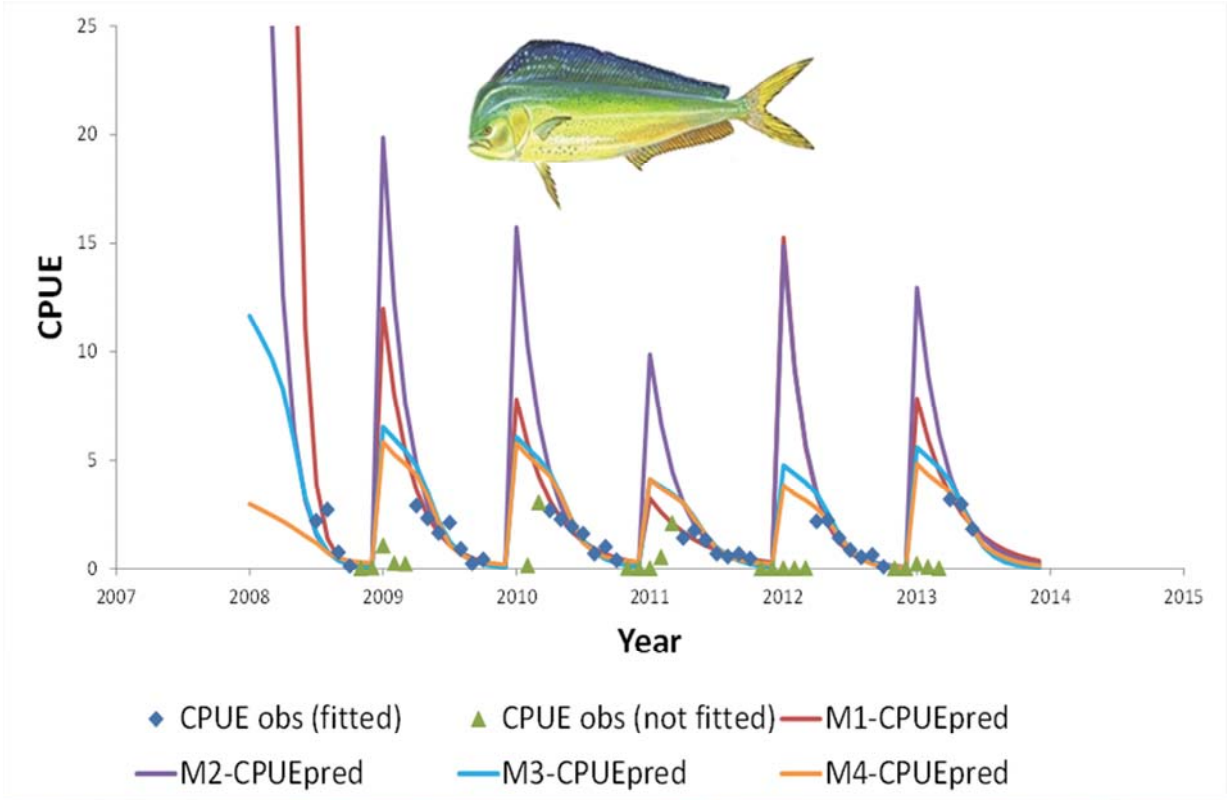
COPEMED II

TECHNICAL DOCUMENTS 44

COPEMED II-MEDSUDMED WORKSHOP ON STOCK ASSESSMENT OF *CORYPHAENA HIPPURUS* IN THE WESTERN-CENTRAL MEDITERRANEAN

13-15 September 2016
Malaga, Spain



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COPEMED II-MEDSUDMED WORKSHOP ON STOCK ASSESSMENT OF *CORYPHAENA HIPPURUS* IN THE WESTERN-CENTRAL MEDITERRANEAN

September 2016

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 (Mº de Agricultura, Alimentación y Medio Ambiente, 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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CopeMed II (GCP/INT/028/SPA – GCP/INT/006/EC) Publications

CopeMed II project publications are issued in the CopeMed Technical Documents series and are related to meetings, missions and research organized or conducted within the framework of the CopeMed II Projects.

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

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Preparation of this document

This document is the final version of the Report of the CopeMed II - MedSudMed Workshop on stock assessment of *Coryphaena hippurus* in the Western-Central Mediterranean. Malaga, Spain 13-15 September 2016.

Acknowledgements

CopeMed II acknowledges the participation and valuable contributions of all experts from fisheries administrations and scientific institutions from Italy, Malta, Spain and Tunisia during and after the meeting for the preparation of this report and the corresponding appendices.

CopeMed II. 2016. Report of the CopeMed II - MedSudMed Workshop on stock assessment of *Coryphaena hippurus* in the Western-Central Mediterranean. Malaga, Spain 13-15 September 2016. CopeMed II Technical Documents Nº44 (GCP/INT/028/SPA - GCP/INT/006/EC). Málaga, 2016. 31 pp.

ABSTRACT

CopeMed II-MedSudMed Workshop on stock assessment of *Coryphaena hippurus* in the Western-Central Mediterranean was held in Malaga on 13-15 September 2016. The meeting was attended by experts from fisheries administrations and scientific institutions from Italy, Malta, Spain and Tunisia, officers from the FAO Regional Projects CopeMed and MedSudMed and from the Inter American Tropical Tuna Commission (IATTC). Participants were trained in the use of a monthly depletion estimator, used by the IATTC to assess the stock of *C. hippurus* in the Eastern Pacific Ocean. A preliminary attempt to carry out the assessment of dolphinfish in the area covered by the traditional FADs (Fish Aggregation Devices) fishery in the four Mediterranean countries was conducted, resulting in preliminary estimates of recruitment and fishing mortality rates. Despite the validity demonstrated by the Monthly Depletion Estimator to the Mediterranean data, participants agreed to continue working on the standardization of CPUE including through the use of General Linear Models and to also consider abundance indices coming from other gears as long-lines when available.

CopeMed II-MedSudMed Workshop on stock assessment of *Coryphaena hippurus* in the Western-Central Mediterranean

Málaga, Spain, 13-15 September 2016

1. OPENING, BACKGROUND AND OBJECTIVES OF THE MEETING

The CopeMed II-MedSudMed Workshop on stock assessment of *Coryphaena hippurus* in the Western-Central Mediterranean was held in Malaga on 13-15 September 2016. The meeting was attended by experts from fisheries administrations and scientific institutions involved in common dolphinfish fisheries from Italy, Malta, Spain and Tunisia, officers from the FAO Regional Projects CopeMed and MedSudMed and from the Inter American Tropical Tuna Commission. The complete list of participants is given in Appendix II.

Ms Pilar Hernandez, CopeMed II fishery expert, introduced some background information about the work carried out on *Coryphaena* fisheries in the framework of the FAO regional Projects, including the conclusions of the last workshops held in Palermo, Italy (05-06 July 2011) and in St. Julian's , Malta (16-18 March 2016). The proposed work program as agreed by the 9th Coordination committee was also reviewed. The group was informed that the Committee had set priorities and provided indications for a new meeting of the WG on *Coryphaena*, which should focus on stock assessment. Previous attempts to apply classical analytical models to *Coryphaena hippurus* had not produced reliable outputs. In this occasion, thanks to the collaboration initiated with scientist from the IATTC, the use of methods recently used in Eastern Pacific was going to be tested for the first time in the Mediterranean.

The objectives of the workshop were:

1. Advance towards the assessment of *C. hippurus* in the WC-Mediterranean
2. Learn the stock assessment model: Monthly Depletion Estimator with the collaboration of IATTC expert
3. Test the model using available data from main fishing countries in the WC-Med (Spain, Italy, Malta and Tunisia)

The agenda as presented in Appendix I was adopted.

2. OVERVIEW ON *Coryphaena hippurus* FISHERIES AND DATA AVAILABLE BY COUNTRY.

National experts presented the data and information brought to the meeting. They are all official data provided by the respective Fishery Administrations. All participants had made available these data in the format and units requested for the exercise. They also updated the group of recent research or monitoring activities in each country on this species. All data sets were then stored in the sharepoint that was made available to the members of the group. Participants agreed to keep this portal active and to start developing a database for *C. hippurus* in the CopeMed II online workspace.

The contents of the database at its current state is summarised in table 1. All data are provided by month for every year of the time series.

Table 1. Summary of available data. N/A: not available, Y: yes

Parameter	Gears	Italy	Malta	Spain	Tunisia
		2008-2015	2005-2015	2002-2015	2003-2015
Catch (t)	FADs	Y	Y	Y	Y
	Longlines	Y	NA	Y	NA
Effort units	FADs	Number of vessels	Number of trips	Number of trips	NA
			Nb. of FADs operated		
	Longlines	1000 hooks	NA	1000 hooks	NA
CPUE units	FADs	Kg/vessel	Kg/trip	Kg/trip	NA
			Kg/FAD op.		
	Longlines	t/1000 hooks	NA	Fish/1000 hooks	NA
Biological parameters	(k, t_0, L_∞, a, b, maturity..)	Y	Y	Y	Y

3. THE INTER-AMERICAN TROPICAL TUNA COMMISSION (IATTC) EXPERIENCE WITH THE ASSESSMENT AND MANAGEMENT OF *Coryphaena hippurus* IN THE EASTERN PACIFIC OCEAN (EPO)

Dr Alexandre Aires da Silva, fisheries officer of the IATTC, explained the recent history of dorado (common name for *C. hippurus* in south America) fisheries in the Eastern Pcific region. It is a non-target species caught in the fishery of tuna by different gears such as drifting FADs, longlines and dolphins aggregations.

Many similarities in the life cycle and spatial distribution in shore and off-shore were identified in both areas (Mediterranean and EPO). Main differences were found in sizes at L_{50}, which are larger in EPO than in Mediterranean. The volumes of catches are 70 times higher in the Pacific but the seasonality that characterizes this fishery is present all around the world with the maximum of catches in the summer months when they approach the coastal areas and only acting on one cohort of young-of-the year. Experts

agree on a very weak relationship, between stock and recruitment in this species which seems to be more related to the environmental drivers than to spawning stock strength.

4. CURRENT METHODOLOGIES TO ASSESS *Coryphaena hippurus* IN THE PACIFIC.

The methods developed by the scientific team of the IATTC for this fishery is an adaptation of Stock Synthesis. The basis is depletion of an annual cohort based on the negative exponential decay of one cohort on a month by month time step.

The method starts with a simple log-linear regression of with-in-year monthly CPUE similar to catch-curve analysis, and end with a monthly depletion estimator that has several modifications similar to those used in the full Stock Synthesis model.

This analysis, which is similar to catch-curve analysis, measures the relative abundance of a cohort as it ages throughout its first year of life, using the CPUE rather than the proportion-at-age in the catch. Only the CPUEs from August through December which are the months of the regulated fishing season in the Mediterranean were used, in order to eliminate months in which the fishery is not principally targeting dorado. To make the regression model more like a population dynamics model, a simple exponential model is used to model the change in relative abundance from one month to the next:

$$\hat{I}_{y,1}=\alpha_y$$

$$\hat{I}_{y,m+1}=\hat{I}_{y,m}e^{-Z_y}$$

Where $\hat{I}_{y,m}$, is the relative abundance, in numbers, in year y and month m, αy is the initial relative abundance in year y, and Z_y is the instantaneous rate of total mortality.

The model is fitted to the monthly CPUE data using a lognormal likelihood function (with the variability parameter fixed at $\sigma_I = 0.2$ and ignoring constants):

$$\sum_{y,m}\frac{\left(ln[I_{y,m}]-ln[\hat{I}_{y,m}w_m]\right)^2}{2\sigma_I^2}$$

Where $\hat{I}_{y,1}$is the observed CPUE-based relative abundance in year y and month m. The parameters to estimate are α and Z for each year.

If monthly catches and selectivity at age are available, the model can incorporate this information, it will increases its complexity and will produce a better fit to the CPUE data. This option is called Model 2. In addition if we know that the effort is not constant throughout the year, the model can overestimate F for the months whose catch data are not fitted. To compensate this effect, if the variation of effort is known the model can accommodate variable F by adding monthly deviations in fishing mortality.

Several extensions can be added to the proposed three models (*i.e.:* only CPUES, monthly total catch data and selectivity; and F- deviations*)* to improve them or make them more similar to a standard integrated stock assessment model (*e.g.* Stock Synthesis) configured with a single recruitment per year and a seasonal dynamic based on months.

All these procedures were explained to participants and additional reading documents were distributed through the SharePoint of the working group. Most of the documents are not public but were provided in a draft mode and can also be found in the IATTC repository.

The tools developed in excel were explained step-by step to allow for easy follow up by the participants who were able to run the model with the data from their own countries. The indicators that the model can estimate are yearly initial relative abundance (recruitment) and fishing mortality.

5. HANDS-ON SESSION. EXPLORATORY ASSESSMENT EXERCISE: EXECUTION OF NATIONAL AND JOINT ASSESSMENTS

Participants run the model with their individual datasets to estimate biomass and fishing mortality separately in Spain, Malta and Italy and then together in a combined dataset.

CPUE was used as abundance index. Depletion dynamic of the different cohorts were obtained including relative recruitment and fishing mortality rates assuming a constant natural mortality rate of 1.0 $year^{-1}$. Main results are shown below in figures 1-9. Best fit of data to the exponential model were obtained when using CPUEs from Spain as the fitting series. The results showed that the depletion of the cohorts is very fast and that at the end of each season only about 20% of initial abundance is left in the sea. Nevertheless this remaining population is enough to reproduce and generate a new cohort of similar strength year after year, sufficiently to sustain this fishery, which apparently and up to now, does not seems to be at risk of recruitment overfishing. These results are however preliminary and will need to be confirmed in the future when applying the model to standardized CPUE data. The species is well known for its high productivity, with growth rates around 1.83 y^{-1} and a turnover rate of 548 %. In the EPO the relationship between stock and recruitment is not evident, and it seems that environment mostly determines recruitment success rather than spawning biomass.

On a second trial, Model 2 was run by adding total monthly catches and fixing selectivity at age 4 (months). The fitting of the CPUEs was better (fig.11) but the resulting indicators seem contradictory: cohorts' reduction was grater (Fig.12) while fishing mortality showed smaller range between 5.2 and 12.9 $year^{-1}$ (Fig.13). Notwithstanding, it has to be noted that previous attempts to assess this stock in the past with a Separable VPA[1] showed quite similar values of F: between 11.7 and 14.5y^{-1}

[1]FAO/COPEMED CORY03. Final report mediterranean dolphinfish fishery (2003) - B. Morales Nin, M. Azevedo, L. Cannizzaro, A. Besbes, R. Besbes, C. Camilleri, M. Camilleri, S. Deudero. http://webco.faocopemed.org/old_copemed/vldocs/0000869/cory03report.pdf

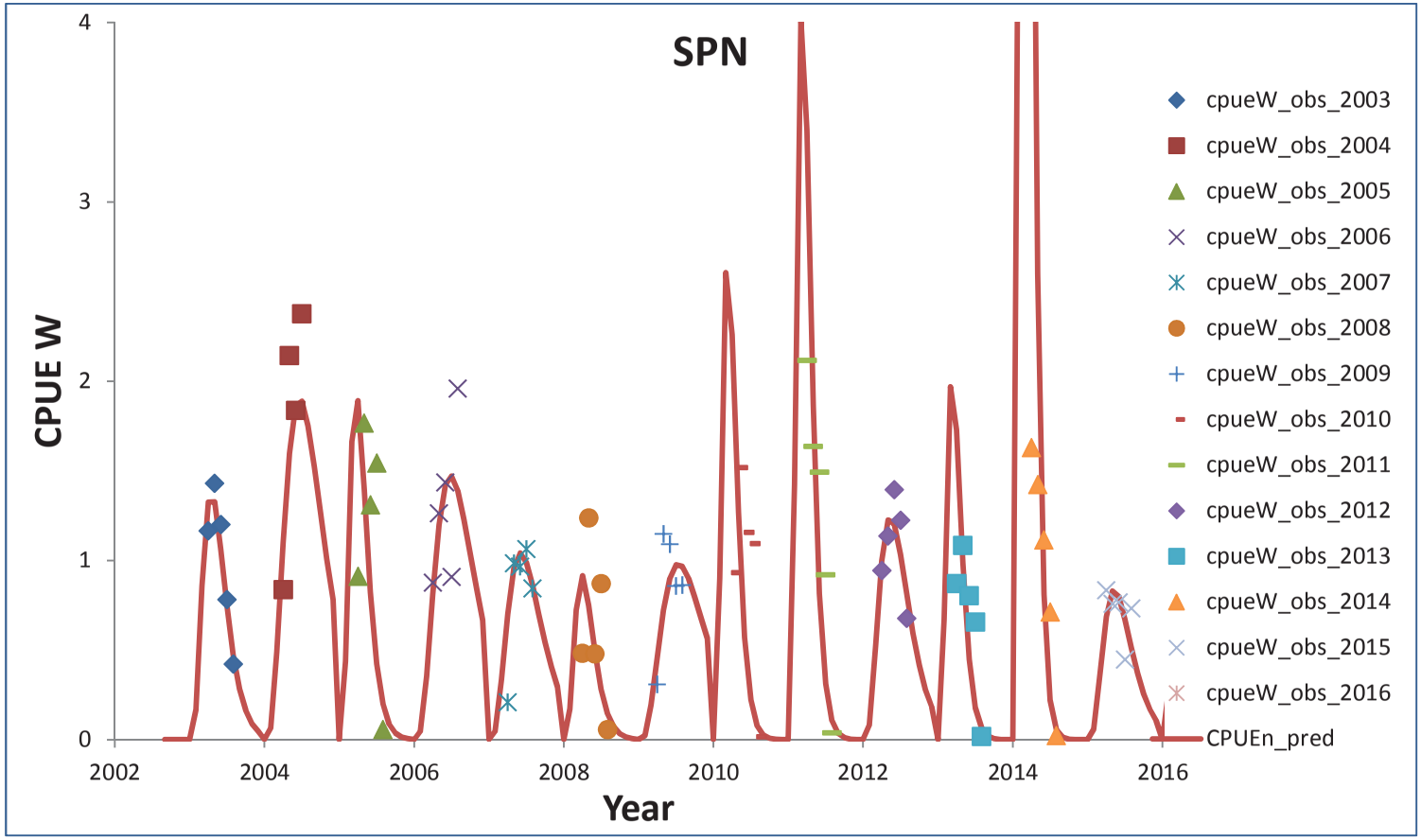

Fig. 1: Monthly observed CPUEs (catch in weight per trip) and model predictions for Spain FADs fishery.The year used in the model starts on 1st May and finishes on 30 April, this is the reason why the last year showed is 2016, which in fact correspond to the fishing season of 2015. The same states for all the following graphs

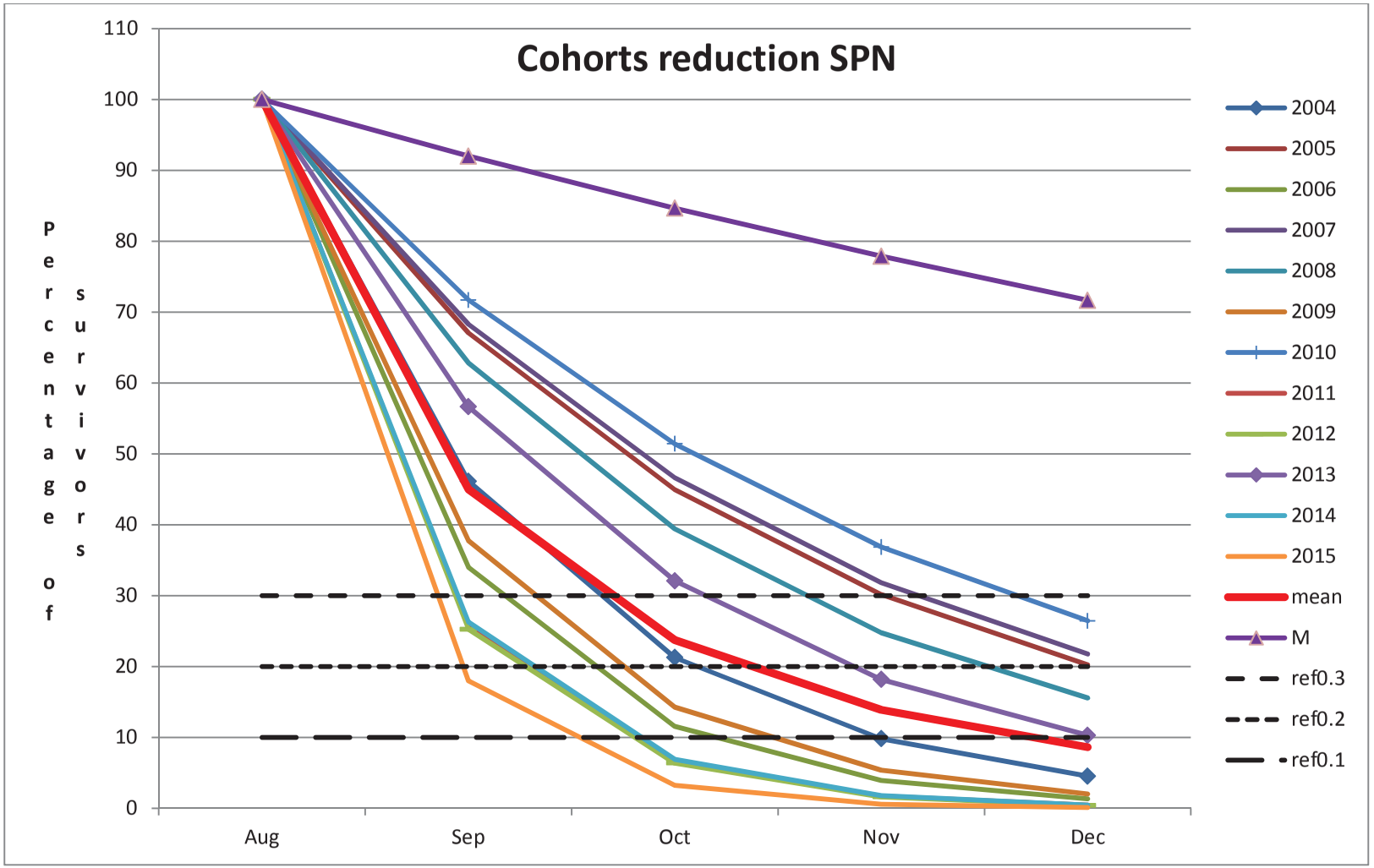

Fig. 2: Cohorts reduction in Spain. “M” indicates only natural mortality. The three lines “Ref” indicate reductions up to 30%, 20% and 10% of initial population size

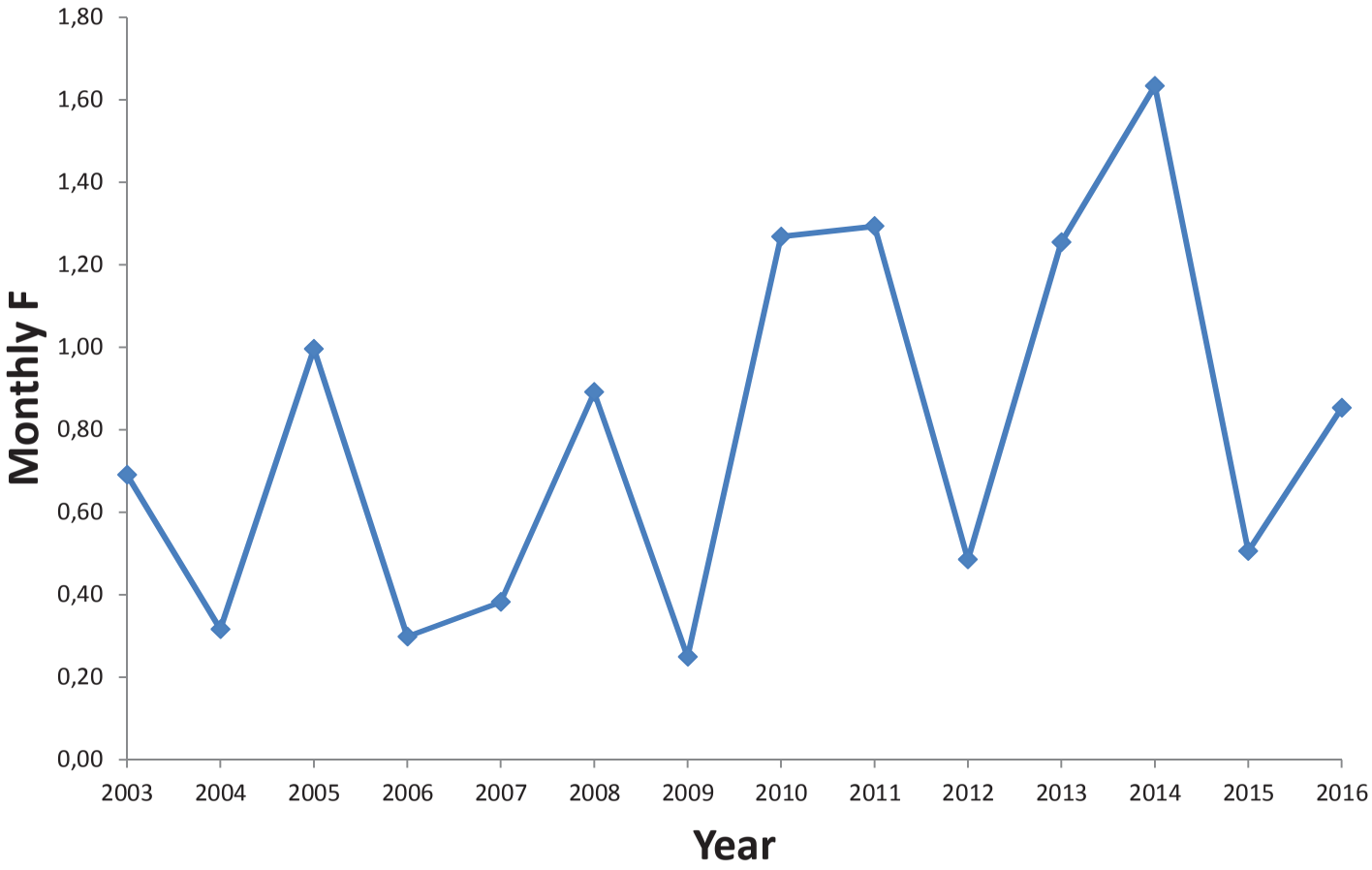

Fig. 3: Fishing mortality rates (month $^{-1}$), as annual average from monthly estimates for Spain.

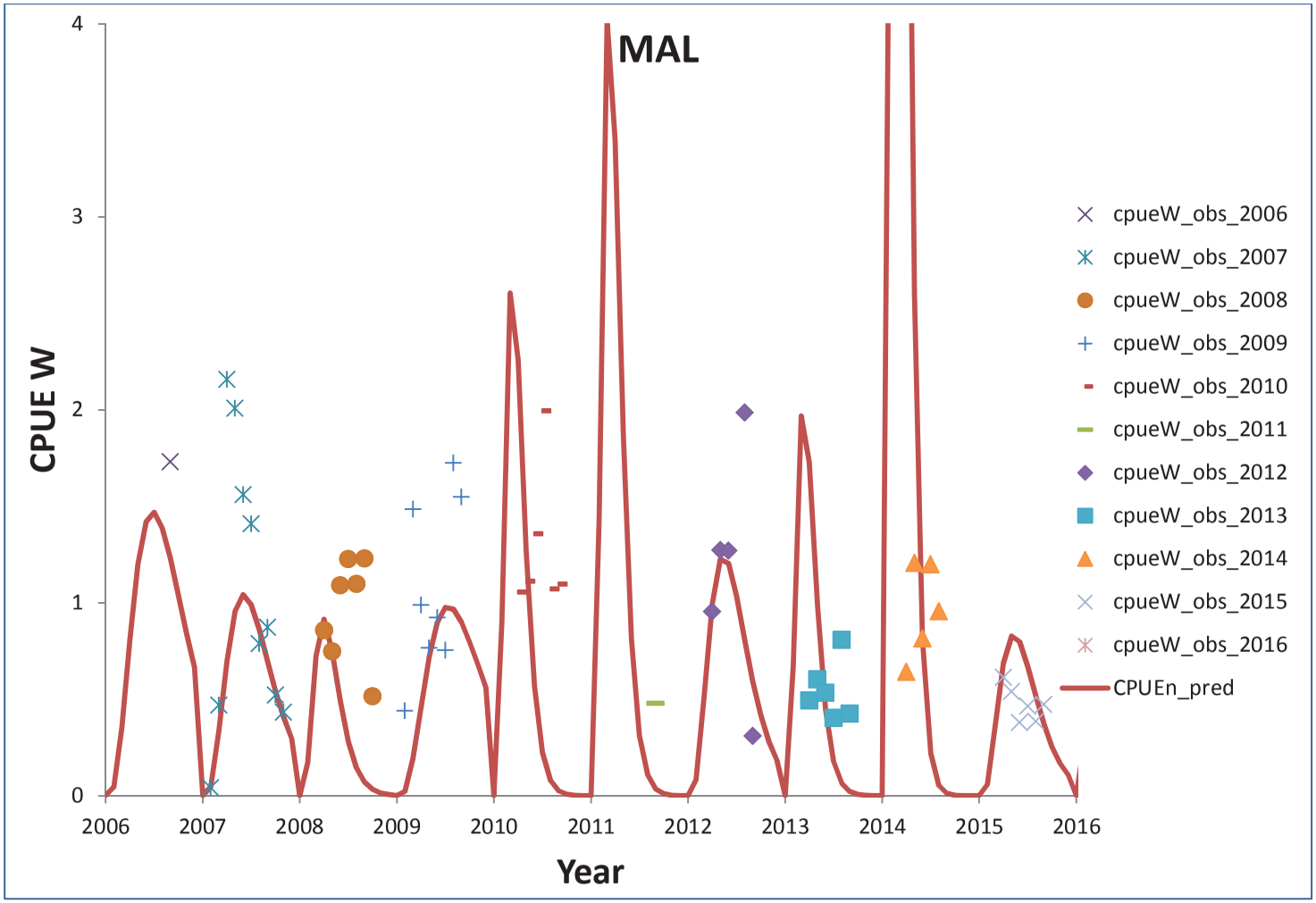

Fig. 4: Annual observed CPUEs (catch in weight per trip) and model predictions for Malta FADs fishery, with Spain CPUEs (2006-2015) as fitting series.

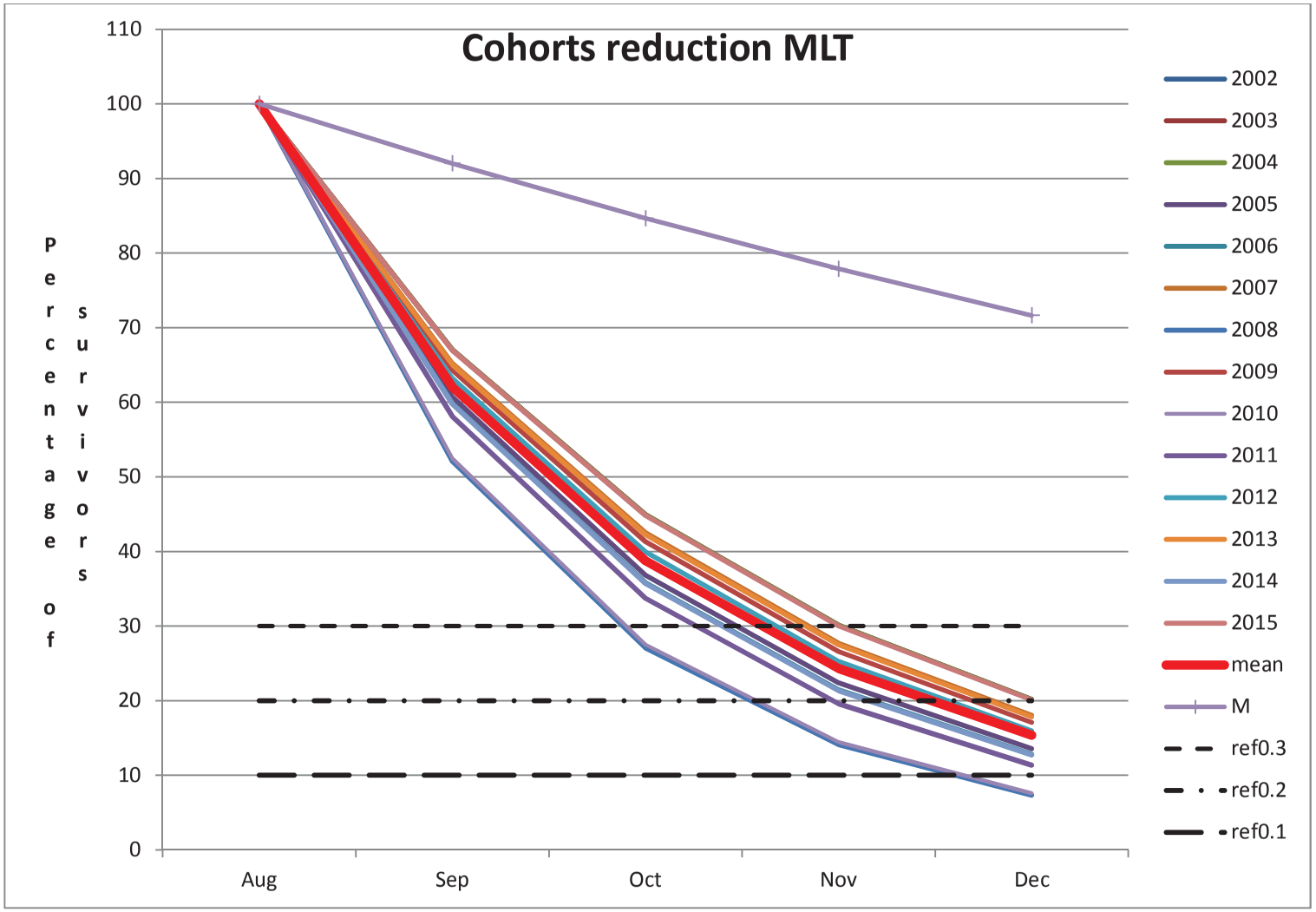

Fig. 5: Cohorts reduction in Malta. M indicates only natural mortality. The three lines "Ref" indicate reductions up to 30%, 20% and 10% of initial population size.

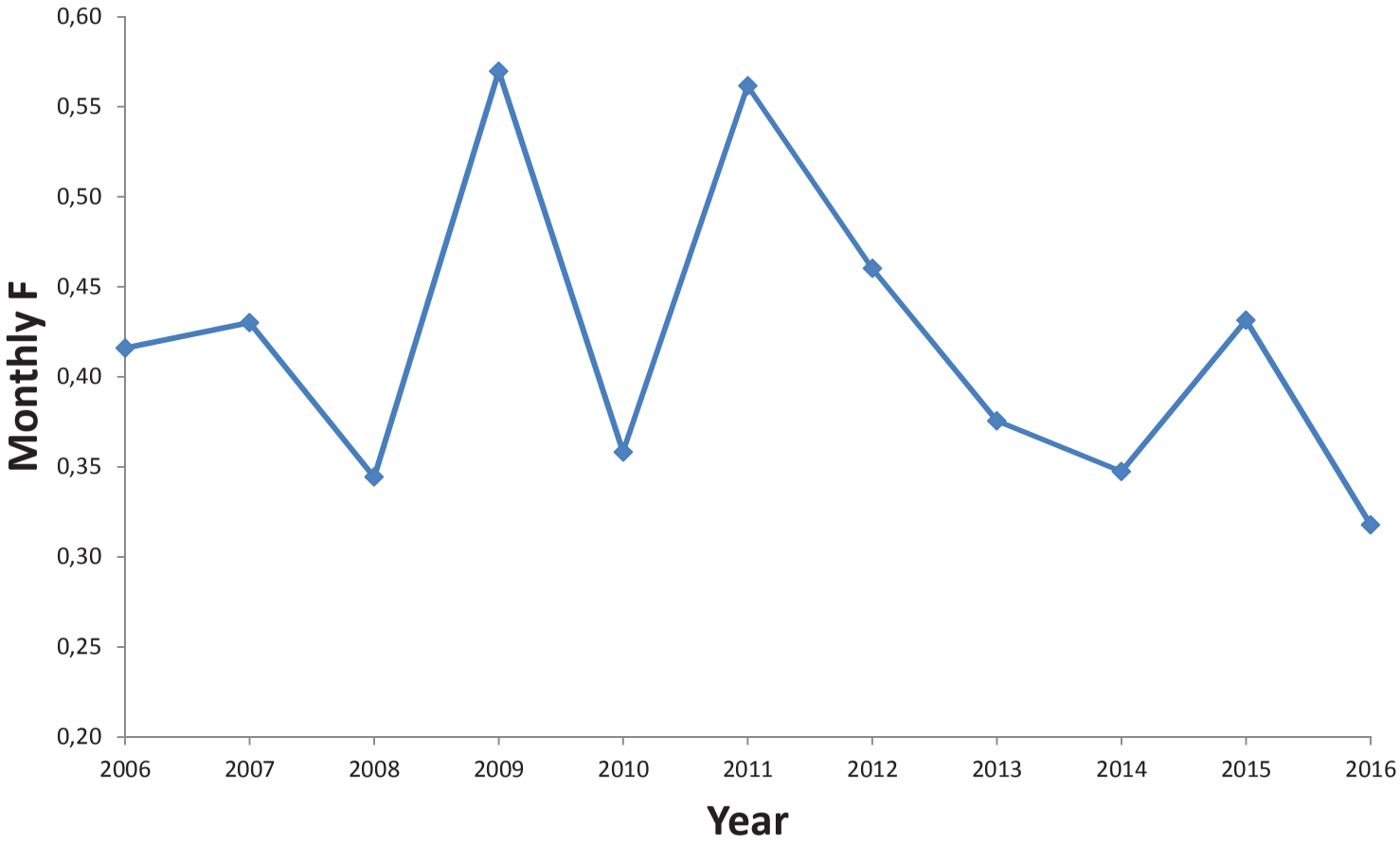

Fig. 6: Fishing mortality rates (month^{-1}) estimated as annual average from monthly estimates for Malta.

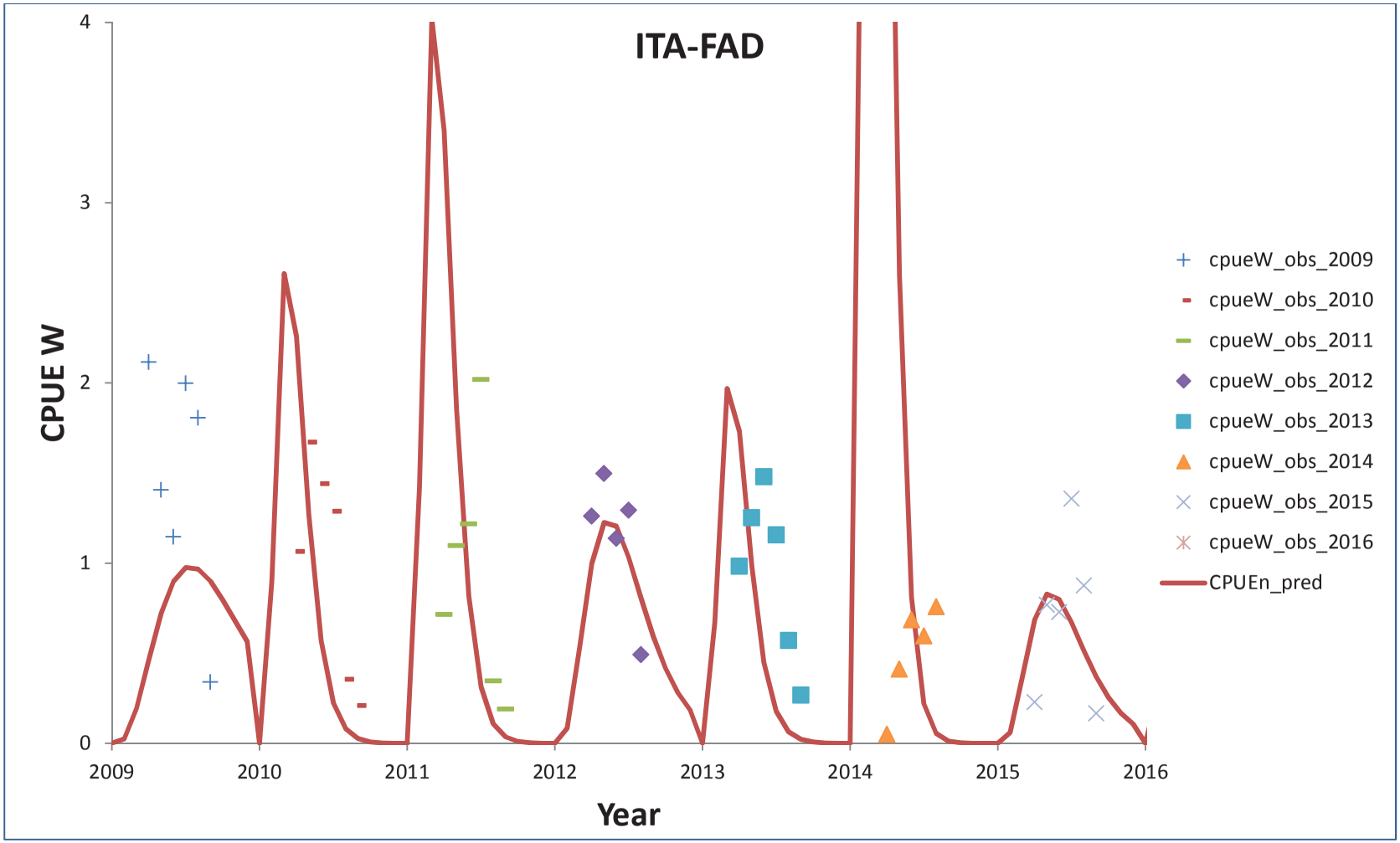

Fig. 7: Annual observed CPUEs (scaled) and model predictions for Italy FADs fishery, with Spain CPUEs (2009-20015) as fitting series.

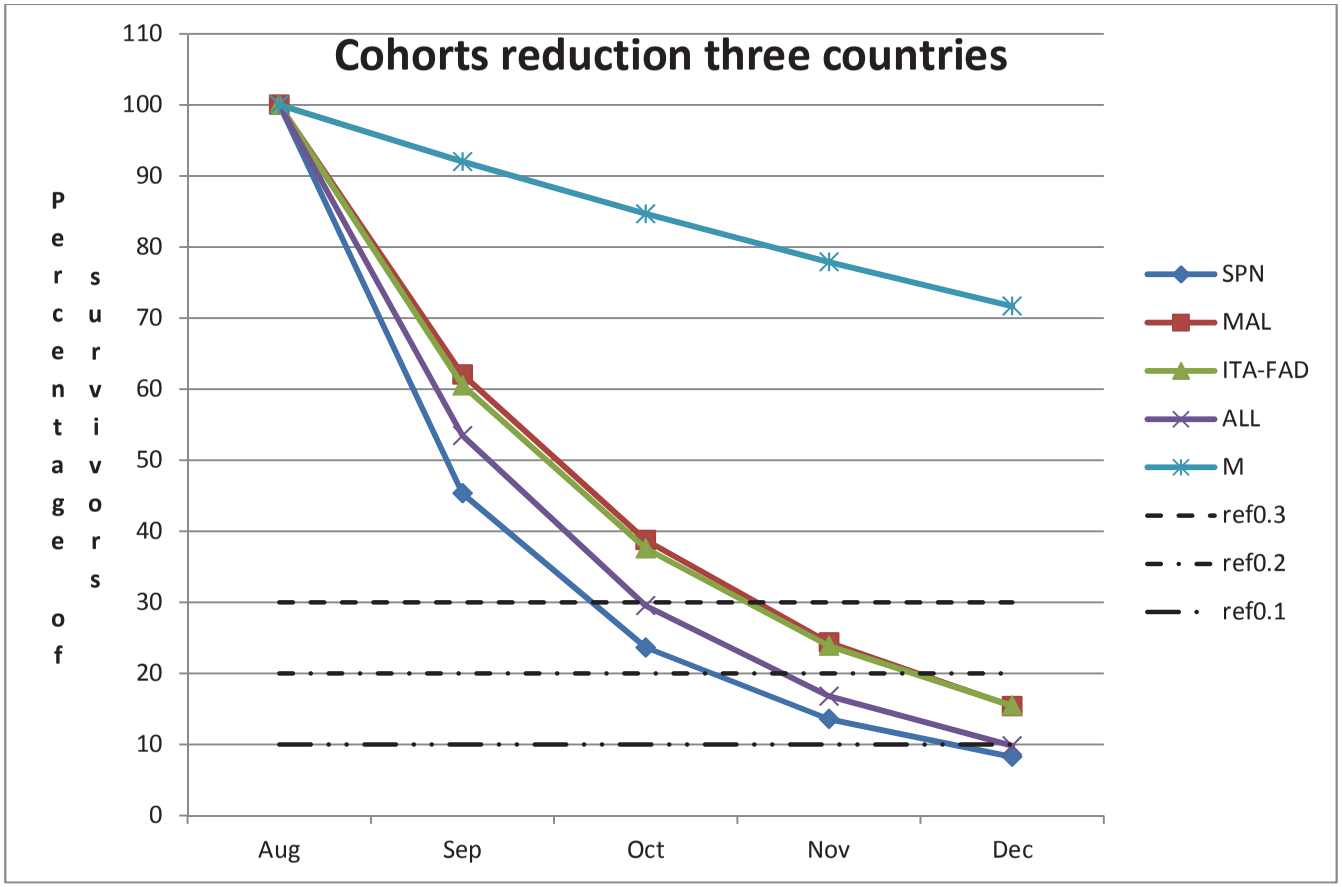

Figure 8: Cohorts reduction for data combined of three countries (Italy, Malta and Spain) when using different CPUEs as fitting series. "ALL" represents a combination of the three CPUEs while "SPN" represents the depletion of the stocks for the three countries combined when we use just the series of SPAIN as the fitting series. And similarly to the other two lines. "M" indicates only natural mortality. The three lines "Ref" indicate reductions up to 30%, 20% and 10% of initial population size.

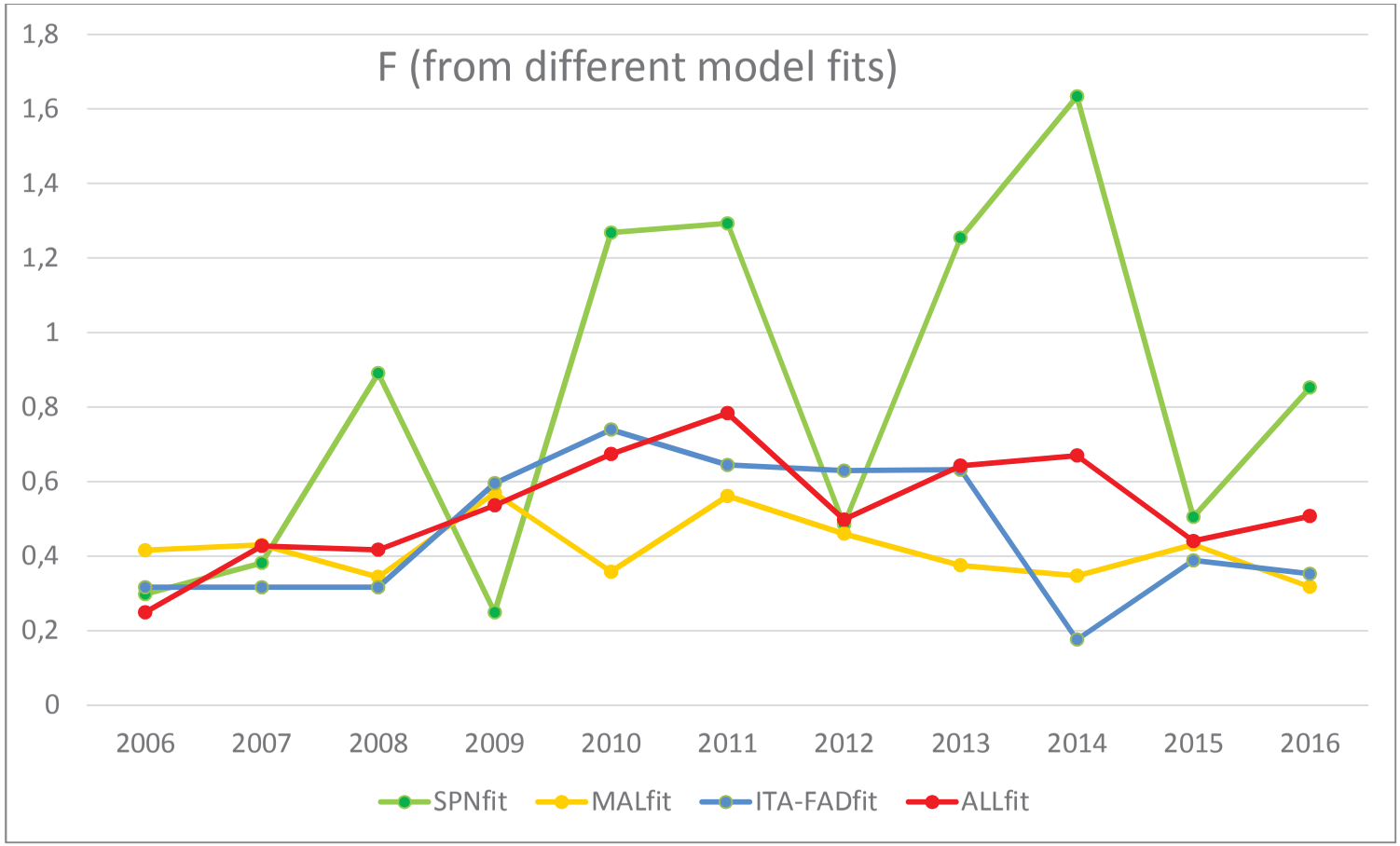

Figure 9: Fishing mortality rates (month^{-1}) estimated as annual average from monthly estimates for the three countries combined when using different CPUEs as fitting series.

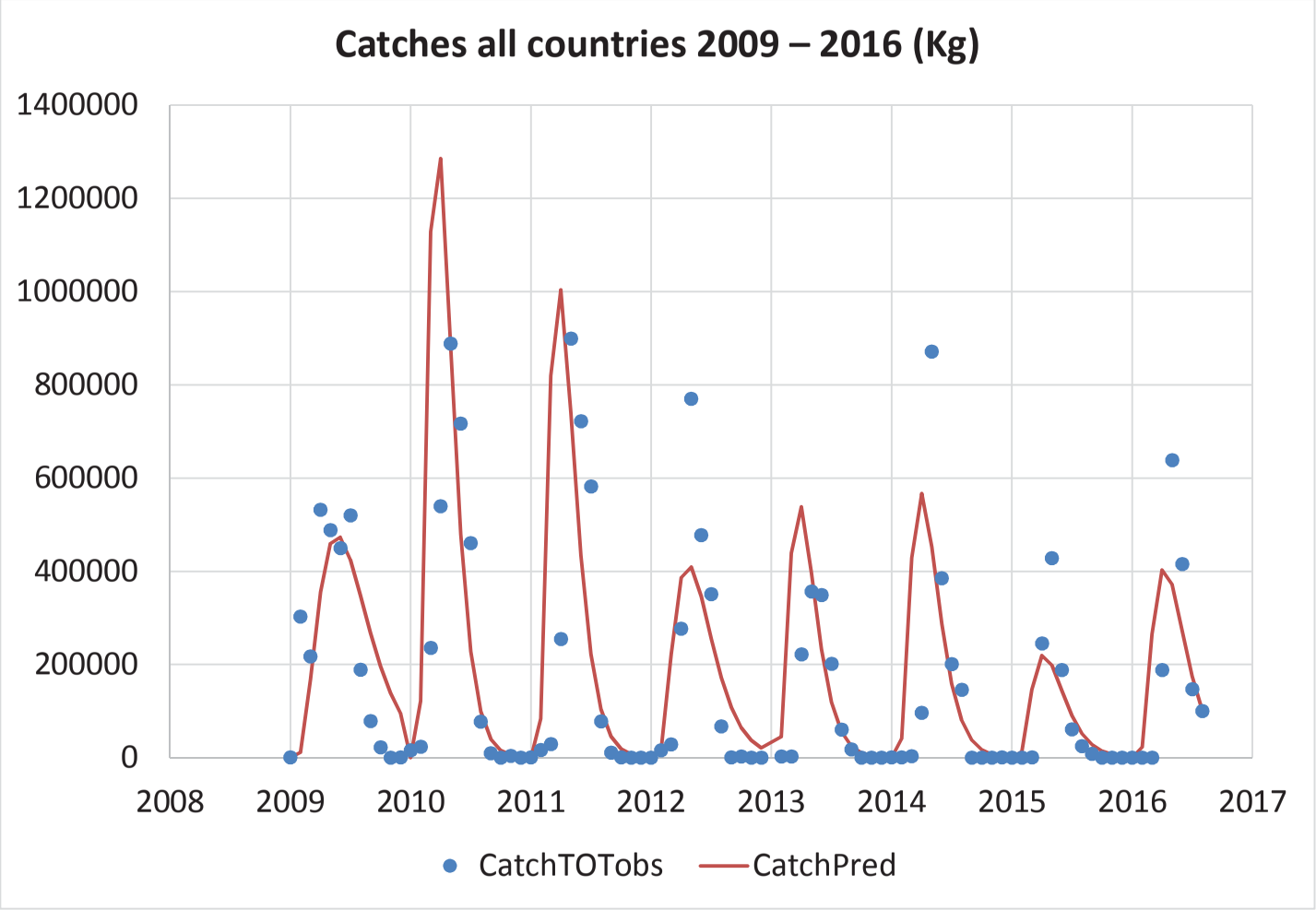

Figure 10: Observed and predicted total monthly catches (kgs) when adding the catch and selectivity to the model.

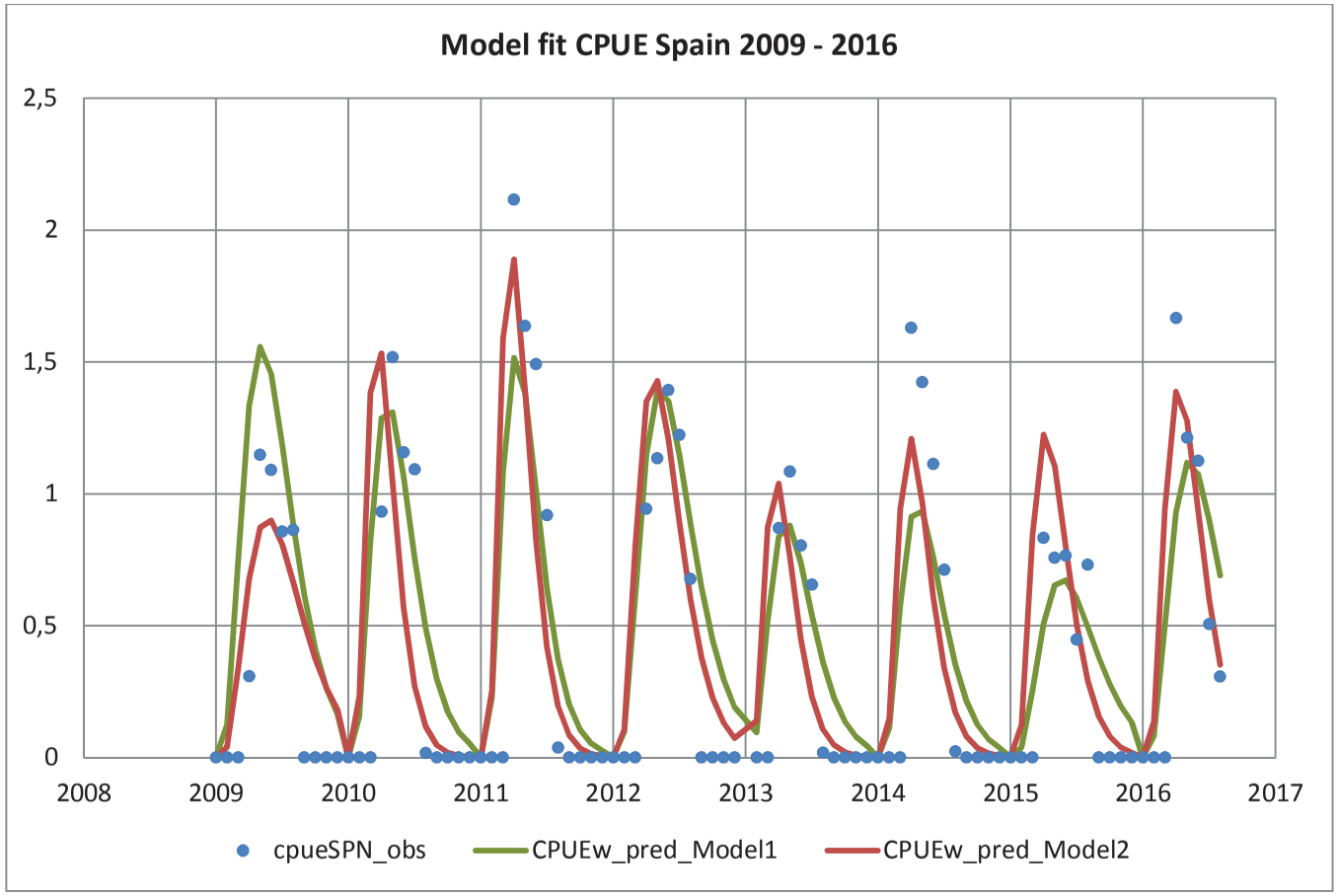

Figure 11: Observed CPUEs (scaled) and model predictions for Spain FADs fishery.Model 1: only CPUE data and Model 2 (adding Catch and Selectivity)

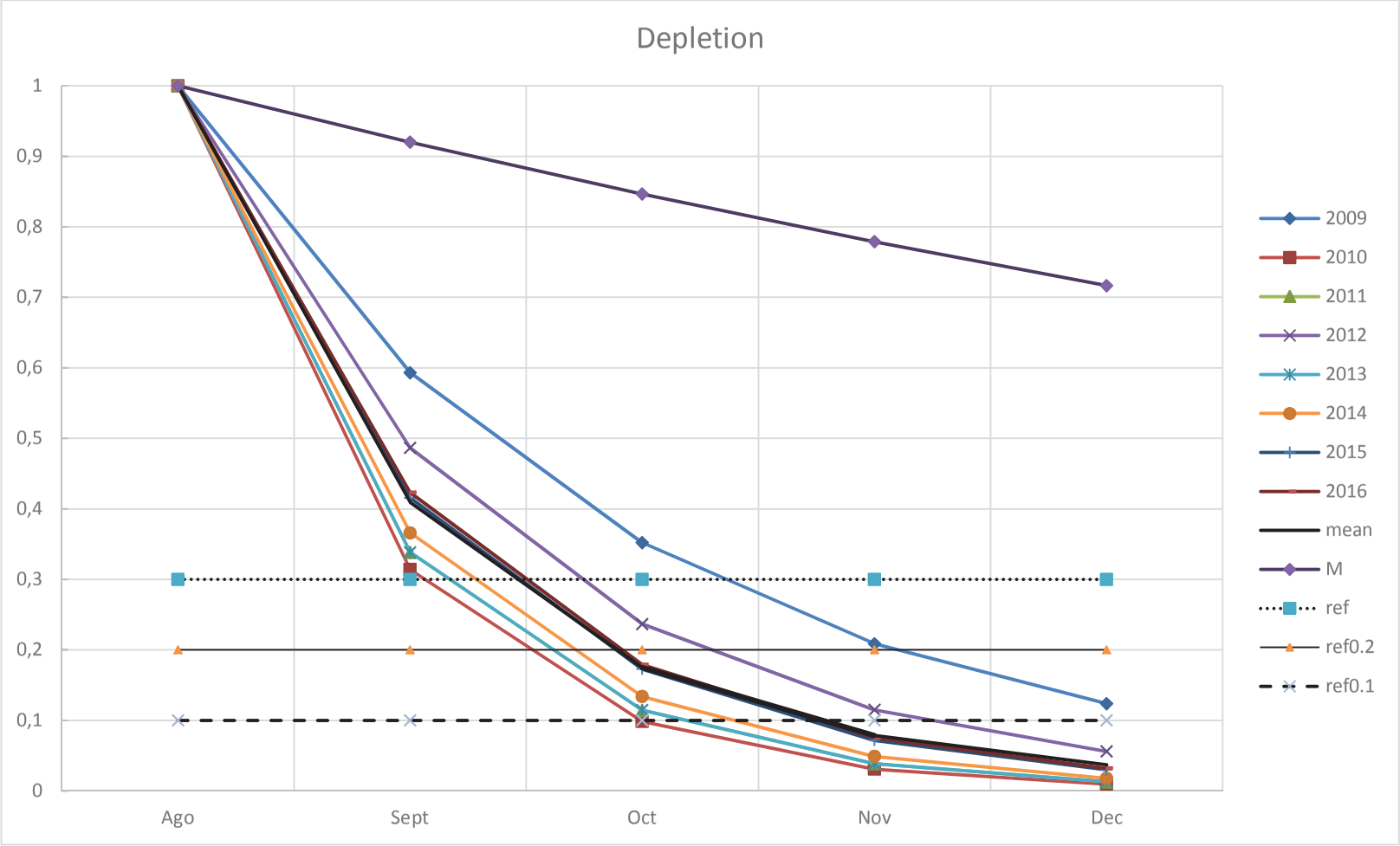

Figure 12: Cohorts reduction for data combined of three countries (Italy, Malta and Spain) when adding the catch and selectivity to the model

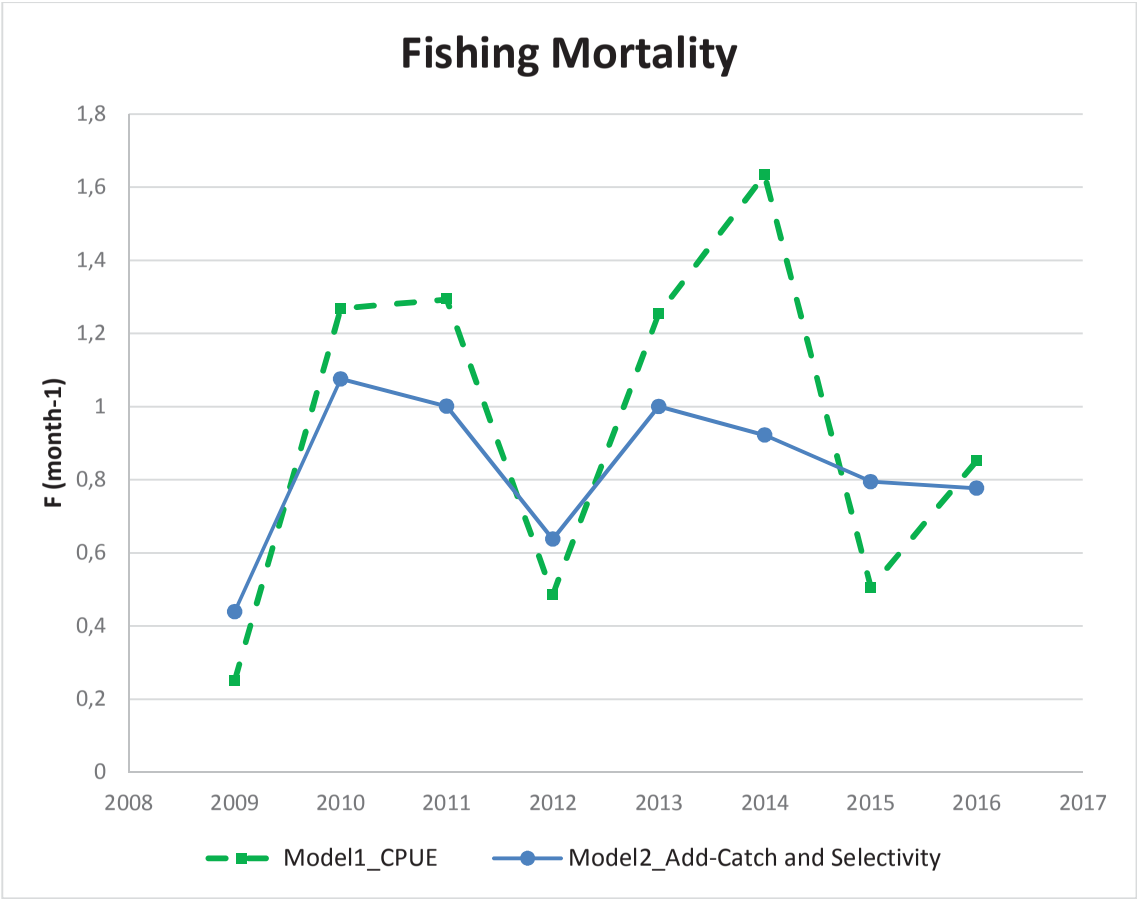

Figure 13: Fishing mortality estimates (monthly average by year) when using Model 1: only CPUE data and Model 2 (adding Catch and Selectivity). Note that these are monthly values; yearly averages would be 12 times higher ranging between 5.2 and 12.9

6. DISCUSSION OF RESULTS

There was consistency in the behavior of the three series tested; better similarity was found between Spain and Italy. Adding more complexity to the model (*i.e.*: total catch and selectivity pattern) did not provide better results (Figs. 10-13). The main constraint identified in the application of the model was that CPUE data are not standardized. Therefore it was necessary to use the index of the country that better fits the model to complete the exercise, *i.e.*: Spain. However, to take the best possible advantage from the model properties, it was necessary to make sure that the index adopted is representative of the core of the fishery. In alternative, it would be necessary to gather better catch and effort data thus reducing the possible source of errors.

The projects were requested to support the collection of better catch and effort data to rerun the assessment.

In addition, participants discussed some questions related to migrations and behavior of the species which still remain uncertain. The model assumes that during the fishing season the resource is fully available to the fishing gear and, therefore, the data used to estimate the CPUE refers to the core of the fishing ground during the fishing season (Aug-Dec on average). That is the rationale for carefully excluding CPUE observations out of the season. If the migration behavior of this species is not properly known, it will be difficult to meet this strong assumption. Indeed, it may be possible that the stock move non-stopping during the year around the Mediterranean but it is only available to the fishery during the months of August to December. If this is the case maybe we would need a spatially structured model with movement between areas instead of a simple model with CPUEs as this.

Some of these uncertainties need to be further investigated by the experts. Participants agreed to produce a comprehensive paper on dolphinfish fishery and ecology in the Mediterranean to deal with all these questions.

7. ANY OTHER MATTERS

Information on fisheries of *Seriola dumerili* (availability and relevance by country).

Seriola dumerilii or greater amberjack is a benthopelagic carangid fish often misclassified as large migratory pelagic which is very commonly associated with dolphinfish catches under the FADs. In the Mediterranean region it has high commercial value, what makes the fishermen retain and commercialize those associated individuals even if the majority of them are juveniles. It is very appreciated by spearfishers and it is targeted only by a few local small scale purse seiners in Sicily. In addition, *S. dumerilii* is captured as by-catch of longlines for albacore and swordfish.

The Coordination Committees of the CopeMed II and MedSudMed projects recommended to investigate further the available knowledge on this species and its fishery for its possible consideration in future research activities.

Participants provided information on *Seriola dumerilii* fisheries and bio-ecology in their countries. A list of references is presented in Appendix III of this report.

Italy: In Sicilian waters spawning occur from May to July when sea surface temperature reaches about 20 ºC. Juvenile of this multi-spawner species can be found under FADs or floating objects in July with size of about 2 cm and remain associated up to about 25

cm until the month of November. In this period they can be illegally caught by fishermen as by catch of dolphinfish. Long-lived species with fast growth on its first year of life, reaches maturity within the fourth year of life at 105 cm. Adults of this species have a high market value in Italy and are caught normally also in sport fishing. In Lampedusa island (Sicily) a specific fishery of large purse seiner target this species in the period from May to July. Sub adults of 60 cm and adults up to 160 cm are caught. This is tied to the presence of large spawning aggregations of this specie around banks and sunk wrecks in the Sicilian channel. According to the experts, the survival rate after release is high in this species and therefore, a possible management suggestion would be to release juveniles caught under FADs.

Malta: There is no target fishery for *Seriola dumerili*. This species is caught by various gears as by-catch of other target species including set gill nets, FADs, trammel nets, trolling lines and set longlines. Catch, effort and size distribution data are available in Malta. Total catches varied between 2911 kg and 10031 kg in 2013 to 2015.
Percentage of *S. dumerilii* catches in FADs in relation to dolphinfish is less than 6%.

Spain: It is by-catch in longlines for albacore and swordfish, for these two fisheries, data on catch and effort are available. Locally important in Alicante and Mallorca, where traditional gears such as "moruna" a static set net target this species in coastal areas. It is also relevant in sports fishing.

Tunisia: Amberjack is captured by a multitude of fishing gears: gillnets, set nets, FADs, longline, as accessory, non-target species. Juveniles are by-caught under FADs during the *Coryphaena hippurus* (August to December) fishing season, while adult specimens are occasionally harvested from deep areas in May. The average national production of the amberjack is around 100 tons per year, and over 60% of the landings come from the inshore fishery. Data on its biology and more specifically on diet and reproduction are available and have been the object of a master thesis. References are presented on appendix III

Publication of a scientific paper

The production of a scientific paper gathering the main outcomes of the two workshops organized in 2016 was discussed by the participants. It was decided to produce a draft to be submitted to an international scientific journal and, as a second option keep always the possibility of publishing it as a CopeMed Technical Document. A table of contents and provisional list of authors was agreed and is included as appendix IV.

8. REVISION AND UPDATE OF THE WORK-PLAN

The work plan was revised and participants agreed with the continuation of the plan but some activities were better defined which are reported in the below section.

9. CONCLUSIONS AND RECOMMENDATIONS

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

Conclusions:

- The IATTC depletion method applied for dolphinfish in the EPO (catch rate analysis) has proved to be valid to produce estimates of total mortality and precent survival rates for individual cohorts of dolphinfish.

- In general, there is consistency in the depletion patterns identified in the four sets of data analysed: Italy, Malta and Spain CPUEs and total catch from Tunisian fisheries. Similarities in the behavior of the indices used with the same type of fluctuations have been identified indicating that the model used is appropriate for the estimation of fishery parameters.

- AS CPUEs time series are the basis for the depletion modeling approach, results are only valid if the CPUE time series are reliable indices of relative abundance for dolphinfish. Some suggestions to further investigate this and other indices were: use General Linear Models to standardize CPUE, consider abundance indices coming from other gears as long-lines when available.

- There is information available on biology of *Seriola dumerili* and also data on catches by different gears. Participants agreed that it is a species relevant only locally for very specific coastal fisheries operating in Sicily, and Mallorca and it is relevant as a valuable piece in recreational fisheries. Specimens associated to the FADs catches during the fishing season of dolphinfish in the four countries are juveniles and should be released at sea to allow for increase in biomass.

Future activities with the support of Projects

- To explore: Size composition, natural mortality, growth and length/weight relationships in the same years in all countries. If necessary enhance sampling programs supported by the project.

- Facilitate the exploitation of existing collections of biological samples by promoting exchange of samples and of researchers to the different institutes.

- Estimate the density of FADs and specimens found under the FADs, and area covered in each country.

- Pilot study with the collaboration of fishermen during a fishing season to collect the most accurate possible data on effort: numbers of visited FADs, with or without fishing operation. In addition, supplementary assistance can be provided where necessary to cover a larger area (e.g. Tunisian coast)

- Produce a review paper to gather all information contained in recent and unpublished papers.

- Create a database with the current fisheries data and metadata to be stored in the CopeMed Sharepoint with restricted access to the members of the group.

Recommendations for data collection (GFCM-DCRF)

- The appropriateness of the model used in this workshop and previous attempts to run analytical models (CopeMed 2003, STECF 2013) concluded that, due to the fast growth of the species, time steps in the iterations must be months

instead of years and therefore, if the species is going to be assessed, data on catches and effort should be reported at monthly level.

- Standardization of effort measure is needed. The number of visited FADs by boat, fished and non-fished is the ideal measure, but as the minimum, number of fishing trips should be made available for future assessments.

Participants agreed to transmit the outcomes of this assessment exercise together with conclusions and recommendations to the next meeting of the Working Groups on Stock Assessment of the GFCM next November 2016 in Rome. Possible comments from these groups will be considered by the respective Coordination Committees of the CopeMed II and MedSudMed Projects for additional actions if relevant.

Appendix I

CopeMed II-MedSudMed Workshop on stock assessment of *Coryphaena hippurus* in the Western-Central Mediterranean

Málaga, Spain, 13-15 September 2016

Agenda

Tuesday 13 September

1. **Opening, background and objectives of the meeting.**
2. **Overview of *C. hippurus* fisheries and data availability by country**
3. **The Inter-American Tropical Tuna Commission (IATTC) experience with el dorado assessment and management in the Eastern Pacific Ocean (EPO)**(IATTC invited expert)
4. **Current methodologies to assess *C. hippurus* in the Pacific. Hands-on session of the EPO data and spreadsheets.** (IATTC invited expert)

Wednesday 14 September

5. **Hands-on session with data from all countries.**
6. **Exploratory assessment exercise: execution of national and joint assessments of *C. hippurus***
7. **Discussion of results**

Thursday 15 September

8. **Any other matters:**
    a. Information on fisheries of *Seriola dumerili* (availability and relevance by country)
    b. Publication of a scientific paper
9. **Revision and update of the work-plan** (March 2016)
10. **Conclusions and Recommendations**

Appendix II

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Appendix III

BIBLIOGRAPHIC REFERENCES ON *Seriola dumerilii*

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Appendix IV

Table of contents and proposed authors for a scientific paper

Title: Dolphinfish (*Coryphaenahippurus*) biology and fisheries in the Mediterranean Sea.

Introduction

P. Hernández*; L. Ceriola; M. Vasconcelhos; A. Aires da Silva

Ecology

***Distribution; Mediterranean Population*:** A. Aires da Silva; I. Catalan; D. Macías*; M. Arculeo; J. Camiñas

***Habitat*:** R. Besbés*; M. Sinopoli

Diet: M. Sinopoli*; A. Besbés

Biology

Growth and Mortality: I. Catalan*; M. Gatt

Sexual maturity and reproduction: A. Besbés*; S. Saber

Recruitment: F. Alemany*; S. Saber

Exploitation

Fishery patterns: D. Macías; J.C. Báez; F. Bertolino; A. Mariani; M; Gambin; R. Mifsud; J. Camiñas*; R. Besbés

Stock assessment: J. Ortiz de Urbina; M. Arculeo, A. DaSilva; A. Mariani, F. Bertolino; P.Hernández*

Overview on potential management measures: J. Camiñas ; M. Sinopoli; R. Besbes; I. Catalan; L. Ceriola; P. Hernández*; F. Andaloro

Discussion

Conclusions

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