REPORT OF THE JOINT GFCM-COPEMED II DATA PREPARATION MEETING ON HAKE AND WORKING GROUP ON STOCK ASSESSMENT OF DEMERSAL SPECIES IN GSAS 01, 03 AND 04

January 2021
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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, Pesca y Alimentación, MAPA), 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 overall objective of the project is to contribute to the sustainability of marine fisheries in the Central and Western Mediterranean by providing technical support towards the improvement of monitoring and management of fisheries at national level and by reinforcing scientific collaboration among countries at the sub-regional level. The activities of the project also support countries in the implementation of recommendations agreed at the regional level by 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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Preparation of this document

This document is the final version of the report on the Report of the Joint GFCM-CopeMed II data preparation meeting on hake and working group on stock assessment of demersal species in GSAs 01, 03, 04, 28-31 October 2019, Malaga, Spain.

All participants (See list in appendix II) have contributed equally to the elaboration of this report.
Acknowledgements

CopeMed II acknowledges the participation and valuable contributions of all experts from CNRDPA (Algeria), INRH (Morocco) and IEO (Spain) in the Joint GFCM-CopeMed II data preparation meeting on hake and working group on stock assessment of demersal species in GSAs 01, 03, and 04.


ABSTRACT

This data preparation meeting was a special session of the CopeMed II Working Group on stock assessment of demersal species organized in collaboration with the GFCM. The meeting had been requested by SAC in view of the benchmark of hake to take place on 2-7 December 2019. The meeting was attended by experts from Algeria (CNRDPA), Morocco (INRH) and Spain (IEO) and counted with the technical support of an external expert on hake. Participants analyzed the existing data on landings, CPUEs, length distribution, the characteristics of the respective fleets, as well as the available life-history parameters and trawl surveys data. The group concluded with a set of growth parameters common for GSAs 01 and 03 and another set of parameters for GSA 04. Differences in the length distribution of both landings and surveys in the three areas suggested differential functional units, although the difference in the length and completeness of data series in GSA 04 prevented further conclusions in this regard. Also, preliminary results from the project on stock boundaries (TRANSBORAN) do not provide evidences for the rejection of the single stock hypothesis. Therefore the group of experts agreed to keep the assessment of hake in GSA 01 and 03 combined and to assess the stock in GSA 04 separately, as done in previous years.
1. Opening and arrangements of the meeting

The meeting was kindly hosted by the ‘Subdelegación del Gobierno de Málaga’ where CopeMed II premises are located. It was attended by 10 participants from 3 countries (Algeria, Morocco and Spain). The agenda was adopted as presented in Appendix I. The list of participants is included as Appendix II.

Copemed II Fishery Expert, Ms Pilar Hernández introduced the scope, the background, the objectives and expected outputs of the current meeting, which aimed at advancing with the data preparation for the planned benchmark session on hake, 2-7 December 2019.

The main objective of the meeting was to provide an in depth analysis of existing data to facilitate decisions on the best way to perform the assessment of the stock, including: i) biological data; ii) Fishery-independent data and iii) Fishery-dependent data.

Previous to the meeting, CopeMed II had launched a data call and provided templates for metadata and raw data. The participants provided these tables completed at the meeting (Appendix III).

2. In-depth analysis of biological data available

Experts presented the existing biological parameters, those recovered from the bibliography as well as those recently obtained. They were all compiled in a table for comparisons and a decision was taken on the selection of parameters by GSA (Tables 1 and 2 and Figures 1 and 2).

<table>
<thead>
<tr>
<th>Method</th>
<th>GSA and Reference</th>
<th>Linf</th>
<th>k</th>
<th>t0</th>
<th>Length at age 0-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assess 2018 (1-3)</td>
<td>*GSA 01, García et al. (2002)</td>
<td>108</td>
<td>0.21</td>
<td>-0.115</td>
<td>22.5</td>
</tr>
<tr>
<td>Modal progression</td>
<td>*GSA 04, Filali &amp; Hamida (2014)</td>
<td>85.5</td>
<td>0.18</td>
<td>-0.71</td>
<td>22.6</td>
</tr>
<tr>
<td>Modal progression</td>
<td>GSA 04, CNRDP A (2015)</td>
<td>78.8</td>
<td>0.17</td>
<td>-0.77</td>
<td>20.5</td>
</tr>
<tr>
<td>Modal progression</td>
<td>GSA 04, CNRDP A (2019)</td>
<td>86.5</td>
<td>0.14</td>
<td>-0.91</td>
<td>20.3</td>
</tr>
<tr>
<td>Modal progression</td>
<td>*GSA 03, INRH (2019)</td>
<td>94.14</td>
<td>0.24</td>
<td>-0.51</td>
<td>28.6</td>
</tr>
<tr>
<td>Modal progression</td>
<td>GSA 01, DCF EU</td>
<td>110</td>
<td>0.176</td>
<td>-</td>
<td>17.7</td>
</tr>
<tr>
<td>Tagging</td>
<td>Mellon-Deval et al (2010)</td>
<td>110</td>
<td>0.178</td>
<td>-</td>
<td>17.9</td>
</tr>
</tbody>
</table>
Figure 1. Growth curves from the three set of parameters selected for each GSA (see Table 1).

Table 2: parameters a and b from the length-weight relationship.

<table>
<thead>
<tr>
<th>GSA and reference</th>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSA 04, Filali &amp; Hemida (2014)</td>
<td>0.0039</td>
<td>3.1387</td>
</tr>
<tr>
<td>GSA 03, INRH (2019)</td>
<td>0.006</td>
<td>3.032</td>
</tr>
<tr>
<td>GSA 01, DCF (2018)</td>
<td>0.005</td>
<td>3.119</td>
</tr>
<tr>
<td>Assessment 2018 DCF-EU ESP (2012)</td>
<td>0.00677</td>
<td>3.035097</td>
</tr>
</tbody>
</table>

Figure 2. Length-weight relationship for the different values of $a$ and $b$ obtained.

The length at maturity were also obtained for the three GSAs and are presented in figure 3 below.
3. In-depth analysis of Fishery-independent data (e.g. trawl surveys)

The experts from the three countries presented the series of data of the trawl surveys. Algeria has 7 years of data (2012-2018) and follows strictly the MEDITS protocol. The period of the surveys is regularly late-spring and early-summer. Morocco carries out two surveys per year, one in spring and one in autumn. The depth range is between the coast and 800 m and the gear used until 2018 is slightly different from the one used in MEDITS (different size of the otter boards but same cod end mesh size of 20 mm stretched). Spain has a time series of survey data of 25 years and uses the protocol MEDITS with the same gear as Algeria: GOC 73 with a cod end of 20 mm. The depth range of the surveys are between 40-750 m.

A discussion was opened on the technical characteristics of the gear used and the period of the year concluding that in Spain and Algeria the surveys are identical, while in Morocco the differences in the net (slightly minor differences to be confirmed) and the fact that the surveys is performed in two different periods of the year make the data not fully compatible. However, the Moroccan experts confirmed that the data provided for the assessments in previous years were only those surveys performed in spring-summer and not those carried out in autumn-winter.

The Working Group requested the experts of the three countries to: i) confirm the mesh size of survey net as well as of commercial nets and, ii) provide information about the regulations concerning minimum commercial size for hake and mesh size to be included in the stock assessment form (SAF) that will be produced for the Benchmark assessment.

The available survey data is plotted in Figure 4. Note that the units are different in Spain and have been plotted in log scale. Opposite trends between data from Spain and Morocco are evident in some years. On the other hand the few years of data available from Algeria shows some consistency with Spain.
Figure 4: Survey indices for hake from the three GSAs in different years and different units.

Figures 5 to 10 shows the length frequency distributions from summer surveys in GSA 01 and GSA 03. According to this analysis, the surveys in GSA 01 capture smaller individuals than in GSA 3, indicating potential nursery areas in GSA 01.

Figure 5. Length structure of hake in the surveys: year 2013.

Figure 6. Length structure of hake in the surveys: year 2014
Figure 7. Length structure of hake in the surveys: year 2015

Figure 8. Length structure of hake in the surveys: year 2017.

Figure 9. Length structure of hake in the surveys: year 2018.
4. In-depth analysis of Fishery-dependent data

Participants presented the available data from commercial fisheries: landings (2003-2018). Morocco and Spain provided a time series of 16 years of CPUEs and length distribution (2003-2018) while Algeria presented 12 years (2005-2016). For the purpose of comparison and detection of trends, the three series are plotted in figures 11 and 12. Figure 13 compares the length distribution of hake in the last four years of available data. The data shows consistently smaller sizes in landings in Algeria.

Figure 10. Average length structure in the surveys (5 years in common) in GSA 01 (red) and GSA 03 (blue).

Figure 11. Landings of hake in GSA 01, 03 and 04.
To proceed with identification of possible similarities or differences in the observed length frequency distributions (LFD) in the three series of landings, we performed similarity analysis by means of ANOSIM (Primer software). Four years of LFD in landings were available from Algeria, 12 for Morocco and 16 for Spain.

The ANOSIM test has showed two clusters: one cluster grouping the LFD of Morocco and Spain with the common years very close, and a second group reassembling Algerian LFDs together with LFDs of years 2003, 2004 and 2006 of Spain (figure 14). Those early years are characterized by the smallest sizes in the Spanish series as shown in figure 15. However the establishment of minimum landing size at 20 cm in both countries in different years (2006 in Spain and 2014 in Morocco) may hamper the correct interpretation of these differences.
5. **Advances on the identification of stock units (TransBoran Project)**

Following SAC and countries recommendations, the CopeMed II Project, in collaboration with eight institutions from five different countries (Algeria, Italy, Morocco Spain and Tunisia) has launched a medium-term research program called TRANSBORAN (Revealing transboundary stock structure of sardine, blackspot seabream and hake in the Alborán Sea and adjacent waters). The objective is to identify stocks boundaries of three commercial species (sardine, hake and blackspot seabream) and their spatial distribution in the Alborán sea (GSAs 1, 2, 3, 4 and adjacent waters). The program started in 2018. It
employs a series of eight different techniques on a multidisciplinary approach i.e.: hydrodynamics modelling, genetics techniques, parasites, life history traits, and elemental composition, morphometry and fishery patterns. The main aim of TRANSBORAN program is to identify potential population units and evaluate the adequacy of the actual geographical statistical units (GSAs) in the Alboran Sea as stock units for assessment and management advice. The progress achieved until October 2019 regarding hake were introduced by the CopeMed fishery expert.

The collection of samples had concluded successfully with enough biologic material to address the objectives of the project. A total of 611 individuals were sampled in 15 out the 17 ports originally proposed; samples were not obtained in Al Hoceïma (Morocco) and Cherchell (Algeria) due to the lack of availability of hake in these localities (Figure 16).

![Figure 16: Number of hake sampled in 15 out of 17 sampling ports.](image)

The summary of the works undertaken for hake by the different techniques are described below:

5.1. Outcomes of the analysis of parasites as natural markers (S. Mattucci, ML. Palomba, C. Abattista from University La Sapienza, M. Feki INSTM)

The genus *Anisakis* includes species of heteroxenous parasites of marine organisms, with crustaceans as first intermediate hosts, fishes and squids as intermediate and/or paratenic hosts, and, finally, cetaceans as definitive ones. The larval stages of *Anisakis* spp. commonly infect the viscera and musculature of many teleost species, also of commercial-economic importance. Their third larval stage, recovered from fish hosts and invertebrates, exhibit morphotypes indicated as *Anisakis* Type I or Type II but they cannot
be identified at the species level based on conventional morphological analysis. Among the genetic methodologies used for the species identification of Anisakis larvae, nuclear (allozymes, DNA microsatellite loci, EF1 α−1 gene locus) and mitochondrial (mtDNA cox2) markers represent the most valuable tools for distinguishing Anisakis species.

During the first year of the TRANSBORAN Project, a total of 283 Anisakis spp. larvae were identified by a multi-markers genotyping approach collected in European hake from the selected localities of the project. These results allowed to: i) provide data on differential distribution of distinct species of Anisakis in hakes caught in different fishing grounds; ii) provide data on the infection levels with Anisakis spp. in different sub-populations of hakes; iii) use the differential distribution of Anisakis spp. genetically identified, and infection levels, as biological tags of hake sub-populations in Alboran Sea and adjacent waters; and iv) infer phylo-geographical analysis of sub-populations of a target parasite species, i.e. Anisakis pegreffii.

In particular, five species of Anisakis were genetically identified: A. pegreffii, A. simplex (s. s.), A. physeteris, A. ziphidarum and A. nascettii. Among those, A. pegreffii and A. simplex (s. s.) were the dominant species in all the fish samples; whereas, A. physeteris, A. ziphidarum and A. nascettii were identified at lower percentage. A. pegreffii and A. simplex (s. s.) showed statistically significant differences in their relative proportions from hakes sampled along the Spanish Atlantic coast, with respect those from those of the Atlantic and Mediterranean coast of Morocco. In the latter sampling locality (Mediterranean Morocco), also a higher percentage of A. physeteris was identified. The species A. ziphidarum and A. nascettii were identified only in hakes sampled along the Atlantic Moroccan coast. No high statistical significance was found between the relative proportions of A. pegreffii and A. simplex (s. s.) infecting hakes sampled from the Mediterranean coast of Spain (i.e. Estepona and Torrevieja) versus those observed in fish sampled along the Spanish Atlantic coast (i.e. Huelva and Cádiz). Further, in these last localities, which is included in the Atlantic contact zone between the two species, few hybrids (likely F1) between A. pegreffii and A. simplex (s. s.), were genetically detected. The similar relative proportion of A. pegreffii and A. simplex (s. s.) was observed in hake samples from Spanish Atlantic coast (i.e Huelva and Cádiz) with respect to that from Mediterranean waters (i.e. Estepona and Torrevieja). The results indicate that those populations of hake are more similar to each other, in terms of their parasites composition, rather than to other fish sub-populations captured in other Atlantic and Mediterranean sea waters. Cartographic display of these preliminary results are showed in figure 17. Also, the occurrence of F1 hybrid individuals in fish samples from Spanish Atlantic and Mediterranean Sea waters seems to further suggest that those hakes would belong to the same Atlantic population. The rare occurrence of few larvae of A. simplex (s. s.) up to the Tunisia coast may result from the occurrence of first intermediate hosts - on which the hakes preyed upon in that area - likely infected by larval stage of the parasite species, perhaps deriving from the oceanographic front of Alboran. Finally, results suggest that a southern population of hake along the Atlantic coast of Morocco would exist, just according to the species of Anisakis identified from the area of Medhia, also due to the absence of A. simplex (s. s.) detected in both Mehdia and Agadir samples of hake.

In addition, preliminary data on the population structure of the parasites species A. pegreffii, inferred from mtDNA cox2 sequences, were also obtained. Genetic diversity data so far acquired seem to indicate that although A. pegreffii is existing as a large panmictic unit, a slight genetic differentiation was found among the meta-population subunits attending to the hakes collected from different fishing grounds. These data on
the genetic structure of a parasite species could be used in future comparative host-parasite co-phylogeographical analysis.

Figure 17: Geographical distribution of proportion of *Anisakis spp.* in hakes sampled in different localities

5.2. **Outcomes of the analysis of fishery data series in Morocco and Spain**

This work has been conducted by Hanane El Yaagoubi as a part of her Master Thesis project defended in past September in the Alicante University and supervised by Manuel Hidalgo and Pilar Hernandez.

Three types of fisheries-dependent and fishery-independent data were used to investigate potential similar or dissimilar variation on information gathered from north and south Alboran (Mediterranean Spanish and Moroccan waters) for the European hake: i) the spatiotemporal variation of fishery patterns using monthly CPUE per port, ii) demographic and spatial distribution indices from scientific bottom trawl surveys (MEDITS) and iii) length distribution of the Mediterranean Spanish and Moroccan waters.

Three different techniques were used for each type of data: i) Dynamic Factor Analyses (DFA) were used to analyze potential synchronic variation as well as to describe the main common modes of seasonal and inter-annual variation on CPUE series; ii) centers of gravity of standardized density obtained from the scientific bottom trawl surveys to assess temporal variation of hake distributions, iii) size distribution tests to analyze temporal and spatial variation of monthly size frequencies of landings per port and reveal potential spatial segregation in the mean size and in the seasonal evolution of the demography (the later only available for GSA 01).

A general differentiation was observed associated to local dynamics at the north and south Alboran, with a secondary segregation between eastern and western ports over the Alboran Sea. While the north-south pattern is consistent with preliminary results obtained by other techniques (i.e. hake parasites results above described), the east-west differences are likely associated to the connection of north and south populations subunits during the dispersive phase that results in the recruitment scenario observed.
The results also showed:

i) Certain asynchronous, but connected, behavior in the spatial distribution of hake recruits at nursery areas between north and south Alboran Sea. In short, results of spatial metrics showed marked density-dependent and inter-annual fluctuations in hake distributions, which were asynchronously related between GSAs (Morocco and Spain), suggesting potential but intermittent linkages between GSAs driven by early life stages connectivity as the most plausible mechanism. That is, years with lower connectivity of larvae from north to south resulted in higher than average recruits abundance in the north (Spain) with a consequent competition for space and resources that triggered a change in the mean distribution of hake recruits. By contrast, in years with higher connectivity, there was higher than average recruitment in the south (Morocco) with space and food competition reflected in deeper distributions in the south.

ii) Different size distributions where observed in the series of landings between the two GSAs with more temporal stability in Spain than in Morocco and a different temporal dynamics in the increasing pattern of the mean size. However, the establishment of minimum landing size (at 20 cm) in both countries in different years, 2006 in Spain and 2014 in Morocco, may hamper the correct interpretation of these results.

iii) First set of analyses have been completed revealing primary north-south differences in the CPUE, and a secondary pattern east-west. Information obtained from the scientific bottom trawl surveys are consistent with a potential connectivity processes between north and south Alboran shaping the recruitment.

The preliminary analysis of the two techniques reported here, suggest potential differentiation of two subpopulations of hake associated to North and South Alboran sea, with certain connectivity at the early life stages. However, in absence of results from other relevant techniques, *i.e.* genetics, hydrodynamic modeling, microchemistry of ootholiths, among others, that are still in progress, the group agreed to continue assessing hake stock as a single stock in GSA 01 and 03. Given that the data series in GSA 04 is quite different from the other two, hake will be assessed separately in GSA 04 by different methods.

6. Collation of data

The data files necessary for the assessment of the stock in the format requested by GFCM were collated and put together by the participants. The files were stored at the CopeMed sharepoint and made available to all the group.

7. Updated assessments of 2019

According to the existing data and the dicussions held during the week, the group proposed to make all the necessary arrangements before the Benchmark session to carry out the following assessments with the models indicated below:

- *Merluccius merluccius* in GSAs 1&3: Extended Survivor Analysis (XSA)
- *Merluccius merluccius* in GSAs 4: Virtual Population Analysis (VIT)
- *Parapenaeus longirostris* in GSA 1-3-4: Virtual Population Analysis (VIT)

The following work plan was agreed by the group to finalise the report and to do the necessary arrangements to be ready for the Benchmark Assessment of hake to be held next 2-7 December and to the WGSAD on 9-14 December 2019 in Rome.
1. Test some models runs
   - HKE:
     - (GSA 1-3): XSA (2010-2018)
   - DPS:
     - (GSA 1, 3, 4): VIT (2015-2018)

2. Prepare input data and draft SAFs for the Working Group on Stock assessment
Appendix I

Joint GFCM-CopeMed II Data Preparation meeting on hake and Working Group on stock assessment of demersal species in GSAs 01, 03, 04

Agenda

Monday 28 October (9:00-18:00)

1. Opening and arrangements of the meeting
2. In-depth analysis of biological data available
   - Growth parameters,
   - Maturity,
   - Spawning and recruitment periods and areas,
   - Natural mortality estimates and methods for the estimation of vectors by age (e.g. Prodbiom, Gislason, Chen & Watanabe, Pauly etc.)
   - Length-weight relationships,
   - Age information
3. In-depth analysis of Fishery-independent data (e.g. trawl surveys).
   - Years, Gears, Seasonality and depth strata (comparison of the three countries’ surveys)
   - length frequency distributions

Tuesday 29 October (9:00-18:00)

4. In-depth analysis of Fishery-dependent data
   - Landings,
   - Effort
   - CPUEs
   - Description of the fleets: segmentation, power and gears.
   - Comparisons of length-frequency distributions from commercial data and identification of possible fishery patterns.
5. Advances on the identification of stock units (TransBoran Project) (CopeMed staff)
   - Outcomes of the analysis of fishery data series in Morocco and Spain
   - Outcomes of the analysis of parasites

Discussion on the appropriateness of combining or separating the assessments

Wednesday 30th October (9:00-18:00)

6. Collation of data
   The agreed assumptions will be detailed and data collated in preparation for the benchmark.
7. Updated assessments of 2019
   Model runs with different model settings and analysis of their performances:
   - Merluccius merluccius in GSAs 1; 3; 1&3; 4 (or as agreed)
   - Parapenaeus longirostris in GSAs 1; 3; 1, 3&4 (or as agreed)

Preparation of the SAFs to be presented at the GFCM WGSAD

Tuesday 31st October (9:00-18:00)
8. **Wrap up of the information to be submitted to GFCM from the three meetings** (Plenary session blackspot seabream, hake and demersal working groups):

8.1. Working Group on stock assessment of P. bogaraveo in the Strait of Gibraltar

8.2. Data Preparation meeting on hake.

8.3. Working Group on stock assessment of demersal species in GSAs 01, 03, 04
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