

**COPEMED II - MEDSUDMED TECHNICAL
WORKSHOP ON *CORYPHAENA HIPPURUS*
FISHERIES IN THE WESTERN-CENTRAL
MEDITERRANEAN**

MALTA 16- 18 MARCH 2016



CopeMed II Technical Documents N°42
GCP/INT/028/SPA; GCP/INT/006/EC

**CopeMed II-MedSudMed Technical
Workshop on *Coryphaena hippurus* Fisheries
in the Western-Central Mediterranean
Malta 16- 18 March 2016**

March 2015

The conclusions and recommendations given in this document and in other documents in the *Co-ordination to Support Fisheries Management in the Western and Central Mediterranean CopeMed II Project* series are those considered appropriate at the time of preparation. They may be modified in the light of further knowledge gained in subsequent stages of the Project. The designation employed and the presentation of material in this publication do not imply the expression of any opinion on the part of Food and Agriculture Organization of the United Nations, FAO, the Government of Spain or the Commission of the European Union concerning the legal status of any country, territory, city or area, or concerning the determination of its frontiers or boundaries. This document has been financed by the European Union and the Government of Spain. The views expressed herein can in no way be taken to reflect the official opinion of the European Union or the Government of Spain.

Preface

The CopeMed II Project on *Co-ordination to Support Fisheries Management in the Western and Central Mediterranean* is executed by the Food and Agriculture Organization of the United Nations (FAO) and funded by the Government of Spain, represented by the Secretaría General de Pesca (M^o de Agricultura, Alimentación y MedioAmbiente, MAGRAMA), and the European Union, represented by the European Commission (EC). The premises of the project at the Subdelegación del Gobierno in Málaga (Spain) are part of the Spanish contribution included in the agreement with the FAO.

The objective of the project is to maintain the sustainability of the marine fisheries in the central and western Mediterranean Sea and its ecosystem, taking into consideration environmental, biological, economic, social and institutional issues. In addition, the project will continue to reinforce the collaboration among the participating countries of the sub-region by facilitating their participation in the activities of the Scientific Advisory Committee (SAC) and in the General Fisheries Commission for the Mediterranean (GFCM).

Regions covered by CopeMed II are the western and central sub-regions of the Mediterranean. Participating countries are Algeria, France, Italy, Libya, Malta, Morocco, Tunisia and Spain. The main beneficiaries are the fishery policy-makers, managers and fishery administrations in the western and central Mediterranean countries. The project is also contributing to the strengthening of regional collaboration by supporting the participation of the countries in relevant regional scientific organizations, such as the FAO's General Fisheries Commission for the Mediterranean (GFCM). Secondary beneficiaries include the national research institutes, fishers and fishers' associations, and industrial organizations.

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Comments on this document would be welcomed and should be sent to the Project premises:

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For bibliographic purposes this document should be cited as follow:

CopeMed II. 2016. Report of the CopeMed II-MedSudMed Technical Workshop on *Coryphaena hippurus* Fisheries in the Western-Central Mediterranean, Malta 16- 18 March 2016. CopeMed II Technical Documents N°42 (GCP/INT/028/SPA - GCP/INT/006/EC). Málaga, 2016. 24 pp.
Author of the cover picture: Sergio Lombardo - Unimar

Preparation of this document

This document is the final version of the CopeMed II-MedSudMed Technical Workshop on *Coryphaena hippurus* Fisheries in the Western-Central Mediterranean, Malta 16- 18 March 2016.

Acknowledgements

CopeMed II acknowledges the participation and valuable contributions of all experts from Italy, Malta, Spain and Tunisia in the CopeMed II-MedSudMed Technical Workshop on *Coryphaena hippurus* Fisheries in the Western-Central Mediterranean.

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ABSTRACT

The meeting was reminded of the previous work done in the framework of the CORY project (CopeMed, phase I) with the participation of the countries and institutions that today are again involved in the WS. Participants from the fisheries administrations and research institutes commented the main activities carried out since the Workshop in Palermo in 2011, and the main research interest of each research institute on dolphinfish species and fisheries and agreed to prepare a Technical Document about *Coryphaena hippurus* Fisheries in the Western-Central Mediterranean



CopeMed II-MedSudMed Technical Workshop on *Coryphaena hippurus* Fisheries in the Western-Central Mediterranean Malta 16- 18 March 2016

1. Opening, Background and Objectives of the Meeting

The CopeMed II-MedSudMed Technical Workshop (WK) on *Coryphaena hippurus* Fisheries in the Western-Central Mediterranean was held in Malta on 16-18 March 2016.

The meeting was attended by experts from some fisheries administrations and scientific institutions involved in common dolphinfish fisheries from Italy, Malta, Spain and Tunisia and officers from the FAO Regional Projects CopeMed and MedSudMed. The complete list of participants is given in Appendix II.

Ms Roberta Mifsud, chief of the Fisheries and Aquaculture Department of the Ministry for Sustainable Development, the Environment and Climate was elected Chairperson. Mr. Enrico Arneri, MedSudMed Coordinator and Mr. Juan Antonio Camiñas from the IEO acted as rapporteurs.

Ms Pilar Hernandez, CopeMed II fishery expert, introduced the main objective of the meeting:

- to take stock of the advances on dolphinfish biology and fisheries since the last CopeMed WK in Palermo, Sicily in July 2011, regarding the identified gaps in knowledge; and
- to draft a work plan to progress on a joint assessment
- to propose management options to be discussed in the ambit of GFCM.

The meeting was reminded of the previous work done in the framework of the CORY project (CopeMed, phase I) with the participation of the countries and institutions that today are again involved in the WS. Ms. Hernández described the available resources in the CopeMed Webpage, including documents and analysis of data that were prepared aiming to the analysis of the status of the stock from 2001 to 2011, when the last regional workshop on this species was held in collaboration with MedSudMed. Ms. Hernández reviewed the achievements during the meeting of 2011, in particular the important amount of data provided, the joint tables elaborated with metadata from the different countries and the gaps identified. An important aspect to underline as reflected in the 2011 report was the existence of data on length frequency distributions available in all countries since 2007 onwards.

The FAO General Fisheries Commission for the Mediterranean (GFCM) recommendation 2006/2 in force, which has the objective of regulating the fishery of *Coryphaena hippurus* in the Mediterranean Sea, was also recalled to put the group in context of the current regional management scenario.

Ms Roberta Mifsud welcomed the participants to Malta and recalled the importance of dolphinfish fisheries and its cultural heritage for Malta and the other participating



countries. Ms. Mifsud reviewed the situation of landings statistics in Malta, noting that the improvement of collection of statistics gave a new picture of the total captures for the species. She also referred to interest of Malta in developing a management plan for the dolphinfish fishery, noting that the adoption of different local management plans or a joint one for a resource that is shared by different countries is one topic that should be considered by all countries involved in the fishery of dolphinfish.

The Chairperson advanced on the revision of the Agenda and proposed the introduction of three new elements for discussion: i) the question of the effects of the fishery on the marine environment and associated resources and ii) the standardisation of the CPUEs and iii) an overview of management measures by country. The agenda with the proposed modification was adopted as presented in Appendix I.

During the round of introduction of participants, experts from the fisheries administrations and research institutes commented the main activities carried out since the Workshop in Palermo in 2011, and the main research interest of each research institute on dolphinfish species and fisheries. Ms Mifsud thanked CopeMed and MedSudMed for helping experts in participating in the WK and the opportunity and interest in contributing with new data and information to the meeting.

2. Review of current state of knowledge and recent developments on *Coryphaena hippurus* research (fisheries monitoring, sampling, biology and ecology) in each country.

National experts presented the data and information available in each country on *Coryphaena hippurus* as well as the source of the information, the research or monitoring activities completed and/or currently ongoing. The presentations were followed by discussions, which are summarized below.

Fishery, Data Availability and Updated Information on the Biology of *Coryphaena hippurus* in Maltese Waters, Central Mediterranean (by M. Gatt)

In the sea around the Maltese Islands, juvenile dolphinfish are exploited by surrounding net in summer and autumn while adult dolphinfish are mainly caught as by-catch from the swordfish and bluefin tuna longline fisheries in Spring and Summer. The Maltese “kannizzati” Fish Aggregating Devices (FADs) fishery targeting dolphinfish is a traditional one in Malta, consisting of a float with tied palm fronds which is anchored by a heavy piece of limestone. Historical landings of dolphinfish highlight the importance of this fishery to Malta, although this is a recent shift towards new and more profitable species of fish, such as swordfish and bluefin tuna. Computation of a standardized catch and effort index of abundance remains a challenging aspect towards the assessment of this species at a Regional level. The type and current availability of dolphin fish data from the Maltese fishery was presented.

Dolphinfish data collected from the Central Mediterranean in the period 2004-2010 from the traditional Maltese Fish Aggregating Devices (FADs) and surface longline fisheries provided updated information on the age, growth and reproduction of this species. The a and b parameters of the length-weight relationship for fish 11-142 cm fork length (FL) ($n = 4042$) were determined as $a = 0.018$ and 0.022 with $b = 2.85$ and



2.79, for males and females respectively. The counting of annual increments from dorsal spines of >65 cm FL dolphinfish ($n = 47$) permitting an age reading resolution in years, and the counting of daily increments from sagittal otoliths of <65 cm FL dolphinfish ($n = 583$) permitting an age reading resolution in days, were performed; the von Bertalanffy growth model applied to these fish gave the following parameters: $L_{\infty} = 107.8$ cm FL and 120.2 cm FL, and $K = 1.9$ yr⁻¹ and 1.56 yr⁻¹, for males and females respectively. The maximum age observed was 2 years. The sex ratio for the fish sampled from the FAD fishery (10.5-131 cm FL) was 1:1.54 (M:F) and for dolphinfish sampled from the surface longline fishery (91-130 cm FL) was 1:0.76 (M:F). Back-calculated hatch dates from age-0 dolphinfish ($n = 518$) suggested that spawning occurs from June to September, with the highest levels in June.

Discussion:

Mr Gatt stated that a total 130 boats are allowed for fishing and have assigned a transect for installing at least 30 FADs. Transect are separated 1 NM from each other and separated 7 NM from land offshore. The maximum number of FADs by transect is not limited (average is 120 with a maximum of 400).

Questions were raised by participants about the methodology to determine the age on adults >65cm (dorsal fin spines and scales) and juveniles (otoliths daily growth rings). Participants put forward a proposal for exchange of hard structures and short stays of scientists in other laboratories to standardize age reading methodologies.

Overview of the Italian Dolphinfish (*Coryphaena hippurus*) fishery (by A. Mariani)

Dolphinfish represents a characteristic “métier” of the Italian fishery. Fishing activity is mainly concentrated in space and time, being focused in the southern Italy and in the late summer - autumn season.

The bulk of the catches comes from the FADs activity (locally “cannizzi”), composed by palm branches suspended at midwater and moored with more or less the same technology of Malta. Fishing is then carried out through small purse seine nets. The number of boats actually carrying out this fishing (not the number of authorized fishing vessels) is not easy to define, since it doesn't exist a specific FAD code in the Italian fishing license.

The approximate number of boats has decreased from 350 to 200 in 2015, and this can be considered among the causes of the reduction in catches. At present the bulk (80%) of total Italian catches corresponds to Sicily and the rest to other parts of the southern Tyrrhenian Sea.

FADs are put in place according to EU and GFCM regulations from 15 August until the end of December up to 20 nm. Average FADs number by boat is 37, with a very wide range (5-95).

A good amount of catches (approximately the remaining 50 % of the total) comes from a variety of other gears, mostly surface longlines, as by catch of other target species. Besides the professional fishing, recreational fishing has also an impact on this species, even if not as target species.



Official figures of the fishing activity were given, as well as the main biological parameters as they are sampled in the framework of the UE Reg. 199/08. Some estimates were also provided when no official data are available or reliable.

Discussion:

The WK underlined the importance in gathering data from recreational fisheries; even if it is not very complete or reliable for quantification purposes, a good collaboration with anglers could be very useful for information about the distribution of the species in the different areas and seasons, and tagging-recapture campaigns with their cooperation could also be considered.

The Tunisian expert Mr Besbes informed the WK that in Tunisia , experimental fishing is done one month before the season starts to collect younger individuals not available to the fishery in order to cover all the size ranges for biological studies. This practice could also be useful to inform the fishers in advance and to better plan the opening of the season during the authorized period.

The meeting was recalled that according to the GFCM Recommendation of 2006, the SAC had been requested to evaluate the impact of the seasonal closure and to propose modifications if necessary. At present, this revision has not yet been done.

Genetic variability of Dolphinfish (*Coryphaena hippurus*) in the Mediterranean Sea: is there a single Mediterranean stock-unit? (by F. Sacco, F. Marrone, S. Lo Brutto, A. Besbes, A. Nfati, M. Gatt, S. Saber, F. Fiorentino and M. Arculeo)

In the Mediterranean Sea and in other part of the world, the dolphinfish *Coryphaena hippurus* (Linnaeus, 1758) is an important target species for artisanal, recreational and commercial fisheries but only few data are currently available on its genetic diversity. In order to fill this gap, the genetic structure of Mediterranean dolphinfish was investigated through the sequencing of fragments of the ND1 and COI mtDNA markers with the explicit aim of singling out the possible presence of distinct local “stock units” to be considered for management purpose. Furthermore, the possible presence of a significant genetic differentiation of the Mediterranean *versus* the Atlantic populations was tested. Analysis of both mtDNA markers showed a significant differentiation between Mediterranean *versus* Atlantic dolphinfish populations, while the degree of genetic differentiation scored within the Mediterranean proved to be low and overall not significant, thus stressing a basin-wide genetic homogeneity of the species in this area. The lack of evident genetic structuring at the Mediterranean-basin-level and the similarity among the sampled sites is likely due to the highly mobile behaviour of the species, which is typical of large pelagic fishes.

Based on presented results, the Mediterranean dolphinfish should be considered a single-stock management unit, which needs a concerted management plan involving all Mediterranean countries that exploit this important fishing resource.

Discussion:

Previous genetic analysis in the framework of CORY project also showed the existence of genetic homogeneity of the Mediterranean single stock (Pla and Pujolar, 1999).



Proposals to extend the study to a larger number of samples from the near Atlantic areas (Gulf of Cadiz and Macaronesia) could improve the knowledge about the extension of the Mediterranean stock to the Atlantic.

Historical series of *Coryphaena hippurus* landing data (1981-2015) from professional fisheries using FADs in the Balearic Island, Spain (by J.A Camiñas, A. M. Grau and P. Hernández)

A traditional small-scale fishery is carried out around Majorca Island during summer-fall using fishing aggregation devices (FADs) targeting *Coryphaena hippurus* (locally called Llampuga). FADs in Balearic Islands, called “capcers”, are particularly used in Majorca Island. FADs are deployed on August 25th and removed on November 30th.

Data on annual production in tons and value (€) were presented for the period 2002-2015 as provided by the Fisheries Directorate from the Balearic Islands (Govern of Balears). To improve fishermen revenues a daily quota by vessel was adopted by the fishermen associations from 2012 onward. General trends of production during the period after the establishment of the landing quota show a continuous increasing in total production (€) but annual variability in total landing.

A series of landings in Mallorca Island for the period 1981-2015 was presented using data from the CopeMed I CORY project and the current series provided by the fisheries administration. An increasing trend in capture from the beginning of the series can be identified with remarkable fluctuations along the 35 years analysed by the authors.

Discussion:

Landing data normally are recorded by weight, do not report the sizes of the fishes landed. Size distributions at landing are not available, so including the number of fishes in individual landing data at Mallorca Island could improve the knowledge on the behavioral and biological aspects of the specie.

Collecting socio-economic data are important in all fisheries for management. Markets and landing prices of *Coryphaena* could be considered economic stressors affecting captures, sizes, total landing or the implementation of a daily quota and should be recommended for compulsory data collection.

Revision of dolphinfish bycatch in Spanish Mediterranean large pelagic longline fisheries, 2000-2014 (by D. Macias, J.C. Báez, S. García, S. Saber and J.M. Ortiz de Urbina.)

Incidental catch or bycatch represents a significant threat for the conservation of fish populations. The western Mediterranean is an important fishing area where the Spanish pelagic and semi-pelagic longline fleets targeting swordfish (*Xiphias gladius*), bluefin tuna (*Thunnus thynnus*) and albacore (*Thunnus alalunga*) operates. Bycatch of these fisheries includes dolphinfish catches. Our previous results indicated that the impact of the pelagic and semipelagic longline on the dolphinfish population is relatively low (1.083 fishes per 1000 hooks), and that the technical characteristics of the fishery and seasonality factors have an important part in explaining the absence or presence of dolphinfish bycatch in the different boat strata, gear types, and seasons. This



contribution provides updated data on *Coryphaena hippurus* bycatch collected by the on-board observer program of the IEO in the Western Mediterranean.

Data on dolphinfish bycatch were collected for the period 2000-2014, throughout the year. Annual differences in bycatch per unit effort (BPUE, fish per 1000 hooks) are reported. In addition, the BPUE series of adult and juveniles are reported separately aiming to compare the incidence of the gear on spawners versus juveniles in the area. The monthly variation in the BPUE of adults and juvenile in the area indicates that the juveniles of dolphinfish began to be recruited to the fishery in April, reaching a pick in August-September.

A spectral analysis and red-noise spectra procedure (REDFIT) algorithm was used to identify the red-noise spectrum from the gaps in the observed time-series of catch per unit effort by number. Our results indicate the presence of cyclic events in bycatches both of immature and mature fishes.

In addition, a bibliography revision of bycatch of dolphinfish in longline fisheries in the Mediterranean, a revision of the length-weight relationships of dolphinfish and a summary of the data sets of dolphinfish catches in the Mediterranean reported to the ICCAT database are reported in this paper.

Discussion:

Bycatch of Spanish surface longline fisheries in the western Mediterranean includes dolphinfish. Rebuilding the life history of the species based on captures of juveniles and adults as bycatch could be a powerful tool to separate areas and periods of the year for the two stages.

The recruitment of juveniles to the gear which take place in last summer-autumn is well documented in this study. As a consequence the adults dominated the catches in spring and summer, and juveniles in autumn.

Dolphinfish Fisheries in Sicilian waters: New insight respect the gaps emerged in the 2011 FAO COPEMED-MEDSUDMED meeting (by M. Sinopoli, A. Allegra, T. Cillari , A. Cuttitta , A. Nicosia, T. Maggio and F. Andaloro)

Italian Dolphin fish fishery in the last 5 years showed similar characteristic regarding to seasonality, fleet consistency, portion of the population exploited and fishing techniques. Annual data on Italian landings collected by MiPAAF (Italian Ministry of Agriculture and Fishery), confirming that dolphin fishery is an almost exclusive activity of Sicilian fleets, and highlights a decline of landings in recent years . This is well recognized over the last ten years despite the natural and highly variable yield of this fishery and the fishing effort that seems to be constant. This last observation raises concern regarding this activity.

Data on the localization of nursery area and on high presence of early life stage in the ichthyoplankton in the Sicilian waters are lacking. The only data on the subject come from commercial fishing data and no specific research project is present. From fishing data, adults and sexually mature dolphinfish (TL > 120 cm) of both sexes are often



caught in May and the first juvenile individuals with sizes around 15 cm appear below FADs at the end of July. Moreover knowledge about growth estimation continues to be missing in the Italian waters.

Analysis of Atlantic-Mediterranean populations by means of molecular markers (mtDNA ND1) was also conducted. Preliminary results showed a genetic differentiation among the analyzed samples, in particular AMOVA and fixation indices revealed a genetic break between Atlantic and Mediterranean samples. Results of demographic analyses leads to suppose that this heterogeneity is the result of a past isolation followed by vicariant events. Moreover no evidence of Mediterranean sub population has been detected by using molecular markers.

The high amount of FADs placed at sea and the relative high environmental cost continue to be an important issue. From this point of view interesting initiatives raised from a local management plan promote the limitation of the number of FADs and a limited number of boats in some area. Finally, experimental experience on use of eco-FADs buoy has provided the chance of significantly decrease the number of FADs placed at sea.

Discussion:

The impact of the FADs in the environment was discussed, particularly the rope effects on other species including vulnerable and protected ones. The effects of blocks used to drop the FAD lines are also a matter of concern among scientist because those can change the bottom surface and the associated communities.

The WK agreed that environmental impacts of the dolphinfish fisheries should be evaluated individually in each country. At present there is a lack of this type of studies in the region and quantification is needed if some management advice is going to be provided.

The use of ecosounder buoys attached to the bottom through the FADs rope that provide information on the amount of fishes beneath the buoy was indicated as a possible option for reducing FADs number and consequently their environmental impact and the costs derived of the trips including the use of fuel and the reduction in visiting time to FADs.

A recent study in Sicily is trying to define a critical umber of FADs to maintain the fishery incomes and the good environmental status. It tries to understand the spatial distribution of the captures along the FADs line which is not homogeneous and may not be proportional to the number of FADs deployed.

Participants showed interest in this type of studies which can help to optimize the catches, the effort and associated economic and environmental costs by reducing the number of FADs.

Dolphin fish *Coryphaena hippurus* of Tunisian coasts. Biological traits and exploitation state (by A. Besbes, R. Besbes, S. Ezzeddine,,B. Chamam, O. Jarboui and H. Missaoui)

Dolphinfish is seasonally present into Tunisian traditional fisheries from August to December, and has a great socio-economic importance in the national coastal fishing. It is practiced by about 300 coastal boats using Fish Aggregating Devices (FADs) locally



called "Ganatsi" or "Jrid", synonymous with "palms". According to field surveys, about 25,000 FADs are deployed annually in Tunisia, whose 85% in the eastern region. Also 68% of national production is made in the eastern region of the country, against 18% in the south and 14% in the northern region.

The annual national production of Dolphinfish seems passed over the last 30 years through three distinct phases: (i) a first phase which covers the 1980s, when it was limited to a few tens of tons, (ii) from the mid-1990s, it has continued to increase, peaking around 1800 tons in 2006 and, (iii) since this year, it has significantly declined especially after 2010 to reach a minimum of 288 tons in 2012, increased then to 800 tons in 2013 and decreasing again to 422 tons in 2014.

Moreover the approach of the exploitation state in the eastern region (42% of total production and 25% of the total boats) by analyzing demographic structures catches confirms the rapid growth of dolphinfish and shows that FADs techniques target young fish (between 15 and 83 cm, Lf); 98% have not yet reached the size at first sexual maturity estimated in Tunisian waters to 53 cm (LF fork length) for females and 60 cm (LF) for males.

We also find that the proportion of fish in catches below the minimum permitted size (29 cm TL), decreased significantly. These catches (usually made at the beginning of fishing season), which exceeded 60% of the total catch in 2005, represent actually only 2.5% (since 2011). This difference is due to the relative progress made by the competent authorities in the enforcement of existing regulations.

A positive relationship has been identified between the catches and the SST, but there are still uncertainties about the origin of the cohort. Have they always been there and therefore affected by the temperature measured at that site? Or do they come from other areas, and in that case the temperature at the site would not have the time to influence the abundance?

The reduction in catches has had an influence on the market; with the low catches of the last years the fish has been sold at very expensive prices (up to 7€/kg)

Discussion:

Discussion was raised on the size at first reproduction in females and males and the different interpretation of these concepts by the group. Dolphinfish has batch fecundity, with a spawning season that extends during several months (May – September) Methodological aspects for calculation batch fecundity applied to other species as Albacore (*Thunnus alalunga*) from the Mediterranean were commented.

The possibility to compare and share techniques and methodologies among different experts from the participating research institutes was recommended particularly when batch fecundity is used to calculate the amount of spawned eggs during each partial spawning in Dolphinfish.

In Tunisia, there are no captures of adults (large sizes) by other fisheries than FADs. Dolphinfish disappear in the fishing area from December until May and there is no information on where the adults are during such period.

Studies on the relationship between reproduction and SST in Tunisia were commented as a possible future line of research to apply in other areas and countries. In general the



association of dolphinfish abundance and distribution with weather and climatic conditions is considered of paramount importance needing future research. The EU project CERES¹ is planning to work on these relationships.

Different management approaches and measures applied in Tunisia for dolphinfish were discussed, in particular the existence of a steering committee for annual decision to the fishery opening date. The steering committee is composed by the administration, fishers, scientists and other stakeholders and the WK underlined this as an example of “good practice” to be considered in other areas.

Review of *Coryphaena* larval studies in the Western Mediterranean (F. Alemany, E. Massutí, I. Álvarez, I. Catalán, W. Koched and A. Sabatés)

The large biomass fluctuations observed in some fish stocks are driven by environmental factors that may affect early life stages mortality rates. Therefore, the knowledge of larval and early juveniles ecology is crucial for achieving a global understanding of fish population dynamics. The comprehension of the recruitment processes is especially important for the management of those species whose fisheries are mainly based on young of the year, as the *Coryphaena hippurus* fisheries in the Mediterranean region. In spite of that, and the fact that *Coryphaena hippurus* larvae are easily recognizable, the information on larvae of this species in the Mediterranean is very scarce, probably because their neustonic behavior, rapid growth and offshore distribution make them difficult to capture within ichthyoplankton surveys performing standard oblique tows. In order to start filling this gap and set the basis for future studies, within this presentation most of available information on *Coryphaena* larvae found in the Mediterranean are compiled. Thus, a total of 53 records, in which 70 larvae were captured, were analyzed. The first conclusion is that spawning peak occurs in June/July, since most of larvae were captured in these months, but spawning can last at least until September. It could be stated that larvae can be potentially found in many places of the Mediterranean during the warmer season in which the water column is stratified, since the larvae were found in sampling stations with Sea Surface Temperature between 21,2 and 27,3 °C (average 24,9°C), both in recent and resident surface Atlantic waters (37,17 to 38,15 PSU). Another conclusion is that this species does not form large schools of spawners, as some tunas do, and spawning events are scattered. Finally, methodologies for improving larval sampling in order to get data enough for modeling purposes (larval habitat, larval indices, recruitment forecast, etc.), are discussed.

Discussion:

The issue of the relationship between the stocks of dolphinfish and the recruitment strength was raised. Usually stock recruitment relationships are very weak, even in demersal species where dense-dependent effects could be expected. It was pointed out that due to the special characteristics of *Coryphaena* offspring, it is well developed and fast growing larvae from hatching, and possibly such stock recruitment relationship is higher than usual. However, the size of the spawning stock biomass, even if it would be

¹ Horizon 2020 EU funded project: “Climate Change and European Aquatic Resources”



well known, is not a good predictor of the recruitment level. In a species in which the professional fisheries are based on the young of the year, as the *Coryphaena*, it was recognized that to know the recruitment strength is crucial for management. Thus, it was agreed that the knowledge on the drivers that determine the recruitment strength every year would be of outmost importance for a proper ecosystem based management. Such knowledge can be primarily achieved deepening in the analysis of larval ecology and therefore, the group agreed that studies on larval stages of *Coryphaena* should be promoted

As the behaviour of the larvae of dolphinfish is neustonic and predominantly offshore, the use of ad hoc sampling methodologies (neuston nets) is recommended in areas where ichthyoplankton surveys are regularly carried out. In addition, international coordination should be enhanced for exploring the possibilities of planning future surveys focused on *Coryphaena* larvae sampling, aiming at gathering enough basic information on environmental scenarios and biological samples to develop models of spawning habitats and recruitment forecast.

CERES Project: New European Union H2020 project analyzing the effect of climate change (CC) on fisheries/aquaculture species, including dolphinfish (by M.Palmer, I. A. Catalán, and B. Morales)

The project CERES “Climate Change and European Aquatic Resources” analyzes the effects of the projected impacts of CC on fisheries and aquaculture resources in Europe. A specific case in the Mediterranean is the dolphinfish fishery. The National Spanish Research Council analyzes both ecological and economical consequences of CC on dolphinfish fishery in the NW Mediterranean by 1) disentangling the environmental from fishery effects on the fishery to date, 2) projecting ecological and bio-economical consequences of CC in a series of future scenarios and 3) developing solutions for risk and adaptation analysis. First, we will build a probabilistic map for the spawning area through merging disperses data from multiple sources, including new field experiments and citizen science. The model will be used to back-calculate the environmental conditions for spawning in the past, and project how these will change in the future.

The project will also develop an empirical model for environmentally-dependent growth of dolphinfish in the Mediterranean. These data will be used to feed a bio-economical model that will also be fed from price, landings and effort time-series derived from *metiers* analyses, in order to project how phenological changes (e.g. size at the opening date of the fishery) may impact the fishery, and how the fishery may use this information.

Further projections on distribution and phenology will be performed using a suite of ensemble models based on the last IPCC scenarios. This 2016 CopeMed-MedSudMed meeting on dolphinfish is regarded as a key forum to search for potential collaborations necessary in a trans-boundary species such as dolphinfish.

Discussion:

As evidenced by some of the presentations, dolphinfish population dynamics are dependent on environmental factors such as temperature. Its annual abundance is clearly driven by recruitment strength, which is highly dependent on the environment.



Environmental and climatic aspects affecting the population need to be approached jointly in a collaborative way. In this sense, the WK supported the objectives of CERES to investigate these effects and to elaborate temperature-dependent models and recruitment-dependent models.

Although dolphinfish is a case study within the CERES framework initially though for Balearic Islands, the experience, after a pilot phase could be improved and extended to a more global area with the contribution of data from other countries/fisheries within the framework of cooperation between the FAO regional projects and de EU-CERES.

Automatic classification of daily boat registers into métiers in Mallorca Island: insights into the dolphinfish fishery from 2004-2015 (by I. A. Catalán, M. Palmer, B. Tolosa, C. Obregón, B. Morales and A. M. Grau)

The dolphinfish fishery in Majorca Island has profound socio economical roots. The fishery is artisanal, based on juveniles, is highly seasonal and highly regulated by international, national and local regulations (time closures, maximum catch/boat/day) and uses specific gear under FADs. Non-published data suggest that sustainability of the fishery is to be attained by optimizing profitability. Profitability in artisanal fisheries needs understanding the complex dynamics by which catches and prices (often self-regulated) are generated, in a frame of rotating gears and species through the year, with some boats not following the general patterns. A key step to this understanding is knowing what combination of gear, species, location and time (all conforming a “métier”, in which a fleet can be segmented) have produced the daily register (species, kg and price of a given landing box) of a boat. This is achieved through the choice of the optimal automatic classification algorithm. The inputs needed are: i) all daily registers, and ii) a sample of daily registers classified in some way (here, 15 fishermen polls, who classified 1550 daily sales forms).

The outputs include 1) the identification of métiers and fishing strategies, ii) an estimate of effort by métier, 3) an estimate of catches by métier and 4) an economical gain by métier. We here present results for the 2004-2015 daily time-series (256490 fish boxes registers) in the Fish Warf of Mallorca, concentrating on the results for dolphinfish.

Results show that in Mallorca the dolphinfish fishery métier can be classified with 99.6% of certainty. This métier generated 8.2% of the fishing days of all the fleet, but 25% of the sales in weight, and 13% in price. Seasonality remained largely as in previous reports but landings fluctuated ca 3 fold.

Prices were not well related to landings, and maximum revenue in the series was by far obtained in 2015, associated to landings that were only the fourth highest in the series. Segmenting the fleet can enable scaling-up variables such as the cost of implementing certain management measures, or better analyzing the dynamics of prices. Comments were given on the potential of this methodology for further management of the species.

Discussion:

The WK praised the effectiveness of the method on identifying métiers and all its associated variables.



The case of Mallorca was further commented as the group was informed that some fishermen association would be in favor to participate in a co-management experience in which they would collect daily the number of FADs visited. This experience could constitute a suitable pilot study to improve the management of the fishery in Balearic Island including the participation of different stakeholders.

CopeMed fishery officer commented the possibility to inform the Spanish fishery administration and organizations involved in co-management of the interest of the project in collaborating in such experience and suggested to sound the options for cooperation with the different stakeholders, if the interest by all parts is confirmed.

3. Current methodologies to assess *Coryphaena hippurus* in the Mediterranean Sea and in other areas. (by D. Macias, S. Saber and J.M. Ortiz de Urbina.)

D. Macías (IEO, Spain) summarized available methodologies for data poor stock based on the review done by a recent ICES WK highlighting the different data needs and types of results for the different methods presented.

The ensuing discussion underlined shortcomings of the current situation related to the availability of data and concluded by proposing the preparation of a set of data for dolphinfish in the western and central Mediterranean for the next meeting of the CopeMed-MedSudMed WK, to check the quality of these data and prepare an exercise for the evaluation of the stock, if possible by more than one method and then comparing the results. It was also underlined the importance of incorporating experts from other areas of the world who also assess *C. hippurus* stocks in the Atlantic (ICCAT) or in the Pacific (IATTC), with whom contacts have already been initiated.

Some participants raised the problem derived from the lack of information in some countries as Algeria, Libya or from the eastern Mediterranean region, which hampers the full description of the fishery of what is understood as a single transboundary stock in the region. The group recommended that efforts be made to gather also data from these other areas and to incorporate more participants to this working group.

In addition, using models that incorporate the environmental and climatic drivers, in line with the objectives of the CERES project, was also considered as a line work to progress in the future.

4. Current management options in the region and by country.

The regional Recommendation adopted by the GFCM (*REC.CM-GFCM/30/2006/2 Establishment of a closed season for the dolphin fish fisheries using Fishing Aggregation Devices (FADs)*) was presented by the CopeMed fishery officer and discussed by the WK. This recommendation establishes a closing season for FAD fishery during a limited annual period, from 1 January to 14 August of each year in the whole Mediterranean. A second consideration of the GFCM Recommendation is the data reporting obligation: annual data on landing and transshipments are mandatory while effort (in number of FADs x number of fishing trips) and average sizes of fish in the landings are optional fields to be transmitted. Participants confirmed that the



measure has been implemented in all countries and an interesting discussion was open on new, and most restrictive measures adopted at national or local levels.

Many regulations are similar with different implementation approaches as regulations on the number of FADs by boat and line, the limited fishing area implemented in Sicily, or the landing quotas applied recently in Mallorca Island can be mentioned as examples. Other restrictions or modus operandi before opening the fishery annually is implemented in Tunisia.

In order to update the information provided during the 2011 meeting on existing management options, participants prepared a summary of the available information on each country, which is reported below:



Sicily (Italy)

Local agreements set up by 5 different COGEPAs (fishers associations) limit the number of FADs to 20 by boat. These agreements are part of a local management plan implemented in 5 ports of Sicily supported by the EU Fisheries Funds to implement local regulations. The technical measures are regulated by an ordinance of the coast guard.

Table 1: summary of the technical measures adopted by 5 Sicilian COGEPAs

COGEPA	Period placing FADs	Period fishing is permitted	Number of FADs per boat	Communicate FADs zone	Obligations of remove FADs after fishing period
Portorosa - Isole Eolie	15 th Sept	30 th Sept – 31 th 10 Dec	20	no	no
Augusta	no	no	no	yes	No
Portopalo- Siracusa	1 th Aug	15 th Aug- 31 th Dec	no	no	Yes within 100 m deep
Palermo EST	15 th Aug	1 th Sept-31 th Dec	yes*	yes*	Yes within 100 m deep **
Palermo OVEST	15 th Aug	1 th Sept-31 th Dec	yes*	yes*	Yes within 100 m deep **

* The location and number of FADs to be placed is known and programmed.

** FADs placed only in areas where depth is higher than 100 m there is the obligation to remove floating parts of FADs.

Malta

In Malta each boat which has a license for this type of fishery is assigned a transect with a minimum of 30 FADs while a maximum is not established in the current regulation. Malta follows the EC Regulations, which includes the obligation to mark the FADs with the name of the boat on it. Complementary to the fishery regulation for dolphinfish the surrounding nets used by this fishery are prohibited for recreational fisheries. Moreover all vessels use GPRs for positioning and logbook for data obligations.

Concerning data collection, Malta follows the GFCM and ICCAT data collection requirements including biological data (length frequency distribution, length at age, and other biological parameters).

Malta is in the process of preparing a management plan and as it has been proved that this transboundary exploited resource should be considered as a single genetic unit, it is reasonable to think that there could be a need to have management actions agreed at regional level.



Spain

In Spain, the only fishery targeting dolphinfish is the artisanal FADs fishery carried out in Mallorca Island. Catches by the Spanish Mediterranean surface longline fleet are considered bycatch and no specific regulation exists for this species. Captures by recreational fisheries are not included as priority to Spain in the EC Regulation, although Spain provides total landing data to EC, ICCAT and the GFCM.

The Balearic Islands fishery targeting dolphinfish with FADs is regulated in several ways (Ordre del conseller d'Agricultura i Pesca de 14 de març de 2002, per la qual es regula la pesca de la llampuga en aigües interiors de l'arxipèlag balear) including: the regulation on gear characteristics and dimension including mesh size; FAD characteristics and number by line; FADs must be marked with the name of the assigned boat; minimum depth of 30 m for mooring a FAD; a restricted fishing period from 25 August to the end of November; the use of other gears during the period of using dolphinfish FADs is forbidden; the obligation of removing the complete FADs structure including rope and mooring after closing the fishing period; moreover the fishery adopted additional measures in successive years including:

- 2002: Reduction of the fishing effort passing from a resting period of 24 to 48 hours during the weekends. “*Ordre de la Consellera d'Agricultura i Pesca de 26 de julio de 2005, per la qual es regula el descans per a la pesca de la llampuga*”.
- 2012: Adoption of individual landing quota of maximum 300 kg by boat and day.
- Complementary to the Balearic Island regulation the Order AAA/1688/2013 by the Fisheries Ministry, of September the 10th, 2013 regulates fishing for Dolphinfish and associated species, with the art of lampuguera in the outer waters of the Balearic archipelago. This Order states that each vessel may anchor a maximum of 50 FADs, in total, in lines located both in offshore waters as in interior waters and always at a distance of less than 18 nautical miles from the home port.

Tunisia

In Tunisia, the fishing period is from the 15th of August to 31st of December according GFCM recommendation, although biological evidences on the size of dolphinfish in July can postpone the opening of the fishing period. To do that an exploratory survey at the end of July is conducted by the scientists of the INSTM to set up the size distribution of the dolphinfish beneath the FADs. Minimum landing size is regulated at 29 cm FL.

Fishing for Dolphinfish in Tunisia is organized in annual campaigns that are regulated by an annual Ministerial Decree issued on the proposal by a Steering Committee. This Steering Committee, which meets as many times as needed towards the end of July and early August at the invitation of Director General of Fisheries and Aquaculture, includes research (INSTM), professionals (unions and owners fishermen), the regional delegates of fishing and the Heads of Ports, Health Authorities and the Supervisory Authorities (national Police). This same Committee organizes trips to detect the presence of dolphinfish and estimated average size. If the size of the fishes does not reach the



regulated size at landing (29 cm.), the precedent month to the theoretical opening, then the opening of the fishery is automatically delayed.

As example: The Order of the Minister of Agriculture No. 2166 of August 15, 2008 governing the fishing of dolphin stated:

- Article 1: the Dolphinfish fishing season is open from 15 August 2008 to 31 January 2009 and placement date for FADs is August the 1st, 2008.
- Article 2: fishing with FADs will be subject to special authorization
- Article 3: The opening of the mesh size is 20 mm in the pocket of the used encircling seine.
- Article 4: The regional fishing authorities limit the minimum and maximum number of FADs allowed for each boat.
- Article 5: FADs are arranged in parallel rows at a distance between each other of at least 500 meters.

As regulations concerning number of FADs are by region (in Tunisia there are three regions for management purposes: north, central and south) the annual numbers may differ from region to region.

Data Collection and reporting under the current regulations

The experts informed about the current reporting obligations with the EU, ICCAT and the GFCM. Although for Malta, Italy and Spain those obligation should be the same, some differences between countries were noted due to the low value of total catches in Spain where dolphinfish is only fished in Majorca. These low value makes the species to be out of the ranking for which length distribution of landings is mandatory. In Malta and Italy, the volume is higher, implying the obligation to measure and report sizes distributions in the landings.

Obligations on data collection and submission of the catches by recreational fishing as well as by longline is also different in each country. Nevertheless, it was noted that to have a complete picture of all the life stages and their area of distribution it is important to compile as much information as possible from all fisheries that catch dolphinfish.

A summary of the new GFCM Data Collection Regulation Framework (DCRF), which adoption by members is foreseen in 2017, was introduced to the group by Pilar Hernandez. The new DCRF includes two types of tables for dolphinfish data collection, one that is compulsory, which includes fields for total landings and number of boats, and a second one, which is optional and includes fields for effort in different units.

Fishing effort is defined by the DCRF as: the total of the n° of FADs, total number of fishing trips, Number of FADs targeted per fishing trip and Number of FADs visited per fishing trip regardless if they have been fished or not. The WK commented that in the present document of the DCRF it is not clear whether these units of effort are exclusive or complementary and suggested to include some additional comment to the table to clarify this question.

The WK also discussed about the number of FADs visited and those effectively fished. These numbers depend on two main drivers: the abundance of fish under the first FADs



visited and the price at market, which can vary with the progress of the season. This variation has to be captured in the evolution of the CPUE, and therefore it was agreed that the number of FADs fished by vessel and by fishing trip is a more precise measure of effort.

If the number of FADs visited is not feasible to be obtained, the number of fishing trips by vessel in the season would be minimum effort measure to be reported.

Other important factor in this fishery is weather conditions. It is well known that fishing operations using FADs require calm weather, being the operation impossible when there are currents or rough seas. Relationship between bad weather indicator and landings should also be explored. In fact, there is a derogation of the GFCM Recommendation extending the season a number of days equal to the days that fishing has not been possible due to bad weather conditions.

As the landing declarations are mandatory in EU countries and also in Tunisia according to the participants' knowledge, the WK suggested using this type of document to report catch and effort (at the units proposed above) for a precise estimation of CPUE indices that can make comparisons possible.

General discussion on management issues:

In addition to Regional management options adopted by GFCM and ICCAT, complementary and more restrictive measures have been adopted in different countries also at local level (e.g. Mallorca, Sicily).

The example of Tunisia where an Advisory Committee decides every year the most suitable management measures for dolphinfish (and other fishing resources) was considered a good example of co-management with many stakeholders involved. The possibility to implement similar annual measures in other countries was considered an option for managers' discussion.

The involvement of fishermen in reducing the effects of FADs on the environment was also the object of discussion. Experiences carried out in Sicily and Majorca where the fishermen are obliged to remove the complete FADs at the end of the season or the use biodegradable materials are also options to be considered by managers.

5. Definition of a work-plan.

A medium-term work plan has been drafted by the WK towards the assessment of the stock and evaluation of potential management options which is summarized in table 2 below. The WK requested the CopeMed and MedSudMed projects coordinators to present the Work Plan to the next Coordination Committee meetings to promote the discussion, call for its adoption and establish priorities for the activities to be implemented in the next period with the financial support of the two Projects.

It was assumed that the continuation of this experts group will improve the scientific knowledge of the specie in the western and central Mediterranean Sea and would facilitate the integration of new and complementary information and data from more countries in the South and Eastern Mediterranean.

To this aim, the consolidation of a stable CopeMed-Working Group on *Coryphaena* that would meet on a regular basis and that would interact through the on-line platform recently established, was recommended by all participants.



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Table 2. Proposal for a medium-term work plan for *C. hippurus* and its fisheries

OBJECTIVES	ACTIVITIES
1.Improve the knowledge on biological parameters	- Compile and review biological parameters from the different research works in progress
	- Conduct comparative studies of values and methods used by the different teams, including trough research stays.
2.Improve knowledge on the life history and spatial dynamics of the species from early stages to adulthood.	- Harmonise and adapt existing ichthyoplankton surveys to optimise <i>Coryphaena</i> larval collection.
	- Promote a pilot tagging program for dolphinfish in the whole region. Consider possibilities with ICCAT and GFCM and with the fishers and recreational anglers associations.
3.To get reliable estimation of stock size and reference points for fishing pressure	- To collect data from other gears than FADs (Catch-effort, size distribution) from all possible sources including recreational fisheries in order to cover all sizes range.
	- Collect catch also in numbers of fish - Measure of effort in the agreed units (either number of trips as the minimum or number of FADs visited by day and boat) - A new WK is proposed focusing on data and methods for stock assessment
	- Compile and review existing data. - Follow up of trends of these indicators (prices, jobs, market)
4.Identify socioeconomic indicators that drive the fishery	- Collaborate with the CERES project in providing data that facilitates the elaboration of models.
6.Reduce the FADs impact on the environment while maintaining or improving the profitability of the fishery.	- Assess the actual impact of FADs structure on the environment.
	- Estimate the critical number of FADs taking into account the spatial component of the FADs catches.
	- Promote the practice of removing FADs by fishermen after the season and explore environmental friendly material for the



	FADs.
7. Confirm recent studies on stock identity.	<ul style="list-style-type: none">- Collect samples to study genetic variations at the subregional scale (Gulf of Cadiz and Canary Islands, Eastern Mediterranean)- Use the most powerful markers like SNPs or microsatellites.

6. Other matters

Ms. Hernández, CopeMed fishery officer presented an online platform based on Share-point that had been prepared for this and other CopeMed II meetings. She commented on the different components of the portals and got the agreement of participants to upload all the presentations. The agenda, and a table with biological parameters prepared during the meeting for collaborative completion of its fields were also uploaded to the portal. The aim of this share-point is to be a tool to facilitate the work of the network while serving to store information, data and documents in a common platform available only to the members of the group, with a username and password.

Participants were requested to complete the share-point with new documents and information of interest to the group. A discussion forum is also available.

This tool was welcome by the WK and interest in contributing to update the share-point was expressed by all participants.

7. Conclusions and recommendations

Quite enriching discussions were held during the meeting on different questions related to the biology, fisheries and research priorities of dolphinfish. A general spirit of cooperation and coordination emanated from all the discussions and proposals. The group was aware that the continuation of its activities depends of the decision of the CopeMed and MedSudMed Coordination Committees but they expressed their willingness to continue working together under the FAO projects framework.

The workshop ended up with a series of conclusions and recommendations reported here below for further transmission to the respective Coordination Committees:

- New evidence presented by the experts participating in the CopeMed-MedSudMed meeting confirms the identity of a single homogenous Mediterranean genetic unit of dolphinfish (*Coryphaena hippurus*) and therefore they considered that the management of this species should be coordinated.
- The existence of fisheries targeting or by-catching dolphinfish in countries not participating in the meeting was put forward as an issue to be further investigated. The WK recommended reinforcing communication particularly with Algeria, Morocco and Libya as well as with the FAO EastMed Project to complete a better picture of the biology and fisheries of the species in the Mediterranean Sea.
- Important advances concerning the biology and fisheries in the participating countries were presented that contributed to fill some of the identified gaps of 2011, however uncertainties and gaps still remain.



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- During the meeting these gaps were identified and a table of main objectives and activities was agreed upon as a work plan proposal for the future (1-2 years).
 - The WK recommended that the work plan be presented to the CopeMed and MedSudMed Coordination Committees to get the agreement of the regional projects on the plan itself and on priorities and timing.
 - The WK needs some stable framework to develop the proposed work plan. It was suggested to establish a CopeMed-MedSudMed Working Group that would meet on a regular basis and will share information through the on-line platform recently established to this end.
 - A new WK is proposed in the next cycle (2016-17) focusing on data and methods for stock assessment, tentatively back-to-back within the framework of the regular WGs on Stock assessment of the CopeMed Project.
 - The WK agreed to collaborate with other FAO projects and non-FAO projects (such as CERES) that work in the Mediterranean on *Coryphaena* fisheries, ecology and biology.
 - The WK suggested extending, when relevant, the network of experts to other areas and RFBs in the world, specifically in the fields of stock assessment and by-catch estimates. In particular the connections with ICCAT and IATTC should be reinforced.

8. References

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Appendix I

CopeMed II-MedSudMed Technical Workshop on *Coryphaena hippurus* Fisheries in the Western-Central Mediterranean Malta 16- 18 March 2016

Agenda

Wednesday 16 March

- 1. Opening, background and objectives of the meeting.**
- 2. Review of current state of knowledge and recent developments on *C. hippurus* research (fisheries monitoring, sampling, biology and ecology) in each country.**

Thursday 17 March

- 3. Current methodologies to assess *C. hippurus* in the Mediterranean Sea and in other areas.**
- 4. Current management options in the region and by country.**
- 5. Definition of a work-plan**

Friday 18 March (half day)

- 5. Definition of a work-plan (Cont.)**
- 6. Any other matters**
- 7. Conclusions and recommendations**



Appendix II

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