Victoria before its introduction (Lockwood, 2013).

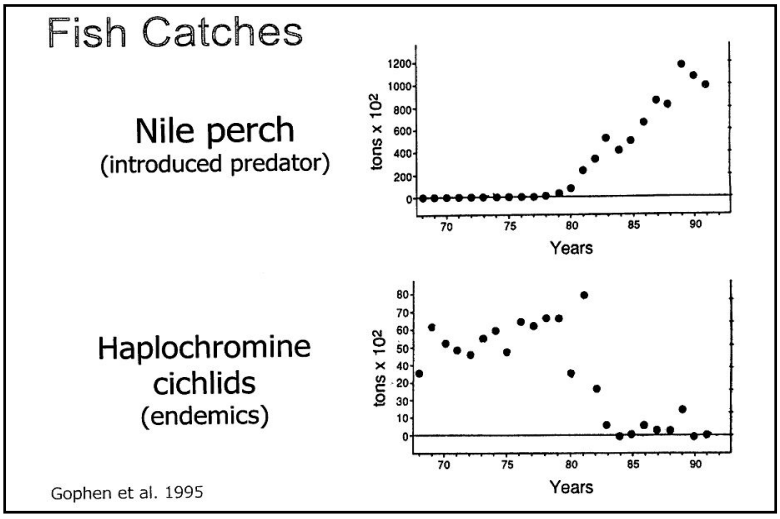


Figure 26. From Gophen *et al.* (1995) the Fish Catches in Lake Victoria

The most important species of Cichlids for ornamental purposes in Lake Victoria

[52] http://www.sipi-online.it, **SIPI** Italian Society of Fish Pathologists, Date accessed: July 7 2014.

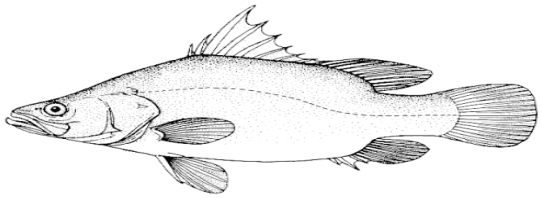
include: *Haplochromis spp*. (the most numerous Genres, with many species and sub-species), *Astatoreochromis spp*., *Astatotilapia spp*., *Platytaeniodus spp*. Among the Non-Cichlids*:* the *Mormyrus spp*. and some *Synodontis spp*.

4.28. NILE PERCH MARKET TREND

"*It is an interesting species and market. Lately in difficulty both because of competition from frozen whitefish fillets from Asia. And the resource is under stress as well. Another complication is that Nile Perch exports rely on cargo space. And if there are fewer planes going therefore some reason, transport costs go up on the return*" (Sr. Audun Lem[53], 2012 personal communication).

Fish, crustaceans, molluscs, etc. (*Source* FAO, 2014)
Capture production by principal species in 2011 (in tonnes)
English name — Scientific name
Nile perch — ***Lates niloticus***

2007	2008	2009	2010	2011
319 466	311 716	315 928	295 499	295 499



Note: These selected species are those with capture production of **150 000 tonnes** (year) or more in **2011**.

Figure 27. FAO Capture Production: the Nile Perch.

Nile Perch is one of the most commercialized species on European fish markets. Its high demand among consumers is due to its neutral tasting fillets, absence of fish bones and its relatively low price.
Nile Perch, or *Lates niloticus*, is to be distinguished from the real Perch Fish, or *Perca fluviatilis*, an highly valued and appreciated species found in the lakes of the Alps, whose demand had exceeded the stock and was therefore increasingly substituted by Nile Perch a few years ago. The differences of quality and availability between the two species are remarkable, and they reflect on the price, the cost of Nile Perch being averagely half of that of real Perch Fish.

[53] www.Globefish.org. Sr. Audun Lem PhD, MBA, Senior Fishery Industry Officer and Deputy Director, FAO FIPM and Globefish Coordinator. UN FAO FOOD AGRICULTURE ORGANIZATION, Fisheries Department – Rome, Italy.

The Nile Perch was artificially introduced in Lake Victoria between the '50s and the '60s, and its rapid proliferation and predatory inclination drastically changed the fishing methods and completely altered the lake's biodiversity.

Before Nile Perch appeared in the lake, fishing was quite an artisanal activity, operated by local seasonal fishermen on dugout canoes and regulated by local communities' rules and monitoring. The amount of fish caught in the lake was stable, whereas the variety of species was vast, counting hundreds of different species fished annually. After some 15-20 years from the introduction of Nile Perch, the scenario changed completely. The spread of this predator brought most of local species near to extinction, and the advent of industrial fishing caused not only an increase of the amount of fish caught in the lake, but also the elimination of the old fishing systems.

The large number of Nile Perch available, combined with the decreasing number of cod and the scarcity *Perca fluviatilis* in Europe, brought to internationalization of the market. The first fishing factories appeared on the lakeshore in the early '80s, but they quickly proliferated to become dozens. Nile Perch is now exported all over the world and indiscriminate fishing methods have been the rule, although now there are clear signs that indicate that it is time to regulate them.

Production

The introduction and diffusion of Nile Perch in Lake Victoria brought radical environmental, political, social and economical changes. Industrial fishing would have been impossible without international private and public investments, and this implied the additional involvement of important political decisions.

Local communities have adapted themselves to the situation, taking advantage of the increasing demand of labor in the fishing industries, although they have paid the price of losing possession of boats, fishing tools and independency.

As Nile Perch industry grew larger, in fact, new fishing tools were needed, for Nile Perch necessitates strong fishing synthetic nets imported from abroad, that local fishermen could not afford.

Up to the end of '70s, fishermen owned boats and fishing gear. Moreover they directly dealt the sales. Today the largest majority (80 percent) does not own either boat or fishing tools. Investors buy boats and gear and appoint managers who organize the activity. Managers choose the captains who, in their turn, select fishermen. Such organization: investors, managers, captains and fishermen, have produced substantial social modifications to the previous status. Nevertheless, fishing is still performed with low technology tools on small canoes and only some industrial boats are present in Kenya and Uganda.

Along with fishing, other allied activities and industries were established on the lakeshore, as processing Nile Perch implies a series of operations carried out in different plants.

First of all, the best fish caught are selected when unloading the boats and immediately transported to the processing plants to be filleted; smaller fish are sent to be desiccated for the flour industry, small, uninteresting or damaged fish becomes available for the local market. Other cuts or whole fish can be obtained from Nile Perch, but they represent only a minor part of the total trade.

Once selected the fish is immediately sent to the filleting plants, where it is washed, selected and refrigerated within 24 hrs.

Fish is usually filleted by hand, and only a few plants use mechanized processes. The fish is selected by quality and size, without being eviscerated. Therefore the discards include skin, fish, bones, swim bladders, and meat residues, fat. All of the rejected parts are re-used on local circuits, as cost of Nile Perch fillets is too high for the poorer, which consume as By-products.

Most of the processing plants operate according to the EU directive 493, 494/2004, and they select fillets depending on the market of destination. Fillets are generally divided in three categories: the best two are exported, while the third is sold on local markets. EU market requires fillets varying from 300 up to 2000 g., whereas fresh fillet markets must not exceed 1.500 gr. Packaging varies depending on type of preservation: fresh fillets are packaged in polyethylene bags and then in polystyrene ready to be transported; frozen products are packaged in boxes containing 6-10 kg. of frozen fish.

Control system

Currently, Europe represents the largest market for Nile Perch, and it applies its own strict control systems from "farm to fork". One of the potential weaknesses of fish lies on its scarce durability, therefore, growing attention has been dedicated to all steps of the fish handling chain from catch, to processing and storage conditions.

Controls are performed by the three countries which share Lake Victoria: Kenya, Tanzania, Uganda through their Competent Authorities, acknowledged by DG SANCO, which carries out regular inspections. If controls detect that EU requirements are not fulfilled, a country's export permits can be suspended or revoked.

Competent Authorities, meanwhile, verify if HACCP system is applied in the processing factories, all along the food chain in general, that is during fishing, unloading, storage, processing, packaging and transport. Most relevant for these purposes are Regulations (EC) 852/2004, 853/2004 and 854/2004, which include a plan for improving the Competent Authorities' control expertise in this field.

Final crucial controls are carried out at Border Inspection Posts (BIP) when entering EU, together with other local sanitary controls once the fish reaches its final destination.

Along the years of growth of Nile Perch trade, there have been a few important sanitary alerts that affected the market, creating alarm in the exporting countries, and growing caution in the consumers.
Here we report the main sanitary alerts:

- 1997 *Salmonella spp*. in containers destined to Spain and Italy. Several containers were consequently rejected;
- *Vibrio cholerae* on the Lake Victoria, EU ban;
- Use of pesticides during fishing, EU ban;

Other alerts concern the growing decline of fish price, and the presence of strong competitors on international Nile Perch Markets.

Preservatives and additives

Perhaps the most critical aspect of Nile Perch export is deterioration. Fish is considered by FAO *an extremely perishable food. For example, most fish become inedible within twelve hours at tropical temperatures. Spoilage begins as soon as the fish dies, and processing should therefore be done quickly to prevent the growth of spoilage bacteria. Fish is a low acid food and is therefore very susceptible to the growth of food poisoning bacteria. This is another reason why it should be processed quickly" (http://www.fao.org/wairdocs/x5434e/x5434e0f.htm).*

But fish does not is only prompt storage because its short durability and shelf life, but also because it is soft and easily damaged and consequently needs extremely careful handling.

Fish age (post-catch days), combined with ill handling or lack of care in all processing operations, can lead to even scarcer edibility of fish.

Consumers choose fish freshness based on sensory analysis, which is using basically visual and olfactory criteria that take into account the fish smell, eyes, skin and gills flavor. Nevertheless they can be misled by the use of preservatives and additives, commonly used to give fish a fresh and healthy aspect for commercial purposes.

Some large-scale retailers treatments are legal, others can be classified as food fraud, as they imply the use of noxious additives or harmful practices. All are apt to conceal either bad smell or the loss of fresh appearance of eyes, skin and gills.
There is a long list of possible food frauds related to fish: from selling thawed fish as fresh, to the use of food coloring for "revive" the fish eye. However the most dangerous is probably to use of noxious additives and preservatives that cannot be immediately detected, but that can cause serious consequences to the consumers' health.

Among these is Cafodos, a dangerous additive of Spanish provenance. Cafodos can alter fish in such a way to "revive" old fish, unfit for human consumption. It can be used alone or combined with peroxide. Its used has caused

several cases of food poisoning syndrome, due to the presence of bacteria and histamine released by the fish flesh. Cafodos is hard to detect because after contact with water or ice, it dissolves completely. Its use constitutes both a commercial and a sanitary fraud, and its sale should be completely banned.
Other illegal additives are: peroxide and chlorine.

Peroxide (H_2O_2) has an extensive use, from hair bleaching to disinfectant. It is also used in food processing, for example whitening fish and enhancing their fresh glossy brightness. Peroxide is volatile and very hard to detect, because it dissolves after contact with water or ice, just like Cafodos.

As for fish in particular, peroxide has been used to bleach and treat thawed fish, which was processed, frozen again and then sold on large-scale food stores. Fish was sometimes labeled as processed with "technological additives".

Peroxide itself is not a harmful, but represents a fraudulent additive as it can alter the color of food and hide the scarce freshness or inedibility of the product. Its use is therefore banned as food preservative and allowed only as medical disinfectant.

Chlorine (e.g. E925, E926), unlike Peroxide, is a legal additive commonly used as food disinfectant, bleaching agent and preservative. Nevertheless, its use can be harmful and modify the cellular structure of food products, alter the aspect of food while hiding deterioration or inedibility of products, just like Cafodos or Peroxide.

Moreover, their use in fish processing has increased the number of food intoxication and allergic reactions, triggered by the histamine present in the fish meat once treated with illegal chemical additives. Chlorine E925 and E926, in particular, are responsible of nutritional losses, as they subtract nutrients like vitamin E, are acknowledged irritation agents and should be banned as food additives.

In conclusion, food preservative and additives can represent both a fraudulent and extremely hazardous for health. More so, because some of them, like volatile Cafodos and Peroxide, can be hard to detect.
Perishable food like fish can be an easy "victims" of food sophistication, and the use of additives, even legal ones like Chlorine should closely limited and monitored.

Globefish Reports on Nile Perch

Data gathered on Nile Perch by FAO Fish-Stat from 2009 to 2012, have been elaborated by Globefish Research Programme staff.

Since 2009 it was evident that the situation of Nile Perch fisheries was disastrous. In 2008, shipments to EU had already showed decline of 10 000 tonnes, and further decline was expected during the following years.

Table 19. Major Nile Perch Exporters (in quantity)

January-December (1000 tonnes)				
	2005	2006	2007	2008
Kenya	5.2	4.2	5.1	4
Tanzania	24	23.6	27.5	23.3
Uganda	23.8	21.2	20.2	15
Total	53.0	48.9	52.8	42.3

Source: FAO Globefish Research Programme.

The reduction of exports was mainly due to the competition with cheap *Tilapia* and, above all, *Pangasius spp*. This Asian product, coming mainly from Thailand and Vietnam, had acquired a remarkable portion of the fresh water fish market, benefiting from the large-scale aquaculture facilities and refined processing sites, capable of satisfy a variegated demands of the Western (EU and USA) markets. Moreover, an efficacious and efficient supply chain and easy and frequent transport connections, contributed to a competitive price and sound market positioning[54].

The situation of Nile Perch was also aggravated by the presence of illegal fisheries. These escaped the control of local authorities and fisheries and sold directly to the processing industries.

Globefish underlined another further alarming crisis factor, is the drastic drop of the Nile Perch stock observed by Kenyan authorities. The first relevant decline took place between 1999 and 2001 (from 1.9 to 1.2 million tonnes), other drastic drops were marked in 2005 (544 000 tonnes) and in 2008 (370 000 tonnes).

Despite the desolating situation, Naturland, a German eco-certifier, had announced that Nile Perch from about ten sites was to be considered sustainable. Germany, through GTZ, had partly financed a project that involved both large and small-scale fisheries in producing both chilled and frozen fillets. Naturland set some strict guidelines that aimed to regulate the whole chain, from environment-friendly fishing methods to ecological processing, avoiding the use of any harmful fishing practice and artificial additives. Furthermore, Naturland's certification involved the adherence to some important social criteria that included the safeguard of fishermen and processing workers' livelihood.

[54] For further and updated information concerning the *Pangasius*' Market trend, see Globefish Research Programme website.

Figure 28. Nile Perch white-rose fillet,

In 2011, Globefish remarked that sustainability was a must as well as the key for a potential market upturn of Nile Perch. The recovery of cod stocks, together with the competition with *Tilapia* and *Pangasius*, had further affected the market of Nile Perch. Therefore it seemed that the export of sustainable certified products could re-position Nile Perch on the EU market.

More so after some red alerts have been raised on the poor quality of the fish from Uganda. Here, a better governance of the fisheries is being implemented and this should improve both the amount of stock and quality of fish.

Australia, which had appeared as a potential market for Nile Perch, thanks to its similarity with Barramundi (*Lates calcarifer*), has lately become a new competitor for the USA market for the same reason: Barramundi is a very similar fish, but with lower toxin levels and higher Omega-3s (Omega-3 fatty acid or *n-3* fatty acid).

Asia, on the other side, does not represent a potential market for Nile Perch because of the availability and popularity of *Pangasius*.

4.29. STATISTICAL DATA: NILE PERCH

Based on the data supplied by United Nations commodity Trade Statistic Database (UNdata) and FAO FISHSTAT Plus. Although there are not specific data on Nile Perch Commodities, we examined the Commodity Code 030 410 regarding the *Fish Fillet or Meat Fresh of Chilled* of Uganda, United Republic of Tanzania and Kenya, because we suppose that Nile Perch represents the major share of this Commodity.

As regards the FAO FISHSTAT Plus, Nile Perch is included among the principal species with a capture production of 150 000 tonnes or more. Besides justifying the importance of the species from an economical point of view, these data reveal a negative trend started in 2008-2009.

4.30. NILE PERCH COMMODITY CODE 030410 (FILLET, FRESH OR CHILLED) – Kenya

Table 20. 030419 Fish Fillet, fresh or Chilled –UNData, The United Nations Commodity Trade Statistic Data Base.

Country or Area	Year	Commodity Code	Description	Flow	Value (USD)	Quantity (kg.)
Kenya	2010	030410	Fish fillet or meat, fresh or chilled	Import	71 211	77 494
Kenya	2010	030410	Fish fillet or meat, fresh or chilled	Export	10 763 297	2 677 269
Kenya	2009	030410	Fish fillet or meat, fresh or chilled	Import	25 016	24 622
Kenya	2009	030410	Fish fillet or meat, fresh or chilled	Export	9 293 562	2 240 611
Kenya	2008	030410	Fish fillet or meat, fresh or chilled	Import	8 104	1 820
Kenya	2008	030410	Fish fillet or meat, fresh or chilled	Export	12 254 667	2 775 518

Source: UNData, The United Nations Commodity Trade Statistic Data Base (2014).

4.31. NILE PERCH COMMODITY CODE 030410 (FILLET, FRESH OR CHILLED) –Uganda

Table 21. 030419 Fish Fillet, fresh or Chilled –UNData, The United Nations Commodity Trade Statistic Data Base.

Country or Area	Year	Commodity Code	Description	Flow	Value (USD)	Quantity (kg.)
Uganda	2012	030410	Fish fillet or meat, fresh or chilled	Import	47 616	4 482
Uganda	2012	030410	Fish fillet or meat, fresh or chilled	Export	47 018 372	9 342 808
Uganda	2011	030410	Fish fillet or meat, fresh or chilled	Export	82 204 185	13 829 284
Uganda	2011	030410	Fish fillet or meat, fresh or chilled	Import	161 350	22 603
Uganda	2010	030410	Fish fillet or meat, fresh or chilled	Re-export	94 836	16 935
Uganda	2010	030410	Fish fillet or meat, fresh or chilled	Export	93 562 427	16 761 595
Uganda	2010	030410	Fish fillet or meat, fresh or chilled	Import	393 789	92 104
Uganda	2009	030410	Fish fillet or meat, fresh or chilled	Import	142 250	24 218
Uganda	2009	030410	Fish fillet or meat, fresh or chilled	Export	77 418 544	15 584 104

Uganda	2008	030410	Fish fillet or meat, fresh or chilled	Import	60 210	15 863
Uganda	2008	030410	Fish fillet or meat, fresh or chilled	Export	99 393 473	21 597 857
Uganda	2008	030410	Fish fillet or meat, fresh or chilled	Re-export	222 983	73 134

Source: UNData, The United Nations Commodity Trade Statistic Data Base (2014).

4.32. NILE PERCH COMMODITY CODE 030410 (FILLET, FRESH OR CHILLED) – United Rep. of Tanzania

Table 22. 030419 Fish Fillet, fresh or Chilled –UNData.

Country or Area	Year	Commodity Code	Description	Flow	Value (USD)	Quantity (kg.)
United Rep. of Tanzania	2013	030410	Fish fillet or meat, fresh or chilled	Import	96 445	51 569
United Rep. of Tanzania	2013	030410	Fish fillet or meat, fresh or chilled	Export	27 436 454	5 728 475
United Rep. of Tanzania	2012	030410	Fish fillet or meat, fresh or chilled	Import	19 714	3 439
United Rep. of Tanzania	2012	030410	Fish fillet or meat, fresh or chilled	Export	24 455 713	4 596 452
United Rep. of Tanzania	2011	030410	Fish fillet or meat, fresh or chilled	Import	3 184	595
United Rep. of Tanzania	2011	030410	Fish fillet or meat, fresh or chilled	Export	57 988 162	10 305 561
United Rep. of Tanzania	2010	030410	Fish fillet or meat, fresh or chilled	Import	200 820	31 939
United Rep. of Tanzania	2010	030410	Fish fillet or meat, fresh or chilled	Export	44 087 711	7 916 874
United Rep. of Tanzania	2009	030410	Fish fillet or meat, fresh or chilled	Export	48 682 756	9 235 733
United Rep. of Tanzania	2009	030410	Fish fillet or meat, fresh or chilled	Import	8 428	6 719
United Rep. of Tanzania	2008	030410	Fish fillet or meat, fresh or chilled	Export	61 263 233	12 855 531
United Rep. of Tanzania	2008	030410	Fish fillet or meat, fresh or chilled	Import	3 225	974

Source: UNData, The United Nations Commodity Trade Statistic Data Base (2014).

4.33. NILE Perch – FAO Capture production by principal species in 2012

Table 23. Nile Perch Capture production, by principal Species.

English name	Scientific Name	2008 Quantity tonnes	2009 Quantity tonnes	2010 Quantity tonnes	2011 Quantity tonnes	2012 Quantity tonnes
Nile Perch	*Lates niloticus* (Linnaeus 1758)	311 716	315 928	295 499	287 094	278 675

Source: FAO FISHSTAT Plus (2012).

Note: this species is included in a 70 species list, those with capture production of 150 000 tonnes or more in 2012.

4.34. CASE STUDY (PRSP) BY COUNTRY

- Tanzania
- Uganda
- Kenya

Republic of Uganda, Tanzania, and Kenya share Lake Victoria's shores and they are all implied in Nile Perch fishing and all allied activities.

As developing countries, they all applied to IMF and WB for assistance in order to define their developing strategies through PRSP – Poverty Reduction Strategy Papers.

Hereby we will illustrate the PRSP of each country in relation to wildlife, fisheries, aquaculture and their relevance on sustainability.

Republic Uganda National Development Plan (2010/11 – 2014/15)

Uganda's National Development Plan (NDP) vision is to *transform Ugandan Society from a peasant to a modern and prosperous country within 30 years*, by using growth, employment and socio-economic transformation to achieve prosperity. Nevertheless, economic growth must intertwine with poverty eradication, and thus the plan pursues the principles established by the Millennium Development Goals.

The most relevant section of Uganda's NDP in relation to our work is doubtlessly the Chapter 5 contained in Section 3 that analyses the Primary Sector and its Subsectors.

Agriculture has been the core sector of Uganda's economy for a long time, both in terms of GDP production and employment rates. In the last few years, though, its growth rate has been unsatisfactory and far from effectively contributes to poverty reduction and guaranteeing Food Security.

Despite its present contraction, the national Plan is conscious that is Agriculture can greatly contribute to the economic growth and poverty reduction

and…
Therefore, investing more in agriculture to achieve higher sector growth rates is the surest way of effectively reducing poverty. It is for these reasons that agriculture is being given a lot of attention in national development (p. 87).

Fisheries is classified a sub-sector of Agriculture. It has represented a very important activity for Uganda, as fish exports are the second largest export earner. Nile Perch has played a fundamental role in the great increase of export rates from early 1990s until 2005.

Since 2005, though, export has experience a remarkable declining catches, mainly due to the use to unsustainable and destructive fishing methods.

Table 24. Sectorial GDP (2002 Prices) Growth Rates and Shares in GDP

Sub-sector	**2003/ 2004**	**2004/ 2005**	**2005/ 2006**	**2006/ 2007**	**2007/ 2008**	**2008/2009**
Fisheries	9.6	13.5	5.6	-3.0	-11.8	-0.4

The main factors that have determined the present decline can be summarized as follows:

- Depletion of natural resources mainly due to over fishing;
- Non-compliance of national regulations;
- Insufficient control on catches by local authorities;
- Inadequate production and post-harvest facilities: these include, farm level storage, cold stores, modern abattoirs, holding grounds, fish fry centers and fish handling facilities.

Despite Uganda could fulfill the high-quality standards required by importing countries, and specifically by EU, maintaining these standards is very costly, and fishing factories and sub-sectors often prefer to illegally export fish in the neighboring countries where sanitary controls are less stringent. Limiting or reversing this decline is very hard for Uganda as well as for all the other developing countries, which often lack in structural soundness.

Nevertheless, in Uganda's NDP, are contained some strategic guidelines, that could improve the situation, without disregarding Sustainability. Paragraph 5.1.3 Objectives, Strategies and Interventions, aims to enhance agricultural production and productivity and Strategy 5, contained in the paragraph, plans to *Increase supply for water for production*. The intervention provides for *Strengthen the legal and institutional framework and capacity for developing water for agricultural production*. In order to do so, it has been increased the extension of water available to livestock, wildlife and aquaculture. Very interesting, in particular, is the importance attributed to Small-Scale Aquaculture, whose acreage has been increased, creating support aquaculture parks and training *staff and farmer groups on stocking methods, harvesting, waster control and management.*

It is evident that Uganda, despite the potential of its available natural resources, needs to work hard on Sustainable Development projects and strengthen the controls of local authorities. Sustainable Aquaculture and Small-scale fisheries could represent the key to reverse the present situation and improve Food Security, despite its initial higher costs.

United Republic Of Tanzania: National Strategy For Growth And Reduction Of Poverty II (2010/11 – 2014/15)

NSGRP II goal is to accelerate the economic growth of the United Republic of Tanzania, while reducing poverty and improving living standards, social welfare, governance and accountability. Like in the case of Uganda's NDP, these achievements are to be attained within the Millennium Development Goals (MDGs).

Agriculture, given the largest portion of people living in rural areas and depending on its production, could play the principal role in reducing poverty and hunger in the country.

Moreover, *Tanzania has immense fishery resource potentials – both in fresh and marine waters, which if sustainably utilized would contribute to improving the stakeholders' livelihoods, including their nutrition and attainment of other* results (e .g. health and education).

Tanzania, like Uganda, has experienced a growth of the fishing sector until 2007-2008, before s substantial decline (2.7 percent) of 2009. The cause of this decline, once again, is a combination of factors:

- Illegal fishing;
- Trafficking of fish and fishery products across borders;
- Use of inappropriate fishing gears;
- Limited credit resource degradation;
- High post fishing losses;

NSGRP II focuses on land, human resource, capital and technology as basic factors to reduce poverty and increase production. Its strategy intends to invest in these factors in order to attain their sustainable and cost-efficient use.

The Strategy of NSRGP II is contained in Chapter 4. Goal 2: *Reducing Income Poverty Through Promoting Inclusive, Sustainable, and Employment- Enhancing Growth and Development*, provides a series of operational targets, among which is the growth of the Fisheries sub-sector that should increase from 2.7 of 2009 up to 5.3 in 2015.

In the same Chapter we can find the Cluster Strategies for raising growth of agriculture in all aspects, including the fisheries sub-sector. Below a list of the most relevant measures to put the Goal 2 in practice in relation to fisheries and

aquaculture:

- Improving existing and expanding irrigation infrastructure, and developing rain water harvesting infrastructure, including water for livestock and fishery;
- Strengthening physical infrastructure to support growth of employment generating and profitable agriculture, including small scale crop faming, livestock, fishery, forestry and hunting;
- Undertaking further land reforms to support access and expansion of land for agriculture and livestock development, aquaculture, categorizing and protecting use for the designated activity; while balancing the demands for large scale and small scale uses;
- Strengthening agro-processing, fishery processing, and service sector and marketing baseline information to support agricultural and fishery growth;
- Promoting and adopting the use of science and technology in agriculture, including R&D for quality and nutritious food, high value cash crops, fishery and livestock products as well as ICT to provide information on prices, markets, and advisory services;
- Developing and equitably deploying and retaining human resources especially crop livestock, forestry and fishery extension services;
- Promoting measures to cushion farmers, livestock farmers, fishers from famine/droughts impacts, including piloting and scaling up farm crops/ livestock insurance;
- Promoting investment in the exploration of Deep Sea and Exclusive Economic Zone fisheries resources (EEZs);
- Promoting longer shelf life of agricultural and fisheries products;
- Strengthening fisheries resource management and utilization (including reduction of post harvest losses), value addition and marketing, protection and law enforcement;
- Promoting effective development of the aquaculture industry;
- Providing adequate fisheries related infrastructure;
- Integrated River and Lake Basin Management and Development Plans in place by 2015.

Goal 4, also included in Chapter 4, contains some important guidelines regarding the environment: *The goal aims at achieving security in food nutrition and environmental sustainability. It also aims at addressing and dealing with adverse*

effect of climate change. Here below we report some of the operational targets:

- Promoting increased fish production through aquaculture to complement declining capture fisheries;
- Improving sustainable fisheries resources development, management, conservation and utilization;
- Promoting grading and packaging of food products (crops, livestock products and fish) and forestry products;
- Increasing farmers, livestock farmers, fishers and aqua farmers awareness on the full impacts of climate change on agriculture;

Tanzania's Poverty Reduction Strategy Paper seems to be strongly oriented towards strengthening agriculture and giving fishing and aquaculture a key role.

All the operational targets and measures seem to be aligned with all the international environmentally concerned agreements and plans. Nevertheless, the Paper refers only to a general development of agricultural infrastructures at a small, medium and large-scale level, whereas we have seen how important is the role of Small-scale activities in an environmentally concerned development plan.

The hope is that this country will be able to attain its goals, although, being a developing country needs to face a series of adversities and threats that are common in Africa as well in other developing areas.

First of all, the present world economic crisis has strongly slowed down domestic growth, and the long recovery of developed country could have further negative impacts. This is evident when we look at Nile Perch exports rates that have abruptly declined and still struggle to raise.

Inadequate progress in implementing regulations, corruption, illegal fishing practices and political instability, could also mine the effective adoption of the Plan.

Finally, adverse natural conditions, such as floods and natural resource depletion of the lake, can affect wild fish stock and thus economic revenues.

Republic of Kenya: Investment Programme For The Economic Recovery Strategy (ERS) for Wealth And Employment Creation (2003-2007)

When introducing Kenya's Strategy Paper, we need to specify that most recent paper available at present is ERS, published in 2004, which refers to the years 2003-2007. Its updated version is Kenya Vision 2030 - First Medium Term Plan Update, published in 2011, but it mentions only briefly the fishery sector, whereas we know that the most substantial market decline and fluctuations happened from 2008 onwards.

In addition, ERS seems to be the most generic plan of the three we have examined. Even if it acknowledges the key role of agriculture as "the growth sector", it does not provide practical operational strategies, and therefore seems to be weaker in terms of effectiveness.

Nevertheless we have also examined a more recent document, the National Environment Action Plan Framework (2009-2013). Published in 2009, NEAP contains some guidelines and strategies directly related to fisheries in general and Lake Victoria in particular, that are interesting for the purposes of this work.

In Kenya, almost 70 percent of the population lives in rural areas. Over the 50 percent of it are under the poverty threshold and are Small-scale farmers. In pursuing food security and poverty reduction as primary goals, ERS underlines how it is necessary to intervene to promote productivity growth and lower costs of *agricultural inputs, particularly among smallholders and subsistence farmers* (p. 55-56)

The fishery sub-sector represents an important source of income, employment and *foreign exchange earnings*. Kenya comprises fresh (lake, rivers and dams) and marine waters. Fresh water is the leading sector and Lake Victoria is the principal fishery, and Nile Perch, with Tilapia and fresh water sardine, the main species captured and commercialized. The lake contributes *almost 50 percent of the total weight of fish landings. The lake currently accounts for over 90 percen of the tonnes of fish caught. Kenya claims 6 percent of Lake Victoria's total surface area, with 43 percent being owned by Uganda and 51 percent by Tanzania. Lake wide fish production is estimated at between 400 – 500 metric tons with Tanzania landing 40 percent, Kenya 35 percent and Uganda 25 percent. The landed value of this catch is between USD 300 – 400 million annually. Kenya's marine coastline stretches over 536 km and accounts for only 4 percent of the total output* (NEAP, p.16).

Despite the potential of fishery for the economic growth of Kenya, ERS does not contain more than a generic government commitment to *developing an enabling environment to ensure sustainability in fisheries development and management. A fisheries policy and Master Plan is currently under development.*

ERS recognizes *that an adequate management of environmental resources is key for long-term sustainable economic growth in rural areas* (ERS, p. 9). Unfortunately the plan does not contain operational strategies or guidelines, and seems to be oriented towards the post-harvest commercialization.

NEAP, on the contrary, examines more carefully the current concerns and threats of water resources and elaborates a series of proposed interventions. Apart from the already mentioned over-fishing on Lake Victoria, Kenya has also experienced *several invasions of invasive and alien species that have had negative impacts on biodiversity, agriculture and human development* (NEAP, p. 31). One of

the most notorious is *Eichhornia crassipes* (a South American floating plant commonly named "water hyacinth" which is native to the amazon basis) in Lake Victoria, which has contributed to an irreversible decline in fishing output and endangered fish species.

According to NEAP, the environmental concerns for the fishery industry are:

- Pollution of water bodies;
- Receding water levels;
- Over-fishing;
- Invasive and alien species;
- Weak implementation and enforcement of relevant legislation.

Proposed Interventions:

- Enhance water catchment and land use management;
- Enforcement of relevant legislation;
- Promotion of sustainable fisheries development and management;
- Undertaking research and strengthening collaborations on invasive and alien species management.

ERS and NEAP are the most relevant plans currently available.

Kenya ERS is both too "old" and generic to constitute an effective tool to preserve the environment while promoting a sustainable development of the fishery sector. Moreover it never mentions aquaculture and its potential as a source of income, employment and growth. Nevertheless, it seems to focus more than the other PRSPs on Small-scale Fisheries, their role in poverty reduction and their minor impact on the environment.

NEAP provides some operational guidelines, but it does not mention either Small-scale Fisheries or aquaculture. Nevertheless it seems to be more aligned with the environmentally concerned international agreements and therefore more interesting for our work.

Conclusion on Uganda, Republic of Tanzania and Kenya's Poverty Reduction Strategy Papers

All the three Strategy papers seem to acknowledge the role that fisheries and aquaculture could play in reduce poverty and hunger in their countries.

Nevertheless there are some sensible differences among them. Uganda shows an attention in principles, Tanzania seems to be inclined some practical measures to raise the growth of this sector, while Kenya seems to be the most generic of the three, despite the remarkable contribution of fresh water fisheries to the country's GDP.

The role of Small-scale Fisheries is neither clearly defined nor emphasized by none of the three Papers, although Tanzania seems to be more inclined to strengthen this size of fisheries to reduce poverty and increase food security.

Aquaculture is seldom if never mentioned in the three Papers, probably showing the tendency to exploit existing natural resources instead of creating new value from fish farming.

4.35. SWOT ANALYSIS TOOL ON THE NILE PERCH CASE STUDY

We decided to use this tool to explore the Nile Perch situation, under all aspects other than biology, resilience, human impact, environment and the future concerning the sustainability of the international market.

- ***Strengths***: Strong adaptability and tolerance to different environment conditions, very high growth rate, low time of resilience, few natural predators, very resistant to all common fish diseases, marketed in fresh and frozen fillets,
- ***Weaknesses***: Negative effect on biodiversity, cases of cannibalism among specimens, non-domesticated species, species non suitable for aquaculture, top level predator, direct food competition with endemic fish fauna,
- ***Opportunities***: Improving sustainable fisheries resources development, management, conservation and utilization, international food safety legislation, potential of the fish processing industry, one the most commercialized freshwater fish in European Market,
- ***Threats*****:** Modified natural environment, overexploitation, worst invasive species, market fluctuation, international financial crisis, weak implementation and enforcement of relevant legislation at regional, national and international level, Illegal Unreported and Unregulated fishing (IUU Fishing), Trafficking of fish and fishery products across borders, Use of inappropriate fishing gears, limited credit resource degradation, high level post fishing losses.

NILE PERCH SWOT MATRIX (2)

INTERNAL			
Strengths	• Strong adaptability and tolerance to different environment conditions; • Very high growth rate; • Low time of resilience; • Few natural predators; • Very resistant to all common fish diseases; • Marketed in fresh and frozen fillets.	• Negative effect on biodiversity; • Cases of cannibalism among specimens; • Non-domesticated species; • Species non-suitable for aquaculture; • Top level predator; • Direct food competition with endemic fish fauna.	Weaknesses

EXTERNAL			
Opportunities	• Improving sustainable fisheries resources development; • Management, conservation and utilization; • International food safety legislation; • Potential of the fish processing industry; • One the most commercialized freshwater fish in European Market.	• Modifications of the natural environment; • Overexploitation; • Decrease of source of food and biodiversity; • Market fluctuations; • International financial crisis; • Weak implementation and enforcement of relevant legislation at regional, national and international level; • Illegal fishing (IUU Fishing); • Trafficking of fish and fishery products across borders; • Use of inappropriate fishing gears; • Limited credit resource and financing; • High-level post fishing losses.	Threats

SWOT ANALISYS SUMMARY
The SWOT analysis chart reported above, highlights that one of the most critical issues of Nile Perch fishing and trade, is the high predatory and reproductive rate proper of this species. This characteristic would require an attentive management of fishing resources, in order to limit the depletion of biodiversity. Absurdly, the most effective solution could be total eradication of the species from the lake in order to re-establish the previous biological balance. Moreover, the excessive dependence from international markets is one of the main causes of the social unsustainability. One of the possible solutions of this second issue could e returning to smaller scale fisheries, capable of supplying affordable food resources and stable labor opportunities for the local population.

4.36. CONCLUSION

After Nile Perch was artificially introduced in Lake Victoria, the social, economic and environmental situation of the Uganda, Tanzania and Kenya, changed sensibly.

The presence of this species modified irreversibly the Lake's biodiversity, extinguishing many endemic fish species belonging to the genus *Haplochromis*, changing the algae primary production and consequently causing water eutrophication.

From the economic point of view, the three countries underwent an undeniable growth by catching, commercializing and exporting Nile Perch. Unfortunately, being an industry that strongly relies on foreign investments, the revenues were and are neither equally nor mainly locally distributed. Moreover, the Nile Perch trade is too vulnerable to international crisis and market fluctuations. This feature has caused a remarkable decline of earnings from this trade and a subsequent decrease of the number of fisheries and related industries on the lake.

Overfishing and illegal unreported unregulated fishing (IUU Fishing) and trade, aggravated by unreported catches, have also contributed to determine a decline of Nile Perch wild stock.

We have examined the single PRSP elaborated by each country sharing the lake. Although they all acknowledge the importance of Lake Victoria's fisheries, which strongly contribute to the countries' GDP, they don't seem to provide specific and effective solutions to problems. Perhaps, however difficult to implement, a more collaborative form of management of the lake among the three countries, could improve the situation.

This, combined with an environmentally oriented mentality, could secure long-term social, economic and environmental benefits.

Sustainable aquaculture could constitute a further instrument to the environment safeguard and economic development, without depletion of natural resources.

BIBLIOGRAPHY

AA.VV. 2009, Veterinary and public health aspects in tilapia aquaculture in Kenya, Uganda and Ethiopia", SIPI Italian Society of Fish Pathologists (www.sipi-online.it), and University of Bologna, Dept. Veterinary Public Health and Animal Pathologies, Rivista Patologica degli Organismi Acquatici, pp. 51-93.

Balirwa S. 1998, Lake Victoria Wetlands and Ecology of the Nile tilapia, *Oreochromis niloticus,* Linne', AA. Balkema / Rotterdam 1998, pp. 2, 7-9.

Bartley D. & Marttin F. (?), Introduction of Alien Specie/Strains and impact on Biodiversity, World Fish Center.

Bene' C. ***et al***. 2007, Increasing the contribution of Small-scale fisheries to poverty alleviation and food security, FAO FOOD AGRICULTURE ORGANIZATION Rome Italy, p. 20.

Bilame O. 2012, Lake Victoria Small-Scale fisheries, a Case of Tanzania Small-Scale Fisheries and its Contribution to Poverty Alleviation, LAP Lambert Academic Publishing Gmbh & Co.

Crisman T. ***et al.*** 2003, Conservation Ecology and Management of African Fresh Waters, University Press of Florida.

Elton C. 2000, The Ecology of invasions by animals and Plants, The University of Chicago Press and London, p. *x* (in preface).

FAO, Globefish, 2014 GLOBEFISH, Products, Trade and Marketing Service and Aquaculture Policy and Economic Division http://www.globefish.org/market-reports.html, Date accessed September 11, 2014.

Goldschmidt T. 1998, Darwin's Dream-pond, drama in Lake Victoria, the MIT Press Cambridge Massachusetts London England.

Gophen ***et al.*** 1995, some aspects of perturbations in the structure and biodiversity of the ecosystem of Lake Victoria (East Africa). Aquatic Living Resources 8, 27-41 *cited in* **Bronmark** ***et al.*** 2009, The Biology of Lake and Ponds 2nd Edition, Biology of Habitats Series, Oxford University Press, pp. 245-247.

Government of Kenya, National Environment Management Authority, 2009, National Environment Action Plan Framework 2009/2013, National Environment Authority, Nairobi Kenya.

Hickling, C.F. 1961, Tropical Inland Fisheries. London, Longmans, p. 287.

Josupeit E. 2006, The Market for Nile Perch, GRP Globefish Research Programme Vol. 84, FAO Food Agriculture Organization of the United Nations, GLOBEFISH, Products, Trade and Marketing Service and Aquaculture Policy and Economic Division (FIPM).

Keenleyside H.A. 1991, Cichlid Fishes Behavior, Ecology and Evolution, Chapman & Hall Fish and Fisheries Series 2, pp. 271-278.

Kees (P.C.) *et a*l. 2006, The invasion of an introduced predator, Nile Perch (*Lates niloticus* Linneo, 1758) in Lake Victoria (East Africa): chronology and causes, Environmental Biology of Fishes Journal Volume 81, Issue 2, pp. 127-139.

Lake Victoria Basin Commission 2011, A study on Aquatic Biodiversity in the Lake Victoria Basin, Kenya: ACTS Press, African Centre for Technology Studies, Lake Victoria Basin Commission.

Lockwood J. *et al.* 2013, Invasion Ecology second edition, Wiley-Blackwell, pp. 12-13, 233-235.

Manzoni P. *et al.* 2008, Grande Enciclopedia illustrata dei pesci. Euro-fish market srl, Trebbo di Reno Bologna, pp. 175, 176, 177.

Monticini P. 2015, Potential of Ornamental Fish Trade in Africa as a Small-scale Fisheries, Globefish Research Programme "Highlights" 1/2015, FAO FOOD AGRICULTURE ORGANIZATION, ROME, **in publication**.

Ndeda V. *et al*. 2013, Genetic Relatedness of *Diplostomum Species* (Digenea: Diplostomidae) infesting Nile Tilapia in Western Kenya, Open Journal of Applied Sciences, 2013, pp. 441-448.

Ochumba P. *et al.* (?), Ecological Changes in Lake Victoria after the invasion of Nile Perch (*Lates niloticus*): the catchment, waters, quality and fisheries management, Kenya Marine and Fisheries Research Institute.

Osborne P.L. 2012, Tropical Ecosystem and Ecological Concepts, 2nd edition, Cambridge University Press, pp. 197-198.

Paperna I. 1996, Parasites, Infections and Diseases of Fishes in Africa, an Update. CIFA Technical Paper 31 Food Agriculture Organization Rome Italy, pp. 98, 109, 116, 180.

Republic of Kenya, Ministry of State Planning, National Development 2011, First Medium Term Plan Update, Republic of Kenya.

Republic Uganda 2009, National Development Plan NDP (2010/11 – 2014/15) Republic of Uganda.

Romanowski N. 2007, Sustainable freshwater aquaculture, the complete guide from backyard to investor, UNSW PRESS, pp. 138-139, 149-151.

Schwartz J. 2001, The functional role of fish Diversity in lake Victoria, East Africa, Boston Graduate School University, (Thesis Prospectus).

Seehausen O. 1996, Lake Victoria Rock Cichlids, taxonomy, ecology and distribution, Verdujyn Cichlid Press, Germany, pp. 13-16.

The Republic Of Kenya Ministry Of Fisheries Development 2013, A Management Plan for Fisheries Targeting Small and Medium Sized Pelagic Fish, Ministry of Fisheries, Nairobi Kenya.

U.S. Fish and Wildlife Service 2012, Nile Perch (*Lates niloticus*), Ecological Risk Screening Summary, Web version – 8/14/2012.

United Republic of Tanzania 2010, National Strategy For Growth And Reduction Of Poverty II (2010/11 – 2014/15), Republic of Tanzania.

4.37. Case Study n. 3: BY-CATCH AND DISCARDS, THE SUSTAINABILITY IN MAJOR FAO FISHING AREA 37

4.38. SUMMARY

By-catch and Discards are general concepts and issues commonly associated to accidental fishing of non-target species. They represent two of the most visible consequences of fishing, perceived as a threat even among consumers. This has generated discussion and investigation among fishing and environmental organizations.

Nevertheless, despite the global growing concern, it appears hard to provide a reliable picture of the subject, due to the scarcity of data and therefore the difficulties of gathering real figures.

When referring to the three pillars of Sustainability described at the beginning of this work, we will see how By-catch, and consequently Discards, have implications in all three aspects: social, environmental and economic.

Being such a large object of study, we had to decide to examine it either by species or by fishing area. We opted for the second, choosing Area 37 (Mediterranean and Black Sea) as it is the closest in terms of distance and information accessibility.

First we will provide an overview of the most commonly recognized terms and practices involved in the concept of By-catch and Discards at international level. Then we will list the FAO Fishing Areas, closely examining Area 37. After this, we will illustrate the international authorities and agreements that legally bind or serve as guidelines for the regulation of By-catch and Discards. Next we will describe the past and present situation in Area 37, with its implication from the point of view of Sustainability and its pillars. Finally, we will try to hypothesize the most sustainable solutions for Area 37 and By-catch in general.

Case Study Structure:

- Definitions;
- FAO Major Fishing Areas;
- International Agreements on By-catch and Discards;
- Area 37 situation;
- Final comments.

4.39. DEFINITIONS

By-catch is defined as discarded catch of any living marine resource and as unobserved mortality due to a direct encounter with fishing gear. Unobserved mortality is included in By-catch for endangered species where data are available (**NOAA, 2011**).

The term "By-catch" is often used in fisheries activities when non-target species are accidentally caught (e.g. different fish species, different size of target species and juveniles specimens). By-catch is also used for the unintentionally capture of other marine organisms such as marine mammals (dolphins and whales), sea turtles and sea birds and sharks.

For this reasons, By-catch is considered a form of unintended overfishing and contributes to the unsustainability of fishing activities.

There are many definitions that identify By-catch; hereby we will report the most recent ones and those that seem most significant for our case study.

In **1994** Alverson *et al*. used the term By-catch "*to identify species retained and sold, species or sizes and sexes of species discarded as a result of economic, legal or personal consideration, and non-target species retained and sold plus all discards"*.

In **1996** Hall defined By-catch as "*that part of the capture fisheries that is discarded at sea, dead or injured*".

In **1997** OECD defined By-catch as "*total fishing mortality*" minus that accounted by the catch of target species.

In **1998** FAO defined the By-catch[55] as "*Part of a catch of a fishing unit taken incidentally in addition to the target species towards which fishing effort is directed. Some or all of it may be returned to the sea as discards, usually dead or dying"*.

FAO in 1999 affirm that is difficult to estimate the volume (in term of quantity) of by-catch, most of non-target species is often discard overboard, (Oyvind, 2008).

In **2000** (reviewed in 2013) the Australian's Governments[56] has developed

[55] http://www.fao.org/fi/glossary/. Definition by the FAO Glossary of fisheries. Data Accessed 13 August 2014.

[56] http://www.daff.gov.au/fisheries/environment/bycatch, Data Accessed 4 September, 2014.

his National Policy on Fisheries By-catch, consequently has provided his definition of by-catch as "*Species that physically interact with fishing Wessel and or Fishing Gear and which are not usually kept by commercial fishers*".

In **2011** NOAA released the first edition of the U.S. National By-catch Report.[57] Here, By-catch is defined as "*discarded catch of any living marine resource and as unobserved mortality due to a direct encounter with fishing gear. Unobserved mortality is included in By-catch for endangered species where data are available*".

On its webpage, NOAA reports another important definition of By-catch stated in the Magnuson-Stevens Fishery Conservation and Management Act[58]: *"Fish which are harvested in a fishery, but which are not sold or kept for personal use, and includes economic discards and regulatory discards. Such term does not include fish released alive under a recreational catch and release Fishery management Programme"* in addition to *"discarded catch of any living marine resource, plus unobserved mortality due to a direct encounter with fishing gear"*.

Other detailed FAO operational terminology can be found in numerous publications such as FAO Fisheries Technical Paper 370. Hereby we report the most significant ones related with the purpose of our work:

- Target Catch: The catch of target species;
- Incidental Catch: The catch of non-target species;
- Discarded Catch: A portion of the catch returned to the sea, usually dead;
- By-catch: Incidental catch of non-target species discarded at sea;
- Discard Mortality: Discard mortality rate;
- Prohibited species: Any species which must, by law, be returned to the sea;
- Unobserved Fishing Mortality: Mortality imposed on a species by the encounter with fishing gear that does not result in capture.

Finally, according to the GFCM e-Glossary, By-catch is defined as follows: *"The total catch of unwanted animals including vulnerable and endangered species. By-Catch of commercial species should be reported as associated species"*[59].

4.40. FAO Fishing Areas

The FAO Fishing Areas or FAO Major Fishing Areas for Statistical Purpose, are artificial concepts and have been defined in an arbitrary manner. They were

[57] http://www.st.nmfs.noaa.gov/st1/commercial/index.html. Data accessed, 13 August 2014.
[58] http://www.nmfs.noaa.gov/by_catch/bycatch_whatis.htm, Data accessed, 13 August 2014.
[59] GFCM e-Glossary, http://sacglossary.gfcmsecretariat.org, Data accessed September 16, 2014.

instituted as an output by CWP[60] (The Coordinating Working Party on Fishery Statistics), through various considerations and consultations with the several International Fishery Organizations involved. According to FAO, the framework of the Major Fishing Areas should coincide with the area of control and competence of a specific Fishery Commission. The Fishing areas are dynamic concepts and therefore can be modified and adjusted according new situation a requirements. Inside the Fishing areas there are other fundamental basic concepts and definitions.

Below we report a brief description of the main ones:

- **Marine Waters** refers to oceans, seas and adjacent saltwater areas;
- **Inland Waters** refers to lakes, rivers, stream, ponds, channels, dams and other "freshwater lands", normally saline or brackish waters[61] that are classified as a part of inland waters;
- **Internal Waters**[62] refers to a part of the sea (internal).

Twenty-seven Major Fishing Areas have been established at international level. Among these, eight areas cover Inland Fishing Areas[63], the other nineteen concern Major Marine Fishing Areas (Atlantic, Indian, Pacific and Southern Oceans). The Fishing Areas are also identified by their name and one two-numbers code:

- 01 Africa – inland water;
- 02 North America – inland water;
- 03 South America – inland water;

[60] According to FAO, the Coordinating Working Party on Fishery Statistics (CWP) provides a system to coordinating fishery statistic programs of all regional fishery bodies and other organization involved in fishery sector. It has been working since 1960 and in 1995 with a new mandate the CWP has extended its mandate to all marine water bodies. A panel of expert nominated by Intergovernmental Organization composes the CWP, which have skills and knowledge in fishery statistical data. Currently 19 Organization are involved in CWP activities such as FAO, GFGM, ICES, IWC, NACA and EU/Eurostat. The CWP Handbook of Fishery Statistical Standards provides information, definitions and concepts. Among these are fundamental the following release: Country or Areas, Fishing Gear classification, Fishery Commodities Classification. There are also included the Fishing Areas in General and the Fishing Areas for statistical purpose. For further information concerning the CWP please refer to the FAO web page and the FAO Fisheries Circular No 903 of 1993 (in Bibliography).

[61] According to FAO Glossary of Aquaculture brackish is defines as a "Water with a salinity intermediate between seawater and freshwater, usually showing wide salinity fluctuations".

[62] For further details concerning the complete and correct definition of Internal Waters please refer to the UNCLOS the United Nations Convention on the Law on the Sea, that assign a specific meaning to the term "Internal Waters": Covers all water and waterways on the landward side of the baseline. The coastal state is free to set laws, regulate use, and use any resource. Foreign vessels have no right of passage within internal waters.
(http://en.wikipedia.org/wiki/United_Nations_Convention_on_the_Law_of_the_Sea), Data accessed September 3, 2014.

[63] Potential problem of definition can be derived from the distinction between capture fishery and aquaculture inside the inland waters.

- 04 Asia – inland water;
- 05 Europe – inland water;
- 06 Oceania – inland water;
- 07 former URSSR area – inland water;
- 08 Antarctica – inland water;
- 18 Arctic sea;
- 21 Northwest Atlantic;
- 27 Northeast Atlantic;
- 31 Western Central Atlantic;
- 34 Eastern Central Atlantic;
- **37 Mediterranean and Black Sea**;
- 41 Southwest Atlantic;
- 47 Southeast Atlantic;
- 48 Atlantic, Antarctic;
- 51 Western Indian Ocean;
- 57 Eastern Indian Ocean;
- 58 Indian Ocean, Antarctic and Southern;
- 61 Northwest Pacific;
- 67 Northeast Pacific;
- 71 Western Central Pacific;
- 77 Eastern Central Pacific;
- 81 Southwest Pacific;
- 87 Southeast Pacific;
- 88 Pacific, Antarctic.

The Major Fishing Areas described above are also sub-classified into:

1. Subareas;
2. Divisions;
3. Subdivisions.

This additional classification has been prepared and implemented by the various international bodies involved. The GCFM covers the FAO Major Fishing Area 37, described as Mediterranean and Black Sea.

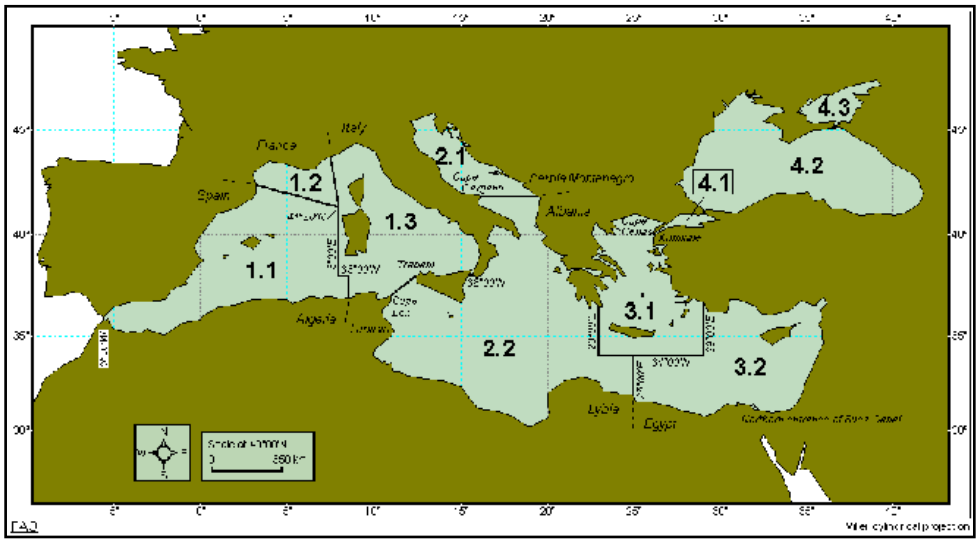


Figure 29. FAO Fishing Area 37
(http://www.fao.org/fi/figis/area/data/assets/images/Area37.gif)

Below, we report a brief description of Mediterranean and Black Sea Area, Subarea and Divisions.

Subareas:

- Western Mediterranean (Subarea 37.1);
- Central Mediterranean (Subarea 37.2);
- Eastern Mediterranean (Subarea 37.3);
- Black Sea (Subarea 37.4)

Divisions:

- Balearic (Division 37.1.1);
- Gulf of Lion (Division 37.1.2)
- Sardinia (Division 37.1.3.);
- Adriatic (Division 37.2.1);
- Ionian (Division 37.2.2);
- Aegean (Division 37.3.1);
- Levant (Division 37.3.2);
- Marmara Sea (Division 37.4.1);
- Black Sea (Division 37.4.2);
- Azov Sea (Division 37.4.3).

Subarea 37.4 is divided into three divisions because there are some significant differences in terms of water salinity, biological diversity of fauna and fish species.

Describing FAO Major Fishing Areas, focusing on Area 37 and specific Divisions, allows us to delimit the research area related to our third Case Study. Given the amplitude of Area 37 and its remarkable internal diversity, we will have to further reduce our focal point in order to examine a homogeneous sample.

GFCM has further divided the Areas of its expertise by establishing the Geographical Sub-areas (GSAs), through the Resolution GFCM/33/2009/2[64], "*On the establishment of Geographical Sub-Areas in the GFCM area amending the Resolution GFCM/31/2007/2".*

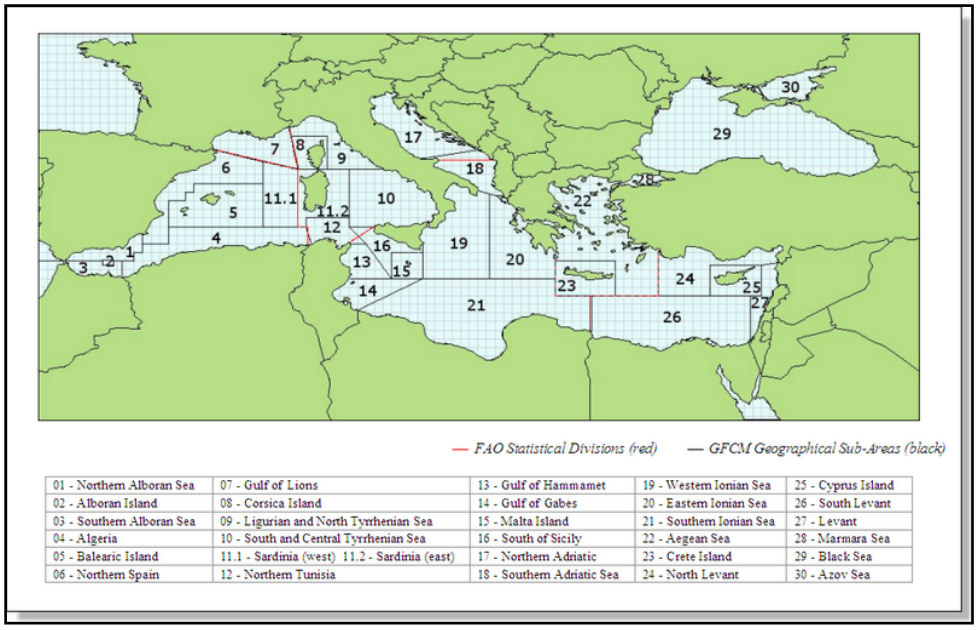


Figure 30. GFCM Geographical Sub-Areas map (http://www.gfcm.org/gfcm/topic/16162/en)

64 Resolution GFCM/33/2009/2, http://www.gfcm.org/gfcm/topic/16100/en, Date accessed 16 September 2014.

FAO SUBAREA	FAO STATISTICAL DIVISION		GSas	
WESTERN	1.1	BALEARIC	1	Northern Alboran Sea
			2	Alboran Island
			3	Southern Alboran Sea
			4	Algeria
			5	Balearic Island
			6	Northern Spain
			11.1	Sardinia (west)
	1.2	GULF OF LIONS	7	Gulf of Lions
	1.3	SARDINIA	8	Corsica Island
			9	Ligurian and North Tyrrhenian Sea
			10	South Tyrrhenian Seas
			11.2	Sardinia (east)
			12	Northern Tunisia
CENTRAL	2.1	ADRIATIC	17	Northern Adriatic
			18	Southern Adriatic Sea (part)
	2.2	IONIAN	13	Gulf of Hammamet
			14	Gulf of Gabes
			15	Malta Island
			16	South of Sicily
			18	Southern Adriatic Sea (part)
			19	Western Ionian Sea
			20	Eastern Ionian Sea
			21	Southern Ionian Sea
EASTERN	3.1	AEGEAN	22	Aegean Sea
			23	Crete Island
	3.2	LEVANT	24	North Levant
			25	Cyprus Island
			26	South Levant
			27	Levant
BLACK SEA	4.1	MARMARA	28	Marmara Sea
	4.2	BLACK SEAS	29	Black Sea
	4.3	AZOV SEA	30	Azov Sea

Figure 31. GFCM Geographical Sub-Areas map
Modified from (http://www.gfcm.org/gfcm/topic/16162/en) by Pierluigi Monticini

4.41. INTERNATIONAL AGREEMENTS ON BY-CATCH AND DISCARDS

There are many International Agreements that involve By-catch and discards from a sustainable point of view.

Here we will analyze the most relevant ones among those reported in Chapter 2.
As we will see, the most important difference lays between Legally and Non-legally Binding Agreements. Despite the righteousness of their principles, in fact, the Non-legally binding ones are often disregarded in practice.

According to WWF, there are around 130 agreements involved in By-catch and discard[65]at different levels, and 40 of them have some international implications. Among the implemented measures we can summarize:

- Measures on net mesh sizes;
- Fishing areas;
- Regulations for discarding fish;
- By-catch mitigation measures;
- Plans for specific fish species;
- Best practices for fishing operations to interdict illegal fishing.

To have a real impact on Natural Ecosystem and on Sustainability, these Laws need to be implemented, monitored end enforced at regional, national and international level. FAO and WTO are the two mostly involved Organizations at international level.

Some of the most important laws and provisions are included in the following international agreements:

- UN Fish Stock Agreement (FSA);
- UN Convention on Migratory Species (CMS);
- UN Convention on the Laws of the Sea (UNCLOS);
- The Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES);
- The World Trade Organization (WTO);
- Agenda 21, UN Conference on Environment and Development;
- The Code of Conduct for Responsible Fisheries;
- The International Plan of Action (IPOAs) for the Conservation and Management of Shark;
- The International Plan of Action (IPOAs) for Reducing Incidental Catch of

[65]http://wwf.panda.org/what_we_do/footprint/smart_fishing/solutions/go...ssure/strengthening_fisheries_policies/strong_laws_against_bycatch/ Date accessed 3 September 2014.

Seabird in Long-line Fisheries.

The table below lists the major International Agreements concerning By-catch and Discards.

Table 25. Major International Agreements concerning By-catch and Discards.

International Agreement	Initiatives and provisions
UN Fish Stock Agreement (**FSA**)	Article 5 General principles (c) …minimize catch by lost or abandoned gear; catch on non-target species, both fish and non-fish species. Article 6 (c) application of the precautionary approach relating the mortality and the impact of fishing activities on non-target species and associated or dependent species.
UN Convention on Migratory Species (**CMS**)	Organization and development of legally binding regional agreement on Marine Mammals and turtles.
UN Convention on the Laws of the Sea (**UNCLOS**)	Part V – Exclusive Economic Zone EEZ from Article 55 to Article 67. The Article 65 treaty marine mammals …States shall cooperate to the conservation of marine mammals….
The Convention on International Trade in Endangered Species of Wild Flora and Fauna (**CITES**)	Marine mammals, turtles and seabirds and some other fish species are listed in Appendix I or in Appendix II. CITES may have a direct effect on fisheries that catch such species.
The World Trade Organization (**WTO**)	WTO plays an important role in By-catch mitigation and has been involved in the issue surrounding the establishment of the mandatory requirement of Turtle Excluder Devices to be fitted into all shrimp trawls that catch and export shrimp to the US market (www.panda.org).
The Code of Conduct for Responsible Fisheries (**CCRF**)	The Code has numerous references to By-catch (these will be described separately).
The International Plan of Action (**IPOAs-Shark**) for the Conservation and Management of Shark	Minimize waste and encourage full use of dead sharks.
The International Plan of Action (**IPOAs-Seabird**) for Reducing Incidental Catch of Seabird in Long-line Fisheries	Prevention of seabird capture and release of seabirds.
Agenda 21, UN Conference on Environment and Development	In Chapter 17, relating the protection of Oceans, were one of the most important actions is to develop criteria for the use of selective fishing gear and practices to minimize waste and By-catch.

The Code of Conduct for Responsible Fisheries (CCRF) and its IPOAs has a great number of references to By-Catch and discards. CCRF also appears to be one

of the most significant international agreements for this work. In fact, one of the numerous principles is to preserve aquatic ecosystems through safeguard in order to minimize non-target catches and the consequent discard.

The most relevant references to the CCCRF are contained in the *General Principles*, under **Article 6.6** "*States…should minimize waste and catch non-target species…"* also under *Fisheries Management* **Article 7.2.2. (g**), "*…waste, discard, catch by lost or abandoned gear, catch on non-target species, both fish and non-fish species… are minimized, through measures …".*

Moreover, under the **Article 7.5** is reaffirmed the Precautionary Approach in particular in **Article 7.5.2** where *"…in implementing precautionary approach…in relation to such reference points, levels and distribution of fish mortality and the impact of fishing activities, including discards, on target and associated or dependent species.*"

The **Article 7.6.9**, included in the Management measures, establishes that "*States should take appropriate measures to minimize waste, discards, catch by lost or abandoned gear, catch of non-target species, both fish and non-fish species, and negative impacts on associated or dependent species, in particular endangered species".*

As regards to the Fishing Operation, **Article 8.4.3** specifies that: "*States should make effort to ensure that documentation with regard to fishing operation, retained catch of fish and non fish-species and, as regards discards…*".

Article 8.4.5 affirms: "*States…should encourage the development and implementation of technologies …that reduce discards. The use of fishing gear and practices that lead to the discarding of catch should be discouraged and the use of fishing gear and practices that increase survival rate of escaping fish should be promoted*".

Article 8.4.8 concerns the research on the environment "*…and social impacts of fishing gear and, in particular, on the impact of such gear on biodiversity and coastal fishing communities should be promoted".* Articles 8.5.1 to Articles 8.5.4 contain detailed information regarding the selectivity of fishing gear.

The Chapter concerning Aquaculture Development appears to be very interesting. From **Articles 9.1** to **Articles 9.4** contained detailed descriptions of Aquaculture Development principles. Thus they also contain the measures to minimize By-catch in Capture-base aquaculture/fisheries. Furthermore, according to Lovatelli *et al*. (2004), the amount of By-catch associated with the collection of wild juvenile stock for Capture-base aquaculture, is not well documented. Besides, the level of By-catch depends on many factors, such as area of fishing, fishing season and selectivity of the fishing gear.

Finally, **Chapter 11** on Post-harvest practices and trade, contains references on By-catch in **paragraph 11.1.8 (b),** Here it is affirmed that "*States should encourage those involved in fish processing, distribution and marketing to improve the use of By-catch to the extend*…".

According to FAO Fisheries Technical Paper 443, By-catch and discards is covered in Chapter 6 "Relevance of the Code of Conduct", section 6.6 "Selectivity, Ghost Fishing By-catch, Discards and Waste". Some sections of the Code contain other references to By-catch that can be added to those reported above, in particular about measures and practices to minimize Discards.

Article 12.10 asserts that: "*States should carry out studies on the selectivity of fishing gear, the environmental impact of fishing gear on target species and on the behavior of target and non-target species in relation to such fishing gear as an aid for management decisions and with a view to minimizing non-utilized catches as well as safeguarding the biodiversity of ecosystems and the aquatic habitat*".

The most relevant FAO Technical Guideline on By-catch and Discards inherent to IPOA-Seabird, is the following:

- *Technical Guidelines for Responsible Fisheries, Number 1: Fishing operations. Supplement 2 Best practice to reduce incident catch of seabird in capture fisheries* (in bibliography).

By-Catch and Discards is also the object of concern of in the following two UN Resolutions (see Bibliography):

- The UN **Resolution 55/8** adopted by the General Assembly of **30 October 2000** at its 55th session on "*Large-scale pelagic drift-net fishing, unauthorized fishing in zones of national jurisdiction and on the high seas, fisheries by-catch and discards, and other developments*";
- The UN **Resolution 57/142** adopted by the General Assembly **of 12 December 2002** at its 57th session on "*Large-scale pelagic drift-net fishing, unauthorized fishing in zones of national jurisdiction and on the high seas/illegal, unreported and unregulated fishing, fisheries by-catch and discards, and other developments*".

Both Resolutions affirm that By-catch and Discards are a serious threat for the environment that urges prompt intervention. Their aim is to at least reduce, if not eliminate, By-catch and discards by adopting a series of measures as well as encouraging the development of selective, environmentally safe and cost-effective fishing gear. They also support FAO and UNEP initiatives, while wishing for further future intervention.

On the other hand, the European Legislation appears less effectives and efficient respect to the Australian and to the United States policies. The European Union, through the European Commission, has defined an action plan to reduce and minimize the By-catch and subsequently the discards in fishery. As a matter of fact, a decline of fish quota and wild stocks is a result of high grade of discards of commercially valuable fish. European legislation also follows international standards of measures to mitigate By-catch, such as the introduction of more selective fishing gears, restriction of fishing area to protect juvenile fish, non-target species and ecosystems, and institution of a voluntary code of conduct to reduce/ban discards. The European Commission and ICES are the two bodies involved in the topics of By-catch and discards.

The following is the main text of reference:

- COM (2007) 136, Communication from the Commission to the Council and the European Parliament "**A policy to reduce unwanted by-catches and eliminate discards in European fisheries**".

One of the most important problems of the European Fisheries is the By-catch and the subsequent Discards. The fishing Capture of Non-Target species and their successive Discards have high negative implications. The catch of juveniles specimens of target species implies a future reduction of the number of catches of target specimens of commercial size, also the caught *"alevins"* not contribute to the increase of the fish biomass and the consequent formation of mating pair during the breeding season. The capture of Non-target species has high grade of negative impact on the Marine Ecosystem as a result of reduction in biodiversity and in modification of trophic chain. No only fish or crustacean are defined as non-target species but in this list are included Sea Birds, Sea Mammals and Sharks. The problem is very serious in particular for species with a low reproductive rate as Sharks and for Endangered species such as Marine Mammals or Marine Turtles, which are listed under of the Washington Convention.

Data provided by the EU Scientific Technical and Economic Committee for Fisheries, for the period 2003-2005, show a Discards rate around of 20-60% of the total catch weight. Data are often incomplete and not representative for all European Fisheries. It may vary from Fishing Areas, from Fishing species. However, data from the Northern Europe fishing areas appear to be more reliable.

For this reason the EU Commission has included this issue as a priority of his agenda. The objectives that the action of the Commission has set are ambitious. The primary goal is to "initiate a policy which will reduce By-catch and progressively eliminate Discards in EU Fisheries". The new policy is based on a combination of technical tools such as an implementation of a new fishing technologies and improved selectivity of fishing hooks (gears). The main goal is to "*remove the*

practice of Discards and minimize the By-catch". Each European Regional Fisheries Management Organization (such as GFCM for the FAO Major Fishing Area 37) has the mandate to promote initiative to reducing discards. The Total allowable Catch (**TACs**) alone in mixed fisheries, does not seem to get the desired results without additional control measures and restriction in the capture management.

Finally, a Plan of Action (ECPOA) for reducing incidental catch of seabirds in fisheries was promoted by the European Community in 2009 in order to adopt the Code of Conduct IPOAs International Plan of Action for Reducing Incidental Catch of Seabird in Long-line Fisheries.

4.42. The General Fisheries Commission for the Mediterranean (GFCM)

The International recognized organization involved in the FAO Major fishing Area 37 is the FGCM. The Agreement for the institutionalization of the General Fisheries Commission for the Mediterranean was approved by FAO in 1949 and adopted in 1952. Subsequent amendments were approved in 1963, 1976 and 1997. The GFCM consists of 24 Member Countries plus the European Union: Albania, Bulgaria, Croatia, Cyprus, France Greece, Italy, Malta, Monaco, Montenegro, Romania, Slovenia, Spain, Algeria, Egypt, Israel, Lebanon, Libya, Morocco, Syrian, Arab Republic, Tunisia, Turkey and Japan. The GFCM's goals and functions are to promote the sustainable development, the environment conservation and the best exploitation of living marine resources. It is also of primary relevance the sustainable development of the Aquaculture in the Mediterranean and in the Black Sea. The GFCM has the mandate to adopt legally binding recommendation for Fisheries and Aquaculture in its intervention Area that is circumscribed as follows: *Mediterranean, Black Sea and connecting waters*. The fish species included in the mandate are all *Living Marine Resources in the GFCM area*. The GFCM implements its measures through the GFCM Secretariat and the following GFCM Committees:

- Committee on Aquaculture (CAQ), 1995;
- Scientific Advisory Committee (SAC), 1997;
- Compliance Committee (CoC), 2006;
- Committee on Administration and Finance (CAF), 2009.

As regards to this Case Study, the Scientific Advisory Committee (SAC), overarching the issues related to By-catch and Discards trough the two following subsidiary bodies:

- Sub-Committee on Stock Assessment (SCSA);
- Sub-Committee on Marine Environment and Ecosystem (SCMEE).

The other three Sub-Commissions operating under the SAC are: the Coordination Meeting of the Sub-Committees (CMSC), Sub-Committee on Statistics

and Information (SCSI) and the Sub-Committee on Economic and Social Sciences (SCESS).

According to the GFCM web page, the most relevant task of SAC is to "*assess information provided by Members and relevant Fisheries Organizations or Programmes on catches, fishing efforts, and other data relevant to the conservation and management of fisheries"*.

4.43. FAO MAJOR FISHING AREA 37 SITUATION

As we previously anticipated, despite the relevance of By-catch and Discards, studies on this subject are scarce and poor in statistical data. This is mainly due to the difficulty, if not impossibility, to gather reliable data on the amount of non-target species captured and consequently discarded.

In fact, the available data are only estimations based on the elaboration of few reported cases. Moreover, as observed by Kelleher (2005), studies on By-catch and Discards cover only a small part of the total fishing activities of FAO major Fishing Area 37.

In addition, this area embraces extremely diverse and inhomogeneous situations from fishing, political, social, economical, cultural and environmental point of views, so that is practically impossible to have a univocal vision of the problem.

For all these reasons, Area 37 has been subdivided in so many Geographical sub-areas (GSAs). Smaller, circumscribed and more homogeneous samples, in fact, allow a more reliable examination of fishing practices and their Sustainability according to the three pillars principles (social, economic, environmental).

Our main sources for this case study have been: *Review Of Existing Knowledge On Fisheries By-Catches And Discards In The GFCM Area* and the successive *List of Abstracts* produced by the 2nd Transversal Working Group On By-Catch of 2011.

Both works list a series of main topics on this subject that can be summarized as follows:

- The Mediterranean is considered a small Ocean shared by three continents, with variegated millennial cultures involved;

- The countless fishing sites have difficulties in recording homogeneous data and relevant information for a potential achievement of sustainable development;

- Several are the countries involved: EC Member States and the rest of the

other European Countries, Middle Eastern Countries, Black sea Countries and Northern African Countries plus Japan[66]. For this reason were created 30 Geographical Sub Areas;

- It is difficult to achieve a harmonious Legislation and operational initiatives, even between EU Member countries and the other European Countries. Further difficulties can be encountered with other non-European countries;

- Legislative operational problems have various origins, although they arise mainly from cultural and economic differences. This makes it always hard to decide the size of fleet, the type of captured species, the period of ban on fishing, etc.;

- There are significant differences in terms of fish species, used equipment and seasonality of the catch for each sub-area examined;

- The total amount of By-catch is just a rough and very fluctuating estimation depending on the fishing season. Data vary according to: target species, countries, seasonality, type of fishing technique and Scale, market price and its demand;

- By-Catch and Discards rates differ significantly if comparing Small–scale fisheries and Large-scale data on catch. Besides the use of fishing techniques, gear and amount of fish captured, By-catch becomes Discards more easily in large-scale fisheries than in Small-scale ones, where it can be utilized by fishermen for personal consumption;

- It is always hard to determine the exact definition of Target species and By-catch composition, due to the heterogeneity of areas and situations as well as number and size of the stakeholders involved;

It is clear that one of main issues of By-catch and Discards in Mediterranean Sea and Black Sea Area, as well as in other areas around the world, is the heterogeneity and number of the stakeholders involved. This makes extremely difficult to conduct precise analysis and therefore obtain a reliable picture of the situation, implement laws and monitor fishing activities.

Maybe the adoption of a global approach that would focus only on a few fundamental principles but that could be modulated according to the different local

[66] Japan is one of the 25 Member Countries of the General Fisheries Commission of the Mediterranean (GFCM) – FAO Major Fishing Areas; due to the relevance of the country in the trade, amount of import and consumption of Blue fin Tuna.

situation and fishing scale, could achieve better results. Small-scale fisheries, which have a lower impact on ecosystems, should be regulated by less strict regulations, but should improve their fishing gear and technique in order to diminish the amount of By-catch and consequently Discards.

Sustainability on Marine Mammals, Seabirds, Sharks and Turtles By-Catch issue in FAO Major Fishing Area 37.

By-catch concerns all the non-target species accidentally captured. It represents a major ecological fishing issue, and the one that is perceived as the most dangerous by the public opinion, is certainly the capture of the so-called *sensitive species*, that is **Marine Mammals, Seabirds, Sharks and Turtles**.

These species are defined as sensitive because they have a low reproductive rate, a low resilience and a long life cycle. Therefore they are either threatened or protected.

Most of the sensitive species that are considered endangered are included in the *IUCN Red List of Threatened Species*. The list is not legally binding, however, most of these species are also included in Annex I and II of the Washington Convention (CITES), which constitutes the basic document for International and National legislation on protected species.

The interaction between sensitive species and fisheries can be very harmful both to marine species and to human activities. In the first case, it can cause depletion of the source of food and direct killing or serious injuries by fishing gear; as for man, the involuntary catch of these species can bring to gear and economic damage, as well as depletion of commercially valuable fish stock (Beddington et al, 1985).

GFCM adopted a series of measures apt to limit By-catch of sensitive species. Here below we report a series of GFCM decisions concerning the already mentioned sensitive species:

Sharks and Rays

Protection of Elasmobranchii taxa is strictly connected to the application of the previously illustrated Precautionary Approach. It also recalls and reaffirms the principles contained in FAO Code of Conduct for Responsible Fisheries and 1999 IPOA-Sharks.

In addition to By-catch, the management of Sharks is also connected to the abolition of finning (and the consequent discards) practices that have been banned in 2012 by GFCM.

Here below we report the list of the main GFCM decisions.

- Decision GFCM/34/2010/4;
- Decision GFCM/35/2011/7;

- Decision GFCM/35/2011/7;
- Decision GFCM/36/2012/3.

Sea Turtles, Cetaceans and Seabirds

The main issue for these sensitive species groups is certainly the need to increasingly reduce the risk of By-catch. The following GFCM decisions are those that specifically treat this subject. Each decision reaffirms the principles FAO Code of Conduct for Responsible Fisheries. Moreover the specific decision concerning Seabirds takes into account the International Plan of Action for Reducing the Incidental Catch of Seabirds in Long-line Fisheries (IPOA-Seabirds).

- Decision GFCM/36/2012/2;
- Decision GFCM/35/2011/3;
- Decision GFCM/35/2011/4.

Monk Seal

Internationally recognized as one of the most endangered mammals in the world, *Monachus monachus* has been object of a specific decision by GFCM that involve the elaboration of updated maps indicating the present diffusion of the species.

- Decision GFCM/35/2011/5.

In the next paragraph we will offer an overview of the most relevant issues on By-catch of sensitive species in the Mediterranean Sea that will be followed by an illustration of the most relevant fishing gears involved in By-catch and Discards.

Marine Mammals:

In FAO Major Fishing Area 37 were found 21[67] Marine Mammals species (some other authors report only 19). Marine Mammals are present in particular the Mediterranean Sea and are less common in the Eastern Mediterranean and Black Sea. Of these, eight species are common and stable but not endemic in the Mediterranean Sea[68]. Moreover, 12 Species are assessed according their current IUCN status:

- One species is consider Critical Endangered (**CR**);
- Five species are consider Endangered (**EN**);
- Two species are consider Vulnerable (**VU**);
- Four species are considering Data Deficient (**DD**).

Among the most threatened species is the *Monachus monachus*, which is catalogued

[67] http://www.parconazionale5terre.it/santuario_dei_cetacei.asp?id_lingue=1, Date accessed, 29 October 2014.

[68] About 80 species of cetaceans classified at global level. 19 species are observed in the Mediterranean Sea and Black Sea. Eight species are common, the other are define "accidental". None of these are endemic species, they are cosmopolitan species distributed in all the oceans of the world. Their origin is mainly Atlantic (Notarbartolo di Sciarra *et a*l. 2004).

as critically endangered by the IUCN and listed in Appendix I of the Washington Convention (CITES). The monk seal population in Mediterranean Sea in close to extinction, and it is presently reduced to groups of few individuals.

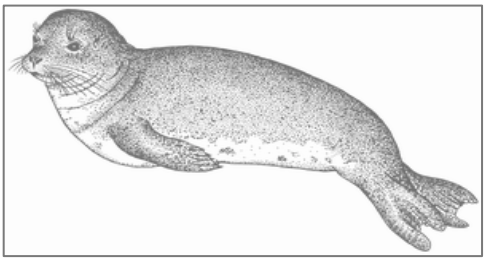


Figure 20. ***Monachus monachus by*** **FAO**

The state of preservation and By-catch of the single species varies considerably, depending on the area of diffusion. This is due to numerous factors: the high number of species considered, the various fishing area and fishing gears involved, and the level of adhesion to the international agreements on By-catch prevention by single nations or regions.

The reduction and depletion of food resource and accidental catches constitute the main threat for cetacean in the FAO Major Fishing Area 37. Monk seals, for example, tend to increase their interaction with gear, trying to prey fish entrapped in nets because overfishing has depleted their natural source of food.
Monk seals and other marine mammals' death is also directly connected to unselected fishing gear, in particular to driftnets used for *Xiphias gladius* (Swordfish). The other most dangerous fishing gear is purse seine, mainly used to catch *Thunnus thynnus* (the Atlantic Bluefin tuna).

Finally, artisanal tools like gillnets, represent the cause of some accidental capture for cetacean, but they remain secondary to the previously mentioned gears.

Marine Turtles:

As regards to the eight classified species of Marine Turtles, five are reported in the Mediterranean Sea. Among these, two are classified as occasional species:

- *Caretta caretta*, (common);
- *Chelonia mydas* (common);
- *Dermochelys coriacea* (common);
- *Lepidochelys kempii* (occasional);
- *Eretmochelys imbricata* (occasional).

The Nile Soft-shelled turtle (*Trionix triunguis*), is a further endemic turtle species which is not properly marine, but lives in the Eastern Mediterranean coastal

wetlands.

All the Marine Turtles species are under the Washington Convention and listed in the Annex I. Despite their status of threatened species, only *Caretta caretta* is classified as Endangered (EN) by Italian IUCN Red List (the other species are consider Not Applicable NA[69]). However, at global level all species are considered Endangered or Vulnerable. As a regard of the FAO Major Fishing Area 37, Marine Turtle are mainly observed in the Southern and Eastern Mediterranean.

According to Lee and Poland (1998), the impact of fisheries on the Marine Turtle population is highly depleting, if we consider the number of accidentally captured individuals (ca. 60,000) and their mortality rate (up to 50 percent).

The most dangerous fishing gears are surface longline (used for swordfish capture) and driftnets. The first can cause deadly injuries, the second keep turtles under water causing death by drowning.

Other gears such as bottom trawl and gillnets constitute secondary threats.

Sharks:

Most of the about 50 Shark species are reported in the Mediterranean Sea, These are classified in five Orders, 17 Families and 27 Genera (Maddalena *et al*, 2005). Other Shark species are sporadically observed in Area 37, but their presence is uncertain. Around of 50% of the Shark species in the Mediterranean Sea are considered Threatened (Critically Endangered **CR**, Endangered **EN** or Vulnerable **VU** according the IUCN Red List). Unfortunately, 30% of the species are considered Data Deficient (**DD**)[70]. The remaining 20% are considered neither threatened nor DD. The General Fisheries Commission for the Mediterranean (GFCM) considers the implementation of the FAO International Plan of Action on-Sharks (IPOA-Sharks) a high priority on its Agenda.

Low selective fishing practices in demersal fishing have a strong impact on the Mediterranean shark population and lead to high By-catches. As in the case of turtles, surface longline and driftnets used to capture swordfish are a direct cause of mortality for sharks. The ratio of By-catches, however, depends on the fishing areas: higher the number of Marine Protected Areas, lower the number by-catches.

Not always sharks' by-catch leads to discard, in fact some of the accidentally capture species are marketed.

Seabirds:

Seabirds constitute a major biological warning indicator of various types of contaminants and environmental depletion.

Mediterranean seabirds are threatened by various factors related to human activities

[69] http://www.iucn.it/liste-rosse-italiane.php?ricerca=Chelonia&submit=Vai, Date accessed 30 October 2014.

[70] http://cmsdata.iucn.org/downloads/mediterranean_shark_information_kit.pdf, Date accessed, 30 October 2014.

such as fishing gear, depletion of fish stock, drainage of lagoons and pollution.

Medmaravis[71] in 2003 classified as endangered 15 species of seabirds and later (2005) added 10 further species to this list. The seabirds were to be treated according to the Action Plan established during Biodiversity Protocol of the Barcelona Convention[72].

The Action Plan provides a series of measures similar to those to be applied for the other sensitive species[73].

- Identification of the most relevant seabird areas;
- Development and implementation of appropriate legislation for the 25 above mentioned seabird species and their habitats;
- Filling knowledge gaps of coastal and pelagic seabirds and their habitats;
- Public awareness and education programs highlighting the vulnerability of threatened species;
- Elaboration of national action plans.

The General Fisheries Commission for the Mediterranean (GFCM) considers the implementation of the FAO International Plan of Action on-Seabird (IPOA-Seabird) a high priority on its Agenda.

Seabirds' mortality can be directly and indirectly connected to fishing activities. Directly when low selectivity of fishing gears leads to the incidental capture of seabirds, indirectly when trophic availability is scarce due to overfishing.

Longline is the principal cause of death in the Mediterranean Area, and also a direct effect of human activity, whereas purse seine affects seabirds food source and therefore and indirect effect.

Interaction of by-catch with target species and gears

We have seen how By-catch is strictly connected to both target species and gears involved for their capture. Some species are more significant than others for their global commercial relevance and visibility, like Bluefin Tuna and Swordfish.
In the following paragraphs we will delineate the example of Bluefin Tuna and then we will illustrate the main fishing gears involved in by-catch.

4.44. Bluefin TUNA Fisheries in FAO Major Fishing Area 37

All tuna species belong to the *Scombridae* family. Bluefin tuna is a common name that encompasses many tuna species and overarches the Genus Thunnus:

[71] http://www.medmaravis.org, Date accessed, 10 November 2014. It is an International Non-Governmental Organization that deals marine environment, conservation of coastal habitats and Seabirds. It studies the role of seabirds as a biological indicators in the ecosystem.
[72] http://www.unepmap.org/index.php?module=content2&catid=001001004, Date accessed, 10 November 2014.

Thunnus maccoyii (the Southern Bluefin tuna), *Thunnus orientalis* (the Pacific Bluefin tuna), *Thunnus tonggol* (the Longtail tuna) and *Thunnus thynnus* (the Atlantic Bluefin tuna). Tuna species are included in the ANNEX I of the UN Convention on the Laws of the Sea (UNCLOS). They also can be classified into tropical tuna such as Yellow fin tuna such as *Thynnus albacares* and temperate tuna species, such as albacore (*Thunnus alalunga*) and Bluefin tuna (Thunnus thynnus).

The Bluefin Tuna is the most representative species for the Mediterranean. It reaches up to approximately 3 meters in length and more than 650 kilos in weight (Block *et al*. 2001). Thanks to its high commercial relevance, Bluefin Tuna stocks can be considered **O**verexploited[74]; the total amount of captures overcomes the Total Allowable Catches (Catch quota *per annum*). Japan (already cited as a member Country of the GFCM), is probably the world tuna stocks major exploiter, especially in relation to Bluefin tuna in the Mediterranean Sea.

Some recognized International Organizations deal with tuna fisheries, monitoring stock assessment and producing evaluations. As regards to this case study, ICCAT[75] (International Commission for the Conservation of Atlantic Tunas, 1969) and the GFCM (General Fisheries Commission for the Mediterranean, 1952) are the two RFMO (Regional Fishery Management Organization) which have the jurisdiction and the responsibility of the Tuna species.

GFCM deals with the Mediterranean Sea area, with the tuna and tuna-like species, while ICCAT deals with the Atlantic Ocean and "adjacent seas". Thanks to FAO's intermediation, ICCAT and GFCM collaborate for the implementation of the measures introduced by ICCAT on tuna fisheries both in the Mediterranean Sea and GFCM Member Countries.

Worth to mention are the small-scale fisheries specialized in capturing Tuna and Tuna-like species. These fisheries have a great relevance in the Mediterranean Sea mainly for the traditional implications. Unfortunately, due to their low economic relevance, Small-scale fisheries are scarcely considered nor studied by international bodies in relation to their the traditional and economic relevance, as well as to their role in terms of By-catch, in particular as regards to sensitive species like Sea Turtles and Marine Mammals. It is difficult to identify Small-scale fishing gears such as gillnets, logline and or other traditional gear such as harpoon. However, in the Mediterranean the total amount of registered capture concerning Tuna is rather low. Data are generally fragmentary or incomplete, and therefore it is impossible to

[74] Overexploitation or overfishing occurs when a fish stock has been fished down, with a risk of stock depletion. http://en.wikipedia.org/wiki/Overexploitation, Date accessed, 27 November 2014.

[75] **ICCAT,** the International Commission for the Conservation of Atlantic Tunas, 1969, it is an Inter-Governmental Organization overarching the conservation of tunas and tuna-like species in the Atlantic Ocean and its adjacent seas such as Mediterranean Sea. https://www.iccat.int/en/, Date accessed, 27 November 2014.

estimate the amount of By-catch. ICCAT and GFCM have often remarked the inconsistency and non-homogeneity of the data collected by the Mediterranean neighboring countries.

Tuna overexploitation is directly connected to its high global demand. As a consequence, tuna captures constitute one of the major causes of depletion of tuna stocks and thus one of the major causes of By-catch. Sustainability of this fishing practice appears therefore extremely hard, if not impossible to achieve. By constantly overcoming fishing quotas, it is almost impossible for tuna stocks to regenerate, putting the whole species at risk of extinction in next few decades.

Moreover, as regard to By-catch, longline and gillnets used to capture tuna and swordfish, are also the most threatening devices for sensitive species such as Marine Mammals, Sharks and Sea Turtles.

In the next paragraph we will examine the major fishing gear utilized in the Mediterranean that are involved in By-catch and Discards.

4.45. Fishing gears and methods

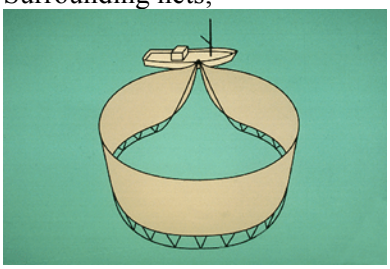
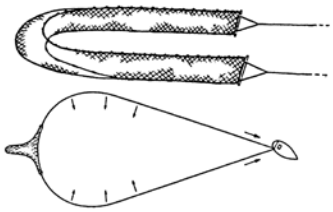
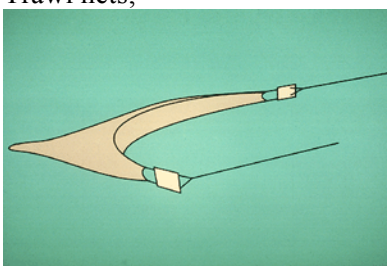
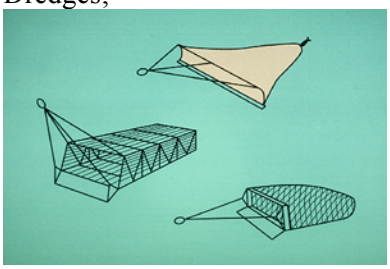
FAO defines Fishing Gear the tool utilized to capture aquatic resources, and Fishing Method the way a gear is used.

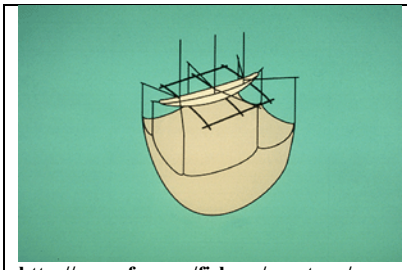
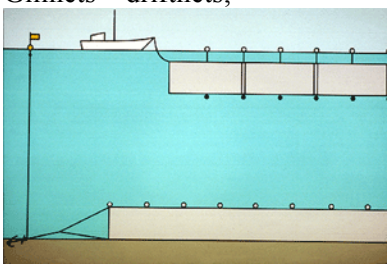
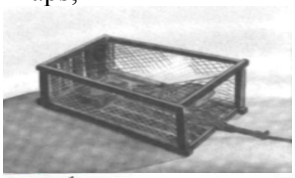
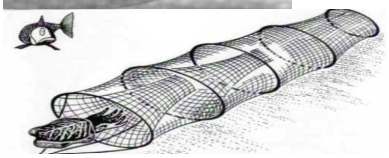
Hereby we report FAO classification of main Fishing Gear Categories[76]. The list is obviously subject to continuous updating and modification according to the development of different techniques apt to decrease By-catch and Discards. In fact, in the past fishing gear was conceived to improve amount of captured fish, whereas today, one of the main goals is to improve selectivity and safeguard of the environment and reduce By-catch:

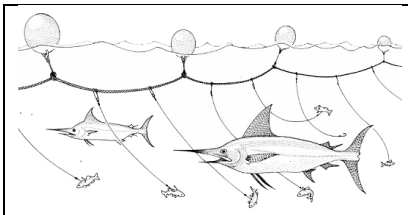
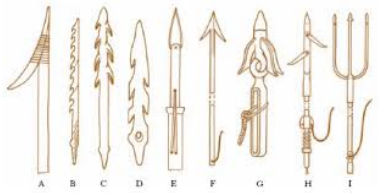
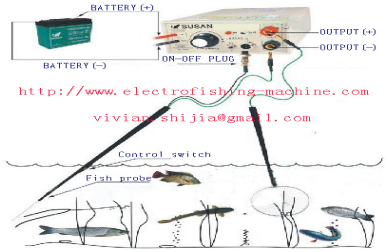
- Surrounding nets;
- Seine nets;
- Trawl nets;
- Dredges;
- Lift net;
- Falling gears;
- Gillnets;
- Traps;
- Hooks and lines;
- Grappling and wounding gears;
- Stupefying devices;

The following is a table classifying the type of gear according to the target species and the non-target species most accidentally captured.

[76] http://www.fao.org/fishery/topic/1617/en, Date accessed, 10 November 2014.

Type of fishing gear	**Target species**	**By-catch**
Surrounding nets;  **http://www.fao.org/fishery/geartype/search/en.**	Pelagic species both large (tuna and tuna-like species) and small ones, e.g. *Thunnus thynnus*.	Dolphins and other cetacean as a sensitive species and small sized and immature specimens of most target species.
Seine nets;  **http://www.fao.org/fishery/geartype/search/en.**	Demersal species, less frequently for pelagic species.	Undersize specimens, no marketable specimens, as results from the use of a large net, with, frequently, too small meshes, in coastal waters.
Trawl nets;  **http://www.fao.org/fishery/geartype/search/en.**	Demersal, pelagic and bottom species. According to the type of trawl net, the impact on the endemic *Posidonia oceanica* and other benthic organisms could be relevant.	The major potential detrimental impact of trawling on species can be the capture and removal from the ecosystem of small sized organisms and non-target species, which frequently are discarded at sea.
Dredges;  **http://www.fao.org/fishery/geartype/search/en.**	Shellfish and mollusks such as oyster, scallops etc.	Impacts to the sea bottom and the associated benthic organisms.
Lift net;	Small pelagic species	Associated species or

 **http://www.fao.org/fishery/geartype/search/en**	such as squid.	smaller sizes of fish can be attracted, in addition to target species (a By-catch which is some time discarded at sea).
Falling gears;   **http://www.fao.org/fishery/geartype/search/en**	Used for capturing the shoal of fish swimming near the water surface, either single fish.	Limited in By-catch, usually used to shallow waters.
Gillnets – driftnets;  **http://www.fao.org/fishery/geartype/search/en**	Pelagic, demersal and benthic species.	Incidental catch of a large number of endangered and sensitive species such as Sea turtles, Sharks, Marine Mammals and Seabird.
Traps;   **http://www.arpa.emr.it/cms3/documenti/_cerca_doc/mare/progetto_mare/attrezzature_da_pesca.htm.**	Used often to catch migrating fish (pelagic and demersal). Pots are also used for catching lobster, crabs, shrimps, octopus, eels, and all kinds of reef fish and Euryhaline species.	Juveniles or undersized specimens, some non-marketable specimens.
Hooks and lines;	Pelagic, demersal and	Some sensitive species.

 **http://fishingdivingliving.blogspot.it**	benthic species such as *Xiphias gladius* . Swordfish Lonlines appeared the be responsible for the major mortality rate in Marine Turtles.	Marine Turtles and Seabirds in particular. Furthermore, Loglines fishing is also the cause of high Seabird mortality rate in Mediterranean fisheries.
Grappling and wounding gears;  **http://www.treccani.it/enciclopedia/arpione/**	Isolated fish and single specimens swimming near the water surface.	In many countries the use of this gear is banned. Harpoon are also utilized in some traditional Small-scale fisheries. The By-Catch are Marine Mammals and Dolphins.
Stupefying devices; Such as cyanide and electroshock  **http://www.electrofishing-machine.com/productinfo/detail_22_39_86.aspx.**	Electrofishing is often used for scientific purpose.	In some countries the use of cyanide, chemical and explosives is banned.

As it clearly emerges from the list of the most relevant fishing gears involved in By-catch illustrated above, eliminating completely By-catch is probably impossible. However, a more constant and consistent application of the already existent legislation at all levels, together with a higher consciousness of the countries involved, the institution of new MPAs (Marine protected Areas) and finally the adoption of more selective fishing gear, could undoubtedly improve the safeguard of sensitive species.

4.46. CONCLUSION

While examining By-catch and Discards from a Sustainable point of view, that is considering the environmental, social and economic issues, we can focus either on the target species or the incidentally captured ones.

If we contemplate the most economically relevant species, such as Tuna and Tuna-like species, we must admit that sustainability is not achievable at present, because the increasing demand of the species, combined with high market prices and ever decreasing fish stock, show us that the environmental and social balance are constantly negative. As for the economic aspect, even if this could be momentarily positive, if fish stock will not regenerate, any revenue will be only a short-term one.

If we examine the problem from the non-target and sensitive species point of view, an increasing fishing effort, trying to capture decreasing target species, unavoidably brings to the impossibility to minimize the impact on sensitive species. At the same time, according to Beddington (Beddington *et al.,* 1985), the incidental capture of non-target species, impacts negatively not only on the environment and biodiversity, but also indirectly on target species (interruption of trophic chain) and to man (gear damage and depletion of commercially valuable fish stock).
In conclusion, Sustainable Fishing cannot avoid taking By-catch and discards into the greatest consideration and can be achieved only by combining a series of actions:

- Application of the already existing International Legislation;
- Institution of new effective MPAs;
- Monitoring fishing practices and gears;
- Research on new and more selective fishing gears;
- Increasing fishermen and consumers awareness;
- Decreasing the size of fishing vessel.

Along with this ineludible actions, much more could be done if only it could be possible to temporarily ban the fishing of some target species such as Tuna, but we are aware that this could internationally arise such major economic, political and cultural problems, that will never be considered as an option.

BIBLIOGRAPHY

Alverson L. *et al.* 1994, A Global assessment on fisheries By-catch and discard. FAO Technical Paper 339 FAO FOOD AGRICULTURE ORGANIZATION ROME.

Abdulla A. 2004, Status and Conservation of Sharks in the Mediterranean Sea, IUCN Global Marine Programme, IUCN The World Conservation Union Publishing.

Affronte M. et al. (?), Tartarughe Marine, Biologia e Conservazione, Progetto *Caretta caretta*, Dipartimento di Biologia Animale e dell'Uomo, Università di Torino, CNR Firenze, Politecnico di Milano, pp. 21, 85.

Beddington J.R. *et al*. 1985, Marine Mammals and Fisheries. George Allen & Unwin. London p. 354.

De Maddalena A. **& Bansh H**. 2005, Squali del Mar Mediterraneo, Franckh-Kosmos Verlags-Gmbh & Co. KG. Stuttgart. p. 70.

Bene' C. *et al*. 2007, Increasing the contribution of Small-scale fisheries to poverty alleviation and food security, FAO Fisheries Technical Paper 481, FAO FOOD AGRICULTURE ORGANIZATION Rome Italy, p. 82.

Block *et al.* 2001, Migratory Movements, Depth Preferences and Thermal Biology of Atlantic Bluefin Tuna. Science, 293, pp. 1310-1314.

Chaloupka M. 2004, Southern Great Barrier Reef Green Sea Turtle (*Chelonia mydas*) Stock cited in **Akacakaya H.R.** 2004, Species Conservation and Management, Oxford University Press Inc. pp. 340-341.

Dayton L. A. et al. 1994, a global assessment of fisheries By-catch and discards, FAO Fisheries Technical Paper No. 339, FAO, FOOD AGRICULTURE ORGANIZATION, ROME.

FAO, 1995, The Coordinating Working Party on Fishery Statistics: Its origin, Role and Structure. FAO Fisheries Circular No. 903 Rome December 1995.

FAO, 1999, Definition and classification of fishing gear categories, FAO Fisheries Technical Paper. No. 222. FAO, FOOD AGRICULTURE ORGANIZATION, ROME.

FAO, 2009, Technical Guidelines for Responsible Fisheries, Number 1: Fishing operations. Supplement 2 Best practice to reduce incident catch of seabird in capture fisheries, FAO FOOD AGRICUTURE ORGANIZATION, ROME.

FAO, 2011, International Guidelines on By-catch Management and reduction of discard FAO FOOD AGRICUTURE ORGANIZATION, ROME.

FAO 1964, Modern Fishing Gear of the World 2. FAO World Fishing Gear Congress, Reykjavik 1970. FAO FOOD AGRICUTURE ORGANIZATION, ROME.

FAO 1971, Modern Fishing Gear of the World 3. FAO World Fishing Gear Congress, London 1963. FAO FOOD AGRICUTURE ORGANIZATION, ROME.

Garcia S.M. ***et al*** 2003, The Ecosystem approach to fisheries, Issue, terminology, principles, institutional foundations, implementation and outlook. FAO, Fisheries Technical paper 443, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, Italy p. 20.

General Fisheries Commission for the Mediterranean 2013, Studies and Reviews No. 93, Indicators for Sustainable Aquaculture in Mediterranean and Black Sea Countries, FAO, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, Italy.

General Fisheries Commission for the Mediterranean 2012, Studies and Reviews No. 91, Elasmobranchs of the Mediterranean and Black Sea: Status Ecology and Biology Bibliographic analysis, FAO, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, Italy.

General Fisheries Commission for the Mediterranean 2012, Rec. Decision GFCM/36/2012/2 En. On mitigation of incidental catches of cetaceans in the GFCM area. FAO, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, Italy.

General Fisheries Commission for the Mediterranean 2012, Rec. Decision GFCM/36/2012/3 En. On Fisheries management measures for conservation of sharks and rays in the GFCM area. FAO, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, Italy.

General Fisheries Commission for the Mediterranean 2011, Rec. Decision GFCM/35/2011/7 En FAO, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, Italy.

General Fisheries Commission for the Mediterranean 2011, Rec. Decision GFCM/35/2011/3 En. On reducing incidental by-catch of seabird in fisheries in the GFCM Competence Area. FAO, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, Italy.

General Fisheries Commission for the Mediterranean 2011, Rec. Decision GFCM/35/2011/4 En. On the incidental by-catch of sea turtles in fisheries in the GFCM Competence Area. FAO, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, Italy.

General Fisheries Commission for the Mediterranean 2011, Rec. Decision GFCM/35/2011/5 En on Fisheries for the conservation of the Mediterranean monk seal (*Monachus monachus*) in the GFCM Competence Area - FAO, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, Italy.

General Fisheries Commission for the Mediterranean 2010, Rec. Decision GFCM/34/2010/4 En FAO, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, Italy.

General Fisheries Commission for the Mediterranean 2009, Studies and Reviews No. 85, Regional Study on Small Tunas in the Mediterranean including The Black Sea. FAO, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, Italy.

General Fisheries Commission for the Mediterranean 2004, Studies and Reviews No. 74, Ecosystem effects of fishing in the Mediterranean: an analysis of the major threats of fishing gear and practices to biodiversity and marine habitats, FAO, FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, Rome, Italy.

GFCM 2011, *Background on marine Mammal's By-Catch issue in Mediterranean and Black Sea*, 2nd Transversal Working Group on By-Catch – 7-9 December 2011 Antalya, Turkey, General Fisheries Commission for the Mediterranean, Scientific Advisory Committee (SAC), Sub-Committee on Marine Environment and Ecosystem Sub-Committee on Stock Assessment.

GFCM 2011, *List of Abstracts*, 2nd Transversal Working Group on By-Catch – 7-9 December 2011 Antalya, Turkey, General Fisheries Commission for the Mediterranean, Scientific Advisory Committee (SAC), Sub-Committee on Marine Environment and Ecosystem Sub-Committee on Stock Assessment.

GFCM 2011, *Review of Existing Knowledge on Fisheries By-Catches and Discards in the GFCM Area*, 2nd Transversal Working Group on By-Catch – 7-9 December 2011 Antalya, Turkey, General Fisheries Commission for the Mediterranean, Scientific Advisory Committee (SAC), Sub-Committee on Marine Environment and Ecosystem Sub-Committee on Stock Assessment.

Gillett R. 2011, By-catch in Small-scale tuna Fisheries, A global study. FAO FISHERIES AND AQUACULTURE TECHNICAL PAPER 560. FAO, FOOD AGRICULTURE ORGANIZATION, ROME.

Gilman E. & Passfield K. & Nakamura K. 2012, Performance Assessment of By-catch and Discards Governance by Regional Fisheries Management Organizations, IUCN Commission on Ecosystem Management and Oceania Regional Office.

Gurbet R. *et al.* 2013, Discards in bottom trawl fishery in the Aegean Sea (IZMIR Bay, Turkey), Journal of Applied Ichthyology, ASFA Marine Biotechnology Abstracts; Oceanic Abstracts.

Hall M.A. 1996, On By catches. Reviews in Fish Biology and Fisheries, 6, pp. 319-352 cited in **Lovatelli A. *et al***. 2004, Capture-Based Aquaculture, FAO Food Agriculture Organization ROME, p. 195.

IUCN/SSC 2010, Sea Turtles in the Mediterranean, Distribution, threats and conservation priorities**.** IUCN/SSC - Marine Turtle Specialist Group Publisher. Gland-Switzerland, pp. 2-9.

IUCN-Med 2010, Mediterranean Pelagic habitat, Oceanographic and Biological Processes. An Overview, IUCM-MED.

Jacek M. 2007**,** Global Fisheries resources of Tuna and Tuna-like species. FAO Fisheries Technical Paper 483. FAO, FOOD AGRICULTURE ORGANIZATION, ROME, p. 9, 19, 26-30.

Kelleher K. 2005, Discards in the world's marine fisheries. An update. FAO Food Agriculture Organization ROME N. 470 p. 131.

Lee H.A. & Poland G.C.R. 1998, Threats by Fishing. Euro Turtle web page: http://www.euroturtle.org/threats.htm, Date accessed November 20, 2014.

Lovatelli A. *et al*., 2004. Capture Based Aquaculture, Food Agriculture Organization ROME, pp. 195-197.

NOAA 2011, U.S. National By-catch Report, NOAA Technical Memorandum NMFS, USA.

Northridge Simon P. 1991, Driftnet fisheries and their impacts on non-target species: a worldwide review. FAO, FOOD AGRICUTURE ORGANIZATION, ROME.

Notarbartolo di Sciarra G. & Demma M. 2004, Guida dei Mammiferi Marini del Mediterraneo, franco Muzio Editore. p. 51, 161.

Notarbartolo di Sciarra G. & Bianchi I. 1998, Guida degli squali e delle Razze del Mediterraneo, Franco Muzio Editore, p. 77.

Oyvind L. 2008, Improving farmed fish quality and safety, CRC Press New York, pp. 329-330.

Pascoe S. 1997, By-catch Management and the economics of discarding, FAO Technical Paper 370, FAO FOOD AGRICUTURE ORGANIZATION, ROME.

Perrin F. *et al.* 2009, Encyclopedia of Marine Mammals, second edition Academic Press Elsevier, Oxford, p. 167.

Pope John G. *et al.* 1996**,** A global assessment on fisheries by-catch and discard, FAO FOOD AGRICUTURE ORGANIZATION, ROME.

Pope John G. *et al.* 2000, Gauging the impact of fishing mortality on non-target species, ICES Journal of Marine Science vol. 57, pp. 689-696.

Schmidt Carl-Christian 2013, The EU fish discards ban: Where's the Catch? OECD Publisher, ASFA Aquatic Sciences and Fisheries Abstracts.

Schwarts H. *et al.* 2008, Aquaculture Research Trends, Nova Science Publiscers, Inc. New York p. 2.

Tortonese E. 1956, *Leptocardia, Ciclostomata, Selachii*, Fauna D'Italia, Voll. II, Edizioni Calderini Bologna Italy.

UN General Assembly 2001, Resolution 55/8 of 30 October 2000 at its 55th session on "Large-scale pelagic drift-net fishing, unauthorized fishing in zones of national jurisdiction and on the high seas, fisheries by-catch and discards, and other developments.

UN General Assembly 2002, Resolution 57/142 of 12 December 2002 at its 57th session on "Large-scale pelagic drift-net fishing, unauthorized fishing in zones of national jurisdiction and on the high seas/illegal, unreported and unregulated fishing, fisheries by-catch and discards, and other developments".

Vander Zwaag D.L & Chao G. 2012, Aquaculture Law and Policy, towards principles access and operations, Rutledge Advances in Maritime Research, pp. 494, 501.

5. CONCLUSION AND PERSPECTIVES

Any veritable perspective on Sustainable Development in Aquaculture and Fisheries is to be integrated in an international context that needs to fulfill the Millennium Development Goals (see Chapter 2) by the end of 2015.
Although a few of the goals have been at least partially achieved, most of them are far from being fulfilled.
The achievement of the Millennium Goals is at the core of our work. We have closely examined Goal 7: Ensure environmental sustainability; we have then focused on its four targets, and in particular on Target 7B, concerned with the reduction of biodiversity loss by 2010.
The indicators for monitoring the progress of Target 7B are the following:

7.1. Proportion of land area covered by forest;
7.2. CO2 emissions, total, per capita and per $1 GPD (PPP);
7.3. Consumption of ozone-depleting substances;
7.4. Proportion of fish stocks within safe biological limits;
7.5. Proportion of total water resources used;
7.6. Proportion of terrestrial and marine areas protected;
7.7. Proportion of species threatened with extinction[77];

Among the above indicators, 7.4 through 7.7 are the most relevant for our work. According to the annual MDG Reports, these indicators show that, although some progress has been made as far as reduction of biodiversity loss, proportion of protected terrestrial and marine areas and safeguard of threatened species, we are still far from the achievement of 7B target.

Data supplied on this subject differ depending on the source, whether they are reported by UN agencies or NGOs. However, even if UN agencies show slightly better results than NGOs, both worlds are conscious that much is still to be done.

The reasons of this negative outcome are to be mainly imputed to Donor Countries that fail to apply the measures they themselves subscribed. This is due to shortsighted economic interests and policies, inserted in the international financial crisis of the past recent years.

Furthermore, the financial crisis led to political instability and low intensity conflicts in several regions, mostly located in developing countries. The same regions are often involved the sustainable development in aquaculture and fisheries, and therefore strive to align with sustainable criteria.

[77] http://mdgs.un.org/unsd/mdg/Host.aspx?Content=indicators/officiallist.htm, Date accessed: November 2, 2015.

As far as our case studies are concerned in relation to Target 7B, we can see that each case study is related to the above indicators. Indicators 7.2 and 7.3 are related to Case Study n.1 as climate change has a heavy impact on the long life cycle of Eel. Failing to achieve them makes this species even more fragile and threatened.

Indicator 7.4 is related to all Case Studies. In Cases 1 and 3 for excessive exploitation, whereas in Case Study n. 2 for the excessive spread and high reproduction rate of Nile Perch that crosses the safe biological limits of other endemic species.

Indicator 7.6, concerned with the marine protected areas, is important in relation to Case Study n. 3. The safeguard of sensitive species involved in By-catch and Discards can certainly be enhanced by the increase of areas where the same species are protected, even if this is not sufficient and must be integrated by more adequate fishing practices.

Finally, indicator 7.7, concerned with the species threatened with extinction, seems to be rather generic if confronted with its goals. It is not clear which species can be considered endangered, whether those enlisted in CITES or in IUCN Red List, or even those Not Evaluated or Data Deficient but still commonly considered threatened by anthropic activities, climate change and alien species.

If we the above indicators to all our case studies, we can easily infer that not only is Target 7B far from being achieved, but it also won't be achieved in the short or medium period.

Eel cannot be adequately protected unless some crucial impeding factors are removed or mitigated: direct anthropic interference with Eel's life cycle and Climate Change are certainly the hardest to mitigate, but there are also other factors to consider, like the inclusion of all Eel species of commercial purpose under Washington Convention Legislation, and the application of already existing international agreements such as CCRF (Code of Conduct of Responsible Fisheries). All these factors are functional to one of the major opportunities for the Eel to avoid extinction: allowing it to complete, at least partially, its natural long life cycle.

Another futuristic opportunity could be to create a closed life cycle that would allow not only having a larger number of specimen available for commercial purposes, but also to safeguard and repopulate wild stock.

Nile Perch is certainly not an endangered species given its high reproduction rate and its top-level predator characteristics, especially where it has been introduced as an alien species in many part of the world. Nile Perch unsustainability is in fact related to its contribution to biodiversity loss through the modifications of natural environment and the menace to the endemic species. Man, though, does not strictly relate to the species, but rather to the overexploitation of one single species the unsustainable social aspects of Nile Perch Fishing activity, for commercial purposes.

Moreover, the excessive dependence of Nile Perch trade from international market fluctuations combined with short-term illegal and disorganized practices; contribute to the vulnerability and unsustainability of Nile Perch trade.

By-catch and Discards issues, embrace all aspects of sustainability. Firstly the capture of non-target species has a strong impact on biodiversity, secondly overexploitation and the consequent scarcity of some species have strong economic and social effects. FAO major Fishing Area 37 is too vast and non-homogeneous to be considered as a whole and solutions could only be found by specific solutions for the numerous sub-areas and contests. Nevertheless, the most powerful tools to reduce accidental catch are to increase the selectivity of fishing gear and the number of marine protected areas (MPAs).

After having examined the three Case Studies from a Sustainable point of view, we can affirm that, besides protecting the long life cycle of Eel, preventing the spread of Nile Perch and consequent loss of biodiversity, improving the selectivity of fishing gears and implementing new protected areas, there is one potential instrument that could help improve the sustainability of our three case studies as well as most of fishing and aquaculture activities, that is Small-Scale Fisheries.

A reduction of size could help reduce the environmental impact in all three cases, but could also improve the social aspects by enlarging the participation to profits (as in Case Study 2). In an unsustainable context, in fact, Small-scale fisheries, combined with adequate education and environmentally oriented policies (e.g. Ecosystem Approach), could reduce the impact while enlarging economic participation, integration and social inclusion.

6. ANNEX.

LIST OF ABBREVIATIONS AND ACRONYMS

APHIS	US-Animal and Plants Health Inspection Service;
CA	*Codex Alimentarius*;
CAF	GFCM Committee on Administration and Finance (CAF),
CAQ	GFCM Committee on Aquaculture (CAQ);
CBD	Convention on Biodiversity;
CC	Codex Alimentarius Commodity Committee;
CCFFP	Codex Committee Fish and Fishery Products;
CCRF	Code of Conduct of Responsible Fisheries;
CITES	Convention on International Trade in Endangered Species of Wild Flora and Fauna;
CMS	UN Convention on Migratory Species;
CMSC	GFCM the Coordination Meeting of the Sub-Committees (CMSC);
CoC	GFCM Compliance Committee (CoC);
COMTRADE	UN-International Trade Statistic Database**;**
COP	Conference of the Parties;
CWP	Coordinating Working Party on Fishery;
DFID	UK Department for Development;
EA	Ecosystem Approach;
EAA	Ecosystem Approach to Aquaculture;
EAF	Ecosystem Approach to Fisheries;
EBFM	Ecosystem-base Fisheries Management;
EC	European Community;
ECPOA	European Community Plan of Action (ECPOA) for reducing incidental catch of seabirds in fisheries;
ECPOA	Plan of Action for reducing incidental catch of seabirds in fisheries by European Community;
EELs	Genus *Anguilla spp*.;
EEZs	Exclusive Economic Zones;
EN	Endangered Species (IUCN Red List);
EPA	US-Environmental Protection Agency;
ESA	US-Endangered Species Act;
EU	European Union;
FAO	UN-Food and Agriculture Organization;
FDA	US-Food and Drug Administration;
FIPM	FAO Fish Utilization and Marketing Service, Fisheries Department;
FSA	UN-Fish Stock Agreement;
FWS	US-Fish and Wildlife Service;

GATT	see WTO; General Agreement on Tariffs and Trade;
GFCM	General Fisheries Commission for the Mediterranean;
GHG	Greenhouse Gas;
GISD	Global Invasive Species Database**;**
GSAs	Geographical Sub-areas (GFCM);
GTZ	The German Organization for Technical Cooperation;
HACCP	Hazard Analysis and Critical Control Point;
HIPC	Heavily Indebted Poor Countries**;**
ICES	International Council for the Exploration of the Sea;
IES	Japanese International Endangered Species;
IFAD	UN-International Fund for Agricultural Development;
IMF	International Monetary Fund
IPOAs	International Plan of Actions;
IPPC	International Plant Protection Secretariat;
ISSG	Invasive Species Specialist Group**;**
IUCN	World Conservation Union;
IUU Fishing	International Plan of Action to stop illegal unreported and unregulated fishing;
LC	Least Concern (IUCN Red List);
LCES	Japanese Law for the Conservation of Endangered species;
LOSC	see UNCLOS;
MAFF	Ministry of Agriculture, Forestry and Fisheries of Japan;
MDGs	Millennium Development Goals;
MOE	Ministry of the Environment of Japan;
MPAs	Marine Protected Areas;
MRLs	Maximum Residue levels;
MSE	Management Strategy Evaluation;
NACA	Network of Aquaculture Centers in Asia-Pacific;
NDP	National Development Plan (Uganda);
NEAP	National Environment Action Plan (NEAP);
NES	Japanese National Endangered Species;
NFP	National Fisheries Plan of New Zealand**;**
NGOs	Non-governmental Organizations;
NOAA	National Oceanic Atmospheric Administration;
NSGRP	National Strategy For Growth And Reduction Of Poverty (Rep. of Tanzania);
OECD	Organization for Economic Cooperation and Development;
OIE	World Organization for Animal Health, (Office International des Epizooties);
PPP	Polluter-Pays Principle;
PRA	Participatory Rural Appraisal;
PRS	Poverty Reduction Strategy;

PRSP	Poverty Reduction Strategy Paper;
PSA	Productivity susceptibility assessment;
SAC	GFCM Scientific Advisory Committee (SAC);
SCESS	GFCM the Sub-Committee on Economic and Social Sciences (SCESS);
SCMEE	GFCM Sub-Committee on Marine Environment and Ecosystem (SCMEE);
SCSA	GFCM Sub-Committee on Stock Assessment (SCSA);
SCSI	GFCM the Sub-Committee on Statistics and Information (SCSI);
SEAFDEC	Southeast Asian Fisheries Development Center;
SIPI	Italian Society of Fish Pathologists;
SLA	Sustainable livelihood approach**;**
SPS	Sanitary and Phytosanitary Agreement;
SRI	Stanford Research Institute;
SSC	IUCN Species Survival Commission;
SWOT	Strengths, Weaknesses, Opportunities and Threats;
TBT	Agreement on Technical Barriers to Trade;
TURFs	Territorial Use Right in Fisheries;
UN	United Nations;
UNCED	United Nations Conferences on Environment and Development;
UNCLOS	UN-Convention on the Laws of the Sea;
UNData	United Nations Commodity Trade Statistic Data Base;
UNDP	United Nations Development Programme;
UPP	User Pays Principle;
USDA	US-Department of Agriculture;
WB	World Bank;
WHO	World Health Organization;
WTO	World Trade Organization;

GLOSSARY

Aquaculture	Aquaculture is the farming of aquatic organisms, in inland and coastal areas, including fish, mollusks, crustaceans and aquatic plants. Farming implies some sort of human intervention and the individual or a corporate ownership in the rearing process, to promote production, such as stocking, feeding and protection from predators (FAO, 1995);
Biodiversity	The Variability among living organisms from all sources, including marine and other aquatic ecosystems and ecological complexes of which they are a part: this includes diversity within species, between species and of ecosystems (Crespi, 2008);
By-catch	The total catch of unwanted animals including vulnerable and endangered species. By-Catch of commercial species should be reported as associated species (GFCM). By-catch also is defines as discarded catch of any living marine resource and as unobserved mortality due to a direct encounter with fishing gear. Unobserved mortality is included in By-catch for endangered species where data are available (NOAA, 2011);
Capture-Base Aquaculture	Is the practice of collecting living seed material – from early life stages to adults from the wild, and its sub-sequent on-growing in captivity to marketable size, using aquaculture techniques (Lovatelli, 2004);
Ecosystem Approach (EAF)	The Ecosystem Approach to Fisheries was defined by Ward *et al*. (2002) as an extension of conventional fisheries management recognizing more explicitly the interdependence between human well-being and ecosystem health and the need to maintain ecosystem productivity for present and future generation;

Ecosystem	Ecosystems can be defined as "a system of complex interaction of populations between themselves and with their environment" or as "the joint functioning and interaction of these two components, populations and environment, in a functional unit of variable size" (Scialabba, 1998; Nybakken, 1982; Odum, 1975; Ellenberg, 1973);
Food Safety	The process of ensuring that products for human consumption meet or exceed standard of quality;
Food security	Exist when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary basic needs and food preferences for an active and healthy life (FAO, 1993); The protection and Management of biological resources for safe and sustainable human consumption (Melba Bondad-Reantaso, 2009);
Fresh Fish	The definition of fresh fish, in accordance with FAO Code of Practice for Fish and Fisheries Products specifies: products that have received no preserving treatment other than chilling. The chilling facility should be capable of maintaining the temperature of the stock between 0 and 4 °C;
Frozen Fish	Definition of frozen fish, in accordance with FAO Code of practice for Fish and Fisheries Products: products subject to a freezing process sufficient to reduce the temperature of the whole product to a level low enough to preserve the inherent quality of the fish. The facility should be capable of maintaining the temperature of the fish below -18 °C;
Inland Waters	It refers to lakes, rivers, stream, ponds, cannels, dams and other "freshwater lands", normally saline or brackish waters[78] are classified as a part of inland waters;

[78] According to FAO Glossary of Aquaculture brackish is defines as a "Water with a salinity intermediate between seawater and freshwater, usually showing wide salinity fluctuations".

Invasive Species	Certain living organisms that can be cause negative effects to economic, environmental and social point of view;
Live fish	The live product must be caught and stored to be sent to markets or distribution centers as quickly as possible, without causing excessive stress for the fish. The product must be in a good state of health without skin damage or the evident presence of skin parasites;
Marine Waters	It refers to oceans, seas and adjacent saltwater areas;
Non-Target Species	Is defines as a species non-target (other species), or in a different size range of the target species;
Poverty	The OECD adopted the following definition of Poverty in 2001:"Poverty encompasses different dimension of deprivation that relate to human capabilities including consumption and food security, health education, right voice, personal security, dignity and decent work";
Precautionary Approach	An approach that take into account precautionary principle;
Resilience	Is intended as the capacity of an ecosystem to resist to disturbances and recover to original conditions once the impact is mitigated or removed;
Risk	According to FAO "Risk" has been defined as "a combination of the severity of consequences and likelihood of occurrence of undesired outcomes";
Small-Scale Aquaculture	FAO Glossary of Aquaculture defines Small-Scale Aquaculture as: "Aquaculture system with a small annual production (max one tonne per unit and 10 tons in total), made of one or small production units; family or communally run; low to moderate input level and limited external labor;

Stakeholder	According to FAO Glossary of Aquaculture: any person o group with a legitimate interest, for instance in the utilization, conservation and management of resources;
Sustainable Development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Bruntland Commission, 1987);