SAC GFCM
Sub-Committee on Stock Assessment

Date*	**17**	**October**	**2011**	**Code***	**HKE0511Gui**

Authors*

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Affiliation*

IEO- Centre Oceanogràfic de les Balears; Moll de Ponent s/n; 07015 Palma (Spain)

Species Scientific name*

1 *Merluccius merluccius - HKE*

Source: GFCM Priority Species

2

Source: -

3

Source: -

Geographical area*

05 - Balearic Islands

Geographical Sub-Area (GSA)*

05 - Balearic Island

Combination of GSAs 1

2

3

SAC GFCM - Sub-Committee on Stock Assessment (SCSA)

Assessment form — **Sheet #0** — **Basic data on the assessment**

Code: HKE0511Gui

Date*	17	Oct	2011	Authors*	Guijarro, Beatriz; Valls, Maria; Massuti, Enric

Species Scientific name*	Merluccius merluccius - HKE	Species common name*	European hake

Data Source

GSA*	05 - Balearic Island	Period of time*	1980-2010

Description of the analysis

Type of data*	Size composition of commercial trawl catches and official landings, CPUE data from survey and commercial fleet	Data source*	IEO, Fishermen Association, Ministry of Fisheries, Regional Government
Method of assessment*	VPA - Extended Survivor Analysis (XSA), Yield per recruit analysis	Software used*	FLR in R; EXCEL

Sheets filled out

B	P1	P2a	P2b	G	A1	A2	A3	Y	Other	D	Z	C
1	1	1	1	---	1	1	1	1	1	1	1	---

Comments, bibliography, etc.

Abella A., J.F. Caddy and F. Serena (1997) Do natural mortality and availability decline with age? An alternative yield paradigm for juvenile fisheries, illustrated by the hake Merluccius merluccius fishery in the Mediterranean. Aquat. Living Resour., 10: 257-269.

Astudillo A. and J.F. Caddy (1986) Periodicidad de los desembarcos de merluza (Merluccius merluccius) y salmonete (Mullus sp. sp.) en la Isla de Mallorca. Int. Symp. Long Term Changes Mar Fish Pop., Vigo: 221-233.

Bruno J., P. Oliver, A. Astudillo, X. Pastor and E. Daroca (1979) Contribution a la connaissance de la biologie du merlu (Merluccius merluccius L.) et du rouget (Mullus surmuletus L. et Mullus barbatus L.). Rapp. Comm. Int. Mer Médit., 25/26(10): 79-86.

Darby C.D. and Flatman, S. (1994) Virtual Population Análisis: version 3.1 (Windows/DOS) user guide. Info. Tech. Ser., MAFF Direct. Fish. Res., Lowestoft, nº 1, 85 pp.

García-Rodríguez M. and A. Esteban (1995) Algunos aspectos sobre la biología y pesca de la merluza mediterránea Merluccius merluccius (Linnaeus, 1758) en la Bahía de Santa Pola (sureste de la península ibérica). Bol. Inst. Esp. Oceanogr., 11(1):3-25.

García-Rodríguez M. and A. Esteban (2002) How fast does hake grow? A study on the Mediterranean hake (Merluccius merluccius) comparing whole otoliths readings and length frequency distributions data. Sci. Mar., 66(2): 145-156.

Comments, bibliography, etc.

Guijarro B. and E. Massutí (2006) Selectivity of diamond- and square-mesh codends in the deepwater crustacean trawl fishery off the Balearic Islands (W Mediterranean). ICES J. Mar. Sci., 62: 52-67.
Hidalgo M. (2007) Recruitment process and population dynamic of the European hake (Merluccius merluccius, L): seasonal and inter-annual approach. Tesis doctoral, Universidad de Vigo, Vigo, España, 198 pp.
Hidalgo J.M., P. Oliver, E. Massutí, B. Guijarro, J. Moranta, J.E. Cartes, J. Lloret and B. Morales-Nin.- 2007. Seasonal and short spatial patterns in European hake (Merluccius merluccius, L) recruitment process at the Balearic Sea (NW Mediterranean): the role of environment on distribution and condition. Journal of Marine Systems, 71: 367-384.
Hidalgo J.M.- 2007. Recruitment process and population dynamics of the European hake (Merluccius merluccius L.) off the Balearic Islands: seasonal and inter-annual approach. Ph.D. Thesis, University of Vigo, 195 pp. + XXXIII.
Massutí E. and O. Reñones (2005) Demersal resource assemblages in the trawl fishing grounds off the Balearic Islands (western Mediterranean). Sci. Mar., 69 (1): 167-181.
Massutí E., S. Monserrat, P. Oliver, J. Moranta, J.L. López-Jurado, M. Marcos, J.M. Hidalgo, B. Guijarro, A. Carbonell and P. Pereda (2007) The influence of oceanographic scenarios on the population dynamics of demersal resources in the western Mediterranean: hypothesis for hake and red shrimp off Balearic Islands. J. Mar. Sys., 421-438.
Mellon-Duval C., de Pontual H., Métral L. and Quemener L. (2009) Growth of European hake (Merluccius merluccius) in the Gulf of Lions based on conventional tagging. ICES Journal of Marine Science, 67: 62-70.
Oliver P. (1991) Dinámica de la población de merluza (Merluccius merluccius L.) de Mallorca: reclutamiento, crecimiento y mortalidad. PhD. Thesis, Universitat de les Illes Balears, 392 pp.
Oliver P. (1993) Analysis of fluctuations observed in the trawl fleet landings of the Balearic Islands. Sci. Mar., 57(2-3): 219-227.
Ordines F., E. Massutí, B. Guijarro and R. Mas (2006) The effect of mesh geometry on the selectivity of a multi-species bottom trawl fishery in the Mediterranean: diamond vs. square mesh in the codends. Aquat. Liv. Res., 19: 329-338.
Palmer M., A. Quetglas, B. Guijarro, J. Moranta, F. Ordines and E. Massutí (2009) Performance of artificial neural networks and discriminant analysis in predicting fishing tactics from multispecific fisheries. Can. J. Fish. Aquat. Sci., 66: 224-237.
Reñones O., E. Massutí and P. Oliver (1995) Some aspects of the reproduction pattern of hake (Merluccius merluccius) in the Balearic Islands. Rapp. Comm. Int. Mer Médit., 34: 255.

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Assessment form

Sheet B
Biology of the species

Code: HKE0511Gui

Biology

Somatic magnitude measured (LH, LC, etc)*	Total length	Units*	cm

Sex	Fem	Mal	Both	Unsexed		
Maximum size observed				72	Reproduction season	all year, but mainly
Size at first maturity				33*	Reproduction areas	deep shelf and upper
Recruitment size				5*	Nursery areas	deep shelf

Parameters used (state units and information sources)

			Sex			
		Units	female	male	both	unsexed
Growth model	L∞				110	
	K				0.178	
	t0					
	Data source	Mellon-Duval et al. (2009)				
Length weight relationship	a				0.0048	
	b				3.12	
	M				0.518***	
	sex ratio (mal/fem)					

Comments

* García-Rodríguez and Esteban (1995)

** Minimum length in catches

*** From PROBIOM (Abella et al., 1997): 1.11 (0), 0.65 (1), 0.42 (2), 0.34 (3), 0.31 (4), 0.28 (5+)

Comments

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Assessment form

Sheet P1

General information about the fishery

Code: HKE0511Gui

Data source*	IEO, Spanish Data Collection Programme (DCF, EU), Fishermen Association and Regional Government	Year (s)*	1980-2010

Data aggregation (by year, average figures between years, etc.)*	By year

Fleet and catches (please state units)

	Country	GSA	Fleet Segment	Fishing Gear Class	Group of Target Species	Species
Operational Unit 1*	ESP	05	E - Trawl (12-24 metres)	03 - Trawls	33 - Demersal shelf species	HKE
Operational Unit 2	ESP	05	E - Trawl (12-24 metres)	03 - Trawls	34 - Demersal slope species	HKE
Operational Unit 3						
Operational Unit 4						
Operational Unit 5						

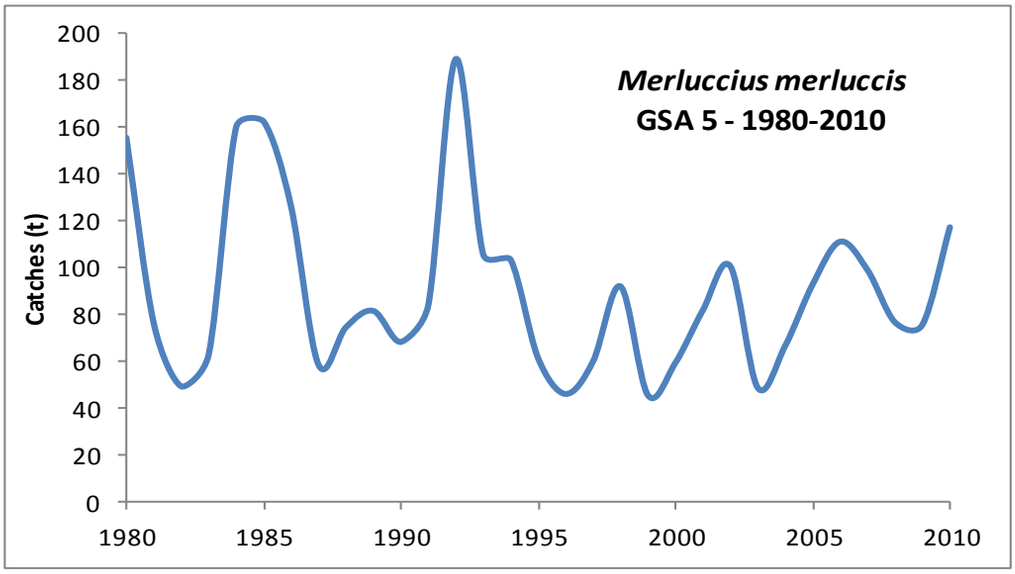
Operational Units*	Fleet (n° of boats)*	Kilos or Tons	Catch (species assessed)	Other species caught	Discards (species assessed)	Discards (other species caught)	Effort units
ESP 05 E 03 33 - HKE	34	Tons	88.3	see comments	8.3		days
ESP 05 E 03 34 - HKE		Tons	20.4	see comments	None		days
Total	34		108.7		8.3		

Legal minimum size	

Comments

Hake catches from the Balearic fleet comes exclusively from bottom trawl.
Fleet and catch (t) data correspond to 2010 from Mallorca island and represent approximately 70 and 90% of the Balearic Islands, respectively.
Nº of boats= 34 (total number of boats in Mallorca 2010)
In the Balearic Islands (western Mediterranean), commercial trawlers develop up to four different fishing tactics, which are associated with the shallow shelf, deep shelf, upper slope and middle slope (Guijarro and Massutí 2006; Ordines et al. 2006), mainly targeted to:
- *Spicara smaris*, *Mullus surmuletus*, *Octopus vulgaris* and a mixed fish category on the shallow shelf (50-80 m).
- *Merluccius merluccius*, *Mullus* spp., *Zeus faber* and a mixed fish category on the deep shelf (80-250 m).
- *Nephrops norvegicus*, but with an important by-catch of big *M. merluccius*, *Lepidorhombus* spp., *Lophius* spp. and *Micromesistius poutassou* on the upper slope (350-600 m).
- *Aristeus antennatus* on the middle slope (600-750 m).

Comments


Merluccius merluccis
GSA 5 - 1980-2010
Catches (t)
200
180
160
140
120
100
80
60
40
20
0
1980
1985
1990
1995
2000
2005
2010

Data source*	Size composition of trawl catches: IEO and Spanish National Data Collection Programme;	OpUnit 1*	ESP 05 E 03 33 - HKE

Time series

Year*	1980	1981	1982	1983	1984	...
Catch	155	76	49	63	160	...
Minimum size	11	10	10	11	10	...
Average size Lc	21.9	20.2	21.9	21.4	19.4	...
Maximum size	56	61	63	56	66	...
Fleet	50*	50*	50*	50*	50*	...

Year	...	2006	2007	2008	2009	2010
Catch	...	110.8	98.7	76.38	75.38	116.99
Minimum size	...	8	8	7	7	5
Average size Lc	...	20	24	21	23.1	22.7
Maximum size	...	68	69	68	75	67
Fleet	...	36	36	34	34	34

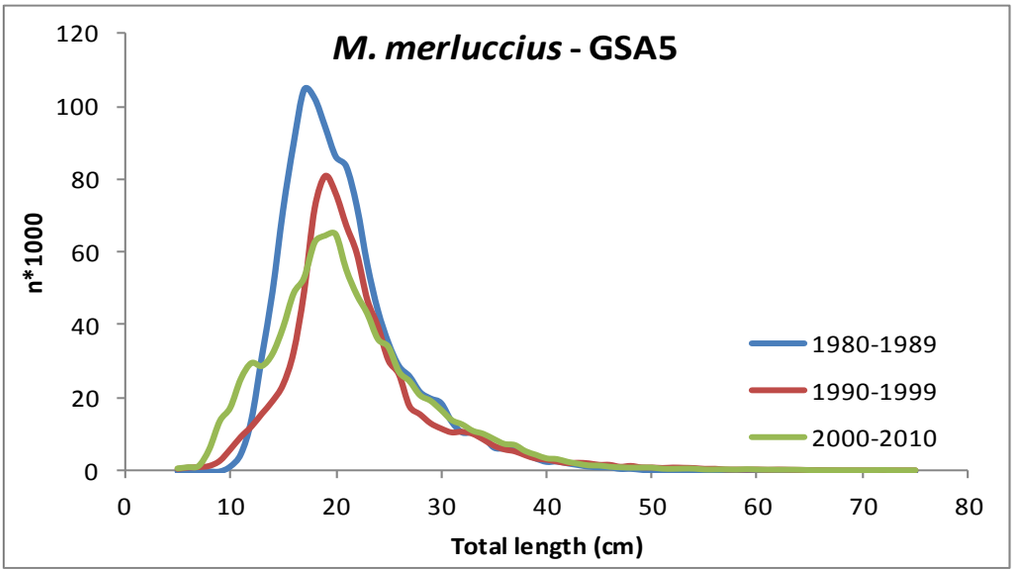
Selectivity

L25	11.2 cm
L50	11.6 cm
L75	12.0 cm
Selection factor	

Remarks

It corresponds to 40 mm diamond mesh in the codend.
Data source: Guijarro and Massutí (2006).

Structure by size or age



Structure by size or age

Although length frequency distributions used in the XSA were annual, these figures represent an average length frequency distribution (cm; total length) of trawl catches in the geographical sub-area 05 (Balearic Islands) for the periods 1980-1989, 1990-1999 and 2000-2010. Size composition of catches have been obtained from monthly length sampling (stratified random method) on board trawl fishing vessels at different ports of Mallorca.

Data source*	IEO and EU Research Project on discards*	OpUnit 1*	ESP 05 E 03 33 - HKE

Regulations in force and degree of observance of regulations

- Fishing license: fully observed

- Engine power limited to 316 KW or 500 HP: not observed (at least, doubled)

- Mesh size in the codend (before Jun 1st 2010: 40 mm diamond: after Jun 1st 2010: 40 mm square or 50 mm diamond -by derogation-): fully observed

- Fishing forbidden shallower than 50 m depth: not fully observed

- Time at sea (12 hours per day and 5 days per week): fully observed

Accompanying species

- *Mullus barbatus*
- *Lophius* spp.
- *Micromesistius poutassou*
- *Eledone cirrhosa*
- *Lepidorhombus* spp.
- *Scyliorhinus canicula*
- *Helicolenus dactylopterus*
- *Pagellus bogaraveo*
- *Phycis blennoides*
- *Parapenaeus longirostris*
- *Nephrops norvegicus*

Carbonell, A. (1997) Discards of the western Mediterranean trawl fleets. Final Report Contract DGXIV-MED/94/027, 142 pp.

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Assessment form

Sheet A1

Indirect methods: VPA, LCA

Code: HKE0511Gui

Sex*	Unsexed

Analysis # *	1

Time series

Data	Size	Age
(mark with X)		X

Model	Cohorts	Pseudocohorts
(mark with X)	X	

Equation used	Catch equation	Tunig method	Extended Survivor Analysis (XSA)
# of gears	1	Software	FLR in R
$F_{terminal}$	0.925		

Population results (please state units)

	Sizes	Ages		Amount	Biomass
Minimum			Recruitment	3.523	91.2
Average			Average population	4.655	237.45
Maximum			Virgin population		
Critical			Turnover	SSN	SSB
				0.12	39.71
				millions	tons

Average mortality

		Gear					
	Total						
F_1	1.29						
F_2							
Z	1.808						

(F1 and F2 represent different possible calculations. Please state them)

Comments

Population results are mean values 1980-2010 at the start of the year (amount in millions and biomass in tons).

F1 was calculated averaging FBAR 0-4 from 1980-2010.

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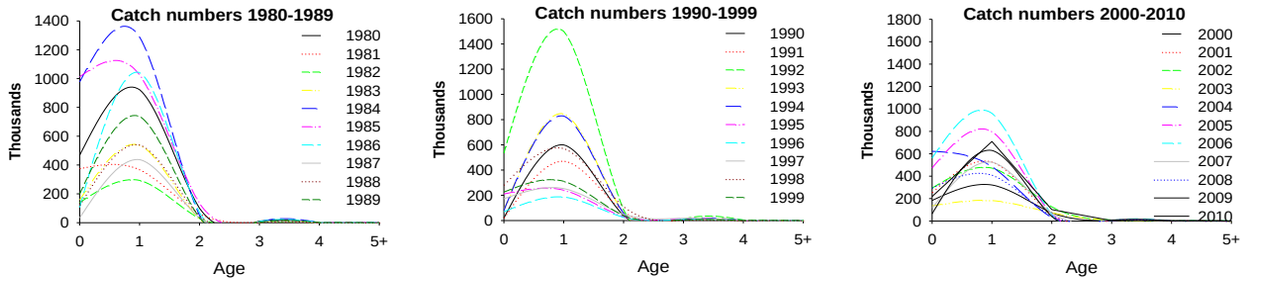
Assessment form	**Sheet A2** **Indirect methods: data**

Code: HKE0511Gui

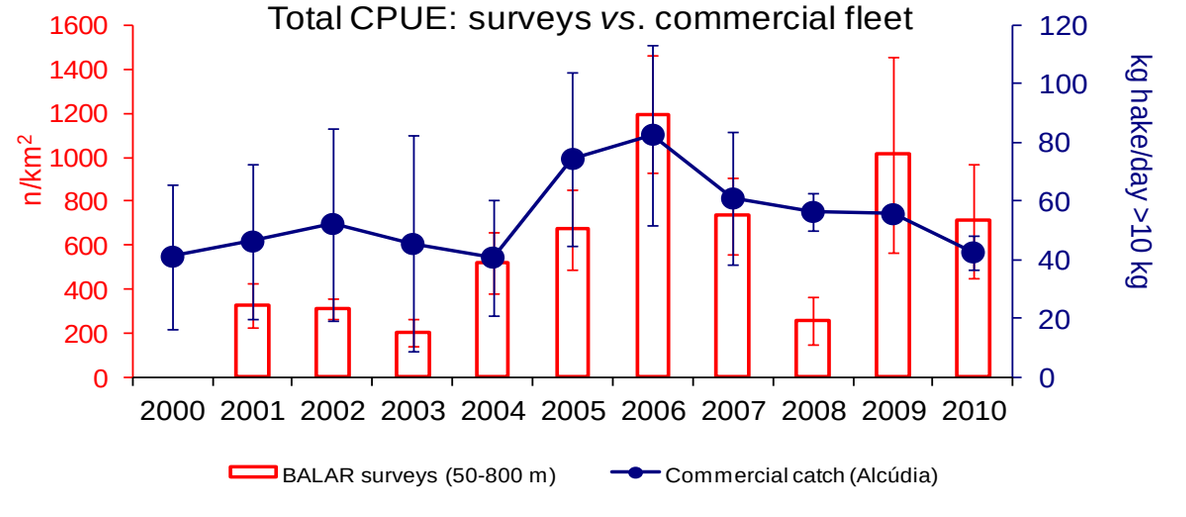
Sex*	Total	Gear*	Bottom trawl	Analysis # *	**1**

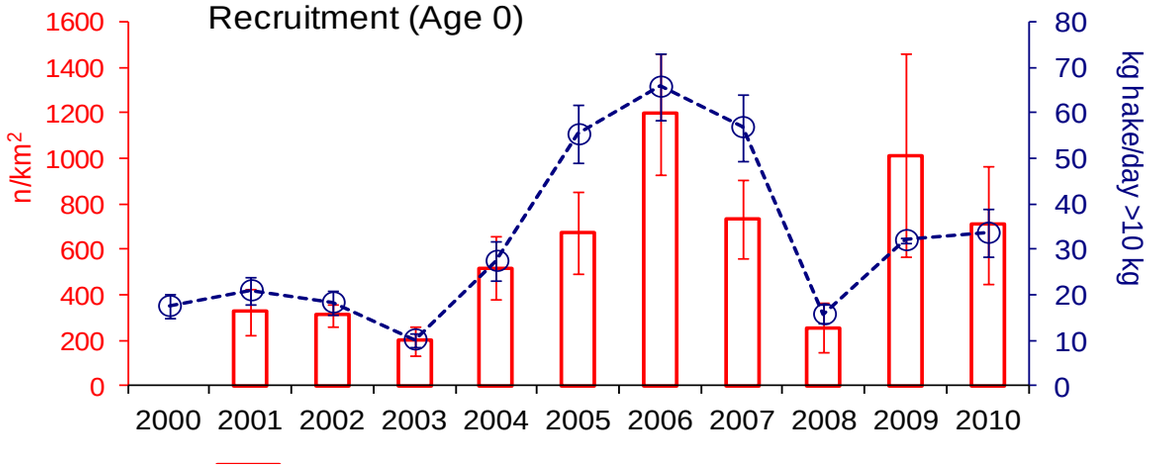
Data source	Catch in number by age and CPUE from surveys and commercial fleet

Data



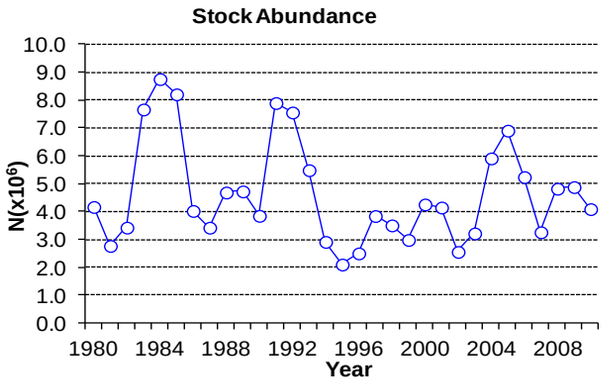
VPA tuning was performed using CPUE data from BALAR-MEDITS surveys (Massutí and Reñones, 2005) and daily landings from Alcudia. This port, situated in the NE of Mallorca, was used because it is the port with highest hake standardised CPUE of the Island. The landings of this port represented around 25% of the total catch of Mallorca. Abundance indices from surveys were calculated considering the whole bathymetric depth where the trawl fleet operates (50-800 m). Although abundance indices from commercial fleet were also calculated for each commercial categories, abundance indices for total hake were used for the VPA tuning.

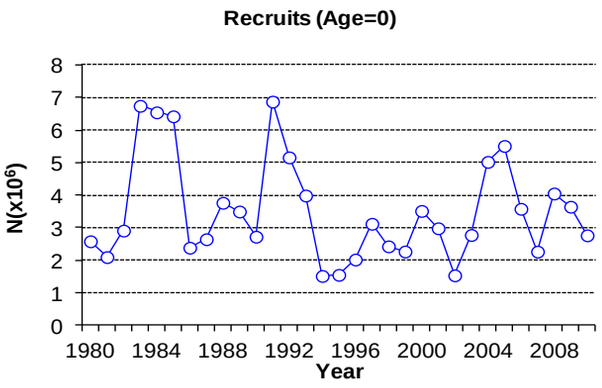




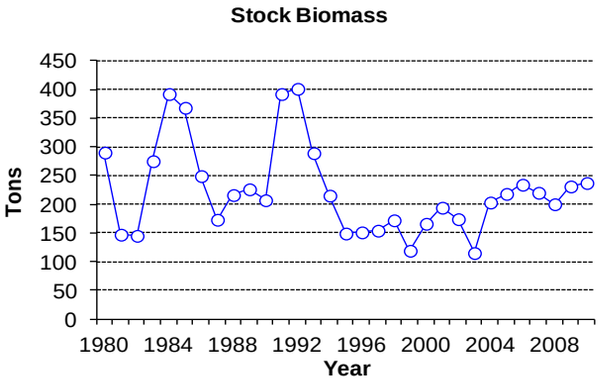
Sex*	Total	Gear*	Bottom trawl	Analysis #*	1

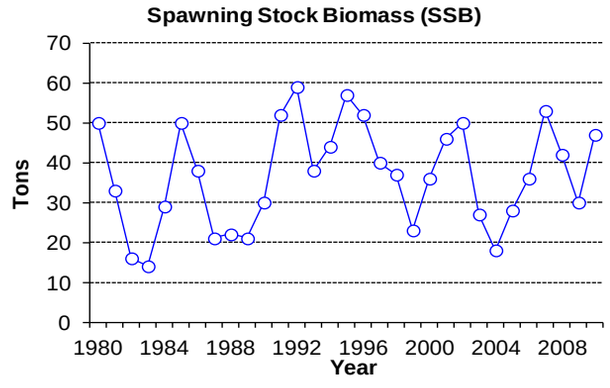
Population in figures



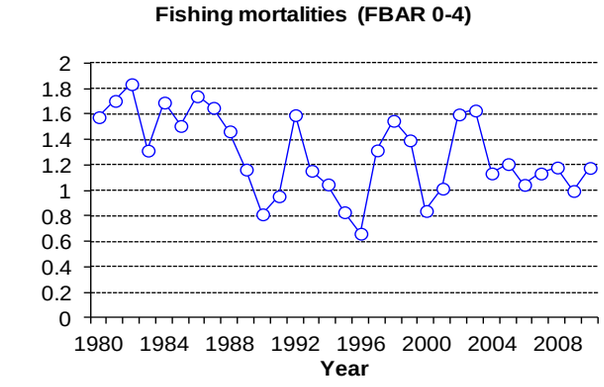


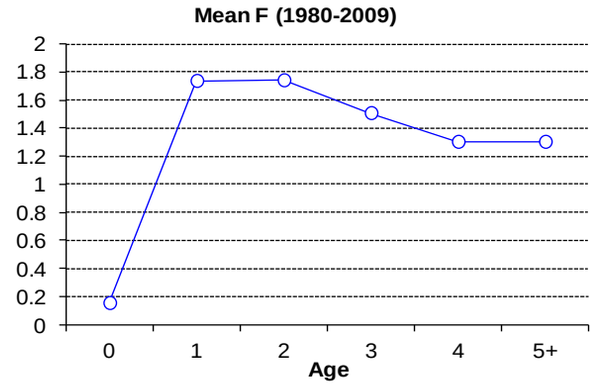
Population in biomass





Fishing mortality rates





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Assessment form

Sheet Y

Indirect methods: Y/R

Code: HKE0511Gui

Sex	Total

Analysis #	2

# of gears	1	Software	EXCEL

Parameters used

Vector F	Mean 2008-2010
Vector M	See sheet B
Vector N	Mean 2008-2010

Model characteristics

From calculated mean weights (2008-2010)

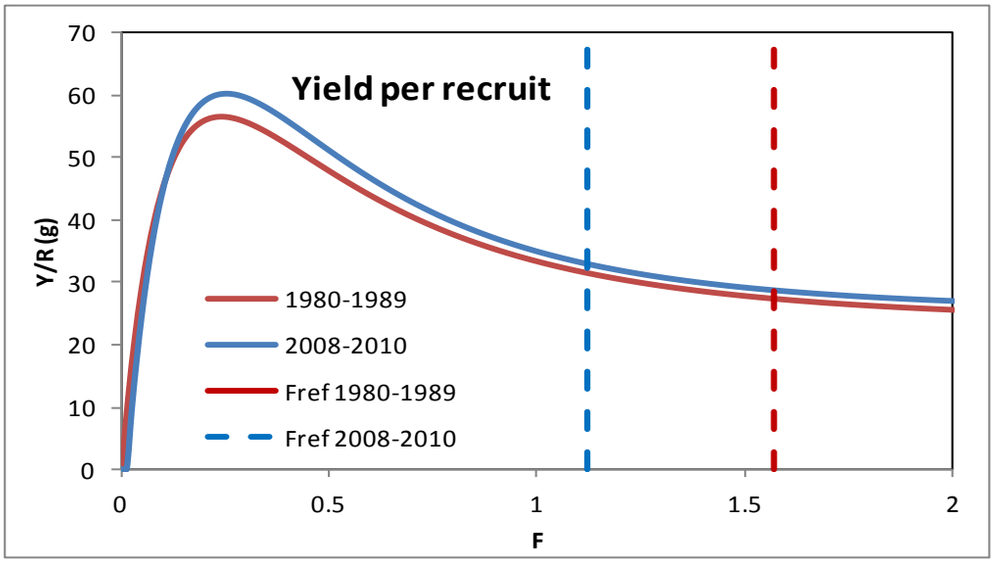
Results

	Total	Gear			
Current YR	29.3 g				
Maximum Y/R	60.3 g				
Y/R 0.1	57.0 g				
F_{max}	0.242				
$F_{0.1}$	0.1573				
Current B/R	63.2				
Maximum B/R	344.9				
B/R 0.1	478				
Fref	1.21				
	2008-2010				

Comments

	2008-2010	1980-1989
Current YR	29.3 g	27.3 g
Maximum Y/R	60.3 g	56.4 g
Y/R 0.1	57.0 g	53.4 g
F_{max}	0.242	0.235
$F_{0.1}$	0.1573	0.157
Current B/R	63.2	61.9
Maximum B/R	344.9	310.4
B/R 0.1	478	418.2
Fref	1.21	1.57

Comments


Yield per recruit
Y/R (g)
F
70
60
50
40
30
20
10
0
0
0.5
1
1.5
2
1980-1989
2008-2010
Fref 1980-1989
Fref 2008-2010

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Assessment form	**Sheet D** **Diagnosis**

Code: HKE0511Gui

Indicators and reference points

Criterion	Current value	Units	Reference Point	Trend	Comments
B					
SSB					
F					
Y					
CPUE					

Stock Status* Use one (or both) of the following two systems for the stock assessment status description

Unidimensional

○	? - (or blank) **Not known or uncertain**. Not much information is available to make a judgment;
○	U - **Underexploited, undeveloped or new fishery**. Believed to have a significant potential for expansion in total production;
○	M - **Moderately exploited**, exploited with a low level of fishing effort. Believed to have some limited potential for expansion in total production;
○	F - **Fully exploited**. The fishery is operating at or close to an optimal yield level, with no expected room for further expansion;
○	O - **Overexploited**. The fishery is being exploited at above a level which is believed to be sustainable in the long term, with no potential room for further expansion and a higher risk of stock depletion/collapse;
○	D - **Depleted**. Catches are well below historical levels, irrespective of the amount of fishing effort exerted;
○	R - **Recovering**. Catches are again increasing after having been depleted or a collapse from a previous;

Bidimensional

Exploitation rate

○	No or low fishing
○	Moderate fishing
◉	High fishing mortality
○	Uncertain / Not assessed

Stock abundance

○	Virgin or high abundance
◉	Intermediate abundance
○	Low abundance

○	Depleted
○	Uncertain / Not assessed

Comments

The stock is in overfishing status.

Code: HKE0511Gui

Management advice and recommendations*

To reduce fishing mortalities by reducing the effort activity and improving the selection pattern of the fishery.

Advice for scientific research*

The use of the information from the vessel monitoring system will help to improve the knowledge about the spatial distribution of the fishing effort.

Abstract for SCSA reporting

Authors Guijarro, Beatriz; Valls, Maria; Massuti, Enric

Year 2011

Species Scientific name Merluccius merluccius - HKE

Source: GFCM Priority Species

Source: -

Source: -

Geographical Sub-Area 05 - Balearic Island

Fisheries (brief description of the fishery)*

The trawl fishery off Mallorca (Balearic Islands; GFCM-GSA05) is developed by around 40 vessels whose total annual landings are approximately 1400 t. The European hake (Merluccius merluccius) is a target species for this fishery, mainly exploited on the deep shelf and upper slope, with annual landings oscillating between 50 and 190 tons during the last decades.

Source of management advice*

(brief description of material -data- and methods used for the assessment)

The information used for the assessment of the stock consisted in annual size composition of catches (estimated from monthly sampling), official landings and the biological parameters estimated from bibliography and the Data Collection Programme. The vector of natural mortality by age was calculated from Caddy's formula using the PRODBIOM Excel spreadsheet. The methodology applied was: (i) a tuned virtual population analysis (VPA), applying the Extended Survivor Analysis (XSA) method on the period 1980-2010 and considering catch per unit effort (CPUE) from the commercial trawl fleet (2000-2010) and bottom trawl surveys (2001-2010) as tuning fleets. The parametrization of the model was checked by retrospective analysis; and, (ii) two yield per recruit (Y/R) analysis based on the exploitation pattern resulting from the XSA model and population parameters for the period 2008-2010, which was compared to the beginning of the data series (1980-1989). The software used was FLR in R and Excel.

Stock Status*

Exploitation rate

High fishing mortality

Stock abundance

Intermediate abundance

Comments

The stock is in overfishing status

Management advice and recommendations*

To reduce fishing mortalities by reducing the effort activity and improving the selection pattern of the fishery.

Advice for scientific research*

The use of the information from the vessel monitoring system will help to improve the knowledge about the spatial distribution of the fishing effort.