Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

MED MARITIME INTEGRATED PROJECTS
Med-IAMER

Adriatic Ionian ecoregion (AIE)

Fisheries

Definition

Generally, a fishing activity is linked with the harvesting of fish. It may involve capture of wild fish or raising of fish through aquaculture (FAO definition). On a broad level, capture fisheries can be classified as industrial, artisanal or recreational. Industrial fisheries involve capital-intensive fisheries using relatively large vessels with a high degree of mechanization and advanced fish finding and navigational equipment. Traditional fisheries could be defined as those involving fishing households, using relatively small amount of capital, relatively small fishing vessels, making short fishing trips (close to shore) and mainly for local consumption. In general, recreational fisheries can be defined as a non-commercial (i.e. not for sale, barter, or trade) subset of capture/harvest fisheries; motivated by catching fish for fun, pleasure, or sport.

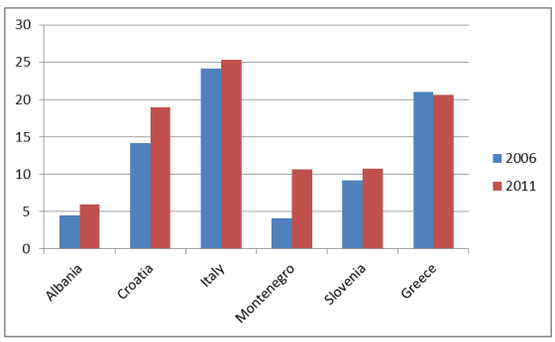
Regional context

Within the Adriatic-Ionian ecoregion (AIE), fishing vessels currently registered exceed 21,000 ships, accounting for over 24% of the total European registered vessels (Eurostat, 2014). At the country level, the largest fleet is found in Italy with 9,962 fishing vessels followed by Croatia with 7,242 vessels (ADRIPLAN, 2014). Taking into account the gross tonnage of fishing fleet, the AIE vessels account for about 14% of the total gross tonnage of the European fleet (Eurostat, 2014).

As far as fish catching is concerned, the region accounts for around 39% of the total fish catches of the Mediterranean Sea with a recent slight decrease of 0.2% between the years 2010-2011[1]. At the country level, Italy leads the fishing industry. In 2011 the landed catches of

[1] Med-IAMER adopts FAO definition of fish production statistics « the volume of fish catches landed by country or territory of capture ». We refer to them as "landed catches" taking into account that illegal catches or by-catch are not registered in the official statistics.

Italian fisheries exceeded 140,000 t followed by Croatia with 70,552 t. Italy's dominance in this sector is also shown by the total fish production per capita (p.c.) figures during the period 2006-2011, that are presented in the next figure. The Italian fishery sector provides the country with a mean production exceeding 20 kg p.c. of fish with an increase up to 25 kg p.c. in 2011. The Greek fisheries sector is also significant providing the market around 20 kg p.c. of fish products. Montenegro and Albania present the lowest production in the AIE. In the last period (2006-2011), all the countries in the region, but Greece, strengthened their supply shown as a steady increase p.c. fish production over time.



Fish Production Per Capita in Adriatic-Ionian Countries (2006-2011), Source: FAO, 2014; Own Elaboration

Additionally, the growth of tourism in various regions and the enhancement of charter fishing tours contributed to the extension of recreational fishing to almost all Mediterranean countries. This results in (a) competition for resources, especially where unlicensed recreational or "hobby" fishermen compete with commercial pots or net fisheries both for resources and by supplying low priced fish to markets and (b) competition for space and gear interactions. On the positive side, chartering by angling parties provides alternative employment opportunities for commercial fishing vessels (Pawson et al., 2008; Stelzenmuller et al., 2013).

Highlighted features

The indicator mapped below illustrates the fishing activities in the AIE calculated as relative catches of overexploited or relevant species per FAO fishing region, the catches being expressed in relation with the number of vessels. The indicator clearly shows the high intensity of catches per vessel in the Northern Adriatic, with Croatia and Italy being the most important users of the resources fished.

Data/Indicator used

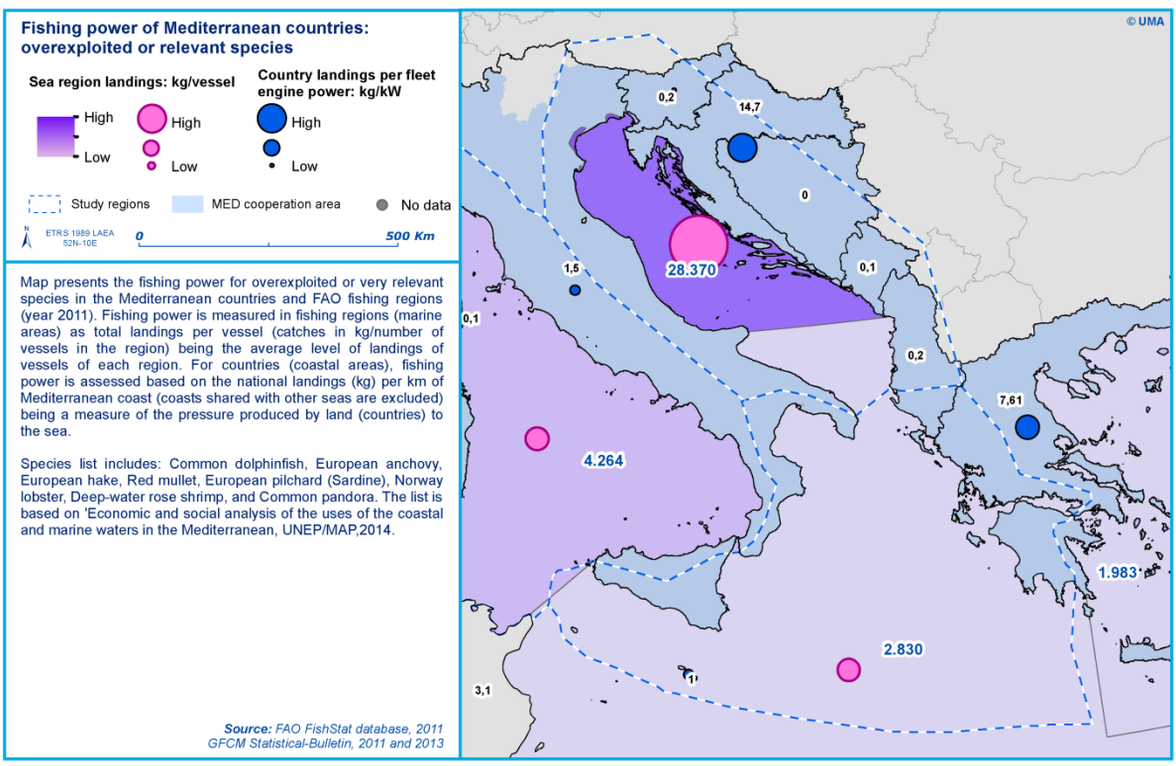
Fishing activity is measured in FAO fishing regions as total catch of overexploited and relevant species per vessel registered by the GFCM in the Mediterranean Sea. Fishing activity is measured by catches as kg/number of vessels in the region, being the average level of catches of vessels of each fishing region.

For land areas, fishing activity is assessed based on the national catches (kg) per kW of fishing fleet of the Mediterranean countries, being a measure of the pressure produced by land (fishing effort) to the sea. In this case, fleet engine power was calculated using DG MARE data on ports and fishing vessels. For each country, only the ports inside the Mediterranean Sea were considered.

Some of the most overexploited species include: Common dolphin fish, European anchovy, European hake, Red mullet, European pilchard (Sardine), Norway lobster, Deep-water rose shrimp, and Common pandora. The list is based on 'Economic and social analysis of the uses of the coastal and marine waters in the Mediterranean' (UNEP/MAP, 2014).

Gaps

Generally, a common drawback of accessible statistics of landings is the high degree of uncertainty associated with



them. These statistics are collected based on fish market figures that do not consider the share of illegal catches and recreational fisheries, making these statistics generally less reliable for their use as such. Recent findings estimate that reconstructed catch data (including illegal catches, recreational fisheries, and official data) to be 1.76 times higher than the official FAO data for the Mediterranean (Pauly et al. 2014). Another uncertainty assigned to the illegal and recreational catches is the restricted knowledge on the type of species catches.

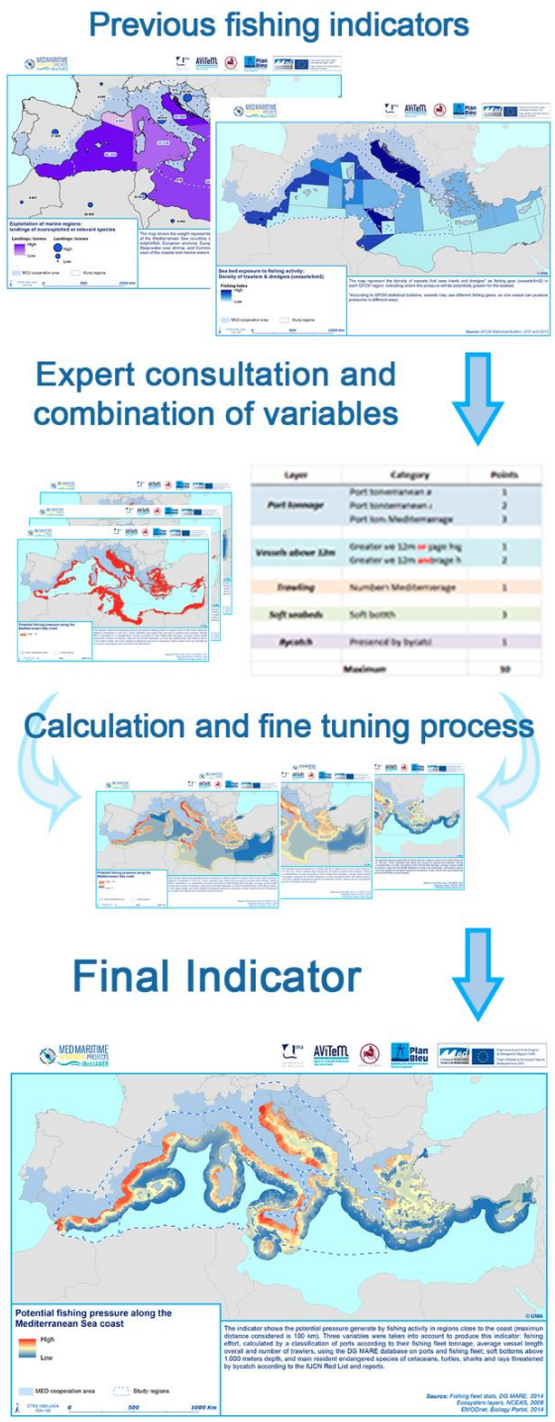
To the date of the project analysis (beginning of 2015), the most recent data available at FAO FishStat correspond to 2011, so it would be recommended to update this information, whenever new statistics are published.

Limits of methodology

The fishing areas of FAO are broad regions that are too coarse to provide, as such, geographically precise information on the intensity of fishing activities and their potential local pressure to marine ecosystems. Additionally, the lack of accessible port specific statistics on landings and catches, hinders more the detailed information on catch distribution.

DG MARE port data do not specify the waters in which the vessels operate. Therefore, fishing effort indicator (kg/kW) considers all vessels in the Mediterranean Sea ports of each country. The fleet power in this indicator is expected to be overestimated because vessels may fish in waters outside the Mediterranean Sea. Nevertheless, this indicator is a first proxy that could be improved whenever local or subnational information is accessible.

The publicly available information on fishing activities, i.e. landed catches, number and tonnage of vessels, type of fishing technique as well as fishing effort, cover FAO or GFCM regions and are related to ports, respectively.



These indicators do not provide information about the actual areas where fishing activities are developed and are attached with specific potential pressures.

The mandatory Vessel Monitoring System (VMS) on the other hand is a data collection with a vast number of data that consist in geographical positions (GPS) recorded at a more or less regular time step by each vessel. It has led to massive acquisition of fishing vessel movement data which offers new means of studying the spatio-temporal dynamics of fishermen (e.g. Gloaguen et al 2014). Due to the restriction in data access and the fact that models are needed to interpret the data, they could not be used in the present assessment of Med-IAMER.

Improvement of indicator

After a consultation with stakeholders from both the fishing and conservation sectors where the first preliminary (area- and port- related indicators) were presented (see first step in the workflow diagram), the need for a spatially explicit mapping of fishing activities was expressed.

Consequently, Med-IAMER developed an expert-based approach to estimate the spatial distribution of fishing activities and the related pressure of harmful fishing techniques on marine environments. This approach resulted in the development of a Cumulative Fishing Indicator that is described below.

The aim of this indicator is to provide a spatially explicit estimation of fishing activities, particularly trawling and dredging, taking into account the variables (listed in the table below) for which spatial data are available and that had a specific influence on marine ecosystem. Based on the intensity of each activity, a scoring has been assigned based on expert judgment. The main activities, ranges of categories and scoring systems datasets are described in the following table.

Layer	Category	Points
Port tonnage	Port tonnage lower than Mediterranean average	1
	Port tonnage higher than Mediterranean average	2
	Port tonnage much higher than Mediterranean average	3
Vessels above 12m	Greater number of vessels above 12m **or** port average higher than 12m	1
	Greater number of vessels above 12m **and** port average higher than 12m	2
Trawling	Number of trawlers higher than Mediterranean average	1
Soft seabeds	Soft bottoms above 1000m depth	3
Bycatch	Presence of species threatened by bycatch	1
	Maximum sum	**10**

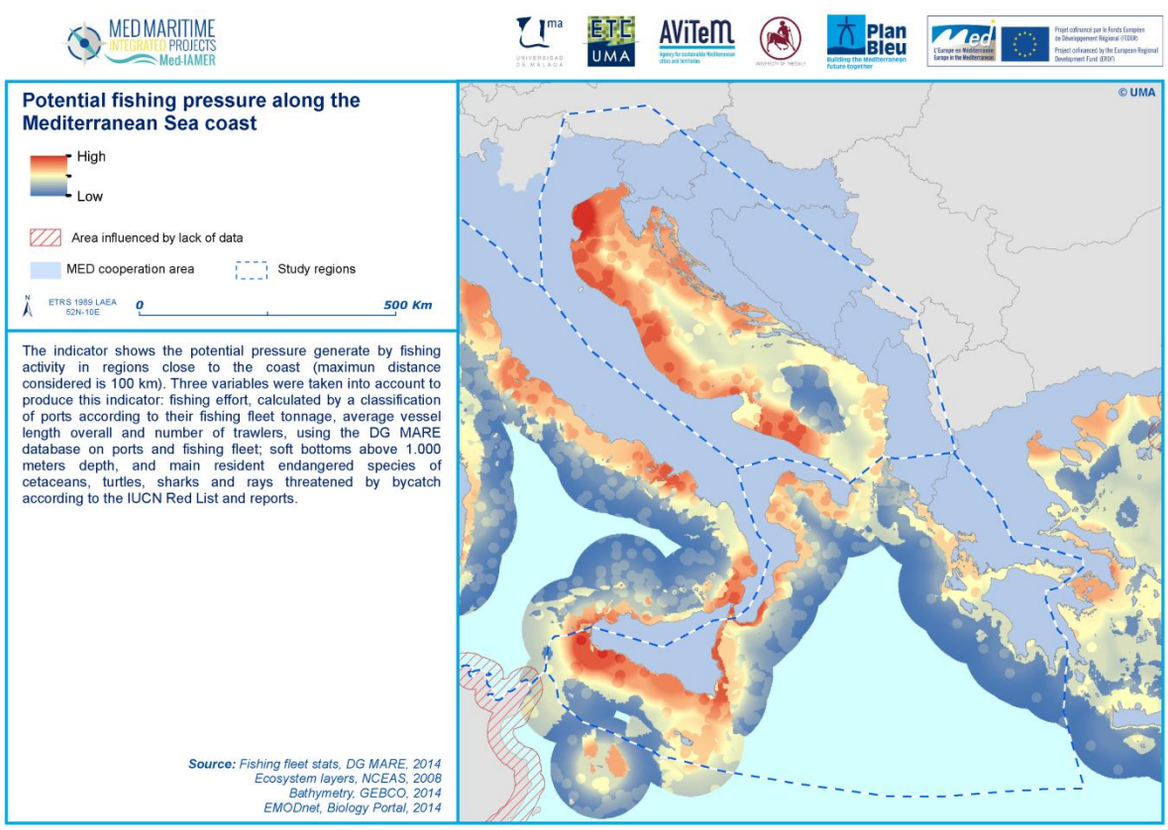
Highlighted features

The map below shows the Cumulative Fishing Indicator, developed by Med-IAMER, on the spatial distribution of potential pressures generated by fishing activities in coastal regions of the Mediterranean Sea. It is clearly visible that the whole Adriatic Sea is highly exposed to this pressure while the activity is relatively low in the Ionian Sea, with a higher pressure in the Western part. The degree of pressure increases again in the Southern Sicily (Italy).

Data/Indicator used

Three variables were taken into account and combined to produce the composite indicator: fishing effort, seabed substrate and biodiversity affected by bycatch.

Fishing effort was calculated by classifying ports according to their fishing fleet tonnage, the average vessel length overall (vessels larger or smaller than 12 meters) and the number of trawlers. Fuel prices and time play an important role for fishermen. Therefore, based on expert criteria, a distance offshore was determined considering a maximum travel time of 3 hours at regular operating speed for fishing vessels (6-8 knots). The resulting



distance is around 24 nautical miles (about 45 km). This area of influence around ports is where the fishing activity is mainly concentrated. From this point (45 km), the probability of finding ships decreases with distance. Exponential distance decay was calculated until 100 km offshore to model this fact.

Marine ecosystems on soft bottoms are vulnerable to trawling. According to expert knowledge, trawling is limited to 1000 meters deep. It is usually practiced between 180-450m. Using bathymetry data (GEBCO 2014), soft bottoms deeper than 1000m were discarded in order to locate seabed that potentially suffer high trawling activity.

As data were so far not facilitated so far from Mediseh project (DG-MARE), information on biodiversity was produced using EMODnet Biology Portal database. The indicator used considers main resident endangered species of cetaceans, turtles, sharks and rays threatened by bycatch according to the IUCN Red List and reports.

Gaps

Port data used to produce the indicator present gaps for ports in Turkey, North African and Middle Eastern countries. Data for Albania and Montenegro were found in different reports of the European Commission.

Limits of methodology

DG MARE port data do not specify waters where vessels operate. Therefore, the fishing effort indicator may be overestimated because vessels may fish in waters outside the Mediterranean Sea.

Biodiversity data used are field observations and not the actual distribution areas of the species. The principle of absence-presence must be considered: just because it has not been seen, it does not mean it is not there. In addition, the indicator only takes into account what is registered in the EMODnet database.

The seabed information is based on a global dataset. A more regionalized data may provide some more detailed information.

Upcoming improvements will include data from MEDISEH Project (DG MARE). A petition to use specific outcomes from the MEDISEH project for the improvement of this indicator has been sent to DG MARE back in November 2014 and Med-IAMER did not have access to such data so far.

Related Pressures

Additionally to the Cumulative Fishing Indicator, individual indicators were developed to account for the potential pressure from fishing on marine ecosystem including:

- Removal/overfishing of target species

Depletion of marine resources is a recognized problem across the Adriatic-Ionian ecoregion. From the approximately 450 species of fish present in this region, 120 (around 27%) are threatened by excessive commercial fishing (EC, 2014). Reduced abundance of target species (as well as by-catch and non-target), particularly removal of larger individuals creates pressure on fish biodiversity outside their safe biological limits. The situation could be reversed if fishing pressure on commercial species was reduced to sustainable levels. For example, reduction of fishing could reliably favor stock recovery and abundance increase for crustacean species of *A. foliacea*, *P. longirostris* and *N. norvegicus* along the north – western Ionian Sea (D'Onghia et al.,

2012). In the northern Adriatic, a reduction of *Merluccius merluccius* biomass and Common Sole (*Solea vulgaris*) stocks were registered for years with available data confirming their overexploitation (high fishing mortality and low abundance) (SHAPE, 2013). The Eastern Ionian Sea shows a similar situation as most important demersal species (*M. merluccius*, *M. surmuletus* and *B. boops*) targeted by trawlers and trammel netters also face considerable fishing pressure. In the Inner Ionian Sea, the most impacting fleet are the purse seiners, making up 3% of the total fishing fleet but removing on average 33% of the total biomass (about 1160 t, data for 2007 fishing period). Moreover, although all fishing boats were found to respect temporal closures, many of them have permits to use multiple fishing gears (i.e. beach seiners continued fishing through summer as trammel netters). These actions are preventing fish stocks from finding temporal and/or spatial refuges (http://www.repcet.com/).

Mortality of non-target populations of fish, seabirds, marine mammals

"Discards" mean noncommercial by-catch (as to species, size or quality) caught, sorted out and returned to the sea – mostly dead or dying – this problem is exacerbated due to the lack in monitoring and recording. Purse seines as well as beach seines and trawlers are considered the most impacting fleet in AIE as they remove high levels of biomass indiscriminately and their landings are characterized by a high number of individuals below the minimum legal size that are either discarded or marketed illegally (http://www.repcet.com/).

Even when exploitation levels of target species are considered sustainable, low resilience of by-catch, non-commercial species (such as sharks, skates, rays, cetaceans) creates an overall unsustainable fishing practice. *Caretta caretta* is considered an endangered species, threatened mainly by trawling and "volante" fishing. Estimates in the north Adriatic reveal that, using the first technique, an average of 4,273 of turtles are yearly captured with a mortality of approximately 2,000 individuals per year; with the latter instead an average of 863 individuals are captured with 1% mortality rate (SHAPE, 2013).

Physical damage (seabed alteration, habitat loss)

Direct physical effects (changing nutrient fluxes between sediment and water, habitat loss) alter seabed habitat specifically through the combined action of mortality of non-target seabed dwelling organisms, large benthic species (bivalves and crustaceans), changes in predation pressure and resuspension, stirring up or removing sediments by bottom fishing gear especially in fragile marine ecosystems (i.e. coral, sponge and sea grass communities). In the Inner Ionian Sea, seagrass beds are negatively affected by bottom trawlers, purse seiners operating illegally in shallow waters and beach seining occurring in nearshore areas (http://www.repcet.com/).

Changes in the food web

Changes in marine food webs are significant as increased mortality of bottom feeding fish alters the pressure on seabed invertebrates and crustaceans while the abundance of top level predators is decreased. Demersal destructive fishing is considered low to medium for the eastern Ionian coast while medium to high for north-central Adriatic (UNEP/MAP, 2012).

List of proposed indicators

The following table lists the indicators developed and mapped within Med-IAMER on the pressures and impacts of fisheries on coastal (land) and marine environments. **All maps, identified by the indicator ID, can be found at the project's web page:** http://www.medmaritimeprojects.eu/section/med-iamer-redirect/outputs

ID	Indicator description
FI01	Marine exposure due to port activity: fishing
FI12	Exploitation of marine regions: catches of overexploitted or relevant species
FI15	Fishing power of Mediterranean countries: overexploited or relevant species (kg/km coast)
FI16	Fishing power of Mediterranean countries: overexploited or relevant species (kg/kW)
FI20	Sea bed exposure to fishing activity: % trawlers and dredgers
FI35	Sea bed exposure to fishing activity: density of trawlers and dredgers
FI36	Marine species exposure to bycatch: density of surrounding and seine nets
FI37 - FI42	Marine species exposure to bycatch: density of [fishing gear] (seiners, hook and lines, etc.)
FI47	Turtle species exposure to bycatch: density of long liners
FI48	Cetaceans species exposure to bycatch: density of gillnets and entangling nets
FI49	Potential fishing pressure along the Mediterranean Sea coast
FT01_2000 - 2014 FT01_v2000-2007 - v2007-2011	Exploitation of marine regions. Total landings. Year 2000, 2007, and 2014. Variations between 2000-2007, 2000-2011, and 2007-2011
FT02_2000 - 2014 FT02_v2000-2007 - v2007-2011	Exploitation of marine regions. Landings of overexploited or relevant species. Year 2000, 2007, and 2014. Variations between 2000-2007, 2000-2011, and 2007-2011
FT03_2000 - 2014 FT03_v2000-2007 - v2007-2011	Number of vessels by port in 2000. Year 2000, 2007, and 2014. Variations between 2000-2007, 2000-2011, and 2007-2011
FT04_2000 - 2014 FT04_v2000-2007 - v2007-2011	Average length overall (m) of vessels by port in 2000. Year 2000, 2007, and 2014. Variations between 2000-2007, 2000-2011, and 2007-2011
FT05_2000 - 2014 FT05_v2000-2007 - v2007-2011	Total tonnage (GT) of fishing vessels by port in 2000. Year 2000, 2007, and 2014. Variations between 2000-2007, 2000-2011, and 2007-2011

Bibliography

ADRIPLAN (2014) Initial Assessment Report, DG MARE

D'Onghia et at. (2012) Exploring relationships between demersal resources and environmental factor in the Ionian Sea http://www.hindawi.com/journals/jmb/2012/279406

EC (2014) Communication and Supporting Analytical Document concerning the European Union Strategy for the Adriatic and Ionian Region - 17.06.2014 - COM(2014) 357 final; WD(2014) 191 final
http://ec.europa.eu/regional_policy/cooperate/adriat_ionian/pdf/supp_analytical_doc_17june.pdf

Eurostat (2014) http://epp.eurostat.ec.europa.eu/

National Aquaculture Sector Overview. Greece. National Aquaculture Sector Overview Fact Sheets. Text by Christofilogiannis, P. In: FAO Fisheries and Aquaculture Department [online]. Rome. Updated 19 November 2010. [Cited 9 October 2014]. http://www.fao.org/fishery/countrysector/naso_greece/en

Gloaguen, P., Mahévas, S., Rivot, E., Woillez, M., Guitton, J., Vermard, Y., and Etienne M.P. (2014). An autoregressive model to describe fishing vessel movement and activity. Environmetrics 26 (1). Pp. 17-28. DOI: 10.1002/env.2319

Micheli et al (2013) Cumulative Human Impacts on Mediterranean and Black Sea Marine Ecosystems: Assessing Current Pressures and Opportunities

DOI: 10.1371/journal.pone.0079889Pauly D., Ulman A., Piroddi C., Bultel E., Coll M. 2014. 'Reported' versus 'likely' fisheries catches of four Mediterranean countries. In: Lleonart J., Maynou F. (eds), The Ecosystem Approach to Fisheries in the Mediterranean and Black Seas. Sci. Mar. 78S1: 11-17.doi:
http://dx.doi.org/10.3989/scimar.04020.17A

Pawson, M.G., Glenn, H., Padda, G. 2008. The definition of marine recreational fishing in Europe. Marine Policy, 32: 339-350SHAPE, (2013a) Definition of the Adriatic ecosystem quality as basis for Maritime spatial planning, Action 4.2 final report
http://www.shape-ipaproject.eu/download/listbox/WP4%20action%20%204.2/Definition%20of%20the%20Adriatic%20ecosystem%20quality%20as%20basis%20for%20MSP.pdf

SHAPE, (2013a) Definition of the Adriatic ecosystem quality as basis for Maritime spatial planning, Action 4.2 final report
http://www.shape-ipaproject.eu/download/listbox/WP4%20action%20%204.2/Definition%20of%20the%20Adriatic%20ecosystem%20quality%20as%20basis%20for%20MSP.pdf

SHAPE, (2013a) Setback zone in the Republic of Croatia and in the Region of Istria, Action 3.2 report
http://www.shape-ipaproject.eu/download/listbox/WP3%20action%203.2%20-%20reports%20on%20setback%20requirements/Croatia%20and%20Region%20of%20Istria%20-%20setback%20requirements.pdf

Stelzenmuller V., Schulze T., Gimpel A., Bartelings H., Bello E., Bergh O., Bolman B., Caetano M., Davaasuren N., Fabi G., Ferreira J.G., Gault J., Gramolini R., Grati F., Hamon K., Jak R., Kopke K., Laurans M., Makinen T., O'Donnel V., O'Hagan A.M., O'Mahony C., Oostenbrugge H., Ramos J., Saurel °C., Sell A., Silvo K., Sinschek K., Soma K., Stenberg C., Taylor N., Vale C., Vasquez F., Verner-Jeffreys D. 2013. Guidance on a better integration of aquaculture, fisheries, and other activities in the coastal zone: from tools to practical examples. Ireland: COEXIST project, 76 pp. 27. Study in support of policy measures for maritime and coastal tourism at EU level Specific contract under FWC MARE/2012/06 - SC D1/2013/01-SI2.648530. Final Report. Ecorys, 2013

UNEP/ MAP (2012) State of the Mediterranean coastal and marine environment
http://www.unepmap.org/index.php?module=library&mode=pub&action=view&id=14636

UNEP/MAP – Plan Blue (2009) State of the environment and development in the Mediterranean
http://planbleu.org/sites/default/files/publications/soed2009_en.pdf

L'Europe en Méditerranée
Europe in the Mediterranean

Projet cofinancé par le Fonds Européen de Développement Régional (FEDER)
Project cofinanced by the European Regional Development Fund (ERDF)

Designed by Plan Bleu