

SAC GFCM Sub-Committee on Stock Assessment

Date*

23	November	2009
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Code*

HKE1009Spe

Authors*

Spedicato Maria Teresa, Giuseppe Lembo
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Affiliation*

COISPA Tecnologia & Ricerca, Bari, Italy
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Species Scientific name* **1** *Merluccius merluccius* - HKE
Source: GFCM Priority Species

2
Source: -

3
Source: -

Geographical area*

1.3

Geographical Sub-Area (GSA)*

10 - South and Central Tirrenian Sea

Combination of GSAs

1	
2	
3	

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Assessment form

Sheet #0

Basic data on the assessment

Code: HKE1009Spe

Date*	23	Nov	2009	Authors*	Spedicato Maria Teresa, Giuseppe Lembo
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Species Scientific name*	Merluccius merluccius - HKE	Species common name*	hake
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Data Source

GSA*	10 - South and Central Tirrenian Sea	Period of time*	1994-2008
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Description of the analysis

Type of data*	Standardised abundance indices (N/km2 and kg/km2) standardised LFD	Data source*	MEDITS, selectivity experiments, DCR monitoring of effort
Method of assessment*	Pool dynamic model, CPUE analyses from surveys, Y/R model	Software used*	ALADYM, LFDA, SURBA, YIELD

Sheets filled out

B	P1	P2a	P2b	G	A1	A2	A3	Y	Other	D	Z	C
1	1	4	4	---	---	---	---	---	3	1	1	---

Comments, bibliography, etc.

The data used in the analyses were from trawl-surveys (time series of Medits and Grund surveys from 1994 to 2008 and from 1994 to 2006 respectively) and from the monitoring of effort and landing within the EU data collection framework. The analyses of population and reference point estimates were conducted using Aladym, LFDA, Surba, and Yield models in a complementary way.

Abella A., Caddy J., Serena F. (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 Res.*, 10: 257-269.

Abella A.J., F. Serena. (1998) - Selettività e vulnerabilità del nasello nella pesca a strascico. *Biol. Mar. Medit.* Vol. 5 (2)

Anonymous 2002. Stock Assessment in the Mediterranean-SAMED. Final Report EU Project n° 99/047.

Caddy J.F. (1991). Death rates and time intervals: is there an alternative to the constant natural mortality axiom? *Rev. Fish. Biol. Fish.* 1: 109-138.

Hoggarth D.D., Abeyasekera S., Arthur R.I., Beddington J.R., Burn, R.W., Halls A.S., Kirkwood G.P., McAllister M., Medley P., Mees C.C., Parkes G.B., Pilling G.M., Wakeford R.C., Welcomme R.L. 2006. Stock assessment for fishery management – A framework guide to the stock assessment tools of the Fisheries Management Science Programme (FMSP). *FAO Fisheries Technical Paper*. No. 487. Rome, FAO: 261p

Comments, bibliography, etc.

Kirkwood G.P., Aukland R., Zara S.J., (2001). Length Frequency Distribution Analysis (LFDA), version 5.0. MRAG Ltd, London, U.K.

Lembo G., Spedicato M.T., Silecchia T., D'Agostino V. (1998) – Distribution of nursery areas of *Merluccius merluccius* obtained by geostatistical techniques. *Cah. Options Méditerran.*, 35: 147-154.

Lembo G., Silecchia T., Carbonara P., Spedicato M.T. (2000) – Nursery areas of *Merluccius merluccius* in the Italian Seas and in the East Side of the Adriatic Sea. *Biol. Mar. Medit.*, 7 (3): 98-116.

Lembo G., Carbonara P., Silecchia T., Spedicato M.T. (2002) – Prove di pesca a strascico con rete a doppio sacco per la valutazione della selettività dell'attrezzo e della qualità del prodotto. I quaderni scientifici di Lega Pesca, Roma: 1-47.

Lembo G., Abella A., Fiorentino F., Martino S. and Spedicato M.-T. 2009. ALADYM: an age and length-based single species simulator for exploring alternative management strategies *Aquat. Living Resour.*, 22: 233–241.

Needle, C. L. 2003. Survey-based assessments with surba. Working Document to the ICES Working Group on Methods of Fish Stock Assessment, Copenhagen, 29 January – 5 February 2003.

Spedicato M.T., Carbonara P., Lembo G. (2003) – Valutazione delle risorse demersali dal Fiume Garigliano a Capo Suvero nel triennio 2000-2002. Relazione Finale GRU.N.D. (L.N. 41/82) U.O. 5, COISPA Tecnologia e Ricerca, Bari: 146 pp.

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Sheet B
Biology of the species

Code: HKE1009Spe

Biology

Somatic magnitude measured (LH, LC, etc)*		TL		Units*	cm
Sex	Fem	Mal	Both	Unsexed	
Maximum size observed	83	45.5			Reproduction season all year round
Size at first maturity	32				Reproduction areas continental shelf
Recruitment size				6	Nursery areas continental shelf

Parameters used (state units and information sources)

		Units	Sex			
			female	male	both	unsexed
Growth model	L ∞	cm	97.9	50.8		
	K		0.135	0.25		
	t0		-0.4	-0.4		
	Data source	trawl survey data and landings				
Length weight relationship	a				0.00355	
	b				3.2	
M						
sex ratio (mal/fem)	0.5					

Comments

A proxy of size at first maturity as estimated in the Samed project (Anonymous, 2002) using the average length at stage 2 (females with gonads at developing stage) indicates an average length of about 30 cm. According to the data obtained in the EU data collection framework, the proportion of mature females (fish belonging to the maturity stage 2 onwards) allowed to estimate a maturity ogive with a size at first maturity varying around 32 cm (maturity range 2 cm).
Mature females were found all year round with peaks in early winter and late spring.

The observed maximum lengths of European hake was 83 cm for females and 45.5 cm for males both registered during the biological samplings.

Estimates of growth parameters were achieved during the Samed project (Anonymous, 2002).

In the DCR framework the growth has been studied ageing fish by otolith readings using the whole sagitta and thin sections for older individuals. Length frequency distributions were also analyzed using techniques as Batthacharya for separation of modal components.

The estimates of von Bertalanffy growth parameters for each sex were obtained from average length at age using an iterative non-linear procedure that minimises the sum of the square differences between observed and expected values.

Vectorial natural mortality was calculated using the PRODBIOM Excel spreadsheet (Abella et al., 1997; Abella and Serena, 1998), which resulted in:

Age	0	1	2	3	4	5+
M	0.85	0.46	0.37	0.33	0.31	0.29

Comments

The geographical distribution pattern of European hake has been studied in the area using trawl-survey data and the geostatistical methods.

The higher concentration of recruits in the GSA10 were localised in the northern side (Gulfs of Napoli and Gaeta). More recent analyses performed in a project at national scale confirmed the presence of important zone for recruits in the northernmost part of the GSA, although sites with a high probability of locating a nursery appeared also along the coasts of southern part of the mainland and North Sicily. From Grund data (autumn surveys) the higher abundance of recruits were instead localised in the central part of the GSA, along the mainland coasts. Persistence of the nursery areas along the time was estimated from the indicator kriging.

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Assessment form

Sheet P1

General information about the fishery

Code: HKE1009Spe

Data source*	EU Data collection framework	Year (s)*	2004-2008
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Data aggregation (by year, average figures between years, etc.)*	by year
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Fleet and catches (please state units)

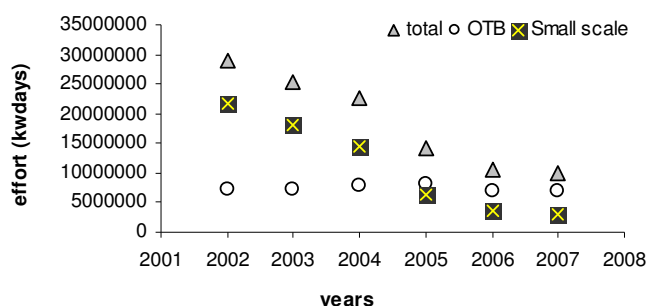
	Country	GSA	Fleet Segment	Fishing Gear Class	Group of Target Species	Species
Operational Unit 1*	ITA	10	C - Minor gear with engine (6-12 metres)	07 - Gillnets and Entangling Nets	33 - Demersal shelf species	HKE
Operational Unit 2	ITA	10	E - Trawl (12-24 metres)	03 - Trawls	33 - Demersal shelf species	HKE
Operational Unit 3	ITA	10	I - Long line (12-24 metres)	09 - Hooks and Lines	33 - Demersal shelf species	HKE
Operational Unit 4	ITA	10	C - Minor gear with engine (6-12 metres)	09 - Hooks and Lines	33 - Demersal shelf species	HKE
Operational Unit 5	ITA	10				HKE

Operational Units*	Fleet (n° of boats)*	Kilos or Tons	Catch (species assessed)	Other species caught	Discards (species assessed)	Discards (other species caught)	Effort units
ITA 10 C 07 33 - HKE	2282	Tons	388				Kwdays
ITA 10 E 03 33 - HKE	251	Tons	641				Kwdays
ITA 10 I 09 33 - HKE	31	Tons	15				Kwdays
ITA 10 C 09 33 - HKE	34	Tons	224				Kwdays
Total	2598		1268				

Legal minimum size	20 cm
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Comments

catches data are referred to 2007. The operational unit ITA 110 C 07 33-HKE include also 91 vessels of the length class 1224 m.



Trend in fishing effort (kW*days) for GSA 10 by major gear types, 2002-2008. Data on specific effort on hake are not available.

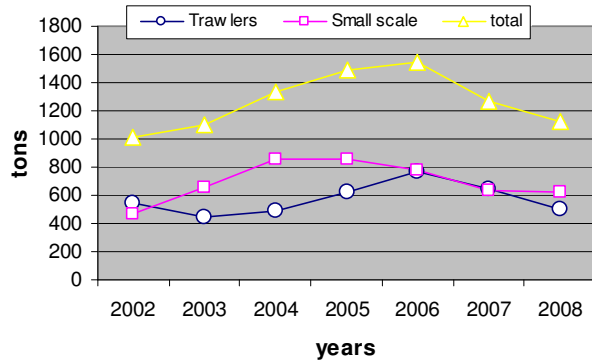
The fishing segments DTS, HOK, PGP, PMP and PTS indicate respectively trawlers, long-lines, small scale fishery (nets), polyvalent, and pair trawl. The fishing effort in kW*days of the trawlers seems almost stable, whilst that of the fishing segments and métiers forming the aggregation of the small scale fishery is decreasing. As a result the whole pattern is decreasing.

Comments

Annual landings (t) by major gear type, 2002-2008

Sum of Weight (tons) FISHING_TECH						
YEAR	SPECIES	DTS	PTS	PGP	PMP	Total
2002	HKE	515.30	26.50	224.80	245.60	1012.30
2003	HKE	425.10	21.30	328.50	321.70	1096.70

Sum of Weight (tons) FT_LVL4							
YEAR		OTB	GNS	GTR	LLS	SB-SV	Total
2004	HKE	487.20	382.90	202.20	266.40		1338.60
2005	HKE	623.80	293.80	297.40	269.70		1484.70
2006	HKE	761.30	343.00	152.10	287.70		1544.10
2007	HKE	640.70	219.80	167.90	240.20		1268.70
2008	HKE	500.60	319.30	67.60	233.90	1.40	1122.80



Landings (t) by year and major gear types, 2002-2008 in the GSA10. The fishing segments DTS, LLS, PGP, PMP and PTS indicate respectively trawler, long-lines, small scale fishery (nets), polyvalent, and pair trawl. Since 2002, landings of hake increased from 1,013 t to 1,544 t in 2006 and decreased to 1,122 t in 2008. Most part of the landings of hake are from trawlers and nets.

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Assessment form

Sheet P2a
Fishery by Operational Unit

Code: HKE1009Spe

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Data source*	EU data collection framework	OpUnit 1*	ITA 10 C 07 33 - HKE
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Time series

Year*	2004	2005	2006	2007	2008	
Catch	568	585	495	387	373	
Minimum size						
Average size Lc						
Maximum size						
Fleet	2104	2046	2315	2282		

Year						
Catch						
Minimum size						
Average size Lc						
Maximum size						
Fleet						

Selectivity

Remarks

L25		
L50		
L75		
Selection factor		
		

Structure by size or age

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Assessment form

Sheet P2a
Fishery by Operational Unit

Code: HKE1009Spe

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Data source*	EU data collection framework	OpUnit 2*	ITA 10 E 03 33 - HKE
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Time series

Year*	2004	2005	2006	2007	2008	
Catch	458.5	623.8	760.4	640.7	500.6	
Minimum size						
Average size Lc						
Maximum size						
Fleet	243	261	255	251		

Year						
Catch						
Minimum size						
Average size Lc						
Maximum size						
Fleet						

Selectivity

Remarks

L25	9	parameters were from selectivity experiments conducted using commercial type gears (e.g. Lembo et al., 2002; Leonori et al., 2005).
L50	12	
L75	15	
Selection factor	~3	

Structure by size or age

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Sheet P2a
Fishery by Operational Unit

Code: HKE1009Spe

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Data source*	EU data collection framework	OpUnit 3*	ITA 10 I 09 33 - HKE
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Time series

Year*	2004	2005	2006	2007	2008	
Catch	16.5	39.9	48.7	15.6	60.3	
Minimum size						
Average size Lc						
Maximum size						
Fleet	34	31	26	31		

Year						
Catch						
Minimum size						
Average size Lc						
Maximum size						
Fleet						

Selectivity

Remarks

L25		
L50		
L75		
Selection factor		

Structure by size or age

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Sheet P2a
Fishery by Operational Unit

Code: HKE1009Spe

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Data source*	EU data collection framework	OpUnit 4*	ITA 10 C 09 33 - HKE
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Time series

Year*	2004	2005	2006	2007	2008	
Catch	249.8	229.8	239.0	224.6	173.6	
Minimum size						
Average size Lc						
Maximum size						
Fleet	90	91	36	34		

Year						
Catch						
Minimum size						
Average size Lc						
Maximum size						
Fleet						

Selectivity

Remarks

L25		
L50		
L75		
Selection factor		

Structure by size or age

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Sheet P2b
Fishery by Operational Unit

Code: HKE1009Spe

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Data source*	EU data collection framework	OpUnit 1*	ITA 10.C 07 33 - HKE
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Regulations in force and degree of observance of regulations

Management regulations are based on technical measures and closed number of fishing licenses for the fleet.

In order to limit the over-capacity of fishing fleet, the Italian fishing licenses have been fixed since the late eighties. After 2000, in agreement with the European Common Policy of Fisheries, a gradual decreasing of the fleet capacity is implemented. Two closed areas were also established in 2004 along the mainland, in front of Sorrento peninsula (Napoli Gulf) and Amantea (Calabrian coasts), although these protected area mainly cover the distribution of coastal species.

Other measures on which the management regulations are based regards technical measures related to the height and length of the gears as well as the mesh size opening, that is 20 mm opening according to the national law (16 mm for the EC 1967/06), and the minimum landing sizes (EC 1967/06).

Accompanying species

European hake is mostly targeted by trawlers, but also by small scale fisheries using nets and bottom long-lines. Fishing grounds are located along the coasts of the whole GSA offshore 50 m depth. *M. barbatus*, *M. surmuletus*, *S. officinalis*, *O. vulgaris*, *E. cirrhosa* and *P. erythrinus* may co-occur in the catches.

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Assessment form

Sheet P2b
Fishery by Operational Unit

Code: HKE1009Spe

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Data source*	EU data collection framework	OpUnit 2*	ITA 10 E 03 33 - HKE
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Regulations in force and degree of observance of regulations

Management regulations are based on technical measures closed number of fishing licenses for the fleet and area limitation (distance from the coast and depth). In order to limit the over-capacity of fishing fleet, the Italian fishing licenses have been fixed since the late eighties. After 2000, in agreement with the European Common Policy of Fisheries, a gradual decreasing of the fleet capacity is implemented. Along northern Sicily coasts two main Gulfs (Patti and Castellammare) have been closed to the trawl fishery up 200 m depth, since 1990. Two closed areas were also established in 2004 along the mainland, in front of Sorrento peninsula (Napoli Gulf) and Amantea (Calabrian coasts), although these protected area mainly cover the distribution of coastal species. Other measures on which the management regulations are based regards technical measures (mesh size) and minimum landing sizes (EC 1967/06). In the GSA 10 the fishing ban has not been mandatory along the time, and from one year to the other it was adopted on a voluntary basis by fishers.

Accompanying species

European hake is mostly targeted by trawlers, but also by small scale fisheries using nets and bottom long-lines. Fishing grounds are located along the coasts of the whole GSA offshore 50 m depth or 3 miles from the coast. Catches from trawlers are from a depth range between 50-60 and 500 m and hake occurs with other important commercial species as *Illex coindetii*, *M. barbatus*, *P. longirostris*, *Eledone* spp., *Todaropsis eblanae*, *Lophius* spp., *Pagellus* spp., *P. blennoides*, *N. norvegicus*.

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Assessment form

Sheet P2b
Fishery by Operational Unit

Code: HKE1009Spe

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Data source*	Eu data collection framework	OpUnit 3*	ITA 10 I 09 33 - HKE
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Regulations in force and degree of observance of regulations

Management regulations are based on technical measures and closed number of fishing licenses for the fleet.

In order to limit the over-capacity of fishing fleet, the Italian fishing licenses have been fixed since the late eighties. After 2000, in agreement with the European Common Policy of Fisheries, a gradual decreasing of the fleet capacity is implemented. Two closed areas were also established in 2004 along the mainland, in front of Sorrento peninsula (Napoli Gulf) and Amantea (Calabrian coasts), although these protected area mainly cover the distribution of coastal species.

Other measures on which the management regulations are based regards technical measures related to the number of hooks and the minimum landing sizes (EC 1967/06).

Accompanying species

European hake is mostly targeted by trawlers, but also by small scale fisheries using nets and bottom long-lines. Fishing grounds are located along the coasts of the whole GSA offshore 50 m depth. Pagellus species may co-occur in the catches.

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Sheet P2b
Fishery by Operational Unit

Code: HKE1009Spe

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Data source*	Eu data collection framework	OpUnit 4*	ITA 10 C 09 33 - HKE
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Regulations in force and degree of observance of regulations

Management regulations are based on technical measures and closed number of fishing licenses for the fleet.

In order to limit the over-capacity of fishing fleet, the Italian fishing licenses have been fixed since the late eighties. After 2000, in agreement with the European Common Policy of Fisheries, a gradual decreasing of the fleet capacity is implemented. Two closed areas were also established in 2004 along the mainland, in front of Sorrento peninsula (Napoli Gulf) and Amantea (Calabrian coasts), although these protected area mainly cover the distribution of coastal species.

Other measures on which the management regulations are based regards technical measures related to the number of hooks and the minimum landing sizes (EC 1967/06).

Accompanying species

European hake is mostly targeted by trawlers, but also by small scale fisheries using nets and bottom long-lines. Fishing grounds are located along the coasts of the whole GSA offshore 50 m depth. Pagellus species may co-occur in the catches.

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Assessment form

Sheet other

Code: HKE1009Spe

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Other assessment methods

- Source of data and methods:

The data used in the analyses were from trawl surveys (time series of Medits and Grund surveys from 1994 to 2008 and from 1994 to 2006 respectively). Information on effort and landings were also used. The analyses on the population were conducted using ALADYM, SURBA and YIELD models and softwares in a complementary way.

The following growth parameters were used to split the LFD for the Surba analyses and to parameterize Aladym model as well as Yield software: $L_{inf}=97.9$ cm, $K=0.135$, $t_0= -0.4$; males: $L_{inf}=50.8$ cm, $K=0.25$, $t_0= -0.4$; length-weight relationship: $a=0.00355$, $b=3.2$.

Size at first maturity was varying around 32 cm (maturity range 2 cm).

Estimates of total mortality and recruitment from Surba were used to feed Aladym model, re-estimating the total and fishing mortality.

The following vector of natural mortality estimated by Prodbiom method was applied in both models.

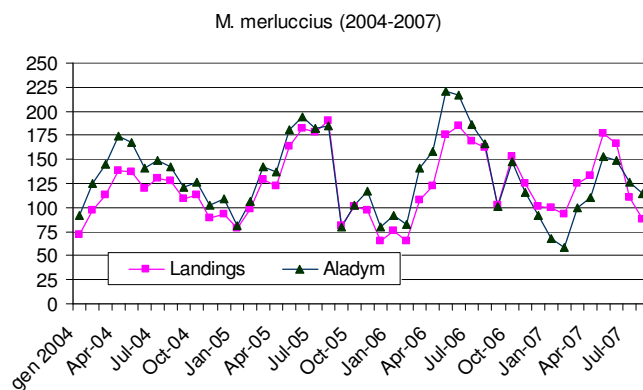
Age	0	1	2	3	4	5+
M	0.85	0.46	0.37	0.33	0.31	0.29

The following q parameters were used to set Surba

q	0.9	1	1	0.75	0.5	0.5
---	-----	---	---	------	-----	-----

The ratio between the month and the average year landing was used to tune the mortality.

Selectivity of the fleet was simulated using an ogive ($L_c=12$ cm: selection range 3 cm) coupled



Comparison of monthly catches from Aladym and landings from DCR (in tons).

Other assessment methods

Brief description of trends:

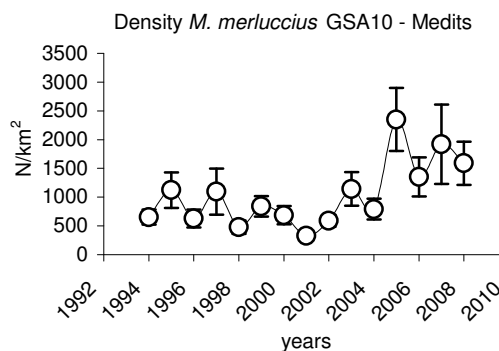
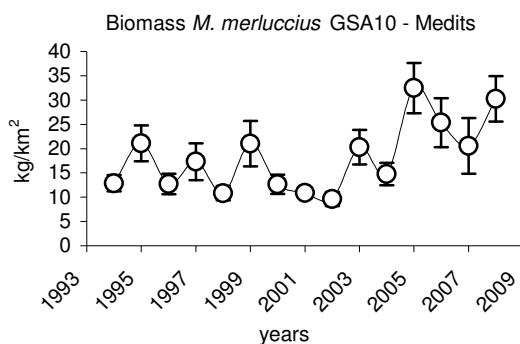
Available landing data are from DCR regulations and range from 1012 tons of 2002 to 1544 tons in 2006. Landings were rising from 2002 to 2006 and then were decreasing to 1122 tons in 2008.

The whole fishing effort (kwdays) of fishing segments (2002-2004) or métier (2005-2007) related with hake capture in the GSA 10 shows a decreasing from 2002 till now, with trawlers almost stable and slightly decreasing in the last 3 years and small scale fishery decreasing from 2002 to 2007.

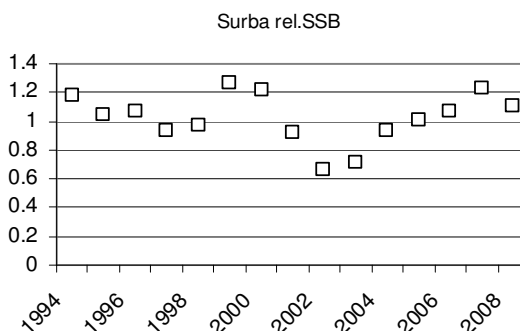
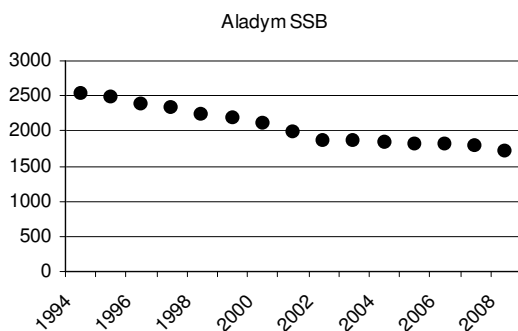
• State of the adult abundance and biomass:

Fishery independent information regarding the state of the hake in GSA 10 was derived from the international survey Medits. Indices from Medits trawl-surveys show an increasing pattern in the last years, although variability is high. The recent levels are the higher observed so far.

The hindcasting approach using ALADYM model shows that the SSB was decreasing along the time series. A similar pattern shows also the spawning potential ratio that was in the range 6 and 4% from 1994 and 2008. The spawning stock biomass from SURBA, that is expressed in relative units and normalized, showed decreasing and increasing cycles.



Bars indicate standard deviation



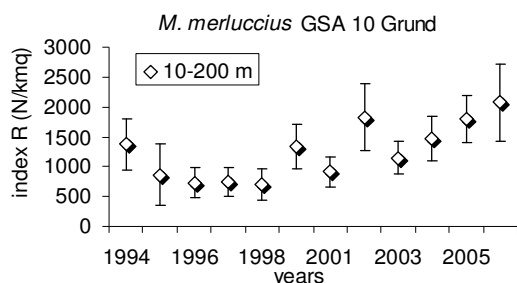
SSB in tons from Aladym simulations and relative SSB from Surba

Other assessment methods

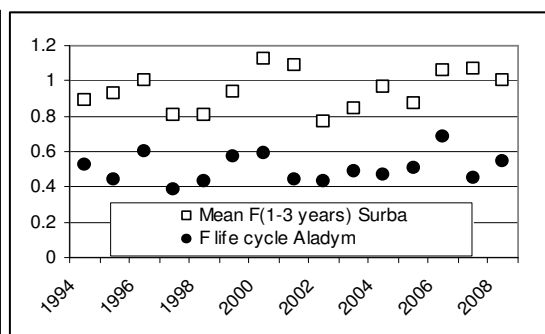
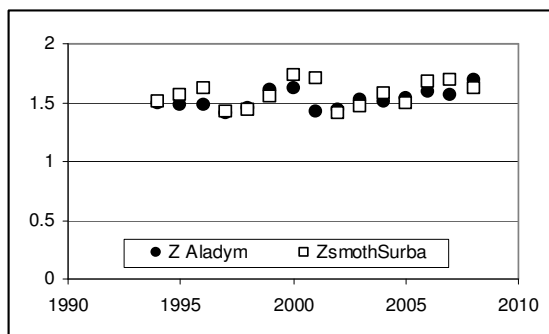
- State of the juvenile (recruits):
Recent recruitment since 2006 appears to be above average.
- State of exploitation:
Estimates of total mortality from SURBA and ALADYM were converging, also a similar pattern was observed for the fishing mortality with difference in levels due to the age range considered.
State of the stock in relation to reference points was estimated using YIELD software.
Considering the level of F estimated in 2008 by ALADYM, i.e. 0.55, a reduction of 55% would be necessary to reach F0.1 (0.244), while a reduction of about 23% would be necessary to reach Fmax.

Equilibrium "Yield results"	F	Y/R	B/R	SSB/R
F(0.1)	0.244	0.615	2.643	1.619
F(Max)	0.419	0.659	0.824	1.691
F(Current)	0.548	0.645	0.5	1.27

Given the results of the present analysis, the stock appears overfished. The results related to the SSB from ALADYM also give similar signals with spawning biomass decreasing along time. Signals from the survey indices are instead increasing, while the global effort appears decreasing.



Recruits N/km² in Grund survey (left) and from Surba (right).



Total (left) and fishing mortality (right) from the two models

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Assessment form

Sheet D
Diagnosis

Code: HKE1009Spe

Indicators and reference points

Criterion	Current value	Units	Reference Point	Trend	Comments
B					
SSB					
F	0.548		F01=0.244		Fmax = 0.42
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 type="checkbox"/>	Moderate fishing	<input type="checkbox"/>	Intermediate abundance	<input type="checkbox"/>	Uncertain / Not assessed
	<input checked="" type="checkbox"/>	High fishing mortality	<input type="checkbox"/>	Low abundance		
	<input type="checkbox"/>	Uncertain / Not assessed				

Comments

Given the results of the present analysis, the stock of hake appears overexploited since the current fishing mortality is higher than $F_{0.1}$ and F_{max} . SGMED 09-02 proposes $F=0.24$ as target management reference point (basis $F_{0.1}$).

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

Assessment form

Sheet Z

Objectives and recommendations

Code: HKE1009Spe

Management advice and recommendations*

SGMED recommends the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed level $F_{0.1}$, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries effects. Catches consistent with the effort reductions should be estimated.

Advice for scientific research*

Supporting of tagging experiments of hake in different Mediterranean areas to improve knowledge on the species growth at larger scale.

Introduce a second annual scientific survey campaign in autumn to improve temporal resolution of survey data, in particular data on recruitment and mortality.