SAC GFCM
Sub-Committee on Stock Assessment

Date*	18	October	2011	Code*	HKE1811Spe

Authors*

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Species Scientific name*

1 *Merluccius merluccius* - *HKE*
Source: GFCM Priority Species

2
Source: -

3
Source: -

Geographical area*

2.1

Geographical Sub-Area (GSA)*

18 - Southern Adriatic Sea

Combination of GSAs
1
2
3

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

Code: HKE1811Spe

Date*	18	Oct	2011	Authors*	Spedicato M.T.1, Bitetto I.1, Lembo G.1, Carbonara P.1, Casciaro L.1, Facchini M.T.1, Milone N.2, Ceriola L.2, Joksimovic A.3, Ikica Z.3, Kasalica O.3, Kolitari J.4, Gjurgji I.4,

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

Data Source

GSA*	18 - Southern Adriatic Sea	Period of time*	1994-2010

Description of the analysis

Type of data*	Standardised abundance indices (N/km2 and kg/km2) standardised LFD, length structure of landings	Data source*	MEDITS, selectivity experiments, DCF monitoring of landings
Method of assessment*	Pool dynamic model, CPUE analyses from surveys, Y/R model	Software used*	ALADYM, SURBA, VIT4win, medium term forecast R-routine (SGMED, 2010), age slicing R-routine

Sheets filled out

B	P1	P2a	P2b	G	A1	A2	A3	Y	Other	D	Z	C
1	1	5	5	---	4	1	4	1	4	1	1	---

Comments, bibliography, etc.

The stock of European hake was assumed in the boundaries of the whole GSA 18 where it inhabits depths from several meters in the coastal area down to 800 m in the South Adriatic Pit.
For the evaluation of hake stock status in GSA 18 different methods and different sources of data (MEDITS data 1994-2010, selectivity experiments, DCF 2007-2010) have been used. Regarding the methods, the SURBA software (Needle, 2003), the ALADYM model (Lembo et al., 2009) and the VIT software (Lleonart and Salat, 1997) were used. In ALADYM mortality levels and harvesting strategies are used to forecast the effects on the population metrics (accounting for cohort structure) and simulated catches, thus even different harvesting strategies from those actually assessed can be evaluated. The current level of the spawning stock vs. the level at F = 0 can be also estimated. The LCA (or pseudocohort analysis age-based) as implemented in VIT allows to perform a length cohort analysis under the steady state assumption and thus the fishing mortality vector is estimated. In addition, the Y/R analysis implemented in the software allows the calculation of the Biological Reference Points F0.1 and Fmax. A transition analysis with VIT was performed, in order to evaluate the impact of different exploitation scenarios. Finally, all the methods for the evaluation are discussed and used in a complementary and integrated way, in order to exploit the advantage of a multi-methods and multi-data approach.

Comments, bibliography, etc.

To account for uncertainty in life history profile of European hake a sensitivity analysis was performed using two scenarios of growth: slow and fast growth. For both scenarios the analyses are conducted for sex combined. Natural mortality vectors for the two scenarios were obtained applying the Prodbiom method (Abella et al., 1997).

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Assessment form — **Sheet B** — **Biology of the species**

Code: HKE1811Spe

Biology

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

Sex	Fem	Mal	Both	Unsexed		
Maximum size observed	93.5	66.5			Reproduction season	all year round
Size at first maturity	33.4				Reproduction areas	continental shelf
Recruitment size				6	Nursery areas	continental shelf

Parameters used (state units and information sources)

			Sex			
		Units	female	male	both	unsexed
Growth model	L∞	cm			95	
	K	year^(-1)			0.14	
	t0	year			-0.4	
	Data source	trawl survey data and landings				
Length weight relationship	a	cm; g			0.0043	
	b	cm; g			3.155	
	M					

sex ratio (mal/fem)	0.5

Comments

Mature females were found all year round with peaks in early winter and late spring. A proxy of size at first maturity (SAMED, 2002) using the average length at stage 2 (females with gonads at developing stage) indicated an average length of about 29 cm. According to the data obtained in the DCF 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 33.4 (±0.15 cm) (maturity range 3.8 ±0.16 cm). The observed maximum lengths of European hake were 93.5 cm for females and 66.5 cm for males both registered during Medits samplings. In the commercial sampling also a female of 93.5 cm length was observed in 2009. In the DCF 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 were obtained for sex combined from average length at age using an iterative non-liner procedure that minimises the sum of the square differences between observed and expected values.
To account for uncertainty in life history profile of European hake a sensitivity analysis was performed using two scenarios of growth for sex combined: Linf = 95, k = 0.14 and t0 = -0.4, (slow scenario); Linf=104 cm, k=0.2, t0= -0.01 (SGMED, 2010 (fast scenario). Length-weight relationship: a=0.0043, b=3.155 for both scenarios.
The plus group 5+ and 4+ were used respectively for slow and fast growth.

Age	0	1	2	3	4	5+
M (slow)	0.76	0.42	0.30	0.25	0.25	0.25
Prop. mature (slow)	0.0004	0.006	0.430	0.946	1	1
Weight (kg) (slow)	0.01	0.04	0.15	0.35	0.66	1.77

Age	0	1	2	3	4+
M (fast)	1.16	0.53	0.40	0.35	0.32
Prop. mature (fast)	0.008	0.248	0.887	1.000	1.000
Weight (kg) (fast)	0.01	0.14	0.53	1.15	2.35

Comments

M. merluccius spawns throughout the year, but with different intensities. The spawning peaks are in the summer and winter periods (Zupanovic, 1968; Ungaro et al., 1993; Donnaloia, 2009). Recent estimates of the batch fecundity (Donnaloia, 2009) reported higher values in comparison to the fecundity reported by Morua et al. (2006) for the Atlantic Sea and Recasens et al. (2008) for the Northern Tyrrhenian Sea. Karlovac (1965) recorded young hake larvae from October to June, the highest numbers were recorded in January and February. Larvae and post-larvae were mainly distributed between 40 and 200 m; the highest number of individuals was caught mainly between 50 and 100 m. Recruitment peaks in the winter and late spring (Ungaro et al., 1993; Donnaloia, 2009).
The geographical distribution pattern of European hake has been studied in the area using trawl-survey data and the geostatistical methods. In the GSA18 nursery areas have been localised off Gargano promontory along the west side (100-200 m depth) and in the southern part of Albanian coasts (Frattini and Paolini, 1995; Lembo et al., 2000; Carlucci et al., 2009).
Kirinčić and Lepetić (1955) and De Zio et al. (1998) investigated the catch size structure from the bottom long-line fishery in the Southern Adriatic. The average total length of the European hake was 58.6 cm (Kirinčić and Lepetić, 1955), while De Zio et al. (1998) found a median total length of 70 cm. The average catch rate was 5.6 specimens per 100 hooks.

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Assessment form

Sheet P1

General information about the fishery

Code: HKE1811Spe

Data source*	EU Data collection framework	Year (s)*	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*	ITA	18	C - Minor gear with engine (6-12 metres)	07 - Gillnets and Entangling Nets	33 - Demersal shelf species	HKE
Operational Unit 2	ITA	18	E - Trawl (12-24 metres)	03 - Trawls	33 - Demersal shelf species	HKE
Operational Unit 3	ITA	18	I - Long line (12-24 metres)	09 - Hooks and Lines	33 - Demersal shelf species	HKE
Operational Unit 4	ITA	18	D - Trawl (6-12 metres)	03 - Trawls	33 - Demersal shelf species	HKE
Operational Unit 5	ITA	18	F - Trawl (>24 metres)	03 - Trawls	33 - Demersal shelf species	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 18 C 07 33 - HKE	839	Tons	19				
ITA 18 E 03 33 - HKE	579	Tons	2876				
ITA 18 I 09 33 - HKE	37	Tons	601				
ITA 18 D 03 33 - HKE	40	Tons	84				
ITA 18 F 03 33 - HKE	61	Tons	440				
Total	1556		4020				

Legal minimum size	20

Comments

The fleet data are referred to the whole GSA and are related to the year 2007 (GFCM Statistical Bulletin 2008). Catch data above reported for the west side are referred to the year 2010 (DCF data). The operational unit ITA18E0333-HKE and ITA18E0333-HKE include also demersal slope fishing (mixed demersal according to DCF classification).
The catch data from the whole GSA18 including the east side are below reported:

Comments

Italy				western	Montenegro	Albania	eastern	Total
Year	LLS	NETS	OTB	landings	OTB	OTB	landing	
2004	233	40	2932	3205				3205
2005	452	56	3276	3784				3784
2006	836	56	4613	5505		265	265	5770
2007	620	37	3498	4155		275	275	4430
2008	551	57	3641	4249		249	249	4498
2009	534	28	3536	4098		292	292	4390
2010	601	19	3400	4020	36	240	276	4296

Data source*	EU data Collection framework	OpUnit 1*	ITA 18 C 07 33 - HKE

Time series

Year*	2007	2008	2009	2010		
Catch	37	57	27	19		
Minimum size						
Average size Lc						
Maximum size						
Fleet						

Year						
Catch						
Minimum size						
Average size Lc						
Maximum size						
Fleet						

Selectivity

L25	
L50	
L75	
Selection factor	

Remarks

Structure by size or age

Structure by size or age

Data source*	EU data Collection framework	OpUnit 2*	ITA 18 E 03 33 - HKE

Time series

Year*	2007	2008	2009	2010		
Catch	3104	3038	2910	2876		
Minimum size						
Average size Lc						
Maximum size						
Fleet						

Year						
Catch						
Minimum size						
Average size Lc						
Maximum size						
Fleet						

Selectivity

Remarks

L25	
L50	
L75	
Selection factor	

Structure by size or age

Data source*	EU data Collection framework	OpUnit 3*	ITA 18 I 09 33 - HKE

Time series

Year*	2007	2008	2009	2010		
Catch	607	490	338	601		
Minimum size						
Average size Lc						
Maximum size						
Fleet						

Year						
Catch						
Minimum size						
Average size Lc						
Maximum size						
Fleet						

Selectivity

Remarks

L25		
L50		
L75		
Selection factor		

Structure by size or age

Data source*	EU data Collection framework	OpUnit 4*	ITA 18 D 03 33 - HKE

Time series

Year*	2007	2008	2009	2010		
Catch	26	100	97	84		
Minimum size						
Average size Lc						
Maximum size						
Fleet						

Year						
Catch						
Minimum size						
Average size Lc						
Maximum size						
Fleet						

Selectivity

Remarks

L25		
L50		
L75		
Selection factor		

Structure by size or age

Data source*	EU data Collection framework	OpUnit 5*	ITA 18 F 03 33 - HKE

Time series

Year*	2007	2008	2009	2010		
Catch	367	505	537	440		
Minimum size						
Average size Lc						
Maximum size						
Fleet						

Year						
Catch						
Minimum size						
Average size Lc						
Maximum size						
Fleet						

Selectivity

Remarks

L25		
L50		
L75		
Selection factor		

Structure by size or age

Data source*	EU data Collection framework	OpUnit 1*	ITA 18 C 07 33 - HKE

Regulations in force and degree of observance of regulations

Management regulations are based on technical measures related to the height and length of the gears as well as the mesh size opening, minimum landing sizes and number of fishing licenses for the fleet.

Accompanying species

European hake is mostly targeted by trawlers, and to a lesser extent 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.

Data source*	EU data Collection framework	OpUnit 2*	ITA 18 E 03 33 - HKE

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 capacity has been gradually reduced. In 2008 a management plan was adopted. Other measures on which the management regulations are based regards technical measures (mesh size), minimum landing sizes (EC 1967/06) and seasonal fishing ban along the west side.

Accompanying species

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*.

Data source*	EU data Collection framework	OpUnit 3*	ITA 18 I 09 33 - HKE

Regulations in force and degree of observance of regulations

Management regulations are based on technical measures related to the number of hooks and the minimum landing sizes (EC 1967/06), besides the regulated number of fishing licences.

Accompanying species

Fishing grounds are located along the coasts of the whole GSA offshore 50 m depth. Pagellus species may co-occur in the catches.

Data source*	EU data Collection framework	OpUnit 4*	ITA 18 D 03 33 - HKE

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 capacity has been gradually reduced. In 2008 a management plan was adopted. Other measures on which the management regulations are based regards technical measures (mesh size), minimum landing sizes (EC 1967/06) and seasonal fishing ban along the west side.

Accompanying species

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.*

Data source*	EU data Collection framework	OpUnit 5*	ITA 18 F 03 33 - HKE

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 capacity has been gradually reduced. In 2008 a management plan was adopted. Other measures on which the management regulations are based regards technical measures (mesh size), minimum landing sizes (EC 1967/06) and seasonal fishing ban along the west side.

Accompanying species

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 A1
Indirect methods: VPA, LCA

Code: HKE1811Spe

Sex*	combined

Analysis # *	LCA

Time series

Data	Size	Age
(mark with X)		X

Model	Cohorts	Pseudocohorts
(mark with X)		X

Equation used	LCA	Tunig method	none
# of gears	4	Software	Vit4Win
$F_{terminal}$	0.25		

Population results (please state units)

	Sizes	Ages		Amount	Biomass
Minimum	10.195 cm	0.416 years	Recruitment	134044287	101 tons
Average	14.575 cm	0.857 years	Average population	115588668	751 tons
Maximum	60.151 cm	7 years	Virgin population		228028 tons
Critical	16.909 cm	1 year	Turnover		

Average mortality

		Gear					
	Total	Longlines ITA	Trawls ITA	Trawls MNE	Trawls ALB		
F_1	0.634	0.0438	0.5414	0.0072	0.0412		
F_2							
Z	1.03						

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

Comments

These results are referred to the slow growth scenario for 2010.
A first exercise for an evaluation at the whole GSA level based on preliminary data of commercial landings from Albanian trawlers for 2010 and also of length-frequency distribution from Montenegrin trawlers in 2010 was accomplished.
The assumption that length-frequency distribution (LFD) of Albanian commercial catch was similar to the Italian LFD has been made, due to the unavailability of suitable LFD data; therefore, the LFD of Italian trawlers was raised to the Albanian production of trawlers. The VPA and the Y/R analysis have been performed for 4 fleet segments: Italian longlines, Italian trawlers, Albanian trawlers and Montenegrin trawlers.

Sex*	combined

Analysis # *	LCA

Time series

Data	Size	Age
(mark with X)		X

Model	Cohorts	Pseudocohorts
(mark with X)		X

Equation used	LCA	Tunig method	none
# of gears	4	Software	Vit4Win
$F_{terminal}$	0.32		

Population results (please state units)

	Sizes	Ages		Amount	Biomass
Minimum	7.966 cm	0.376 years	Recruitment	149487082	178 tons
Average	11.412 cm	0.593 years	Average population	90643533	5329 tons
Maximum	68.742 cm	5.587 years	Virgin population		207797 tons
Critical	19.361 cm	1 year	Turnover		

Average mortality

		Gear					
	Total	Longlines ITA	Trawls ITA	Trawls MNE	Trawls ALB		
F_1	0.865	0.073	0.727	0.01	0.055		
F_2							
Z	1.47						

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

Comments

These results are referred to the fast growth scenario for 2010.
A first exercise for an evaluation at the whole GSA level based on preliminary data of commercial landings from Albanian trawlers for 2010 and also of length-frequency distribution from Montenegrin trawlers in 2010 was accomplished.
The assumption that length-frequency distribution (LFD) of Albanian commercial catch was similar to the Italian LFD has been made, due to the unavailability of suitable LFD data; therefore, the LFD of Italian trawlers was raised to the Albanian production of trawlers. The VPA and the Y/R analysis have been performed for 4 fleet segments: Italian longlines, Italian trawlers, Albanian trawlers and Montenegrin trawlers.

Sex*	combined

Analysis # *	LCA

Time series

Data	Size	Age
(mark with X)		X

Model	Cohorts	Pseudocohorts
(mark with X)		X

Equation used	LCA	Tunig method	none
# of gears	2	Software	Vit4Win
$F_{terminal}$	0.25		

Population results (please state units)

	Sizes	Ages		Amount	Biomass
Minimum	10.22 cm	0.42 years	Recruitment	133267586	101 tons
Average	14.11 cm	0.81 years	Average population	113242215	6817 tons
Maximum	60.151 cm	7 years	Virgin population		239221 tons
Critical	16.909 cm	1 year	Turnover		

Average mortality

		Gear					
	Total	Trawls ITA	Longlines ITA				
F_1	0.67	0.65	0.02				
F_2							
Z	1.07						

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

Comments

These results are referred to the slow growth scenario and are an average among 2007-2009.
An assessment based on the LCA analysis was performed for the west side of the GSA 18 for years 2007, 2008, 2009 using the VIT software.
To perform LCA, using VIT4win, landings data for years 2007-2009 sent for Mediterranean and Black Sea data call - 2011 were used.
The complete results for each year are in sheet A3/3.

Sex*	combined

Analysis # *	LCA

Time series

Data	Size	Age
(mark with X)		X

Model	Cohorts	Pseudocohorts
(mark with X)		X

Equation used	LCA	Tunig method	none
# of gears	2	Software	Vit4Win
$F_{terminal}$	0.32		

Population results (please state units)

	Sizes	Ages		Amount	Biomass
Minimum	7.661 cm	0.38 years	Recruitment	157832345	169 tons
Average	10.65 cm	0.57 years	Average population	95927380	4519 tons
Maximum	68.6 cm	5.59 years	Virgin population		217972 tons
Critical	19 cm	1 year	Turnover		

Average mortality

		Gear					
	Total	Trawls ITA	Longlines ITA				
F_1	0.93	0.86	0.07				
F_2							
Z	1.54						

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

Comments

These results are referred to the fast growth scenario and are an average among 2007-2009.
An assessment based on the LCA analysis was performed for the west side of the GSA 18 for years 2007, 2008, 2009 using the VIT software.
To perform LCA, using VIT4win, landings data for years 2007-2009 sent for Mediterranean and Black Sea data call - 2011 were used.
The complete results for each year are in sheet A3/4.

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Assessment form

Sheet A2
Indirect methods: data

Code: HKE1811Spe

Sex*	combined	Gear*	trawls, longlines	Analysis # *	LCA

Data source	Landings data from GSA18 west side, data collection framework

Data

Input landing data for VIT, slow growth scenario, years 2007, 2008, 2009 west side

	2007		2008		2009	
Age	OTB	LLS	OTB	LLS	OTB	LLS
0	28156832	0	13395985	0	14822304	0
1	30013686	6678	32222568	279	29813198	702
2	3158670	66783	3116519	17234	3844490	64318
3	499744	80140	575560	13161	527576	100629
4	151568	31971	167871	35926	59762	67422
5+	10826	241840	108139	278129	76253	201058

Input landing data for VIT, slow growth scenario, year 2010, west and east sides

Age	LLS Italy	OTB Italy	OTB Montenegro	OTB Albania
0	0	16771917	292799	1185559
1	4884	24160166	247290	1707813
2	81072	2563259	10611	181189
3	184610	604273	701	42715
4	91360	187220	0	13233
5+	197765	130238	0	9210

Input commercial catch data for VIT, fast growth scenario, years 2007, 2008, 2009, west side

	2007		2008		2009	
Age	OTB	LLS	OTB	LLS	OTB	LLS
0	37063571	0	20247450	0	22137061	0
1	24112189	60105	28274930	12209	26096500	40901
2	772260	101180	883297	31826	807857	166541
3	43305	108870	134619	141812	58047	82740
4+	0	157257	46346	158883	44119	142543

Input landing data for VIT, fast growth scenario, year 2010, west and east sides.

Age	LLS Italy	OTB Italy	OTB Montenegro	OTB Albania
0	0	24431218	377991	1726973
1	81330	19014072	172538	1344050
2	244912	763364	872	53960
3	95724	138384	0	9783
4+	137725	70035	0	4953

All the other parameters used in the analyses were provided in the previous sheets.

Assessment form

Sex*	combined	Gear*	trawls, longlines

Population in figures

Results slow scenario west and east sides 2010.

VPA Results--Numbers		
Age	**Initial number**	**Mean number**
0	134044287	84017458
1	48321083	22091008
2	7674550	4871175
3	2851116	2022165
4	1371955	1043263
5+	771799	1543597

Population in biomass

Results slow scenario west and east sides 2010.

VPA Results--Weight		
Age	**Initial Weight**	**Mean Weight**
0	101	736
1	1516	1377
2	1063	1044
3	962	922
4	852	809
5+	751	2830

Weights are in tons

Fishing mortality rates

Results slow scenario west and east sides 2010.

Age	Z	Total F	F LLS Italy	F OTB Italy	F OTB Montenegro
0	1.02	0.26	0	0.235	0.007
1	1.84	1.41	0	1.289	0.023
2	0.99	0.69	0.019	0.62	0.005
3	0.731	0.481	0.102	0.352	0.001
4	0.575	0.325	0.098	0.211	0
5+	0.5	0.25	0.143	0.099	0

	Analysis #*	LCA

F OTB Albania
0.018
0.098
0.047
0.027
0.016
0.008

Assessment form

Sex*	combined	Gear*	trawls, longlines

Population in figures

Results fast scenario west and east sides 2010.

VPA Results--Numbers		
Age	**Initial number**	**Mean number**
0	149487082	75998326
1	31756053	11744241
2	2667866	1614914
3	883917	622270
4+	418183	663783

Population in biomass

Results fast scenario west and east sides 2010.

VPA Results--Weight		
Age	**Initial Weight**	**Mean Weight**
0	178	1297
1	1569	1311
2	831	812
3	730	699
4+	642	1913

Weights are in tons

Fishing mortality rates

Results fast scenario west and east sides 2010.

Age	Z	Total F	F LLS Italy	F OTB Italy	F OTB Montenegro
0	1.549	0.391	0	0.355	0.009
1	2.477	1.957	0.006	1.787	0.028
2	1.105	0.705	0.142	0.522	0.001
3	0.748	0.408	0.144	0.245	0
4+	0.63	0.32	0.195	0.116	0

	Analysis #*	LCA

F OTB Albania
0.027
0.136
0.04
0.019
0.009

Assessment form

Sex*	combined	Gear*	trawls, longlines

Population in figures

Results slow scenario west side 2007-2009.

	VPA Results--Numbers-2007		VPA Results--Numbers-2008		VPA Results-
Age	Initial number	Mean number	Initial number	Mean number	Initial number
0	145132770	87760833	125916522	81939033	128753467
1	47963844	20787318	49631009	21444725	49550372
2	6537752	3765472	6705561	4053140	7469783
3	1915807	1372426	2213845	1647840	1968631
4	943015	734844	1187662	947379	935778
5+	559826	1119651	741921	1483842	606863

Population in biomass

Results slow scenario west side 2007-2009.

	VPA Results--Weight-2007		VPA Results--Weight-2008		VPA Results
Age	Initial Weight	Mean Weight	Initial Weight	Mean Weight	Initial Weight
0	108	765	94	746	101
1	1544	1318	1598	1358	1592
2	945	832	969	903	1055
3	681	662	787	799	676
4	622	608	783	785	591
5+	581	2206	770	2924	600

Weights are in tons

Fishing mortality rates

Results slow scenario west side 2007-2009.

	VPA Results--Mortalities-2007				
Age	Z	Total F	F OTB Italy	F LLS Italy	Z
0	1.107	0.347	0.347	0	0.931
1	1.993	1.563	1.562	0	2.002
2	1.227	0.927	0.908	0.02	1.108
3	0.709	0.459	0.394	0.065	0.623
4	0.521	0.271	0.223	0.048	0.47
5+	0.5	0.25	0.01	0.24	0.5

	Analysis #*	LCA

-Numbers-2009
Mean number
82943021
22239870
4125263
1388775
759487
1213725

--Weight-2009
Mean Weight
758
1408
879
643
602
2255

VPA Results--Mortalities-2008			VPA Results--Mortalities-2009		
Total F	F OTB Italy	F LLS Italy	Z	Total F	F OTB Italy
0.171	0.171	0	0.955	0.195	0.195
1.572	1.572	0	1.892	1.462	1.462
0.808	0.804	0.004	1.334	1.034	1.016
0.373	0.365	0.007	0.744	0.494	0.414
0.22	0.185	0.035	0.433	0.183	0.086
0.25	0.076	0.174	0.5	0.25	0.069

F LLS Italy
0
0
0.017
0.079
0.097
0.181

Assessment form

Sex*	combined	Gear*	trawls,longlines

Population in figures

Results fast scenario west side 2007-2009.

	VPA Results--Numbers-2007		VPA Results--Numbers-2008		VPA Results--I
Age	**Initial number**	**Mean number**	**Initial number**	**Mean number**	**Initial number**
0	177596553	87694773	145901945	78310271	149998539
1	34890260	11570273	35735228	12083159	35341612
2	2040156	1184106	2233418	1394716	2178660
3	609407	439597	797994	549441	642793
4+	304708	483663	358789	569506	344964

Population in biomass

Results fast scenario west side 2007-2009.

	VPA Results--Weight-2007		VPA Results--Weight-2008		VPA Results-
Age	**Initial Weight**	**Mean Weight**	**Initial Weight**	**Mean Weight**	**Initial Weight**
0	190	94	156	84	160
1	1630	1184	1670	1247	1651
2	619	579	678	692	662
3	495	489	649	608	523
4+	463	1386	545	1632	524

Weights are in tons

Fishing mortality rates

Results fast scenario west side 2007-2009.

	VPA Results--Mortalities-2007				
Age	**Z**	**Total F**	**F OTB Italy**	**F LLS Italy**	**Z**
0	1.627	0.469	0.469	0	1.407
1	2.839	2.319	2.314	0.005	2.773
2	1.208	0.808	0.724	0.084	1.029
3	0.693	0.353	0.109	0.244	0.799
4+	0.63	0.32	0	0.32	0.63

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Indirect metho

Cod

	Analysis #*	LCA

Numbers-2009
Mean number
79316370
11901929
1258245
478530
547562

-Weight-2009
Mean Weight
85
1226
615
534
1569

VPA Results--Mortalities-2008			VPA Results--Mortalities-2009		
Total F	F OTB Italy	F LLS Italy	Z	Total F	F OTB Italy
0.249	0.249	0	1.446	0.288	0.288
2.253	2.252	0.001	2.786	2.266	2.259
0.629	0.609	0.02	1.221	0.821	0.662
0.459	0.236	0.224	0.622	0.282	0.125
0.32	0.078	0.242	0.63	0.32	0.083

F LLS Italy
0
0.003
0.12
0.157
0.237

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Assessment form

Sex	combined

# of gears	4	Software	Vit4Win

Parameters used

Vector F	as in sheet A3/1 and A3/2
Vector M	as in sheet B
Vector N	

Model characteristics

Below the Y/R results are reported, fast scenario

Results

	Total		
		LLS Italy	OTB Italy
Current YR	28.551	3.997	22.555
Maximum Y/R	53.391	19.46	31.332
Y/R 0.1	52.503	20.228	29.822
F_{max}	0.27	0.21	0.34
$F_{0.1}$	0.21		
Current B/R	36.65		
Maximum B/R	381.8		
B/R 0.1	487.8		

Comments

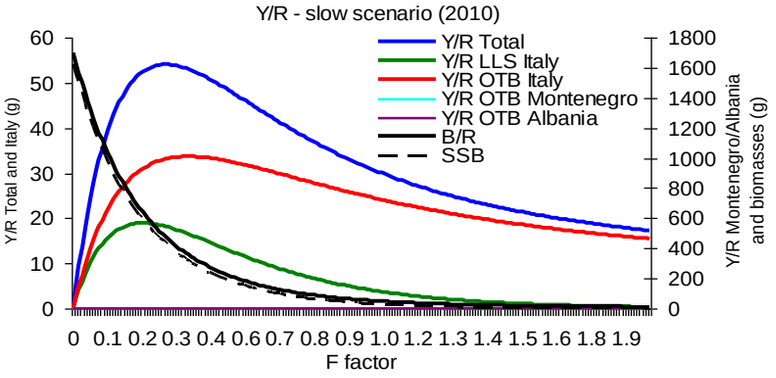
The outputs obtained using the slow growth in 2010 are reported below:

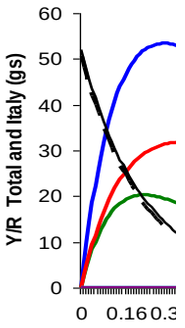
slow

	2010 Factor	F	Y/R	B/R	SSB	Y/R LLS Italy	Y/R OTB Italy
F(0)	0	0	0	1701.146	1628.004	0	0
F(0.1)	0.25	0.1583	52.798	620.142	569.681	18.931	31.305
Fmax	0.33	0.209	54.042	476.969	431.207	18.203	33.108
Fcurr	1.01	0.6332	31.84	57.575	37.067	4.458	25.154
Fdouble	2	1.2664	17.269	11.431	1.787	0.352	15.46

Comments

Y/R curves by fleet segment for 2010 from VIT analysis. F-factor, F (F0, F0.1, Fmax, Fcurr, Fdouble), reported. Slow and fast growth scenario. West and east sides.

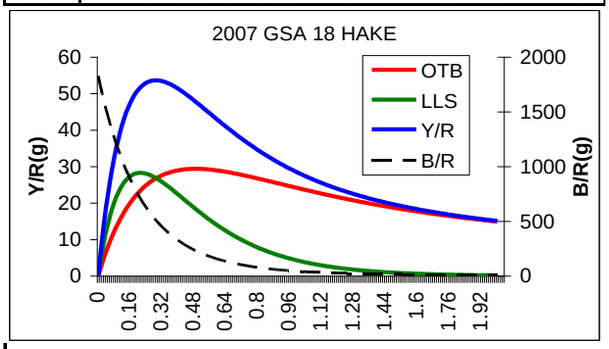


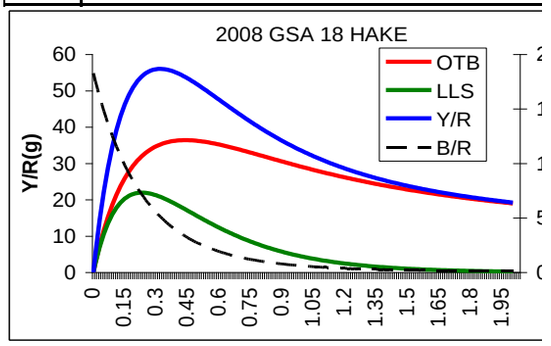


Y/R curves by gear and year from VIT analysis. For each year the overall estimates regarding F-factor, F (F Y/R, B/R and SSB are reported. Slow growth scenario, 2007-2009. West side.

2007	Factor	F	Y/R	B/R	SSB	Y/R OTB	Y/R LLS
F(0)	0	0	0	1828.674	1752.427	0	0
F(0.1)	0.23	0.164082	52.586	655.031	604.056	24.393	28.194
Fmax	0.3	0.21402	53.652	509.331	463.135	26.785	26.867
Fcurr	1.01	0.7134	28.367	44.032	26.228	24.112	4.255
Fdouble	2	1.4268	15.116	8.803	0.851	14.933	0.183

2008	Factor	F	Y/R	B/R	SSB	Y/R OTB
F(0)	0	0	0	1828.674	1752.427	0
F(0.1)	0.25	0.1572	54.823	663.876	612.079	32.926
Fmax	0.33	0.207504	56.037	509.596	462.759	35.245
Fcurr	1.01	0.6288	33.308	59.684	38.609	28.978
Fdouble	2	1.2576	19.24	12.311	1.671	19.006

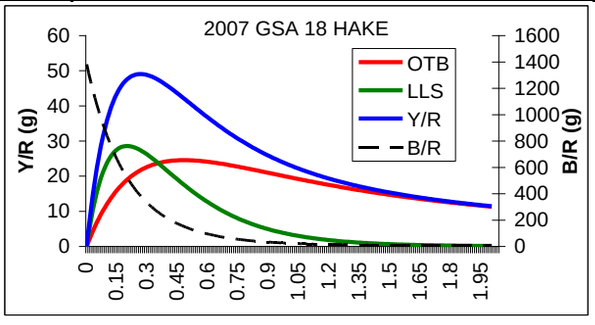


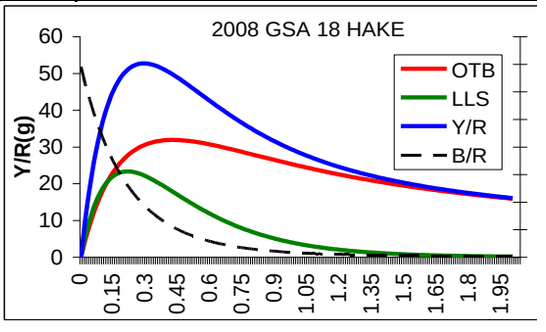


Y/R curves by gear and year from VIT analysis. For each year the overall estimates regarding F-factor, F (F Y/R, B/R and SSB are reported. Fast growth scenario, 2007-2009. West side

2007	Factor	F	Y/R	B/R	SSB	Y/R OTB	Y/R LLS
F(0)	0	0	0	1381.036	1339.336	0	0
F(0.1)	0.21	0.207323	48.021	495.671	467.101	19.486	28.535
Fmax	0.28	0.27643	49.036	375.719	349.897	21.816	27.22
Fcurr	1.01	0.98725	23.182	23.928	14.393	19.704	3.477
Fdouble	2	1.9745	11.424	4.625	0.513	11.296	0.129

2008	Factor	F	Y/R	B/R	SSB	Y/R OTB
F(0)	0	0	0	1381.036	1339.336	0
F(0.1)	0.23	0.206425	51.634	490.657	461.364	28.334
Fmax	0.3	0.26925	52.733	380.801	353.91	30.43
Fcurr	1.01	0.8975	28.745	32.704	20.788	25.008
Fdouble	2	1.795	16.078	7.042	0.968	15.911





sment (SCSA)

Sheet Y

Indirect methods: Y/R

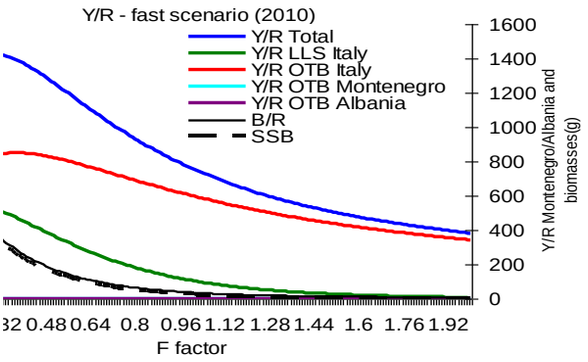
Code: HKE1811Spe

Analysis #	Y/R

Gear	
OTB Montenegro	OTB Albania
0.286	1.713
0.215	2.38
0.188	2.265
0.7	0.34

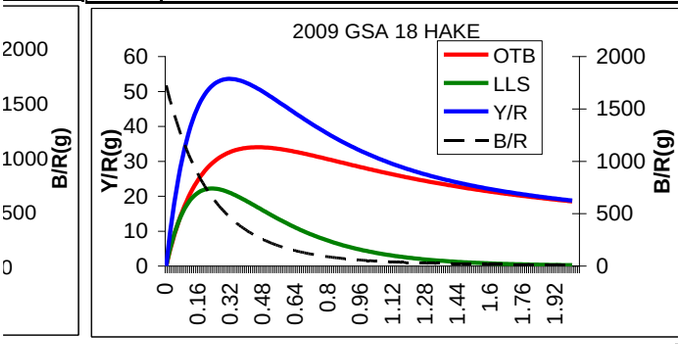
Y/R OTB Montenegro	Y/R OTB Albania
0	0
0.185	2.378
0.217	2.515
0.318	1.91
0.282	1.174

overall and by fleet segment Y/R, B/R and SSB are



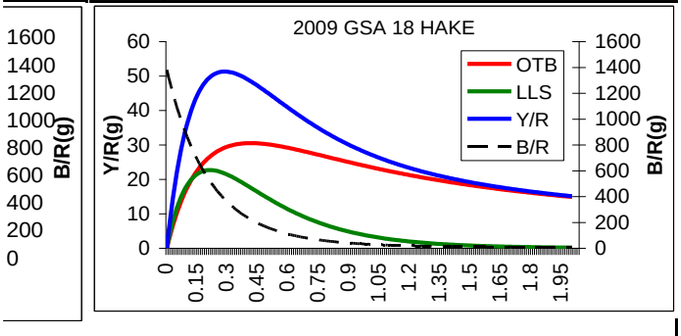
F0, F0.1, Fmax, Fcurr, Fdouble), overall and by gear

Y/R LLS	2009	Factor	F	Y/R	B/R	SSB	Y/R OTB	Y/R LLS
0	F(0)	0	0	0	1724.235	1649.594	0	
21.898	F(0.1)	0.25	0.1684	52.626	597.744	547.022	30.539	22.08
20.792	Fmax	0.32	0.215552	53.601	471.577	425.027	32.529	21.07
4.33	Fcurr	1.01	0.6736	31.898	50.839	29.922	27.751	4.14
0.233	Fdouble	2	1.3472	18.743	11.759	1.172	18.512	0.23



F0, F0.1, Fmax, Fcurr, Fdouble), overall and by gear

Y/R LLS	2009	Factor	F	Y/R	B/R	SSB	Y/R OTB	Y/R LLS
0	F(0)	0	0	0	1381.036	1339.336	0	0
23.299	F(0.1)	0.23	0.210278	50.389	481.424	452.502	27.381	22.628
22.303	Fmax	0.3	0.274275	51.292	371.702	345.229	29.29	21.599
3.737	Fcurr	1.01	0.91425	27.38	30.241	18.818	23.629	3.559
0.167	Fdouble	2	1.8285	15.094	6.473	0.812	14.877	0.177



Other assessment methods

SURBA

SURBA software was applied to get a first evaluation of the mortality and recruitment levels, using MEDITS abundance (N/km2) estimates by length and then age sliced using the 2 sets of parameters (slow and fast growth) used for LCA.

All the other parameters were those reported in the sheets 0 and B. Catchability was set as follows:

Age		0	1	2	3	4	5+
q (slow)		0.90	1.00	1.00	1.00	0.75	0.75
q (fast)	0.90	1.00	1.00	0.75	0.75		

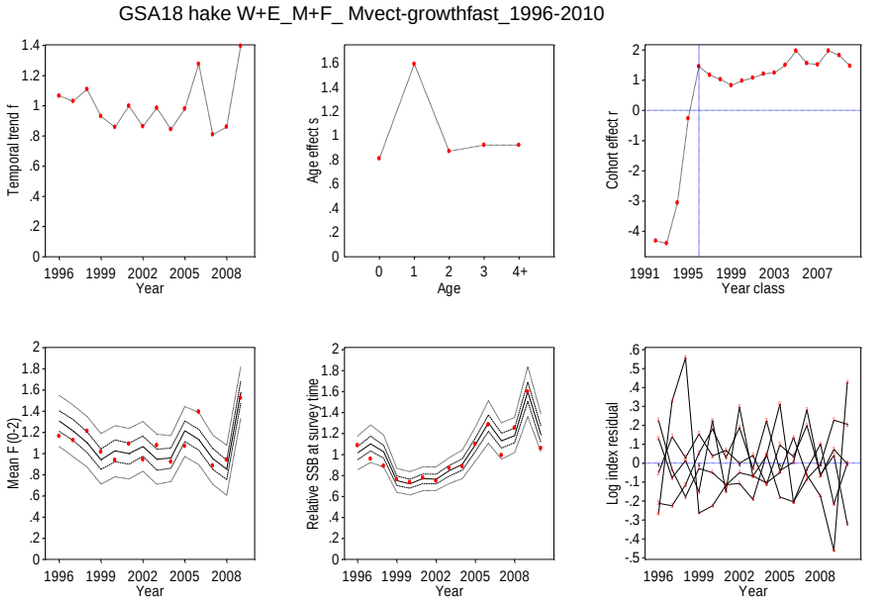
The age groups derived from the age slicing are reported in the table below.

'Slow' age groups

Year	0	1	2	3	4	5+
1996	460	231	33	4	1	2
1997	272	200	39	5	1	2
1998	254	167	15	3	1	2
1999	165	111	14	2	1	2
2000	367	121	15	2	1	2
2001	256	128	11	2	1	1
2002	632	96	16	2	1	1
2003	282	113	21	3	1	1

Results

On the overall, results from SURBA highlight a level of Z from 1.2 to 1.6 under the slow growth and a range of 1.6-2.1 under the fast growth scenario, while F is respectively 0.7-1.2 and 0.8-1.4, as expected according to an accelerated dynamics is higher in the fast growth scenario.



Trends in various stock parameters from SURBA, hake GSA18, fast growth pattern

Other assessment methods

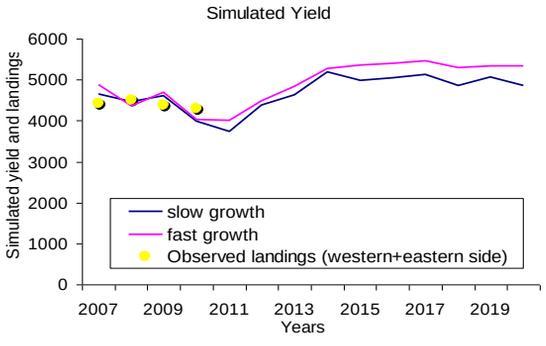
ALADYM

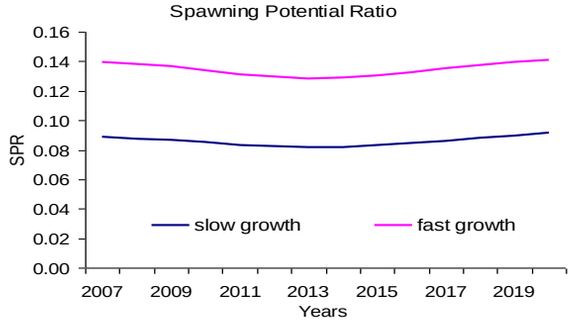
Aladym model was applied to evaluate the consequences of the mortality and harvesting strategies on the population metrics and simulated catches, using an hindcasting approach. The total mortality and the recruitment estimated by VIT for 2007-2010 were used to parameterize the model. For 2010 the estimates of from the whole area were used. To estimate Z and recruitment in 2011 a geometric mean among 2007-2010 was calculated.

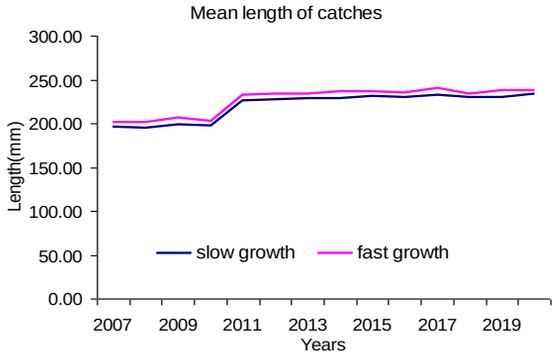
The fleet fishing selectivity was simulated using an ogive model with the following parameters: Lc=12cm; selection range (SR) 1 cm. This was coupled with a deselection ogive with 50% deselection size at 40 cm and a deselection range of 1 cm, to account for possible avoidance/reduced availability of older fish. Also the coefficient of monthly activity of the fleet was considered in the simulation. From 2012 the enforcement of 50 mm mesh size was assumed widely applied. Lc = 16 cm (SR = 1 cm) from 2012 until the end of simulation (2020) was set.

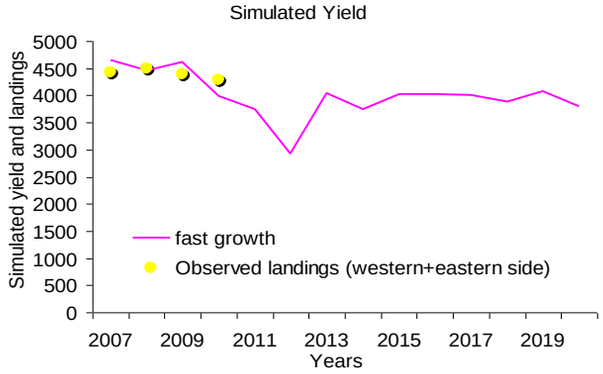
In addition a simulation was also performed from 2012 to 2020 implementing possible management measure to fulfill the target reference points. A reduction of the fishing activity was set, reducing of 40% the current monthly level and assuming a fishing ban of 2 months with a 30%activity of the current levels. In addition a further reduction of 15% of mortality was simulated from 2014.

Aladym, results of simulation from 2007 to 2020, slow and fast scenario, with increase of Lc from 12 to 16 cm (graphs 1-3). Aladym, results of simulation from 2007 to 2020, enforcing mesh size, reducing fishing activity by month and further reducing fishing mortality from 2014, fast growth scenario (graph 4).





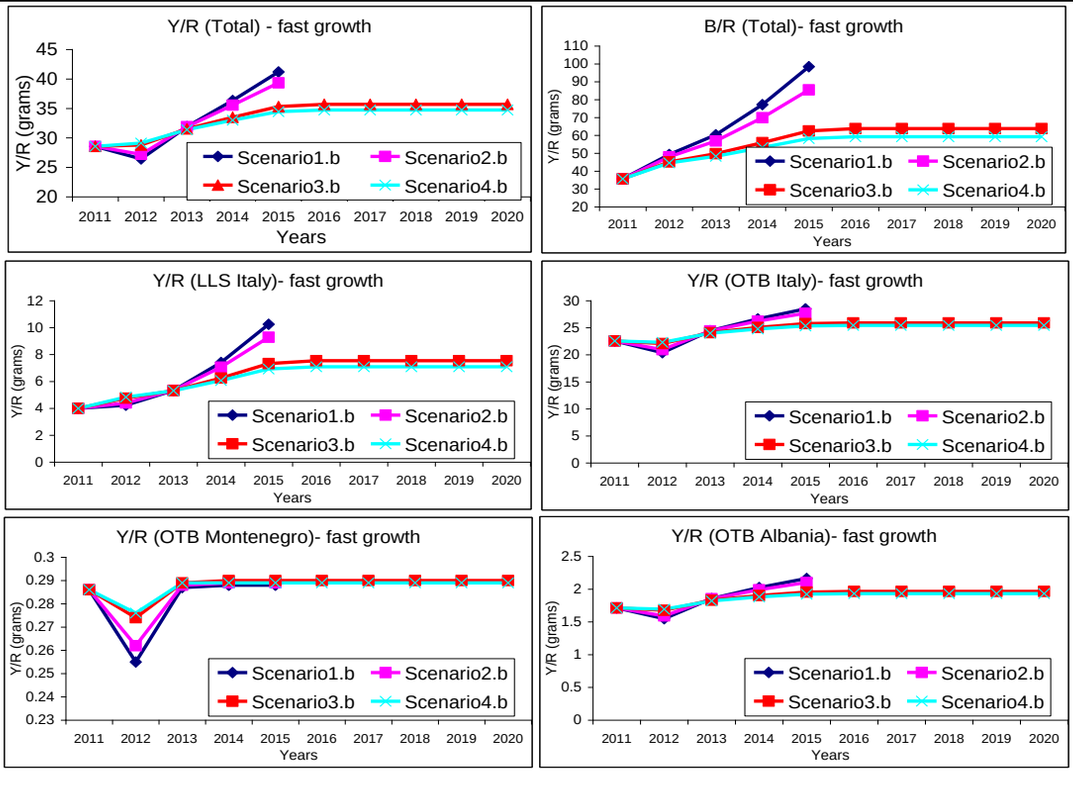




Other assessment methods

VIT- Transition analysis
The transition analysis using VIT software assuming a steady state was performed, simulating eight different scenarios of gradual reduction of fishing mortality to the target BRP F0.1 and the limit BRP Fmax. The landing data from Italy, Albania and Montenegro of 2010 were used:
Scenario 1.a: Reduction to F0.1 level until 2015, with a gradual annual decrease of 29% for slow growth.
Scenario 1.b: Reduction to F0.1 level until 2015, with a gradual annual decrease of 30% for fast growth.
Scenario 2.a: Reduction to Fmax level until 2015, with a gradual decrease of 24% for slow growth.
Scenario 2.b: Reduction to Fmax level until 2015, with a gradual decrease 25% for fast growth.
Scenario 3.a: Reduction to F0.1 level until 2020, with a gradual annual decrease of 14% for slow growth.
Scenario 3.b: Reduction to F0.1 level until 2020, with a gradual annual decrease 15% for fast growth.
Scenario 4.a: Reduction to Fmax level until 2020, with a gradual annual decrease of about 12% for slow growth.
Scenario 4.b: Reduction to Fmax level until 2020, with a gradual annual decrease of 12% for fast growth.

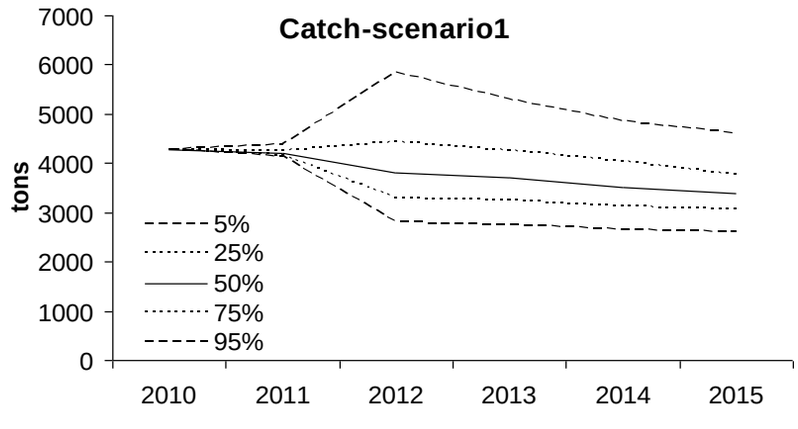
The results of the fast growth scenario are reported below.

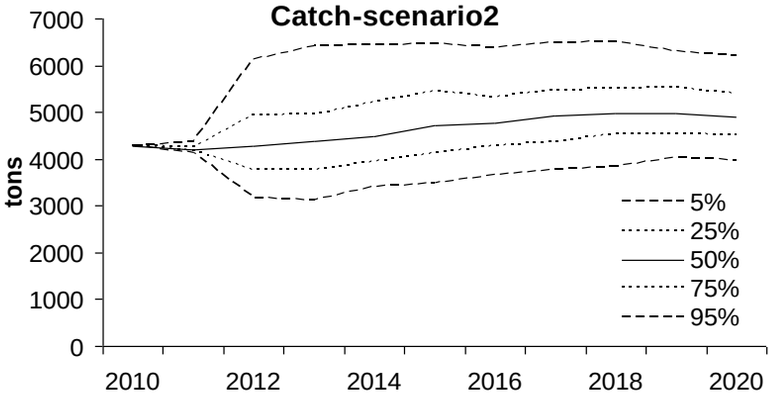


Other assessment methods

Medium term forecast R-routine (SGMED, 2010)

A medium term forecast was also performed, using the R routine developed during SGMED 2010.
Two scenarios have been projected, starting from a fishing level equal to the F current calculated by LCA (VIT) in the fast scenario for 2010 (F = 0.86) in order to achieve F0.1 until 2015 (annual reduction of 30%, scenario1) and until 2020 (annual reduction of 15%, scenario 2).





SAC GFCM - Sub-Committee on Stock Assessment (SCSA)	
Assessment form	**Sheet D** **Diagnosis**

Code: HKE1811Spe

Indicators and reference points

Criterion	Current value	Units	Reference Point	Trend	Comments
B					
SSB					
F		F0.1(fast)=0.21			Fmax(fast)=0.27
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

After the exceptional peak of recruitment observed in 2005, the recruit abundance reached comparable levels as in the years before 2005. However a remarkable abundance of recruits was also observed in 2008. Given the results of the present analysis, the stock of hake appears overexploited since the current fishing mortality is higher than F0.1 and Fmax.

Code: HKE1811Spe

Management advice and recommendations*

Given the results from this analysis, on 2010 based on the whole information from the area, it is necessary to consider that a remarkable reduction of the fishing mortality is necessary to allow the achievement of both the limit and target reference points, regardless of the growth pattern of the species. The limit and target BRPs F0.1 and Fmax can be gradually achieved by multiannual management plans that will require a more sharp reduction in the short term than in the medium term. However, it should also be taken into account that a more gradual reduction will very likely imply lower social and economic costs compared to a sharp reduction, without hampering the sustainability objective.
Simulations also show that the objectives of a more sustainable harvest strategy could be achieved with a multiannual plan that foresees a reduction of fishing mortality through fishing activity limitations and possibly fishing capacity decreasing.
It is however necessary to consider in the eventual implementation of multiannual management plans that most of the fishing mortality is derived from the Italian bottom trawlers that represent about 85% of the total F in the GSA and that of the Italian longlines accounting for about 7-8%, with an overall percentage of about 92-93%, while Montenegrin trawlers account only for about 1% of the F exerted on the GSA and Albanian trawlers of about 6.5%. Moreover, the production of hake in GSA 18 is split in 14% caught by Italian longlines, 79% by Italian trawlers, about 1% by Montenegrin trawlers and about 6% by Albania trawlers.

Proportion of F level by fleet for slow and fast growth scenarios
F - proportion

Growth	LLS it	OTB it	OTB Mon	OTB Alb
slow	0.069	0.854	0.011	0.065
fast	0.084	0.841	0.011	0.064

Advice for scientific research*

Supporting of tagging experiments of hake to improve knowledge on the species growth at larger scale and improving knowledge on hake behaviour at different life-stages.
Introduce a second annual scientific survey campaign in autumn to improve temporal resolution of survey data, in particular data on recruitment and mortality.

Abstract for SCSA reporting

Authors Spedicato M.T.1, Bitetto I.1, Lembo G.1, Carbonara P.1, Casciaro L.1, Facchini M.T.1, Milone N.2, Ceriola L.2,

Year 2011

Species Scientific name Merluccius merluccius - HKE

Source: GFCM Priority Species

Source: -

Source: -

Geographical Sub-Area 18 - Southern Adriatic Sea

Fisheries (brief description of the fishery)*

Merluccius merluccius is a high-score priority species in the Geographical Sub Area 18 that remarkably contribute to the fishery production.
Fishing grounds are located on the soft bottoms of continental shelves and the upper part of continental slope along the coasts of the whole GSA. 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.
Most part of the landings of hake are from trawlers.
In 2010 the landings of hake were about 4020 tons in the west side with the higher production from trawlers (3400 tons) followed by longliners (601 tons) and by the gillnets (19 tons). Along the east side the production from trawlers in 2010 was about 276 tons divided by 36 tons from Montenegro and 240 tons from Albania.

Source of management advice*

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

For the evaluation of hake stock status in GSA 18 different methods and different sources of data (fishery dependent and fishery independent) have been used. SURBA software, ALADYM model and VIT software were used. All the methods for the evaluation are discussed and used in a complementary and integrated way, in order to exploit the advantage of a multi-methods and multi-data approach. To account for uncertainty in life history profile of European hake a sensitivity analysis was performed using two scenarios of growth: slow and fast growth. For both scenarios the analyses are conducted for sex combined. Natural mortality vector for the two scenarios were obtained applying the Prodbiom method.

Stock Status*

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;

Exploitation rate

High fishing mortality

Stock abundance

Comments

Management advice and recommendations*

Advice for scientific research*