Building the Mediterranean future together

TECHNICAL REPORT

May 2013

Greening the Mediterranean fisheries: tentative assessment of the economic leeway

UNEP

MAP

Plan Bleu

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Foreword

This report is the result of the analytical work done by Plan Bleu, as part of its program on the Sustainability of Maritime Economic Activities in the Mediterranean, MedSEA. The objectives of the MedSEA program are to assess the technical, economic and social characteristics of the activities that draw directly from the marine environment, and to analyze their interaction with marine ecosystems, in terms of both impacts to and benefits from these natural assets. The fisheries component of this program was also a contribution to 2012 MedReport.

The 2012 MedReport is an initiative of the Environmentally Sustainable Development Program, « Sustainable MED », which is aimed at mainstreaming environment within the economic development agenda of southern and eastern Mediterranean countries. The overall objective of the project is to apply sound economic analysis methodologies in order to tackle the main challenges facing the Mediterranean region, and to produce a report that will provide decision makers who may not be environmental specialists with the information and the tools that will strengthen the integration of environmental considerations as essential criteria driving policy decisions in coastal Mediterranean countries.

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Acknowledgments

The authors wish to express their gratitude for the guidance provided by the World Bank staff involved in the MedReport activity, mainly Gilles Pipien, Jean Pascal Bassino (consultant) and Xavier Vincent, PROFISH team member.

The authors are especially grateful for the contributions of Charlotte de Fontaubert, World Bank consultant, who reviewed the report and wrote the case study on Moroccan small scale fisheries.

The authors acknowledge the Sea Around Us Project, the Fisheries Centre of the University of British Columbia and particularly Rashid Sumaila, the works of which have been a constant source of inspiration for this study, whether in the form of publications or data.

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For bibliographic purposes this volume may be cited as:

Sauzade D., Rousset N. (2013). *Greening the Mediterranean fisheries: tentative assessment of the economic leeway*. Plan Bleu, Valbonne.

Acronyms and abbreviations

CFP	Common Fisheries Policy
DAP	Dedicated Access Privileges
EU	European Union
FCP	FAO Country Profiles
FTE	Full-Time Equivalent
FYA	Former Yugoslavia Area
GFCM	General Fisheries Commission for the Mediterranean
GRT	Gross Registered Tonnage
GSA	GFCM sub-area
GT	Gross Tonnage
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICES	International Council for the Exploration of the Sea
ISSCAAP	International Standard Statistical Classification of Aquatic Animals and Plants
ITQ	Individual Transferable Quota
IUU	Illegal, Unreported and Unregulated Fishing Activities
JRC	Joint Research Centre
MENA	Middle East and North Africa
MPA	Marine Protected Area
NEMC	North and East Mediterranean Countries
Nm	Nautical miles
OECD	Organization for Economic Co-operation and Development
RFMO	Regional Fisheries Management Organization
SAUP	Sea Around Us Project
SMC	South Mediterranean Countries
SSCF	Small Scale Coastal Fleet
STECF	Scientific, Technical and Economic Committee for Fisheries
TAC	Total Allowable Catches
WTO	World Trade Organization

Executive summary

The aims of this report are twofold: first, to assess the current economic and social value of marine fisheries to the Mediterranean region and, second, and perhaps more importantly, to estimate the sector's full potential economic and social value if it were managed optimally, with a view to maximizing the benefits that could be derived from marine environmental assets over the long run while considering employment. Setting the conditions that will put marine fisheries on a more sustainable path is critical from an economic and social standpoint. The immediate goal is to avoid the predicted Tragedy of the Commons, which, when applied to fisheries, leads to a "race to the last fish" and its attendant destruction of critical marine ecosystems, the cost of which will be borne by present and future generations. This objective can only be achieved through greater cooperation at the regional, national and local scales.

Evidence of sustained fisheries in the Mediterranean has been documented over millennia. Taking advantage of the great ecological diversity of this enclosed sea, multi-specific and multi-gears fisheries were developed over time, and today have come to represent particularly important socio-economic sectors in most of the coastal countries. They are an important source of nutrition, employment and income, and they meet a growing demand for fish products in ever-greater demand emblematic of the Mediterranean art of living so prized by tourists. Most, if not all Mediterranean fisheries, however, now face serious challenges resulting from a series of impacts: environmental degradation, overexploitation of the stocks targeted and poor managements of these shared resources. In addition, the impacts of climate change are now starting to be felt, exacerbating the impacts on both ecosystems and species.

These growing difficulties are not specific to the Mediterranean, but rather mirror the global fisheries crisis that has now become abundantly clear. This point is widely documented in a number of recent studies carried out at a global level by UNEP, the World Bank and the FAO. These authoritative studies illustrate not only the extent of the problem (85% of the stocks worldwide are either fully exploited, overexploited, depleted, or recovering from depletion), but also clearly illustrates some of the root causes of the problem, including the completely irrational system of subsidies, which worldwide fuels overfishing to a significant degree.

To draft this report, data have been collected from various statistical sources (Eurostat, UNData, FishStat, FAO Country Profiles...). Recommendations drawn at the regional (Mediterranean) level by the General Fisheries Commission for the Mediterranean (GFCM), European level in the wake of the preparation of the next Common Fishery Policy and the International Convention for the Conservation of Atlantic Tuna (ICCAT) have also been considered to present a new set of propositions, which focuses on the marine fisheries component, as opposed to inland captures and aquaculture.

The total catch from the Mediterranean marine capture fisheries rose from 420,000 tonnes in 1950 to close to 1,000,000 tonnes in the 1980s, with a peak of 1,093,000 tonnes reached in 1995. Ever since, the level of catches has been slowly decreasing, with the exception of a short-burst increase in 2006, which was essentially due to an exceptional level of landings for small pelagics, species that are very sensible to environmental variations. The total landed value presents a different pattern, with a clear peak in 1985 at US$ 3 billion (three times the 1950 value per tonne), followed by a quasi-constant decrease to US$ 1.5 billion, which is a similar value to that reached in 1975 in real 2000 US$ value. The significant difference in landed values between the SMC (Southern Mediterranean Countries) and the NEMC (North and East Mediterranean Countries) can be explained by the very low level of value added for catches sold locally in the SMC.

While employment in capture fisheries has declined since the 1990's in countries on the northern shore of the Mediterranean, figures are much higher on the southern shore, where 319,000 individuals are still employed in the sector. Over 55% of this workforce is employed in small-scale fisheries, which play an important role in the social fabric and cultural identity of many Mediterranean coastal regions, and where capture fisheries-related employment in southern rim countries can reach almost 1.3% of the total active population, without even counting aquaculture employment or upstream activities - boat construction, engine maintenance, gear manufacture, etc.

In spite of the importance of this sector for so many coastal populations, most of these fisheries are exploited at an unsustainable level, which directly threatens stocks with overexploitation and the attendant long-term depletion of the whole sector, increasing economic costs and employment losses. In the span of 15 years, from 1991 to 2006, the percentage of fisheries resources in overexploitation has increased from 15% to nearly 60%, affecting especially the most valuable species (bottom fishes, lobsters) and top predators (tuna, sharks and rays), which are known to play key roles in the control of the whole trophic chain. The situation is slightly less worrisome in the home fishing areas of southern rim countries, where the number of their resources in overexploitation has only increased by a third, while it has more than doubled in those of other Mediterranean countries during the same period.

The essential findings of this analysis can be summarized as follows:

1. **Marine fisheries are crucial, both socially and economically, to the Mediterranean region,** providing animal protein and supporting food security for over 452,000,000 people. An estimated 32% of this population lives in close proximity to coastal areas, relying on fish resources not just for food but also for their livelihoods – from fishing and induced activities, but also increasingly from fishing tourism. Currently, Mediterranean fisheries deliver annual revenues that amount to around US$ 1.3 billion and support directly and indirectly 458,000 jobs. When the total direct and indirect economic effects arising from fish populations in the regional economy are accounted for, the total contribution of the sector to national economic outputs is estimated at some US$ 3.1 billion a year.

2. **However, Mediterranean marine fisheries, and more particularly the northern ones, are not only overexploited, they also have been underperforming in both economic and social terms for decades**. Mediterranean countries currently generate a negative rent of US$ 1 billion a year from fishing, when the total cost of fishing (US$ 1.6 billion) and subsidies (US$ 727 million) are deducted from the total value of US$ 1.3 billion that fishing generates. This appalling result, however, does not extend to all fisheries, as some artisanal fisheries still succeed in generating positive rents.

3. **Investments that will help achieve sustainable levels of fishing can secure a vital revenue stream in the long run.** If the current path is followed, overexploitation will increase and the operating deficits can be expected to increase, requiring still higher subsidies. Any effort to increase the sustainability of fisheries will require a reallocation of public expenditures, particularly as they relate to a reduction in harmful subsidies. It is imperative that fisheries management be strengthened to allow overfished and depleted stocks to recover, including via a significant reduction of excess capacity through de-commissioning vessels and equitably relocating employment in the short term. It is estimated that an investment of US$ 3 billion would reduce excessive capacity, allow depleted stocks to recover, and could result in the long term in an 66% increase of catch per unit effort, in spite of an expected 17% drop in total Mediterranean catches.

4. **Transitioning to sustainability in the fisheries sector would result in a dramatic increase in resource rent from Mediterranean fisheries**. Projections indicate that reforming Mediterranean fisheries could transform resource rent from a negative US$ 1 billion to a positive US$ 315 million a year. The total value-added to the economy of the region from fishing in such a scenario is estimated at US$ 668 million a year, compared to the negative feature of US$ 222 million in the current situation. Even without accounting for the potential boost to recreational fisheries, multiplier and non-market values that are likely to be realized, the potential present value of benefits of reforming fisheries is at least six times the cost of the required investment.

5. **Bringing and keeping the capacity of the fishing fleets in line with the sustainable fishing scenario will improve the wealth of the nation and the individual revenues of remaining fishermen but inevitably lead to less overall employment in the catching sector**. However, it should be considered that the employment losses could be more important in case of continuation of the business as usual scenario. History of fisheries shows that overexploitation can lead to disasters, as in the case of the cod exploitation in Newfoundland, the largest cod fishery in the world, where the industry and associated employments collapsed entirely in the early 1990s, without recovery to date in spite of moratorium on fishing, due to provoked irreversible changes in ecosystems. Management of reforms towards sustainable fisheries and cushioning of the effect on impacted populations are political issues.

6. **A number of other management tools and funding sources are available that can also be used to move the regional fisheries sector from its current underperforming state** to a sector that delivers higher, but socially acceptable benefits, while achieving sustainable levels of fishing in the long run for the benefits of current and future generations. The necessary downsizing of the fleet should be carried out with a view to trying to protect small-scale fisheries and associated and dependent coastal communities, while allowing larger fleets to undergo the necessary adaptations. To that end, two differentiated management regimes could be envisaged, with one designed for large-scale fleets and where capacity adjustment and economic efficiency are at the core, and the other targeted at small-scale fleets in coastal communities, with a focus on social objectives. In line with the principles of the future European CFP (Common Fisheries Policy), arrangements for the large-scale segment could include economic incentives for fleet adaptation such as market-based allocation mechanisms, while small-scale coastal fisheries would be managed through direct allocation of quotas or effort or through collective schemes. The approach to public financial support could be different for the two segments: the large-scale fleet would be expected to be economically self-reliant, while public funding may help the small-scale segment adapt to changing conditions towards more sustainable fisheries, thereby strengthening its economic viability, and maintain its contribution to the livelihood of coastal communities. These proposals are illustrated in two cases studies, the first on the emblematic Bluefin Tuna large-scale fishery and the second presenting reforms in the Moroccan small-scale artisanal fisheries.

Introduction

OBJECTIVE AND SCOPE OF THIS REPORT

Like elsewhere in the world, Mediterranean fish resources play key roles for human food supply and aquatic ecosystems, and small-scale fisheries are often vital for local coastal communities. The main pressures on these resources include fisheries overexploitation, coastal development and pollution loads from land-based sources, maritime transport, and maritime dumping. Many valuable fish stocks are already fully or over- exploited, and though total fish catches seem to decline at the regional level, Illegal, Unreported and Unregulated fishing (IUU) is widespread and seriously undermines sustainable fishery management objectives.

From an economic standpoint, sustainable fisheries are fundamental not only to achieve the restoration of fish stocks and the preservation of marine biodiversity, but also to improve livelihoods, trade, fish food security and to contribute to regional economic growth.

This report aims to achieve a number of objectives: (i) to present an overview of Mediterranean fisheries, exploited fish stocks and their direct and indirect impacts on economy and employment of the riparian countries; (ii) to assess their current economic performance in comparison to an optimal use of exploited stocks; (iii) to estimate the investment needed to reform the fisheries towards a better use of these natural assets; and (iv), finally to propose concrete solutions as illustrated in two cases studies.

This work is not the fruit of an academic research *stricto sensu,* but rather represents an adaptation of selected existing studies performed at different scales to the case of the Mediterranean fisheries. In particular, several outstanding and global recent studies on global fisheries have been adapted to the Mediterranean context. These studies are presented in the section on literature review. It should be noted, however, that scarcity of socio-economic data on the fisheries in general, and more specifically for the Mediterranean, has been one of the main constraints faced by the authors.

The analyses contained in this report have been performed at various scales, from the county level to the regional level, depending on the subject and data availability. In general, the current status of the fisheries has been analyzed at country level, and economic performance established at regional level. Results at country level are aggregated in two groups of countries presenting similarities in the historical development of their fisheries:

- Northern and Eastern Mediterranean Countries (NEMC): Spain, France, Monaco, Italy, Malta, Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Albania, Greece, Cyprus and Turkey.
- Southern Mediterranean Countries (SMC): Syria, Lebanon, Israel, Palestinian Territories, Egypt, Libya, Tunisia, Algeria and Morocco.

It should be noted that the SMC are also the Middle East and North Africa (MENA) coastal countries of the Mediterranean. From here on end, "Mediterranean countries" are meant to encompass all coastal countries of the Mediterranean.

The fisheries sector is usually understood as consisting of three main components: (i) marine captures; (ii) inland captures; and (iii) aquaculture. This report focuses almost exclusively on marine capture fisheries. Inland fisheries and aquaculture are discussed only insofar as they relate to marine capture fisheries.

LITERATURE REVIEW

Mediterranean fisheries are now confronted to serious challenges from environmental impacts, exacerbated by the growing threat of climate change, overexploitation of stocks and poor managements of shared resources.

These difficulties, however, are not specific to the Mediterranean but are being met by most fisheries in the world, as highlighted in recent studies on the management of fisheries at the global level carried out by UNEP, the World Bank and FAO (UNEP *Green Economy Report – Fisheries* (Sumaila, 2011), *The Hidden Harvests* (World Bank, FAO, WorldFish Center, 2010), *Rising to depletion?* (Garcia, 2009), *The Sunken Billons* (Willmann et *al*., 2009). To the extent possible, results have also been adapted from various statistical sources (FishStat, FAO Fishery Country Profiles, *Sea Around Us* Project, Eurostat, OECD...) and detailed at coastal countries levels. Recommendations at Mediterranean level from GFCM (General Fisheries Commission for the Mediterranean) and ICCAT (International Commission for the Conservation of Atlantic Tunas) have also been draw upon to elaborate concrete recommendations. The list of the documents reviewed for this analysis, mainly but not exclusively scientific, is provided in the Reference section, at the end of this report.

Main features of Mediterranean fisheries

SPECIFICITIES OF THE MEDITERRANEAN FISHERIES

For many centuries Mediterranean fisheries have played an important role in economic, social and cultural terms. They are mentioned as far back as the VIIIth century BC by Homer in the Iliad and Odyssey (Bas Peried, 2005). Fish production and trade have since flourished all over and, for millennia, this activity contributed to the development of coastal nations.

The structure of the present fishing industry in the Mediterranean is rather homogeneous, with few exceptions (Spagnolo, 2003) and can be characterized as follows:

- Resource fragmentation, strong multi-specificity and multi-gear activity;
- Importance of small-scale activity carried out throughout the coastal areas;
- Importance of artisanal feature in the productive structure, meaning that fishermen primarily target family income rather than profit;
- Size of vessels is reduced and depends on eco-biological factors and physical structures;
- Extent of the continental shelf is quite narrow;
- Fleets operate mostly from their home ports, excepted for a few components of the fleet that tend to fish in distant waters for well-defined target species (e.g. shrimp, tuna, swordfish);
- Shared stocks among different neighboring countries are a minority in relation to other exploited stocks.

SMALL-SCALE FISHERIES

Small-scales fisheries play a particularly important role in Mediterranean fisheries, where they represent more than 80% of the total vessel fleet.

Despite the fact that they represent a large majority of fisheries worldwide, small-scale fisheries, often also referred to as artisanal fisheries, are difficult to define simply and unambiguously, as the term tends to apply to different situations in different countries, spanning a huge spectrum of activities using a large variety of fishing gears. FAO defines them in a lengthy definition as involving fishing households (as opposed to commercial companies), using relatively small amounts of capital and energy, relatively small fishing vessels (if any), making short fishing trips close to shore, and mainly for local consumption. It should also be noted that FAO has developed a vision for small-scale fisheries where their importance to national economies and food security is recognized, valued and enhanced[1].

The COPEMED project (Coppola, 2006) has tentatively identified the main technical and economic features of the Mediterranean artisanal fisheries.

Technical characteristics:

- Small tonnage (≤ 10 GT);
- Low power < 100 HP with or without outboard engine;
- Reduced range < 24 hours;
- Very often, locally produced engines;
- Minimum or non-existent safety features and equipment;
- Use of diverse fishing gears, depending on:
    - Presence of species, in space and time;
    - Nature of the sea bed;
    - Existence of specific regulations;
- A thorough knowledge of target species and of their behaviors; and
- Targeted towards noble and higher value species.

Socio-economic characteristics:

1 http://www.fao.org/fishery/ssf/en

- Boat owners (or their family);
- Also practice another professional activity;
- Small crew (1 to 5 people);
- High employment in connection with investment;
- Direct sales to fish traders or restaurants;
- Individual catches of low tonnage but of relatively higher value;
- Low level of hierarchy in the work at sea.

For the European Commission, the length of the vessel is generally the main criterion for the application of relevant regulations, with thresholds of 10 m. or 12 m. most often used. For instance, the recent project on the reform of the CFP provides that vessels under 12m will be exempted from the application of ITQ (Individual Transferable Quotas) measures.

In a study on small-scale coastal fisheries in Europe, Ifremer (2007), concluded that a useful and operational definition of a small-scale coastal fleet (SSCF) must include at least vessel size, gear polyvalence, degree to which gear is active or passive, and the level of dependence on national territorial waters (as opposed to fishing in areas beyond national jurisdiction). SSCF tend to operate in coastal waters, use predominantly passive gears and traditionally show a higher degree of gear polyvalence. The diversity of the catch may be high or low, but in many cases, the catch is better targeted and bycatch tends to be lower.

Some Mediterranean countries have adopted their own definition, and Turkey for instance defines a small-scale fisherman as operating on a vessel of less than 10 m. length and no more than five crew members (Turkish Statistical Institute, 2010).

Sacchi (2011), in a recent analysis of the Mediterranean fisheries activities commissioned by Plan Bleu, underlines the fact that the fate of the production tends to differ between small-scale fisheries and larger operations, with local markets for the former and exports for latter.

In general, however, length of the vessel is usually used as the most practical criterion, with a limit of 12 m. for small-scale fisheries. Despite all the limitations mentioned above, this pragmatic approach is the one used in this study.

DATA ON MEDITERRANEAN FISHERIES

Statistical information on fisheries is generally deficient for several reasons. Catch operations are often highly dispersed, making collection of comprehensive catch information challenging, particularly for small-scale fisheries. The variety of species and products, and the differences in methods of counting or measuring production (e.g. shell on/off, gutted, whole, dried, or salted) at point of harvest or first sale also present major technical problems. Illegal and unreported fishing is ubiquitous (World Bank, FAO, World FishCentre, 2010). As a result, there is currently a lack of updated fishery databases offering adequate coverage and reliability, in particular in items related to socio-economic aspects and to technical characteristics of the fleets and fishing effort. A very limited number of sources of authoritative information on the Mediterranean fisheries is thus available. In spite of these difficulties, two main sources of information have been used, as they provide coherent information on every coastal country of the Mediterranean Sea, the FAO databases, and The *Sea Around Us* project.

FAO is the only source of comprehensive and updated fishery statistics covering the whole region. Fisheries statistics are usually obtained from national reporting offices and, wherever possible, verified with other sources. Estimates are produced when data are lacking or are considered unreliable. The Fishery Statistics programme currently maintains a regional capture time series in close cooperation with the GFCM, the Regional Fishery Management Organisation, and with ICCAT for the tuna. These time series are available through FishStat database. FAO, in collaboration with participating countries, also maintains a structured set of information about the national activities in fisheries and aquaculture, the Country Profiles. For the Mediterranean countries, the quality of these Profiles is highly variable and depends greatly on the goodwill of the countries that provide the relevant data.

The *Sea Around Us* project (SAUP) was initiated in 1999 to study impacts of fisheries on the marine ecosystems of the world, and to offer mitigating solutions. SAUP does this through databases, analyses and articles in peer-reviewed journals or other media. Products at the scale of countries' Exclusive Economic Zones, Large Marine Ecosystems and other spatial scales are regularly updated. Whilst the catch time series starting in 1950 are derived from the FAO data, the global Ex-vessel Fish Database covers an important gap in analyzing fisheries management and economics, at least at the scale of the Mediterranean basin. The FAO publishes processed and product fish prices, but no ex-vessel prices, i.e. the price that fishers receive when they sell their catches upon landing. Currently, a number of price databases for fish exist, but they are widely scattered and incomplete, and frequently not available in the public domain. The SAUP ex-vessel fish price

database has been used largely in this study and compared when possible to other available sources. Methods are described in Sumaila and *al.* (2007). SAUP also provides updated and coherent fisheries-related information on every maritime country, including government subsidies (Sumaila, 2010), which have been used in this study. SAUP operates in close cooperation with the Fisheries Centre of the University of British Columbia (Canada), which has constructed another comprehensive database, the Global Cost of Fishing Database (Lam et *al.*, 2010). This database has been used in this study to estimate the value of the landings and to compute the aggregated economic rent. This unique and complex database is subject to periodic update by the SAUP team. Some minor incoherence flaws have been discovered in the version available online during the study regarding data concerning some Mediterranean Countries. These flaws have been signaled to the SAUP teams and corrected as far as possible.

Other consulted sources, although they do not cover all coastal countries, also provided very detailed information. Eurostat provides for the European countries general fisheries statistics, including socio-economic aspects. JRC and STECF publish for the DG Mare a yearly edition of the Annual Economic Report on the European Fishing Fleet, which delivers useful national insight into employment and the economic performance of the sector (Anderson and Guillien, 2010). Some member states, however, and among them some major Mediterranean fishery states, are still failing to comply with their obligations to provide timely and accurate data.

OECD has produced valuable in-depth reviews of national fisheries, providing policies and summary statistics in OECD countries, which are incidentally the major fishing countries in volume of the Mediterranean Sea (Spain, France, Italy, Greece and Turkey) (OECD, 2010). OECD[2] has also published several analyses on the fisheries management, such as role of market mechanisms, capacity reduction, pirate fishing, fisheries policy reform, decommissioning schemes, bio-economic modeling for developing rebuilding strategies, fisheries and green growth, etc.

Some national data sources also provide detailed insights into national fisheries, particularly for Spain, Italy and Turkey.

Finally, it should be borne in mind that fishery statistics are often aggregated on a national basis and are not detailed enough to provide an overview at the Mediterranean level. This national aggregation is particularly problematic for countries bordered by different coasts, as it is the case for major fishing countries such as Spain, France, Turkey, Egypt and Morocco.

REVIEW OF THE STATUS OF MEDITERRANEAN FISHERIES

The review bears on the long-term trends in volume and value of landings, as well as on the production tools, as represented by the size of the fishing fleet. Employment is treated separately in the next chapter, "Challenges and opportunities for Mediterranean fisheries".

Long term trends in volume and value of landings

The main sources of data on the volume of landings were the SAUP Landings Database (Mediterranean Large Marine Ecosystem) for the years 1950-2006 and GFCM for some required adjustments (Turkey, where inconsistency with GFCM data was found; Libya, who was aggregated in "others" and updates for years 2007 and 2008).

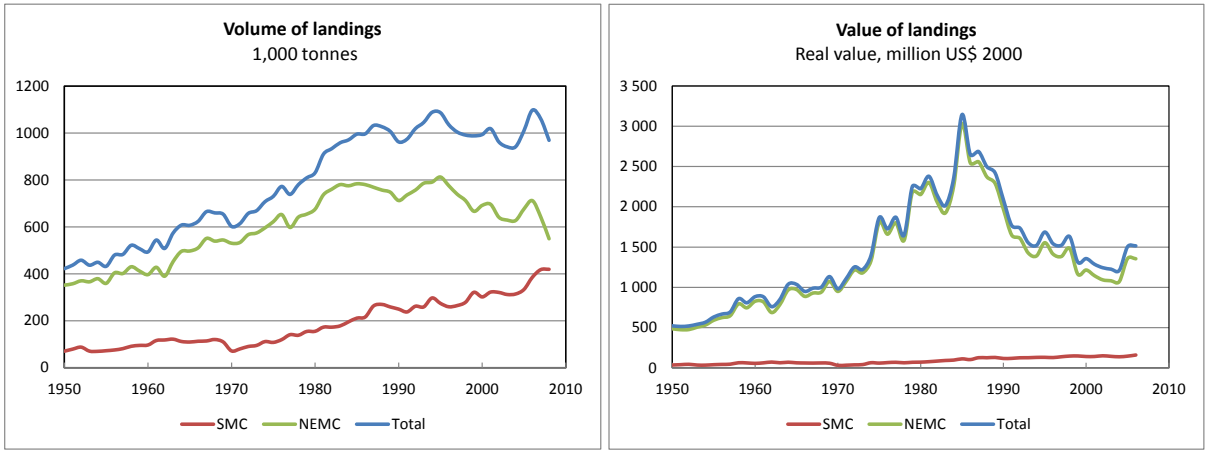
Volumes of landings have been smoothed using a five-year mobile mean (three years for the penults, unchanged for the ultimates) in order to insight the general trend.

The main source for the value of landings is the SAUP Landed Value Database. Ex-vessel fish unit prices have been calculated by simple divisions between the corresponding tables of the Landed value and Volume of Landings Databases. Prices are in constant 2000 US dollars. Further details are available for the SAUP Ex vessel data on the SAUP web site[3]. Values are provided up to year 2006. For the years 2007 and 2008, it has been assumed that prices have been constant on the period 2006-2008. This is consistent with i) the general pattern of price trend constructed by Sumaila et *al.* (2007), which shows that price declines are observed quite constantly since the 1970s across groups of species, and ii) with the FAO Fish Price Index, which indicates a strong increase in 2007 until September 2008, followed by a sharp decline due mostly to the global financial crisis (FAO, 2010).

Volume and value of landings have been aggregated at NEMC and SMC levels, although catches in the Mediterranean Sea are available for each coastal country.

2 http://www.oecd.org/department/0,3355,en_2649_33901_1_1_1_1_1,00.html
3 http://www.seaaroundus.org/doc/saup_manual.htm#13

Figure 1. Landings and landed value[4] of regional marine fisheries between 1950 and 2008



Sources: Sea Around Us (landings and values) and CGPM (recent landings).
NEMC: North and East Mediterranean Countries; SMC: South Mediterranean Countries.

Total catches from the Mediterranean marine capture fisheries rose from 420,000 tonnes in 1950 to approach 1,000,000 tonnes in the 1980s (Figure 1, left) and to reach a recorded peak of 1,128,000 tonnes in 1995. Since then, however, catch level has slowly been decreasing, except for a recent peak in 2006, essentially due to an exceptional catch of small pelagics, which are very sensible to environmental variations.

The total landed value (Figure 1, right) presents a different pattern, with a clear peak in 1985 at US$ 3 billion (three times the 1950 value per tonne) followed by a quasi-constant fall down to US$ 1.3 billion, a value reached in 1975 in real 2000 US$ value.

The relatively low landed value estimated for the SMC compared to that of the NEMC can be explained by the low valorisation of catches sold locally in the SMC.

The Mediterranean Fishing Fleet

There is no international database that provides a comprehensive record of the Mediterranean countries' fishing fleets. This fundamental information is scattered in several databases under various forms, such as:

- Eurostat, for the EU Member States;
- OECD, through various studies concerning the participating countries;
- FAO, through its statistical bulletins fort the years 1970-1995, then in the Fishery Country Profiles;
- GFCM, which recently (2007) started requiring data on activities, characteristics and production of the coastal countries fleets (GFCM Task1);
- National statistical registers, which remain the basic source of information as they should contain the most updated data. It appears, however, that they differ from country to country in their presentation and their level of detail;
- Past monographs on the Mediterranean fisheries, mainly Bas Peried (2005), Franquesa et *al.* (2008) and
- Past studies carried out by programmes of the FAO, GFCM or European Commission, such as COPEMED, ADRIAMED, EASTMED or EVOMED.

From this variety of sources, the present (2008) status of the Mediterranean fishing fleet has been assessed by Sacchi (2011) for each coastal country and displayed according to the following six categories:

4 Landings smoothed using five-year mobile means

Table 1. Estimated fishing fleets of the Mediterranean coastal countries operating in the Mediterranean Sea in 2008

Fleet (2008)	TRWL	PSP	PLV	ART	PST	MAD	Total
Albania	180	22	-	67	-	-	269
Croatia	800	400	-	2,600	23	-	3,823
Cyprus	8	1	28	628	1	-	666
France	111	24	27	1,079	32	-	1,273
Greece	311	281	511	16,250	2	-	17,355
Italia	3,520	305	292	9,258	46	6	13,427
Malta	17		114	1,018	3	-	1,152
Montenegro	30	18	-	170	-	-	218
Slovenia	20	9	-	152	-	-	181
Spain	840	277	168	2,052	6	1	3,344
Turkey	300	167	33	7,406	86	-	7,992
NEMC	**6,137**	**1,504**	**1,173**	**40,680**	**199**	**7**	**49,700**
Algeria	487	1,039	-	2,908	7	-	4,441
Egypt	1,095	238	-	1,791	-	-	3,124
Israel	31	19	-	388	-	-	438
Lebanon	-	70	-	2,590	-	-	2,660
Libya	140	165	-	4,695	29	-	5,029
Morocco	119	150	112	2,974	3	1	3,359
Palestinian Territories	18	67	-	632	-	-	717
Syria	21	5	30	1,157	-	-	1,213
Tunisia	399	360	227	10,316	24	-	11,326
SMC	**2,310**	**2,113**	**369**	**27,451**	**63**	**1**	**32,307**
Total	**8,447**	**3,617**	**1,542**	**68,131**	**262**	**8**	**82,007**

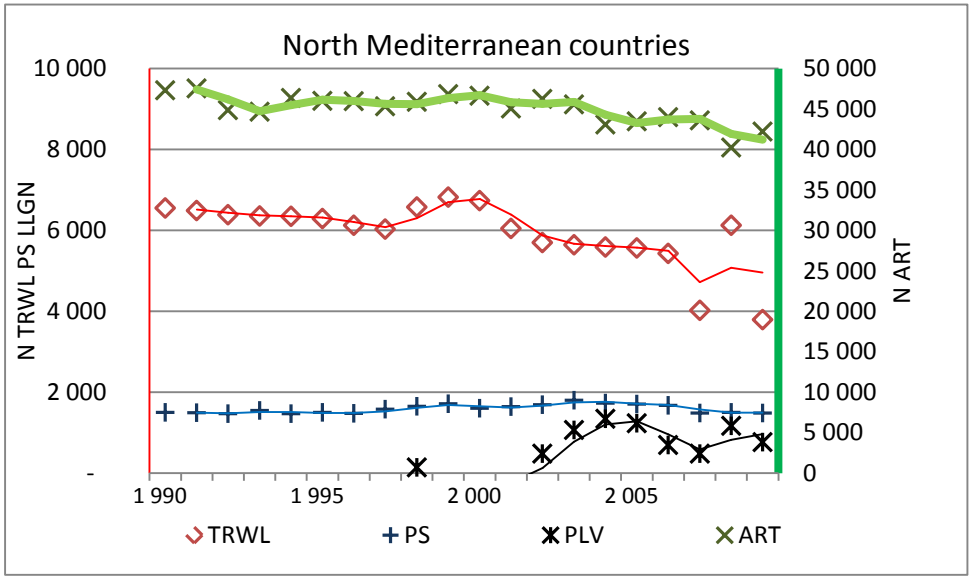
Source: Sacchi (2011)
TRWL: Trawlers and Dredgers, ART: Artisanal boats, PSP: Purse Seiners for small pelagics, PST: Tuna Purse Seiners, PLV: Polyvalent vessels exceeding 12 m., MAD: Tuna traps.

The artisanal boats represented 83% of the total fleet, respectively 82% in the NEMC and 85% in the SMC. In 2008, the fishing fleet of the SMC countries represented approximately 40% of the total Mediterranean fleet.

From roughly 100,000 units at the end of the 1980s (Bas Peried, 2005), the total number of vessels has since slightly decreased. This general trend represents an increase for the southern and eastern states, and a sharper decline for northern states, which particularly affects the artisanal fleet.

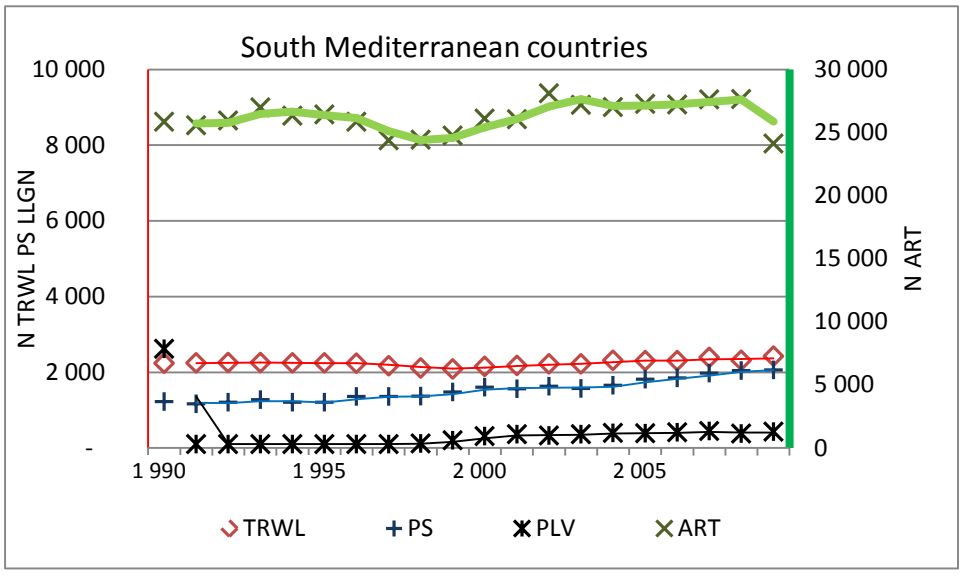
Sacchi (2011) has also reconstructed in more detail the evolution in time of the Mediterranean fleet, from 1990 to 2009.

Figure 2. Number of vessels from the NEMC operating in the Mediterranean



Source; Sacchi (2011)
TRWL: Trawlers and Dredgers, PS: Purse Seiners, PLV: Polyvalent vessels exceeding 12 m., ART: Artisanal boats

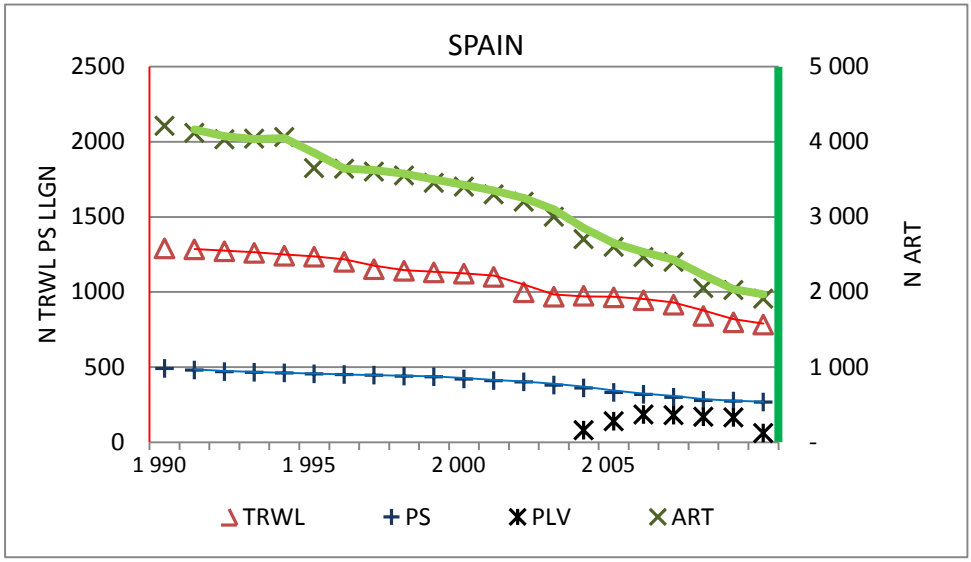
Figure 3. Number of vessels from the SMC operating in the Mediterranean



Source; Sacchi (2011)
TRWL: Trawlers and Dredgers, PS: Purse Seiners, PLV: Polyvalent vessels exceeding 12 m., ART: Artisanal boats.

The overall apparent stability in number of units operating in the Mediterranean actually masks very different trends amongst countries of these groups, as illustrated by the following two cases, Spain and Algeria.

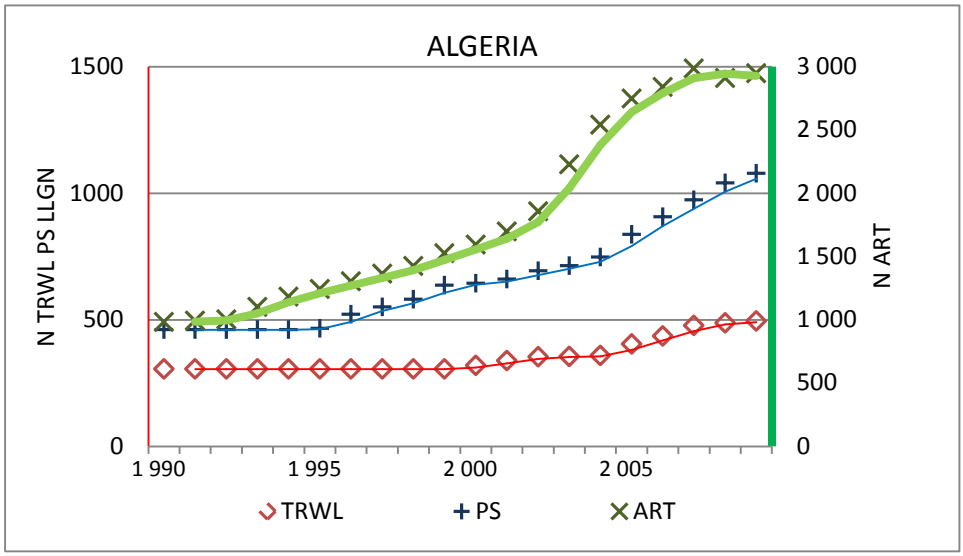
Figure 4. Number of Spanish vessels operating in the Mediterranean



Source; Sacchi (2011)
TRWL: Trawlers and Dredgers, PS: Purse Seiners, PLV: Polyvalent vessels exceeding 12 m., ART: Artisanal boats.

The number of vessels, especially in the artisanal fleet, has clearly decreased in Spain (Figure 4) during the period, as was the case for most of the southern European countries, particularly France, Italy and Greece.

Figure 5. Number of Algerian vessels operating in the Mediterranean



Source; Sacchi (2011)
TRWL: Trawlers and Dredgers, PS: Purse Seiners, PLV: Polyvalent vessels exceeding 12 m., ART: Artisanal boats.

Conversely, some Mediterranean countries have seen an increase in their fishing fleets during the same period, as is the case for Algeria (Figure 5), Albania, Lebanon and Turkey. In other Mediterranean countries, the overall evolution in the number of vessels is less clear.

Challenges and opportunities for Mediterranean fisheries

CHALLENGES

Overexploitation of the resources

A thorough analysis and assessment of fisheries resources in the Mediterranean has always been considered very difficult to achieve (Bas Peried, 2005). Part of the difficulty lies in the approach itself, which requires consideration of interactions between population dynamics, ecosystem variations and fishing effort. Another source of the difficulty stems from the characteristics that prevail in the area, mainly:

i. The large number of exploited species as well as the different types of fisheries imply a large variety of data to record;

ii. The relative importance of artisanal fisheries, with highly polyvalent fishing strategies, difficulty in tracking, and generally poor reporting;

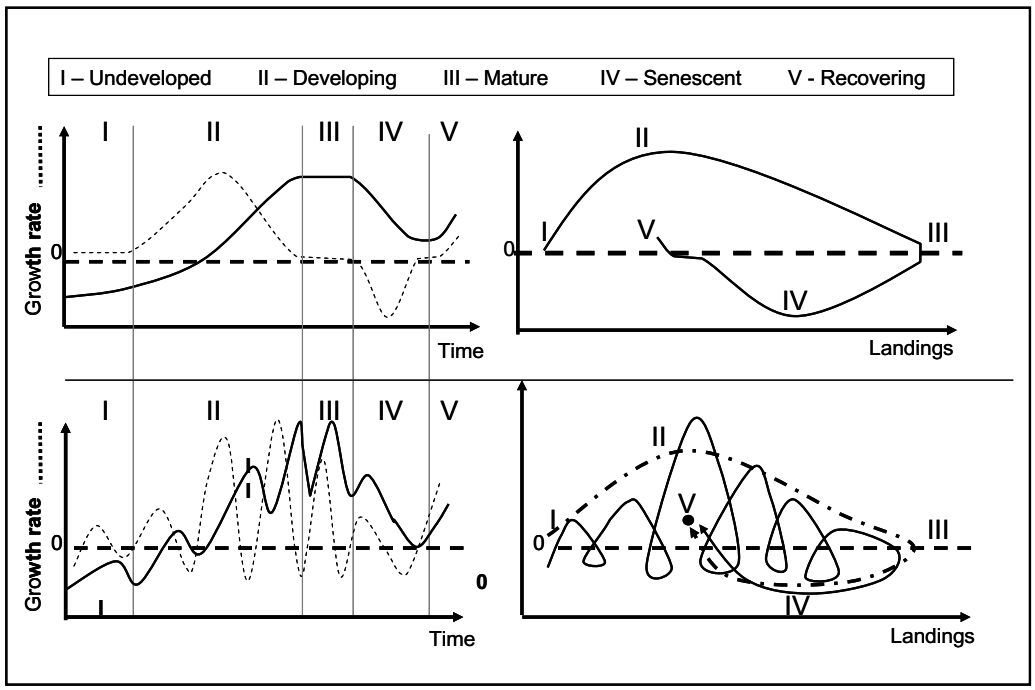
iii. The recreational fisheries are poorly understood and monitored; and

iv. The recent and still weak understanding by most of the profession that controls are necessary and that collecting data on catches and means of production are of the utmost importance.

The General Fisheries Commission for the Mediterranean (GFCM) is responsible for the assessment of shared stocks, except for tuna and tuna-like species, which falls under the purview of the International Commission for the Conservation of Atlantic Tunas (ICCAT). The GFCM Scientific Advisory Committee compiles assessments available for the main targeted species, and the last compilation (GFCM, 2011) confirms the diagnosis of overexploitation for the majority of the assessed stocks (see also FAO, 2010). These complex assessments are mainly based on statistical analysis of the results of scientific surveys, which are expensive and barely cover all the exploited stocks in a timely fashion. Simpler and more aggregated indicators are needed in complement of current knowledge, and the World Bank has developed an analysis of the FAO landing data, aggregated by main resources type, to produce a global and regional assessment (Garcia, 2009). For this report, a similar approach has been applied to the Mediterranean, compiling and analysing updated landing data aggregated at the country level (Garcia, 2011).

The methodology used by Garcia (2009, 2011) is based on a diachronic analysis of the landings according to a fishery development cycle model that identifies several sequential phases from Development to Maturity and eventually to Senescence characterising the overexploitation and, sometimes, to Recovery. The main assumption behind this model is that the trends in landings, in spite of any problems – real or perceived – with their reliability, reflect mainly the impact of the fishing fleets. In that process, the annual growth rate of the landings characterizes the different phases of the development cycle (Figure 5). They decrease on the long term as the fleets catches reach the maximum long-term potential that the area can offer.

Figure 6. Idealized aggregated fisheries development model



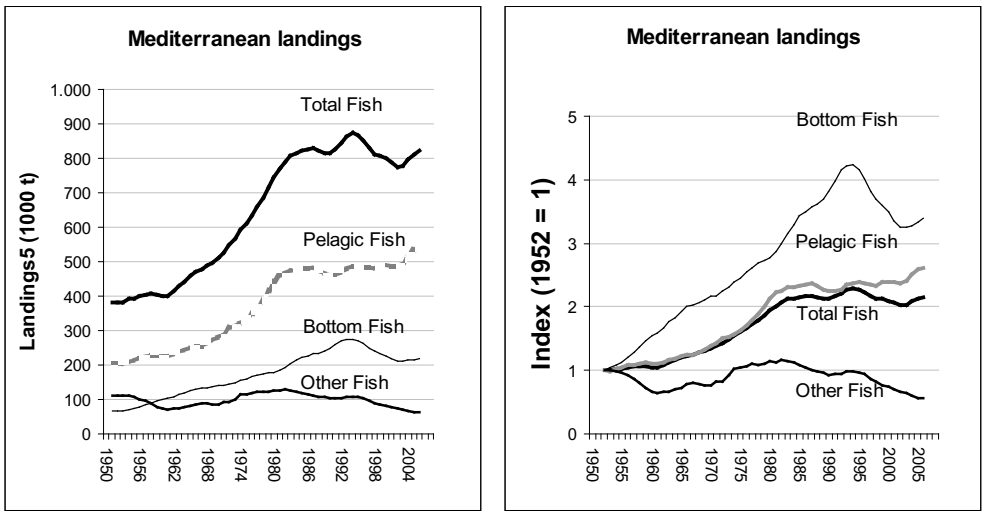
Source: modified from Garcia (2009)

Note: Top left: Trends in landings and growth rates (modified from Grainger and Garcia 1996). Courtesy of FAO. Top right: phase graph. The zero-growth line relates only to the rate of increase (right vertical axis). Reproduced Bottom: same representations with environmental and other noises.

This study analyses the state of the fisheries looking at trends in landings and landing growth rates for the key species in the Mediterranean. It does so at the level of the entire Mediterranean, the different GFCM statistical areas, and the coastal countries (Home Areas). The data are taken from the FAO Fishstat databases for the FAO Fishing Area 37 – Mediterranean and Black Sea 1950-2008 (after removing the Black Sea data) and the GFCM dataset for 1970-2008. From these data, key groups of species were selected using the ISSCAAP categories to reflect the fisheries for demersal species (on the shelf and the slope) as well as small pelagics. Sharks and rays, lobsters, shrimp and prawn as well as squid, cuttlefish and octopus were also included. Tuna and tuna-like species, as well as species such as coral, turtles, cetaceans, tunicates, etc. were not included at this stage.

At the Mediterranean-wide level, the aggregated landings for these species show an overall stagnation of the aggregated production (about 800,000 tonnes) over two and a half decades. The pelagic, of relatively low value, shows the same pattern (about 500,000 tonnes) while landings of demersal high-value species increase to close to 300,000 tonnes in 1990 and thereafter decline until 2008.

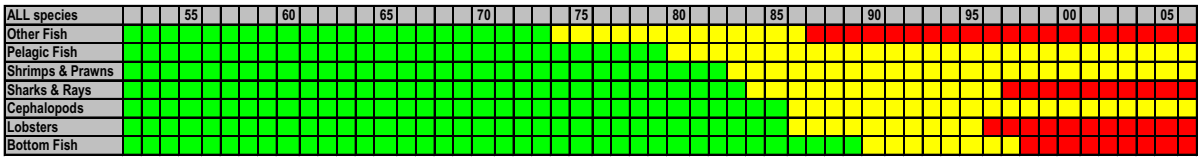
Figure 7. Mediterranean-wide trends in selected landing categories

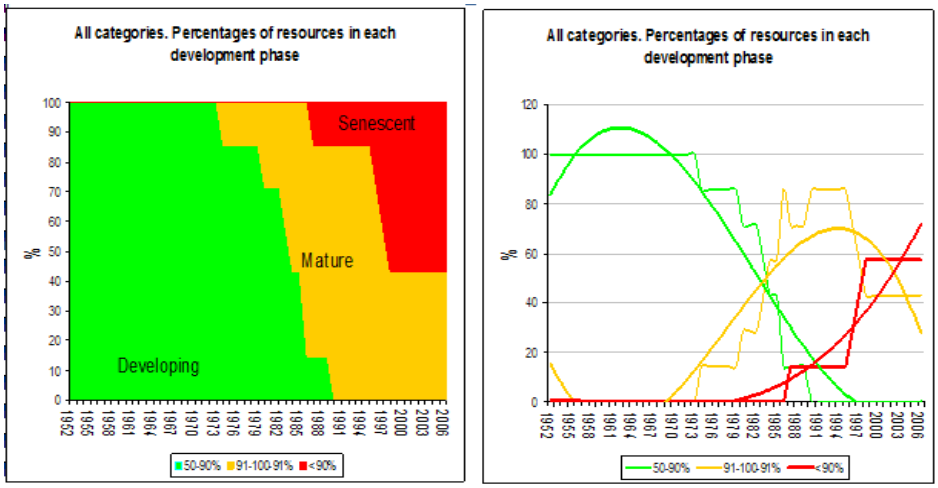


Source: Garcia (2011)
Note: Left: tonnage. Right: relative index, base 1952

As noted below, in Figure 8, fisheries development systems targeting the various resource categories reached maturity between 1975 and 1990.

Figure 8. Development phases of Mediterranean fisheries (all categories, 1952-2006)





Source: Garcia (2011)
Note: All categories 1952-2006. Top: Development phases. Green: Development, Yellow: Maturity and Red: Senescence. Resources arranged in ascending order of the date of entry into maturity. Bottom: Yearly percentages of selected resource categories in the various development phases, Right: cumulated percentages, Left: trend expressed by polynomial regression curves.

When looked at in more detail, however, the eight GFCM sub-areas tell a different story. The resources increase in some areas, stagnate in others and decrease in the rest. The following general patterns can be observed:

- The fisheries appear generally in more advanced stage of development (and of senescence) in the western and northern areas of the Mediterranean than in southern and eastern parts.

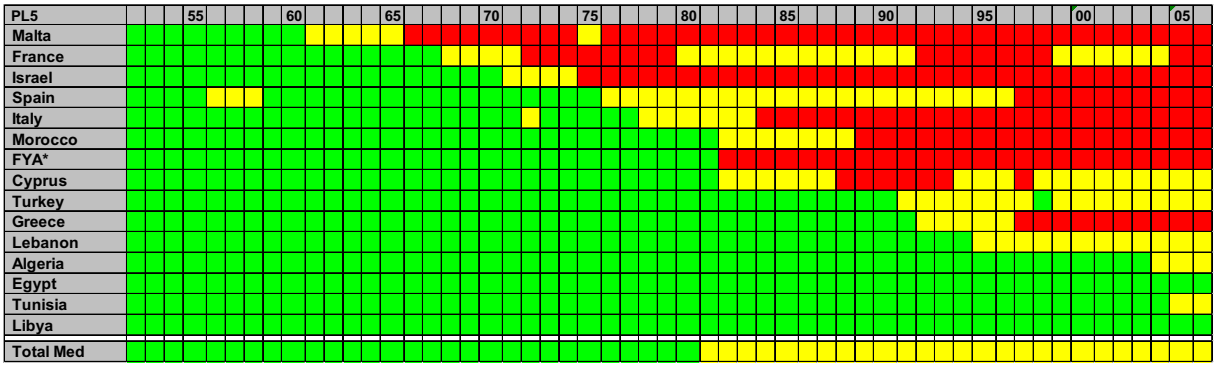
- In general, pelagics appear to be under less pressure than demersals, in coherence with the higher economic value of the second. Also, among the high-value species, lobsters appear to be under more pressure and less able to sustain maturity situations. Similarly, sharks and rays are under extreme pressure for the entire period, probably with a collapse of all targeted fisheries in the 1960 and repeated cycles of Development-Maturity-Senescence. Shrimp resources are in better shape and are still increasing, and though they might have perhaps reached their maximum. The situation appears to be similar for cephalopods. For all these resources the entry in "Maturity" and "Senescence" occurs earlier in the northern and western areas and maturity stages tend to be shorter as well in these regions.

At the national level, the same general patterns prevail with some differences, but the overall trend in development pressure from west to east is clear. Consequently, the south-east countries of the Mediterranean still have a chance to avoid repeating the present situation in EU fisheries, which are characterized by "overfishing, fleet overcapacity, heavy subsidies, low economic resilience and decline of the volume of fish caught by European fishermen" (quote, from the introduction of the Green paper on the reform of the Common Fisheries Policies, CEC, 2009).

This situation can be can be synthesized from the state of the resources for the main fishing countries made by Garcia (2011).

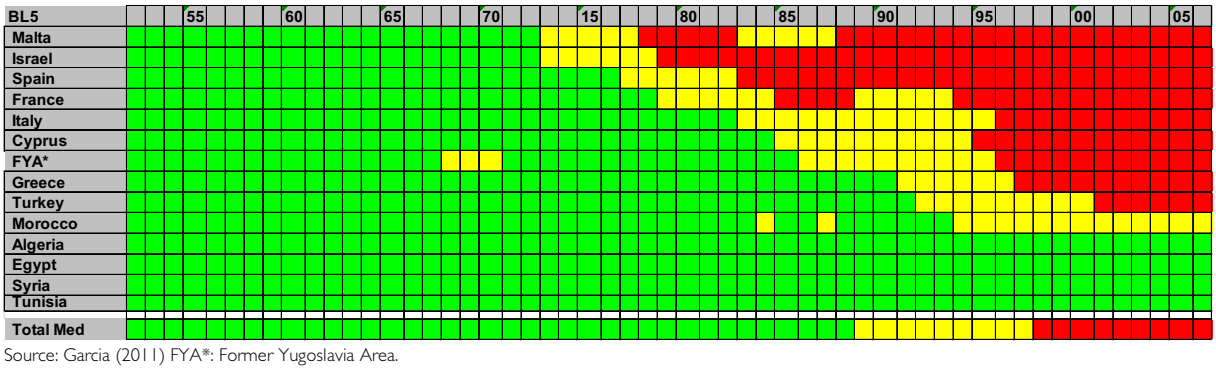
From the Figure 8 (top), it is easy to deduct that, in the span of 15 years - from 1991 to 2006, the percentage of species in senescent phase has increased from 15% to nearly 60%, affecting especially the most valuable species (bottom fishes, lobsters) and top predators (tuna, sharks and rays), which are known to play key roles in the control of the whole trophic web. Garcia's analysis also disaggregates at the country level the two main resources in terms of volume: small pelagics (Figure 9) and demersals (Figure 10).

Figure 9. Diachronic view of the state of the small pelagics by country (1952 to 2006)



Source: Garcia (2011) FYA*: Former Yugoslavia Area.
Green: developing; Yellow: mature; Red: senescent.

Figure 10. Diachronic view of the state of demersals by country (1952 to 2006)



Source: Garcia (2011) FYA*: Former Yugoslavia Area.
Green: developing; Yellow: mature; Red: senescent.

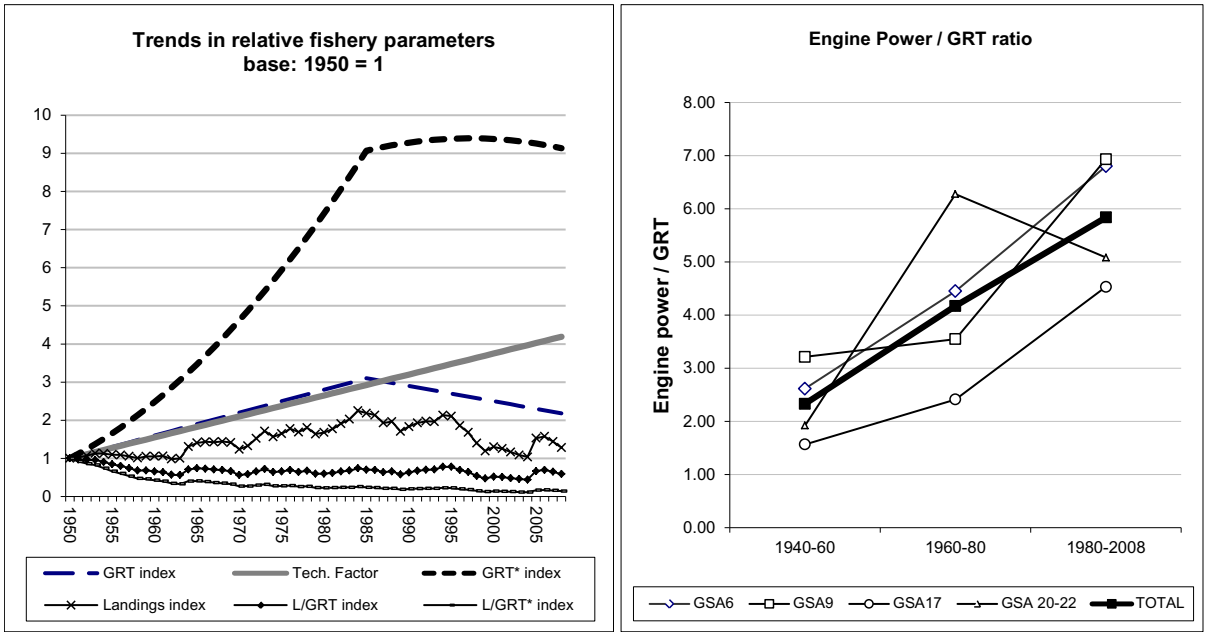
A summary examination of Figures 9 and 10 shows that the situation is slightly less worrisome in southern rim countries, as the number of their resources (small pelagic and demersals) in senescent phase has only increased by a third from 1991 to 2006. The situation however is much more worrisome in other Mediterranean countries, where the same indicator has more than doubled during the same period.

Overcapacity

Over the course of the last half century, fisheries managers worldwide have consistently attempted to address overfishing and related socio-economic crises in domestic and global fisheries, but it is only recently that these problems have started to be recognized as a symptom of a far more serious problem: structural overcapacity. This overcapacity is now identified as a significant, if not the primary, reason behind the global fisheries crisis. As defined by FAO, fishing capacity (or fishing effort) is the amount of fish that can be produced of a period of time (e.g. a year or a fishing season) by a vessel or a fleet if fully utilized and for a given resource condition. Yet the world's current fishing capacity is widely estimated to be two and a half times greater than what is needed to land the maximum sustainable yield (MSY) (Willmann et *al.*, 2009).

With regards to Mediterranean fisheries, Garcia (2011) has clearly illustrated the level of fleet overcapacity with the help of the results of the EVOMED project. Analysing the exploitation of demersals in the Mediterranean, this study raises the issue of the evolution of the technological factor (or technological creep) as shaping the evolution of fishing capacity and distorting the perception of fisheries performances. Fitzpatrick (1996) estimated the technological improvement factor resulting from progressive modernization of fishing vessels (about 5% per year). Assuming a similar technological factor can also be applied to the efficient Mediterranean fisheries of European countries, the trends in the aggregate system of bottom fisheries of Spain, Italy and Greece are portrayed in Figure 11 (left) in which all values have been standardized to their respective value in 1950 to facilitate comparisons.

Figure 11. Evolution of the bottom fishery systems in Catalonia (Spain), Italy and Greece (left) and evolution of the power/size ratio in GFCM sub-areas (right)



Source: Landings from Fishstat; GRT from EVOMED (2011) in 1950, 1985 and 2008, interpolated; Technological factor from Garcia and Newton (1997) (left). All variables are standardized to their value in 1950. Data EVOMED (2011) (right).
Note: GRT* = GRT corrected by the technological factor, GSA: GFCM sub-areas

As illustrated in Figure 11, Garcia shows that the landing index reported for selected categories of demersals (ISSCAAP categories 31, 32, 33, 34, 38, 39, 43, 45, and 57) by Spain, Italy and Greece, increases throughout 1980-1990 and declined afterwards at about the same rate, until 2008. The total GRT (Gross Registered Tonnage) estimated by EVOMED (Part II, section 4.1) for Catalonia (Spain), Italy and Greece is 120,000 tonnes in 1950, increases to 337,500 in 1980 and declines to 194,500 in 2008. The data for the intermediate years have been linearly interpolated to generate a complete time series. This snapshot also illustrates the increase in the technological factor and the evolution of the GRT when corrected by this factor (GRT*), although total real engine power and capacity are probably even higher than what is reported in official sources. The product of the fleet GRT by the technological factor (which can be considered as an

index of fishing capacity adjusted for the rise of the fishing vessel power), increases until the mid-1980s and then remains at that level despite a decrease in the volume of the fleet. The shape of the GRT* curve indicates that it is likely that the big surge in fishing effort and capacity of the 1960s and 1970s has been stalled and that current installed engine power and capacity are similar to the values of the first half of the 1980s.

The landing per unit of GRT indicator can be used as a very raw index of nominal abundance of the resource aggregates. The figure shows a decrease of that ratio from 1 in 1950 to about 0.55 over the last decade. Considering that the stock was not virgin in 1950, this 50% decrease is already substantial and, in a production model, would bring the present fishing pressure close to the effort corresponding to the Maximum Sustainable Yield level. However, this assertion cannot be sustained as it assumes that a unit of GRT in 1959 has the same efficiency and impact on the stocks than a unit in 2008, which is obviously not the case. The landing/unit of GRT*, taken as an index of abundance corrected for technological improvement in fishing power decreases much more rapidly and is about 0,14 in the last decade, well below the 0,55 index found above and well below the abundance that would correspond to MSY. This elaboration does not account for the fact that the horsepower/GRT ratio (Figure 11, right) has also increased with time and therefore that the total engine power of the fleets (a key factor in trawl fisheries) has increased three times faster than GRT and is even now most probably underestimated by official records (EVOMED 2011). The trend in corrected capacity between 1950 and 2008, as reflected in Figure 11 (left) could therefore be underestimated.

This elaboration, however, is very crude: (i) it averages the trends in three different countries; (ii) it divides the total landings (with all the deficiencies they may have) by a global measure of capacity that mixes artisanal fisheries in more coastal areas with semi-industrial fisheries in deeper waters and (iii) it aggregates trends in a mosaic of resources belonging to two different "ecosystems", the shelf and the slope, which contributed different proportions of the total at different times.

It is therefore too coarse for management purposes except for raising further the policy-makers awareness, illustrating the huge increase in fishing pressure that has affected the fishery resources of the northern Mediterranean since 1950. There is no equivalent study for the southern and eastern Mediterranean. The intense development started probably later in these areas, but it also probably progresses faster as good technologies and fishing practices that had already been tested in the northern Mediterranean could easily be transferred east and south.

Factors undermining the sustainability of Mediterranean fisheries

The issue of factors that undermines the sustainability of Mediterranean fisheries has been the subject of multiple analyses. Specifically, FAO organized a regional workshop focused on the southern Mediterranean, the conclusions of which are still relevant (Bodiguel, 2009):

- Strong demand for limited resources: Almost all species in the Mediterranean are subject to strong demand by national and regional markets. The rising demand trend is due to various factors, such as increased purchasing power, food preferences and dietary requirements. Moreover, the Mediterranean area is also characterized by the demand from restaurants, which are willing to pay high prices, mainly for fresh fish. In addition to strong national and local demand, there is also regional and international demand for some high commercial value species. This strong demand, which is not controlled through appropriate management of fishing capacities, leads to a generalized fleet overcapacity and then, inevitably, to overfishing.
- Failure of institutions and policies: The policies and laws of many countries are out of date and take insufficient account of the current approaches for sustainable fisheries management. Fisheries are often considered as a poor sector for poor people, a provider of jobs of last resort, or an area where breaching the law is tolerated. The management of the fisheries sector is sometimes undefined, or insufficiently formalized in institutional, legal and operational terms. Mediterranean fisheries are also seriously affected by failure to apply the rules and regulations, partly due to the false perception of the sector and its economic and social role, which undermines compliance and enforcement.
- Inappropriate incentives: Many incentives are inappropriate. Market-related incentives are often wrongly interpreted and poorly regulated or unregulated. Subsidies granted to the sector are too often still being channeled, directly or indirectly, to the purchase of fisheries inputs, in a situation of generalized fleet overcapacity. More generally, it has been noted that the management system does not encourage fishermen to behave responsibly, even when they have rights to the resources or rights of access to the resources, which should guarantee them continuity of their activity. An example of negative incentives is the failure to apply the rules, regulations and penalties consistently, a situation that encourages fishermen to flout the law and ignore management measures.

Subsidies

The WTO definition of subsidies has been summarized by Willmann et *al.* (2009) as a financial contribution by the public sector that provides private benefits to the sector. The contribution can be direct or indirect (such as forgone tax revenues), be provided as goods or services, income or price supports. Common fisheries sectors subsidies include grants, concessional credits and insurance, tax exemption, fuel price support (or fuel tax exemption), direct payments to private beneficiaries, such as vessel buyback schemes, fish price support and public financing of fisheries access agreements.

To illustrate the importance of the amounts at stake, the review of potential annual financial transfers to fisheries in the EU has been evaluated by Salz (2009) at nearly two billion per year for the period 2007-2013 and a study by the World Bank estimates annual global fisheries subsidies as more than 10 billion a year (Willmann et *al*., 2009).

The justification offered for subsidies ranges from protection of infant industries, through national food security and prevention of fish spoilage, to social rationales such as preservation of traditional livelihoods and poverty reduction. The reduced costs restore profitability and create perverse incentives for continued fishing in the face of declining catches. The result is overfishing, fleet overcapacity and then overcapitalization, reduced economic efficiency of the sector, and resource rent dissipation.

Fisheries subsidies have been criticized by FAO and OECD in the context of fisheries management, but also in the context of WTO trade negotiations.

Being the target of these international organizations or NGOs working for the preservation of natural resources (WWF, 2001), subsidies to fisheries are rarely transparent and clearly publicized by the concerned countries; as a consequence, their evaluation is not simple. Sumaila (2010) has developed a database of fisheries subsidies in the frame of the SAUP. A key feature of their estimation approach is that it explicitly deals with missing data from official sources. Fisheries subsidies have been computed for 2003.

Although relatively not recent, this source revealed to be the only available covering most of the Mediterranean countries, with a relevant approach of the different categories of subsidies.

According to Sumaila (2010) a set of fishery resources in a particular region can be viewed as a portfolio of natural capital assets capable of yielding a stream of economic benefits (both market and non-market) to society through time. If natural capital is renewable, then one can, within limits, engage in 'investment' in the natural capital assets, by refraining from fishing and allowing the resource to rebuild to a biological optimum. Similarly, one can also engage in 'disinvestment' in the natural resource, for example, through overfishing. Based on this theory, three broad categories of subsidies are identified: (i) 'beneficial' or 'good'; (ii) 'capacity-enhancing' or 'bad'; and (iii) 'ambiguous' or 'ugly' subsidies.

'Beneficial subsidies' are subsidy programs that lead to investment in natural capital assets. They enhance the growth of fish stocks through conservation and the monitoring of catch rates through control and surveillance measures to achieve maximum long-term sustainable net benefits. This category includes fisheries management programs and services, fishery research and development (R&D) and support to Marine Protected Areas (MPA) development.

'Capacity-enhancing subsidies' are defined as programs that lead to disinvestments in natural capital assets such that the fishing capacity develops to a point where resource overexploitation makes it impossible to achieve maximum sustainable long-term benefits. This category gathers fuel subsidies, boat construction, renewal and modernization programs, fishing port construction and renovation programs, price and marketing support, processing and storage infrastructure programs, fishery development projects and support services and foreign access agreements.

'Ambiguous subsidies' concern programs whose impacts are undetermined, i.e., they may lead to either investment or disinvestment in the fishery resource. These subsidy programs can lead to positive impacts such as resource enhancement programs or to negative impacts such as resource overexploitation. Subsidies in this category include controversial fisher assistance programs, vessel buyback programs but also rural fisher community development programs.

Data on subsidies have been extracted from Sumaila (2010) for the available Mediterranean countries and from the SAUP database, thus concerning almost all the Mediterranean countries.

These national data should be adjusted to cover only the Mediterranean fisheries. Adjustment has been made for each country proportionally to an employment ratio: Mediterranean direct fishery employment/national direct fishery employment, as it has been assumed that subsidies are mainly attributed for employment sake.

Table 2. Subsidies to marine capture fisheries by Mediterranean countries for 2003 (in 1,000 US$)

Values in 1000'US$	Total	Beneficial	Capacity enhancing	Ambiguous	Sub total Capacity enhancing and Ambiguous
NEMC	659,600	164,099	269,276	226,226	495,501
SMC	67,086	30,468	35,846	772	36,618
Total	726,687	194,567	305,122	226,998	532,119

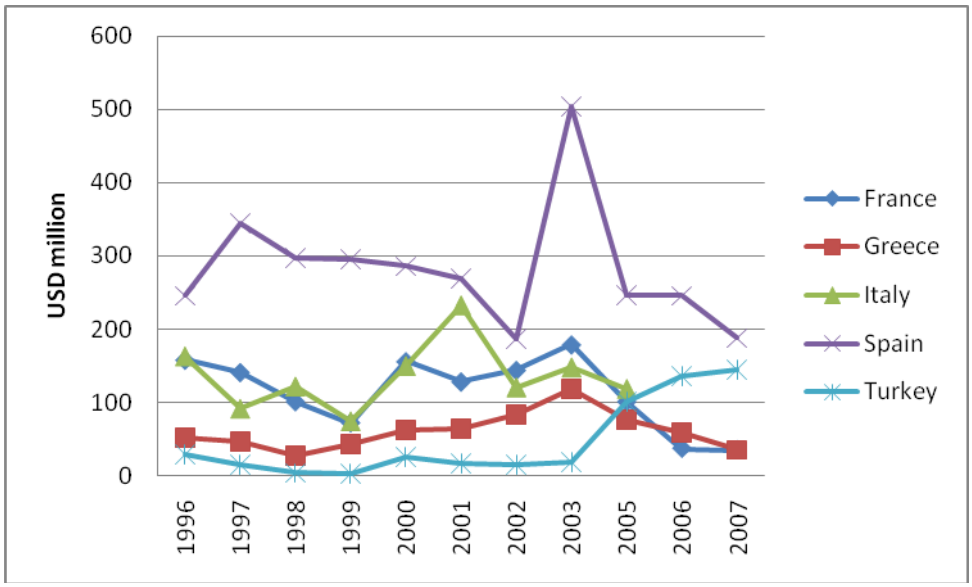
Source: Sumaila (2010). Adjustment of the employment ratio to Mediterranean fisheries made by Plan Bleu.

Table 2 shows that in 2003, subsidies concerned mainly the NEMC for 90%. Capacity enhancing and ambiguous subsidies represented 75% of the total, although it was only 55% for the SMC countries.

These results have been cross-checked with more recent OECD studies, which cover only the participating countries (OECD, 2006; 2009; 2010).

Figure 12 shows that the amounts of government financial transfers (GFT) estimated by the OECD in these studies are lower than the subsidies amounts given by Sumaila (2010). There is no contradiction if we consider i) the GFT account only for a fraction of the subventions, and ii) Sumaila (2010) subsidies not only from observed data but also from estimates, to cover the un-transparent part of the subsidies.

Figure 12. Government financial transfers to marine capture fisheries



Source: OECD (2010)

OPPORTUNITIES

Employment provided by fisheries

Direct employment

Data on employment provided by marine fisheries in the Mediterranean Sea are even more difficult to gather than information on fishing fleets. Each country maintains statistical data on employment related to fisheries, but they generally aggregate all types of fisheries as well as aquaculture, including all the country's coast, but not limited to the Mediterranean.

FAO Fishery Country Profiles (FCP) contain national estimates of employment in the fisheries sector, presented in a non-harmonized way, including generally marine and fresh water fisheries as well as aquaculture, without clear distinction between direct and indirect employment.

Drawing on his analysis of the Mediterranean fishing fleets, Sacchi (2011) estimates direct employment by allocating a typical crew for each category of vessel, taking into account the current practices in each country. This allocation table has been constructed from personal expertise and cross-checked with other sources, mainly from the FCPs elaborated by the FAO.

Table 3. Estimation of crew capacity per category of fishing vessel for the main Mediterranean fishing countries in 2008 (nb of persons)

Country	TRWL	PS	PLV	ART	PST	MAD	Total
Albania	729	97	-	158	-	-	984
Croatia	4,000	5,600	-	5,200	-	-	14,800
Cyprus	48	12	112	754	-	-	926
France	455	240	95	1,101	512	-	2,403
Greece	1,866	2,529	1,789	15,138	32	-	21,354
Italia	10,965	2,277	1,153	14,953	736	420	30,504
Malta	68		460	1,527	48	-	2,103
Montenegro	120	135	-	255	-	-	510
Slovenia	100	108	-	228	-	-	436
Spain	3,675	2,206	647	2,152	96	70	8,846
Turkey	1,500	3,340	149	12,590	1,376	-	18,955
NEMC	**23,526**	**16,544**	**4,405**	**54,056**	**2,800**	**490**	**101,821**
Algeria	4,480	20,780	-	13,480	112	-	38,852
Egypt	8,760	4,760		4,478	-	-	17,998
Israel	248	399	-	776	-	-	1,423
Lebanon	-	840	-	8,194	-	-	9,034
Lybia	560	1,320	-	5,313	464	-	7,657
Morocco	1,785	3,900	1,568	8,922	-	70	16,245
Palestin. T	90	670	-	2,528	-	-	3,288
Syria	252	100	165	3,471	-	-	3,988
Tunisia	5,426	5,508	1,249	36,106	384	-	48,673
SMC	**21,601**	**38,277**	**2,982**	**83,268**	**960**	**70**	**147,158**
Total	**45,127**	**54,821**	**7,387**	**137,324**	**3,760**	**560**	**248,979**

Source: Sacchi (2011) from compilation of various data sources, mainly FAO Country Profiles and national statistical bulletins.
Note: TRWL: Trawlers and Dredgers, ART: Artisanal boats, PSP: Purse Seiners for small pelagics, PST: Tuna Purse Seiners, PLV: Polyvalent vessel exceeding 12 m., MAD: Tuna traps.

As shown in Table 3, the total crew capacity is estimated at just fewer than 250,000 in 2008. The breakdown by country shows that four countries (Italia, Greece, Algeria, and Tunisia) represent 56% of the total, the EU members representing only 26% of the whole, against 59% for southern countries, of which 42% are accounted for by the three countries of the Maghreb (Morocco, Algeria and Tunisia).

Employment is concentrated mainly in artisanal fleets (ART: 55%), followed by purse seiners for small pelagics (PS: 22%) and trawlers and dredgers (TRWL: 18%).

This assessment, however, underestimates the number of small-scale artisanal fishermen, as national fleet statistics often do not take into account small or non-motorized boats.

Indirect employment

Employment in the fisheries sector also contributes to the economy of the Mediterranean countries in a myriad of ways. The focus of this study is on the marine capture fisheries and this segment is taken to include post-harvest activities such as fish processing and selling. Employment in these related activities could be qualified as indirect employment of the marine capture fisheries segment. Although aquaculture and recreational fisheries are increasingly important sub-sectors, they are not considered in this study, which is focused solely on professional marine capture fisheries.

Information on indirect employment in marine capture fisheries is even scarcer than that on direct employment. Some data can be found in the Fishery Country Profiles prepared by FAO, EUROSTAT, OECD studies or national statistical bulletins, but they are far from coherent and generally do not reach the level of disaggregation that would be required for the purposes of this study. For this reason, it was not possible to estimate the upstream activities, such as manufacture of fishing gear and nets, or boat construction.

Indirect employment has been estimated by Sacchi (2011) mainly from the FCP, which generally provide information on the total employment of the fisheries sector, including aquaculture and capture fisheries, at the national level. In the absence of better information, these national data have been adjusted to fit with the scope of this study and it has been assumed that the ratio of indirect employment on total sector employment was similar for capture and aquaculture activities, and spatially constant for all the coasts of the considered country.

For countries that also have fishing activities outside the Mediterranean (Spain, France, Turkey, Egypt and Morocco), a ratio has been used, based on landed volumes (Mediterranean landings/Total landings) since these landings are usually segregated from coast to coast.

The fisheries employment has also been valued with reference to the active population in Mediterranean coastal areas, where this kind of employment takes place.

The active coastal population of each country has been estimated from the national active population in 2008 (UNData), to which a "coastal ratio" was applied, which signifies a ratio between coastal population and total population (Attané et *al*., 2001).

Table 4. Fisheries direct, indirect and total employment, at national and Mediterranean level, year 2008

	National						Mediterranean			
Areas	**Fisheries 1,000p**	**Aquaculture 1,000p**	**Direct Emplt 1,000p**	**Indirect Emplt 1,000p**	**Total Emplt 1,000p**	**Mult. Coef.**	**Fisheries 1,000p**	**Total Emplt 1,000p**	**Active coastal pop 1,000p**	**%**
	A	B	C=A+B	D	E=C+D	F=E/C	G	H=G*F	I	H/I
NEMC	172	64	236	95	331	1.40	102	138	38,695	0.36%
SMC	212	83	295	626	921	3.1	147	319	25,608	1.20%
Total Med	**384**	**147**	**531**	**721**	**1,252**	**2.36**	**249**	**458**	**64,303**	**0.70%**

Sources: FCP, Sacchi (2011) and UNData, adjusted by Plan Bleu.

Economic impact of Mediterranean fisheries

The impact of fisheries extends beyond landings and includes several post-harvest activities such as processing, marketing, and transportation, along with "upstream" activities that directly support fish production, such as boat construction and fishing gear manufacture. World Bank, FAO and WorldFish Centre (2010) show that the contribution of the fisheries sector is often poorly recognized by decision makers. It is largely as a result of the fragmented nature of the activities that compose the sector and their treatment in reporting on the economy. Economic statistical information on fisheries is particularly deficient for several reasons listed by the authors: i) catch operations and first sells are highly dispersed, making challenging collection of comprehensive information on catches and moreover value of these catches; ii) official fisheries values tend to focus on large-scale fisheries and may often underestimate small-scale fisheries and subsistence production, trade and barter; and finally, iii) the relationships between catches and economic returns are non-linear and complex.

The FAO reporting system requires the national authorities to report information on the GDP generated by their fishery activities. Sacchi (2011) reviewed the Fishery Country Profiles of the Mediterranean Countries and estimates, for the countries that did report this information, that contributions of the capture fisheries to national GDP are generally below 1% and at best as high as 2.5% for Morocco. However, in most cases, the sub-sectors considered are not specified. Moreover, these data are national and not disaggregated at the Mediterranean level for countries engaging in fisheries on more than one coast.

Following Sumaila (2011), we have considered that, although officially recorded national contributions to GDP are generally low, the fisheries sector nevertheless supports considerable economic activity by the way of linkages with other sectors. These linkages have been modelled by Wassily Leontief in his input-output analysis.

Dick and Sumaila (2010) applied this method to estimate the total direct, indirect and induced economic effect arising from marine fish populations in the world economy.

Input-output analysis uses inter industry transaction data to compute a technical coefficient matrix **A**, which is composed of entries **aij,** summarizing the output from industry i required to produce a unit output for industry j. The authors computed this technical coefficient matrix for every maritime country of the world, expressing the economy of each country as a system of linear equations summarized by the equation:

$$Ax + d = x$$

Where A is the matrix of technical coefficients describing input requirements for each sector, **x** is a vector of sector inputs, and **d** is a vector of final demand. The above equation then simply states that the sum of intermediate demand (Ax) and final demand (**d**) is equal to supply (**x**).

The concept of "multiplier" has been developed from this basic equation (for details, see Dick and Sumaila, 2010). Two types of output multipliers can be calculated:

- Type I multiplier is an output multiplier that allows to compute the sum of the direct and indirect outputs required to support a unit of output for a given industry, in this case, fisheries.
- Type II multiplier include all Type I effects plus the induced economic effects by including households as endogenous. With Type I multipliers, household consumption is part of the final demand sector, and therefore assumed to be exogenous, while the household consumption with Type II multipliers becomes endogenous by treating it as an additional intermediate sector in the technical coefficients matrix A.

Following the terms used by Dick and Sumaila (2010), the product of Type II multiplier calculated for marine fisheries by the landed value gives what is called the "Economic Impact" of the corresponding input fisheries, including indirect and induced effects.

The process of collecting 'supply' and 'use' data (usually published by national statistical agencies) and transforming them into symmetrical input-output tables, where flows of goods can be followed in a symmetrical industry-by-industry format, requires efforts even more important than levels of aggregation are detailed and can take a significant amount of time. In consequence, there is generally a significant lag between present day and available input-output tables. Furthermore, there is no standard by which input-output tables are compiled and they may vary considerably in sectoral aggregation. Collecting input-output data that is comprehensive and standardized at the global level is one of the issues dealt by the Global Trade Analysis Project (GTAP) at Purdue University in order to develop computable general equilibrium (CGE) models using a collection of standardized input-output tables as its core covering economic flows for 57 sectors and 113 regions of the world. The authors have adapted this database to identify the fisheries from the other extractives activities in order to estimate the output multiplier matrix, for each coastal country specified independently. Turning to coastal nations where input-output tables are not available, they use the regional table estimates from GTAP to estimate economic multipliers and applied them to the 2003 Landed Value, extracted from the SAUP global ex-vessel fish price database. Regarding the Mediterranean coastal countries, it appeared that input-output tables were available for the largest fishery producers (see for details Dyck and Sumaila, 2009).

For the present work, we used the output multipliers estimated by Dick and Sumaila (2010) for the Mediterranean coastal countries and applied them to the landed values of their marine fisheries in the Mediterranean, as estimated for 2004 (See Table 5, below). It is generally considered that the output multipliers remain relatively stable over time. As noted by Dick and Sumaila (2010), the results show a great deal of variation in fishing output multipliers between countries. For example, the multiplier for Israel has been estimated on a regional basis, which explains its low and probably largely underestimated level. It is not surprising to note, however, that the output multiplier is higher for NEMC than for SMC.

Table 5. Economic impact of Mediterranean fisheries by countries

Country	Value of landings, 1,000 US$	Output Multipliers	Economic Impact, 1,000 US$
Albania	921	1.63	1,499
Croatia	11,695	3.27	38,272
Cyprus	1,811	0.61	1,102
France	53,047	4.11	218,149
Greece	275,496	3.31	913,014
Italy	551,726	1.75	964,543
Malta	890	2.54	2,260
Montenegro	590	2.10	1,240
Slovenia	1,111	6.23	6,925
Spain	151,080	3.86	583,739
Turkey	115,614	1.59	183,833
Total NEMC	**1,163,981**	**2.50**	**2,914,577**
Algeria	35,935	1.19	42,694
Egypt	12,258	2.42	29,621
Israel	1,976	1.03	2,027
Lebanon	4,054	1.02	4,146
Libya	24,860	1.19	29,530
Morocco	7,981	2.81	22,425
Syria	1,767	1.02	1,811
Tunisia	43,279	1.46	63,065
Total SMC	**132,109**	**1.48**	**195,319**
Grand Total	**1,296,090**	**2.40**	**3,109,896**

Sources: SAUP global ex-vessel fish price database for the value of Mediterranean landings (2004); Dick and Sumaila (2010) for the multipliers

Table 6 gives the weighted multipliers for the Mediterranean fisheries in the NEMC and SMC sub-regions. As they reflect the industrial frameworks of the sub-region, we considered that these output multipliers remain relatively stable over time, and we used them to give a first guess of the economic impact of the Mediterranean fisheries in 2008.

Table 6. Estimation of the economic impact of Mediterranean fisheries by group of countries in 2008

Sub-region	Value of landings, *US$ million*	Output Multipliers	Economic Impact, *US$ million*
NEMC	1,136	2.50	2,845
SMC	175	1.48	259
Total	1,311	2.37	3,103

Sources: SAUP global ex-vessel fish price database for the value of Mediterranean landings in 2008; Table 5 above for the multipliers

This economic impact of the capture fisheries in Mediterranean countries amounts to more than two time the value of landings, or 3.1 billion for the year 2008, as shown in Table 6.

The economic case for Mediterranean fisheries

ECONOMIC CONTRIBUTION OF THE MEDITERRANEAN FISHERIES

The economic rent

This study is based on the concept of economic rent. Economists traditionally use economic rent as a measure of the net economic benefits attributable to a natural resource, in our case, wild stocks targeted by Mediterranean fisheries. This concept is particularly useful as it allows us to highlight the dissipation of the rent due to overfishing, as occurs in an open access situation (where the full "value" of the rent cannot be captured).

The concept of economic rent comes from Ricardo. In the fisheries sector, the idea is that different fisheries generate different levels of resource rent. For example, a fishery for a high-value species in coastal waters will generate more rent (or profits to fishers) than a fishery for a low-value species harvested at higher cost in deeper waters. As more fishers join a profitable fishery, they add to the aggregate costs of catching the limited quantity of fish available. As a result, the aggregate net benefit, or economic rent, decreases, and is dissipated among the fishers in the form of higher costs and lower returns for their fishing activity or fishing effort (and their investment). The rents may even become negative when public financial transfers or subsidies are provided to support an economically unhealthy fishery and where more money is spent in than earned by the fishery. As more fishers expand greater efforts (for example by investing in more efficient fishing gears) to maintain their previous level of catch, the fishers tend to deplete the fish stock capital that sustains the productivity of fishery (more fishermen go after fewer fish). This further reduces the potential net benefits (Willmann et *al.*, 2009).

As soon as the level of fishing effort moves above the point of maximum economic yield, which theoretically allows maximizing the economic rent of a given stock, a situation of economic overfishing occurs. Such "economic overfishing" can exist even if the biological effect of fishing on the stock remains sustainable.

The aim of this study is to estimate the loss of potential economic benefits, or rent dissipation, at an aggregate Mediterranean level. The Mediterranean level of rent loss can be considered as a good (inverse) metric of the economic and biological health of Mediterranean fisheries. Indeed, the economic performance, or the inefficiency, of the Mediterranean marine fisheries may be measured as the difference between maximum rent that should be theoretically obtainable from the fisheries and the actual rent currently obtained.

This estimate of rent dissipation in Mediterranean marine capture fisheries focuses on the harvesting sector, understood as fishing activities up to the point of first sale (notwithstanding the change in value once the catches have landed and been sold at first sale). Thus, the first step is to estimate the actual economic rent from Mediterranean fisheries, as calculated by deducting the costs of fishing and subsidies from the value of landings at the Mediterranean level. This value is then compared to the potential maximum economic rent that could theoretically be derived, on the basis of the aggregate model for global fisheries developed by Arnason (2007) and extrapolated to the Mediterranean context.

Costs of fishing

There is no representative dataset on the costs of fishing in the Mediterranean. Precise costs and earnings, however, are available from a number of countries and fisheries. One prominent effort on this topic is conducted yearly by the European Union on its major fishing fleets (EC, 2006). Fishing costs vary greatly by type of fishery and locality. In general, the major cost factors for most fisheries are labor (30-50%), fuel (10-25%), fishing gear (5-15%), repair and maintenance (5-10%) and capital cost, such as depreciation and interest (5-25%), (Willmann et *al.*, 2009). To evaluate total cost of fishing by country, we used estimates of cost of fishing by gear and by country calculated by Lam et *al.* (2010) and data of catch by gear and by country for the year 2004 from Sea Around Us Project database (see Table 7).

Estimation of rent from fisheries

Based on the value of landings by country contained in the *SAUP* database and estimations of costs of fishing, it was possible to calculate the current economic rent, the profits and the total added value at the country and Mediterranean levels. Wages and payment to capital are estimated on the basis on the comprehensive costs and earning data set available for European fishing fleet (EC, 2006). Labor costs and payments to capital were conservatively calculated at

respectively 39% and 9% of the total cost of fishing. Moreover, subsidies by country have been calculated for the year 2003 using the world database developed by Sumaila (2010), (see section 3.1.4).

Table 7. Estimation of the rent and added value of the Mediterranean marine capture fisheries in 2004

Country	Vol. of landings 1,000 t.	value of landings 1,000 $	Value/ ton, $	cost of fishing 1,000 $	Subsidies 1,000 $	Rent 1,000 $	Wages 1,000 $	payment to capital 1,000 $	Profit 1,000 $	Added-value 1,000 $
Albania	2	3	1,483	4	1	-3	2	0	-1	-1
Croatia	105	110,444	1,055	149,372	1,802	-40,730	58,255	13,443	-38,928	30,969
Cyprus	2	3,887	1,925	3,298	1,440	-851	1,286	297	589	732
France	37	42,502	1,146	63,498	63,024	-84,019	24,764	5,715	-20,995	-53,540
Greece	134	309,565	2,307	309,466	148,347	-148,248	120,692	27,852	99	296
Italy	128	259,668	2,029	306,887	240,421	-287,640	119,686	27,620	-47,219	-140,334
Malta	9	30,574	3,539	16,880	1,589	12,105	6,583	1,519	13,694	20,207
Montenegro.	5	10,148	2,160	8,468	161	1,519	3,302	762	1,680	5,584
Slovenia	1	536	659	901	210	-575	352	81	-365	-143
Spain	97	124,591	1,286	165,759	166,330	-207,498	64,646	14,918	-41,168	-127,934
Turkey	144	190,560	1,319	168,207	34,941	-12,589	65,601	15,139	22,352	68,151
TOTAL NEMC	**663**	**1,085,526**	**1,636**	**1,197,141**	**659,600**	**-771,215**	**466,885**	**107,743**	**-111,614**	**-196,587**
Algeria	114	23,465	207	98,556	6,689	-81,780	38,437	8,870	-75,091	-34,473
Egypt	28	15,646	553	31,916	13,143	-29,414	12,447	2,872	-16,271	-14,094
Israel	4	3,028	773	4,752	1,218	-2,942	1,853	428	-1,724	-661
Lebanon	7	7,500	1,017	8,479	587	-1,566	3,307	763	-979	2,504
Libya	21	10,782	524	21,882	5,089	-16,189	8,534	1,969	-11,100	-5,685
Morocco	39	11,740	302	41,319	13,105	-42,685	16,115	3,719	-29,580	-22,852
Syria	3	4,523	1,469	3,840	776	-93	1,498	346	683	1,750
Tunisia	173	183,266	1,057	209,839	26,479	-53,052	81,837	18,886	-26,573	47,670
TOTAL SMC	**389**	**259,949**	**668**	**420,583**	**67,086**	**-227,721**	**164,027**	**37,852**	**-160,634**	**-25,841**
TOTAL	**1,053**	**1,345,475**	**1,278**	**1,617,724**	**726,687**	**-998,936**	**630,912**	**145,595**	**-272,249**	**-222,428**

Sources: SAUP; Lam et al. (2010); EC (2006); Sumaila (2010); OECD (2010)

Mediterranean countries currently generate a negative rent of more than US$ 1 billion a year from fishing (based on data for 2004), when the total cost of fishing (US$ 1.6 billion) and subsidies (US$ 727 million) are deducted from the total value of US$ 1.3 billion generated by fisheries (See Table 7). The negative rent as well as the negative profits observed at the Mediterranean level is a clear indication of the current overcapacity and economic inefficiency of the fisheries sector in the Mediterranean. Nevertheless, this appalling result is not uniformly widespread, as some south artisanal fisheries succeed in producing a positive rent (Idrissi et *al.*, 2003).

POTENTIAL CONTRIBUTION FROM SUSTAINABLE FISHERIES

The aggregate model

Based on Arnason (2007), an aggregate model of the global fisheries is applied to estimate the total rent lost by Mediterranean marine fisheries. The model implies several gross abstractions and assumptions. In particular, the model assumes that global fisheries, and in our case Mediterranean fisheries, can be modeled as a single fish stock with an aggregate biomass growth function. Similarly, the Mediterranean harvesting sector is represented by an aggregate fisheries profit function, composed of an aggregate harvesting function, relating the harvest to fishing effort and biomass, and an

aggregate cost function relating fishing effort to fisheries costs. The condensed form of the model is shown in the Box 1, below.

In order to estimate the rent lost in the base year at the Mediterranean level, this study compares maximum sustainable rent to the actual rent achieved in the base year. Thus, the rent loss estimate assumes that the existing biological overfishing is entirely reversible in the long run. Finally, the estimate does not take into account the actual costs that would have to be assumed to restore global fisheries to economic health. Nevertheless, the costs and the benefits of the transition to sustainable fishery at the Mediterranean level have been estimated separately and are presented respectively in sections 3.3 and 3.4, above.

Box 1. Condensate model of fisheries

(1) $\dot{x} = \alpha.x - \beta.x^2 - y$ (Logistic)

Ou (Biomass function growth)

$\dot{x} = \alpha.x - \beta \ln(x).x - y$ (Fox)

(2) $y = q.e.x^b$ (Harvesting function)

(3) $R = p.y\left(\frac{c}{q}\right).y.x^{-b}$ (Fishery rent)

(4) $\Pi = p.y - \left(\frac{c}{q}\right).y.x^{-b} - fk$ (Profit function)

Change in fishing effort from an initial to an optimal fishery. Ratio can be calculated as:

(5) $\varphi = \frac{e^*}{e(t^*)} = \frac{p.y^* - \Pi^*}{p.y(t^*) - \Pi(t^*)}$ with, e(t^*) = initial effort and e* = optimal effort

Thus, (5) $e^* = \varphi.e(t^*)$

Source: Willmann et *al.*, (2009)

The population dynamics of the exploitable aggregate biomass are modeled through a logistic, or Schaeffer-type (1954), model and through a Fox model (1970). The main difference between these two biomass growth functions is that the Fox model assumes that, all else being equal, the biomass is much more resilient to increasing fishing effort, in other words, the sustainable biomass and harvest will decline more slowly as fishing effort increases (Willmann and *al.*, 2009). The Fox model is consistent with the experience from the Mediterranean fisheries that proved to be relatively resilient. In fact, even though many of the most valuable demersal stocks have become depleted, the aggregate Mediterranean harvest has continued to increase and has not contracted significantly, despite ever-increasing fishing effort (Garcia, 2011).

The use of the aggregated model of Arnason (2007) calls for several assumptions, as summarized in Table 8.

Table 8. Input data for the aggregated model

Input data		Units	Value
Biological data			
Maximum sustainable yield	MSY	m. metric tonnes	1.07
Carrying capacity	X_{max}	m. metric tonnes	5.03
Fisheries data in base year (2004)			
Biomass growth in base year t*	‹ (t*)	m. metric tonnes	-0.06
Landings in base year t*	y(t*)	m. metric tonnes	1.05
Price of landings in base year t*	p(t*)	1,000$/tonnes	1.28
Profits in base year t*	Π(t*)	billion $	-0.27
Fixed cost ratio in base year t*(fk/TC(t*))	ε(t*)	ratio	0
The schooling parameter	b	no units	0.64
Elasticity of the demand with respect to biomass	d	no units	0.24
Effort (index or real base year effort)			
Fishing effort (fleet) in base year	e(t*)	index	1.00

The global **Maximum Sustainable Yield** (**MSY**) is higher than the reported marine catch in base year (1.05 million tons) and lower than the sum of the maximum reported catch for each functional group in the past (1.19 million tons). A conservative value of 1.07 million tons is used in the model and represents 90% of the sum of maximum reported catch for each functional group in the Sea Around Us project database. We use the same rule of thumb as Willmann and *al.* (2009) in the flagship publication of the World Bank and FAO on the world fishery rent "*The Sunken Billions, the Economic Justification for Fisheries Reform*". This amount is also conservative as Illegal, Unreported and Unregulated fishing (IUU) are not taken into account in the maximum reported catch for each functional group, which is probably quite high for the Mediterranean, particularly as pertains to unreported fishing.

The **carrying capacity** (X_{max}) corresponding to this MSY is assessed as 5.03 million tons and represents 4.7 times the calculated MSY. This is based on the average relationship between the known carrying capacity and the MSY for a number of fisheries, as used by Willmann and *al.* (2009) at the global level.

The base year for fisheries data used in the model is 2004. A more recent year might have been preferable, but 2004 was the last year for which it was possible to compute components of the rent from available data. At that time, **volume of landings** (**y(t*)**) and **value of landings** (**p.y(t*)**) are estimated at 1.05 million tons and US$ 1.35 billion (real 2000 value in US$) respectively, which corresponds to an average landed price (**p(t*)**) of 1,278 US$ per ton (real value).

Profits (**(t*)**) are estimated by subtracting the costs of fishing from the value of landings in the base year. As calculated previously (see Table 7), a negative profit (real loss) of US$ 272 million is used in the model to characterize the situation in the year 2004.

Harvests of species with a strong tendency to congregate in relatively dense schools (such as anchovies and sardines) are often little-influenced by the overall biomass of the stock (Hanneson, 1993). The opposite is true for species that are relatively uniformly distributed over the fishing grounds (such as hakes or red mullets). For these species, harvests tend to vary proportionately with the available biomass for any given level of fishing effort. The **schooling parameter** (**b**) reflects these features of fisheries and normally has a value between zero and unity. The lower the schooling parameter, the more pronounced the schooling behavior and the less dependent the harvest is on biomass. In the harvesting function for the Mediterranean fishery, the aggregate schooling parameter should reflect the schooling behavior of the different species. The schooling parameters estimated by Willmann and *al.* (2009) for species groups have been then applied to the different functional groups of species used in this study. An average of schooling parameters by fishery group weighted by their landed volume for the year 2001 to 2006 gives an aggregate schooling parameter of approximately 0.64, which is the value used in this study.

In the fisheries model, the average price of landings depends on the Mediterranean marine commercial biomass according to a coefficient referred to as the **elasticity of demand with respect to biomass** (**d**). Following Willmann and *al.* (2009), a value of 0.2 is used in this Mediterranean study, meaning that if the global biomass doubles, then the average price of landings increases by 20%. The rationale of this feature is based on the theory of economic rent of Ricardo. In fact, fishing activities initially target the most valuable fish stocks and the most profitable fisheries. As the fishing effort increases, high-value species stocks become depleted and the fishing activity moves to less valuable fish stocks. In this situation of overfishing, the higher proportion of lower-value species tends to depress the average price of the aggregate catch. However, when the reverse takes place, under a governance regime that restores biomasses and the health of fish stock, the average price will tend to rise since higher value stocks will once again be targeted.

The marginal cost and catchability, *c* and *q*, do not play an independent role in this model, and the ratio of the two (*c*/*q*), may be regarded as a single coefficient, referred as to "normalized marginal cost".

Finally, the characterization of the fixed cost ratio parameter (**μ(t*)**)follows choices that have been made in Willmann's Sunken Billions report (2009). All the costs are assumed as variable. In fact, the potential foregone rent is estimated as the difference between the rent in base year and the maximum sustainable rent, which is the maximum rent achieved when the biomass (fish stocks) and the capital stock (fleet) are in equilibrium. This equilibrium prevails when fish stocks have been rebuilt and when the fleet has been fully adjusted to sustainable catch levels. During the period of fleet adjustment, the capital costs, normally regarded as fixed costs, are in fact variable. Therefore, for the purpose of the study, all costs are considered as variable, and then the fixed cost ratio is set to zero in these calculations.

The potential rent

In line with Willmann and *al.* (2009), the aggregated model has been run using both Logistic and Fox functions, the results of which have been averaged to make the analysis more robust. Results indicate that reforming Mediterranean fisheries could increase resource rent from negative US$ 1 billion to an average of US$ 314 million a year (Table 9). As was done by Sumaila (2011) in the fishery chapter of the UNEP *Green Economy Report,* subsidies are assumed not to have been eliminated but reduced by half of the current amount towards aiding the transition to sustainable fisheries. The total value

added to the economy by fisheries in the region under such a scenario is estimated at 668 million US$ a year, compared to the negative feature of US$ 222 million of the current situation.

Table 9. Sustainable fisheries, key economic figures, comparison between two scenarios, current situation illustrated by the year 2004 and sustainable fisheries as an average of two modeled situations: Fox and Logistic

	Units	Current situation	Sustainable fisheries (Fox)	Sustainable fisheries (Logistic)	Sustainable fisheries (average)
Harvest	1,000 tonnes	1,053	860	891	**876**
Fishing effort	index	1	0.53	0.38	**0.46**
Price of landings	1,000US$/t	1.3	1.5	1.7	**1.6**
Value of landing	US$ million	1,345	1,294	1,535	**1,415**
Cost of fishing	US$ million	1,618	857	617	**736**
Subsidies	US$ million	727	363	363	**363**
Rent	US$ million	-999	74	556	**315**
Wages	US$ million	631	334	240	**287**
Payment to capital	US$ million	146	77	55	**66**
Total added-value	US$ million	-222	485	851	**668**

Methods: Sumaila (2011); Willmann et *al.* (2009); Arnason (2007); Srinivasan et *al.* (2010); and Lam et *al.* (2010).
Data: Sea Around Us project and FishStatJ

THE COST-BENEFIT ANALYSIS OF MAKING MEDITERRANEAN FISHERIES MORE SUSTAINABLE

Costs of adjusting the size of the fishing fleet

The current fishing capacity in the Mediterranean is broadly estimated to be two times greater than what would be needed to land the quantity of fish that would maximize the potential economic rent. This implies that, in order to shift the fishing industry to a more sustainable scenario and to maximize sustainable economic rent, excess fishing capacity would need to be trimmed significantly. The model results show that fishing effort need to be reduced by some 50%. It is estimated that 83,400 boats are actively engaged in Mediterranean marine fisheries (see Table 1), meaning that the total fishing fleet may need to be reduced by up to 41,700 vessels. Likewise, it is also estimated that the total fishing industry in the Mediterranean employs more than 249,000 people, which would indicate that up to 124,500 fewer fishermen would be required in the sustainable scenario. However, this calculation does not take account of differences in fishing capacity by vessel type, as the overcapacity of small artisanal boats is likely to be much less than that of hyper efficient industrialized fishing vessels.

Similarly, the cost of reducing capacity will vary by fishery and type of vessel. In the worst case scenario, Sumaila (2011) calculates on the basis of vessel and crew data from the European Commission (EC, 2006) that the average cost of vessel buyback is roughly equal to the average interest payments on a vessel for five years and the average cost of crew retraining is estimated as 1.5 years average annual crew wages. These values have been estimated to be US$ 15,000 per vessel buyback and US$ 18,750 per crew retraining. Based on this information, we estimate that the total investment needed to reduce fishing capacity by half is around US$ 3 billion. It should be noted that this total amount could, and probably should be spread over time if necessary.

Cost-benefit analysis of making sustainable fisheries

As presented earlier, the transition to the sustainable scenario would lead to an increase in Mediterranean added value from fishing from negative US$ 222 million to positive US$ 668 million a year. This is a net increase of US$ 890 million a year. Given that the cost of restructuring the Mediterranean fishing fleet would in a worst case scenario amount to a one-time investment of about US$ 3 billion (i.e approximately 3 times the yearly net calculated increase) the costs could be recovered and benefits would be realized in few years if fish stocks recover fast.

Furthermore, discounting the flow of US$ 891 million per year over the next 50 years at 3% and 5% represents a present value of US$ 16 and 23 billion US$ from shifting to sustainable fisheries, which is respectively six and eight times the estimate cost of such a policy, thus demonstrating that the transition to sustainable fisheries could potentially provide a huge economic benefit.

Although a variety of assumptions have been needed to produce these estimates, it is clear that the potential economic gains from shifting to sustainable Mediterranean fisheries are substantial and compelling enough to compensate for even the drastic changes that are called for in these assumptions.

Bringing and keeping the capacity of the fishing fleets in line with the sustainable fishing scenario will improve the wealth of the nation and the individual revenues of remaining fishermen but inevitably lead to less overall employment in the catching sector. However, it should be considered that the employment losses could be more important in case of continuation of the 'Business as Usual' scenario. History of fisheries shows that overexploitation can lead to disasters, as in the case of the cod exploitation in Newfoundland, the largest cod fishery in the world, where the industry and associated employments collapsed entirely in the early 1990s, without recovery to date in spite of moratorium on fishing, due to provoked irreversible changes in ecosystems. Management of reforms towards sustainable fisheries and cushioning of the effect on impacted populations are political issues.

Suggestions for steering toward sustainable fisheries: case studies

A number of other management tools and funding sources are available that can be used to move the regional fisheries sector from its current underperforming state to a sector that delivers higher but socially acceptable benefits, while achieving sustainable levels of fishing over the long run for the benefits of current and future generations. The necessary downsizing of the fleet should be made whilst trying to protect the small-scale fisheries and the associated fragile coastal communities, while not preventing larger fleets from undergoing the necessary adaptations. A possible way could be to have differentiated management regimes: one for large-scale fleets, where capacity adjustment and economic efficiency are at the core, and another for small-scale fleets in coastal communities, with more focus on social objectives.

In line with the principles of the future European CFP, arrangements for the large-scale segment could include economic incentives for fleet adaptation such as market-based allocation mechanisms, while small-scale coastal fisheries would be managed through direct allocation of quotas or effort or through collective schemes. The approach to public financial support could be different for the two segments: the large-scale fleet would be expected to be economically self-reliant, while public funding may help the small-scale segment adapt to changing conditions towards more sustainable fisheries, thereby strengthening its economic viability, and maintain its contribution to the life of coastal communities. These proposals for steering toward sustainable, socially beneficial and economically profitable fisheries are illustrated in two cases studies, the first about the emblematic Bluefin Tuna large scale fishery and the second presenting reforms in the Moroccan small-scale artisanal fisheries.

THE BLUEFIN TUNA CASE

Bluefin Tuna (BFT) has been listed in the IUCN Red List as an endangered population. BFT, one of the most valuable harvested fish in the world, faces a significant risk of outright collapse, jeopardizing an activity that currently provides around 4,000 direct jobs and 4,000 more indirect ones. Sumaila and Huang (2010) have analyzed the BTF economy for each fishing country. Referring only to Mediterranean coastal countries, Table 10 summarizes their findings for 2006, showing a low rent that stands in contrast with an estimated economic impact in the range of half a billion dollars. A collapse of this fishery would thus be likely to have dramatic impacts, both economically and socially for the communities involved.

Table 10. Economics of BFT in 2006

Area	Total reported catch (t)	Landed value (US$ million)	Cost (US$ million)	Ressource rent (US$ million)	Economic impact (US$ million)
NEMC	17,544	171	155	24	563
SMC	5,053	50	45	5	71
Total	**22,597**	**221**	**200**	**29**	**634**

Sources: Sumaila and Huang (2010); ICCAT (2008)

Because of increasingly poor management, ICCAT, the Regional Fisheries Management Organization (RFMO) in charge of this resource, has had to set the Total Allowable Catches (TAC) for 2011 at 12,900 t, to try and allow the stock to recover. By contrast, ICCAT estimates that the long-term potential yield is as high as 50,000 t/year, but only if sustainable practices are followed. The difference can be valued between 370 million US$ (landed value) and 950 million US$ (Japanese market) per year.

The difference in volume is calculated by subtracting the ICCAT-recommended TAC for 2011 (12,900t) from the long-term *potential* yield estimated by ICCAT (50,000t/year), i.e. 37,100t/year.

The valuation of this volume is given as a range between values:

- Average landing value for the BTF fished in Mediterranean Sea according Sumaila & Huang (2010): 9.80$/kg in 2006.

- Average fresh Tuna price of market in "Ten cities wholesale markets" 2,972 Yen/kg in 2006 (source: Japan Statistical Yearbook, 2011) or 25.55$/kg.

According to Murno and FAO (2010), the root of the problem is straightforward: as illustrated by the well-known "prisoner's dilemma", the cooperative game that should be the base of any RFMO decision has degenerated in the case of the BFT into a competitive one, resulting in the predictable overexploitation of the resource. Game theory clearly shows that there is no better solution but to strengthen regional cooperation in order to adopt tried and true successful management measures for BFT. Sumaila and Huang (2010), amongst others, suggested effective cooperative mechanisms, such as introducing enforceable penalty regimes and intensifying monitoring systems. More specifically, the authors recommend studying the establishment of Marine Protected Areas in the well-defined spawning areas of the BFT, where reproducing individuals are especially vulnerable. A mutual compensation funds could be established to promote such cooperation among concerned countries. Moreover, the EU should be convinced to reduce its fishery subsidies for BFT fattening farms and vessel modernization. Individual countries could improve the management of their national fleets by allocating Individual Transferable Quotas (ITQ) or even Dedicated Access Privileges (DAP). Since they effectively grant to individuals or communities the privilege to fish a portion of the national TAC, DAPs are probably more adapted to this highly migratory resource and would be considered as more equitable by fishermen.

SMALL-SCALE ARTISANAL FISHERIES: INVOLVING STAKEHOLDERS IN THE SUSTAINABLE MANAGEMENT OF MARINE LIVING RESOURCES

Small-scale artisanal fisheries are often at a disadvantage, particularly as regards their interactions with others, larger fisheries. In Morocco, the artisanal fishermen are in direct conflict with coastal fishermen, who, even though they are legally excluded from a zone that extends three nautical miles from the coast, often "poach" in these same waters. Artisanal fishermen operate much smaller and rudimentary wooden boats, equipped with outboard engines, and operate all their fishing gears by hand. In addition, a major source of hardship for these fishermen is that they are frequently at the mercy of traders and collectors who buy their catches at fixed and depressed prices, and supply them with basic necessities (replacement gear, engine repair, gas and even investment funds) at prohibitive rates. As a result, these fishermen are amongst the poorest in Morocco and their activities are coming under increasing pressure, including from the impacts of climate change on the stocks they target.

In spite of these great difficulties, however, a number of innovative initiatives were recently launched in Morocco to try and support their activities, without increasing the level of effort, and thus the pressure that is brought to bear on the stocks. These initiatives are remarkable in that they address the sustainability of the resource at different but important stages: before it is harvested ("fish in the water" and critical ecosystems), as it is being harvested (restrictions on destructive fishing gear), and after it is landed. This approach clearly recognizes that no single link of the fishing/marketing chain can be ignored and that creative and innovative approaches must be adopted to address the multitude of factors at play.

Protecting stocks and key ecosystems

The most innovative approaches taken to protect marine living resources in Morocco involve parallel approaches focusing on the biological integrity of targeted stocks and related ecosystems: marine protected areas (MPAs) and artificial reefs. The artificial reefs initiative was inspired by a similar and successful pilot project first developed in Tunisia, where very basic underwater structures are deployed at sea, in areas that are known by the fishermen to be usual breeding grounds. These structures provide shelter to juveniles that are thus protected while they are still growing, and thus of limited commercial value. When the individuals grow to adult size, they can no longer find refuge in the reefs and thus migrate to surrounding areas, where they become fair game for the fishermen who had the wisdom to let them grow past the reproductive stage. The structures are very cheap to build and indeed are often built by cooperatives of fishermen themselves, with very basic material (poured concrete, rebar, pottery jars for octopus, etc). Fishermen are also trained on the importance of refraining from fishing in these areas, and an added benefit of these structures is that they present a risk for the coastal trawling fleets, which are thus discouraged from fishing in the area designated for artisanal fishermen.

In parallel, the Kingdom of Morocco has recently launched a national initiative on marine protected areas (MPAs), which are now becoming a fully recognized fisheries management tool. Here again, this approach is predicated upon the recognition that some critical habitats must be protected from destructive fishing practices and that some stocks must be spared at least during some of their life stages (particularly around breeding grounds and nurseries). These MPAs are being set up in full cooperation with the fishermen themselves, and with the understanding that those who will have borne the costs of the MPAs (particularly the opportunity cost of not fishing in these areas) will also be the ones who will reap the benefits expected (in the form of increased biomass in areas surrounding the MPAs).

Protecting the fish while they are still in the water is necessary, but far from sufficient to reduce poverty amongst artisanal fishermen. Whilst they can expect healthier stocks, and thus higher catch per unit effort (CPUE), fishermen also recognize the importance of maintaining the quality of the fish once it has been caught. To that end, a national initiative aimed at improving landing sites and port access was recently launched, which specifically addresses the need for adequate infrastructures to keep the catches as fresh and as long as possible. A network of landing sites is thus being built along both the Mediterranean and the Atlantic coast, with access to water, electricity and ice, and open markets where prices are determined by supply and demand. The goal is for fishermen to increase their revenue by increasing the quality of the catches they land, *without* increasing the volume of their landings.

Encouraging ownership of the resource throughout the value chain

The final level at which direct support is being provided to the fishermen is through the marketing of the landed catches. When looking at the value chain for the fisheries sector in Morocco, it quickly becomes apparent that the largest marginal increase in value occurs very early on, at the so-called first sale stage, where the fishermen sell and completely lose ownership of their catches. A small number of fishing cooperatives have attempted to capture that increase in value, by grouping and purchasing all the landings from their members and then re-selling to various intermediaries, thus cutting, to the extent possible, the middlemen who traditionally take advantage of artisanal fishermen under pressure.

Although some of the initiatives described below are still at embryonic stages, some key lessons can already be learned:

- Reducing poverty, in the long run, can only be achieved by increasing the *value* of the catches, rather than their *quantity*;
- Efforts cannot be applied to the targeted stocks alone, but rather an ecosystem approach is called for, which also takes into account key and related ecosystems;
- Intervention should occur at all stages: when the resources are still in the water, when they are landed, and as they enter the transformation and marketing cycle;
- Small-scale fishermen are almost always better off when they organize and form cooperatives. These cooperatives in turn must be supported by local, regional and national authorities, and be provided with significant capacity building;
- Regional lesson sharing is key, as illustrated in the case of the artificial reefs, where the approach adopted in Morocco was initially piloted in Tunisia, for similar fisheries; and
- Because these initiatives are complex and interrelated, different donors are required to cooperate in order to avoid overlap and gaps. The various activities described above were funded by a combination of Government of Morocco, Japanese bilateral assistance (JICA), US bilateral assistance (Millennium Challenge Corporation, or MCC), and the World Bank.

Conclusion

Decades of mismanagement of coastal zones and fish stocks on the northern shores of the Mediterranean provide lessons for decision makers on the southern shores, offering them an opportunity to consider a more sustainable path. Overfishing in the southern and eastern Mediterranean is less severe than in the northern Mediterranean, but some stocks are already at risk, making immediate action a necessity to avoid irreversible environmental and economic losses.

Mediterranean fisheries are underperforming both in economic and social terms. Preserving threatened environmental assets and rebuilding depleted stocks as well as implementing effective management could increase the overall marine fisheries catch, and raise the economic contribution of this sector to the regional economy.

In order to achieve sustainable levels of fishing in economic, ecological and social terms, a serious reduction in current excessive capacity is required. Downsizing of the fleet should be carried out with a view to protecting small-scale fisheries and dependent coastal communities. To that end, two differentiated management regimes could be envisaged, one designed for large-scale fleets (where capacity adjustment and economic efficiency are the core) and the other targeted at small-scale fleets in coastal communities (with a focus on social objectives). Given the wide difference in the catching power, the job creation potential, and the livelihood implications of large scale versus small-scale fishing vessels, it appears that a reduction effort focused on large-scale vessels could reduce overcapacity at lower socio-economic costs to society. Successful experiences are being conducted based on mechanisms to manage the transition and adjustment within the fishing industry, through vessel buyback programmes, compensation, provision of social security and retraining programmes for fishers, to learn from and build upon.

Implementing these recommendations to the Mediterranean fisheries sector would require additional public funding. However, the gains would more than pay for the investments and in a few years' time. Simulations carried out in this study by using an aggregate bio-economic model of fisheries applied to the Mediterranean basin show that the transition to the sustainable scenario would lead to an increase in Mediterranean added value from fishing from negative US$ 222 million to positive US$ 668 million a year. This is a net increase of US$ 890 million a year. Given that the costs of restructuring the Mediterranean fishing fleet could amount to a one-time investment of about US$ 3 billion, these investments could be recovered in few years if fish stocks recover fast, and allow further benefits.

Moreover, the remaining subsidies to the sector should be partly dedicated to improve fisheries management. This would enable a more effective implementation of management tools that have proven to be effective, including stock assessments, monitoring and controlling programs, transferable and non-transferable quota systems, and expanding marine protected areas. Catch operations are often highly dispersed, making collection of comprehensive catch information challenging, particularly for small-scale fisheries. The variety of species and products, and the differences in methods of measuring production at point of harvest or first sale also present major technical problems. Statistical information on fisheries, whether it is on economic or employment issues, is generally deficient.

Strengthening data availability, accessibility and reliability remains thus a major issue for policy and decision making. In addition, reinforcement of fishery institutions both in national administrations and regional fishery management organizations such as GFCM and ICATT would allow a more effective governance and management of resources.

References

Anderson, J., Guillien, J. (eds) (2010) *The 2010 Annual Economic Report on the European Fishing Fleet*, Report # 24554 EN, JRC, STECF, EC, DG Mare

Arnason, R. (2007) *An Excel Program to Estimate Parameters and Calculate Fisheries Rents*, FAO

Attané, I., Courbage, Y.,Batisse, M. (2001) *La démographie en méditerranée*, Economica, Les fascicules du Plan Bleu.

Bas Peried, C. (2005) *The Mediterranean sea: living resources and exploitation*, CIHEAM-IAMZ / FAO COPEMED Project, 509p.

Bernard, F., Brun, L. (2011) *Préservation des espaces naturels, Lagune de Nador, Maroc, Mission exploratoire Rapport de synthèse*, Conservatoire du littoral et SIBOJAÏ

Bodiguel, C., (2009) Factors of unsustainability and overexploitation in marine fisheries*/*: views from the southern Mediterranean, West Africa, Southeast Asia and the Caribbean. Food and Agriculture Organization of the United Nations, Rome.

CEC (2009) Green paper on the reform of the common fisheries policy, Commission of the European Communities, Brussels, COM 163, 28

CMI (2012 – in press) 2012 *MED REPORT Towards green growth in the Mediterranean countries – Implementing policies to enhance the productivity of natural assets*, CMI, World Bank, EIB, Femise, AFD, Plan Bleu.

Coppola, S.R. (2006) Inventory of artisanal fishery communities in the western and central Mediterranean, *Studies and Reviews GFCM*, 77, 82 pp.

Dyck, J. A., Sumaila, U. R. (2009) *Contribution of Ocean Fish populations to the World Economy*, Fisheries Centre, The University of British Columbia, Working Paper Series, Working paper # 2009-08

Dyck, J. A., Sumaila, U. R. (2010) Economic impact of ocean fish populations in the global fishery, *J. of Bioeconomics*, 12(3), pp. 227-243

EC (2006) *Economic Performance of Selected European Fishing Fleets*, Annual Report 2005, Economic Assessment of European Fisheries, EC contract FISH/205/12, March 2006

EC (2008) *Economic Performance of Selected European Fishing Fleets in 2008*, The Potential Economic Impact on Selected Fleet Segments of TACs proposed by ACFM and reviewed by SGRST for 2008 (EIAA-model calculations), Nov. 2007.

EVOMED (2011) *The 20th Century evolution of Mediterranean exploited demersal resources under increasing fishing disturbance and environmental change*, EVOMED, Draft final Report January 2011, Contract EU DGMARE SI2 539097, Prepared by CIBM (Livorno, Italy), HCMR (Athens, Greece), ICM-CISC (Barcelona, Spain) and UNIMAR (Rome, Italy): 239 p. (Part 1) +276 p. (Part 2).

FAO, FishStatJ, Software for fishery statistical time series, http://www.fao.org/fishery/statistics/software/fishstatj/en

FAO (2010) *The State of World Fisheries and Aquaculture* – 2010

Fitzpatrick, J. (1996) *Technology and fisheries legislation*, In: Precautionary Approach to Fisheries. Part 2: Scientific Papers (Technical Consultation on the Precautionary Approach to Capture Fisheries (Including Species Introductions), Lysekil, Sweden, 6-13 June 1995). D. Bartley, Å. Bjordal, J.F. Caddy, K.-C. Chong, E.J. de Boer, W. de la Mare (eds), FAO Fisheries Technical Paper No. 350, Part 2. FAO, Rome, pp. 191-199.

Franquesa, R., Oliver P., Basurco B. (2008). *The Mediterranean fisheries sector: a review of facts and figures*, Options Méditerranéennes, Série B, N° 62

Garcia, S. (2009) *Rising to depletion? Towards a dialogue on the state of national marines fisheries*, The World Bank

Garcia, S. (2011) *Long-term trends in small pelagic and bottom fisheries in the Mediterranean*: 1950-2008, Technical Report, Plan Bleu, Sophia-Antipolis

GFCM. (2011) Draft report of the 12th session of the SAC Sub-Committee on Stock Assessment (SCSA). Saint George's Bay Malta, 28 November-3 December 2010. GFCM: SAC13/2011/Inf. 19:

GFCM /SAC, (2011), *Report of SCESS/SCSA/SCSI transversal workshop on fishing capacity*, Rome, Italy, 27-28 September 2010

Griffiths R. C., Robles, R., Coppola, S. R., Camiñas, J. A.(2007) *Is there a future for artisanal fisheries in the western Mediterranean?* COPEMED, FAO, Rome, 2007

Hannesson, R. (1993) *Bioeconomic Analysis of Fisheries*, Food and Agriculture Organization of the United Nations, Rome

Hardin, G. (1968), The tragedy of the commons, *Science*, 162, 1243-1248

ICCAT (2008) *Report of the 2008 Atlantic bluefin tuna stock assessment session*. Madrid, Spain.

ICCAT (2010a) *10-04 BFT - Recommendation by ICCAT amending the recommendation by ICCAT to establish a multi-annual recovery plan for bluefin tuna in the eastern Atlantic and Mediterranean*. http://www.iccat.int/en/RecsRegs.asp

ICCAT (2010b) *Report of the Standing Committee on Research and Statistics (SCRS)* Madrid, Spain, 2010

Idrissi, M., Zahri, Y., Houssa, R., Abdelaoui, B., El Ouamari, N. (2003) *Pêche artisanale dans la lagune de Nador,: exploitation et aspects socio-économiques, Artisanal fishery communities in the Mediterranean, two case studies*, FAO COPEMED Project

Ifremer (coord.) (2007) *Small-Scale Coastal Fisheries in Europe*, Final report for the European Commission of the contract n° FISH/2005/10, 447 p.

Lam, W.Y.V., Sumaila, U.R., Dyck, J. A., Pauly, D.,Watson R. (2010) *Construction and Potential Applications of a Global Cost of Fishing Database*, Working paper # 2010-13, Fisheries Centre, University of British Columbia, Vancouver, Canada.

Munro, G.R. (2010) *From Drain to Gain in Capture Fisheries Rents: A Synthesis Study*, FAO Fisheries and Agriculture Technical Paper 538, Food and Agriculture Organization of the United Nations, Rome 49p.

NMFS. (2010). *Supplemental Environmental Assessment, Regulatory Impact Review, and Final Regulatory Flexibility Analysis for the Final 2010 Atlantic Bluefin Tuna Quota Specifications*. U.S. Department of Commerce, NOAA, National Marine Fisheries Service, Office of Sustainable Fisheries, Highly Migratory Species Management Division. April 2010.

OECD (2006) *Financial support to fisheries – Implications for sustainable development*, Organisation for Economic Co-operation and Development, Paris, France, 374p.

OECD (2009) *Review of fisheries in OECD Countries 2009 – Policies and summary statistics*, Organisation for Economic Co-operation and Development, Paris, France, 412p.

OECD (2010). *Review of Fisheries in OECD Countries 2009 Policies and Summary Statistics*,/Organisation for Economic Co-operation and Development, Paris, France

Sacchi, J., (2011) *Analysis of Economic Activities in the Mediterranean: Fisheries and aquaculture sectors,* Technical Report, Plan Bleu, Sophia-Antipolis.

Salz, P. (2009) *Towards Elimination of Subsidies in Fisheries*, Framian BV, Baltic Sea 2020 Foundation.

Sea Around Us Project, Large Marine Ecosystems, Global Database: Catches, Values and Subsidiaries http://www.seaaroundus.org/

Spagnolo M. (2003) *The Management of Mediterranean Fisheries Resources*, in FAO Fisheries Report No. 700, Report and Documentation of the International workshop on the implementation of international fisheries instruments and factors of unsustainability and overexploitation in fisheries, Mauritius, 3-7 February 2003

Srinivasan, U.T., Cheung, W.W.L., Watson, R.,·Sumaila, U. R. (2010) *Food security implication of global marine catch losses due to overfishing*, J. Bioeconomics, 12, 183–200

Sumaila, U.R. (2010) *A bottom-up re-estimation of global fisheries subsidies, J. Bioeconomics*,12, pp. 201-225

Sumaila, U.R. (2011) Coordinating author. *Green Economy Synthesis Report: Part I - Investing in natural capital – Fisheries*, UNEP publication

Sumaila, U. R., Marsden, A. D., Watson, R., Pauly, D. (2007) *A Global Ex-vessel Fish Price Database: Construction and Applications* . J. Bioeconomics 9: 39-51.

Sumaila, U. R., Huang, L. (2010), *Managing bluefin tuna in the Mediterranean sea*, Economic Research Forum, Working Paper 576

Turkish Statistical Institute (2010) Fisheries statistics, October 2010, 73p.

Willmann, R., Kelleher, K., Arnason, R. (2009) *The Sunken Billions, The Economic justification for Fisheries Reform*, The World Bank & FAO publication, Washington, DC.

World Bank, FAO, WorldFish Center (2010) *The Hidden Harvests, the global contribution of capture fisheries,* The World Bank publication, Washington, DC

WWF (2001) *Hard facts, hidden problems: A review of current data on fishing subsidies*, WWF, Washington, DC.

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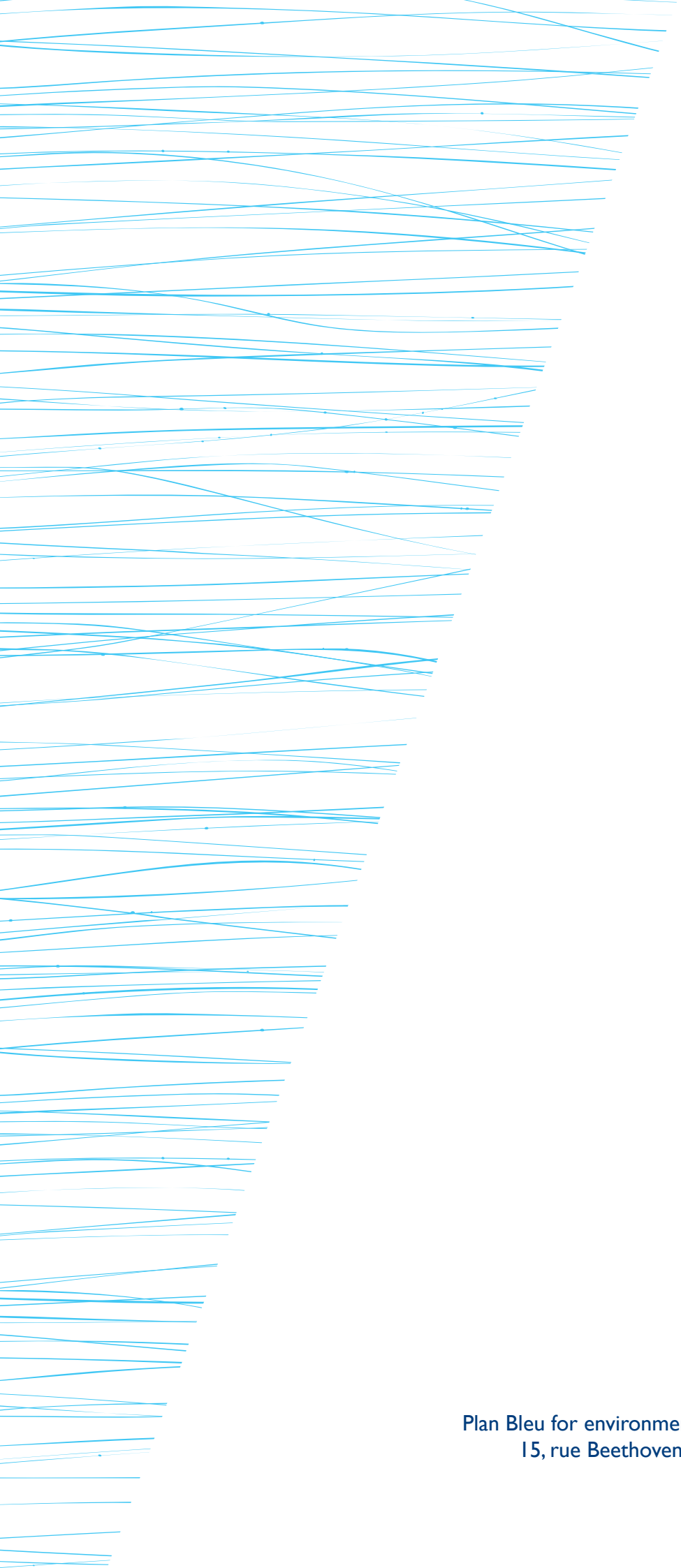

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