Stock Annex: Megrim (*Lepidorhombus whiffiagonis*) in divisions 8.c and 9.a (Cantabrian Sea and Atlantic Iberian waters)

Stock specific documentation of standard assessment procedures used by ICES.

Stock	Southern megrim (Division 8c, 9a)_meg.27.8c9a
Working Group:	Working Group for the Bay of Biscay and Iberian Waters Ecoregion (WGBIE)
Date:	13 May 2014
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A. General

A.1. Stock definition

The genus Lepidorhombus is represented in eastern Atlantic waters by two species, megrim (*L. whiffiagonis*) and four-spot megrim (*L. boscii*). Three stocks of megrims are assessed by ICES: megrim in ICES Subareas 4 and 6, megrim in Divisions 7b-k and 8a,b,d and megrim in Divisions 8c and 9a.

Megrim (*L. whiffiagonis*) is in both ICES Divisions (8c and 9a), with its highest abundance in Division 8c (Sánchez *et al*., 2002). There is a certain bathymetric segregation between the two species of megrim. *L. boscii* has a preferential depth range of 100 to 450 m and *L. whiffiagonis* of 50 to 300 m (Sanchez *et al*, 1998).

A.2. Fishery

Management of megrim is both by TAC and technical measures. The two species (*L. whiffiagonis* and *L. boscii*) are managed under a common TAC. They are caught and recorded together in the landings statistics. It is impossible to manage each species separately under a common TAC. The spatial distribution of the two stocks shows some differences that could be utilized for separate management of the two stocks.

The minimum mesh size for towed gears ranges between 55 and 70 mm, depending on catch species composition. Minimum landing size for the two species changed from 25 to 20 cm in year 2000 (Council Regulation EC 850/98).

Both megrim species are included in the landings from ICES Divisions 8c and 9a. The percentage of megrim (*L. whiffiagonis*) in landings of both species by weight was between 6% and 37% over the whole period for which data are available.

Both species of megrims are taken as by-catch in the mixed bottom trawl fisheries targeting "white fish" by Portuguese and Spanish fleets, and also in small quantities by the Portuguese artisanal fleet. The majority of the catches are taken by Spanish trawlers. No landings data are available for these stocks before 1986, although some Spanish harbours have longer landings series. Total international landings for both stocks of megrims increased sharply from 1986 to 1989, when they reached 3340 t, and then showed a continuous declining trend until their lowest level of 837 t in 2002. There has been some increase in landings since that year, being 1531 t in 2014, the maximum value of the last decade.

Since the early 1990´s the Spanish bottom trawl fleet has diversified its fishing strategy, introducing a new trawl gear which targets primarily pelagic species (as horse mackerel and mackerel) (Punzón *et al*, 2010; Castro *et al*, 2011). This gear affects catches of *L. boscii* more than those of *L. whiffiagonis*, probably due to differences between the distribution area of both species. Also, the fishing ban for all trawlers in grounds within 100 m depth (RD 1441/1999, 10 sept) may affect in the proportion of both species in catches due to their different bathymetric distribution.

The Prestige oil spill in the northwest Spanish coast (November 2002) prompted a redistribution of fishing effort, particularly in the Galician area. Some regulation measures, such as spatial and seasonal closures, were adopted in order to minimise the oil spill impact on fisheries. Some trawl fleets display lower effort in 2003 in relation to later years (Abad *et al*, 2010).

Horse mackerel, Atlantic mackerel, blue whiting, anglerfish, hake, megrim, different cephalopods and *Nephrops* account for a high percentage (around 90%) of all retained species in this multispecies trawl fishery (Castro *et al*, 2011). A great number of species are caught as by-catch.

Discards are important, particularly for younger ages of both megrim species. Around 10-65% of the individuals caught are discarded by trawlers (Pérez *et al*, 2011). Lack of commercial interest, variations in market price, fish size (MLS or market size), storage capacity as well as distance to home port are the main reasons for discarding. Artisanal fleets catch few megrims and discards of all species in these fleets are very low.

Megrims have been affected by the Recovery Plan for the Southern hake and Iberian *Nephrops* stocks (Council Regulation EC 2166/2005), since January of 2006, with the fishing effort limitation measurements in the Spanish and Portuguese mixed trawl fisheries.

A.3. Ecosystem aspects

The Iberian Region along the eastern Atlantic shelf (Divisions 8c and 9a) is an upwelling area with high productivity, especially along the Portuguese and Galician coasts; upwelling takes place during late spring and summer (Álvarez-Salgado *et al*., 2002; Serrano *et al*., 2008). The region is characterized by a large number of commercial and non-commercial fish species caught for human consumption.

Many flatfish species show a gradual offshore movement of juveniles as they grow. This might indicate that habitat quality for flatfish is size-dependent. Another common pattern is the annual micro- and macroscale movements and migrations between spawning, feeding and wintering areas (Gibson 1994). Also, most flatfishes are associated with finer sediments, rather than with hard substrata because burying themselves provides some protection from predators and reduces the use of energy (van der Veer *et al*., 1990, 2000; Beverton and Iles 1992; Bailey 1994; Wennhage and Pihl 2001).

Previous studies on megrim species show that they generally occurred outside zones with hydrographical instabilities that foster the vertical interchange of organic matter (Sánchez and Gil, 1995) and disappear at the mouth of the most important rivers (Sánchez *et al*., 2001). Both species appear to show a gradual expansion in their bathymetric distribution throughout their lifetimes, with the larger individuals tending to occupy shallower waters than the juveniles. Bearing in mind that the two species have similar characteristics, a certain degree of interspecific competition may be assumed (Sanchez *et al*, 1998).

Juveniles of these species feed mostly on detritivore crustaceans inhabiting deep-lying muddy bottoms. Adults *L. whiffiagonis* are more ichthyophagous and rates of crustacean in diet decrease

with fish size (Rodriguez-Marín, 2002). None of the two species represent an important part of the diet for the main fish predators in the area. However, Velasco (IEO, Santander, Spain, pers. comm.) observed that they are occasionally present in stomach contents of hake, anglerfish and rays.

The spawning period of these species is short. Mature males can be found from November to March and mature females from December to March, but spawning peaks in March. In southern areas megrims spawn from January to April (BIOSDEF, 1998; study contract 95/038).

The growth rate also varies (Landa *et al*, 1996; Landa, 1999), growth is quicker in the southern area for both species but the maximum length attained is smaller than in the north. The maximum age for megrim also varies with latitude. In Subarea 7 the maximum age of megrim is 14 years, this decreases to 12 years in Divisions 8c and 9a (BIOSDEF, 1998; Landa et. al, 2000).

B. Data

B.1. Commercial catch

Landings

Landings data are provided by National Government and research institutions of Spain and Portugal. The available series began in 1986.

The proportions of each megrim species in Portuguese and Spanish landings are estimated using the relative abundances of the two species of megrim in the sampled landings.

For *L. whiffiagonis*, landings present an increase for a few years at the beginning of the time series and a general declining trend till 2011. Since then, the stock is increasing again.

Discards

Discards estimates are available for Spanish trawlers in some years and are used in this assessment, where discards are missing, mainly in the historic data these have been estimated using the mean of the time-series for each age. A discarding sampling programme runs regularly since the establishment of the European Data Collection Programme in 2003. Before this year, Spanish discards data are available only for 1994, 1997, 1999 and 2000. The raising procedure used to estimate Spanish discards for the sampled years was based on effort.

In order to include discards data in the assessment, discards estimates from the average by period have been used for imputing missing data. For the first period (1986-1999), the average of available years 1994, 1997 and 1999 were used and for the second period (2000-2012) the absence of data in 2001 and 2002 was replaced by the average of the closest years. The raison of using these two periods is the change of the Minimum landing size (MLS) in 2000 that could bring a shift in the discarding behaviour. The whole time series of discards have been added to the landings data to calculate catch data.

B.2. Biological

Landings numbers at length

For *L. whiffiagonis*, annual length distributions were available for both Spanish and Portuguese landings until 1998, when Portuguese length frequency data were mainly based on samples from Aveiro. Due to the uncertainties of this port since 1999, Spanish length distributions were raised

to the total international landings for all subsequent years. Portuguese landings only represent 10% of the total landings on average.

There has been a strong decrease in landings of fish under 15 cm in length since 1994 and under 20 cm in recent years for both species. This change probably results from stricter enforcement of the minimum landing size and a mesh size increase regulation in year 2000.

Catch numbers at age

Age compositions of landings are based on annual Spanish ALKs since 1990, whereas a survey ALK from 1986 combined with an annual ALK from 1990 was applied to years 1986-1989. Landings weights-at-age are also used as the weights-at-age in the stock. The following parameter values were used in the length-weight relationship (BIOSDEF, 1998):

	L. whiffiagonis
a	0.006488
b	3.0114

Natural mortality is set to 0.2 and assumed constant over all ages and years. This is the same value used for *L. whiffiagonis* in Divisions 7b-k and 8abd.

The sex combined maturity ogive (BIOSDEF, 1998) is assumed constant over time, with the following proportions of fish mature at each age:

Age	0	1	2	3	4	5+
L. whiffiagonis	0	0.34	0.90	1	1	1

B.3. Surveys

The Portuguese October groundfish survey (PtGFS-WIBTS-Q4) and the Portuguese Crustacean survey (PT-CTS (UWTV (FU 28-29))) and one Spanish groundfish survey (SpGFS-WIBTS-Q4) series are available since 1990, 1997 and 1983, respectively.

It should be taken into consideration that during years 1996, 1999, 2003, 2004 and 2012 the October Portuguese survey was carried out with a different vessel and gear from the one used in the rest of the series. The Crustacean survey was performed with different vessels in different years and covers a partial area; in 2004 it had many operational problems.

For these reasons and because indices from these surveys are not considered to be representative of megrim abundance, due to the very low catch rates, only the Spanish survey (SpGFS-WIBTS-Q4) is used in the assessment of the two species. The survey covers the distribution area and depth strata of these species in Spanish waters (covering both 8c and 9a). The survey appears to be quite good at tracking cohorts through time *for L. whiffiagonis*.

B.4. Commercial CPUE

LPUE and Fishing Effort data are available for the following fleets: Spanish trawlers targeting demersal fish based in A Coruña port (SP-LCGOTBDEF) and in Avilés port (SP-AVSOTBDEF) fishing in Division 8c since 1986 and Portuguese trawlers fishing in Division 9a since 1988. Effort from the Portuguese fleet is estimated from a sample of logbooks from sea trips where megrim occurred in the catch.

Commercial fleets used in the assessment of L.whiffiagonis to tune the model

SP-LCGOTBDEF: This fleet contributed with data of effort (fishing days per 100 horse power), LPUE (as kg per fishing day per 100 horse power) and length composition of landings.

SP-AVSOTBDEF: This fleet contributed with data of effort (fishing days per 100 horse power), LPUE (as kg per fishing day per 100 horse power) and length composition of landings.

B.5. Other relevant data

C. Assessment: data and method

Model used: Extended Survivors Analysis (XSA), (Shepherd, 1992)

- Software used: VPA95 Lowestoft suite.

Model Options chosen *L. whiffiagonis*:

- Input data types and characteristics

TYPE	NAME	YEAR RANGE	AGE RANGE	VARIABLE FROM YEAR TO YEAR
Caton	Catch in tonnes	1986–present	1–7+	Yes
Canum	Catch at age in numbers	1986–present	1–7+	Yes
Weca	Weight at age in the commercial catch	1986–present	1–7+	Yes
West	Weight at age of the spawning stock at spawning time.	1986–present	1–7+	Yes
Mprop	Proportion of natural mortality before spawning	1986–present	1–7+	No
Fprop	Proportion of fishing mortality before spawning	1986–present	1–7+	No
Matprop	Proportion mature at age	1986–present	1–7+	No
Natmor	Natural mortality	1986–present	1–7+	No

- Tuning data:

TYPE	NAME	YEAR RANGE	AGE RANGE
Tuning fleet 1	SP-LCGOTBDEF	1986–present	3–6
Tuning fleet 2	SP-AVSOTBDEF	1986–present	3–6
Tuning survey 1	SpGFS-WIBTS-Q4	1990–present	1–6

- Model options:

Type	Setting
Taper	No
Tuning range	
Ages catch dep. on stock size	1–2
Q plateau	5
F shrinkage s.e.	1.5
Shrinkage year range	5
Shrinkage age range	3
Fleet s.e.threshold	0.2
F bar range	2–4

D. Short-Term Projection

- *L. whiffiagonis*
- Model used: Age structured

Software used: MFDP prediction with management option table and yield per recruit routines.

Initial stock size: Taken from the XSA survivors.

- Recruitment-at-age 1 assumed equal in all projection years (GM from 1998 to final assessment year minus 2).
- If if the XSA last year recruitment is considered poorly estimated, age 2 is replaced by GM98- final assessment year minus 2 reduced by total estimated mortality, obtained from the fishing mortality of age 1 of the last year and the natural mortality.

Maturity: Average maturity ogive for the last three years

F and M before spawning: Set to 0 for all ages in all years.

Weight at age in the stock: Average stock weights for the last five years or an appropriate number of years selected by the working group.

Weight at age in the catch: Average of the last five years or an appropriate number of years selected by the working group.

- Exploitation pattern: Scale F-at-age within each year, then average the scaled last five years weighted to the final year or an appropriate number of years selected by the working group.
- Intermediate year assumptions: Average Fbar for the last three years.
- Stock recruitment model used: None.
- Procedures used for splitting projected catches: Forecast catch numbers-at-age are divided into landings and discards (at age) based on the proportions given as inputs to the projection software; the software does it automatically. These proportions were taken (for each age) to be those corresponding to the observed aver-age of the most recent 5 years.

E. Medium-Term Projections

Medium term projections are not conducted for these stocks.

F. Long-Term Projections

Model used: yield and biomass per recruit over a range of F values.

Software used: MFYPR.

Yield per recruit calculations are conducted using the same input values as those used for the short term forecasts.

G. Biological Reference Points

During the 2015 WKMSYREF4, the software EqSim was used to define biological reference points for this stock. The methodology is described in the report of the workshop (ICES, 2015). Also, an ICES special request adviced was published with F_{MSY} ranges (ICES, 2016).

L. whiffiagonis

	Type	Value	Technical basis
MSY Approach	MSY $B_{trigger}$	980 t	B_{pa}
	F_{MSY}	0.191	
	F_{MSY} lower	0.122	based on 5% reduction in yield
	F_{MSY} upper (with advice rule)	0.29	based on 5% reduction in yield
	F_{MSY} upper (without advice rule)	0.24	based on 5% reduction in yield
	$F_{P.05}$	0.24	5% risk to B_{lim} without $B_{trigger}$.
Precautionary Approach	B_{lim}	700 t	B_{loss} estimated in 2015
	B_{pa}	980 t	1.4 B_{lim}
	F_{lim}	0.45	Based on segmented regression simulation of recruitment with B_{lim} as the breakpoint and no error
	F_{pa}	0.32	$F_{pa} = F_{lim} \times \exp(-\sigma \times 1.645)$ σ=0.2

H. Other Issues

H.1. Historical overview of previous assessment methods

WG YEAR	2013	2014	2015	2016	2017	2018
Model	XSA	XSA	XSA	XSA	XSA	XSA
Software	VPA95 Lowestoft suite	VPA95 Lowestoft suite	VPA95 Lowestoft suite	VPA95 Lowestoft suite	VPA95 Lowestoft suite	VPA95 Lowestoft suite
Stock	*L.whiffiagonis*	*L.whiffiagonis*	*L.whiffiagonis*	*L.whiffiagonis*	*L.whiffiagonis*	*L.whiffiagonis*
Catch data range	Landings 1986–2012	Landings and Discards 1986–2013	Landings and Discards 1986–2014	Landings and Discards 1986–2015	Landings and Discards 1986–2016	Landings and Discards 1986–2017
Age range in catch data	1–7+	1–7+	1–7+	1–7+	1–7+	1–7+
SP-CORUTR8c	1990–2010 Ages 2–6					
SP-LCGOTEBDEF		1986–2013 Ages 3–6	1986–2014 Ages 3–6	1986–2015 Ages 3–6	1986–2016 Ages 3–6	1986–2017 Ages 3–6
SP-AVILESTR	1990–2003 Ages 2–6					
SP-AVSOTBDEF		1986–2013 Ages 3–6	1986–2014 Ages 3–6	1986–2015 Ages 3–6	1986–2016 Ages 3–6	1986–2017 Ages 3–6
SpGFS-WIBTS-Q4 survey	1990–2010 Ages 1–6	1990–2013 Ages 1–6	1990–2014 Ages 1–6	1990–2015 Ages 1–6	1990–2016 Ages 1–6	1990–2017 Ages 1–6
Taper	No	No	No	No	No	No
Tuning range	23	24	25	26	27	28
Ages catch dep. stock size	1–4	1–2	1–2	1–2	1–2	1–2
Q plateau	5	5	5	5	5	5
F shrinkage s.e.	1.5	1.5	1.5	1.5	1.5	1.5

WG YEAR	2013	2014	2015	2016	2017	2018
Shrinkage year range	5	5	5	5	5	5
Shrinkage age range	3	3	3	3	3	3
Fleet s.e. threshold	0.2	0.2	0.2	0.2	0.2	0.2
F bar range	2–4	2–4	2–4	2–4	2–4	2–4

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