

SAC GFCM Sub-Committee on Stock Assessment

Date*

24	November	2009
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Code*

HKE0509Gui

Authors*

Guijarro, Beatriz; Ordines, Francesc; Valls, Maria and Massutí, Enric

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	

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Assessment form

Sheet #0

Basic data on the assessment

Code: HKE0509Gui

Date*	24	Nov	2009	Authors*	Guijarro, Beatriz; Ordines, Francesc; Valls, Maria and Massutí, Enric
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Species Scientific name*	Merluccius merluccius - HKE	Species common name*	European hake
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Data Source

GSA*	05 - Balearic Island	Period of time*	1980-2008
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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), LCA- Pseudocohort analysis, Yield per recruit analysis	Software used*	Lowestoft VPA V3.2 (Darby & Flatman, 1994), VIT (Lleonart and Salat, 1992), EXCEL

Sheets filled out

B	P1	P2a	P2b	G	A1	A2	A3	Y	Other	D	Z	C
1	1	1	1	---	4	1	4	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 Analysis: version 3.1 (Windows/DOS) user guide*. Info. Tech. Ser., MAFF Direct. Fish. Res., Lowestoft, n° 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.
- Leonart J. and J. Salat (1992) VIT. Programa de Análisis de Pesquerías. *Inf. Téc. Sci. Mar.*, 168-169: 116 pp.
- 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 (2008) Performance of artificial neural networks and discriminant analysis in predicting fishing tactics from multispecific fisheries. *Can. J. Fish. Aquat. Sci.*, (in press).
- 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: HKE0509Gui

Biology

Somatic magnitude measured (LH, LC, etc)*		Total length		Units*	cm
Sex	Fem	Mal	Both	Unsexed	
Maximum size observed				72	Reproduction season
Size at first maturity				33*	Reproduction areas
Recruitment size				5*	Nursery areas
					all year, but mainly
					deep shelf and upper
					deep shelf

Parameters used (state units and information sources)

		Units	Sex			
			female	male	both	unsexed
Growth model	L ∞				85	
	K				0.172	
	t0				-0.177	
	Data source	Otolith readings (Spanish National Data Collection P				
Length weight relationship	a				0.0048	
	b				3.12	
	M				0.46***	
	sex ratio (mal/fem)					

Comments

* García-Rodríguez and Esteban (1995)

** Minimum length in catches

*** From PROBIOM (Abella et al., 1997): 1 (0), 0.7 (1), 0.5 (2), 0.4 (3), 0.4 (4), 0.4 (5+)

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Sheet P1
General information about the fishery

Code: HKE0509Gui

Data source*	IEO, Spanish Data Collection Programme (DCF, EU), Fishermen Association and Regional Government	Year (s)*	1980-2007
Data aggregation (by year, average figures between years, etc.)*	By year (XSA) and averages (1980-1989, 1990-1999, 2000-2007 for pseudocod)		

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						

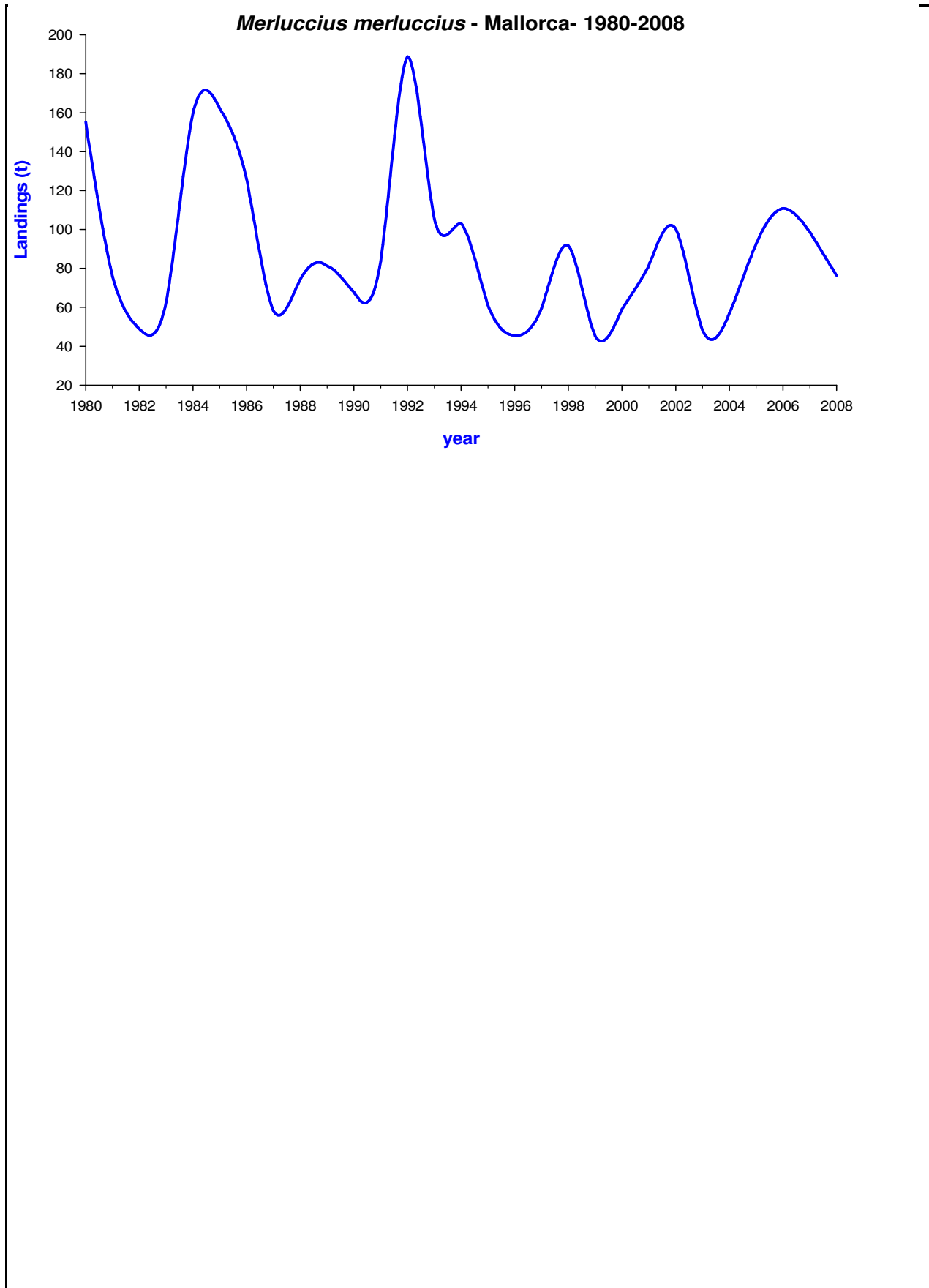
Operational Units*	Fleet (n° of boats)*	Kilos or Tons	Catch (species assessed)	Other species caught	Discards (species assessed)	Discards (other species caught)	Effort units
ESP 05 E 03 33 - HKE	38	Tons	36.4	see comments	11.7		1292
ESP 05 E 03 34 - HKE	38	Tons	19.7	see comments	None		1347
Total	76		56.1		11.7		

Legal minimum size	20cm
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Comments

Hake catches from the Balearic fleet comes exclusively from bottom trawl.
 Fleet and catch (t) data correspond to average 2000-2007 from Mallorca island and represent 72 and 90% of the Balearic Islands, respectively.
 N° of boats (38) = total number of boats
 Catch and standardised effort in days (average 2000-2007; Palmer et al., 2008):
 ESP 05 E 03 33 - HKE (DS, DS+SS, DS+MS)= 36.4 t; 1292 days
 ESP05 E 03 34 - HKE (US, US+SS, US+MS)= 19.7 t; 1347 days
 DS+US= 3.9 t; 191 days (included in the previous groups)
 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 portusae*, on the upper slope (350-600 m).

Comments



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Sheet P2a
Fishery by Operational Unit

Code: HKE0509Gui

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Data source*	Size composition of trawl catches: IEO and Spanish National Data Collection Programme;	OpUnit 1*	ESP 05 E 03 33 - HKE
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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	...	2004	2005	2006	2007	2008
Catch	...	59	92	110.8	98.7	76.38
Minimum size	...	8	7	8	8	7
Average size Lc	...	18	19.6	20	24	21
Maximum size	...	61	59	68	69	68
Fleet	...	37	37	36	36	34

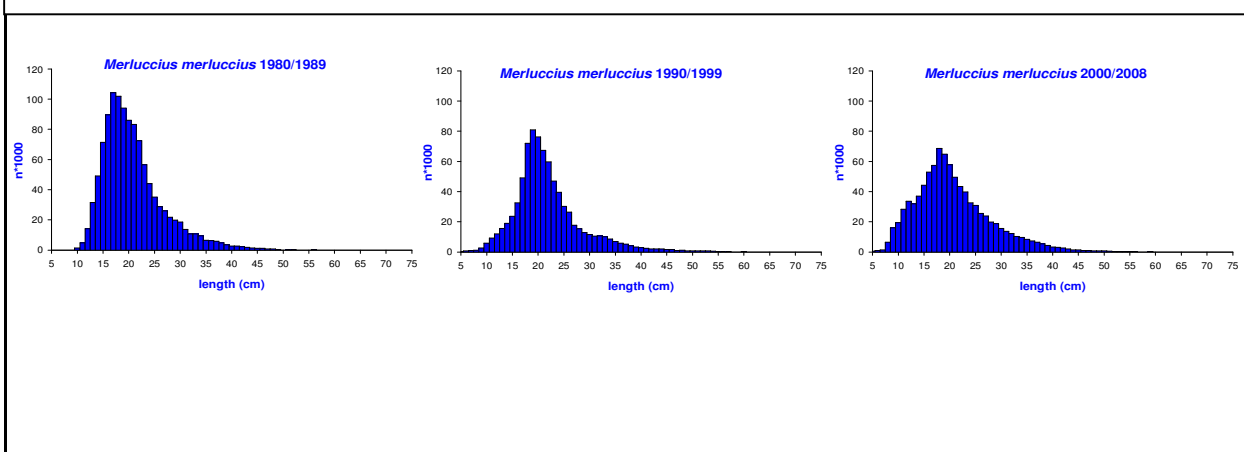
Selectivity

Remarks

L25	11.2 cm	It corresponds to 40 mm diamond mesh in the codend. Data source: Guijarro and Massutí (2006).
L50	11.6 cm	
L75	12.0 cm	
Selection factor		

Structure by size or age

Although length frequency distributions used in the VPA 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 2000-2008. Size composition of catches have been obtained from monthly length sampling (stratified random method) on board trawl fishing vessels at different ports of Mallorca.



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Assessment form

Sheet P2b
Fishery by Operational Unit

Code: HKE0509Gui

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Data source*	IEO and EU Research Project on discards*	OpUnit 1*	ESP 05 E 03 33 - HKE
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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 (40 mm diamond): 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: HKE0509Gui

Page 1 / 4

Sex* Unsexed

Analysis # * 1

Time series

Data	Size	Age
(mark with X)		X

Model	Cohorts	Pseudocohorts
(mark with X)	X	

Equation used	Catch equation	Tuning method	Extended Survivor Analysis (XSA)
# of gears	1	Software	Lowestoft VPA V3.2 (Darby and Flatman, 1994)
F _{terminal}	0.81		

Population results (please state units)

	Sizes	Ages		Amount	Biomass
Minimum			Recruitment	2.08	37.6
Average			Average population	3.68	214.4
Maximum			Virgin population		
Critical			Turnover	SSN	SSB
				0.3	89.4
				millions	tons

Average mortality

	Total	Gear					
F ₁	0.78						
F ₂							
Z	1.24						

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

Comments

Population results are mean values 1980-2008 at the start of the year (amount in millions and biomass in tons).

F1 was calculated averaging FBAR 0-4 from 1980-2008.

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Assessment form

Sheet A1
Indirect methods: VPA, LCA

Code: HKE0509Gui

Page 2 / 4

Sex* Unsexed

Analysis # * 2 (1980-1989)

Time series

Data	Size	Age
(mark with X)		X

Model	Cohorts	Pseudocohorts
(mark with X)		X

Equation used	Catch equation	Tuning method	No tuning
# of gears	1	Software	VIT (Lleonart and Salat, 1992)
F _{terminal}	0.81		

Population results (please state units)

	Sizes	Ages		Amount	Biomass
Minimum			Recruitment	1.68	20.96
Average	14	0.6	Average population	2.4	130.2
Maximum			Virgin population		2372.8
Critical	20.6	1	Turnover		188.5
				SSB	24.5
				millions	tons

Average mortality

	Total	Gear					
F ₁	1.17						
F ₂	0.84						
Z	1.63						

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

Comments

B_{now}/B_{virgin}(%)= 2.5
 F1= Mean F
 F2= Global F
 Biomass= N_{initial} * W_{mean}
 Z= M+F1

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Assessment form

Sheet A1
Indirect methods: VPA, LCA

Code: HKE0509Gui

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Sex* Unsexed

Analysis # * 3 (1990-1999)

Time series

Data	Size	Age
(mark with X)		X

Model	Cohorts	Pseudocohorts
(mark with X)		X

Equation used	Catch equation	Tuning method	No tuning
# of gears	1	Software	VIT (Lleonart and Salat, 1992)
F _{terminal}	0.81		

Population results (please state units)

	Sizes	Ages		Amount	Biomass
Minimum			Recruitment	1.29	16.8
Average	15.5	0.7	Average population	1.96	145.9
Maximum			Virgin population		1815.1
Critical	20.6	1	Turnover		150.6
				SSB	38.7
				millions	tons

Average mortality

	Total	Gear					
F ₁	1.14						
F ₂	0.69						
Z	1.6						

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

Comments

B_{now}/B_{virgin}(%)= 4.1
 F1= Mean F
 F2= Global F
 Biomass= N_{initial} * W_{mean}
 Z= M+F1

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Assessment form

Sheet A1
Indirect methods: VPA, LCA

Code: HKE0509Gui

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Sex* Unsexed

Analysis # * 4 (2000-2008)

Time series

Data	Size	Age
(mark with X)		X

Model	Cohorts	Pseudocohorts
(mark with X)		X

Equation used	Catch equation	Tuning method	No tuning
# of gears	1	Software	VIT (Lleonart and Salat, 1992)
F _{terminal}	0.81		

Population results (please state units)

	Sizes	Ages		Amount	Biomass
Minimum			Recruitment	1.4	17.6
Average	15.3	0.7	Average population	2.1	149.8
Maximum			Virgin population		1977.1
Critical	34.3	1	Turnover		144.6
				SSB	42.2
				millions	tons

Average mortality

	Total	Gear					
F ₁	0.7						
F ₂	0.76						
Z	1.16						

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

Comments

B_{now}/B_{virgin}(%)= 4.0
 F1= Mean F
 F2= Global F
 Biomass= N_{initial} * W_{mean}
 Z= M+F1

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Assessment form

Sheet A2

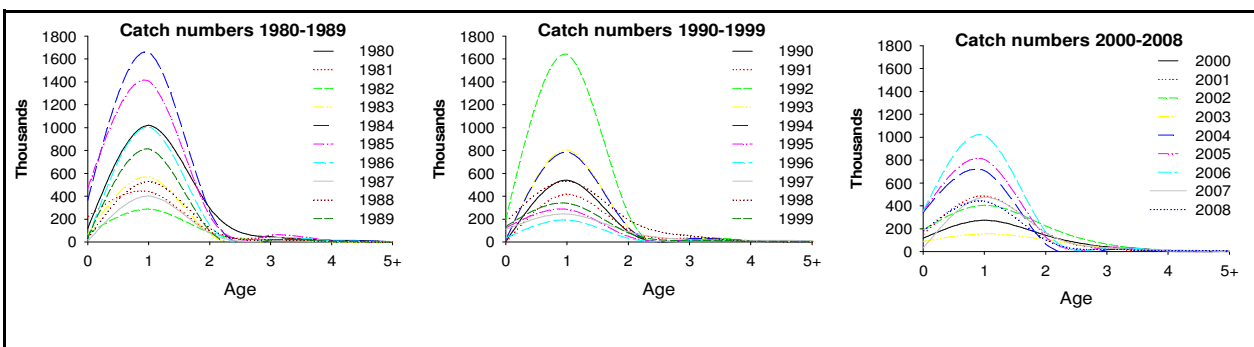
Indirect methods: data

Code: HKE0509Gui

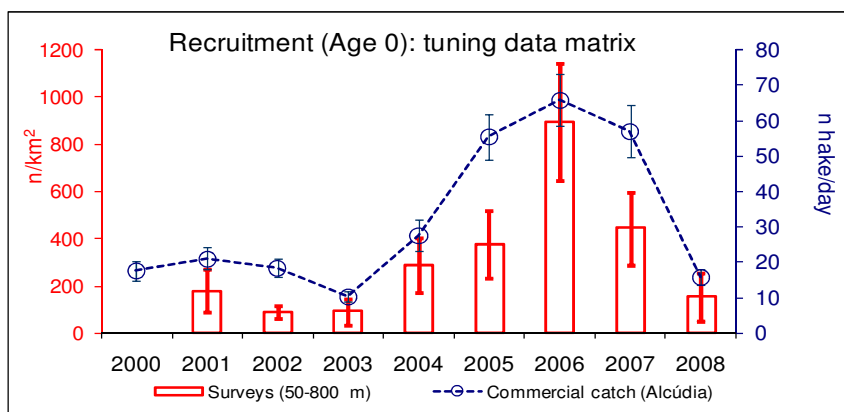
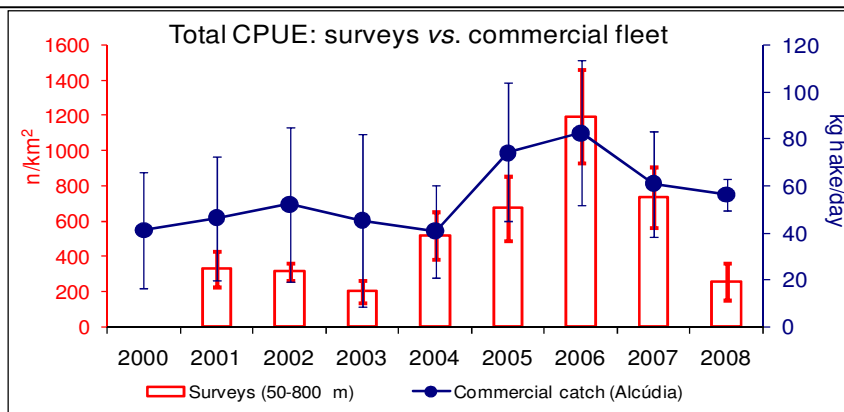
Sex*	Unsexed	Gear*	Trawl	Analysis # *	1
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Data source	Catch in number by age and CPUE from surveys and commercial fleet
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Data



VPA tuning was performed using CPUE data from BALAR-MEDITS surveys (Massutí and Reñones, 2005) and daily landings from Alcúdia. 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.



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Assessment form

Sheet A3

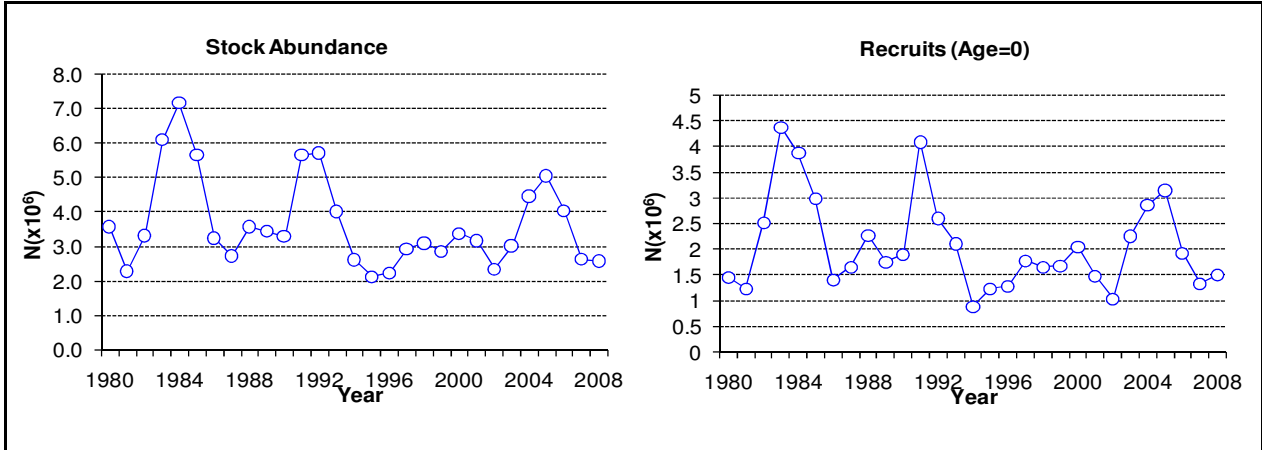
Indirect methods: VPA results

Code: HKE0509Gui

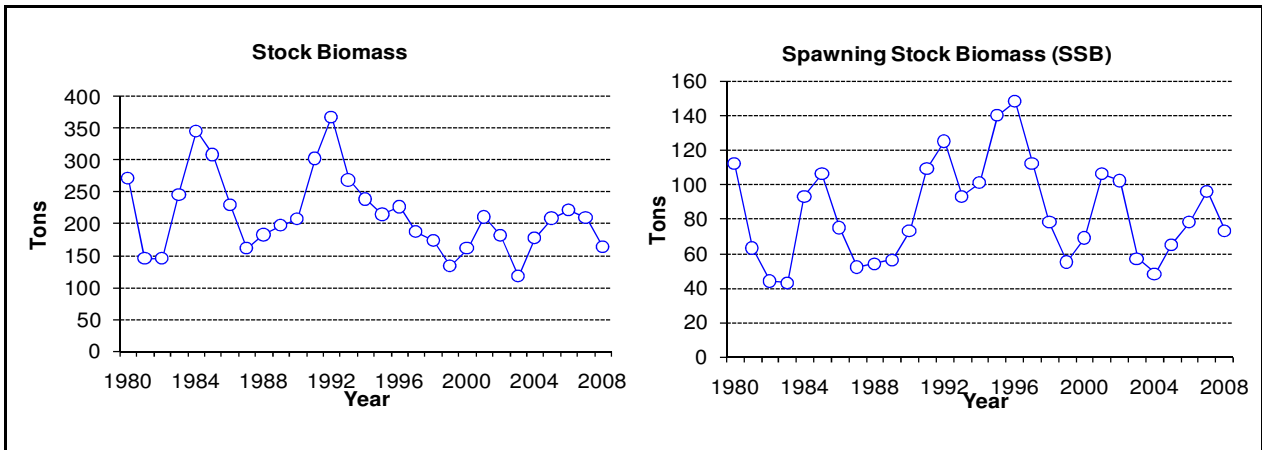
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Sex*	Unsexed	Gear*	Trawl	Analysis #*	1
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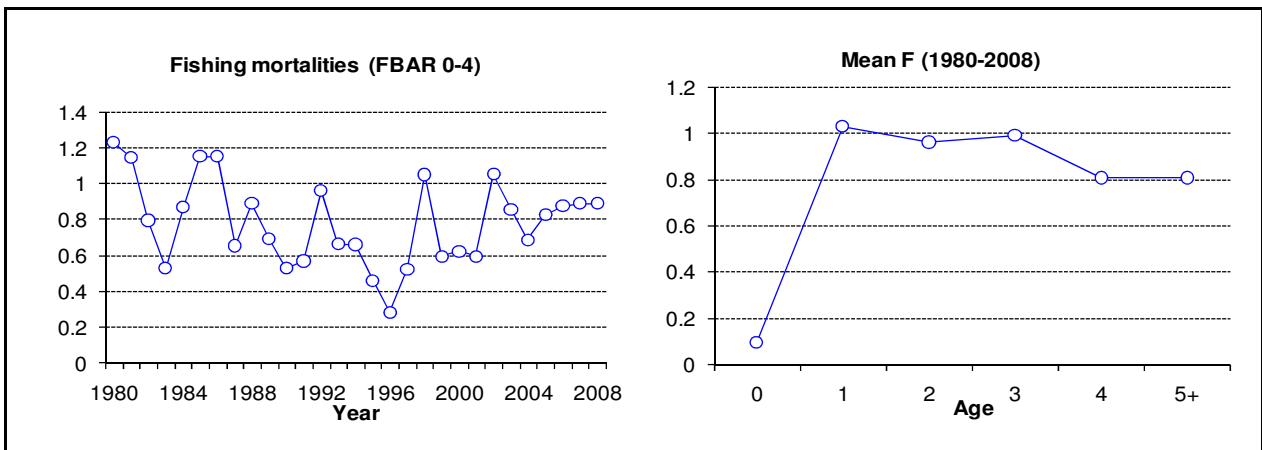
Population in figures



Population in biomass



Fishing mortality rates



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Assessment form

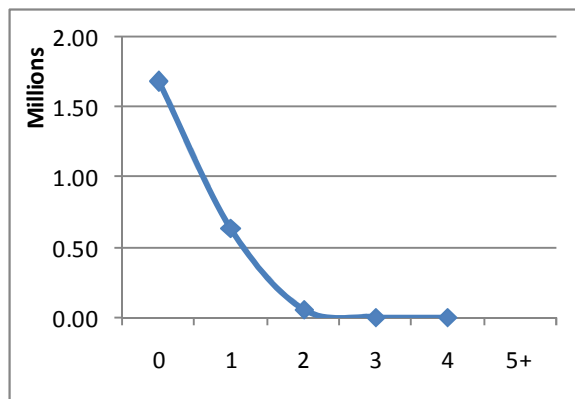
Sheet A3
Indirect methods: VPA results

Code: HKE0509Gui

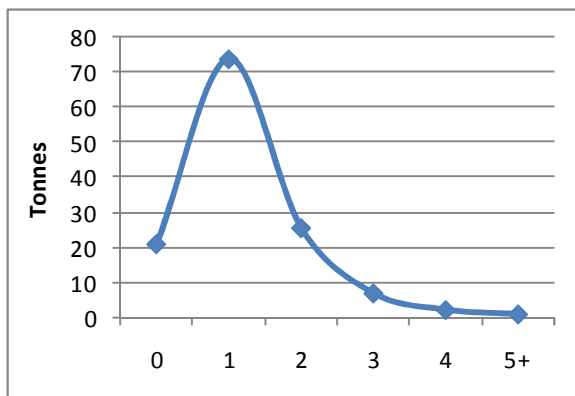
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Sex*	Unsexed	Gear*	Trawl	Analysis #*	2 (1980-1989)
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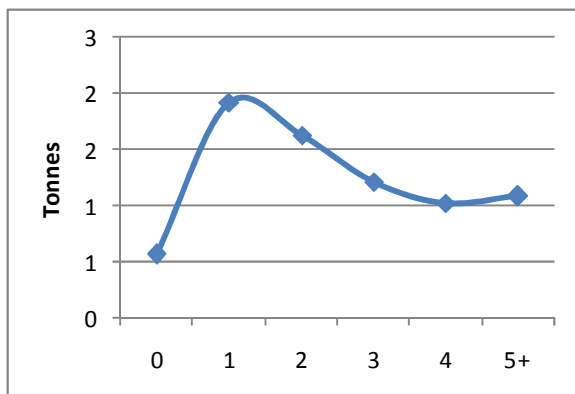
Population in figures



Population in biomass



Fishing mortality rates



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Assessment form

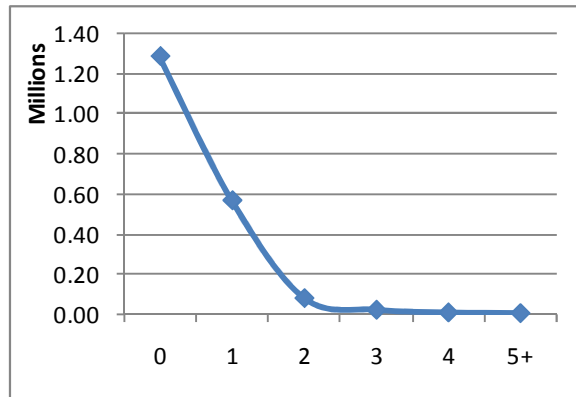
Sheet A3
Indirect methods: VPA results

Code: HKE0509Gui

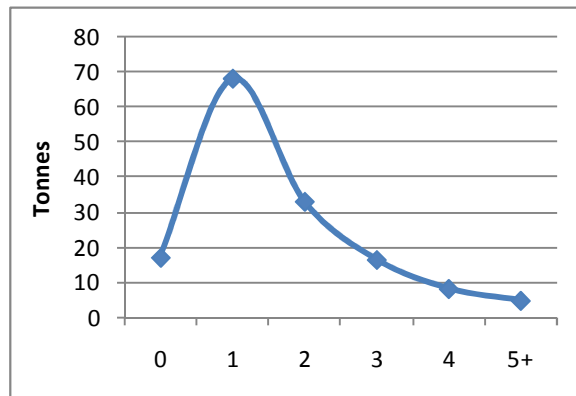
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Sex*	Unsexed	Gear*	Trawl	Analysis #*	2 (1990-1998)
------	---------	-------	-------	-------------	---------------

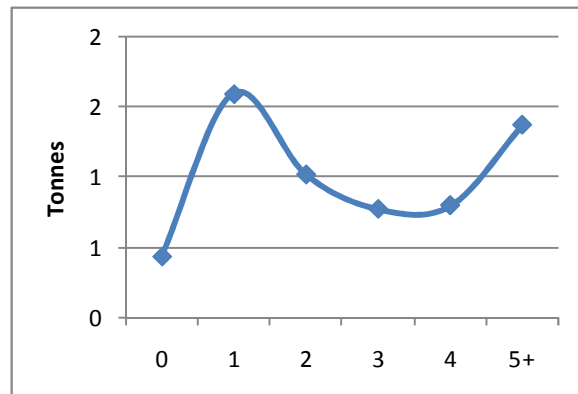
Population in figures



Population in biomass



Fishing mortality rates



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Assessment form

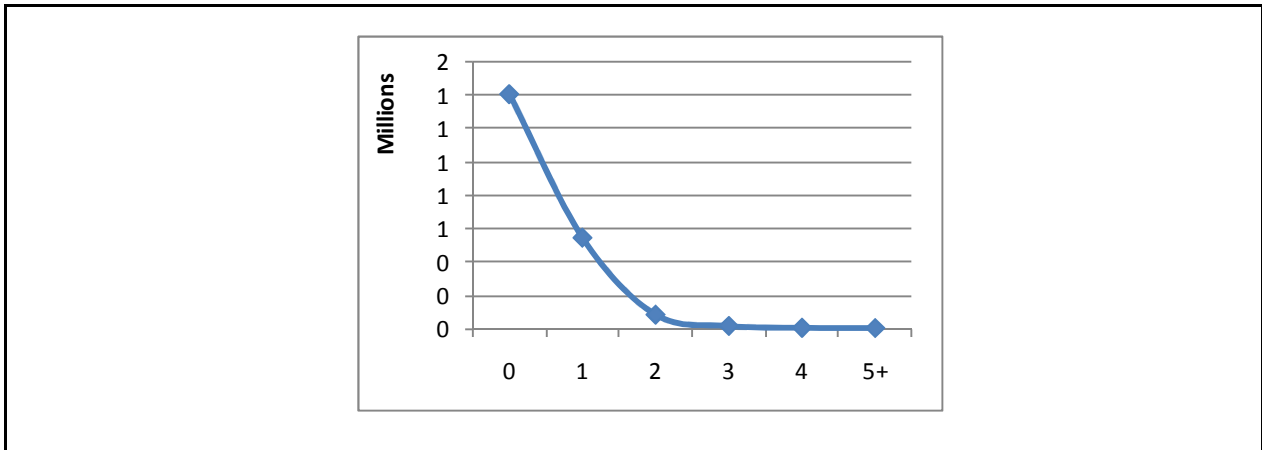
Sheet A3
Indirect methods: VPA results

Code: HKE0509Gui

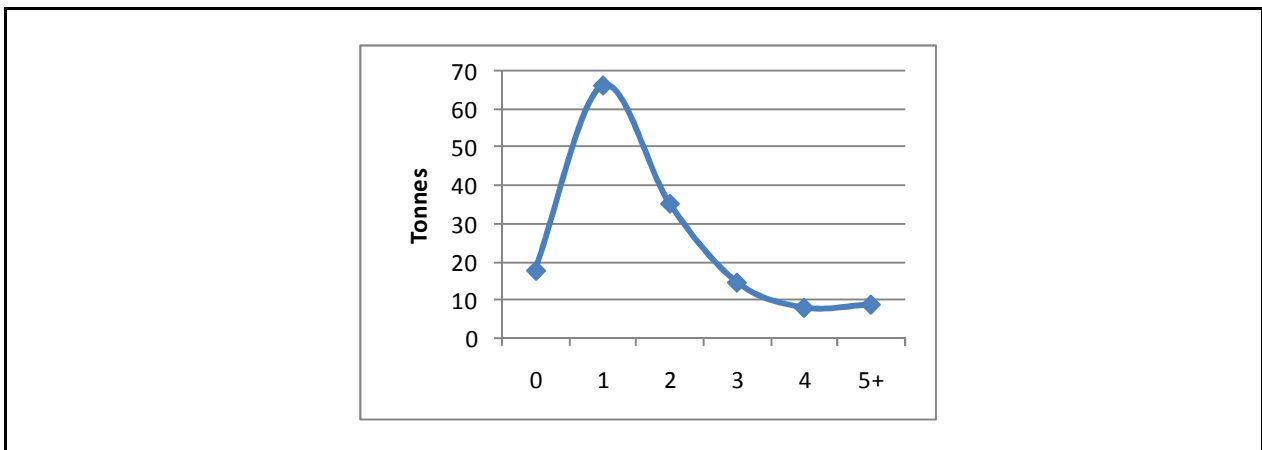
Page 4 / 4

Sex*	Unsexed	Gear*	Trawl	Analysis #*	3 (2000-2008)
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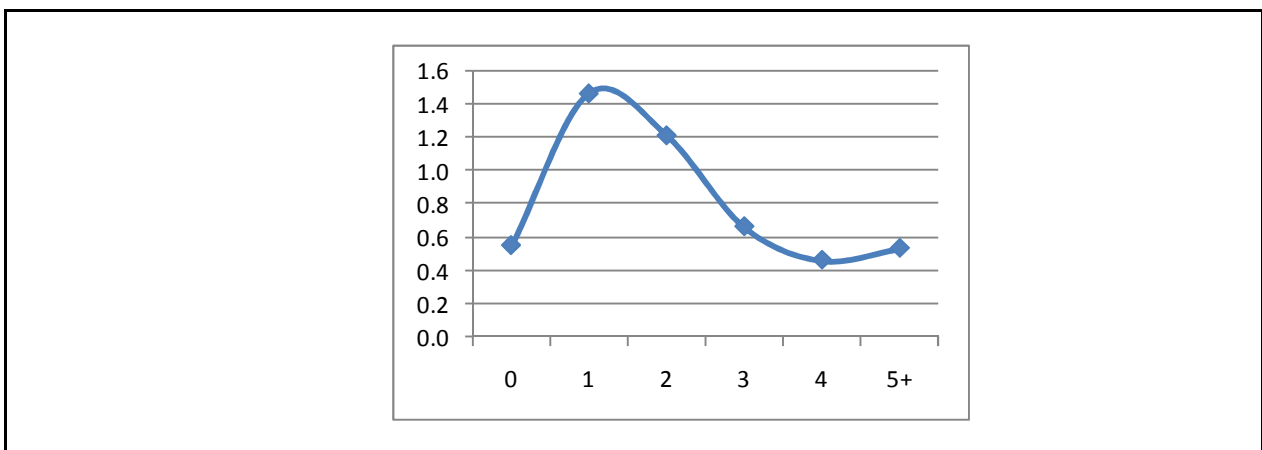
Population in figures



Population in biomass



Fishing mortality rates



SAC GFCM - Sub-Committee on Stock Assessment (SCSA)	
Assessment form	Sheet Y Indirect methods: Y/R

Sex	Unsexed	Code: HKE0509Gui	
		Analysis #	2, 3, 4

# of gears	1	Software	VIT (Leonart and Salat, 1992)
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Parameters used

Vector F	
Vector M	See sheet B
Vector N	From pseudocohort analysis

Model characteristics

From calculated mean weights (2000-2008)	

Results

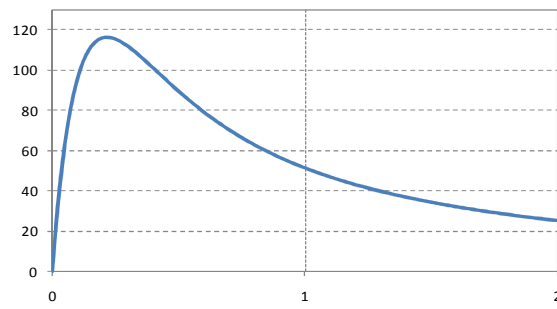
	Total	Gear			
Current YR	58.9				
Maximum Y/R	98.9				
Y/R 0.1	96.4				
F _{max}	0.34				
F _{0.1}	0.25				
Current B/R	56.1				
Maximum B/R	515.5				
B/R 0.1	515.5				

Comments

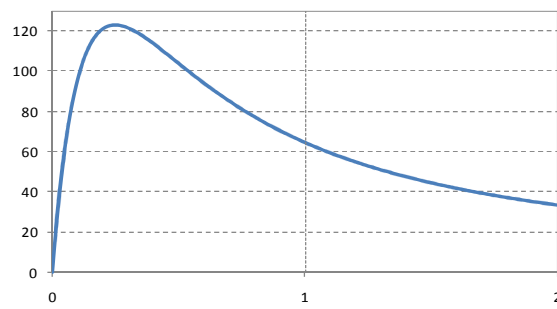
	1980-89	1990-99	2000-08
Current YR	51.4	64.5	58.9
Maximum Y/R	116.3	122.9	98.9
Y/R 0.1	112.7	118.7	96.4
F _{max}	0.23	0.26	0.34
F _{0.1}	0.16	0.18	0.25
Current B/R	34.5	58.2	56.1
Maximum B/R	402.2	461.2	515.5
B/R 0.1	549	610.2	515.5

Comments

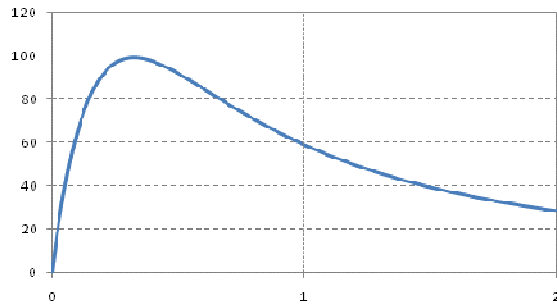
1980-89



1990-99



2000-08



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Assessment form

Sheet D
Diagnosis

Code: HKE0509Gui

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	<input type="checkbox"/>	? - (or blank) Not known or uncertain . Not much information is available to make a judgment;
	<input type="checkbox"/>	U - Underexploited, undeveloped or new fishery . Believed to have a significant potential for expansion in total production;
	<input type="checkbox"/>	M - Moderately exploited , exploited with a low level of fishing effort. Believed to have some limited potential for expansion in total production;
	<input type="checkbox"/>	F - Fully exploited . The fishery is operating at or close to an optimal yield level, with no expected room for further expansion;
	<input checked="" type="checkbox"/>	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;
	<input type="checkbox"/>	D - Depleted . Catches are well below historical levels, irrespective of the amount of fishing effort exerted;
	<input type="checkbox"/>	R - Recovering . Catches are again increasing after having been depleted or a collapse from a previous;

Bidimensional	Exploitation rate		Stock abundance			
	<input type="checkbox"/>	No or low fishing	<input type="checkbox"/>	Virgin or high abundance	<input type="checkbox"/>	Depleted
	<input checked="" type="checkbox"/>	Moderate fishing	<input checked="" type="checkbox"/>	Intermediate abundance	<input type="checkbox"/>	Uncertain / Not assessed
	<input type="checkbox"/>	High fishing mortality	<input type="checkbox"/>	Low abundance		
	<input type="checkbox"/>	Uncertain / Not assessed				

Comments

Although we consider that the stock is overexploited, we don't think that there is a high risk of stock depletion/collapse

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

Assessment form

Sheet Z

Objectives and recommendations

Code: HKE0509Gui

Management advice and recommendations*

To improve the trawl exploitation pattern and reduce the trawl effort.

To apply the Council Regulation (EC) 1967/2006, in force, concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea, in relation to the replacement of 40 mm diamond mesh in the bottom trawl cod-end by 40 mm square mesh. It could improve the exploitation pattern of this species and reduce the discards. In the Balearic Islands, Guijarro and Massutí (2006) and Ordines et al. (2006) have estimated that a change of diamond to square mesh in the cod-end could produce an increase of length at first capture for hake from 11 to 15 cm, respectively, without a significant decrease in commercial yields. In addition, discards on the deep shelf, where hake it is mainly exploited, could be reduced by 50%, specially fishes (both the commercial *Scyliorhinus canicula*, *Lepidotrigla cavillone* and *Chelidonichthys cuculus* and the non commercial *Capros aper*, *Macrorhamphosus scolopax*, *Synchiropus phaeton* and *Boops boops*).

Advice for scientific research*

We consider very necessary the improvement of national statistics on landings and fishing effort, especially in relation to the engine power, but also through the use of the information from the vessel monitoring system.