Stock Annex: Red Sea bream in Subarea IX

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Red sea bream in ICES Subarea IX; **sbr-ix_SA**
Working Group	WGDEEP
Date	March 2015
Revised by	WGDEEP / Juan Gil Herrera

A. General

A.1. Stock definition:

Stock limits are generally determined not only by biological considerations but also by agreed boundaries and coordinates. ICES considered three different components for this species: a) Areas VI, VII, and VIII; b) Area IX, and c) Area X (Azores region). This separation does not pre-suppose that there are three different stocks of red sea bream, but it offers a better way of recording the available information" (ICES, 2007). The inter-relationships of the red sea bream from Areas VI, VII, and VIII, and the northern part of Area IXa, and their migratory movements within these areas have been observed by tagging methods (Gueguen, 1974). However, there is no evidence of movement to the southern part of IXa where the main fishery currently occurs. Tagging has been done also in the Strait of Gibraltar area, where the majority of the fishery currently occurs. No significant movements are reported, although local migrations are also observed: feeding grounds are distributed along the entire Strait of Gibraltar and the species seems to remain in this area as a resident population (Gil, 2006). In 2007, Piñera *et al*. suggests no significant genetic differences are present along Spanish coasts (Mediterranean and Atlantic areas).

Besides, in the case of the Strait of Gibraltar red sea bream also inhabit in Morocco waters. In fact recaptures of tagged fish were also notified by Moroccan fishermen.

A.2. Fishery

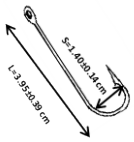
Although *Pagellus bogaraveo* is caught by Spanish and Portuguese fleets in Subarea IX, only a more complete description of one of the fisheries has been provided to the Working Group, the corresponding to the Spanish fishery in the southern part of Subarea IX, close to the Strait of Gibraltar.

The majority of landings on deep-water species at mainland Portugal are conducted by the artisanal fleet, mainly longline fisheries. These operated in the Portuguese continental slope and located in ports as Peniche, Sesimbra and Sagres. Red sea bream landings

reflect a seasonal activity probably related with a larger availability of the species or market demands that lead fishermen to spend some time targeting this species (I. Figueiredo, *pers. com*.).

In relation to the Spanish fishery in the southern ICES Subarea IXa, an updated description of it has been presented to the Working Group by Gil *et al*. (WD to the 2014 WGDEEP), that complete the information offered in the previous WGs (Gil *et al*., 20002003, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012 and 2013; Gil and Sobrino, 2001, 2002 and 2004). This artisanal longline fishery targeted red sea bream has been developed along the Strait of Gibraltar area. In recent years this fishery covers more than the 70% of the landings for the species in the Subarea IX. The base and landing ports are two: Algeciras and mainly Tarifa (Cádiz, SW Spain). The "*voracera*", a particular mechanised hook and line baited with sardine, is the gear used by the fleet (Table 1). The mean technical characteristics of this fleet by port are 8.95 and 6.52 meters length and 5.84 and 4.0 tons G.T.R. for Tarifa and Algeciras, respectively (Gil *et al*., 2000). Currently around 60 boats are involved in the fishery. Fishing grounds are located at both sides of the Strait of Gibraltar and quite close to the main ports (Figure 1). Fishing is carried out taking advantage of the turnover of the tides in depths from 200 to 400 fathoms. Landings are distributed in categories due to the wide range of sizes and to market reasons (these categories have varied in time but from 2000 onwards still the same).

Table 1. Red sea bream Spanish fishery of the Strait of Gibraltar: Fleet and gear summary descriptive.

Fleet ID	Gear type	N° boats	Number of lines	Hook type and size	Mean soaktime	Effort (days at sea)
LHM_DEF	Vertical mechanized handline ("voracera")	±60	Maximum of 30 lines per day (each line attached a maximum of 100 hooks, usually ±70)	L=3.95±0.39 cm  S=1.40±0.14 cm	±30 min	Maximum 140 days

From 2002 onwards artisanal boats from other port, Conil, have begun to direct its fishing activity to *P. bogaraveo* in different fishing grounds and with different fishing gear (longlines) than the "*voracera*" fleet boats. Nowadays, only around six boats are developing this fishery.

In addition, Moroccan longliners have been fishing in the Strait of Gibraltar area since 2001. Around 102 boats are mainly based in Tangier and their average technical characteristics are: 20 GRT, 160 CV and about ten years old. Moreover, 435 artisanal boats (±15 CV, ≤2 GRT and 4–6 m length) also target this species in the Strait of Gibraltar area (S. Benchoucha, *pers.com*.). The WG considers the account of Moroccan data appropriate as the fishery operates in the same area as the Spanish fishery and obviously targets the same stock. Unfortunately, no updated information was available in 2015 and no new information from the Moroccan fishery has been received in the last three years.

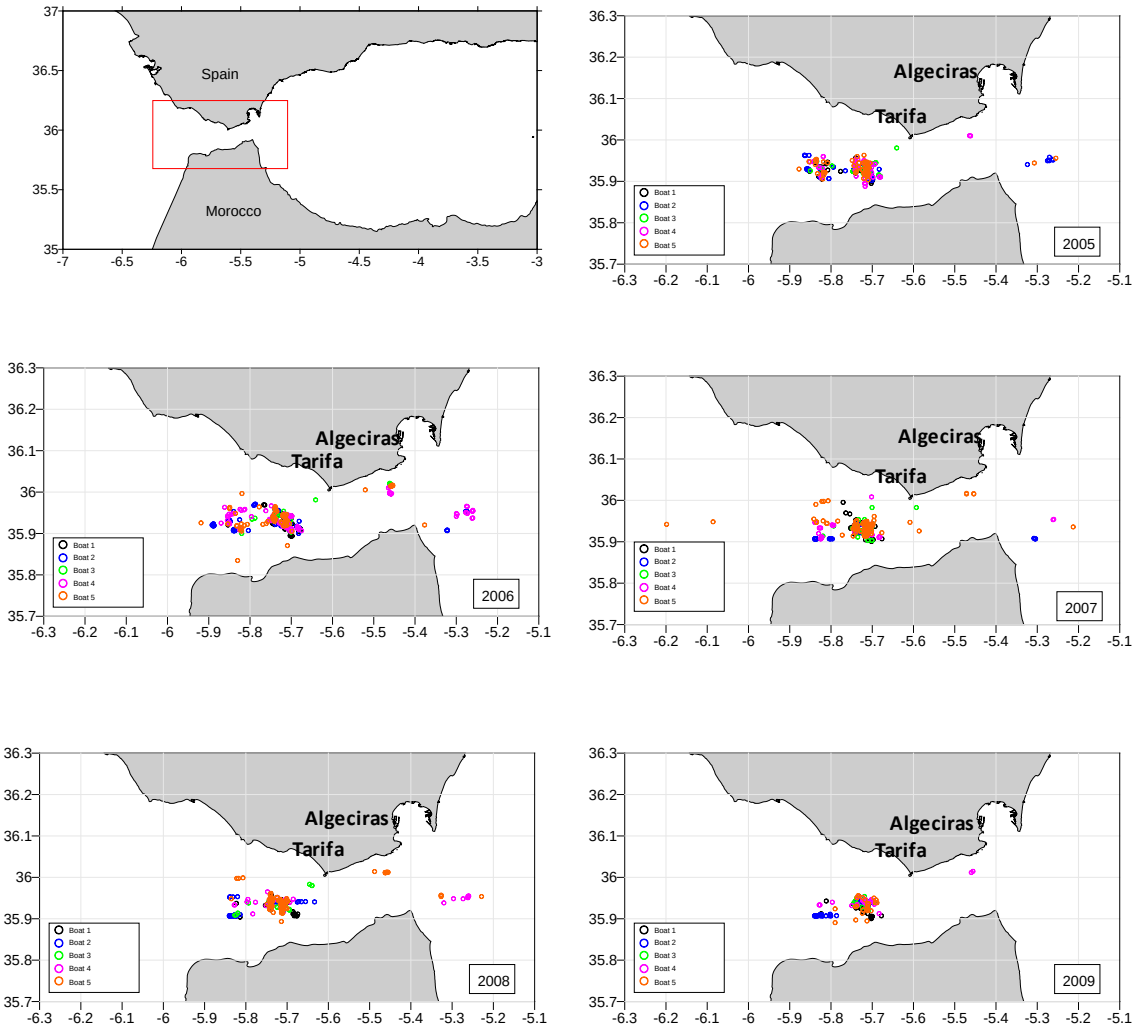


Figure 1. Red sea bream Spanish fishery of the Strait of Gibraltar: Yearly soaking positions footprints from observers on-board programme (from Gil *et al.*, WD 19 to the 2011 ICES WGDEEP).

A.3. Ecosystem aspects

Red sea bream is a bentho-pelagic species that inhabits various types of bottom (rock, sand, and mud) down to a depth of 900 m. It is found in the Northeast Atlantic, from South of Norway to Cape Blanc, in the Mediterranean Sea, and in the Azores, Madeira and Canary Archipelagos (Desbrosses, 1938; Pinho and Menezes, 2005). Hareide (2002) reported also occasional occurrence of this species along the Mid-Atlantic Ridge (North and South of the Azores).

Feeding habit of this species has been little studied. Morato *et al*. (2001) describes the diet of *Pagellus bogaraveo* and *Pagellus acarne* in the Azores and Olaso and Pereda (1986) describe the diet of 22 demersal fish in the Cantabrian Sea including *Pagellus bogaraveo*. In the Strait of Gibraltar fishery, feeding studies presents the difficult of the use of bait (sardine), which should be ignored to describe the feeding habit of the species. A total of 1106 red sea bream stomachs contents were analysed: 725 stomachs were empty and 381

were fullness. Vacuity index (VI) was 66%. The trophic spectrum is composed of 24 prey taxa, six orders, eleven families and 15 species and genera are represented. Despite the trophic spectrum diversity observed, the overall diet is not very diverse. Red sea bream in the Strait of Gibraltar has only a main prey, *Sergia robusta* (J. Gil, *pers.com*.).

Main red sea bream predators are unknown in the Strait of Gibraltar waters but maybe dolphins' (personal communication from Ceuta veterinary) and Bluefin tuna's (personal communication from fishermen) predation should be taken into account. Studies in Azores (Gomes *et al*., 1998) cite that *Conger conger, Raja clavata* and *Galeorhinus galeus* must be considered as potential predators (all three species are present in Strait of Gibraltar area). Besides, other considerations as the competition for food of Red sea bream with other big predators in the Strait of Gibraltar (i.e. Bluefin tuna, marine mammals, etc.) and those related with environmental parameters (variation and long-term atmospheric oscillations) might affect the stock status as well as its the fisheries.

Deep-sea coral ecosystems represent true biodiversity hot spots. OSPAR identified cold-water coral ecosystems as one of the most vulnerable ecosystems where action is required now to mitigate further loss of biodiversity. Figure 2 shows the Deep-water coral occurrences in the Strait of Gibraltar.

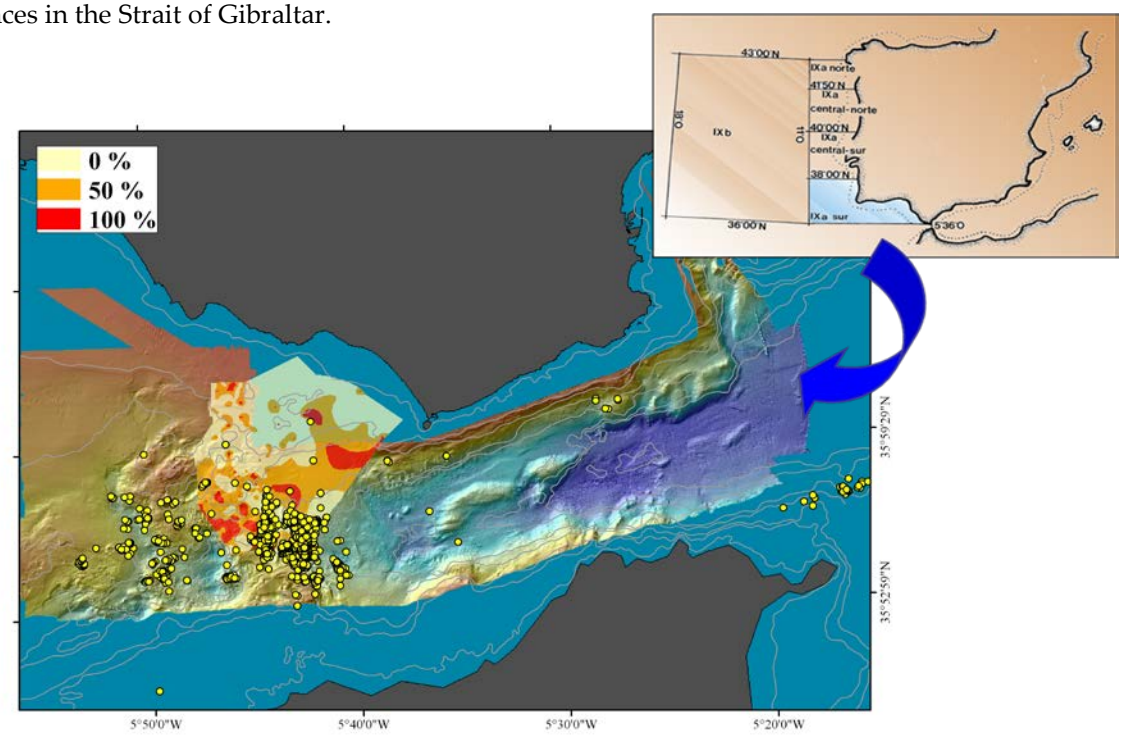


Figure 2. Coral distribution in the Strait of Gibraltar (adapted from Álvarez-Pérez *et al*. in Freiwald and Roberts, Eds. 2005). Yellow points correspond to "*voracera*" fleet fishing grounds from observers on board programme. Legend refers to percentage cover of coral.

B. Data

B.1. Commercial catch

In Subarea IX, catches, most of them taken by lines, correspond to Spain and Portugal. Spanish landings data from this area are available from 1983 and Portuguese from 1988 onwards. The maximum catch in this period was obtained in 1993–1994 and 1997 (about 1000 t). Catches in 2009 amount to 718 t, but decreases again (484 t) over the last years (180 t in 2013, the minimum of the available time-series). Moroccan information shows a continuous increasing trend in landings from 2001 to 2011.

Almost all Spanish catches in this area are taken in waters close to the Gibraltar Strait. Until 2002 they were restricted to two ports (Tarifa and Algeciras), but from 2002 significant catches were obtained also by artisanal Spanish boats of a third port (Conil) in different fishing grounds of the same area. An increasing trend in landings was observed but since 2008 it only rates an average of 15 t, lower than in the early years.

In the Portuguese landings no clear tendency is observed. The maximum values took place in 1988 (370 t) and in 1998 (357 t) and the minimum one in 2000 (83 t). In 2013 landings was 90 t.

Length frequencies of landings are only available for the Spanish red sea bream fishery in the Strait of Gibraltar. There was a decrease of the mean size from 1995 to 1998. It is necessary to point out that the red sea bream may have a variable length distribution depending on its geographic and bathymetric distribution, as suggests the different mean length of landings measured in ports (Tarifa and Algeciras). The mean length of the landings increased steadily in both ports from 1999 onwards then decreased but has been increasing again between 2006 and 2009. The mean length from both landing ports declined in 2010. However the median value is lower than the mean since 1995, and very close to the minimum landing size in Algeciras.

A Kolmogorov-Smirnoff test reflects significant differences ($p<0.05$) between the length distributions from Spain and Morocco (Belcaid *et al.*, WD 20 to the 2011 ICES WGDEEP) and also within Spain (Gil *et al.*, WD 19 to the 2011 ICES WGDEEP). Differences among the sampling protocols may be the explanation to the observed difference. In Moroccan and Spanish observers' programme the sampling covers certain the boats (random sampling) while in the Spanish first sale fish market the sampling covers the four market categories (stratified sampling). So raising the random sampling weight to the total landings did not take into account the difference due to the variability of the length composition related to bathymetric distribution of the species and the stratified sampling seems to be more appropriate.

B.2. Biological

Red sea bream is a protandric hermaphrodite species changing from males to females. Red sea bream have a low productivity and they change sex as they age, starting as males

and becoming females between ages 4 and 6. Measures to ensure balanced exploitation between younger fish (males) and older fish (females) are essential.

An annual reproductive cycle has been described for the species in this area (Gil, 2006). The spawning season seems to take place during the first quarter of the year. The smallest specimens are mainly males, maturing at a L_{50}=30.15 cm. At about 32.5 cm in total length, an important percentage of individuals change sex and became females, maturing at L_{50}=35.73 cm. Thus, from age 5 all individuals can be considered mature, whether they are males or females.

Red sea bream is considered a slow growing species. A combined ALK was obtained by three agreed readings from 1497 otoliths collected from 2003 to 2008 (Gil *et al*., 2009). It comprises lengths from 24 to 54 cm and ages between 3 and 10, but it has not been validated yet. According to the available information the maximum age recorded in Subarea IX is ten years. However, the ages of older fish may be underestimated and it is possible that this species may be slower growing and longer-lived than current studies indicate. In fact, there was one recapture from tagging surveys notified more than ten years after its release (J. Gil, *pers. com*.). Table 2 presents different estimates of von Bertalanffy Growth Function (VBGF) parameters available from otoliths readings or tag–recapture data.

Table 2. Red sea bream of the Strait of Gibraltar: VBGF parameter estimates.

Authors	Study Area	Methodology	t_0	k	L_∞
Sobrino and Gil, 2001	Strait of Gibraltar	Otholits reading	-0.67	0.169	58.00*
Gil *et al*., 2008	Strait of Gibraltar	Otholits reading	-1.23	0.169	62.00*
Gil *et al*., 2009	Strait of Gibraltar	Otholits reading	-0.34	0.162	62.00*
Gil *et al*., 2008	Strait of Gibraltar	Recaptures (1)		0.079	62.00*
Gil *et al*., 2008	Strait of Gibraltar	Recaptures (2)		0.098	62.00*
Gil *et al*., 2008	Strait of Gibraltar	Recaptures (3)		0.161	62.00*
Gil *et al*., 2008	Strait of Gibraltar	Recaptures (4)		0.080	62.00*

(1)Gulland y Holt, 1959 (2)Munro, 1982 (3)Fabens, 1965 (4)Appeldoorn, 1987.

*** Fixed (from the largest observed sample).**

Padillo *et al*. (WD17 to the 2011 WGDEEP) present new information based on Discriminant Analysis of several of the samples used to make the ALK, combining morphometric and morphological variables to re-estimate red sea bream ages. The reclassification success percentage was 85.3%, well above from the 70% adopted by other authors (Palmer *et al*., 2004 and Galley *et al*., 2006). Changes in otolith shape could be related to the growth rate and be also strongly influenced by environmental components. Therefore, future work should include the analysis of such factors throughout years and cohorts.

The natural mortality of *Pagellus bogaraveo* is uncertain because there are no data available to estimate M directly. A mortality rate of 0.2 $year^{-1}$ has been adopted by several authors in several studies from other areas (Silva, 1987; Silva *et al*., 1994; Krug, 1994, Pinho *et al*., 1999, Pinho, 2003) and also by Gil (2006) for the Strait of Gibraltar.

Age and growth based on otolith readings were revised along the ICES WKAMDEEP meeting (October, 2013): No more than ten years of age was estimated from otolith readings in the Strait of Gibraltar area but two recaptures from the tag–recapture programme have remained at sea for more than ten years (J. Gil, *pers. com*.). Moreover, growth estimates from tag–recapture experiments suggest that otolith readings may underestimate age and that some hyaline rings are uncounted and/or missing. The use of biased age estimates may have important consequences.

B.3. Surveys

Only tagging surveys were carried out in the Strait of Gibraltar area. Several tagging surveys (56 days at sea in 2001, 2002, 2004, 2006 and 2008) have been conducted in the Strait of Gibraltar area. 4500 fish were tagged and 404 recaptures have been reported. No significant movements have been observed, although local migrations were noted: feeding grounds are distributed along the entire Strait of Gibraltar and the species seems to remain within this area as a resident population (Gil, 2006). Recaptures of tagged fish have also been reported by the Moroccan fishery.

B.4. Commercial cpue

It should be noted that the effort unit from the historical series, number of sales, may be inappropriate, as it fails to consider the missing effort from boats that have not caught enough fish to go to the market. Thus, in the years this missing effort has increased substantially (fishing vessels with no catches and no sale sheet to be recorded) and its lpue values may be overestimated.

Gil *et al*. (WD 19 to the 2011 WGDEEP) presents a short series of cpue (2005–2009) from the observers' on-board programme in the red sea bream fishery of the Strait of Gibraltar. Sampling level was five boats and three trips per month. Number and length measurements of caught species were recorded. Values vary around three red sea bream per ±70 hooks but the general trend seems to be slightly decreasing throughout the years.

Burgos *et al*. (2013) demonstrated that a VMS system in operation since 2009 provided a reliable estimate of actual fishing effort and derived a cpue time-series. This cpue series is now used as a biomass index of the stock (see Section C below).

VMS information cannot be updated within the 2015 WGDEEP but the lpue from sales sheets (as a proxy of fishing trip) reverted to increase (Figure 3).

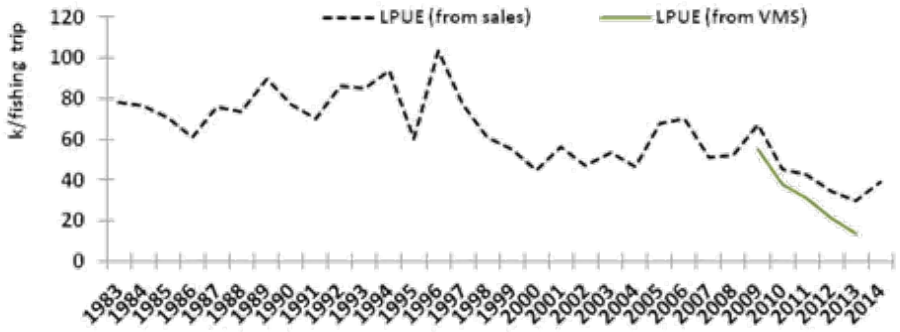


Figure 3. Spanish *"voracera"* Red (blackspot) sea bream fishery of the Strait of Gibraltar (ICES Subarea IX): Estimated lpue using sales sheets (dashed line) and VMS data as unit of effort (continued line) (adapted from Gil et *al.*, WD to the 2015 WGDEEP).

B.5. Other relevant data

None.

C. Assessment: data and method

Model used: No model was adopted for the assessment yet. Till the moment the assessments attempts were no accepted and only several trends (landings and length distributions) were used for the scientific advice.

So according to the available information, DLS method 3.2 was selected to estimate C_{y+1} as a reduction of C_{y-1}, applying the 20% Uncertainty Cap and the 20% Precautionary Buffer because the steep declining the catch and in the biomass index occurred over the last years.

Software used: None

Model Options chosen: None

Input data types and characteristics:

D. Short-term projection

Model used: None

Software used: None

Initial stock size:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock–recruitment model used:

Procedures used for splitting projected catches:

E. Medium-term projections

Model used: None

Software used: None

Initial stock size:

Natural mortality:

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Intermediate year assumptions:

Stock–recruitment model used:

Uncertainty models used:

1) Initial stock size:
2) Natural mortality:
3) Maturity:
4) F and M before spawning:
5) Weight-at-age in the stock:
6) Weight-at-age in the catch:
7) Exploitation pattern:
8) Intermediate year assumptions:

9) Stock–recruitment model used:

F. Long-term projections

Model used: None

Software used: None

Maturity:

F and M before spawning:

Weight-at-age in the stock:

Weight-at-age in the catch:

Exploitation pattern:

Procedures used for splitting projected catches:

G. Biological reference points

	Type	Value	Technical basis
MSY	MSY $B_{trigger}$	N/A	
Approach	F_{MSY}	$F_{0.1}$	YpR Analysis
	B_{lim}	N/At	
Precautionary	B_{pa}	N/A	
Approach	F_{lim}	N/A	
	F_{pa}	N/A	

No biological reference points have been defined.

H. Other issues

H.1. Historical overview of previous assessment methods

Historical series of landings data available to the Working Group have been exploratory assessed by the WGDEEP since 2006. No discard data were available to the Working Group, but for this species this could be considered minor. The landings data used in the assessment exercise of red sea bream in IX included Spanish and Portuguese landings from 1990 onwards.

New assessment exercises were presented to the Group in 2011. An Extended Survivors' Analysis (XSA) attempt with the Strait of Gibraltar Spanish red sea bream fishery data is described by González and Gil (WD 18 to the 2011 WGDEEP). Belcaid *et al*. (WD 20 to the 2011 WGDEEP) presents the results obtained by a Yield-per-recruit analysis from 2005–2007 Spanish and Moroccan landings length distribution available information from the Strait of Gibraltar area.

In 2012, new assessment attempts for the Strait of Gibraltar fishery were presented to the Group by González *et al*. (WD to the 2012 WGDEEP). Simple assessment methods that use historical catches and available trend or size-composition information could potentially be applied to many data-poor stocks. The exercise, which includes two different approaches, appears to be enough indicative because this quite small area comprises more than the 80% from the total of the species in the ICES IX Subarea:

- Depletion-Corrected Average Catch (DCAC) input parameters were: Sum of Catch along 29 years=12 723, Natural Mortality=0.2 (standard deviation of 0.5 and Lognormal distribution), FMSY to M=0.8 (standard deviation of 0.2 and Lognormal distribution), Depletion Delta=0.47 (standard deviation of 0.3 and Lognormal distribution) and B_{MSY}/B_0=0.4 (standard deviation of 0.1 and Beta distribution). The number of iterations chosen was 10 000.
- Besides, from 2009–2011 available information (Spanish and Moroccan landings and length distributions) Length Cohort (LCA) and Yield-per-recruit (YpR) analysis were carried out. A plus group of 50 cm was established because the anomalous F values in larger length classes. After exploratory analysis using different F terminal random seed values (0.3–0.5–0.8) 0.5 was adopted as F terminal in the final run.

Another join assessment between Spain and Morocco took place in Tangier in November 2014: info update till 2013 and three assessment exercises (LCA, Production model and MSY Catch) using SP+MOR data were attempted. Report of the "3rd Meeting of the CopeMed II Working Group between Spain and Morocco on Blackspot sea bream (*Pagellus bogaraveo*) of the Strait of Gibraltar area" will be available soon.

Besides, along the 2012 WGDEEP meeting several exercises were attempted:

- The Catch-MSY method (Martell and Froese) propose a new method for estimating maximum sustainable yield (MSY) from a time-series of catch data, resilience of the species, and estimations about depletion, i.e. relative stock abundances at the beginning and the end of the time-series by means of the Catch-MSY method. With the guidance and help from R. Froese a Catch MSY with the total landings in Subarea IX was carried out.
- Two new functions within FLR (FLAdvice package) allow us the simulation of a fish stock based on its life-history parameters. From a species complete set of parameters: ages 1 to 17, VBGF growth model (Linf= 62 and k=0.169) and the length–weight relationship (a= 0.014 and b=3.014) the functions derive in a set of biological reference points, including $F_{0.1}$ and $F_{30\%SPR}$.
- Another approach was considered along the WG to estimate BRPs using the Beverton and Holt function developed in R by Azevedo and Cadima (BHAC). As same as the previous, a set of life-history parameters and derives in an F vector (which includes F_{MAX}, $F_{0.1}$ and $F_{30\%SPR}$ for example).

And also several Biological Reference Points estimates from different approaches were available. Table below summarizes the methods adopted and its estimates:

Method/Estimate	F_{MAX}	$F_{0.1}$	$F_{30\%SPR}$	$F_{40\%SPR}$	F_{SQ}
Gislason spreadsheet (WKLIFE) with AFC=3	0.61	0.26	0.36	0.24	-
Gislason spreadsheet (WKLIFE) with AFC=4	0.77	0.29	0.62	0.37	-
BHAC (WKLIFE)	0.39	0.17	0.20	0.14	-
FLAdvice (WKLIFE)		0.16	0.16		-
YpR Analysis (from LCA outputs)[1]	0.30	0.11		0.12	0.19

[1]**Landings from the Strait of Gibraltar only.**

WKLIFE Gislason spreadsheet was applied using an L_{MAX} of 62 cm and AFC = 3 and 4. The parameters estimated by the mode were unrealistic based on what is known about this stock and the F_{MAX} value was substantially higher than that estimated by YPR. This may be because the underpinning empirical relationships may not apply to a protandric hermaphrodite species.

In the 2014 meeting no analytical assessment was attempted. Results from gadget exploratory analysis that was presented should be considered preliminary as the model needs a better parameterization. However it was decided the use of the cpue as a biomass index rather than the use of recent landings (like two years before). Thus, the quantitative advice was given according to the DLS 3.2 method instead of the 6.2 that appears in the ICES DLS Guidance Report 2012.

In summary, recent trends are fairly clear; despite Moroccan landings from the Strait of Gibraltar are not available in the years 2012 and 2013. It is however assumed that these landings follow a decreasing trend. Landings have declined significantly over the last four years and may be considered as a substantial reduction in exploitable biomass. Mean length distribution and lpue decreasing trends may also be consistent with overexploited population signals. However, in 2014 all signals (landings, lpue and length distribution) reverted to increase but without any evidence of its sustainability.