



JRC SCIENTIFIC AND POLICY REPORTS

REPORT OF THE SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF) 2012 Assessment of Mediterranean Sea stocks part II (STECF 13-05)

Edited by Massimiliano Cardinale, Giacomo Chato Osio & Aymen Charef

This report was reviewed by the STECF during its 42nd plenary meeting
held from 8 to 12 April, 2013 in Brussels, Belgium

European Commission
Joint Research Centre
Institute for the Protection and Security of the Citizen

Contact information

STECF secretariat

Address: TP 051, 21027 Ispra (VA), Italy

E-mail: stecf-secretariat@jrc.ec.europa.eu

Tel.: 0039 0332 789343

Fax: 0039 0332 789658

<https://stecf.jrc.ec.europa.eu/home>

<http://ipsc.jrc.ec.europa.eu/>

<http://www.jrc.ec.europa.eu/>

Legal Notice

Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use which might be made of this publication.

This report does not necessarily reflect the view of the European Commission and in no way anticipates the Commission's future policy in this area.

Europe Direct is a service to help you find answers to your questions about the European Union

Freephone number (*): 00 800 6 7 8 9 10 11

(*): Certain mobile telephone operators do not allow access to 00 800 numbers or these calls may be billed.

A great deal of additional information on the European Union is available on the Internet.

It can be accessed through the Europa server <http://europa.eu/>

JRC 81592

EUR 25971 EN

ISBN 978-92-79-29905-6

ISSN 1831-9424

doi:10.2788/89997

Luxembourg: Publications Office of the European Union, 2013

© European Union, 2013

Reproduction is authorised provided the source is acknowledged

How to cite this report:

Scientific, Technical and Economic Committee for Fisheries (STECF) – 2012 Assessment of Mediterranean Sea stocks part II (STECF 13-05). 2013. Publications Office of the European Union, Luxembourg, EUR 25309 EN, JRC 81592, 618 pp.

Printed in Italy

TABLE OF CONTENTS

TABLE OF CONTENTS	3
2012 Assessment of Mediterranean Sea stocks - part 2 (STECF-13-05)	34
Request to the STECF	34
STECF observations	34
STECF conclusions	38
STECF advice	38
EXPERT WORKING GROUP ON Assessment of Mediterranean Sea stocks - part 2 (STECF EWG 12-19)	40
1. Executive summary	41
2. Conclusions of the Working Group	43
3. Recommendations of the working group	47
4. Introduction	50
4.1. Terms of Reference for the STECF EWG 12-19	50
4.2. Participants	57
5. ToR a-d update and assess historic and recent stock parameters (summary sheets)	59
5.1. Summary sheet of Blue whiting in GSA 01	60
5.2. Summary sheet of Norway lobster in GSA 01	63
5.3. Summary sheet of Black-bellied anglerfish in GSA 05	65
5.4. Summary sheet of Norway lobster in GSA 06	67
5.5. Summary sheet of Red mullet in GSA 09	70
5.6. Summary sheet of Greater forkbeard in GSA 09	74
5.7. Summary sheet Giant red shrimp in GSA 10	76
5.8. Summary sheet of Blue and red shrimp in GSA 10	78
5.9. Summary sheet of European Hake in GSA 11	81
5.10. Summary sheet of Red mullet in GSA 11	83
5.11. Summary sheet of Giant Red Shrimp in GSAs 12-16	85
5.12. Summary sheet of Anchovy in GSA 16	89
5.13. Summary sheet of Sardine in GSA 16	92

5.14.	Summary sheet of European Hake in GSA 17	96
5.15.	Summary sheet of Sole in GSA 17	98
5.16.	Summary sheet of Anchovy in GSA 17	101
5.17.	Summary sheet of Sardine in GSA 17	103
5.18.	Summary sheet of European Hake in GSA 18	105
5.19.	Summary sheet of Pink shrimp in GSA 18	110
5.20.	Summary sheet of Giant red shrimp in GSA 18	114
5.21.	Summary sheet of European Hake in GSA 19	116
5.22.	Summary sheet of Red mullet in GSA 19	118
6.	ToR a-d update and assess historic and recent stock parameters (detailed assessments)	120
6.1.	Stock assessment of blue whiting in GSA 01	120
6.1.1.	Stock identification and biological features	120
6.1.1.1.	Stock Identification	120
6.1.1.2.	Growth	120
6.1.1.3.	Maturity	120
6.1.2.	Fisheries	120
6.1.2.1.	General description of fisheries	120
6.1.2.2.	Management regulations applicable in 2010 and 2011	121
6.1.2.3.	Catches	121
6.1.2.3.1.	Landings	121
6.1.2.3.2.	Discards	122
6.1.2.4.	Fishing effort	123
6.1.3.	Scientific surveys	124
6.1.3.1.	MEDITS	124
6.1.3.1.1.	Methods	124
6.1.3.1.2.	Geographical distribution patterns	125
6.1.3.1.3.	Trends in abundance and biomass	125
6.1.3.1.4.	Trends in abundance by length or age	126
6.1.3.1.5.	Trends in growth	129
6.1.3.1.6.	Trends in maturity	129
6.1.4.	Assessments of historic stock parameters	129

6.1.4.1.	Method: LCA	129
6.1.4.1.1.	Justification	129
6.1.4.1.2.	Input parameters	129
6.1.4.1.3.	Results	131
6.1.5.	Long term prediction	134
6.1.5.1.	Justification	134
6.1.5.1.1.	Input parameters	134
6.1.5.1.2.	Results	135
6.1.6.	Data quality	136
6.1.7.	Scientific advice	136
6.1.7.1.	Short term considerations	136
6.1.7.1.1.	State of the stock size	136
6.1.7.1.2.	State of recruitment	137
6.1.7.1.3.	State of exploitation	137
6.2.	Stock assessment of Norway lobster in GSA 01	138
6.2.1.	Stock identification and biological features	138
6.2.1.1.	Stock Identification	138
6.2.1.2.	Growth	138
6.2.1.3.	Maturity	138
6.2.2.	Fisheries	138
6.2.2.1.	General description of the fisheries	138
6.2.2.2.	Management regulations applicable in 2010 and 2011	138
6.2.2.3.	Catches	139
6.2.2.3.1.	Landings	139
6.2.2.3.2.	Discards	139
6.2.2.4.	Fishing effort	139
6.2.3.	Scientific surveys	140
6.2.3.1.	MEDITS	140
6.2.3.1.1.	Methods	140
6.2.3.1.2.	Geographical distribution patterns	141
6.2.3.1.3.	Trends in abundance and biomass	141

6.2.3.1.4.	Trends in abundance by length or age	142
6.2.3.1.5.	Trends in growth	146
6.2.3.1.6.	Trends in maturity	146
6.2.4.	Assessments of historic stock parameters	146
6.2.4.1.	Method 1: pseudo-cohort VPA (VIT)	146
6.2.4.1.1.	Justification	146
6.2.4.1.2.	Input parameters	147
6.2.4.1.3.	Results	148
6.2.5.	Long term prediction	149
6.2.5.1.	Justification	149
6.2.5.1.1.	Input parameters	150
6.2.5.1.2.	Results	150
6.2.6.	Data quality	152
6.2.7.	Scientific advice	152
6.2.7.1.	Short term considerations	152
6.2.7.1.1.	State of the spawning stock size	152
6.2.7.1.2.	State of recruitment	153
6.2.7.1.3.	State of exploitation	153
6.3.	Stock assessment of Black bellied anglerfish in GSA 5	154
6.3.1.	Stock identification and biological features	154
6.3.1.1.	Stock Identification	154
6.3.1.2.	Growth	154
6.3.1.3.	Maturity	154
6.3.2.	Fisheries	155
6.3.2.1.	General description of the fisheries	155
6.3.2.2.	Management regulations applicable in 2010 and 2011	155
6.3.2.3.	Catches	155
6.3.2.3.1.	Landings	155
6.3.2.3.2.	Discards	156
6.3.2.3.3.	Fishing effort	156
6.3.3.	Scientific surveys	156

6.3.3.1.	BALAR and MEDITS surveys	156
6.3.3.1.1.	Methods	156
6.3.3.1.2.	Geographical distribution patterns	156
6.3.3.1.3.	Trends in abundance and biomass	156
6.3.3.1.4.	Trends in abundance by length or age	157
6.3.3.1.5.	Trends in growth	157
6.3.3.1.6.	Trends in maturity	157
6.3.4.	Assessment of historic stock parameters	157
6.3.4.1.	Method 1: XSA	157
6.3.4.1.1.	Justification	157
6.3.4.1.2.	Input parameters	157
6.3.4.1.3.	Results	159
6.3.5.	Long term prediction	162
6.3.5.1.	Justification	162
6.3.5.1.1.	Input parameters	162
6.3.5.1.2.	Results	162
6.3.6.	Data quality	162
6.3.7.	Scientific advice	162
6.3.7.1.	Short term considerations	162
6.3.7.1.1.	State of the stock size	162
6.3.7.1.2.	State of recruitment	162
6.3.7.1.3.	State of exploitation	163
6.4.	Stock assessment of Norway lobster in GSA 06	164
6.4.1.	Stock identification and biological features	164
6.4.1.1.	Stock Identification	164
6.4.1.2.	Growth	164
6.4.1.3.	Maturity	164
6.4.2.	Fisheries	164
6.4.2.1.	General description of the fisheries	164
6.4.2.2.	Management regulations applicable in 2010 and 2011	165
6.4.2.3.	Catches	165

6.4.2.3.1.	Landings	165
6.4.2.3.2.	Discards	165
6.4.2.4.	Fishing effort	165
6.4.3.	Scientific surveys	166
6.4.3.1.	MEDITS	166
6.4.3.1.1.	Methods	166
6.4.3.1.2.	Geographical distribution patterns	167
6.4.3.1.3.	Trends in abundance and biomass	167
6.4.3.1.4.	Trends in abundance by length or age	168
6.4.3.1.5.	Trends in growth	172
6.4.3.1.6.	Trends in maturity	172
6.4.4.	Assessments of historic stock parameters	173
6.4.4.1.	Method 1: pseudo-cohort VPA (VIT)	173
6.4.4.1.1.	Justification	173
6.4.4.1.2.	Input parameters	173
6.4.4.1.3.	Results	174
6.4.5.	Long term prediction	175
6.4.5.1.	Justification	175
6.4.5.1.1.	Input parameters	175
6.4.5.1.2.	Results	176
6.4.6.	Data quality	178
6.4.7.	Scientific advice	178
6.4.7.1.	Short term considerations	178
6.4.7.1.1.	State of the spawning stock size	178
6.4.7.1.2.	State of recruitment	178
6.4.7.1.3.	State of exploitation	178
6.5.	Stock assessment of Red mullet in GSA 09	180
6.5.1.	Stock identification and biological features	180
6.5.1.1.	Stock Identification	180
6.5.1.2.	Growth	180
6.5.1.3.	Maturity	180

6.5.2.	Fisheries	181
6.5.2.1.	General description of fisheries	181
6.5.2.2.	Management regulations applicable in 2011	182
6.5.2.3.	Catches	182
6.5.2.3.1.	Landings	182
6.5.2.3.2.	Discards	183
6.5.2.4.	Fishing effort	183
6.5.3.	Scientific surveys	184
6.5.3.1.	MEDITS	184
6.5.3.1.1.	Methods	184
6.5.3.1.2.	Geographical distribution patterns	185
6.5.3.1.3.	Trends in abundance and biomass	187
6.5.3.1.4.	Trends in abundance by length or age	188
6.5.3.1.5.	Trends in growth	188
6.5.3.1.6.	Trends in maturity	188
6.5.4.	Assessment of historic stock parameters	188
6.5.4.1.	VPA Methods 1: XSA and ADAPT	188
6.5.4.1.1.	Justification	188
6.5.4.1.2.	Input parameters	189
6.5.4.1.3.	Results	189
6.5.4.2.	Method 2: Stock-Production model	189
6.5.4.2.1.	Justification	189
6.5.4.2.2.	Input parameters	189
6.5.4.3.	Method 3: Yield-per-Recruit model	195
6.5.4.4.	Comparisons of results with Reference Points derived from Y/R and Production model	196
6.5.5.	Short term prediction for 2009-2010	196
6.5.5.1.	Justification	196
6.5.6.	Medium term prediction	196
6.5.6.1.	Justification	196
6.5.7.	Scientific advice	198
6.5.7.1.	Short term considerations	198

6.5.7.1.1.	State of the spawning stock size	198
6.5.7.1.2.	State of recruitment	198
6.5.7.1.3.	State of exploitation	198
6.5.7.2.	Medium term considerations	198
6.6.	Stock assessment of Greater forkbeard in GSA 09	199
6.6.1.	Stock identification and biological features	199
6.6.1.1.	Stock Identification	199
6.6.1.2.	Growth	199
6.6.1.3.	Maturity	200
6.6.2.	Fisheries	200
6.6.2.1.	General description of the fisheries	200
6.6.2.2.	Management regulations applicable in 2010 and 2011	200
6.6.2.3.	Catches	201
6.6.2.3.1.	Landings	201
6.6.2.3.2.	Discards	202
6.6.2.4.	Fishing effort	202
6.6.3.	Scientific surveys	203
6.6.3.1.	MEDITS	203
6.6.3.1.1.	Methods	203
6.6.3.1.2.	Geographical distribution patterns	204
6.6.3.1.3.	Trends in abundance and biomass	206
6.6.3.1.4.	Trends in abundance by length or age	207
6.6.3.1.5.	Trends in growth	210
6.6.3.1.6.	Trends in maturity	210
6.6.4.	Assessment of historic stock parameters	210
6.6.4.1.	Method 1: LCA	210
6.6.4.1.1.	Justification	210
6.6.4.1.2.	Input parameters	210
6.6.4.1.3.	Results	211
6.6.4.2.	Method 2: SURBA	212
6.6.4.2.1.	Justification	212

6.6.4.2.2.	Input parameters	212
6.6.4.2.3.	Results	213
6.6.5.	Long term prediction	215
6.6.5.1.	Justification	215
6.6.5.2.	Input parameters	215
6.6.5.3.	Results	215
6.6.6.	Data quality	215
6.6.7.	Scientific advice	216
6.6.7.1.	Short term considerations	216
6.6.7.1.1.	State of the stock size	216
6.6.7.1.2.	State of recruitment	216
6.6.7.1.3.	State of exploitation	216
6.7.	Stock assessment of Giant red shrimp in GSA 10	217
6.7.1.	Stock identification and biological features	217
6.7.1.1.	Stock Identification	217
6.7.1.2.	Growth	218
6.7.1.3.	Maturity	219
6.7.2.	Fisheries	220
6.7.2.1.	General description of fisheries	220
6.7.2.2.	Management regulations applicable in 2011 and 2012	220
6.7.2.3.	Catches	221
6.7.2.3.1.	Landings	221
6.7.2.3.2.	Discards	222
6.7.2.4.	Fishing effort	222
6.7.3.	Scientific surveys	223
6.7.3.1.	MEDITS	223
6.7.3.1.1.	Methods	223
6.7.3.2.	Grund	224
6.7.3.2.1.	Methods	224
6.7.3.2.2.	Geographical distribution patterns	224
6.7.3.2.3.	Trends in abundance and biomass	225

6.7.3.2.4.	Trends in abundance by length or age	226
6.7.3.2.5.	Trends in growth abundance by length or age	231
6.7.3.2.6.	Trends in maturity	231
6.7.4.	Assessment of historic stock parameters	231
6.7.4.1.	Method 1: Surba	231
6.7.4.1.1.	Justification	231
6.7.4.1.2.	Input parameters	231
6.7.4.1.3.	Results	232
6.7.4.2.	Method 2:XSA	235
6.7.4.2.1.	Justification	235
6.7.4.2.2.	Input parameters	235
6.7.4.2.3.	Results	237
6.7.5.	Long term prediction	243
6.7.5.1.	Justification	243
6.7.5.1.1.	Input parameters	243
6.7.5.1.2.	Results	243
6.7.6.	Data quality and availability	244
6.7.7.	Scientific advice	244
6.7.7.1.	Short term considerations	244
6.7.7.1.1.	State of the spawning stock size	244
6.7.7.1.2.	State of recruitment	244
6.7.7.1.3.	State of exploitation	244
6.8.	Stock assessment of Blue and red shrimp in GSA 10	245
6.8.1.	Stock identification and biological features	245
6.8.1.1.	Stock Identification	245
6.8.1.2.	Growth	246
6.8.1.3.	Maturity	246
6.8.2.	Fisheries	247
6.8.2.1.	General description of fisheries	247
6.8.2.2.	Management regulations applicable in 2011 and 2012	247
6.8.2.3.	Catches	248

6.8.2.3.1.	Landings	248
6.8.2.3.2.	Discards	248
6.8.2.4.	Fishing effort	249
6.8.3.	Scientific surveys	249
6.8.3.1.	MEDITS	249
6.8.3.1.1.	Methods	249
6.8.3.2.	Grund	251
6.8.3.2.1.	Methods	251
6.8.3.2.2.	Geographical distribution patterns	251
6.8.3.2.3.	Trends in abundance and biomass	252
6.8.3.2.4.	Trends in abundance by length or age	252
6.8.3.2.5.	Trends in growth abundance by length or age	256
6.8.3.2.6.	Trends in maturity	256
6.8.4.	Assessment of historic stock parameters	256
6.8.4.1.	Method 1: VIT	256
6.8.4.1.1.	Justification	256
6.8.4.1.2.	Input parameters	256
6.8.4.1.3.	Results	257
6.8.5.	Long term prediction	257
6.8.5.1.	Method 1: VIT	257
6.8.5.1.1.	Justification	257
6.8.5.1.2.	Input parameters	257
6.8.5.1.3.	Results	258
6.8.6.	Data quality and availability	258
6.8.7.	Scientific advice	259
6.8.7.1.	Short term considerations	259
6.8.7.1.1.	State of the spawning stock size	259
6.8.7.1.2.	State of recruitment	259
6.8.7.1.3.	State of exploitation	259
6.9.	Stock assessment of European Hake in GSA 11	261
6.9.1.	Stock identification and biological features	261

6.9.1.1.	Stock Identification	261
6.9.1.2.	Growth	261
6.9.1.3.	Maturity	261
6.9.2.	Fisheries	261
6.9.2.1.	General description of fisheries	261
6.9.2.2.	Management regulations applicable in 2010 and 2011	262
6.9.2.3.	Catches	262
6.9.2.3.1.	Landings	262
6.9.2.3.2.	Discards	264
6.9.2.4.	Fishing effort	265
6.9.3.	Scientific surveys	267
6.9.3.1.	MEDITS	267
6.9.3.1.1.	Methods	267
6.9.3.1.2.	Geographical distribution patterns	268
6.9.3.1.3.	Trends in abundance and biomass	268
6.9.3.1.4.	Trends in abundance by length or age	269
6.9.3.1.5.	Trends in growth	270
6.9.3.1.6.	Trends in maturity	270
6.9.4.	Assessment of historic stock parameters	270
6.9.4.1.	Method 1: SURBA	270
6.9.4.1.1.	Justification	270
6.9.4.1.2.	Input parameters	270
6.9.4.1.3.	Results	272
6.9.4.2.	Method 2: XSA -HKE	275
6.9.4.2.1.	Justification	275
6.9.4.2.2.	Input parameters	275
6.9.4.2.3.	Results	280
6.9.4.3.	Method 3: Yield-per-Recruit model	281
6.9.4.3.1.	Justification	281
6.9.4.3.2.	Results	282
6.9.5.	Data quality and data consistency of 2012 data call	283

6.9.6.	Scientific advice	283
6.9.6.1.	Short term consideration	283
6.9.6.1.1.	State of the spawning stock size	283
6.9.6.1.2.	State of recruitment	283
6.9.6.1.3.	State of exploitation	283
6.10.	Stock assessment of Red Mullet in GSA 11	284
6.10.1.	Stock identification and biological features	284
6.10.1.1.	Stock Identification	284
6.10.1.2.	Growth	284
6.10.1.3.	Maturity	284
6.10.2.	Fisheries	285
6.10.2.1.	General description of the fisheries	285
6.10.2.2.	Management regulations	285
6.10.2.3.	Catches	286
6.10.2.3.1.	Landings	286
6.10.2.3.2.	Discards	286
6.10.2.4.	Fishing effort	286
6.10.3.	Scientific surveys	287
6.10.3.1.	MEDITS	287
6.10.3.1.1.	Methods	287
6.10.3.1.2.	Geographical distribution patterns	289
6.10.3.1.3.	Trends in abundance and biomass	290
6.10.3.1.4.	Trends in abundance by length or age	290
6.10.3.1.5.	Trends in growth	291
6.10.3.1.6.	Trends in maturity	291
6.10.4.	Assessment of historic stock parameters	291
6.10.4.1.	Method 1: XSA - MUT	291
6.10.4.1.1.	Justification	291
6.10.4.1.2.	Input parameters	291
6.10.4.1.3.	Results	295
6.10.4.2.	Method 2: SURBA	296

6.10.4.2.1.	Justification	296
6.10.4.2.2.	Input parameters	296
6.10.4.2.3.	Results	297
6.10.4.3.	Method 3: Yield-per-Recruit model	300
6.10.4.3.1.	Justification	300
6.10.4.3.2.	Results	300
6.10.5.	Data quality	301
6.10.6.	Scientific advice	301
6.10.6.1.	Short term considerations	301
6.10.6.1.1.	State of the spawning stock size	301
6.10.6.1.2.	State of recruitment	301
6.10.6.1.3.	State of exploitation	301
6.11.	Stock assessment of giant red shrimp in GSAs 12-16	303
6.11.1.	Stock identification and biological features	303
6.11.1.1.	Stock Identification	303
6.11.1.2.	Growth and natural mortality	303
6.11.1.3.	Maturity	304
6.11.2.	Fisheries	305
6.11.2.1.	General description of fisheries	305
6.11.2.2.	Management regulations applicable in 2010 and 2011	306
6.11.2.3.	Catches	307
6.11.2.3.1.	Landings	307
6.11.2.3.2.	Discards	308
6.11.2.4.	Fishing effort	309
6.11.3.	Scientific surveys	310
6.11.3.1.	MEDITS	310
6.11.3.1.1.	Methods	310
6.11.3.1.2.	Geographical distribution patterns	312
6.11.3.1.3.	Trends in abundance and biomass	313
6.11.3.1.4.	Trends in abundance by length or age	314
6.11.3.1.5.	Trends in growth	317

6.11.3.1.6.	Trends in maturity	317
6.11.4.	Assessment of historic stock parameters	317
6.11.4.1.	Method 1: SURBA	317
6.11.4.1.1.	Justification	317
6.11.4.1.2.	Input parameters	318
6.11.4.1.3.	Results	319
6.11.4.2.	Method 2: XSA	322
6.11.4.2.1.	Justification	322
6.11.4.2.2.	Input parameters	322
6.11.4.2.3.	Results	325
6.11.5.	Data quality	330
6.11.6.	Scientific advice	330
6.11.6.1.	Short term considerations	330
6.11.6.1.1.	State of the spawning stock size	330
6.11.6.1.2.	State of recruitment	331
6.11.6.1.3.	State of exploitation	331
6.12.	Stock assessment of anchovy in GSA 16	333
6.12.1.	Stock identification and biological features	333
6.12.1.1.	Stock Identification	333
6.12.1.2.	Growth	333
6.12.1.3.	Maturity	333
6.12.2.	Fisheries	333
6.12.2.1.	General description of fisheries	333
6.12.2.2.	Management regulations applicable in 2010 and 2011	334
6.12.2.3.	Catches	334
6.12.2.3.1.	Landings	334
6.12.2.3.2.	Discards	335
6.12.2.4.	Fishing effort	335
6.12.3.	Scientific surveys	336
6.12.3.1.	Acoustics	336
6.12.3.1.1.	Methods	336

6.12.3.1.2.	Geographical distribution patterns	338
6.12.3.1.3.	Trends in abundance and biomass	338
6.12.3.1.4.	Trends in abundance by length or age	338
6.12.3.1.5.	Trends in growth	338
6.12.3.1.6.	Trends in maturity	339
6.12.4.	Assessment of historic stock parameters	339
6.12.4.1.	Method 1: Surplus production modelling	339
6.12.4.1.1.	Justification	339
6.12.4.1.2.	Input parameters	340
6.12.4.1.3.	Results	340
6.12.4.2.	Method 2: XSA	344
6.12.4.2.1.	Justification	344
6.12.4.2.2.	Input parameters	344
6.12.4.2.3.	Results including sensitivity analyses	345
6.12.5.	Long term prediction	350
6.12.6.	Scientific advice	350
6.12.6.1.	Short term considerations	350
6.12.6.1.1.	State of the spawning stock size	350
6.12.6.1.2.	State of recruitment	350
6.12.6.1.3.	State of exploitation	350
6.12.6.2.	Management recommendations	351
6.13.	Stock assessment of Sardine in GSA 16	353
6.13.1.	Stock identification and biological features	353
6.13.1.1.	Stock Identification	353
6.13.1.2.	Growth	353
6.13.1.3.	Maturity	353
6.13.2.	Fisheries	353
6.13.2.1.	General description of fisheries	353
6.13.2.2.	Management regulations applicable in 2010 and 2011	353
6.13.2.3.	Catches	354
6.13.2.6.1.	Landings	354

6.13.2.6.2.	Discards	354
6.13.2.7.	Fishing effort	354
6.13.3.	Scientific surveys	355
6.13.3.1.	Acoustics	355
6.13.3.1.1.	Methods	355
6.13.3.1.2.	Geographical distribution patterns	357
6.13.3.1.3.	Trends in abundance and biomass	357
6.13.3.1.4.	Trends in abundance by length or age	358
6.13.3.1.5.	Trends in growth	358
6.13.3.1.6.	Trends in maturity	358
6.13.4.	Assessment of historic stock parameters	358
6.13.4.1.	Method: Surplus production modeling	358
6.13.4.1.1.	Justification	358
6.13.4.1.2.	Input parameters	359
6.13.4.1.3.	Results	359
6.13.5.	Long term prediction	363
6.13.6.	Scientific advice	363
6.13.6.1.	Short term considerations	363
6.13.6.1.1.	State of the stock size	363
6.13.6.1.2.	State of recruitment	363
6.13.6.1.3.	State of exploitation	363
6.13.6.2.	Management recommendations	364
6.14.	Stock assessment of Hake in GSA 17	365
6.14.1.	Stock identification and biological features	365
6.14.1.1.	Stock Identification	365
6.14.1.2.	Growth	367
6.14.1.3.	Maturity	368
6.14.2.	Fisheries	369
6.14.2.1.	General description of fisheries	369
6.14.2.2.	Management regulations applicable in 2010 and 2012	369
6.14.2.3.	Catches	370

6.14.2.3.1.	Landings	370
6.14.2.3.2.	Discards	371
6.14.2.4.	Fishing effort	371
6.14.3.	Scientific surveys	372
6.14.3.1.	MEDITS	372
6.14.3.1.1.	Methods	372
6.14.3.1.2.	Geographical distribution patterns	374
6.14.3.1.3.	Trends in abundance and biomass	374
6.14.3.1.4.	Trends in abundance by length or age	374
6.14.3.1.5.	Trends in growth	376
6.14.3.1.6.	Trends in maturity	376
6.14.4.	Assessment of historic stock parameters	376
6.14.4.1.	Method 1: XSA	376
6.14.4.1.1.	Justification	376
6.14.4.1.2.	Input data and parameters	377
6.14.4.1.3.	Results	382
6.14.4.2.	Method 2: SURBA	385
6.14.4.2.1.	Justification	385
6.14.4.2.2.	Input data and parameters	385
6.14.4.2.3.	Results	386
6.14.4.3.	Method 3: Steady state VPA (VIT Model)	388
6.14.4.4.1.	Justification	388
6.14.4.4.2.	Input data and parameters	388
6.14.4.4.3.	Results	389
6.14.5.	Long term prediction	389
6.14.5.1.	Justification	389
6.14.5.1.1.	Input parameters	390
6.14.5.1.2.	Results	390
6.14.6.	Data quality and data consistency of 2012 Italian data call	391
6.14.7.	Scientific advice	391
6.14.7.1.	Short term consideration	391

6.14.7.1.1.	State of the spawning stock size	391
6.14.7.1.2.	State of recruitment	391
6.14.7.1.3.	State of exploitation	391
6.15.	Stock assessment of red mullet in GSA 17	393
6.15.1.	Stock identification and biological features	393
6.15.1.1.	Stock identification	393
6.15.1.2.	Growth	394
6.15.1.3.	Maturity	395
6.15.2.	Fisheries	395
6.15.2.1.	General description of the fisheries	395
6.15.2.2.	Management regulations applicable in 2011 and 2012	395
6.15.2.3.	Catches	395
6.15.2.3.1.	Landings	395
6.15.2.3.2.	Discards	396
6.15.2.4.	Fishing effort	396
6.15.3.	Scientific surveys	397
6.15.3.1.	MEDITS	397
6.15.3.1.1.	Methods	397
6.15.3.1.2.	Geographical distribution patterns	399
6.15.3.1.3.	Trends in abundance and biomass	399
6.15.3.1.4.	Trends in abundance by length or age	399
6.15.3.1.5.	Trends in growth	400
6.15.3.1.6.	Trends in maturity	400
6.15.4.	Assessment of historic stock parameters	400
6.15.4.1.	Method 1: Length cohort analysis (LCA)	400
6.15.4.1.1.	Justification	400
6.15.4.1.2.	Input parameters	401
6.15.4.1.3.	Results	402
6.15.5.	Short term prediction	404
6.15.6.	Long term prediction	404
6.15.6.1.	Method 1: VIT	404

6.15.6.1.1.	Justification	404
6.15.6.1.2.	Input parameters	404
6.15.6.1.3.	Results	405
6.15.6.2.	Method 2: Extended Survivor Analysis (XSA)	405
6.15.6.2.1.	Justification	405
6.15.6.2.2.	Input parameters	405
6.15.6.2.3.	Results	408
6.15.7.	Short term prediction	411
6.15.7.1.	Method and justification	411
6.15.7.1.1.	Input parameters	411
6.15.7.1.2.	Results	411
6.15.8.	Data quality	412
6.15.9.	Scientific advice	412
6.15.9.1.	Short term considerations	412
6.15.9.1.1.	State of spawning stock biomass	412
6.15.9.1.2.	State of recruitment	413
6.15.9.1.3.	State of exploitation	413
6.16.	Stock assessment of Anchovy in GSA 17	414
6.16.1.	Stock identification and biological features	414
6.16.1.1.	Stock Identification	414
6.16.1.2.	Growth	414
6.16.1.3.	Maturity	414
6.16.1.4.	Natural mortality	414
6.16.2.	Fisheries	415
6.16.2.1.	General description of the fisheries	415
6.16.2.2.	Management regulations applicable in 2010 and 2011	415
6.16.2.3.	Catches	415
6.16.2.3.1.	Landings	415
6.16.2.3.2.	Discards	416
6.16.3.	Scientific surveys	417
6.16.3.1.	MEDIAS	417

6.16.3.1.1.	Methods	417
6.16.3.1.2.	Geographical distribution patterns	417
6.16.3.1.3.	Trends in abundance and biomass	418
6.16.3.1.4.	Trends in abundance by length or age	420
6.16.3.1.5.	Trends in growth	420
6.16.3.1.6.	Trends in maturity	420
6.16.4.	Assessment of historic stock parameters	420
6.16.4.1.	Method: ICA	420
6.16.4.1.1.	Justification	420
6.16.4.1.2.	Input parameters	421
6.16.4.1.3.	Results	421
6.16.5.	Scientific advice	429
6.16.5.1.	Short term considerations	429
6.16.5.1.1.	State of the spawning stock size	429
6.16.5.1.2.	State of recruitment	429
6.16.5.1.3.	State of exploitation	429
6.17.	Stock assessment of Sardine in GSA 17	430
6.17.1.	Stock identification and biological features	430
6.17.1.1.	Stock Identification	430
6.17.1.2.	Growth	430
6.17.1.3.	Maturity	430
6.17.1.4.	Natural mortality	430
6.17.2.	Fisheries	430
6.17.2.1.	General description of the fisheries	430
6.17.2.2.	Management regulations applicable in 2010 and 2011	431
6.17.2.3.	Catches	431
6.17.2.3.1.	Landings	431
6.17.2.3.2.	Discards	432
6.17.3.	Scientific surveys	432
6.17.3.1.	MEDIAS	432
6.17.3.1.1.	Methods	432

6.17.3.1.2.	Geographical distribution patterns	433
6.17.3.1.3.	Trends in abundance and biomass	434
6.17.3.1.4.	Trends in abundance by length or age	436
6.17.3.1.5.	Trends in growth	436
6.17.3.1.6.	Trends in maturity	436
6.17.4.	Assessment of historic stock parameters	436
6.17.4.1.	Method 1: ICA	436
6.17.4.1.1.	Justification	436
6.17.4.1.2.	Input parameters	437
6.17.4.1.3.	Results	437
6.17.5.	Data quality	445
6.17.6.	Scientific advice	445
6.17.6.1.	Short term considerations	445
6.17.6.1.1.	State of the spawning stock size	445
6.17.6.1.2.	State of recruitment	445
6.17.6.1.3.	State of exploitation	445
6.18.	Stock assessment of Giant red shrimp in GSA 18	446
6.18.1.	Stock identification and biological features	446
6.18.1.1.	Stock Identification	446
6.18.1.2.	Growth	446
6.18.1.3.	Maturity	446
6.18.2.	Fisheries	446
6.18.2.1.	General description of fisheries	446
6.18.2.2.	Management regulations applicable in 2010 and 2011	447
6.18.2.3.	Catches	447
6.18.2.3.1.	Landings	447
6.18.2.3.2.	Discards	448
6.18.2.4.	Fishing effort	448
6.18.3.	Scientific surveys	449
6.18.3.1.	MEDITS	449
6.18.3.1.1.	Methods	449

6.18.3.1.2.	Geographical distribution patterns	451
6.18.3.1.3.	Trends in abundance and biomass	451
6.18.3.1.4.	Trends in abundance by length or age	452
6.18.3.1.5.	Trends in growth abundance by length or age	455
6.18.3.1.6.	Trends in maturity	455
6.18.4.	Assessment of historic stock parameters	455
6.18.4.1.	Method 1: VIT	455
6.18.4.1.1.	Justification	455
6.18.4.1.2.	Input parameters	455
6.18.4.1.3.	Results	455
6.18.5.	Long term prediction	456
6.18.5.1.	Method 1: VIT	456
6.18.5.1.1.	Justification	456
6.18.5.1.2.	Input parameters	456
6.18.5.1.3.	Results	456
6.18.6.	Data quality and availability	458
6.18.7.	Scientific advice	458
6.18.7.1.	Short term considerations	458
6.18.7.1.1.	State of the spawning stock size	458
6.18.7.1.2.	State of exploitation	459
6.19.	Stock assessment of European Hake in GSA 19	460
6.19.1.	Stock identification and biological features	460
6.19.1.1.	Stock Identification	460
6.19.1.2.	Growth	460
6.19.1.3.	Maturity	460
6.19.2.	Fisheries	460
6.19.2.1.	General description of fisheries	460
6.19.2.2.	Management regulations applicable in 2010 and 2011	461
6.19.2.3.	Catches	461
6.19.2.3.1.	Landings	461
6.19.2.3.2.	Discards	462

6.19.2.4.	Fishing effort	462
6.19.3.	Scientific surveys	463
6.19.3.1.	MEDITS	463
6.19.3.1.1.	Methods	463
6.19.3.1.2.	Geographical distribution patterns	464
6.19.3.1.3.	Trends in abundance and biomass	464
6.19.3.1.4.	Trends in abundance by length or age	464
6.19.3.1.5.	Trends in growth	468
6.19.3.1.6.	Trends in maturity	468
6.19.4.	Assessment of historic stock parameters	468
6.19.4.1.	Method 1: XSA	468
6.19.4.1.1.	Justification	468
6.19.4.1.2.	Input Data	468
6.19.4.1.3.	Results	471
6.19.5.	Long term prediction	472
6.19.5.1.	Justification	472
6.19.5.1.1.	Input parameters	472
6.19.5.1.2.	Results	473
6.19.6.	Scientific advice	473
6.19.6.1.	Short term considerations	473
6.19.6.1.1.	State of the spawning stock size	473
6.19.6.1.2.	State of recruitment	473
6.19.6.1.3.	State of exploitation	474
6.19.7.	Data quality	474
6.20.	Stock assessment of Red mullet in GSA 19	475
6.20.1.	Stock identification and biological features	475
6.20.1.1.	Stock Identification	475
6.20.1.2.	Growth	476
6.20.1.3.	Maturity	476
6.20.2.	Fisheries	476
6.20.2.1.	General description of fisheries	476

6.20.2.2.	Management regulations applicable in 2010 and 2011	476
6.20.2.3.	Catches	476
6.20.2.3.1.	Landings	477
6.20.2.3.2.	Discards	477
6.20.2.4.	Fishing effort	478
6.20.3.	Scientific surveys	479
6.20.3.1.	MEDITS	479
6.20.3.1.1.	Methods	479
6.20.3.1.2.	Geographical distribution patterns	479
6.20.3.1.3.	Trends in abundance and biomass	479
6.20.3.1.4.	Trends in abundance by length or age	480
6.20.3.1.5.	Trends in growth	483
6.20.3.1.6.	Trends in maturity	483
6.20.4.	Assessment of historic stock parameters	483
6.20.4.1.	Method 1: XSA	483
6.20.4.1.1.	Justification	483
6.20.4.1.2.	Input Data	483
6.20.4.1.3.	Results	486
6.20.4.2.	Method 2: LCA	487
6.20.4.2.1.	Justification	487
6.20.4.2.2.	Input Data	487
6.20.4.2.3.	Results	488
6.20.5.	Long term prediction	490
6.20.5.1.	Justification	490
6.20.5.1.1.	Input parameters	490
6.20.5.1.2.	Results	491
6.20.6.	Scientific advice	493
6.20.6.1.	Short term considerations	493
6.20.6.1.1.	State of the spawning stock size	493
6.20.6.1.2.	State of recruitment	493
6.20.6.1.3.	State of exploitation	494

7.	ToR F Short term, medium term and long term forecasts of stock size and yield	494
7.1.	Short term predictions for <i>Nephrops norvegicus</i> in GSA01 (2012-2013)	494
7.1.1.	Short term prediction 2012-2013	494
7.1.1.1.	Input parameters	494
7.1.1.2.	Results	496
7.2.	Short term predictions for Black-bellied anglerfish in GSA 5	498
7.2.1.	Short term prediction 2012-2014	498
7.2.1.1.	Method and justification	498
7.2.1.2.	Input parameters	498
7.2.1.3.	Results	499
7.2.2.	Medium term prediction	501
7.2.2.1.	Method and justification	501
7.3.	Short term forecast for Common octopus in GSA 5	502
7.3.1.	Short term prediction 2012-2014	502
7.3.1.1.	Method and justification	502
7.3.1.2.	Input parameters	502
7.3.1.3.	Results	502
7.3.2.	Medium term prediction	503
7.3.2.1.	Method and justification	503
7.3.2.2.	Input parameters	503
7.3.1.		503
7.3.2.		503
7.3.2.3.	Results	503
7.4.	Short term prediction for Norway lobster in GSA 5	506
7.4.1.	Short term prediction 2012-2014	506
7.4.1.1.	Method and justification	506
7.4.1.2.	Input parameters	506
7.4.1.3.	Results	507
7.4.2.	Medium term prediction	509
7.4.2.1.	Method and justification	509
7.5.	Short and medium term predictions for Blackbellied Anglerfish in GSA 06	510

7.5.1.	Short term prediction 2012-2013	510
7.5.1.1.	Input parameters	510
7.5.1.2.	Results	511
7.5.2.	Medium term prediction	512
7.5.2.1.	Method and justification	512
7.5.2.2.	Input parameters	512
7.5.2.3.	Results	512
7.6.	Short term predictions for Blue and red shrimp in GSA 06	517
7.6.1.	Short term prediction 2012-2014	517
7.6.1.1.	Method and justification	517
7.6.1.2.	Input parameters	517
7.6.1.3.	Results	518
7.6.2.	Medium term prediction	519
7.6.2.1.	Method and justification	519
7.6.2.2.	Input parameters	520
7.6.2.3.	Results	520
7.7.	Short term predictions for Nephrops Norvegicus GSA06 (2012-2013)	525
7.7.1.	Short term prediction 2012-2013	525
7.7.1.1.	Input parameters	525
7.7.1.2.	Results	526
7.8.	Short term predictions for Red mullet in GSA 07	527
7.8.1.	Short term prediction 2009-2011	527
7.8.1.1.	Method and justification	527
7.8.1.2.	Input parameters	527
7.8.1.3.	Results	528
7.8.2.	Medium term prediction	529
7.8.2.1.	Method and justification	529
7.9.	Short term prediction for European Hake in GSA 7	530
7.9.1.	Short term prediction 2012-2013	530
7.9.1.1.	Method and justification	530
7.9.1.2.	Input parameters	530

7.9.1.3. Results	531
7.9.2. Medium term prediction	533
7.9.2.1. Method and justification	533
7.10. Short and medium term predictions for Spottail mantis in GSA10	534
7.10.1. Input parameters	534
7.10.2. Results	534
7.11. Short and Medium term predictions for Red mullet in GSA 11	536
7.11.1. Short term prediction for 2012 and 2014	536
7.11.1.1. Justification.	536
7.11.1.2. Input parameters	536
7.11.1.3. Results	536
7.11.2. Medium term prediction	537
7.11.2.1. Justification	537
7.12. Short and Medium term predictions for European Hake in GSA 11	538
7.12.1. Short term prediction for 2012 and 2014	538
7.12.1.1. Justification.	538
7.12.1.2. Input parameters	538
7.12.1.3. Results	538
7.12.2. Medium term prediction	539
7.13. Short term predictions of Giant Red Shrimp in GSAs 12-16	540
7.13.1. Short term prediction 2012-2014	540
7.13.1.1. Method and justification	540
7.13.1.2. Input parameters	540
7.13.1.3. Results	541
7.13.2. Medium term prediction	542
7.13.3. Long term prediction	542
7.14. Short term prediction of Red mullet in GSA 15-16	543
7.14.1. Short term prediction 2012-2014	543
7.14.1.1. Input parameters	543
7.14.1.2. Results	544
7.15. Short term predictions of Common Pandora in GSA 15 - 16	546

7.15.1.	Short term prediction 2012-2014	546
7.15.1.1.	Method and justification	546
7.15.1.2.	Input parameters	546
7.15.1.3.	Results	547
7.15.2.	Medium term prediction	548
7.15.3.	Long term prediction	548
7.16.	Short and medium term predicitions for Common sole in GSA 17	550
7.16.1.	Short term prediction 2012-2014	550
7.16.1.1.	Method and justification	550
7.16.1.2.	Input parameters	550
7.16.1.3.	Results	552
7.16.2.	Medium term prediction	553
7.17.	Short term predictions for Anchovy in GSA 16	554
7.17.1.	Short term prediction 2013-2014	554
7.17.1.1.	Method and justification	554
7.17.1.2.	Input parameters	554
7.17.1.3.	Results	555
7.18.	Short and medium term prediction for European Hake in GSA 17	556
7.18.1.	Short term prediction for 2012 and 2014	556
7.18.1.1.	Justification.	556
7.18.1.2.	Input parameters	556
7.18.1.3.	Results	557
7.18.2.	Medium term prediction	558
7.19.	Short term prediction for Red mullet in GSA 18	559
7.19.1.	Short term prediction 2012-2014	559
7.19.1.1.	Method and justification	559
7.19.1.2.	Input parameters	559
7.19.1.3.	Results	561
7.19.2.	Medium term prediction	562
7.20.	Short term prediction for European Hake in GSA 18	562
7.20.1.	Short term prediction 2011-2013	562

7.20.1.1.	Method and justification	562
7.20.1.2.	Input parameters	562
7.20.1.3.	Results	564
7.21.	Short term predicitions for Pink shrimp in GSA 18	565
7.21.1.	Short term prediction for 2012 and 2013	565
7.21.1.1.	Method and justification	565
7.21.1.2.	Input parameters	566
7.21.1.3.	Results	567
8.	TOR E	569
8.1.	Time series of anchovy and sardine total biomass in the Adriatic Sea	569
8.2.	Estimation of reference points for Sardine and Achovy in GSA 17	572
8.1		572
8.2		572
8.2.1.	Introduction	572
8.2.2.	Methodology	572
8.2.3.	Results	573
8.2.3.1.	Sardine in GSA 17	573
8.2.3.1.1.	The data	573
8.2.3.1.2.	Scenario 1: SGMED assessment stock-recruit data	574
8.2.3.1.3.	Scenario 2: SGMED assessment stock-recruit data with high recruitment removed	577
8.2.3.1.4.	Scenario 3: stock-recruit data from ICA fit to the full series using 2010 settings	580
8.2.3.1.5.	Scenario 4: GFCM 2011 assessment stock-recruit data	583
8.2.3.2.	Summary and recommendations	586
8.2.4.	Anchovy in GSA 17	586
8.2.4.1.	The data	586
8.2.4.1.1.	Scenario 1: SGMED assessment stock-recruit data	587
8.2.4.1.2.	Scenario 2: SGMED assessment stock-recruit data with high SSBs removed	589
8.2.4.1.3.	Scenario 3: SGMED assessment stock-recruit data with age zero removed	592
8.2.4.2.	Summary and recommendations	594
9.	ToR F Mixed fisheries	596
10.	ToR G Quality Checks	598

10.1.	Checks on MEDITS data	598
10.1.1.	Summary of the JRC SQL quality checks on MEDITS data	599
10.1.2.	Conclusions	601
10.2.	Evaluation of fisheries and effort data quality by EWG Experts	603
10.2.1.	Data coverage in GSA 1	603
10.2.2.	Data coverage in GSA 5	608
10.2.3.	Data coverage in GSA 6	611
10.2.4.	Data coverage in GSA 7	616
10.2.5.	Data coverage in GSA 9	621
10.2.6.	Data coverage in GSA 15	630
10.2.7.	Data coverage in GSA 17	633
11.	ToR H Revision and suggestions for dcf data call	637
12.	ToR I Identification of stock priority list	638
13.	ToR J Other Business:	642
14.	References	646
	ANNEX I LIST OF PARTICIPANTS TO STECF EWG 12-19	658
–	ANNEX II STOCK SUMMARY TABLE	661
–	LIST OF BACKGROUND DOCUMENTS	661

SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)

2012 Assessment of Mediterranean Sea stocks - part 2 (STECF-13-05)

**THIS REPORT WAS REVIEWED DURING THE PLENARY MEETING HELD IN BRUSSELS
8 – 12 April 2013**

Request to the STECF

STECF is requested to review the report of the **EWG 12-19** held from 10 – 14 December 2012 in Ancona, Italy, to evaluate the findings and make any appropriate comments and recommendations.

Introduction

The report of the Expert Working Group on Assessment of Mediterranean Sea stocks - part 2 (STECF EWG 12-19) was reviewed by the STECF during the plenary meeting held from 8 to 12 April, 2013 in Brussels, Belgium. The following observations, conclusions and recommendations represent the outcomes of that review.

STECF observations

The meeting was the planned second STECF expert meetings for undertaking stock assessments of small pelagic and demersal species in the Mediterranean. The meeting was held in Ancona, Italy from 10 to 14 December 2012. The meeting chair person was Massimiliano Cardinale and the EWG was attended by 22 experts in total, including 4 STECF members plus 3 JRC experts.

Historic fisheries and scientific survey data were obtained from the official Mediterranean DCF data call made on April 12th 2012. Greece, Italy, Spain and Slovenia did not provide any MEDITS data for 2012.

The EWG 12-19 performed stock assessment of 16 demersal stocks and 4 small pelagic stocks. The assessment of sole in GSA17 carried out during the last GFCM meeting held in Split, Croatia, 5-9 November 2012 was presented. With the exception of sardine in GSA 16, all the stocks assessed were classified as being subject to overfishing.

The WG examined the work performed by JRC on data quality of MEDITS surveys for which several inconsistencies had emerged during previous meetings and some small amendments in the data call format based on JRC's recommendations were proposed.

Particular attention was paid to a request for preparation of a ranking list of stocks based on a multi-criteria approach, which included exploitation status, data availability, ecosystem role, etc by GSA as well as for identifying a timeline for assessments over the period 2013-2015. A proposal to pay a major attention on the stocks ranked on the top as well as to limit the number of stocks (a maximum of 30) to be assessed in each EWG was agreed in order to allow sufficient time for discussion and to address the quality of the assessments.

The issue of suitable methods for assessing Cephalopod stocks and the sampling strategy consistent with their life history traits under the DCF was briefly discussed and attempts to undertake assessments using biomass dynamic models were carried out.

A summary of the assessments from EWG 12-19 and all preceding assessments EWGs is plotted in Figures 1 and 2. Both Figures are constructed according to GSA (each panel) and include all the stocks with agreed F_{curr} and F_{MSY} estimates that have been assessed since 2009. The ratio F_{curr}/F_{MSY} has been calculated and status is classified as overexploited if $\log(F_{curr}/F_{MSY}) > 0$ and as sustainable if $\log(F_{curr}/F_{MSY}) \leq 0$. Year refers to the year in which the assessment was performed. F_{curr} is the most recent estimate of F and generally relates to the assessment year -1.

Figure 1 Overview of Mediterranean stock assessments from EWG 12-19 and all preceding assessments EWGs since 2009 for GSA 1 to 15-6. Each panel is a GSA and $\log(F_{curr}/F_{MSY}) > 0$ indicates that a stock is overexploited.

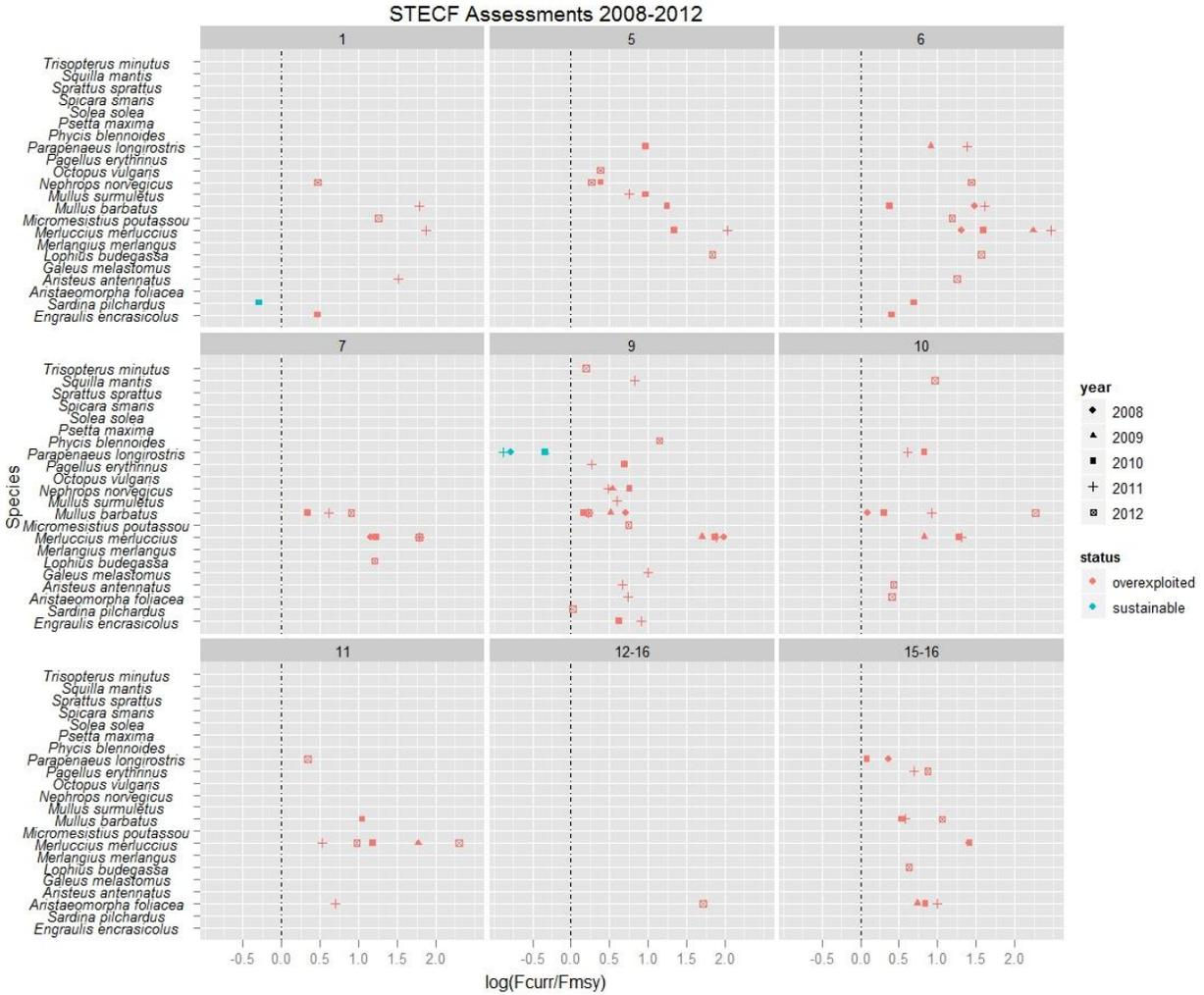
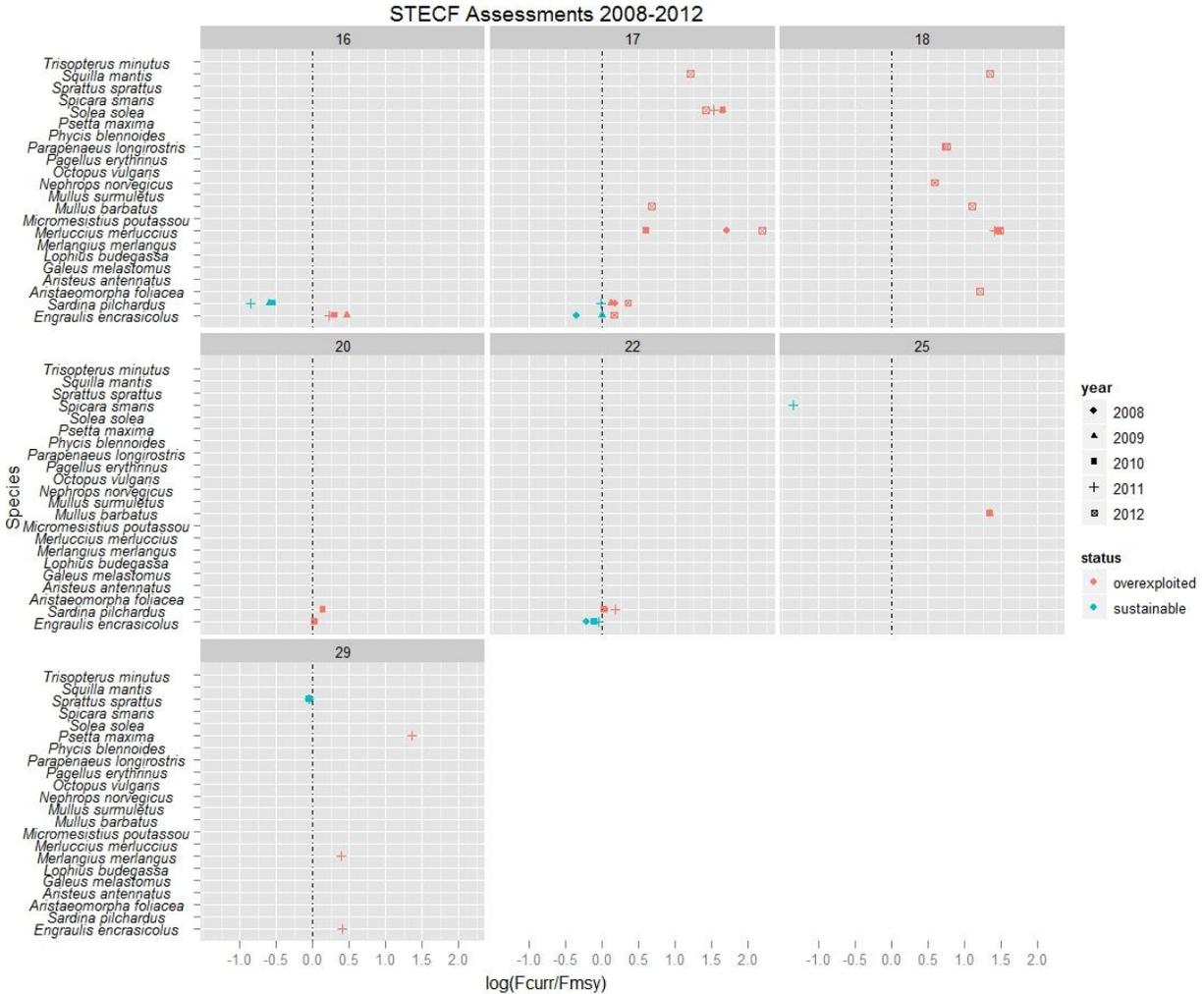


Figure 2 Overview of Mediterranean stock assessments from EWG 12-19 and all preceding assessments EWGs since 2009 for GSA 16 to 29 (Black Sea). Each panel is a GSA and $\log(F/F_{msy}) > 0$ indicates that a stock is overexploited.



The EWG 12-19 also estimated short-term catch and stock size forecasts for 21 stocks. Medium-term forecasts were undertaken for those stocks for which a meaningful stock recruitment relationship supported such an analysis.

Additionally, the issue of the choice of biomass reference points for some small pelagic stocks was addressed. JRC experts delivered analyses for anchovy and sardine in GSA 17, based on the methodology in Simmonds et al. (2011). The methodology uses stochastic forecasts to estimate

reference points by identifying the levels of fishing mortality that have a high probability of delivering the maximum yield while avoiding SSB to fall under B_{lim} . The resulting reference points are different from those proposed by the GFCM, which were derived using a different approach and a shorter time series. STECF suggests that the methodology of Simmonds et al. (2011) continue to be used to estimate biomass reference points for Mediterranean stocks whenever possible depending on the data availability.

STECF conclusions

According to the results of the assessments presented in the report the STECF EWG 12-19, based on these new assessments, concludes that the:

- **two** stocks in GSA 1, Norway lobster (*Nephrops norvegicus*) and Blue Whiting (*Micromestius poutassou*), are subject to overfishing.
- **one** stock in GSA 5, Black-bellied anglerfish (*Lophius budegassa*) is subject to overfishing.
- **one** stock in GSA 6, Norway lobster (*Nephrops norvegicus*) is subject to overfishing.
- **two** stocks in GSA 9, Red mullet (*Mullus barbatus*) and Great forkbeard (*Phycis blennoides*) are subject to overfishing.
- **two** stocks in GSA 10, Blue and red shrimp (*Aristeus antennatus*) and Giant red shrimp (*Aristaeomorpha foliacea*) are subject to overfishing.
- **two** stocks of Hake (*Merluccius merluccius*) and Red Mullet (*Mullus barbatus*) in GSA 11 are subject to overfishing.
- **one** stock of Giant red shrimp (*Aristaeomorpha foliacea*) in GSAs 12-16 is subject to overfishing.
- **one** stocks of Sardine (*Sardina pilchardus*) is exploited sustainably and **one** stock of Anchovy (*Engraulis encrasicolus*) is subject to overfishing in GSA 16.
- **five** stocks, Red mullet (*Mullus barbatus*) and Hake (*Merluccius merluccius*), Sole (*Solea solea*), Sardine (*Sardina pilchardus*) and Anchovy (*Engraulis encrasicolus*) in GSA 17 are subject to overfishing.
- **two** stocks of Red mullet (*Mullus barbatus*) and Giant red shrimp (*Aristaeomorpha foliacea*) in GSA 18 are subject to overfishing.
- **two** stocks of Red mullet (*Mullus barbatus*) and Hake (*Merluccius merluccius*) in GSA 19 are subject to overfishing

STECF advice

Given that 95% of the demersal and small pelagic stocks in the Mediterranean assessed by STECF in 2012 were classified as being subject to overfishing, STECF advises that in order to avoid further losses in stock productivity and landings in the long-term, fishing mortality needs to be reduced to the proposed F_{MSY} reference points.

REPORT TO THE STECF

EXPERT WORKING GROUP ON Assessment of Mediterranean Sea stocks - part 2 (STECF EWG 12-19)

Ancona, Italy 10-14 December 2012

This report does not necessarily reflect the view of the STECF and the European Commission and in no way anticipates the Commission's future policy in this area

1. EXECUTIVE SUMMARY

The meeting was the second of two STECF expert meetings, within STECF's 2012 work programme, planned to undertake stock assessments of small pelagic and demersal species in the Mediterranean Sea. The meeting was organized by CNR in Ancona (Italy) and ran from 10 to 14 of December 2012. The meeting was chaired by Massimiliano Cardinale and attended by 22 experts in total, including 4 STECF members plus 3 JRC experts.

Historic fisheries and scientific survey data were obtained from the official Mediterranean DCF data call issued to Member States on April 12th 2012 with deadlines on 18 June and 3 December 2012. The latter deadline had been specifically set to call for in-year (2012) MEDITS survey data to improve the precision of short term forecasts of stock size and catches under various management scenarios. Greece, Italy, Spain and Slovenia did not provide any MEDITS data for 2012.

In fulfillment of **TORs (a-d)** the EWG 12-19 undertook the stock assessment of 16 demersal stocks, 4 stocks of small pelagic species and the revision of 2 assessments from GFCM. Around 95% of assessed stocks were classified as being subject to overfishing.

Following **TOR (e)** the EWG 12-19 also estimated short and medium term forecasts of stock size and catch for 21 stocks, where a meaningful stock recruitment relationship supported such analyses.

Additionally it was requested to estimate biomass reference points for some small pelagics stocks. JRC experts delivered the analysis for TOR (e) in GSA 17. These consisted in producing catch forecasts to get high yield under different recruitment scenarios while avoiding with high probability the risk that SSB fall under B_{lim} .

In particular:

1. Estimate the biomass reference points (i.e. $SSB_{trigger}$ both as SSB_{lim} and SSB_{pa}) defined as the levels of SSB below which recruitment is considered likely to become increasingly impaired and thus actions should be taken (i.e. reducing fishing mortality below F_{MSY} and the exploitation rate E well below 0.4) when the SSB approaches such stock sizes. Unless other more adequate approach is advisable, a segmented regression based on the stock recruitment data should be used.

2. Using the framework developed at ICES-WKFRAME 2010, estimate the level of F which minimizes the risk of SSB falling below SSB_{trigger} and maximize the total yield from the stock in the long term (5, 10 and 20 years) with different recruitment assumptions.

TOR (f) EWG 12-19 updated the discussion on evaluation of different approaches to analyse and provide management advice regarding mixed fisheries under various scenarios. The group reviewed the relevance of tools with different potential methodologies that have been developed in recent years to guide management and to design multiannual management plans towards sustainable fisheries. The EWG continuously note that the selection of the various mixed fisheries involved in the exploitation of certain stocks potentially varies with the areas, gears and the fishing strategies.

TOR (g) The JRC examined the data quality of MEDITS survey data for which several inconsistencies had emerged during previous meetings. The data quality analysis was facilitated by checks developed in SQL by JRC, exploring inconsistencies across tables (TA, TB, TC) and for hauls parameter. STECF EWG 12-19 reviews DCF data availability and quality of GSAs 1, 6, 7, 9, 15 and 17.

TOR (h) The EWG 12-19 reviewed the DCF data call format and made some minor amendments based on JRC's recommendations.

TOR (i) The EWG 12-19 was requested to identify a list of stock by GSA based on a multi-criteria including exploitation status, data availability, etc. and to identify a timeline for assessment over the period 2013-2015.

ToR (J) EWG 12-19 revised the methods to assess Cephalopod stocks and DCF data collection adequacy in terms of sampling

The EWG's report will be presented and reviewed during the STECF spring plenary meeting PLEN 13-01, 4-8 April 2013.

2. CONCLUSIONS OF THE WORKING GROUP

ToR a-d) update and assess historic and recent stock parameters: The EWG 12-19 assessed the status of 18 demersal stocks, 4 small pelagic stocks and their fisheries, which resulted in an estimate of the current exploitation rate compared to F_{MSY} or E. All stock assessed were classified as being exploited unsustainably with the exception of Sardine in GSA 16 (Annex II and Figure 1-2).

The EWG 12-19 could provide for the assessed stocks detailed summary sheets informing about the stocks' status and their state of exploitation in relation to proposed management reference points consistent with high long term yields (F_{MSY}).

The STECF EWG 12-19, based on new assessments, concludes that the:

- **two** stocks in GSA 1, Norway lobster (*Nephrops norvegicus*) and Blue Whiting (*Micromestius poutassou*), are subject to overfishing.
- **one** stock in GSA 5, Black-bellied anglerfish (*Lophius budegassa*) is subject to overfishing.
- **one** stock in GSA 6, Norway lobster (*Nephrops norvegicus*) is subject to overfishing.
- **two** stocks in GSA 9, Red mullet (*Mullus barbatus*) and Great forkbeard (*Phycis blennoides*) are subject to overfishing.
- **two** stocks in GSA 10, Blue and red shrimp (*Aristeus antennatus*) and Giant red shrimp (*Aristaeomorpha foliacea*) are subject to overfishing.
- **two** stocks of Hake (*Merluccius merluccius*) and Red Mullet (*Mullus barbatus*) in GSA 11 are subject to overfishing.
- **one** stock of Giant red shrimp (*Aristaeomorpha foliacea*) in GSAs 12-16 is subject to overfishing.
- **one** stocks of Sardine (*Sardina pilchardus*) is exploited sustainably and **one** stock of Anchovy (*Engraulis encrasicolus*) is subject to overfishing in GSA 16.
- **five** stocks, Red mullet (*Mullus barbatus*) and Hake (*Merluccius merluccius*), Sole (*Solea solea*), Sardine (*Sardina pilchardus*) and Anchovy (*Engraulis encrasicolus*) in GSA 17 are subject to overfishing.
- **two** stocks of Red mullet (*Mullus barbatus*) and Giant red shrimp (*Aristaeomorpha foliacea*) in GSA 18 are subject to overfishing.

•two stocks of Red mullet (*Mullus barbatus*) and Hake (*Merluccius merluccius*) in GSA 19 are subject to overfishing

A summary of the assessments from EWG 12-19 and all preceding assessments EWGs have been plotted in Figure 1-2. The plot is constructed by GSA (each panel) and it includes all species for which an assessment with accepted F_{curr} and F_{msy} has been finalized or attempted since 2009. The ratio F_{curr}/F_{msy} has been calculated and status is classified as overexploited if $\log(F_{curr}/F_{msy}) > 0$ and as sustainable if ≤ 0 . The F values are referred to the year in which the assessment was performed (thus it generally refers to the actual F of one year before), assessments pre-2009 were considered outdated.

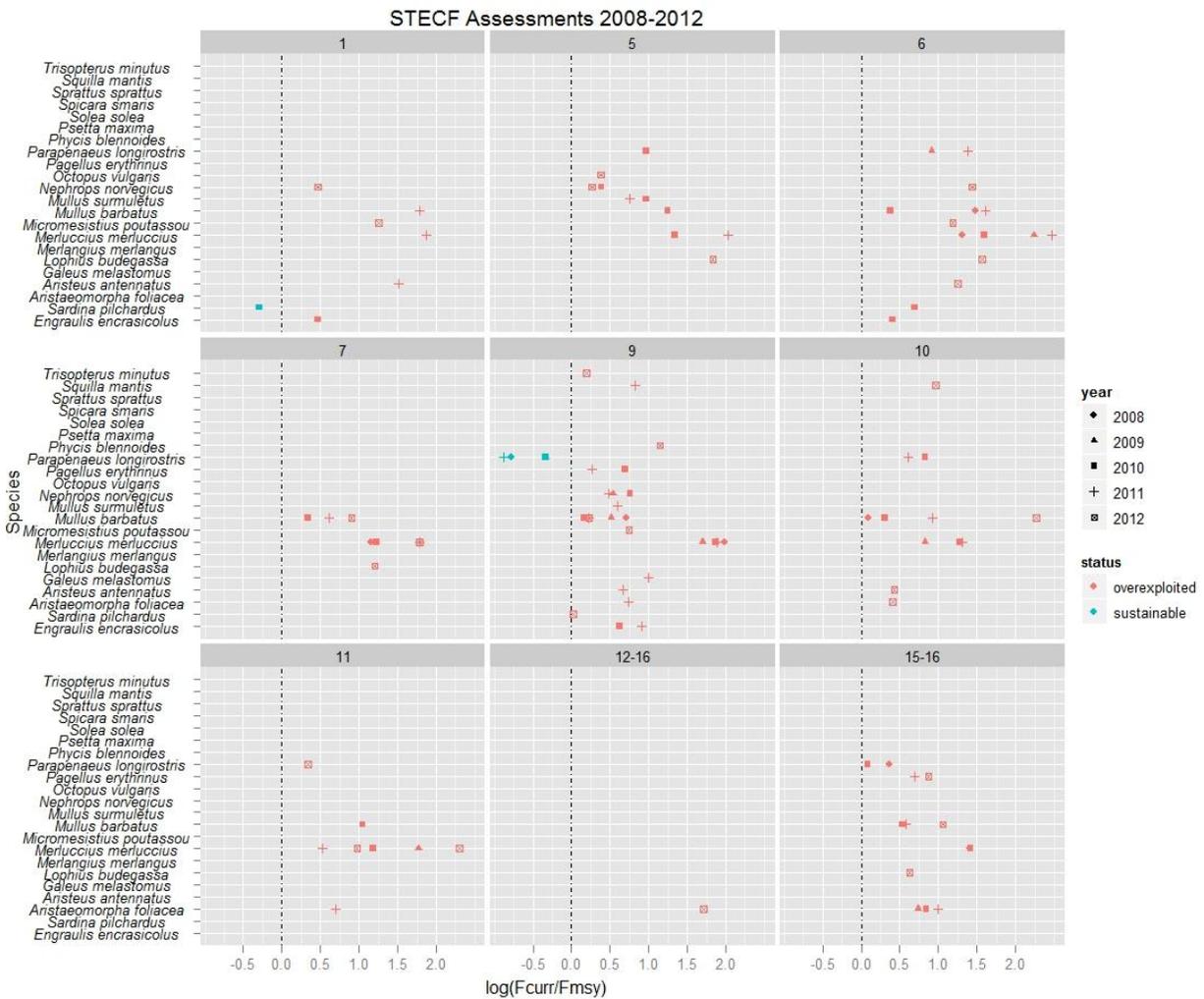


Figure 1. Overview of Mediterranean stock assessments from EWG 12-19 and all preceding assessments EWGs since 2009 for GSA 1 to 15-6. Each panel is a GSA and $\log(F/F_{msy}) > 0$ indicates that a stock is overexploited.

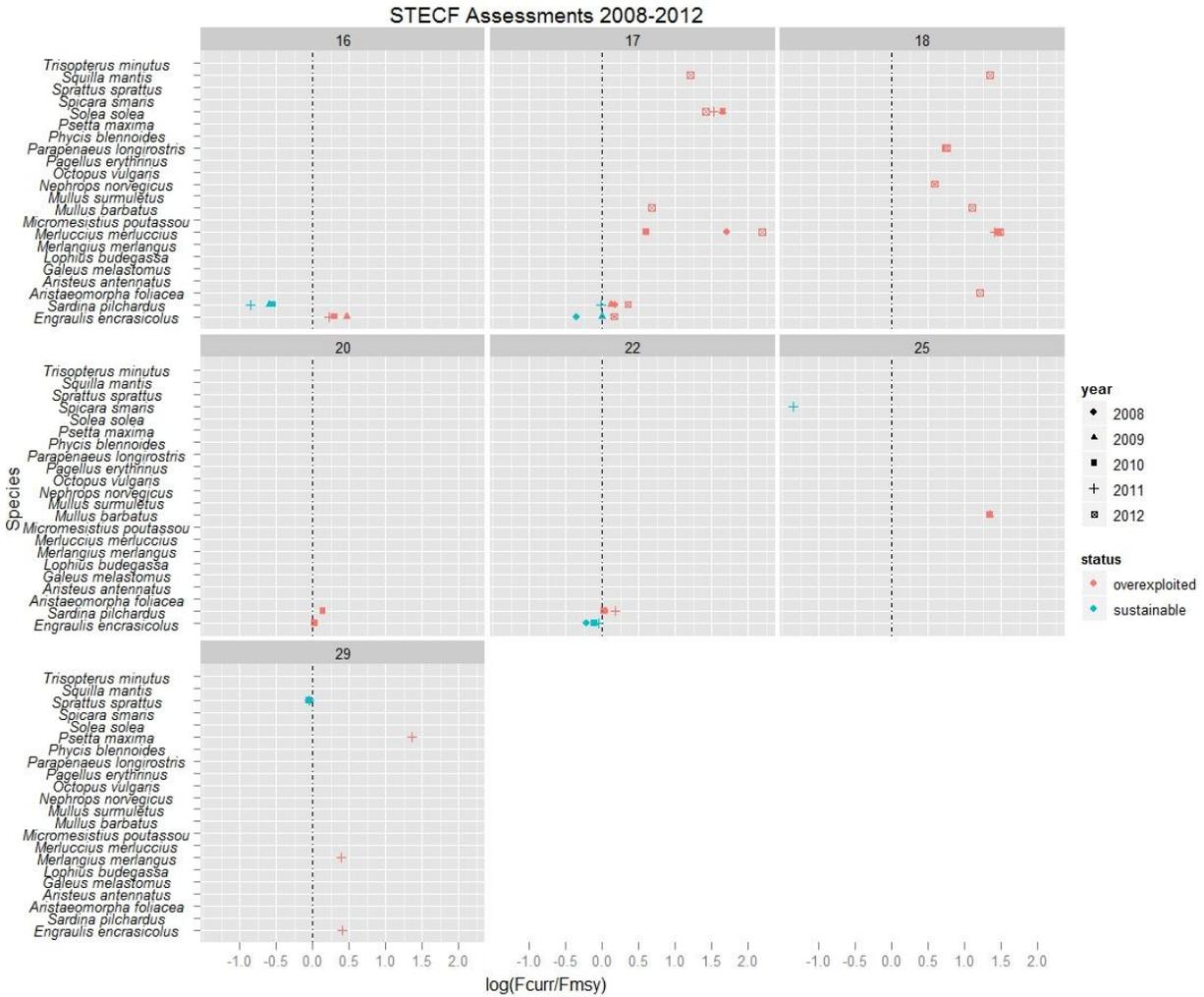


Figure 2. Overview of Mediterranean stock assessments from EWG 12-19 and all preceding assessments EWGs since 2009 for GSA 16 to 29 (Black Sea). Each panel is a GSA and $\log(F/F_{msy}) > 0$ indicates that a stock is overexploited.

ToR (e), short and medium term forecast EWG 12-19 where performed as follow:

- 22 short term forecasts (for detail of species see Annex II).
- 4 medium term forecasts (for detail of species see Annex II).

Specifically for Sardine and Anchovy in GSA 17, the following reference points were derived: F_{lim5} , F_{lim10} and F_{lim50} are the F values that give a 5%, 10% and 50% probability of SSB falling below B_{lim} . F_{MSY} is the median F that gives maximum sustainable yield and $F_{max\ catch}$ maximises average catch. F_{crash5} and

$F_{\text{crash}50}$ are the F values that give 5% and 50% probability of crashing the stock. For these two stocks B_{lim} could not be estimated from the segmented regression and was thus defined as 30% of maximum observed SSB. B_{pa} was defined as 1.4 time B_{lim} . Based on the data and stock recruitment scenarios specific B_{lim} and F_{MSY} were proposed for Anchovy and Sardine in GSA 17. In particular for Anchovy EWG 12-19 suggest to adopt $B_{\text{lim}} = 148,623$ t (i.e. 30% of SSB_{max} in scenario 2) and $F_{\text{msy}} = 0.56$ (i.e. $F_{\text{max catch}}$). For Sardine suggest to adopt $B_{\text{lim}} = 408,032$ t (i.e. 30% of SSB_{max}) and $F_{\text{msy}} = 0.25$ (i.e. $F_{\text{max Catch}}$).

ToR (f), mixed fisheries: The EWG 12-19 was requested to review and evaluate the mixed fisheries frameworks and computer programs to deliver mixed fisheries management advice. EWG 12-19 updated the discussion on evaluation of different approaches to analyse and provide management advice regarding mixed fisheries under various scenarios. The group emphasized the relevance of tools with different potential methodologies that have been developed in recent years to guide management and to design multiannual management plans towards sustainable fisheries.

ToR (g) MEDITS quality checks: JRC presented 26 checks have been designed (following the philosophy of the ROME routine developed by Spedicato and Bitetto) and applied to the Medits dataset submitted in response to the 2012 data call. Total run time of the checks is approximately 7 min for all countries, years, GSAs with no optimization of the queries. There was a significant number of inconsistencies detected at a different level of importance. The trends in error patterns show more errors in earlier years and to specific areas.

ToR (g) Evaluation of DCF data quality by EWG Experts: data quality and availability was assessed for GSAs 1, 6, 7, 9, 15, 17. Data was evaluated by species and year in samplings from commercial fleet, surveys at sea, maturity ogive, length-weight and growth parameters (otolith reading or others). Additionally landings information by gear (DCR: 2005-2008) or métier (DCF: 2009-2011) was assessed by GSA.

ToR (h) The EWG 12-19 reviewed the DCF data call format and made some minor amendments based on JRC's recommendations.

ToR (i) STECF EWG 12-19 identified major stocks of the different species and proposed about 30 stocks to be assessed annually, biennially or over a longer timeframe starting from 2013. So far the number of stock and fisheries assessments carried out and their selection rather depended on the presence of experts and their proposals. This shall facilitate the STECF systematic approach in monitoring and following recovery of major stocks and fisheries in the Mediterranean based on a prioritized schedule of stock assessments.

ToR (J) Review of Cephalopod assessment methods and data collection: EWG 12-19 was requested to identify the most likely scientific procedure(s) making use, as required, of scientific surveys and/or commercial data for Cephalopods. Biomass dynamic and Depletion models were considered and the latter seemed more appropriate when data derived from monthly sampling is available. Alternatively, when full assessment input data are not available, time series approaches can be applied on CPUE indexes. Based on conclusions from ICES WGCEPH, the current DCF quarterly sampling frequency is too low and should be at least monthly.

3. RECOMMENDATIONS OF THE WORKING GROUP

ToR (a-d) update and assess historic and recent stock parameters: The EWG 12-19 recommends the reduction of the effort and/or the catches of the relevant fleets' exploiting the following stocks until fishing mortality is below or at the proposed level F_{MSY} , in order to avoid future loss in stock productivity and landings: Norway lobster (*Nephrops norvegicus*) and Blue Whiting (*Micromestius poutassou*) in GSA 1, Black-bellied anglerfish (*Lophius budegassa*) in GSA 5, Norway lobster (*Nephrops norvegicus*) in GSA 6, Red mullet (*Mullus barbatus*) and Great forkbeard (*Phycis blennoides*) in GSA 9, Blue and red shrimp (*Aristeus antennatus*) and Giant red shrimp (*Aristaeomorpha foliacea*) in GSA 10, Hake (*Merluccius merluccius*) and Red Mullet (*Mullus barbatus*) in GSA 11, Giant red shrimp (*Aristaeomorpha foliacea*) in GSAs 12-16, Anchovy (*Engraulis encrasicolus*) in GSA 16, Red mullet (*Mullus barbatus*), Hake (*Merluccius merluccius*), Sole (*Solea solea*), Sardine (*Sardina pilchardus*) and Anchovy (*Engraulis encrasicolus*) in GSA 17, Red mullet (*Mullus barbatus*) and Giant red shrimp (*Aristaeomorpha foliacea*) in GSA 18 and Red mullet (*Mullus barbatus*) and Hake (*Merluccius merluccius*) in GSA 19.

The F_{MSY} target should be reached by means of a multi-annual management plan taking into account mixed-fisheries effects. Catches and effort consistent with F_{MSY} should be estimated.

Sardine (*Sardina pilchardus*) in GSA 16 is exploited sustainably.

ToR(e) STECF EWG 12-19 recommends to perform short and medium term predictions only when meaningful stock-recruitment relations can be fitted.

EWG 12-19 recommends the new approach, adopted and modified from WKFRAME, for deriving biomass and exploitation rates in a probabilistic framework as for Sardine and Anchovy in GSA 17. This is a step forward from deterministic reference points and should be applied when possible.

ToR (f), mixed fisheries: STECF EWG 12-19 after revising the available approaches, advises that the potential use of existing tools to improve the selectivity of mixed fisheries shall be evaluated and promoted in order to simplify overly complex fisheries strategies through reduction of by catch and number of species exploited by the same gear. The mixed fisheries framework is considered very essential issue and relevant investigations shall be continued during the forthcoming meetings. Because of the complexity of the subject and the overload work during the current meeting, the group advises to establish a dedicated working framework to thoroughly tackle the subject.

ToR (g) data quality and MEDITS: EWG 12-19 recommends a revision of the MEDITS records emerging from each of the quality checks and correction of erroneous entries. EWG 12-19 recommends the use of quality check routines such as the JRC one (although not currently distributed) and the ROME library.

ToR (h) EWG 12-19 recommends accommodating length classes greater than 100 cm in fisheries table B, call MEDITS according to new format, with the exception of new table TE and call for biological parameter that have not been called since 2009. The revised data call format shall improve the structure of data which will be called from next year 2013.

ToR (i) EWG 12-19 recommends to base the work of the next expert working groups on the stock priority list (outlined in section 12, Table 12.1.1.1) with particular emphasis on not exceeding 30 analytical stock assessments per year in order to maintain a proper quality.

ToR (j) EWG 12-19 recommends to further investigate assessments methods for cephalopods in the Mediterranean Sea and to assess the cost benefits of a monthly vs quarterly sampling of catches within the DCF.

Future planning of Mediterranean expert group meetings: The next STECF expert meeting (EWG 13-9: Assessment of Mediterranean Sea stocks - part 1) will be convened on the week 15-19 July 2013 in the Ispra (Italy) and the second one (EWG 13-xx: Assessment of Mediterranean Sea stocks - part 2) will tentatively be held in Brussels the week 9-13 of December 2013.

4. INTRODUCTION

The expert working group on Mediterranean stock and fisheries assessment STECF EWG 12-19 held its second meeting planned for 2012 in Ancona (Italy), 10-14 December 2012.

The chairman opened the meeting at 9.00 am on Monday, 10 December 2012, and adjourned the meeting by 4.00 pm on Friday, 14 December 2012. The meeting was attended by 23 experts in total, including 3 STECF members and 3 JRC experts.

The structure of the present report is in accordance with the terms of reference to STECF, as defined in the following chapter.

4.1. Terms of Reference for the STECF EWG 12-19

The STECF-EWG 12-19 is requested to:

a) update and assess, by all relevant individual GSAs or combined GSAs where appropriate, historic and recent stock parameters for the longest time series possible of the priority 9 species listed below as well as of other species listed in the Annex to this ToR reporting Appendix 7 of the DCF data call issued on 12 April 2012¹.

Due account shall be given to technical interactions and description of the concerned multispecies and multiple-gears fisheries also in terms of fishing effort deployed (trends over time) and allocation of stock catches among different metier.

To the extent possible, the assessment shall provide the target (biological, bio-economic), the precautionary (threshold) and conservation (limit) reference points, either model based or empirical. The reference points shall be related to long-term high yields and low risk of stock/fishery collapse and ensure that the exploitation levels maintain or restore marine biological resources at least at levels which can produce the maximum sustainable yield.

Assessment data and methods are to be fully documented with particular reference to the completeness and quality of the data submitted by Member States as response to the official Mediterranean DCF data call issued on April and reminded in June and December 2012.

¹ MARE D/2/D(2012)448251

- Sardine (*Sardina pilchardus*)
- Anchovy (*Engraulis encrasicolus*)
- European hake (*Merluccius merluccius*)
- Common sole (*Solea solea*)
- Red mullet (*Mullus barbatus*)
- Deep-water rose shrimp (*Parapenaeus longirostris*)
- Red shrimp (*Aristeus antennatus*)
- Giant red shrimp (*Aristaeomorpha foliacea*)
- Norway lobster (*Nephrops norvegicus*)

Assessment priority shall be given on stocks/GSAs not yet assessed either analytically or through data-shortage methods; special attention shall be given, in particular, to demersal stocks in GSA **7, 10, 11, 17, and 18.**

Data collected outside the DCF and/or delivered to the meeting by non-EU scientists shall be used as well and merged with DCF data whenever necessary. Due account shall also be given to data used and assessments carried out within the FAO regional projects co-funded by the European Commission and EU-Member States in particular when using data collected through the DCF/DCR and EU funded research projects, studies and other types of EU funding.

In particular, for the Adriatic we draw your attention to the recent publication Piccinetti C., Vroge N., Marceta B., Manfredi C. (2012)"Recent state of demersal resources in the Adriatic Sea" in Acta Adriatica- Monograph Series no 5" from which some excerpts of stocks sheets have been scanned and provided as background document for this meeting.

The table below summarizes particular stocks assessed in 2011 which should deserve much lower priority in 2012 unless they need to be treated to address specific items of these ToRs.

Moreover, in case the GFCM-SAC working groups have carried out and/or endorsed an assessment for a stock not listed in the table below there is no need to redo the analyses unless new scientific and fishery elements have emerged that calls for a revised assessment. A revision of a GFCM assessment has to be conducted only if raw data to generate the input data for the assessment are made available to the WG the first day of the meeting at latest.

GSA	Common name	NO Need to UPDATE since assessment done in 2011
1	Hake	N
1	Pink shrimp	N
1	Red mullet	N
1	Blue and red shrimp	N
5	Hake	N
5	Striped red mullet	N
6	Hake	N
6	Pink shrimp	N
6	Red mullet	N
7	Hake	N
7	Red mullet	N

9	Anchovy	N
9	Common Pandora	N
9	Hake	N
9	Norway lobster	N
9	Pink shrimp	N
9	Red mullet	N
9	Blue and red shrimp	N
9	Spottail mantis shrimp	N
9	Striped red mullet	N
9	Blackmouth catshark	N
9	Giant red shrimp	N
10	Hake	N
10	Pink shrimp	N
10	Red mullet	N
11	Giant red shrimp	N
11	Hake	N
15-16	Giant red shrimp	N
15-16	Red mullet	N
15-16	Common Pandora	N
16	Anchovy	N
16	Sardine	N
17	Common sole	N
17	Sardine	N
18	Hake	N
22	Anchovy	N
22	Sardine	N
25	Picarel	N

b) The DCR/DCF data call of April 2012 includes the entire list of the common reference species for the MEDITS surveys. Test the consistency of the data, assess whether there is sufficient data and resolution to carry out adequate assessments for some stocks, including data-shortage methods (e.g. biomass dynamic models; demographic models; SURBA; AIM; SEINE etc.).

Moreover, during SGMED 10-02 via inspection of MEDITS trends it was assessed which species could be used for trend estimation (Table 3.4.2). If adequate corresponding data is available in the Landings and discard data from DCR/DCF, potentially new assessments should be conducted during the current and/or next meeting(s) for: *Lophius spp*, *Pagellus erythrinus*, *Trigla lucerna*, *Trachurus spp*, *Eutrigla gurnardus*, *Micomestius poutassou*, *Trisopterus minutus*, *Mullus surmuletus*, *Spicara spp*, and *Boops boops*.

Special attention shall be given, in particular, to demersal stocks in GSA **5, 6, 7, 10, 11, 17, and 18**.

Data collected outside the DCF and/or delivered to the meeting by non-EU scientists shall be used as well and merged with DCF data whenever necessary. Due account shall also be given to data used and assessments carried out within the FAO regional projects co-funded by the European Commission and

EU-Member States in particular when using data collected through the DCF/DCR and EU funded research projects, studies and other types of EU funding.

However, in case the GFCM-SAC working groups have carried out and/or endorsed an assessment there is no need to redo the analyses unless new scientific and fishery elements have emerged that calls for a revised assessment. A revision of a GFCM assessment has to be conducted only if raw data to generate the input data for the assessment are made available to the WG the first day of the meeting at latest.

Table 3.4.2 List of priority species by Medits code and GSA. Enough data is available for trend estimation (YES), not enough data for trend estimation (NO), status of the data unclear due to errors in database (na, ?) or occasional occurrence of the species in the surveys.

GSA	LOPH PIS	LOPH BUD	PAGE ERY	TRIG LUC	TRAC MED	TRAC TRA	EUTR GUR	MICM POU	SQUI MAN	BOOP BOO	SOLE VUL	SPAR AUR
6	YES	YES	YES	?	YES	YES	YES	YES	NO	YES	?	na
7	YES	NO	YES	YES	na							
8	YES	YES	YES	na	YES	YES	no	YES	na	YES	?	na
9	YES	no										
10	YES	YES	YES	YES	YES	YES	NO*	YES	YES	YES	NO*	NO*
11	na	YES	na	na	YES	na	YES	YES	na	na	?	na
16	YES	?	NO									
17	YES	?	NO									
18	YES	?	NO									
20	?	YES	NO									
22+23	YES											
0 Infl.				yes							YES	

*rare presence or absence of the species during the surveys

c) assess, review and propose biological fisheries management reference points, either model based or empirical, of exploitation and stock size related to high yields and low risk of stock/fishery collapse of each of the stocks listed under a), b) and assessed by STECF or other scientific frameworks. This work shall provide, to the extent possible, the target (management) for sustainable fishing at MSY or proxy, the precautionary (threshold) and conservation (limit) reference points. Assessment data and methods are to be fully documented with particular reference to the completeness and quality of the data submitted by Member States as response to the official Mediterranean DCR/DCF data calls.

d) provide a synoptic overview on the recent status of exploitation level and stock size of the species listed under a), b) in relation to the biological fisheries management reference points as identified under c).

e) provide short term, medium term and long term forecasts of stock biomass and yield for the demersal and small pelagic stocks assessed in 2012, including assessments carried out in scientific frameworks other than STECF and funded by the EC. Specific attention shall be given to small pelagic stocks in GSAs 01, 05, 06, 07, 10, 16, 17 and 18.

The forecast scenarios shall include, inter alia:

- the status quo

and

- target to F_{MSY} or other appropriate proxies for 2013, 2015 and 2020, respectively.

In particular, produce catch forecasts to get high yield under different recruitment scenarios while avoiding with high probability the risk that SSB fall under Blim. In particular:

1. Estimate the biomass reference points (i.e. $SSB_{trigger}$ both as SSB_{lim} and SSB_{pa}) defined as the levels of SSB below which recruitment is considered likely to become increasingly impaired and thus actions should be taken (i.e. reducing fishing mortality below F_{MSY} and the exploitation rate E well below 0.4) when the SSB approaches such stock sizes. Unless other more adequate approach is advisable, a segmented regression based on the stock recruitment data should be used.
2. Using the framework developed at ICES-WKFRAME 2010, estimate the level of F which minimizes the risk of SSB falling below $SSB_{trigger}$ and maximize the total yield from the stock in the long term (5, 10 and 20 years) at different level of assumed recruitment.
3. Estimate, on the basis of commercial average catch rates by métier, the level of fishing effort by métier which is commensurate to the sustainable short-term and long-term catch forecasts

Raw data used to generate the input data for the assessment should be made available to allow for testing different settings and data scenarios.

Implications of the proposed changes in fishing mortality on the fishing effort exerted by the relevant fisheries/métier concerned have to be identified. The identification and description of the fisheries/métier to be considered are left to the experts on the basis of their knowledge of fisheries in each GFCM-GSA.

The simulation by fishery for the abovementioned targets shall be driven either by the most relevant stock(s) (either in quantity and/or economic value), or the most vulnerable stock or a scientifically weighed mix of MSY targets for the species involved in the fishery.

f) review and evaluate existing scientific frameworks for the elaboration of mixed fisheries management advice, and develop a framework to deliver management advice for multi-species/stocks fisheries in the Mediterranean. Such framework shall consider and be consistent with the management advice for fisheries of single species/stocks provided by STECF so far and provide medium-long term scenarios constrained by one or all species/stocks specific management points to be achieved by 2015 or 2020, respectively. The framework shall be age-structured, to the extent possible, and be based on ecological data and concepts as a first step; considerations shall be given to accommodate within this framework, whenever necessary, empirical indicators. The input data required and model processes to deliver management advice for multi-species/stocks fisheries shall be described in detail.

The management advice shall consider quantitative annual effort changes and consistent catch possibilities. If this point cannot be thoroughly addressed during this meeting, then proposes a roadmap and ways to start addressing this issue in the subsequent STECF EWG meetings in 2013 and 2014;

g) review the quality and completeness of all data resulting from the official Mediterranean DCF data call issued on April 2012 requesting MEDITS trawl survey data updated to year 2012. STECF is requested to summarize and concisely describe in detail all data quality deficiencies of relevance for the assessment of stocks and fisheries. Such review and description are to be based the data format of the official DCF data calls for the Mediterranean and Black Sea issued on April 2012. Particular attentions should be devoted to assessing the quality of MEDITS survey for which several inconsistencies had emerged during the EWG 11-12 and EWG 12-10 meeting.

Test and validate some of the error patterns emerging from MEDITS quality checks, developed in SQL by JRC, exploring inconsistencies across tables (TA, TB, TC) and for hauls parameter. Such routines share a similar philosophy to the ROME script but a different implementation and functionality.

h) review the DCF data call in 2012 for Mediterranean stocks, fisheries and surveys and where necessary suggest adjustments on data needs and quality of data to be requested in the DCF call in 2013.

i) taking into account the catch composition of the different fisheries/métier, the biological characteristics and the current level of overfishing identify the major stocks of the different species whose scientific

assessment has to be carried annually, biennially or over a longer timeframe starting from 2013. This should facilitate the STECF systematic approach in monitoring and following recovery of major stocks and fisheries in the Mediterranean based on a prioritized schedule of stock assessments. Such exercise is to be based on pragmatic expertise on data coverage by GFCM GSA resulting from Mediterranean DCF data calls.

j) Any Other Business:

– Cephalopods represent relevant species for some fisheries/métier and play important ecological roles in the marine food webs; there is increasing need to identify the best appropriate scientific approaches, proportionate to the consistency and value of the catches, to evaluate their status and calibrate their exploitation with a low risk of poor recruitment in the subsequent fishing season. Identify the most likely scientific procedure(s) making use, as required, of scientific surveys and/or commercial data. Evaluate whether the data collected through the DCF are adequate to that regard in the different GSA and where necessary propose solutions to fill the gaps.

ANNEX: reporting Appendix 7 of the DCF data call MARE D (2012)448251 of 12 April 2012.

SPECIES	CODE	Common name
<i>Aristaeomorpha foliacea</i>	ARS	Giant red shrimp
<i>Aristeus antennatus</i>	ARA	Blue and red shrimp
<i>Aspitrigla cuculus</i>	GUR(c)	Red gurnard
<i>Boops boops</i>	BOG	Bogue
<i>Citharus linguatula</i>	CIL(c)	Spotted flounder
<i>Coryphaena hippurus</i>	DOL	Common dolphinfish
<i>Dicentrarchus labrax</i>	BSS	Sea bass
<i>Diplodus spp.</i>	SRG ^(a)	Sargo breams
<i>Eledone cirrhosa</i>	OCM(c)	Horned octopus
<i>Eledone moschata</i>	OCM(c)	Musky octopus
<i>Engraulis encrasicolus</i>	ANE	Anchovy
<i>Eutrigla gurnardus</i>	GUG	Grey gurnard
<i>Galeus melastomus</i>	SHO	Blackmouth catshark
<i>Helicolenus dactylopterus</i>	BRF(c)	Rockfish
<i>Illex coindetii</i>	SQM(c)	Broadtail squid
<i>Lepidorhombus boscii</i>	LDB(c)	Four-spotted megrim
<i>Loligo vulgaris</i>	SQC(c)	European squid
<i>Lophius budegassa</i>	ANK	Black-bellied angler
<i>Lophius piscatorius</i>	MON	Anglerfish
<i>Merlangius merlangus</i>	WHG ^(b)	Whiting
<i>Merluccius merluccius</i>	HKE	European hake
<i>Micromesistius poutassou</i>	WHB	Blue whiting
<i>Mugilidae</i>	MUL	Grey mullets
<i>Mullus barbatus</i>	MUT (a,b)	Red mullet
<i>Mullus surmuletus</i>	MUR (a,b)	Striped red mullet
<i>Nephrops norvegicus</i>	NEP	Norway lobster
<i>Octopus vulgaris</i>	OCC	Common octopus
<i>Pagellus acarne</i>	SBA ^(a,c)	Axillary seabream
<i>Pagellus bogaraveo</i>	SBR ^(a,c)	Blackspot seabream

<i>Pagellus erythrinus</i>	PAC	Common Pandora
<i>Parapenaeus longirostris</i>	DPS	Deep water rose shrimp
<i>Penaeus kerathurus</i>	TGS	Caramote prawn
<i>Phycis blennoides</i>	GFB ^(c)	Greater forkbeard
<i>Psetta maxima</i>	TUR	Turbot
<i>Raja clavata</i>	RJC	Thornback ray
<i>Rapana venosa</i>	RPW ^(b)	Rapa
<i>Sardina pilchardus</i>	PIL	Sardine
<i>Scomber spp.</i>	MAZ	Mackerel
<i>Scyliorhinus canicula</i>	SYC	Small-spotted catshark
<i>Sepia officinalis</i>	CTC	Common cuttlefish
<i>Solea solea</i>	SOL	Common sole
<i>Sparus aurata</i>	SBG	Gilthead seabream
<i>Spicara flexuosa</i>	PIC ^(c)	Picarel
<i>Spicara smaris</i>	SPC	Picarel
<i>Sprattus sprattus</i>	SPR	Sprat
<i>Squalus acanthias</i>	DGS	Piked dogfish
<i>Squilla mantis</i>	MTS	Spottail mantis squillids
<i>Trachurus mediterraneus</i>	HMM	Mediterranean horse mackerel
<i>Trachurus trachurus</i>	HOM	Horse mackerel
<i>Trigla lucerna</i> (= <i>Chelidonichthys lucerna</i>)	GUU	Tub gurnard
<i>Trigloporus lastoviza</i>	GUU(c)	Streaked gurnard
<i>Trisopterus minutus</i>	POD ^(c)	Poor cod
<i>Zeus faber</i>	JOD ^(c)	John Dory

^a are requested as important under the Mediterranean regulation (Council Regulation (EC) N° 1967/2006)

^b are requested as important species in the Black Sea

^c included in the list of reference species for the Medits survey (Medits, Instruction manual 2007)

4.2. Participants

The full list of participants at EWG 12-19 is presented in Annex I to this report.

5. TOR A-D UPDATE AND ASSESS HISTORIC AND RECENT STOCK PARAMETERS (SUMMARY SHEETS)

The following section of the present report does provide short stock specific assessments in the format of summary sheets. Such summary sheets are only provided in cases when the analyses resulted in an analytical assessment of the exploitation rate. The assessments are presented in geographic order by GSA, and not any longer by species. Detailed versions of the assessments of stocks and fisheries are provided in the following section 6 of the report.

5.1. Summary sheet of Blue whiting in GSA 01

Species common name:	Blue whiting
Species scientific name	<i>Micromesistius poutassou</i>
Geographical Sub-area(s) GSA(s):	GSA 01

Most recent state of the stock

State of the adult abundance and biomass:

A Length Cohort Analysis (VIT software) was carried out during STECF EWG 12-19 using DCF data of landings at age (2009-2011). MEDITS survey indices and landings data showed a variable pattern without a clear trend. Since no precautionary level for the stock of blue whiting in GSA 01 was proposed, STECF EWG 12-19 cannot evaluate the stock status in relation to the precautionary approach.

State of the juvenile (recruits):

LCA recruits estimates were as follows: 12.9×10^6 in 2009, 52.5×10^6 in 2010 and 30.3×10^6 in 2011.

State of exploitation:

STECF EWG 12-19 proposed $F_{0.1}=0.40$ as limit reference point consistent with high long term yield (F_{msy} proxy). Based on the assessment results ($F_{2.5}(2009)=1.0$; $F_{2.5}(2010)=1.3$; $F_{2.5}(2011)=1.4$), STECF EWG 12-19 assessed the status of the stock of blue whiting in GSA 01 as being exploited unsustainably.

Source of data and methods:

Length cohort analysis VIT was computed using as input DCF data on landings (2009-2011) and size structure of the bottom otter trawl catches.

The following biological parameters were used for LCA analyses:

Growth parameters (von Bertalanffy): $L_{inf}=48.4$ cm, $k=0.19$, $t_0=0$
Length-weight relationship: $a=0.0007$, $b=3.69$
M vector (ProdBiom): Age1=0.55, Age2=0.48, Age3=0.4, Age4=0.37, Age5=0.35, Age6=0.33, Age7=0.32, Age8=0.32, Age9=0.31, Age10=0.3
Maturity at age: Age1=0.01, Age 2=0.61, Age3=1.0, Age4=1.0, Age5=1.0, Age6=1.0, Age7=1.0, Age8=1.0, Age9=1.0, Age10=1.0

Outlook and management advice

STECF EWG 12-19 recommends the fishing effort and/or catches to be reduced until fishing mortality is below or at the proposed level F_{MSY} , 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 and effort consistent with F_{MSY} should be estimated.

Short and medium term scenarios:

Short and medium term predictions of stock biomass and catches cannot be estimated due to the short data period available.

Fisheries

No particular description is provided. Landings data were reported to EWG through the Data collection regulation. The majority of landings are reported by otter trawlers. Landings fluctuated during the period 2002-2011 with a maximum value of 3125t in 2006 and a minimum value of 426t in 2008. Discards are reported in the period 2009-2011 but there was no detailed length or age distribution of these discards.

Annual landings (t) by fishing technique as reported to STECF EWG 12-19 through the DCR data call.

SPECIES	ARE A	COUNTR Y	FT_LVL 4	FT_LVL 5	FT_LVL 6	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
WHB	1	ESP	OTB	DEMSP	40D50	431	773	1155	1249	3124	953	426	671	1031	644
WHB	1	ESP	PS		14D16	7.602	17.13	2.68	8.79	0.92	0.381				
WHB-Discard	1	ESP	OTB	DEMSP	40D50								231.6	151.6	34.48

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 12-19

$F_{0.1}$ (mean: F_{bar} 2-5) adopted as proxy for F_{MSY}	≤ 0.40
F_{max} (age range)=	
F_{msy} (2-5)=	≤ 0.40
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	

$B_{pa}(B_{lim}, \text{spawning stock})=$	
-------------------------------------------	--

Comments on the assessment

The detailed assessment of blue whiting in GSA 01 can be found in section 6.1 of this report.

5.2. Summary sheet of Norway lobster in GSA 01

Species common name:	Norway lobster
Species scientific name:	<i>Nephrops norvegicus</i>
Geographical Sub-area(s) GSA(s):	GSA 01

Most recent state of the stock

State of the adult abundance and biomass:

Survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h) without a clear trend. However, recent values are in the lower range since 1994, with a peak in those indices between 2002 and 2005. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 12-19 is unable to fully evaluate the status of the stock biomass with respect to these.

State of the juvenile (recruits):

Recruitment decreased over the last 3 years (2009-2011). However, no precautionary recruitment reference points have been proposed for this stock. As a result, EWG 12-19 is unable to fully evaluate the status of the stock recruitment with respect to these.

State of exploitation:

EWG 12-19 proposes $F \leq 0.20$ as limit management reference point (basis $F_{0.1}$ as a proxy of FMSY) consistent with high long term yields. A reduction is necessary to approach the FMSY reference point (Factor; 40% of the current F value). This stock had not been previously assessed.

Source of data and methods:

The data used in the analyses were DCF length frequencies from the 2012 data call, corresponding to the years 2009 to 2011. The pseudo-cohort VPA approximation in the VIT software was used for this analysis, run separately for each year. The following growth parameters were used (males and females combined): $L_{\infty} = 72.1$ mm CL, $k = 0.169$ yr⁻¹, $t = 0$ yr, while the length-weight relationship parameters were: $a = 0.000373$ g mm⁻³ and $b = 3.1576$. Natural mortality vector was obtained using the Prodbiom method.

Outlook and management advice

EWG 12-19 recommends the relevant fleet's effort and/or catches to be reduced until fishing mortality is below or at FMSY 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.

Fisheries

The Norway lobster is a target species of the mixed deep-water bottom trawl fishery.

Landings of Norway lobster in the period 2002 – 2011 are shown in the table below. Discards are negligible because this species has high commercial value in the entire size range. Undersized individuals (< 20 mm CL) are virtually absent from the catches.

2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
168.27	158.33	121.68	65.68	59.24	61.52	80.6	93.14	77.4	74.62

Limit and precautionary management reference points

Table of limit and precautionary management reference points **proposed by EWG 12-19**

F0.1 (age 3-7)=	≤0.20
F _{max} (age 3-7)=	0.38
F _{msy} (age 3-7)=	≤0.20
F _{pa} (F _{lim}) (age 3-7)	
B _{msy} (spawning stock)=	
B _{pa} (B _{lim} , spawning stock)	

Table of limit and precautionary management reference points **agreed by fisheries managers**

F0.1 (age 3-7)=	
F _{max} (age 3-7)=	
F _{msy} (age 3-7)=	
F _{pa} (F _{lim}) (age 3-7)	
B _{msy} (spawning stock)=	
B _{pa} (B _{lim} , spawning stock)	

Comments on the assessment

The detailed assessment of Norway lobster in GSA 01 can be found in section 6.2 of this report.

Data quality check

Data reported in the DCF 2012 data call is of sufficient quality to perform a pseudo-cohort VPA by year. Biological parameters were not available for the area and were taken from GSA 05.

5.3. Summary sheet of Black-bellied anglerfish in GSA 05

Species common name:	Black-bellied anglerfish
Species scientific name	<i>Lophius budegassa</i>
Geographical Sub-area(s) GSA(s):	GSA 05

Most recent state of the stock

State of the adult abundance and biomass:

SSB oscillates between 2001 and 2007, with a decreasing trend thereafter and with the minimum values at the end of the data series (2009-2011). However, since no biomass reference point for this stock has been proposed, EWG 12-19 cannot evaluate the stock status in relation to these.

State of the juvenile (recruits):

Recruitment showed maximum values at the beginning of the time series (2001) with a decreasing trend thereafter and a moderate recover during last 4 years (2008-2011). However, since no recruitment reference point for this stock has been proposed, EWG 12-19 cannot evaluate the stock status in relation to these.

State of exploitation:

EWG 12-19 proposed $F_{0.1}$ as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account that the current $F_{1.5}=1.13$ is larger than $F_{0.1}=0.18$, the black bellied-anglerfish in GSA 05 is considered exploited unsustainably.

Source of data and methods:

An Extended Survivor Analysis (XSA) was performed using as input data bottom trawl landings and age distributions (from sliced length frequency distributions) from 2001-2011 (2002-2011 from DCF data and 2001 from other projects). Biological parameters used correspond to those available from GSA 06. Bottom trawl surveys (BALAR and MEDITS) were used as tuning fleets.

Outlook and management advice

EWG 12-19 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, 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 considerations. Catches and effort consistent with F_{MSY} should be estimated.

Short and medium term scenarios:

Short term projection (assuming F at status quo and as recruitment the arithmetic mean of last three years), showed a decrease of the catch of 21% from 2011 to 2013 and an increase in the spawning stock biomass of

1% from 2013 to 2014. Fishing at $F_{0.1}$ generates a decrease of the catch of 81% from 2011 to 2013 and an increase of the spawning stock biomass of 72% from 2013 to 2014.

Since no stock-recruitment relationship could be reliably fitted to the dataset, no medium term predictions were conducted.

Fisheries

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: (i) *Spicara smaris*, *Mullus surmuletus*, *Octopus vulgaris* and a mixed fish category on the shallow shelf (50-80 m); (ii) *Merluccius merluccius*, *Mullus* spp., *Zeus faber* and a mixed fish category on the deep shelf (80-250 m); (iii) *Nephrops norvegicus*, but with an important by-catch of big *M. merluccius*, *Lepidorhombus* spp., *Lophius* spp. and *Micromesistius poutassou* on the upper slope (350-600 m) and (iv) *Aristeus antennatus* on the middle slope (600-750 m). The black bellied anglerfish, *L. budegassa*, is an important by-catch species in the upper slope although it is also caught in the shallow and deep shelf.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 12-19

$F_{0.1}$ (ages 1-5) =	0.18
F_{max} (age range)=	
F_{MSY} (ages 1-5) =	0.18
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{MSY} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Comments on the assessment

The detailed assessment of black-bellied anglerfish in GSA 05 can be found in section 6.3 of this report.

5.4. Summary sheet of Norway lobster in GSA 06

Species common name:	Norway lobster
Species scientific name:	<i>Nephrops norvegicus</i>
Geographical Sub-area(s) GSA(s):	GSA 06

Most recent state of the stock

State of the adult abundance and biomass:

Survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h) without a clear trend. However, recent values are in the lower range since 1994, with a peak between 2000 and 2004. No precautionary biomass reference points have been proposed for this stock. As a result, EWG 12-19 is unable to fully evaluate the status of the stock with respect to these.

State of the juvenile (recruits):

Recruitment increased over the last 3 years (2009-2011). However, no precautionary recruitment reference points have been proposed for this stock. As a result, EWG 12-19 is unable to fully evaluate the status of the stock recruitment with respect to these.

State of exploitation:

EWG 12-19 proposes $F \leq 0.15$ as limit management reference point (basis $F_{0.1}$ as a proxy of FMSY) consistent with high long term yields. A considerable reduction is necessary to approach the FMSY reference point (Factor; 75% of the current F value). This stock had not been previously assessed.

Source of data and methods:

The data used in the analyses were DCF length frequencies from the 2012 data call, corresponding to the years 2009 to 2011. The pseudo-cohort VPA approximation in the VIT software was used for this analysis, separately for each year. The following growth parameters were used (males and females combined): $L_{\infty} = 72.1$ mm CL, $k = 0.169$ yr⁻¹, $t = 0$ yr, while the length-weight relationship parameters were: $a = 0.000373$ g mm⁻³ and $b = 3.1576$. Natural mortality vector was obtained using the Prodbiom method.

Outlook and management advice

EWG 12-19 recommends the relevant fleet's effort and/or catches to be reduced until fishing mortality is below or at FMSY 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.

Fisheries

The Norway lobster is a target species of the mixed deep-water bottom trawl fishery.

Landings of Norway lobster in the period 2002 – 2011 are shown in the table below. Discards are negligible because this species has high commercial value in the entire size range. Undersized individuals (< 20 mm CL) are virtually absent from the catches.

2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
187.48	381.79	370.83	189.42	256.79	224.98	313.99	355.51	406.36	496.76

Limit and precautionary management reference points

Table of limit and precautionary management reference points **proposed by EWG 12-19**

F _{0.1} (age 3-7)=	≤0.15
F _{max} (age 3-7)=	0.29
F _{msy} (age 3-7)=	≤0.15
F _{pa} (F _{lim}) (age 3-7)	
B _{msy} (spawning stock)=	
B _{pa} (B _{lim} , spawning stock)	

Table of limit and precautionary management reference points **agreed by fisheries managers**

F _{0.1} (age 3-7)=	
F _{max} (age 3-7)=	
F _{msy} (age 3-7)=	
F _{pa} (F _{lim}) (age 3-7)	
B _{msy} (spawning stock)=	
B _{pa} (B _{lim} , spawning stock)	

Comments on the assessment

The detailed assessment of Norway lobster in GSA 06 can be found in section 6.4 of this report.

Data quality check

Data reported in the DCF 2012 data call is of sufficient quality to perform a pseudo-cohort VPA by year. Biological parameters were not available for the area and were taken from GSA 05.

5.5. Summary sheet of Red mullet in GSA 09

Species common name:	Red mullet
Species scientific name:	Mullus barbatus
Geographical Sub-area(s) GSA(s):	GSA9

Most recent state of the stock

State of the adult abundance and biomass:

The index of stock abundance derived from MEDITS surveys suggest an increasing trend up to 2002 followed by a relatively steady status up to 2011. Since no biomass reference point for this stock has been proposed, EWG 12-19 cannot evaluate the stock status in relation to these.

State of the juvenile (recruits):

also the index of abundance of juveniles shows a high variability, with higher values in years 2000-2003 and with recent levels similar to those of 1994-95. Since no recruitment reference point for this stock has been proposed, EWG 12-19 cannot evaluate the stock status in relation to these.

State of exploitation:

The exploitation level as regards the agreed precautionary and target reference points $F_{0.1}$ and F_{MSY} can be defined as the stock is exploited unsustainably even though in the recent years F levels decreased to approaching the rate corresponding to MSY (F/F_{MSY} of about 1.13) while current biomass reached more than 60% of B_{MSY} .

Source of data and methods:

Data used derive from trawl surveys, which supply data on abundance indices, on commercial landings by size/age, data on catches and fishing effort directed to the species in question in the two main ports of the area proceeding from commercial catch assessment surveys.

A dynamic Biomass Production model (ASPIC) using both, time series from 1994 and 2011 of catch and effort of commercial vessels proceeding from two of the main ports (Viareggio and Porto Santo Stefano) and an abundance index derived from trawl surveys for the same time interval were used to estimate relative values of F and B expressed as the rates F/F_{MSY} and B/B_{MSY} , f_{MSY} , and a vector of F for each year along the time series.

An attempt of using VPA approaches (XSA and ADAPT) based on commercial landings demographic structure for the years 2006-2011 was done for deriving F estimates by year, the value of some reference

points, numbers at age and other features, but quality of data jeopardized any attempt of obtaining reliable results with those approaches.

The main biological parameters used for the analyses were:

$L_{\infty}=29$, $K=0.6$, $t_0=-0.1$ L/W relationship $a=0.00053$ $b=3.12$

An M vector (age1=1.30, age2 0.79, age 3 0.62, age 4= 0.54) and a weighted mean value of M of 0.75

$L_c=9.3\text{cm}$; L_m 11cm(males) and 13cm (females)

Fisheries

The species is mainly exploited by bottom trawlers, being the catches derived from artisanal fisheries negligible. *Mullus barbatus* catch rates are much higher in late summer-autumn. About 200 trawlers and a relatively small but variable number of artisanal vessels exploit the species in the GSA 09. Annual landings, mostly proceeding from trawling, ranged from 500 to 1100 tons in the last years.

The species is caught as a part of a species mix that constitutes the target of the trawlers operating near shore. The main species caught in GSA9 are *Squilla mantis*, *Sepia officinalis*, *Trigla lucerna*, *Merluccius merluccius*, *Mullus barbatus* *Gobius niger*. Landings of red mullet are higher in late summer-beginnings of autumn, when juveniles are highly concentrated near shore. Age of first capture is of about 7 cm. Catch is mainly composed by individuals of age 0 and 1 while older age classes are poorly represented in the catch. Catch rates have shown an increasing trend and considering that no important changes occurred neither on effort allocation nor on other aspects of fishing behaviour along the analysed period, this increase has to be attributed to an enhancement in biomass.

Table 5.5.1. Total catches of *Mullus barbatus* by gear in GSA9 from 2004 and 2011.

	2004	2005	2006	2007	2008	2009	2010	2011
Nets	59.9	30.8	16.4	8.6	11.2	10.2	12.3	10
Trawlers	521.1	648	1033.2	1087.4	716.3	728.1	748.2	865.3
Longliners								
Miscellaneous	2.3		0.5					
Seines		0.1						
Total	583.3	678.9	1050.1	1096	727.5	738.3	760.5	875.3

Outlook and management advice

The results of the Biomass Dynamic Model suggest that the species in the GSA 09 is exploited unsustainably ($F_{curr}/F_{MSY}=1.13$). A reference value of F_{MSY} of 0.61 was estimated while the model estimated for the more recent year an F rate of about 0.68. It is important to highlight that landings per unit effort shows a positive trend up to 2001 followed by a fairly stable level thereafter. It was observed that, while Biomass shows a general increasing trend, F decreases along the analysed period. A reduction in fishing mortality of about 13% should drive the stock to more productive and safe status.

Identification of some critical issues

Sampling density of trawl surveys is relatively low and some issues were found for the standardization of surveys performed before 1994 due to occurred changes in vessels, gear and sampling design along time. Regarding fisheries dependent information, it is difficult to quantify the effort exerted by each métier.

For the standardization of fishing effort there was the need of dealing with the technological creeping linked with likely changes in the characteristics of the vessels and a major use of sophisticated electronic devices. In any case, analysis of the fishing power of the involved vessels and the moderate variability in the structure of the fleet targeting red mullet within the analysed time frame suggests that technological creeping has a negligible influence on the results.

The scarce quality of commercial information (catch and landings by year, reconstruction of the age structure of the catch, etc) made unfeasible the use of VPA approaches.

Short, medium and long term scenarios

For performing forecast for short and medium term, the ASPIC-P was used starting from the output of ASPIC using catch and effort data series for the more important ports of the GSA combined with a time series of abundance index derived from trawl surveys.

Two scenarios were hypothesized for running ASPIC-P, namely the maintenance of F for the next 8 years (up to 2020) at the current value, and the reduction of F to the F_{MSY} level (-13%). While in the first case, (status quo situation) a further increase in B is expected, such increase will not reach the value of B_{MSY} . With the 13 % reduction of F , the level of B_{MSY} will be reached in about 8 years. Relative yields derived from a reduction in F will be still lower than those resulting by keeping F at 2011 level in the first years in the projection while will be higher in the last portion of the projected time interval, up to a 50% increase in yields for 2020.

Precautionary and target management reference points or levels

Table of **proposed** precautionary and target management reference points or levels

$F_{0.1} = 0.54$ (average for all age classes)	From Y/R
F_{max} (average value for all ages)=0.84	From Y/R
F_{msy} (all exploited ages)=0.60	From catch and effort with ASPIC
F_{pa} (F_{lim}) (age range)	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)	

Table of **agreed** precautionary and target management reference points or levels

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{msy} (age range)=	

$F_{pa} (F_{lim})$ (age range)=	
B_{msy} (spawning stock)=	
$B_{pa} (B_{lim}, \text{spawning stock})$ =	

Comments on the assessment

The detailed assessment of red mullet in GSA 09 can be found in section 6.5 of this report.

5.6. Summary sheet of Greater forkbeard in GSA 09

Species common name:	Greater forkbeard
Species scientific name	<i>Phycis blennoides</i>
Geographical Sub-area(s) GSA(s):	GSA 09

Most recent state of the stock

State of the adult abundance and biomass:

A Length Cohort Analysis (VIT software) was carried out during EWG 12-19 using DCF data of landings at age (2011). MEDITS survey indices and landings data showed a variable pattern without a clear trend. However, since no biomass reference point for this stock has been proposed, EWG 12-19 cannot evaluate the stock status in relation to these.

State of the juvenile (recruits):

Since no recruitment reference point for this stock has been proposed, EWG 12-19 cannot evaluate the stock status in relation to these.

VIT estimated for 2011 a recruitment abundance of about $55 \cdot 10^6$ individuals. Since no recruitment reference point for this stock has been proposed, EWG 12-19 cannot evaluate the stock status in relation to these.

State of exploitation:

EWG 12-19 proposed $F_{0.1} = 0.32$ as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 1.01), the stock is considered exploited unsustainably.

Source of data and methods:

Length cohort analysis VIT was computed using as input DCF data on landings (2011) and size structure of the bottom otter trawl catches.

Outlook and management advice

EWG 12-19 recommends the relevant fleets' effort or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, 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 considerations. Catches and effort consistent with F_{MSY} should be estimated.

Short and medium term scenarios:

Short and medium term predictions of stock biomass and catches will be carried out during the follow-up meeting in accordance with data availability.

Fisheries

No particular description is provided. Landings data were reported to EWG 12-19 through the DCF and national statistics. The majority of landings are reported by otter trawlers. Landings increased during the last two years until about 30t. Very high discards values are detected (more than 94% of total catches).

Annual landings (in tons) by fishing technique as reported to STECF EWG 12-19 the DCR data call (2011) and national data.

SPECIES	AREA	COUNTRY	FT_LVL4	FT_LVL5	FT_LVL6	2010	2011
GFB	09	ITA	OTB	DEMSP	40D50	20	16
GFB	09	ITA	OTB	MDDWSP	40D50	15	15

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 12-19

$F_{0.1}$ (ages 0-3+) =	0.32
F_{max} (age range)=	
F_{MSY} (ages 0-3+)	0.32
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{MSY} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Comments on the assessment

The detailed assessment of greater forkbeard in GSA 09 can be found in section 6.6 of this report.

5.7. Summary sheet Giant red shrimp in GSA 10

Species common name:	Giant red shrimp
Species scientific name	<i>Aristaeomorpha foliacea</i>
Geographical Sub-area(s) GSA(s):	GSA 10

Most recent state of the stock

State of the adult abundance and biomass:

EWG 12-19 is unable to fully evaluate the state of the spawning stock due to the absence of proposed or agreed management reference points. However, survey indices indicate an increasing biomass in the recent years, excluding 2011 that is decreasing. However, since no biomass reference point for this stock has been proposed, EWG 12-19 cannot evaluate the stock status in relation to these.

State of the juvenile (recruits):

In 1997, 2005 and 2010 the MEDITS surveys indicated peaks in recruitment. However, since no recruitment reference point for this stock has been proposed, EWG 12-19 cannot evaluate the stock status in relation to these.

State of exploitation:

EWG 12-19 proposes $F_{MSY} \leq 0.4$ as limit management reference point consistent with high long term yields. Thus, given the results of the present analysis, the stock appeared to be exploited unsustainably during 2006-2011. A reduction of F ($F_{current}=0.48$) of about 20% would be necessary in order to avoid future loss in stock productivity and landings.

Source of data and methods:

The assessment of giant red shrimp in GSA 10 has been performed during this EWG 12-19 for the first time. The time series from 2006 to 2011 has been considered covering the mean life span of the species, allowing to assess the stock using XSA method. The DCF official landing data of commercial catch have been used. A sex combined analysis was carried out. The survey indices from MEDITS data from 2006 to 2011 have been used for the tuning. Yield per recruit analysis has been conducted by means of VIT software using the data of 2011 to estimate BRPs.

Outlook and management advice

EWG 12-19 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, 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 considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

The giant red shrimp is only targeted by trawlers and fishing grounds are located offshore 200 m depth, mainly southward Salerno Gulf. In general, demersal trawlers account for the total landing quantity. Landings are decreasing from 2006 to 2008 and then slightly increasing from 2008 to 2010. After a new slight decrease is observed in 2011.

Table 5.7.1. Annual landings (tons) by fishery, from 2006 to 2011.

YEAR	GEAR	FISHERY	LANDINGS
2006	OTB		412
2007	OTB		291
2008	OTB		113
2009	OTB	DWSP	59
2009	OTB	MDDWSP	148
2010	OTB	DWSP	62
2010	OTB	MDDWSP	127
2011	GNS		6
2011	OTB		135

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG

$F_{0.1}$ (ages 1-3) =	0.4
F_{max} (age range)=	
F_{MSY} (ages 1-3) =	0.4
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{MSY} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Comments on the assessment

The detailed assessment of giant red shrimp in GSA 10 can be found in section 6.7 of this report.

5.8. Summary sheet of Blue and red shrimp in GSA 10

Species common name:	Blue and red shrimp
Species scientific name:	<i>Aristeus antennatus</i>
Geographical Sub-area(s) GSA(s):	GSA 10

Most recent state of the stock

State of the adult abundance and biomass

The estimated abundance indices show variable trend with peaks in 1994 and 1997. Biomass indices show a considerable peak also in 2001. The lower values were recorded in 1995 and 1996. The most recent biomass index (2011) is among the higher of the time series. However, in the absence of proposed biomass management reference points, EWG summary 12-19 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

State of the juveniles (recruits)

Recruitment estimates from MEDITS surveys (individuals at age 1 were considered as recruits) in the GSA 10 indicate annual variations with an exceptional peak in 1997. Higher values were observed in 1994, in 1999-2001 and in 2005-2006. The current values are around the average of the time series.

However, in the absence of proposed management reference points, EWG 12-19 is unable to fully evaluate the status of the recruitment in relation to these.

State of exploitation

EWG 12-19 proposed $F_{0.1} = 0.31$ as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the pseudocohort analysis ($F_{current}=0.51$), the stock is considered exploited unsustainably.

Source of data and methods:

The analyses were conducted using VIT software. Used growth parameters were $CL_{\infty} = 6.6$ cm, $K = 0.243$, $t_0 = -0.2$; length-weight relationship: $a = 0.86$, $b = 2.37$. A natural mortality vector M was estimated using PRODBIOM (Abella et al., 1997). Management reference points were estimated by an YPR analysis using VIT software.

Outlook and management advice

EWG 12-19 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, 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 considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

The blue and red shrimp is only targeted by trawlers and fishing grounds are located offshore 200 m depth. Catches from trawlers are from a depth range between 400 and 700 m depth; the blue and red shrimp occurs with *A. foliacea*, *P. longirostris* and *N. norvegicus*, *P. blennoides*, *M. merluccius*, depending on operative depth and area. In general, demersal trawlers account for the total landing quantity. Landings are decreasing from 2006 to 2008 and then slightly increasing from 2008 to 2009. Thereafter, a new slight decrease is observed in 2010 followed by a remarkable increase in 2011 (a value close to that of 2006).

YEAR	Level 4	LANDINGS
2006	OTB	51.6
2007	OTB	39.5
2008	OTB	23.0
2009	OTB	27.4
2010	OTB	20.1
2011	OTB	48.5

The fishing effort of the trawlers that is a major component of fishing in the area is decreasing.

AREA	COUNTRY	GEAR	2004	2005	2006	2007	2008	2009	2010	2011
SA 10	ITA	DRB	86505	294424	312180	144186	238122	188909	209574	196692
SA 10	ITA	FPO		314508	153589					156
SA 10	ITA	GND	369729	128153	676640	443277	496680	435913	112632	44621
SA 10	ITA	GNS	4362276	5038906	3024622	2226520	2506323	2525668	2782604	2963679
SA 10	ITA	GTR	3671219	1745574	4394209	3883167	3208597	2450304	2689599	2611624
SA 10	ITA	LLD	1823662	1138482	1013389	361358	387768	1471790	2469932	2130245
SA 10	ITA	LLS	7079323	1811552	1493720	1185423	1399622	1010226	1272999	1695680
SA 10	ITA	LTL								6324
SA 10	ITA	none	7799360	4540824	3986171	3370493	2539043	3487970	2681538	2106037
SA 10	ITA	OTB	6970928	8028733	7156787	7112581	5724631	5997764	5603044	5234759
SA 10	ITA	PS	5807234	2502000	1781508	1783526	1188917	1903718	1652686	1567061
SA 10	ITA	PTM	6995							

Limit and precautionary management reference points

Table of limit and precautionary management reference points **proposed by EWG 12-19**

$F_{0.1}$ (2-6)	= 0.31
F_{max} (2-6)	= 0.91
F_{MSY} (2-6)	= 0.31
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Table of limit and precautionary management reference points **agreed by fisheries managers**

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{MSY} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Comments on the assessment

The detailed assessment of blue and red shrimp GSA 10 can be found in section 6.8 of this report.

5.9. Summary sheet of European Hake in GSA 11

Species common name:	European Hake
Species scientific name	<i>Merluccius merluccius</i> (L., 1758)
Geographical Sub-area(s) GSA(s):	GSA 11

Most recent state of the stock

State of the adult abundance and biomass:

An Extended Survivor analysis was carried out during EWG 12-19. Landings at age catch data and survey data from the DCF were used to assess the stock of *Merluccius merluccius* in the GSA 11. Over the period 2005-2011, SSB highest stock size was observed in 2006 (462 t), and it rapidly decreased to a minimum around 102 t (2010). The comparison between XSA and SURBA assessment shows the same decreasing trend.

No baseline for comparison of the current values against historic SSB is available. Since no biomass reference point for this stock has been proposed, EWG 12-19 was not able to fully evaluate the state of the spawning stock in comparison to these.

State of the juvenile (recruits):

Relative indices estimated by SURBA and XSA indicated very high fluctuations of recruitment.

SURBA indicate a continuous decreasing trend in the last 6 years, while XSA shows a variable pattern with the lowest value in 2009 and 2011. In the absence of proposed management reference points, EWG 12-19 is unable to fully evaluate the status of the recruitment in relation to these.

State of exploitation:

EWG 12-19 proposed $F_{0.1} = 0.25$ as proxy of F_{MSY} . Taking into account the results obtained by the XSA analysis (current $F = 2.5$), the stock is considered exploited unsustainably.

Source of data and methods:

An XSA was performed using DCF data over 2005-2011. Landings has been sliced taking in to account the respective length composition of the catches. Catch data was tuned with fishery independent information (MEDITS survey). Natural mortality vector was derived by PRODBIOM.

Outlook and management advice

EWG 12-19 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, 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 considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

DCR landing data shows that hake is targeted by two gears only (OTB, otter bottom trawl and GTR, trammel net). Catches are mostly from the OTB (86% of the total).

During 2005-2011 annual landings decreased from 866 t (2005) to 389 t in 2011. Looking at the discards data series the information reported for 2011 seems to be not realistic: abundances are more than 10 times greater of previous years and do not match the indirect information achieved for the same year by the survey (MEDITS), where nor a peak in recruitment nor a strong increase in abundances is observed. Moreover seem to be not reliable that in 2011 OTB discards are 90% of the total catches and OTB landings account only for 10%.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG

$F_{0.1}$ (ages 0-3) =	0.25
F_{max} (age range)=	
F_{MSY} (ages 0-3) =	0.25
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{MSY} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Comments on the assessment

The detailed assessment of red mullet in GSA 11 can be found in section 6.9 of this report.

5.10. Summary sheet of Red mullet in GSA 11

Species common name:	Red mullet
Species scientific name	<i>Mullus barbatus</i>
Geographical Sub-area(s) GSA(s):	GSA 11

Most recent state of the stock

State of the adult abundance and biomass:

An Extended Survivor analysis was carried out during EWG 12-19. Landings at age, catch data and survey data from the DCF were used to assess the stock of *Mullus barbatus* in the GSA 11. Over the period 2005-2011, SSB highest stock size was observed in 2009 (300 t), and it rapidly decreased to a minimum around 150 t (2011). No baseline for comparison of the current values against historic SSB is available. Since no biomass reference point for this stock has been proposed, EWG 12-19 was unable to fully evaluate the state of the spawning stock in comparison to these.

State of the juvenile (recruits):

Recruitment did show a peak of abundance ($7 \cdot 10^5$) in the middle of the time series (2008) and a large decreasing trend to the minimum of 10^5 recruits in 2011. In the absence of proposed or agreed reference points, EWG 12-19 is unable to fully evaluate the state of the spawning stock in comparison to these.

State of exploitation:

EWG 12-19 proposed $F_{0.1} = 0.291$ as proxy of F_{MSY} . Taking into account the results obtained by the XSA analysis (current $F = 0.97$), the stock is considered exploited unsustainably.

Source of data and methods:

An XSA was performed using DCF data over 2005-2011. Landings and discards has been sliced taking into account the respective length composition of the catches. Catch data was tuned with fishery independent information (MEDITS survey). Natural mortality vector was derived by PRODBIOM.

Outlook and management advice

EWG 12-19 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, 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 considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

DCR landing data shows that Red mullet is targeted by one gear only (OTB, otter bottom trawl). Catches from trammel net (GTR) are negligible.

During 2005-2011 annual catches have a mean of 268.7 t and ranged between 171 t in 2011 and 346 t in 2007. Discards information is available for 4 years only, ranging from 17 to 59 t (mean 14.2 t).

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG

$F_{0.1}$ (ages 1-3) =	0.291
F_{max} (age range)=	
F_{MSY} (ages 1-3) =	0.291
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{MSY} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Comments on the assessment

The detailed assessment of red mullet in GSA 11 can be found in section 6.10 of this report.

5.11. Summary sheet of Giant Red Shrimp in GSAs 12-16

Species common name:	Giant Red Shrimp
Species scientific name:	<i>Aristaeomorpha foliacea</i>
Geographical Sub-area(s) GSA(s):	GSAs 12-16

Most recent state of the stock

State of the adult abundance and biomass:

SURBA analysis of 1994-2011 GSA 16 MEDITS data showed that the spawning stock biomass in 2011 was at the lowest observed level. Based on XSA analysis results, spawning stock biomass (SSB) fluctuated around an average of 1120 t in 2006-2011. Whilst the spawning stock biomass estimates were similar for 2006 and 2008-2011, a drop to 775 t was recorded in 2007. Since no biomass reference points for this stock have been proposed, EWG 12-19 cannot evaluate the stock status in relation to these.

State of the juvenile (recruits):

Estimates from the XSA analysis showed that recruitment declined from 75 million in 2006 to 43 million in 2007 but increased back to previous levels in 2008-2011, when it fluctuated around an average of 85 million. Since no recruitment reference points for this stock have been proposed, EWG 12-19 cannot evaluate the stock status in relation to these.

State of exploitation:

EWG 12-19 proposed $F_{0.1} = 0.30$ as proxy of F_{MSY} as the exploitation reference point. Taking into account the results obtained by the XSA analysis of EWG 12-19 (current F is around 1.67), the giant red shrimp stock is considered exploited unsustainably. Moreover the current fishing mortality exceeds the exploitation limit reference point F_{max} (0.45).

Source of data and methods:

Data coming from DCR/DCF in GSA 15 (Malta) and GSA 16 (Sicily) for the period 2006-2011 were used to run an XSA, tuned with fishery independent data (i.e. MEDITS abundance indices for 2006-2011). Total landings data for bottom otter trawlers (OTB) was available for both GSA 15 and 16 in 2006-2011. Landings at length information for GSA 15 was available for 2009-2011; 2009 data was used to extrapolate this information backwards. Landings at length data for 16 was available for 2006-2011. Discards at length data was only available for 2010 in GSA 16, however overall discards can be considered to be minimal in this shrimp fisheries.

Outlook and management advice

STECF advises the relevant fisheries' effort and/or catches 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. Based on XSA estimates and taking $F_{0.1}$ as a proxy of F_{MSY} , a reduction in fishing mortality of 82% is necessary to reach F_{MSY} . This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

Giant red shrimp are a key target species for the Sicilian and Maltese bottom otter trawl fleets operating on the slope of the continental shelf in the Strait of the Sicily throughout the year. Based on the available information and the distribution of fishing ground targeted by the Sicilian long distance trawl fleet, giant red shrimp found in the Central Mediterranean GSAs 12-16 were considered to form a single stock for the purpose of this assessment. *A.foliacea* is fished exclusively by otter trawl, mainly in the central – eastern side of the Strait of Sicily, whereas in the western side it is substituted by the violet shrimp, *Aristeus antennatus*. Other commercial species frequently caught together with giant red shrimp are the deep water rose shrimp (*Parapenaeus longirostris*), Norway lobster (*Nephrops norvegicus*), blue and red shrimp (*Aristeus antennatus*), greater forkbeard (*Phycis blennoides*) and hake (*Merluccius merluccius*). Numerically, deep water rose shrimp and Norway lobster, together with giant red shrimp, make up the bulk of catches (Bianchini, 1999). Although there is anecdotal evidence that *A. foliacea* in GSA 12 is also fished by Tunisian vessels, compared to the large volumes of giant red shrimp caught by the Sicilian trawl fleet, landings by Tunisian vessels are likely to be negligible.

Yield for Italian and Maltese trawlers combined in the period 2005-2011 peaked in 2010, at 1684 tonnes. The lowest landings were reported in 2008, at 1287 tonnes. The average of giant red shrimp landings was 1474 tonnes from Sicilian trawlers and 31 tonnes from Maltese trawlers in 2005-2011; the average annual contribution of Maltese catches to the total catch in this period was 2.1%. No information is available on giant red shrimp catches by the Tunisian trawl fleet.

Table 5.11.1 Landings (t) of *A. foliacea* by year for the bottom otter trawl gear in 2005-2011 as reported through the EU DCR / DCF for GSA 15 (Malta, right hand axis) and GSA 16 (Sicily, left hand axis).

Area	Country	2005	2006	2007	2008	2009	2010	2011
15	Malta	18	30	34	27	39	27	41
16	Italy	1270	1424	1541	1260	1616	1657	1553
15&16	Italy & Malta	1288	1454	1575	1287	1655	1684	1594

Limit and precautionary management reference points

Table of limit and target management reference points or levels **proposed by STECF EWG 12-19**

$F_{0.1}$ (2-5) =	0.30
F_{max} (2-5) =	0.45
F_{msy} (2-5)=	0.30
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Table of limit and target management reference points or levels **agreed by fisheries managers**

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Comments on the assessment

The detailed assessment of giant red shrimp in GSAs 12-16 can be found in section 6.11 of this report.

5.12. Summary sheet of Anchovy in GSA 16

Species common name:	Anchovy
Species scientific name:	<i>Engraulis encrasicolus</i>
Geographical Sub-area(s) GSA(s):	GSA 16 – South of Sicily

Most recent state of the stock

State of the adult abundance and biomass:

Biomass estimates of total population obtained by hydro-acoustic surveys for anchovy in GSA 16 show a decreasing trend over the period 1998-2011, despite the occurrence of quite large inter-annual fluctuations, from a maximum of about 22,900 t in 2001 to a minimum of 3,100 t in 2008. Biomass estimates over the period 2006-2009 surveys were the lowest of the series (their average representing less than one-quarter of the maximum recorded value). The stock appeared to partially recover in 2010, when estimated biomass was higher than the average value over the entire time series (about 16,000 t vs. 13,000 t), but current (2011) estimate is again close to the lower level of biomass in the series.

State of the juvenile (recruits):

No recruitment data were used for this assessment.

State of exploitation:

The EWG 12-19 recommends $E=0.4$ as limit management reference point consistent with high long term yields (Patterson, 1992). The first approach used herewith for the evaluation of stock status is based on the analysis of the harvest rates experienced in the available time series over the last years and on the related estimate of the current exploitation rate. The current (year 2011) harvest rate is 79.3% (DCF data were used for landings). The estimated average value over the years 2008-2011 is again 79.3%. Depending on the adopted two alternative approaches for the estimation of natural mortality, the exploitation rate estimates were respectively $E=0.55$ and $E=0.59$. Consequently, this stock should be considered as being exploited unsustainably.

The results of the first formal assessment approach, based on the implementation of a non-equilibrium logistic surplus production model incorporating an index of production potential, are consistent with the previous considerations. Current fishing mortality is far above the sustainable fishing mortality at current biomass levels. Fishing mortality showed very high values during the considered period, frequently well above the reference limit. In addition B/B_{MSY} values were below 100% over the entire time series, indicating the stock being exploited unsustainably.

The results of the second analytical assessment approach (XSA) are consistent with the results obtained with the other methodology, confirming steadily increasing and high exploitation rates for the anchovy stock in GSA 16, above the reference limit for the entire considered period (2004-2011).

Source of data and methods

Census data for catch and effort data were obtained from census information (on deck interviews) in Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA16), accounting for about 2/3 of total landings in GSA 16. Acoustic data were used for fish biomass evaluations. Von-Bertalanffy growth parameters were estimated by FISAT with DCF data collected in GSA16 over the period 2007-2009. For BHI method, the equation $M = \beta * k$ was applied, with β set to 1.8 and $k = 0.40$. Natural mortality was also estimated according to Pauly (1980) and Gislason (2010). The anchovy stock in the area was also assessed using a non-equilibrium surplus production model based on the Schaefer (logistic) population growth model. The input data used for the stock was total yearly catch estimates and a series of abundance indices. The model implementation adopted allows for the optional incorporation of environmental indices, so that the r and K parameters of each year can be considered to depend on the corresponding value of the applied index. Finally, XSA analysis was also run on age-disaggregated data, using echosurvey biomass indexes as tuning data. Obtained results were also used to produce short-term projections.

Outlook and management advice

Results of the surplus production modelling approach suggest that the environmental factors can be very important in explaining the variability in yearly biomass levels (mostly due to recruitment success) and indicate that the stock status was well below the B_{MSY} during the considered period. The results of the second analytical assessment approach (XSA) are consistent with the results obtained with the alternative methodologies, confirming steadily increasing and high exploitation rates for the anchovy stock in GSA 16, above the reference limit ($E=0.4$) for the entire considered period (2004-2011).

Based on available information and assuming status quo exploitation in 2011, EWG 12-19 recommends the relevant fleet effort and/ or catches to decrease in order to reach $E = 0.4$. EWG 12-19 notes that mere effort management of fisheries targeting stocks of small pelagics implies a high risk due to their schooling behavior and the multi-species character of their fisheries (changing target species as available and appropriate). EWG 12-19 rather recommends the consideration of catch restrictions as a more effective management tool for small pelagics. EWG 12-19 recommends a multi-annual management plan being implemented taking into account mixed-fisheries effects, in particular the technical relation with anchovy fisheries. In addition, due to

the low level of the anchovy stock, measures should be taken to prevent a shift of effort from anchovy to sardine.

Fisheries

In Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA 16), accounting for about 2/3 of total landings in GSA 16, two operational units (OU) are presently active, purse seiners and pelagic pair trawlers. The fleet in GSA 16 is composed by about 50 units (17 purse seiners and 30 pelagic pair trawlers were counted up in a census carried out in December 2006). In both OUs, anchovy represents the main target species due to the higher market price.

Average anchovy landings in Sciacca port over the period 1998-2011 were about 2,100 metric tons, with large inter-annual fluctuations and a general increasing trend.

Fisheries management reference points or levels

Table of limit and target management reference points or levels **proposed by EWG 12-19**

E_{msy} (F/Z, F age range)=	≤ 0.4
$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Table of limit and target management reference points or levels **agreed by fisheries managers**

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Comments on the assessment

The detailed assessment of anchovy in GSA 16 can be found in section 6.12 of this report.

5.13. Summary sheet of Sardine in GSA 16

Species common name:	Sardine
Species scientific name:	<i>Sardina pilchardus</i>
Geographical Sub-area(s) GSA(s):	GSA 16 – South of Sicily

Most recent state of the stock

State of the adult abundance and biomass:

Biomass estimates of the total population obtained by hydro-acoustic surveys for sardine in GSA 16 show that the recent stock level has been below the average value over the period 1998-2011.

STECF EWG 12-19 notes that no age-structured production model was used at this stage. An attempt to use an analytical approach (XSA) failed for possible problems in input data. However, a logistic (Shaefer) non-equilibrium general production modeling approach was adopted for the evaluation of stock status.

State of the juvenile (recruits):

No recruitment data were used for this assessment.

State of exploitation:

EWG 12-19 recommends the application of the proposed exploitation rate $E \leq 0.4$ as management target for stocks of anchovy and sardine in the Mediterranean Sea (Patterson, 1992), though this value might be revised in the future when more information becomes available. The first approach used herewith for the evaluation of stock status is based on the analysis of the harvest rates experienced in the available time series over the last years and on the related estimate of the current exploitation rate. The current (year 2011) harvest rate is 11.9% (DCF data were used for landings). The estimated average value over the years 2008-2011 is 13.7%. The exploitation rate corresponding to $F=0.137$ is $E=0.15$, if $M=0.77$, estimated with Pauly (1980) empirical equation, is assumed, and $E=0.16$ if $M=0.72$, estimated with Beverton & Holt's Invariants method (Jensen, 1996), is used instead. Thus, using the exploitation rate as a target reference point, the stock of sardine in GSA 16 would be considered as being sustainably exploited.

The results of the second assessment approach, which is based on the implementation of a non-equilibrium logistic surplus production model incorporating an index of production potential, are consistent with the previous considerations. The current (year 2011) fishing mortality is below the sustainable fishing mortality at current biomass levels ($F_{Cur}/F_{SY_{Cur}}=0.69$) but slightly above F_{MSY} ($F_{MSY}=0.16$; $F_{Cur}/F_{MSY}=1.05$), and fishing mortality experienced high values during the considered period, sometimes above F_{MSY} . In addition B/B_{MSY} values were low over last decade, indicating the stock being overfished. However, the average production of the last three years (1400 tons) is well below the estimated MSY (5307 tons).

Source of data and methods

Census data for catch and effort data were obtained from census information (on deck interviews) in Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA16), accounting for about 2/3 of total landings in GSA 16. Acoustic data were used for fish biomass evaluations. Von-Bertalanffy growth parameters were estimated by FISAT with DCF data collected in GSA16 over the period 2007-2009. For BHI method, the equation $M = \beta * k$ was applied, with β set to 1.8 and $k = 0.40$.

The sardine stock in the area was also assessed using a non-equilibrium surplus production model based on the Schaefer (logistic) population growth model. The input data used for the stock was total yearly catch estimates, and a series of abundance indices.. The model implementation adopted allows for the optional incorporation of environmental indices, so that the r and K parameters of each year can be considered to depend on the corresponding value of the applied index.

Outlook and management advice

Based on available information and assuming status quo exploitation in 2011, EWG 12-19 recommends that the relevant fleet effort and/or catches should not be allowed to increase in order to avoid future loss in stock productivity and landings. The EWG notes that mere effort management of fisheries targeting stocks of small pelagics implies a high risk due to their schooling behavior and the multi-species character of their fisheries (changing target species as available and appropriate). EWG 12-19 rather recommends the consideration of catches restrictions as a more effective management tool for small pelagics. EWG 12-19 recommends a multi-annual management plan being implemented taking into account mixed-fisheries effects, in particular the technical relation with anchovy fisheries. In addition, due to the low level of the anchovy stock, measures should be taken to prevent a shift of effort from anchovy to sardine.

Fisheries

In Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA 16), accounting for about 2/3 of total landings in GSA 16, two operational units (OU) are presently active, purse seiners and pelagic pair trawlers. The fleet in GSA 16 is composed by about 50

units (17 purse seiners and 30 pelagic pair trawlers were counted up in a census carried out in December 2006). In both OUs, anchovy represents the main target species due to the higher market price.

Average sardine landings in Sciacca port over the period 1998-2011 were about 1,400 metric tons, with a general decreasing trend. The production dramatically decreased in 2010 (-70%), but significantly increased again in 2011 (+ 372%).

Fisheries management reference points or levels

Table of limit and target management reference points or levels **proposed by SGMED**

E_{msy} (F/Z, F age range)=	≤ 0.4
$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Table of limit and target management reference points or levels **agreed by fisheries managers**

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Comments on the assessment

The detailed assessment of sardine in GSA 16 can be found in section 6.13 of this report.

5.14. Summary sheet of European Hake in GSA 17

Species common name:	European Hake
Species scientific name:	<i>Merluccius merluccius</i>
Geographical Sub-area(s) GSA(s):	GSA17

State of the spawning stock size:

The spawning stock biomass estimated by XSA and SURBA models shows a clear decrease trend in both analyses.. However, since no biomass reference point for this stock has been proposed, EWG 12-19 cannot evaluate the stock status in relation to these.

State of recruitment:

The recruitment estimated by XSA and SURBA models shows a fluctuating pattern with a general decreasing trend. EWG 12-19 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses. However, since no recruitment reference point for this stock has been proposed, EWG 12-19 cannot evaluate the stock status in relation to these.

State of exploitation: In the three method used, the values of the most recent F_{bar} range from 1.48 to 2.02 and the values of $F_{0.1}$ is 0.2, thus the stock of hake in GSA17 is considered exploited unsustainably.

Source of data and methods:

In the Adriatic, the species is mainly fished with bottom trawl nets, but long-lines is also used in the eastern side of the basin.

According to the FAO statistics (www.fao.org/fishery/statistics/software/fishstatj/en), in the Adriatic Sea, the annual landings of hake in the 1980s and 1990s were estimated at around 2,000-4,000 t, with some peaks over 5,000 tons. A decreasing trend occurred from 1993 to 2000, followed by a positive trend.

The analyses performed were: XSA, SURBA and steady state VPA using VIT program (Lleonart and Salat, 1992).

Outlook and management advice

long term scenarios:

The Yield/Recruit analyses were performed using the XSA and VPA selectivity patterns. Taking into account that the current F is comprised in the range 1.48-2.1 and is higher than the $F_{0.1}$ (0.20), the stock has to be considered exploited unsustainably.

Precautionary and target management reference points or levels

Table of limit and target management reference points or levels **proposed by EWG 12-19**

$F_{0.1}$ (0-4) = (proxy for F_{msy} when stock dynamics are not well known)	0.2
F_{msy} (0-4)= 0.2	
F_{mean} (0-4)=	1.48-2.1
Z_{msy} (age range)=	
Z_{mean} (age range)=	

Comments on the assessment

The detailed assessment of Hake in GSA 17 can be found in section 6.14 of this report.

5.15. Summary sheet of Sole in GSA 17

Species common name:	Sole
Species scientific name:	<i>Solea solea</i>
Geographical Sub-area GSA:	GSA 17

Most recent state of the stock

XSA based assessments, together with a SURBA model were carried out during GFCM-SAC SCSEA Working group on demersal in November 2012.

XSA, SURBA and Statistical Catch at Age assessments, together with a steady state VPA using VIT-model were applied. Input data were provided by the Italian and Slovenian DCF official data call, estimations derived from the Croatian Primo Project, and tuning data were collected during the SoleMon survey.

State of the adult abundance and biomass:

According to the XSA, SURBA and SCAA analyses a general decreasing trend of SSB is observed. In particular the XSA showed a decrease from around 400 tons in 2006 to around 200 tons in 2010. However, in the absence of proposed biomass management reference points, EWG 12-19 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

State of the juvenile (recruits):

Recruitment varied without any trend in the years 2005-2011, with values oscillating between 24 to 36 million of recruits. However, in the absence of proposed management reference points, EWG 12-02 is unable to fully evaluate the status of the recruitment in relation to these.

State of exploitation:

From the most recent estimate of fishing mortality (varying between $F_{curr}= 0.73$ and $F_{curr}= 1.43$) and with $F_{0.1}=0.26$ and $F_{max}=0.46$, the stock is considered being exploited unsustainably.

Source of data and methods:

FAO-GFCM Working group on demersal 2012 has updated the assessment carried out during the STECF EWG 11-12 with 2011 fishery dependent and independent data coming from both DCF official data call, SoleMon project and Croatian Primo Project.

Outlook and management advice

A reduction of fishing pressure, especially by rapido trawling, would be recommended, also taking into account that the exploitation is mainly orientated towards juveniles and the success of recruitment seems to be strictly related to environmental conditions. This could be achieved by a two-months closure for rapido trawling inside 11km (6 nm) offshore along the Italian coast, after the fishing ban of August, would be advisable to reduce the portion of juveniles in the catches. Moreover, information provided by VMS will be useful in order to quantify the fishing effort of rapido trawlers in such area and period.

Specific studies on rapido trawl selectivity are necessary. In fact, it is not sure that the adoption of a larger mesh size would correspond to a decrease of juvenile catches. The same uncertainty regards the adoption of square mesh.

A preparation of a specific management plan for the establishment of a set of specific rules for rapido trawl fishery would be advisable (e.g.: size and number of gears, mesh size, towing speed, spatial and/or temporal closure).

Fisheries

The Italian fleets exploit this resource with *rapido* trawl and set nets (gill nets and trammel nets), while only trammel net is used in the countries of the eastern coast. Sole is an accessory species for otter trawling. More than 85% of catches come from the Italian side. Landings fluctuated between 1,000 and 2,300 t in the period 1996-2010 (data source: FAO-FishStat; DCR data). The fishing effort applied by the Italian *rapido* trawlers gradually increased from 1996 to 2005, and slightly decreased in the last years.

Exploitation is based on 1 and 2 year old individuals. In the last years, the annual landings of this species were around 2000 tons in the overall GSA. Otter and *rapido* trawlers carry out their activity all year round, with the only exception of the fishing ban (end of July – beginning of September), while set netters show a seasonal activity (spring-fall). The fishing grounds exploited by rapido trawlers extend from 5.5 km from the shoreline to 50-60 m depth, while otter trawlers carry out their activity in the overall area, except for the Croatian waters. Set netters operate in the shallower waters usually close to the fishing harbors.

Precautionary and target management reference points or levels

Table of limit and target management reference points or levels **proposed by STECF**

$F_{0.1}$ (Y/R, sexes combined, ages 0-4) ≤ 0.26	Proxy for F_{MSY} target
F_{max} (Y/R, sexes combined)= 0.46	0.46
Z_{max} (Y/R, sexes combined)=	
Z_{mean} (0-4, sexes combined)=	

Table of **agreed** precautionary and target management reference points or levels

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	

B_{msy} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

5.16. Summary sheet of Anchovy in GSA 17

Species common name:	Anchovy
Species scientific name:	<i>Engraulis encrasicolus</i>
Geographical Sub-area(s) GSA(s):	GSA 17

State of the spawning stock size:

Estimates of fishery independent surveys for anchovy in GSA 17 indicated a slight increase from lower levels in 2004 to the most recent estimates in 2011. The highest value is registered in 2008 with about 850000 tons. Similarly, results of the Integrated Catch at Age analysis indicated an increasing trend starting in 1999 from the lowest biomass in the time series of 400000 tons (start year total biomass). Reference points were estimated for the first time during this EWG as described in section 8.2.4.. The level of anchovy SSB in 2011 is lower than the estimated reference point for B_{lim} .

State of recruitment:

ICA model estimates had shown a quite stable trend in the number of recruits since the beginning of the time series, which fluctuates around a value of about 92000000 thousands specimens. However, since no recruitment reference point for this stock has been proposed, EWG 12-19 cannot evaluate the stock status in relation to these.

State of exploitation:

Based on ICA results, the F of the reference age 2 is strongly increasing since 1995. The F_{bar} (1-3) shows the same increasing trend with the highest value in 2000 equal to 1.4. In 2011 the F_{bar} resulted 0.83. The exploitation rate since 1998 remained above the reference point of 0.4 while in 2011 gets lower to a value of 0.47. Based on this assessment results the stock is considered to be exploited unsustainably.

Source of data and methods:

The analyses performed were: ICA (Patterson, 1996)

Outlook and management advice

Long term scenarios:

The annual exploitation rate $E = F/(F+M)$ or F/Z was calculated over the years for the ages 1-3. The values obtained were compared with the threshold $F/Z = 0.4$ adopted as biological reference point for small pelagics (Patterson, 1992). The current level of exploitation ($E = 0.47$) is higher than the 0.4 reference point.

Precautionary and target management reference points or levels

Table of limit and target management reference points or levels proposed by EWG 12-19.

$F_{0.1}$ (0-4) = (proxy for F_{msy} when stock dynamics are not well known)	
E_{MSY}/F_{MSY} (0-4)=	0.40
F_{mean} (1-3)=	0.83
$E=F/Z$	0.47
Z_{mean} (age range)=	

Comments on the assessment

The detailed assessment of Anchovy in GSA 17 can be found in section 6.16 of this report.

5.17. Summary sheet of Sardine in GSA 17

Species common name:	Sardine
Species scientific name:	<i>Sardina pilchardus</i>
Geographical Sub-area(s) GSA(s):	GSA 17

State of the spawning stock size:

Estimates of fishery independent surveys for sardine in GSA 17 indicated a strong increase in biomass in the last year, reaching the value of about 500000 tons. Results of the Integrated Catch at Age analysis indicated a more or less stable biomass in the last 10 years, being the 2011 the highest, with 156000 tons. Reference points were estimated for the first time during this WG as described in section 8.2.3.. The level of sardine SSB in 2011 is much lower than the estimated reference point for B_{lim} .

State of recruitment:

After the drop in recruitment occurred from 1985 to 1998, the recruitment level stabilized around an average value of 6144973 thousands individuals between 1999 to 2011. The last year estimates is the highest registered since 1994 and it is equal to 12069880 thousands specimens.

State of exploitation: Based on ICA results, the F of the reference age 3 is strongly increasing since 1995, with low values only between 2004 and 2008. The F_{bar} (1-4) shows the same increasing trend with the highest value in 2011 equal to 1.6. The exploitation rate in the last 3 years is above the reference point of 0.4, being equal in 2011 to 0.57. Based on this assessment results the stock is considered to be exploited unsustainably.

Source of data and methods:

The analyses performed were: ICA (Patterson, 1996)

Outlook and management advice

Long term scenarios:

The annual exploitation rate $E = F/(F+M)$ or F/Z was calculated over the years for the ages 1-4. The values obtained were compared with the threshold $F/Z = 0.4$ adopted as biological reference point for small pelagics (Patterson, 1992). The current level of exploitation ($E = 0.57$) is higher than the 0.4 reference point.

Precautionary and target management reference points or levels

Table of limit and target management reference points or levels **proposed by EWG 12-19**

$F_{0.1}$ (0-4) = (proxy for F_{msy} when stock dynamics are not well known)	
E_{MSY}/F_{MSY} (0-4)=	0.40
F_{mean} (1-3)=	1.6
$E=F/Z$	0.57
Z_{mean} (age range)=	

Comments on the assessment

The detailed assessment of Sardine in GSA 17 can be found in section 6.17 of this report.

5.18. Summary sheet of European Hake in GSA 18

Species common name:	European hake
Species scientific name:	<i>Merluccius merluccius</i>
Geographical Sub-area(s) GSA(s):	GSA 18

Most recent state of the stock

State of the adult abundance and biomass:

Survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h) without a temporal trend. However, recent values are higher or similar to those observed since 1996.

Results from ALADYM model in previous years showed that current levels of SSB are around 5-6% of the value of SSB estimated under the hypothesis of $F=0$. No precautionary biomass reference points have been proposed for this stock. As a result, WG Demersals of GFCM and EWG 12-19 are unable to fully evaluate the status of the stock with respect to spawning biomass.

State of the juvenile (recruits):

MEDITS data showed a sharp increase of recruitment in 2005 and thereafter a level similar or higher than in the past years. In 2008 a new, though lower peak, was observed. No trends were identified. No precautionary recruitment reference points have been proposed for this stock. As a result, WG Demersals of GFCM and EWG 12-01 is unable to fully evaluate the status of the stock with respect to recruitment.

State of exploitation:

WG Demersals of GFCM and EWG 12-19 proposes $F \leq 0.21$ as proxy of F_{MSY} . Given the results of the present analysis (current F is around 0.92), the stock appeared to be exploited unsustainably in 2008-2011. Total and fishing mortality obtained from SURBA showed a decreasing trend to 2004 and then an increasing in 2005, thereafter the level was similar to the beginning of the time series. A considerable reduction is necessary to approach the reference point.

Source of data and methods:

The data used in the analyses were from trawl surveys (MEDITS 1996-2011) and from commercial fisheries from the whole GSA18 (2008-2011). The analyses were conducted using SURBA, VIT software and YPR analyses in a complementary way. Fast growth parameters were used for sex combined ($L_{\infty} = 104$ cm; $K = 0.2$; $t_0 = -0.01$) to split the LFDs for the VIT age-class analyses and SURBA inputs. A natural mortality vector M was estimated using PRODBIOM.

Age	0	1	2	3	4+
M (fast)	1.16	0.53	0.4	0.35	0.32
q (fast)	0.9	1	1	0.75	0.75
Proportion mature (fast)	0.008	0.248	0.887	1	1
Weight (kg) (fast)	0.01	0.14	0.53	1.15	2.35

Age groups from MEDITS survey indices (N/km²) sliced from LFDs as inputs in SURBA.

	0	1	2	3	4+
1996	499	223	6	1	1
1997	317	191	8	1	1
1998	316	118	4	1	1
1999	189	101	3	1	1
2000	399	104	3	1	1
2001	292	102	4	1	1
2002	654	89	3	0	1
2003	324	91	4	1	0
2004	582	123	4	2	0
2005	1451	111	10	1	1
2006	509	139	8	1	2
2007	423	98	7	2	1
2008	969	141	6	2	0
2009	595	190	15	2	1
2010	526	103	7	2	2
2011	319	87	5	2	1

LFDs by fleet

- Italy: 2008-2011 LFDs from DCF;
- Montenegro: 1 trimester of 2008 was lacking and it was estimated using the average of the same trimester of 2010 and 2011; the year 2009 was estimated as an average of 2008 and 2010.
- Albania: LFD 2008-2011 obtained raising the proportion of the Italian LFD to Albanian adjusted production. This adjustment was based on the Albanian exports (data are recorded at national level) that accounts for about 64% of the total Albanian production (FAO Yearbook of Fishery Statistics).

Catch in numbers for LCA

2008				
Age	Longlines-Italy	Trawlers-Italy	Trawlers-Montenegro	Trawlers-Albanian
0	0	21387493	288142	2289681
1	44932	30981465	362979	3316783
2	77461	595517	6532	63754
3	200964	65379	0	6999
4+	120743	14377	0	1539
2009				
Age	Longlines-Italy	Trawlers-Italy	Trawlers-Montenegro	Trawlers-Albanian
0	0	22666365	312294	2920335
1	50757	26061805	288188	3357804
2	230115	765077	4045	98573
3	107267	54593	0	7034
4+	117528	11558	0	1489
2010				
Age	Longlines-Italy	Trawlers-Italy	Trawlers-Montenegro	Trawlers-Albanian
0	0	24849136	267489	2947703
1	51354	23052576	497206	2734588
2	288335	834144	2764	98950
3	118074	132062	0	15666
4+	128334	41007	0	4864
2011				
Age	Longlines-Italy	Trawlers-Italy	Trawlers-Montenegro	Trawlers-Albanian
0	0	17399123	151020	2126890
1	79444	23661071	398481	2892359
2	227711	878657	1201	107408
3	87544	106219	0	12984
4+	108016	51249	0	6265

SURBA results showed a decreasing trend of total and fishing mortality to 2004 and then an increasing in 2005 and 2006, thereafter the level was similar to the beginning of the time series. On the average, the mean F was around 1.

Reconstructed catches and mortality estimated by VIT are dominated by the trawl fishing system. The current level fishing mortality was 0.92. The YPR analysis indicates that this point is far beyond F_{MSY} .

Outlook and management advice

Given the results from this analysis, based on the whole information from the area, it is necessary to consider that a remarkable reduction of the fishing mortality is necessary to reach the F_{MSY} .

As observed in 2011, the fishing mortality from the Italian bottom trawlers represents about 80% of the total F in the GSA and that of the Italian longlines is accounting for about 9.5%, while Montenegrin trawlers account only for about 1% of the F exerted on hake in GSA 18 and Albanian trawlers of about 9.7%. Moreover, the production of hake in GSA 18 is split in 12.5% caught by Italian longlines, 77.2% by Italian trawlers, about 1% by Montenegrin trawlers and about 9.4% by Albania trawlers.

EWG 12-19 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed FMSY level, 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 considerations. Catches and effort consistent with F_{MSY} should be estimated.

Estimates of total and fishing mortality by ages and fleets from pseudocohort analysis in 2011

Age	Z	Total F	Longlines Ita	Trawlers Ita	Trawlers Mne	Trawlers Alb
0	1.41	0.25	0.00	0.22	0.00	0.03
1	2.67	2.15	0.01	1.89	0.03	0.23
2	1.26	0.86	0.16	0.62	0.00	0.08
3	0.76	0.42	0.18	0.22	0.00	0.03
4+	0.63	0.32	0.21	0.10	0.00	0.01
Average(0-3)	1.53	0.92	0.09	0.74	0.01	0.09

Fisheries

Hake is one of the most important species in the Geographical Sub Area 18 representing in some years about 20% of landings from trawlers. Trawling is the most important fishery activity on the whole area with an effort of about 70% (average among the years 2004-2011) of the total effort. In 2011 the landings of hake in the whole GSA 18 were about 4258 tons. Landings by demersal trawlers dominate the fisheries, however the Mediterranean hake is also caught by off-shore bottom long-lines, but these gears are utilised by a low number of boats (less than 5% of the whole South-western Adriatic fleet). Long-line landings account for about 10-12% of the total hake production.

Fishing grounds are located on the soft bottoms of continental shelves and the upper part of continental slope. Catches from trawlers are from a depth range between 50-60 and 500 m and hake occurs with other commercial species as *Illex coindetii*, *M. barbatus*, *P. longirostris*, *Eledone spp.*, *Todaropsis eblanae*, *Lophius spp.*, *Pagellus spp.*, *P. blennoides*, *N. norvegicus*.

Annual landings (t) 2008-2011 by fleet and total.

Year	Italy-LLS	Italy-OTB	Mne-OTB	Alb export OTB	Alb adjusted OTB
2008	550	3640	59	249	390
2009	532	3540	52	292	456
2010	597	3372	46	240	375
2011	534	3285	37	257	402

Year	Total GSA
2008	4639
2009	4580
2010	4390
2011	4258

The fishing effort of the western side (see table below), that is the major component of fishing effort in the area, is slightly decreasing.

NOMINAL EFFORT	GEAR										
	YEAR	DRB	GNS	GTR	LLD	LLS	none	OTB	PS	PTM	Total
2004	374929	1457047	396599			556022	655	14685616	161895	224372	17857135
2005	582141	2035861	515167	170327	1082879		4295	13563127	555333	1046113	19555243
2006	765092	1833287	70950	45979	754338		45187	14684386	496211	1433668	20129098
2007	845785	1280477	324507	35380	688853		3474	12729135	656313	1968559	18532483
2008	502235	894323	1021626	15028	1260704		25997	11463435	350205	2085703	17619256
2009	745537	1205076	837252	22116	884150		0	13878367	335023	2027392	19934913
2010	641665	570405	885271	207661	1263867			11856268	266421	2121029	17812587
2011	600545	450946	777735	245858	922942		18934	11329443	308723	2104853	16759979
Total	5057929	9727422	4829107	742349	7413755		98542	104189777	3130124	13011689	148200694

Limit and precautionary management reference points

Table of limit and precautionary management reference points **proposed by EWG 12-01**

$F_{0.1}$ (0-4)	≤ 0.21
F_{max} (0-4)	
F_{msy} (0-4)=	≤ 0.21
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Table of limit and precautionary management reference points **agreed by fisheries managers**

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Comments on the assessment

This assessment was performed within the Adriamed project. It was presented and endorsed at the Working Group of Demersal of GFCM of 2012 in Split (Croatia).

5.19. Summary sheet of Pink shrimp in GSA 18

Species common name:	Deepwater pink shrimp
Species scientific name:	<i>Parapenaeus longirostris</i>
Geographical Sub-area(s) GSA(s):	GSA 18

Most recent state of the stock

State of the adult abundance and biomass:

Survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h). MEDITS indices indicate a remarkable peak of abundance and biomass in 2005, followed by a sharp decrease in 2007 and an increase in 2008. After this year, abundance slightly increases in 2009 and successively decreased to 2011. However, in the absence of proposed biomass management reference points, EWG 12-19 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

State of the juvenile (recruits):

Recruitment (individuals smaller than 17 mm CL) estimates from MEDITS peaked in 2005 then sharply decrease in 2007-2008. Afterwards there was a rising from 2008 to 2009 and a slight reduction in 2010 followed by a very slight increase in 2011. However, in the absence of proposed management reference points, EWG 12-02 is unable to fully evaluate the status of the recruitment in relation to these.

State of exploitation:

WG Demersals of GFCM and EWG 12-19 proposed $F_{0.1} = 0.68$ as proxy of F_{MSY} . Given the results of the present analysis (current F is around 1.45), the stock appeared to be subject to overfishing in the period 2007-2011. A considerable reduction is necessary to approach the reference point.

Source of data and methods:

The data used in the analyses were from trawl surveys (MEDITS 1996-2011) and from commercial fisheries (2008-2011) on the whole GSA18, while 2007 from Italy only. The analyses were conducted using VIT software. Growth parameters ($L_{\infty} = 46$ mm; $K = 0.6$; $t_0 = -0.2$) were used to split the LFDs for the VIT age-class analyses. A natural mortality vector M was estimated using PRODBIOM.

Age	0	1	2	3+
Natural Mortality	1.41	0.81	0.7	0.65
Proportion mature	0.47	0.98	1	1
Weight (kg)	0.002141	0.00993	0.019342	0.027388

LFDs by fleet

- Italy: 2008 LFD was an average between 2007 and 2009 (the species was not a target in DCF in 2008), 2007, 2009, 2010, 2011 from DCF;
- Montenegro: 1 trimester of 2008 was lacking and it was estimated using the average of the same trimester of 2010 and 2011; the year 2009 was estimated as an average of 2008 and 2010.
- Albania: LFD 2008-2011 obtained raising the proportion of the Italian LFD to Albanian adjusted production. This adjustment was based on the Albanian exports (fishery data recorded at national level) that accounts for about 64% of the total Albanian production (FAO Yearbook of Fishery Statistics).

Age	2007
	ITA
0	44,373,665
1	60,210,210
2	3,861,590
3+	129,286

Age	2008			2009			2010			2011		
	ITA	ALB	MON	ITA	ALB	MON	ITA	ALB	MON	ITA	ALB	MON
0	47050175	16214436	1529056	49726684	14641780	1170339	33031391	15353046	811623	24282722	9237992	893721
1	61874367	21323151	1964002	63538523	18708608	2161107	67284792	31274084	2358211	63964980	24334503	900611
2	3322535	1145012	102436	2783480	819582	163066	3791438	1762267	223696	3390175	1289740	23483
3+	106760	36792		84235	24802		158304	73580		182168	69303	

A sensitivity analysis performed for 2011 with terminal F equal to 0.9, 1.0 and 1.1 indicates slight variations of F estimates in response to changes of terminal F. Estimates of current F were respectively 1.43, 1.45 and 1.46 and $F_{0.1}$ were respectively 0.7, 0.68 and 0.67. A terminal fishing mortality $F_{term} = 1$ was used.

The fishing mortality acting on the age groups shows values changing from 1.45 in 2011 to 1.73 in 2009, with an average over the last three years of 1.57. The lowest value was estimated in 2011.

Management reference points were estimated by an YPR analysis. The medium term forecasts were performed using the R routine for the medium term forecast (SGMED, 2010).

Outlook and management advice

EWG 12-19 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, 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 considerations. Catches and effort consistent with F_{MSY} should be estimated.

It is however necessary to consider that most part (71%) of the total F in the GSA is exerted by the Italian fleet, while Montenegrin trawlers account only for about 1.7% of the F exerted on the GSA and Albanian trawlers of about 27.1%. Contribute of each fleet to the total production in the GSA18 is: Italy 71 %, Albania 26%, Montenegro 3%.

VPA Results--Mortalities in 2011 from VIT					
Age class	Z	Total F	Italy	Albania	Montenegro
0	1.53	0.12	0.08	0.03	0.01
1	2.97	2.16	1.53	0.58	0.05
2	2.79	2.09	1.50	0.57	0.02
3+	1.65	1	0.72	0.28	0
Average 0-2	2.43	1.45	1.04	0.39	0.02

Fisheries

Deep-water rose shrimp is an important species in demersal trawl fishery of the whole Geographical Sub Area 18. The species is only targeted by trawlers and fishing grounds are located along the coasts of the whole GSA. Catches from trawlers are from a depth range between 50-60 and 500 m and the species may co-occurs with other important commercial species as *M. merluccius*, *Illex coindetii*, *Eledone cirrhosa*, *Lophius* spp., *Lepidorhombus boscii*, *N. norvegicus*.

Time series of landing data from the whole GSA is short. The Landings of hake in GSA 18 in 2011 is lower than in the other years (weight in tons).

Landings of hake in GSA 18 for Italy, Albania and Montenegro (2008-2011)

Year	Production (tons)			
Fleet	ITA	ALB	MON	TOT
2007	863			
2008	898	309	39	1246
2009	934	275	36	1245
2010	881	409	32	1322
2011	863	328	27	1217

The fishing effort of the western side (see table below), that is the major component of fishing effort in the area, is decreasing.

NOMINAL EFFORT	GEAR									
	DRB	GNS	GTR	LLD	LLS	none	OTB	PS	PTM	Total
2004	374929	1457047	396599		556022	655	14685616	161895	224372	17857135
2005	582141	2035861	515167	170327	1082879	4295	13563127	555333	1046113	19555243
2006	765092	1833287	70950	45979	754338	45187	14684386	496211	1433668	20129098
2007	845785	1280477	324507	35380	688853	3474	12729135	656313	1968559	18532483

2008	502235	894323	1021626	15028	1260704	25997	11463435	350205	2085703	17619256
2009	745537	1205076	837252	22116	884150	0	13878367	335023	2027392	19934913
2010	641665	570405	885271	207661	1263867		11856268	266421	2121029	17812587
2011	600545	450946	777735	245858	922942	18934	11329443	308723	2104853	16759979
Total	5057929	9727422	4829107	742349	7413755	98542	104189777	3130124	13011689	148200694

Limit and precautionary management reference points

Table of limit and precautionary management reference points **proposed by EWG 12-19**

$F_{0.1}$ (0-3)	≤ 0.68
F_{max} (0-3)	1.46
F_{msy} (0-3) =	≤ 0.68
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Table of limit and precautionary management reference points **agreed by fisheries managers**

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Comments on the assessment

This assessment was performed before in the EWG 12-10 on the western side of GSA18 then within the Adriamed project it was carried out on the whole GSA. It was presented and endorsed at the Working Group on Demersal of GFCM of 2012 in Split (Croatia).

5.20. Summary sheet of Giant red shrimp in GSA 18

Species common name:	Giant red shrimp
Species scientific name:	<i>Aristaeomorpha foliacea</i>
Geographical Sub-area(s) GSA(s):	GSA 18

Most recent state of the stock

State of the adult abundance and biomass

Survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h) that is oscillating without trend. However, in the absence of proposed biomass management reference points, EWG 12-19 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

State of the juveniles (recruits)

Recruitment estimates from MEDITS surveys (individuals smaller than ~30 mm carapace length) in the GSA 18 are highly fluctuating and showed three peaks: in 1999-2000, in 2003 and in 2009; the values of 2010 and 2011 are among the lower of the time series. However, in the absence of proposed management reference points, EWG 12-19 is unable to fully evaluate the status of the recruitment in relation to these.

State of exploitation

EWG 12-19 proposed $F_{0.1} = 0.30$ as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the pseudocohort analysis (current F is around 1.00), the stock is considered exploited unsustainably.

Source of data and methods:

The analysis was carried out for the western side of the GSA 18, given the availability of fishery data only for this side. The analyses were conducted using VIT software. Used growth parameters were $CL_{\infty} = 7.3$ cm, $K = 0.438$, $t_0 = -0.1$; length-weight relationship: $a = 0.678$, $b = 2.51$. A natural mortality vector M was estimated using PRODBIOM (Abella et al., 1997). Management reference points were estimated by an YPR analysis using VIT software.

Outlook and management advice

EWG 12-19 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, 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 considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

The Giant red shrimp is only targeted by trawlers on fishing grounds located offshore 200 m depth, mainly in the northernmost and southernmost parts of the GSA between 400 and 700 m depth. Giant red shrimp occurs with *A. antennaus*, *P. longirostris* and *N. norvegicus*, depending on operative depth and area.

Higher landings were observed in 2006, 2007 and 2010

YEAR	Level 4	Level 5	LANDINGS
2004	OTB	MDDWSP	89
2005	OTB	MDDWSP	72
2006	OTB	MDDWSP	166
2007	OTB	MDDWSP	115
2008	OTB	DWSP	59
2008	OTB	MDDWSP	37
2009	OTB	DWSP	30
2009	OTB	MDDWSP	58
2010	OTB	DWSP	48
2010	OTB	MDDWSP	79
2011	OTB	DWSP	21
2011	OTB	MDDWSP	54

The fishing effort of trawlers that is the major component of fishing in the area is decreasing.

YEAR	GNS	GTR	LLS	OTB		
				DEMSP	DWSP	MDDWSP
2004	67828	29235	60741	147850		2388604
2005	94644	69435	80581	56423		2309466
2006	120055	32007	76098	598799		2054616
2007	70224	45292	74171	519085		1759397
2008	50376	83968	107911	1890398	29701	119323
2009	78139	80946	64941	2101567	18235	266753
2010	57056	79765	87474	1608697	21524	437823
2011	44943	79593	76512	1607442	10809	281989

Limit and precautionary management reference points

Table of limit and precautionary management reference points **proposed by EWG 12-19**

$F_{0.1}$ (0-3)	= 0.30
F_{max} (0-3)	= 0.58
F_{MSY} (0-3)	= 0.30
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Table of limit and precautionary management reference points **agreed by fisheries managers**

$F_{0.1}$ (age range)=	
F_{max} (age range)=	
F_{MSY} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	

$B_{pa} (B_{lim}, \text{ spawning stock})=$	
---------------------------------------------	--

Comments on the assessment

The detailed assessment of giant red shrimp GSA 18 can be found in section 6.18 of this report.

5.21. Summary sheet of European Hake in GSA 19

Species common name:	European hake
Species scientific name	<i>Merluccius merluccius</i>
Geographical Sub-area(s) GSA(s):	GSA 19

Most recent state of the stock

State of the adult abundance and biomass:

An XSA (Extended Survivor analysis) assessment was performed using DCF catch data. Over 2006- 2011, SSB highest stock sizes corresponded to 2006 (1169 t) and 2009 (1125 t), while in the last two years of the analyzed period (2010 and 2011) SSB was at its lowest level (892 and 701 t). No baseline for comparison of the current values against historic SSB is available. In the absence of proposed or agreed reference points, EWG 12-19 is unable to fully evaluate the state of the spawning stock in comparison to these.

State of the juvenile (recruits):

Recruitment decreased by 40% over 2006-2009 (XSA results), from around $45 \cdot 10^6$ to $27.7 \cdot 10^6$ recruits (class0). In 2010, but also in 2011, the number of recruits was higher than in 2009, despite the observed relative small SSB size in 2010. In the absence of proposed or agreed reference points, EWG 12-19 is unable to fully evaluate the state of the spawning stock in comparison to these.

State of exploitation:

Fishing mortality was highest in 2006, at the beginning of the analyzed period, and sharply decreased in 2007 and 2008. In the last three years F was around 1, well above $F_{0.1} = 0.12$ as estimated from YPR, therefore, the stock is considered as being exploited unsustainably. EWG 12-19 proposes $F_{0.1} = 0.12$ as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields.

Source of data and methods:

An XSA was performed using DCF data over 2006-2011 (landings, discards, length composition of the catches), by gear (otter bottom trawl, gillnet, trammel net and longline), tuned with fishery independent abundance indices (MEDITS survey). Natural mortality vector was obtained applying PRODBIOM. In addition, Yield per Recruit (YPR) analysis was performed for the estimation of $F_{0.1}$ (i.e. proxy of F_{MSY}).

Outlook and management advice

EWG 12-19 recommends the relevant fleets' effort or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, 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 considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

European hake is fished with bottom trawl (OTB) and different small-scale gears (long-line (LLS), gillnet (GNS) and trammel net (GTR)). The main fisheries operating in GSA 19 are from Gallipoli, Taranto, Schiavonea and Crotone. The fishing pressure varies between fisheries and fishing grounds. Over 2006-2011, annual landings ranged between 1648 t in 2006 and 820 t in 2011.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG

$F_{0.1}$ (ages 0-2) =	0.12
F_{max} (age range)=	
F_{MSY} (ages 0-2) =	0.12
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{MSY} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Comments on the assessment

The detailed assessment of European hake in GSA 19 can be found in section 6.19 of this report.

5.22. Summary sheet of Red mullet in GSA 19

Species common name:	Red mullet
Species scientific name	<i>Mullus barbatus</i>
Geographical Sub-area(s) GSA(s):	GSA 19

Most recent state of the stock

State of the adult abundance and biomass:

An XSA (Extended Survivor analysis) assessment was performed using DCF catch data. Over 2006- 2011, SSB highest stock size was observed in 2006 (1125 t), and it sharply decreased to 715 t in 2007, a stock size similar to that observed in 2011. No baseline for comparison of the current values against historic SSB is available. In the absence of proposed or agreed reference points, EWG 12-19 is unable to fully evaluate the state of the spawning stock in comparison to these.

State of the juvenile (recruits):

Over 2006- 2011, recruitment did not show neither decreasing nor increasing trend, although it did display marked inter-annual variations, ranging from $92.1 \cdot 10^6$ recruits (class 0) in 2009 and $47.0 \cdot 10^6$ recruits in 2007. In the absence of proposed or agreed reference points, EWG 12-19 is unable to fully evaluate the state of the spawning stock in comparison to these.

State of exploitation:

By comparing $F_{\text{bar}(0-2)}$ against $F_{0.1}$ EWG 12-19 concludes that the stock is exploited unsustainably and proposes $F_{0.1(\text{mean } 2009-2011)} = 0.3$ as proxy of F_{MSY} and as exploitation reference point consistent with high long term yields.

Source of data and methods:

An XSA was performed using DCF data over 2006-2011 (landings, discards, length composition of the catches), by gear (otter bottom trawl, gillnet and trammel net), tuned with fishery independent abundance indices (MEDITS survey). Natural mortality vector was obtained applying PRODBIOM. In addition, Yield per Recruit (YPR) analysis was performed, separately for 2009, 2010 and 2011, for the estimation of $F_{0.1}$ (i.e. proxy of F_{MSY}).

Outlook and management advice

EWG 12-19 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, 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 considerations. Catches and effort consistent with F_{MSY} should be estimated.

Fisheries

Red mullet is targeted by otter bottom trawl (OTB) and small- scale fisheries (gillnet (GNS) and trammel net (GTR)). The highest trawl fishing pressure occurs along the Calabrian coast while the presence of rocky bottoms on the shelf along the Apulian coast prevents the fishing by trawling in this sector. During 2006-2011 annual catches ranged between 727 t in 2006 and 360 t in 2008.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 12-19

$F_{0.1}$ (ages 0-2) =	0.3
F_{max} (age range)=	
F_{MSY} (ages 0-2) =	0.3
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{MSY} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{MSY} (spawning stock)=	
B_{pa} (B_{lim} , spawning stock)=	

Comments on the assessment

The detailed assessment of red mullet in GSA 19 can be found in section 6.20 of this report.

6. TOR A-D UPDATE AND ASSESS HISTORIC AND RECENT STOCK PARAMETERS (DETAILED ASSESSEMENTS)

The following section of the present report does provide detailed stock specific assessments and all relevant data of such stocks and their fisheries. The assessments are presented in geographic order by GSA. Short versions of the assessments of stocks and fisheries in the format of summary sheets are provided in the preceding section in cases when the analyses resulted in an analytical assessment of the stock status.

6.1. Stock assessment of blue whiting in GSA 01

STECF EWG 12-19 assessed this stock using as input data DCF data on sizes and the parameters used for this species in Spanish National Data Collection for the areas 05 and 06.

6.1.1. Stock identification and biological features

6.1.1.1. Stock Identification

No information was documented during STECF EWG 12-19.

6.1.1.2. Growth

The parameters are the following: $L_{inf}= 48.4$, $K= 0.19$, $t_0= 0$. Length-weight relationships: $a=0.0007$, $b=3.69$ (data source: Spanish National Data Collection).

6.1.1.3. Maturity

No new information was presented during STECF EWG 12-19. Adopted from FishBase the size at first maturity: 18 cm. Age/maturity relationships were obtained through size to age transformation:

Age	0	1	2	3+
Maturity	0	0.01	0.61	1

Estimated age at first maturity is two years.

6.1.2. Fisheries

6.1.2.1. General description of fisheries

No updated information was available to STECF EWG 12-19. Blue whiting is a demersal species important locally and is mainly exploited by otter trawlers.

Landings data were reported to STECF EWG 12-19 through the DCF. The majority of the landings corresponded to bottom otter trawlers; landings reported for purse seine represented <0.9 % of the landings.

Table 6.1.2.1.1. Annual landings (t) by gear in GSA01 from DCF data.

SPECIES	AREA	COUNTRY	FT_LVL4	FT_LVL5	FT_LVL6	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
WHB	1	ESP	OTB	DEMSP	40D50	431	773	1155	1249	3124	953	426	671	1031	644
WHB	1	ESP	PS		14D16	7.602	17.13	2.68	8.79	0.92	0.381				

6.1.2.2. Management regulations applicable in 2010 and 2011

The management regulations applicable are those applicable to bottom trawling (Regulation (EC) No 1967/2006). Bottom trawling is practiced five days a week, a maximum of 12 hours at sea a day. No specific regulations are applicable to this resource (no minimum landing size established).

6.1.2.3. Catches

6.1.2.3.1. Landings

The time series of the landings data (tons) and the MEDITS trawl survey biomass indices (Kg/h) for the period 2002-2011 were shown in Figure 6.1.2.3.1.1. During this period both series showed a fluctuating trend with a good coincidence between landings and MEDITS from 2005 to 2011. Maximum landing values and maximum trawl survey biomass were achieved in 2006.

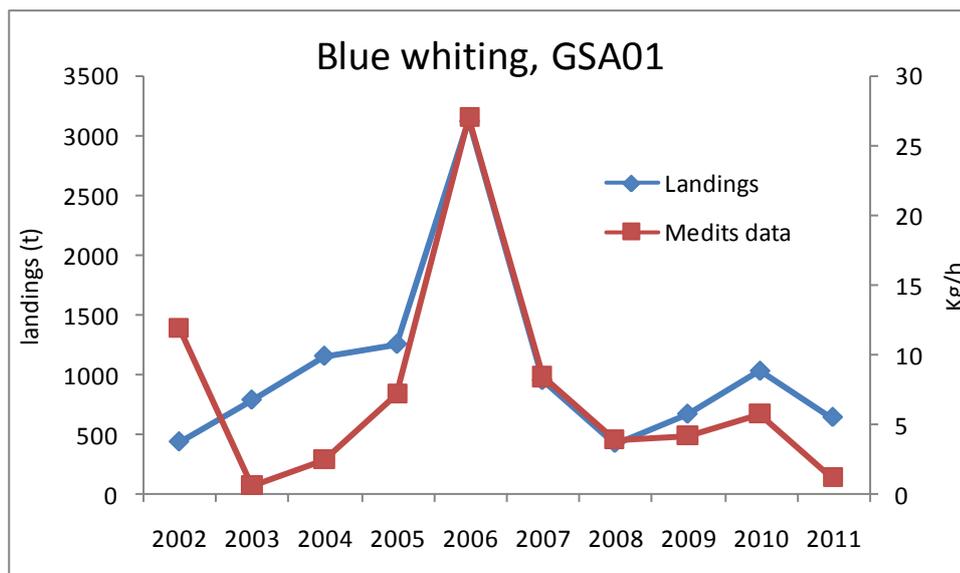


Fig. 6.1.2.3.1.1. Blue whiting in GSA01: comparison between total annual landings (t) and the MEDITS biomass indices for the period 2002-2011.

DCF data on age structure of otter trawl blue whiting landings in GSA01 were available for the period 2009-2011, and were shown in Figure 6.1.2.3.1.2. This species is commercialised mainly from age 1, in adult or pre-adult phase. Recruitment is usually discarded.

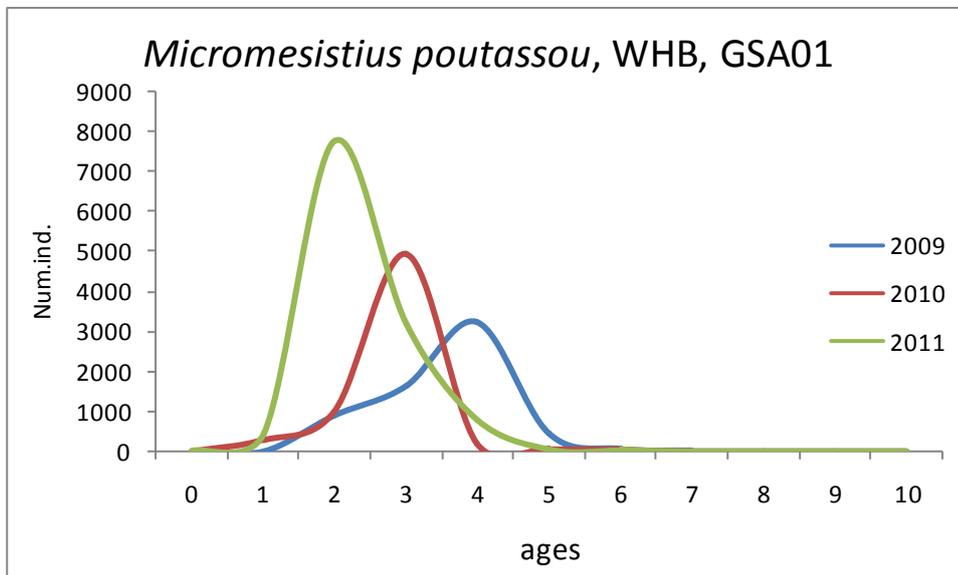


Fig. 6.1.2.3.1.2. DCF age frequency distribution of *M. poutassou* landed in the GSA01 from 2009 to 2011.

6.1.2.3.2. Discards

Information on discards was available for 2009, 2010 and 2011. The amount of discards is relatively important in 2009 and 2010 but no data on lengths or ages are available for discards. Figure 6.1.2.3.2.1 shows the comparison between landings and catches.

Table 6.1.2.3.2.1. Annual discards (t) by gear in GSA01 from DCF data.

SPECIES	AREA	COUNTRY	FT_LVL4	FT_LVL5	FT_LVL6	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
WHB	1	ESP	OTB	DEMSP	40D50								231.6	151.6	34.48

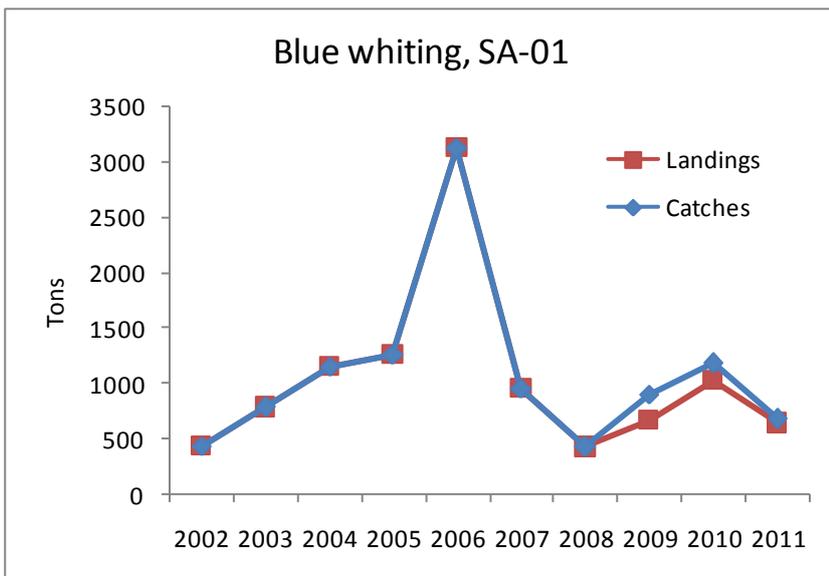


Fig. 6.1.2.3.2.1. Blue whiting in GSA01: comparison between annual landings (t) and catches (landings and discards) for the period 2002-2011.

6.1.2.4. Fishing effort

The number of vessels and GT days at sea of OTB fleet in GSA 01 in the period 2002-2010 by fleet segment were presented in Table 6.1.2.4.1 and Figure 6.1.2.4.1. There was a light decreasing trend in number of vessels in the total fleet. In the case of biggest vessels (>24 m), they have increased during this period. GT days at sea did have a decreasing trend until 2008, and then GT values have been increasing. There was no information about specific effort for blue whiting in GSA 01.

Table 6.1.2.4.1. Number of vessels of OTB by fleet segment in GSA01.

Num.vessels	2002	2003	2004	2005	2006	2007	2008	2009	2010
VL0012	10	10	6	8	5	6	3	4	6
VL1224	166	170	165	166	157	152	152	142	136
VL2440	11	21	20	18	21	23	26	24	25
ALL	187	201	191	192	183	181	181	170	167

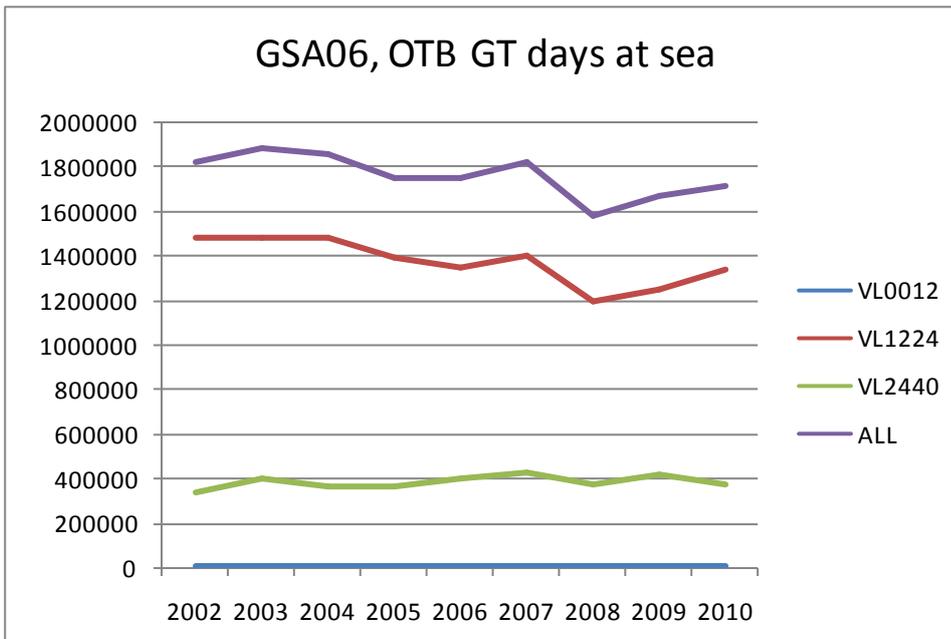


Fig. 6.1.2.4.1. OTB GT days at sea by fleet segment in GSA_06 from 2002 to 2010.

6.1.3. Scientific surveys

6.1.3.1. MEDITS

6.1.3.1.1. Methods

Since 1994 MEDITS trawl survey was regularly carried out each year during spring season. Based on the DCR data call, abundance and biomass indices were recalculated. In GSA01 the following number of hauls was reported per depth stratum (Table 6.1.3.1.1.1).

Table 6.1.3.1.1.1. Number of hauls per year and depth stratum in GSA 01, 1994-2011.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
GSA01_010-050	2	1	2	2	2	2	2	4	4	4	4	2	4	4	4	2	3	3
GSA01_050-100	5	5	5	6	6	9	6	6	8	12	8	8	8	8	7	8	6	6
GSA01_100-200	3	3	3	5	5	5	5	5	8	6	5	6	6	7	7	7	4	4
GSA01_200-500	8	9	11	10	7	11	13	10	11	11	13	11	13	13	13	13	6	8
GSA01_500-800	8	9	12	10	12	12	12	13	13	14	13	11	19	13	9	9	6	7

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Y_{st} = \Sigma (Y_i * A_i) / A$$

$$V(Y_{st}) = \Sigma (A_i^2 * s_i^2 / n_i) / A^2$$

Where:

A=total survey area

A_i=area of the i-th stratum

s_i=standard deviation of the i-th stratum

n_i=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Y_i=mean of the i-th stratum

Y_{st}=stratified mean abundance

V(Y_{st})=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval:

$$\text{Confidence interval} = Y_{st} \pm t(\text{student distribution}) * V(Y_{st}) / n$$

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.1.3.1.2. Geographical distribution patterns

No information was documented during STECF EWG 12-19.

6.1.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the blue whiting in GSA 01 was derived from the international survey MEDITS and was compiled during STECF EWG 12-19.

Figure 6.1.3.1.3.1 displays the estimated trend in blue whiting abundance and biomass in GSA 01. The estimated abundance and biomass indices show a great variability especially on 1997 and 2006 data.

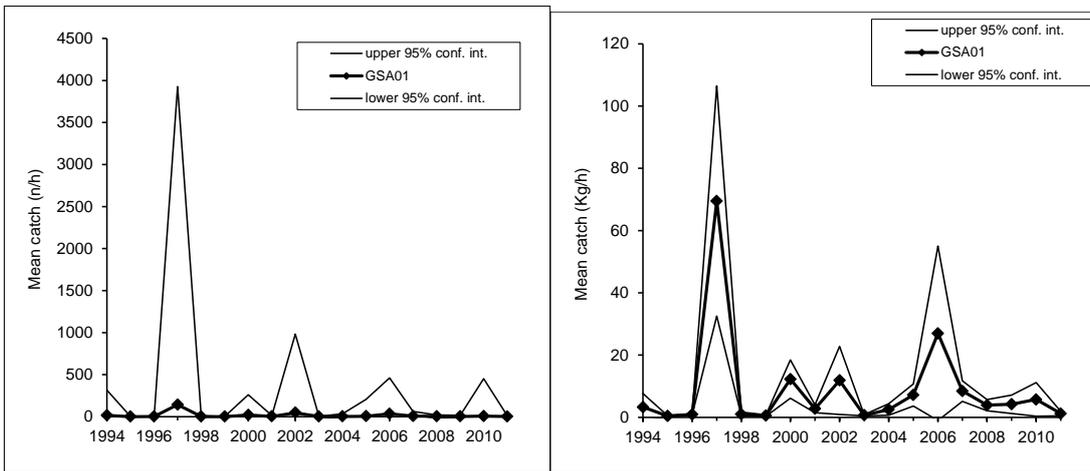


Figure 6.1.3.1.3.1. Abundance and biomass indices of blue whiting in GSA 01.

6.1.3.1.4. Trends in abundance by length or age

The following Figures 6.1.3.1.4.1, 2 and 3 display the stratified abundance indices of GSA 01 in 1994-2001, 2002-2009 and 2010-2011 respectively and were compiled in this SGMED report.

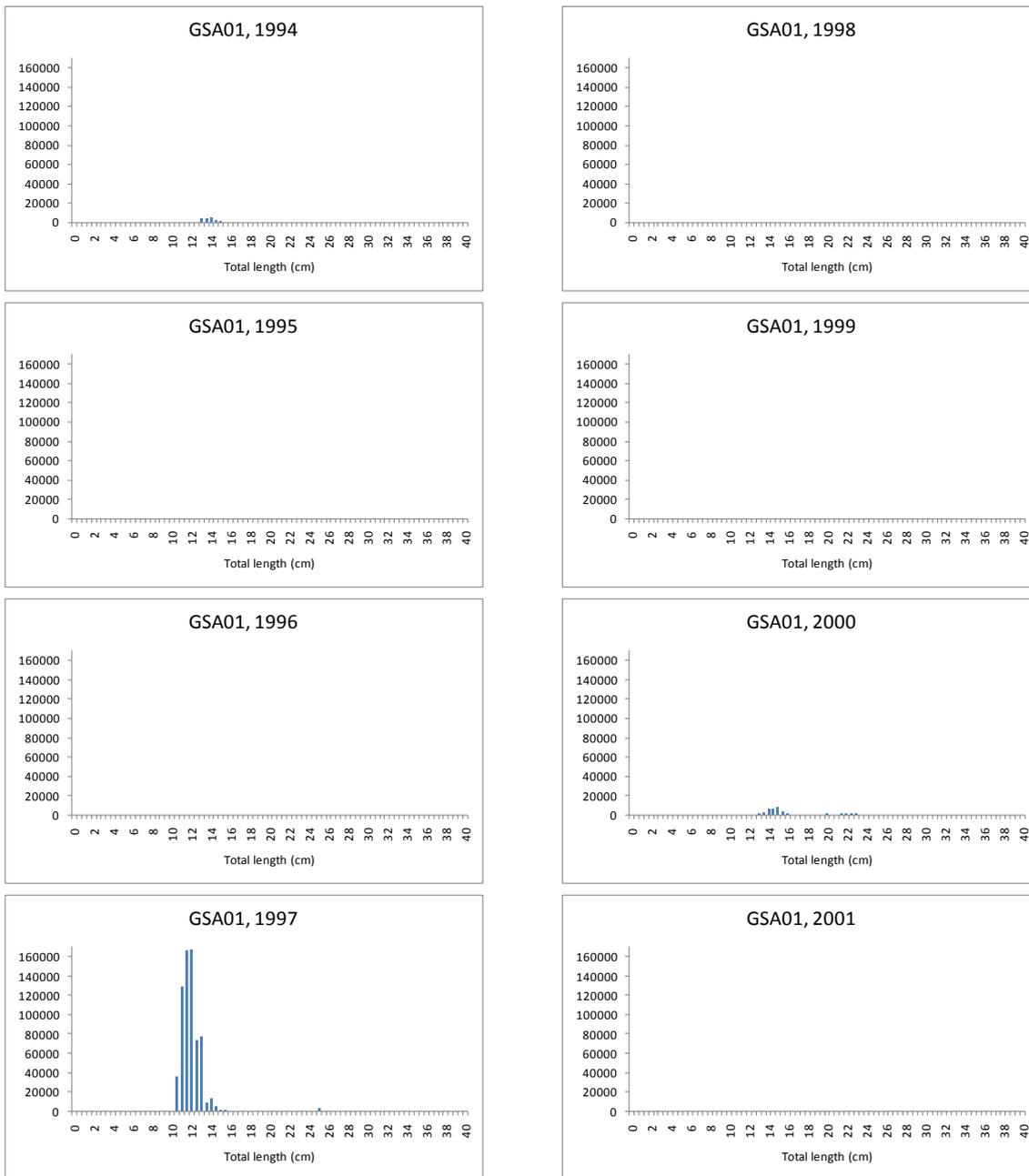


Fig. 6.1.3.1.4.1 Stratified abundance indices by size, 1994-2001.

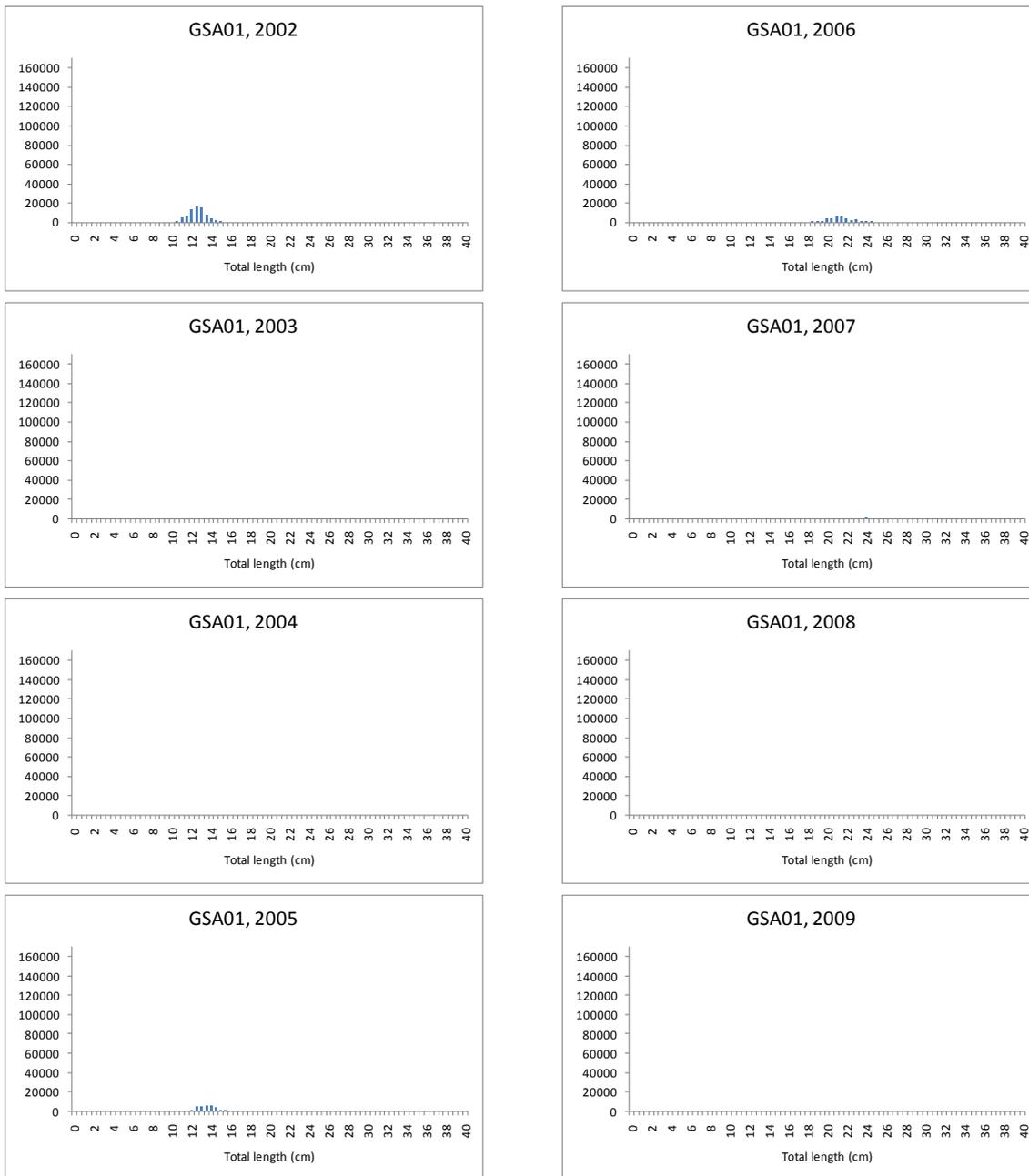


Fig. 6.1.3.1.4.2 Stratified abundance indices by size, 2002-2009.

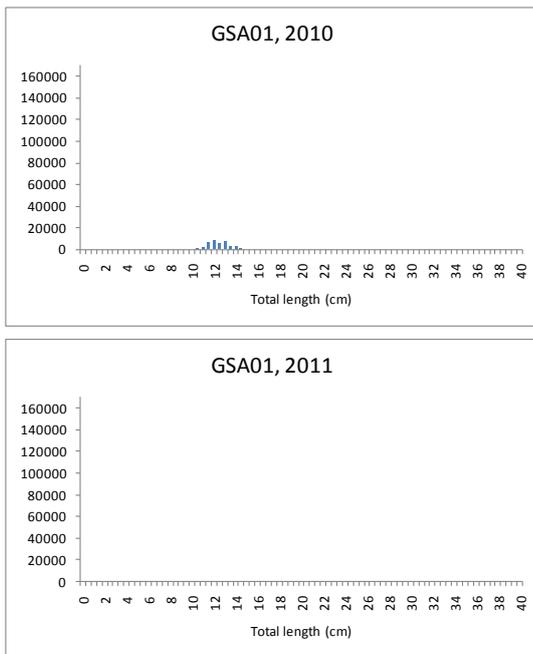


Fig. 6.1.3.1.4.3 Stratified abundance indices by size, 2010-2011.

6.1.3.1.5. Trends in growth

No information has been documented.

6.1.3.1.6. Trends in maturity

No information has been documented.

6.1.4. Assessments of historic stock parameters

6.1.4.1. Method: LCA

6.1.4.1.1. Justification

This is the first assessment of blue whiting in GSA 01. Three pseudo-cohort analyses, for 2009, 2010 and 2011 separately, were performed, using VIT software (Leonart and Salat 1992).

6.1.4.1.2. Input parameters

Analyses were performed using age frequencies obtained from length frequencies by slicing method using VIT software.

The biological parameters used were the following:

The set of growth parameters used for the assessment of blue whiting in GSA 01 were those used in the Spanish National Data Collection for GSA 06: $L_{inf}=48.4$ cm, $K=0.19$, $t_0=0$. Length-weight relationships: $a=0.0007$, $b=3.69$.

Natural mortality by age was calculated using the PRODBIOM spreadsheet (Abella et al. 1997), obtaining the following vector:

Age	0	1	2	3	4	5	6	7	8	9	10	Mean
M	1.12	0.55	0.48	0.4	0.37	0.35	0.33	0.32	0.32	0.31	0.3	0.44

A terminal fishing mortality $F_{\text{term}}=0.3$ was assumed.

The maturity ogive used was obtained from the size at first maturity reported for blue whiting in FishBase.

Age	0	1	2	3	4	5	6	7	8	9	10
Maturity	0	0.01	0.61	1	1	1	1	1	1	1	1

The length frequency distributions used for the present assessment (Table 6.1.4.1.2.1 and Figure 6.1.4.1.2.1) showed a different size range and modal differences. 2010 and 2011 data showed a mode around 19 cm while in 2009 data there are two modes: 21 and 27 cm. Minimum and maximum lengths also presented differences between years (2009: 17cm/36cm; 2010: 12cm/41 cm; 2011: 12cm/35 cm).

Table 6.1.4.1.2.1 Input data for LCA Catch at length 2009-2011.

Total length (cm)	2009	2010	2011
10	0	0	0
11	0	0	0
12	0	23.176	30.95
13	0	47.182	14.903
14	0	92.385	162.308
15	0	307.856	817.932
16	0	1263.958	1281.781
17	13.2	4040.769	1374.062
18	71.4	5537.285	1565.782
19	278.9	5727.768	1730.791
20	517.7	4835.165	1218.865
21	555.9	3233.245	777.66
22	255.1	1887.339	617.446
23	86.0	481.829	684.144
24	219.8	177.378	707.942
25	684.5	136.803	552.478
26	954.4	85.345	382.647
27	1050.9	88.44	180.634
28	950.5	68.972	70.243
29	299.0	39.058	34.381
30	165.5	22.67	11.809
31	94.1	11.264	8.405
32	60.1	6.221	1.205
33	27.0	9.693	3.632
34	5.1	1.68	2.844
35	0.9	0.597	0.484

36	1.3	0	0
37	0	0	0
38	0	0.489	0
39	0	0	0
40	0	0	0
41	0	1.578	0
42	0	0	0
43	0	0	0
44	0	0	0
45	0	0	0

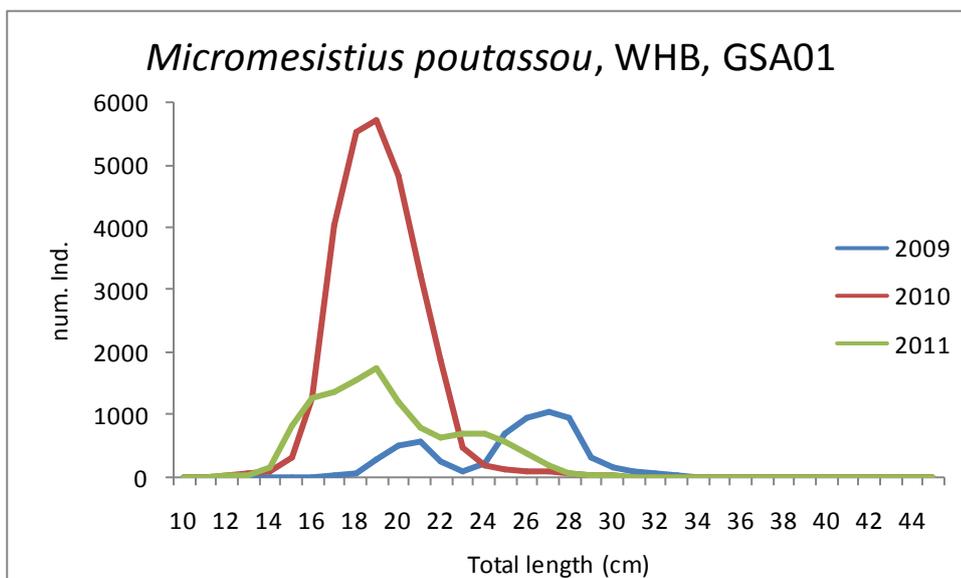


Fig. 6.1.4.1.2.1. Input data for LCA- Blue whiting length frequencies for the period 2009-11.

6.1.4.1.3.Results

Table 6.1.4.1.3.1 shows the summary results from the pseudo-cohort analysis in 2009, 2010 and 2011. Ages and lengths of the catches and the stock in 2010 and 2011 were quite similar, while in 2009 were higher, reflecting the effect of the differences on the length frequencies observed in the landings. Turnover is lower in 2009 data. Results on biomass were variable showing a decreasing trend and recruitment was also variable but being notably higher in 2010 and 2011.

Table 6.1.4.1.3.1 Summary results of stock parameters derived from the VIT model for the 2009, 2010 and 2011.

	2009	2010	2011
Catch mean age	3.916	2.584	2.749
Catch mean length	25.106	18.63	19.444
Mean F	0.889	0.577	0.919
Total catch (Tons)	637.04551	904.92661	594.991

Catch/D%	60.76	68.08	65.85
Catch/B%	60.8	95.23	84.39
Current Stock Mean Age	2.995	1.788	1.884
Current Stock Critical Age	4	2	2
Virgin Stock Critical Age	6	6	6
Current Stock Mean Length	20.734	13.703	14.274
Current Stock Critical Length	25.765	15.301	15.301
Virgin Stock Critical Length	32.921	32.921	32.921
Number of recruits, R	12883070	52470010	30291000
Mean Biomass, Bmean (Tons)	1047.69799	950.27626	705.00993
Spawning Stock Biomass, SSB (Tons)	977.12537	500.50094	427.64364
Biomass Balance, D (Tons)	1048.40461	1329.16713	903.5455
Bmax/Bmean	43.66	54.15	41.52
Turnover, D/Bmean	100.07	139.87	128.16

Age frequencies showed a mode on age 2 in 2010 and 2011. In 2009 the first capture corresponds at age 2 and the catch mode is around age 4. Maximum ages were 7 years in 2009 and 2011 and 10 in 2010 (Figure 6.1.4.1.3.1.)

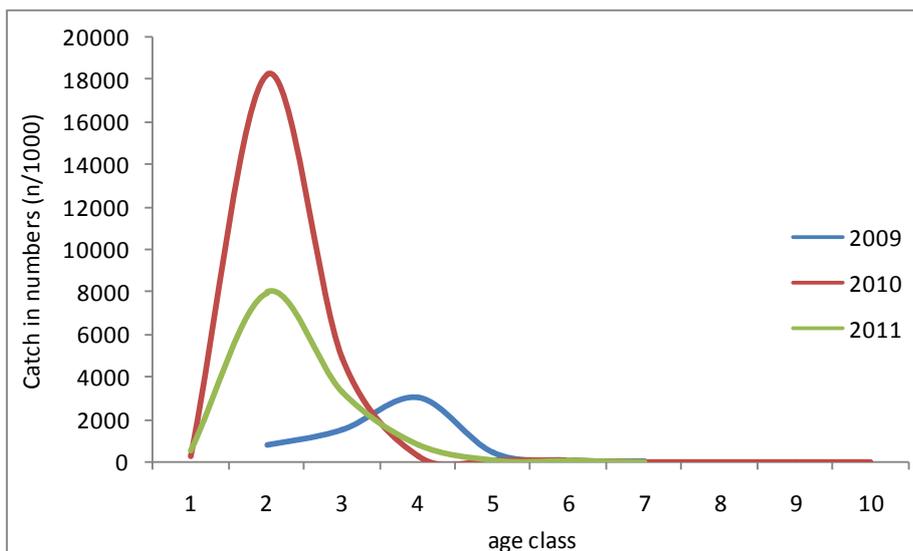


Fig. 6.1.4.1.3.1. Catch at age calculated by slicing method with VIT software.

Figure 6.1.4.1.3.2. LCA results on initial numbers of stock. Recruitment is different in the three years, and it reaches a higher value on 2010. For age classes 5-10, stock numbers are very low.

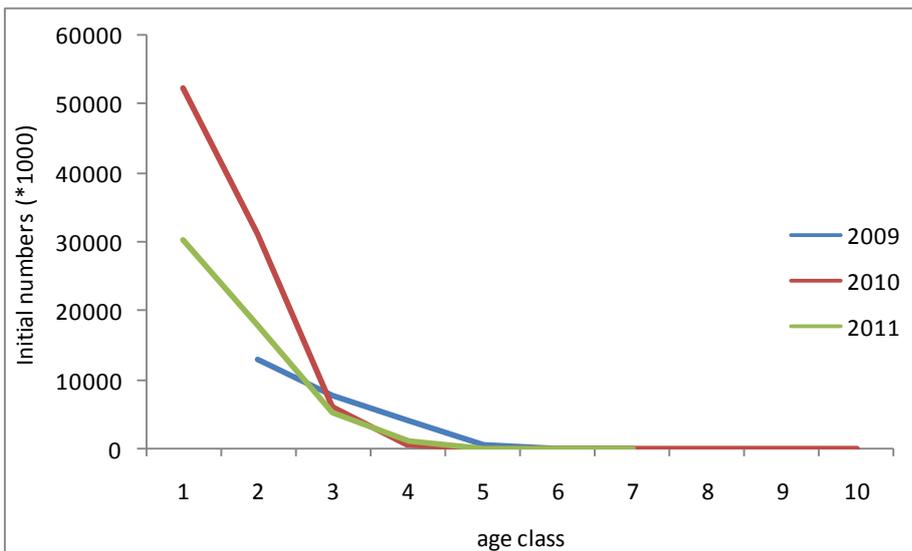


Fig. 6.1.4.1.3.2. LCA output. Stock numbers at age of *M. poutassou* in the GSA01.

Figure 6.1.4.1.3.3. Vector of fishing mortality by age resulting from the pseudo-cohort analysis. Fishing mortality vectors are quite different, the highest mortalities reported in age classes 3 in 2010, age 4 in 2011 and age 5 in 2009. F_{bar} (2-5) that represents the majority of the catch, was calculated and it is shown in Figure 6.1.4.1.3.4, values obtained were 1.0 (2009), 1.3 (2010) and 1.4 (2011), showing an increasing trend on this period.

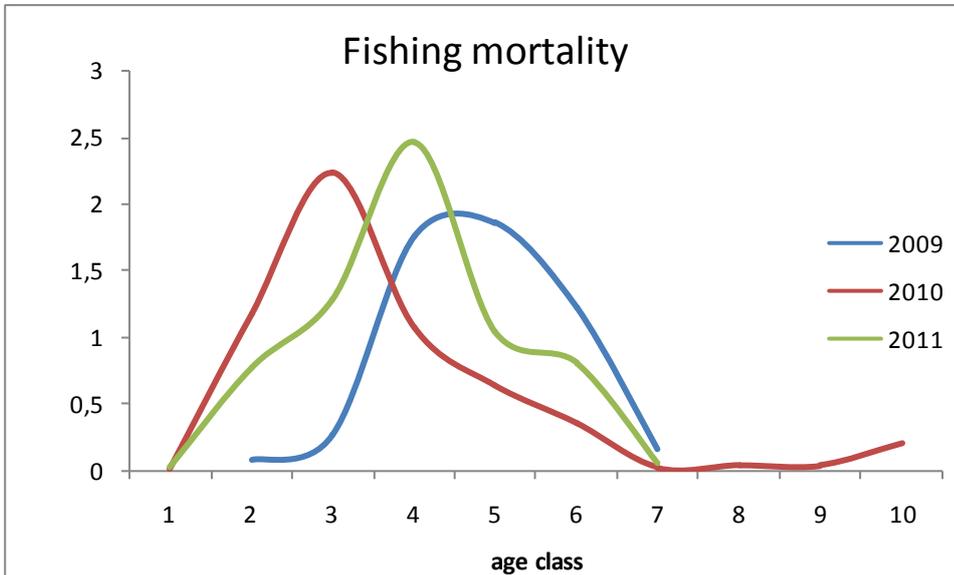


Fig. 6.1.4.1.3.3. LCA output. Fishing mortality by age of *M. poutassou* in the GSA01.

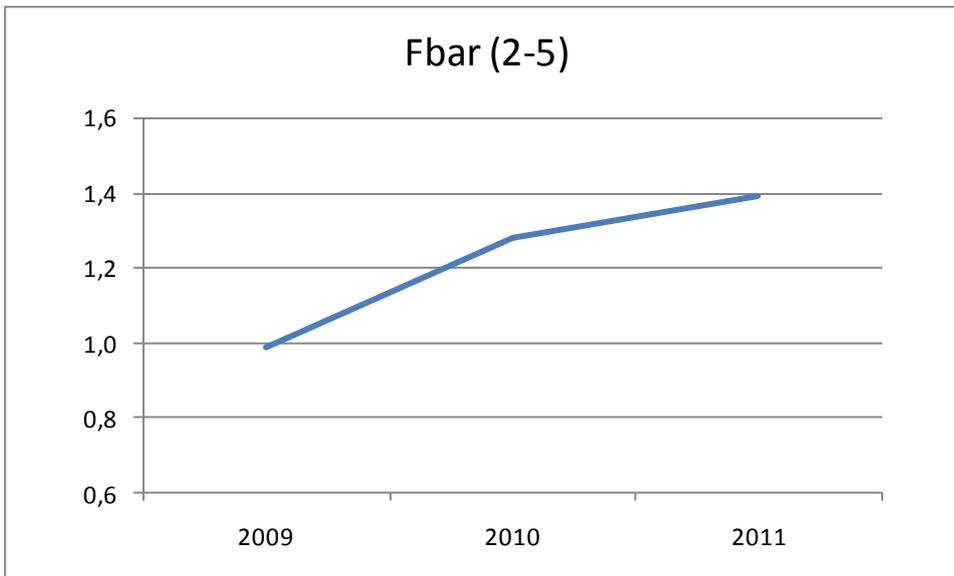


Fig. 6.1.4.1.3.4. LCA output. F-bar 2-5 calculated from fishing mortality vector.

6.1.5. Long term prediction

6.1.5.1. Justification

A Y/R analysis for years 2009, 2010 and 2011 was conducted using VIT software and based on results obtained on previous pseudocoorts analyses with VIT software.

6.1.5.1.1. Input parameters

The age frequency data of 2009, 2010 and 2011 and the biological parameters were used as given in Table 6.1.5.1.1.1.

Table 6.1.5.1.1.1. Input parameters to the yield per recruit analysis, separately for 2009, 2010 and 2011.

2009	age group	stock weight (g)	catch weight (g)	maturity	F	M
	2	31.327	31.327	0.8	0.079	0.48
3	78.061	78.061	1	0.255	0.4	
4	137.428	137.428	1	1.759	0.37	
5	218.46	218.46	1	1.859	0.35	
6	313.201	313.201	1	1.217	0.33	
7	414.303	414.303	1	0.162	0.32	

2010	age group	stock weight (g)	catch weight (g)	maturity	F	M
	1	6.91	6.91	0.01	0.005	0.55
2	28.191	28.191	0.61	1.181	0.48	
3	69.659	69.659	1	2.237	0.4	
4	141.224	141.224	1	1.066	0.37	
5	226.33	226.33	1	0.643	0.35	
6	319.48	319.48	1	0.355	0.33	
7	415.424	415.424	1	0.016	0.32	

	8	506.303	506.303	1	0.037	0.32
	9	591.95	591.95	1	0.031	0.31
	10	669.414	669.414	1	0.195	0.3

2011	age group	stock weight (g)	catch weight (g)	maturity	F	M
	1	6.893	6.893	0.01	0.02	0.55
	2	29.279	29.279	0.61	0.777	0.48
	3	73.359	73.359	1	1.285	0.4
	4	134.072	134.072	1	2.46	0.37
	5	223.585	223.585	1	1.043	0.35
	6	316.155	316.155	1	0.801	0.33
	7	415.163	415.163	1	0.05	0.32

6.1.5.1.2.Results

Table 6.1.5.1.2.1 lists the results from the Y/R analysis, and Figure 6.1.5.1.2.1 shows the Y/R curve. Value of Y/R at the current exploitation level is 20 g/recruit for 2010 and 2011 while for 2009 Y/R at the current exploitation level is 52 g/recruit. These differences are due to different exploitation pattern in 2009, where the first exploited age is 2 and almost all individuals caught are adults. 2010 and 2011 curves were quite similar. The Figure 6.1.5.1.2.1 indicates signs of overexploitation in the three years.

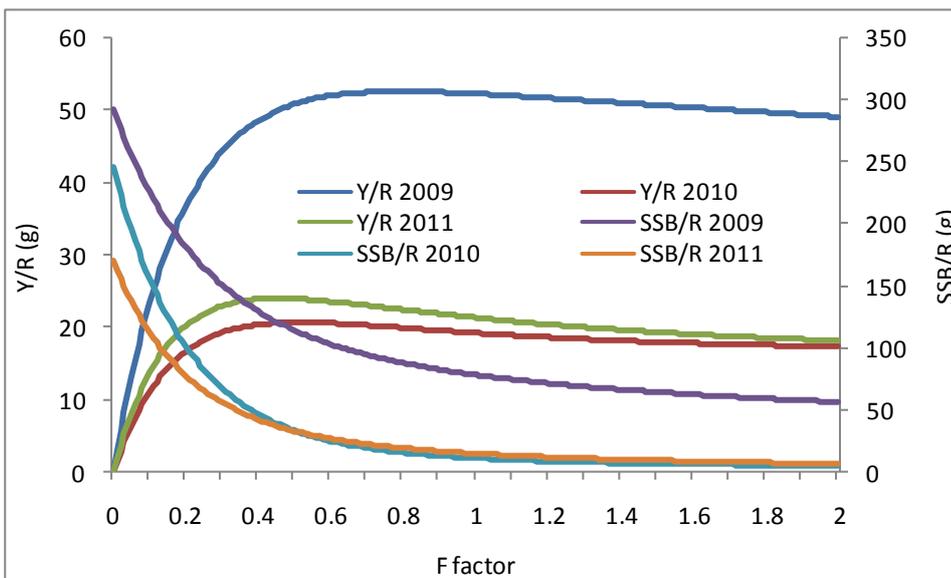


Fig. 6.1.5.1.2.1. Y/R outputs. Y/R and SSB per recruit curves for blue whiting in GSA 01.

Table 6.1.5.1.2.1. Results of the Y/R analysis.

	2009	Factor	Y/R	B/R	SSB
F(0)		0	0	298.584	292.858
F(0.1) factor		0.41	48.949	133.391	127.751

Fmax	0.8	52.684	93.301	87.741
Fcurrent	1.01	52.362	83.622	78.103

2010	Factor	Y/R	B/R	SSB
F(0)	0	0	257.868	246.574
F(0.1) factor	0.31	19.574	75.214	64.83
Fmax	0.52	20.813	40.911	31.035
Fcurrent	1.01	19.339	19.536	10.577

2011	Factor	Y/R	B/R	SSB
F(0)	0	0	182.289	170.994
F(0.1) factor	0.29	22.686	68.679	58.007
Fmax	0.46	23.889	46.984	36.637
Fcurrent	1.01	21.253	24.715	15.243

$F_{0.1}$ calculated considering an F_{bar} 2-5 are:

	2009	2010	2011
Fbar2-5	1.0	1.3	1.4
F(0.1)factor	0.41	0.31	0.29
F0.1	0.41	0.40	0.40

An F_{01} mean of 0.4 is proposed.

Taking into account the present assessments, the status of this stock would be defined as exploited unsustainably.

6.1.6. Data quality

Although there are an amount of discards registered in catches, there is no data in GSA 01 about length or age frequencies of these discards, which could be important for this species due to age class 0 that is almost absent in landings and must compose the majority of discards.

6.1.7. Scientific advice

6.1.7.1. Short term considerations

6.1.7.1.1.State of the stock size

Stock assessment has been computed by Length Cohort Analysis (VIT software) using as input DCF data of annual distributions of sizes (2009-2011). Results obtained did not show a clear trend in the stock size. MEDITS survey indices showed also a variable pattern of abundance and biomass. Since no precautionary level for the stock of blue whiting in GSA 01 was proposed. STECF EWG 12-19 cannot evaluate the stock status in relation to the precautionary approach.

6.1.7.1.2.State of recruitment

STECF EWG 12-19 is unable to provide any scientific advice of the state of the recruitment given that only three years of data are available.

6.1.7.1.3.State of exploitation

STECF EWG 12-19 proposes $F_{0.1} \leq 0.4$ as limit management reference point.

According to the F estimates using Length Cohort Analyses. average F ages 2-5 was over the average estimated $F_{0.1}$ values.

Based on this assessment results STECF EWG 12-19 assessed the status of the stock of blue whiting in GSA01 as being exploited unsustainably.

6.2. Stock assessment of Norway lobster in GSA 01

6.2.1. Stock identification and biological features

6.2.1.1. Stock Identification

Due to the lack of specific information on stock structure of the Norway lobster (*Nephrops norvegicus*) populations in the western Mediterranean, this stock was assumed to be confined within GSA 01 boundaries. The species is of high economic importance in the area because despite its relatively low level of catches (ca. 100 t / year) the price at first sale is high (25-35 €/kg).

N. norvegicus is a mud-burrowing species that prefers sediments with mud mixed with silt and clay in variable proportions. In GSA01 the species is found in deep-waters between 350 and 600 m.

6.2.1.2. Growth

Maximum observed size in GSA 01 was 88 mm CL in a single male and 62 mm CL in one female. 95% of the length samples were comprised between 23 and 63 mm CL in males and 23 and 52 mm CL in females. Due to the lack of recent growth estimates for this species in the area, the biological parameters from GS05 used in EWG12-10 were:

$$L_{\infty} = 72.1$$

$$K = 0.169$$

Length-weight relationships: $a = 0.000373$, $b = 3.1576$.

6.2.1.3. Maturity

Due to the lack of specific biological information for GSA 01, the maturity curve was obtained from the stock assessments parameters corresponding to GSA 05 in EWG12-10:

age class	1	2	3	4	5	6	7	8	9	10	11	12	13
proportion mature	0.05	0.14	0.32	0.58	0.8	0.92	0.97	0.99	1	1	1	1	1

6.2.2. Fisheries

6.2.2.1. General description of the fisheries

Norway lobster catches are produced exclusively with otter bottom trawl in GSA 01, by the fleet in length classes VL1224 and VL2440 fishing in deep waters (350-600 m depth).

6.2.2.2. Management regulations applicable in 2010 and 2011

Fishing license: number of licenses observed

Engine power limited to 316 KW or 500 HP: partial compliance (in some cases real HP is at least the double)

Mesh size in the codend (before June 1st 2010: 40 mm diamond: after June 1st 2010: 40 mm square or 50 mm diamond -by derogation-): full compliance

Time at sea (12 hours per day and 5 days per week): full compliance

Minimum landing size (EC regulation 1967/2006, 20 mm CL): mostly full compliance.

6.2.2.3. Catches

6.2.2.3.1.Landings

Landings of Norway lobster in GSA 01 come exclusively from bottom otter trawl. In the period 2002-2011 landings of *N. norvegicus* in GSA 01 decreased by half approximately after 2004 from *ca.* 150 t to 75 t in 2011.

Table 6.2.2.3.1.1. Landings of *Nephrops norvegicus* in GSA 01 from the DCF 2012 data call.

2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
168.27	158.33	121.68	65.68	59.24	61.52	80.6	93.14	77.4	74.62

6.2.2.3.2.Discards

Discards of Norway lobster in GSA01 can be considered negligible due to the high market value of the species and none are reported in the DCF 2012 data call. Undersized individuals (less than 20 mm CL) are scarce in the landings.

6.2.2.4. Fishing effort

Fishing effort has decreased steadily over the last years, due to the effort reduction programs in the Mediterranean, from a maximum in the years 2000-2002. Catches are produced by demersal otter trawlers in the categories 12-24 m and 24-40 m (fleet segments VL1224 and VL2440) and the trends in 3 fishing effort indicators between 2002 and 2011 are shown below:

yr	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Nb of Vessels	759	758	739	706	712	708	688	652	630	612
Nominal effort (000s)	4340	4383	4236	3899	3972	4074	3550	3838	3976	3925
GT_days at sea (000s)	1812	1878	1851	1749	1748	1822	1576	1669	1713	1701

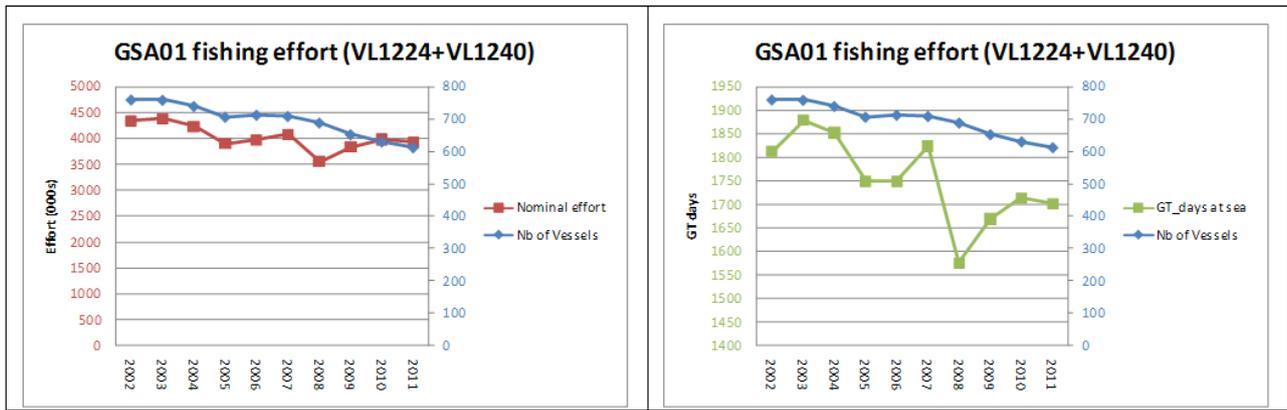


Fig. 6.2.2.4.1. Trend of number of vessels (OTB vessels VL1224 and VL2440), nominal effort and GT_days_at_sea in the period 2002- 2011 in GSA 01.

6.2.3. Scientific surveys

6.2.3.1. MEDITS

6.2.3.1.1. Methods

Since 1994 standard bottom trawl surveys have been conducted in GSA 01 in spring, following the general methodology of the MEDITS protocol described in Bertrand et al. (2002). In GSA 01 the following number of hauls was reported per depth stratum in the DCF 2012 data call.

Table 6.2.3.1.1.1. Number of hauls per year and depth stratum in GSA01, 1994-2011.

STRATUM	GSA06_010-050	GSA06_050-100	GSA06_100-200	GSA06_200-500	GSA06_500-800
1994	3	6	3	8	8
1995	1	5	3	9	10
1996	2	5	3	11	13
1997	2	7	5	10	10
1998	2	6	5	8	13
1999	2	9	5	11	12
2000	2	6	5	13	13
2001	4	7	6	10	13
2002	4	8	8	11	15
2003	4	12	6	11	14
2004	4	8	5	13	13
2005	2	8	6	11	11
2006	4	8	6	14	19
2007	4	8	7	13	13
2008	5	7	7	13	11
2009	2	8	7	13	9
2010	3	6	4	6	7
2011	3	6	4	8	7

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Y_{st} = \sum (Y_i * A_i) / A$$

$$V(Y_{st}) = \sum (A_i^2 * s_i^2 / n_i) / A^2$$

Where:

A=total survey area

A_i=area of the i-th stratum

s_i=standard deviation of the i-th stratum

n_i=number of valid hauls of the i-th stratum n=number of hauls in the GSA

Y_i=mean of the i-th stratum

Y_{st}=stratified mean abundance V(Y_{st})=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = $Y_{st} \pm t(\text{student distribution}) * V(Y_{st}) / n$

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.2.3.1.2. Geographical distribution patterns

Norway lobster is distributed from 350 to 600 m depth approximately in GSA01 on soft muddy bottoms.

6.2.3.1.3. Trends in abundance and biomass

Fishery independent information from the MEDITS surveys in the period 1994-2011 was used to derive indices of abundance and biomass for Norway lobster in GSA 01. Both abundance and biomass have fluctuated in the area during this period with no clear trend, although a peak in abundance was observed in the years 2002-2005.

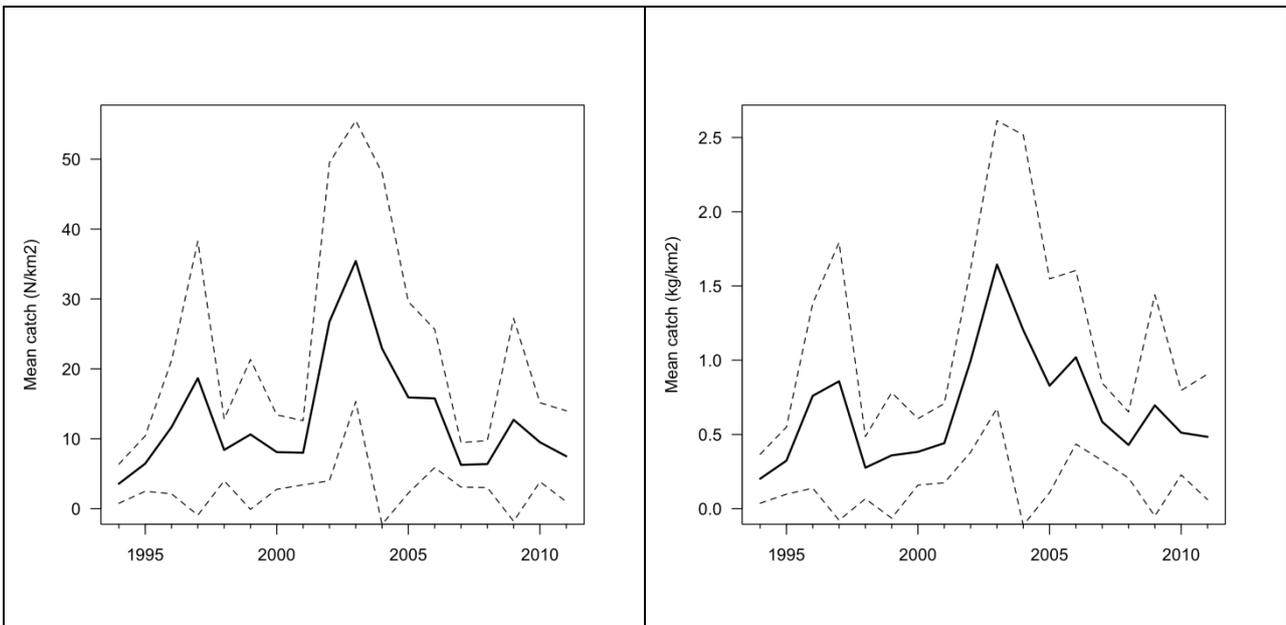
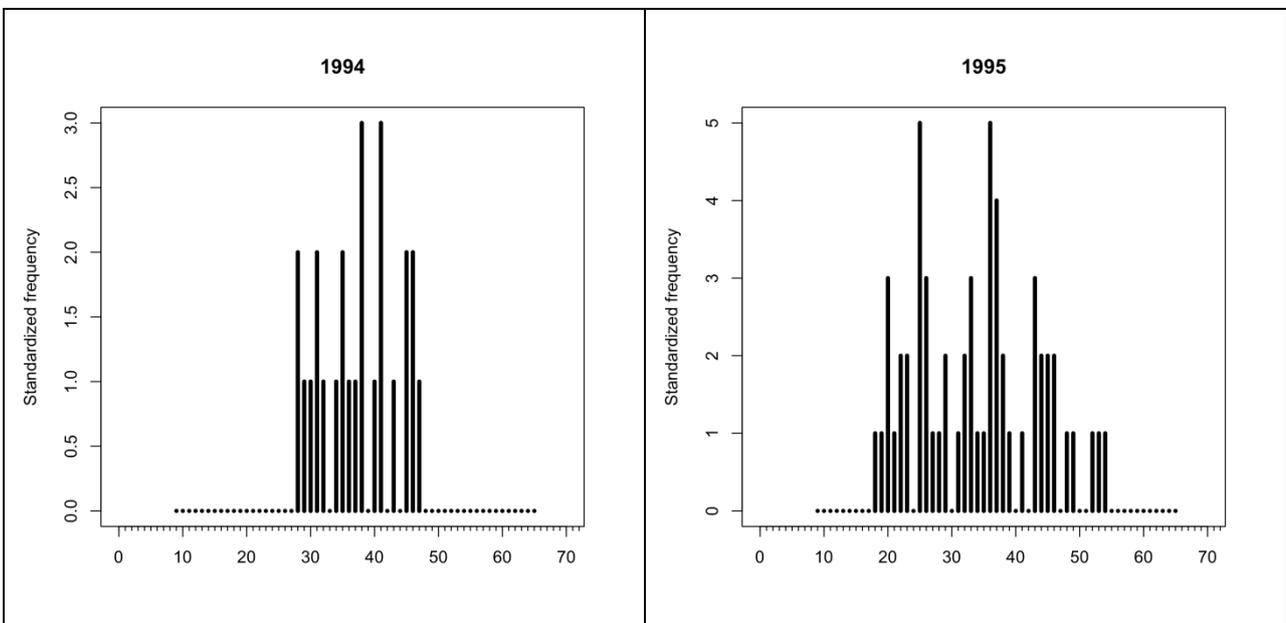
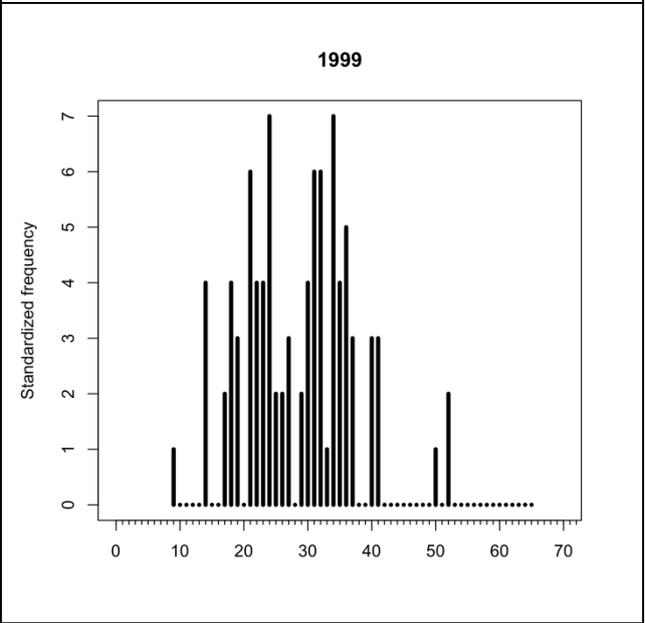
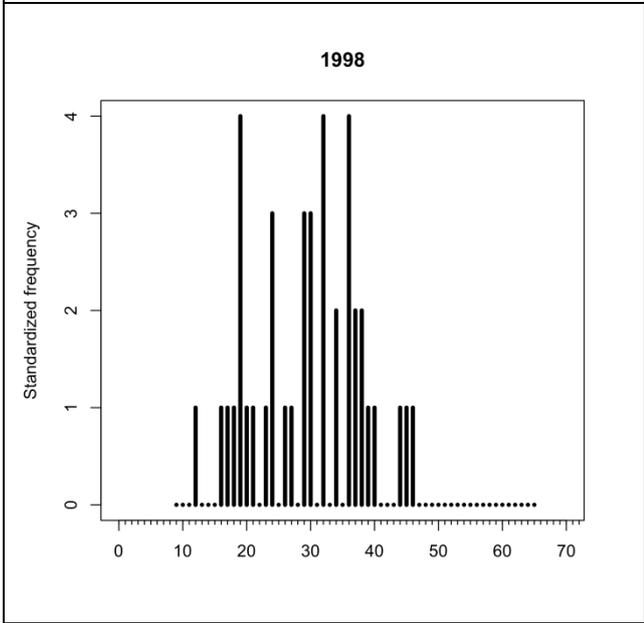
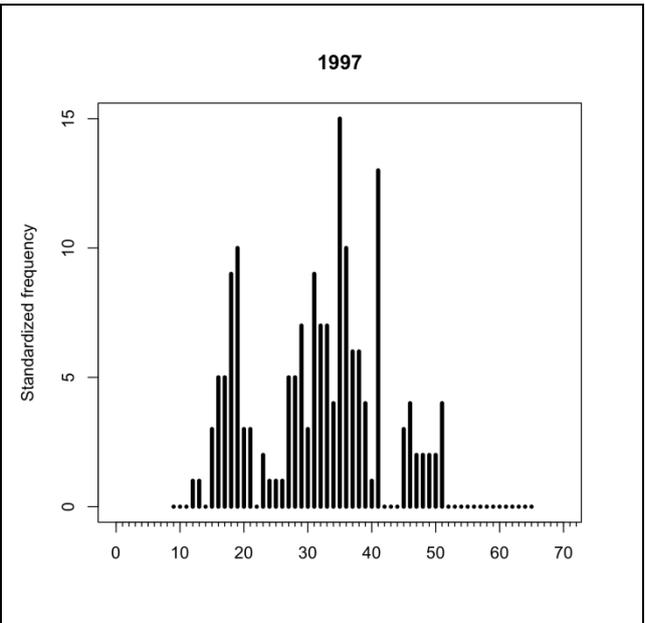
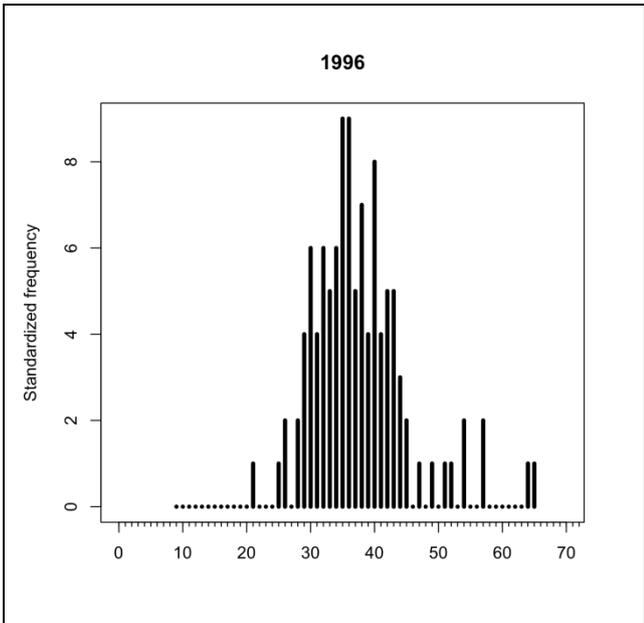


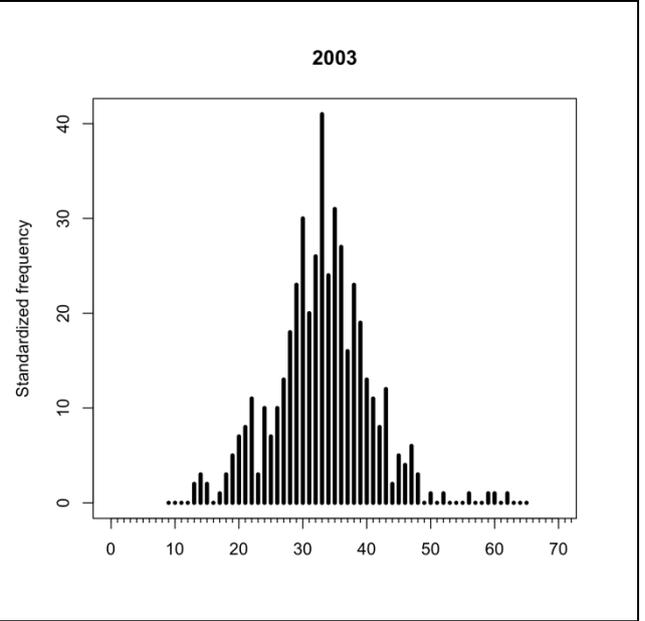
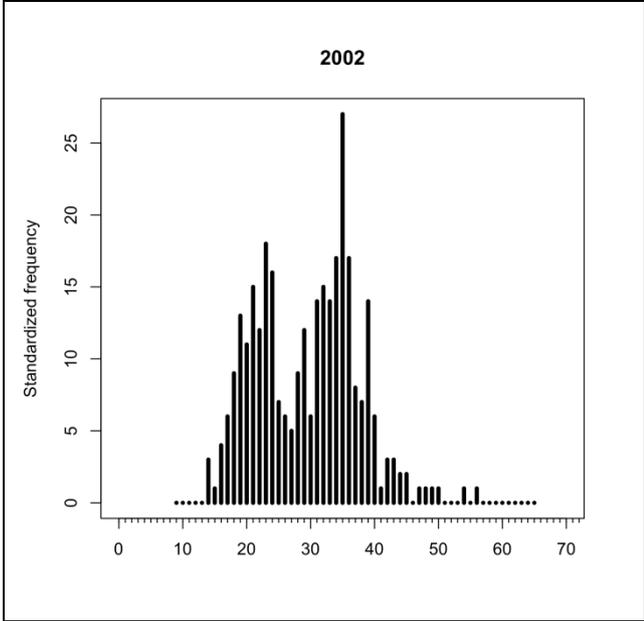
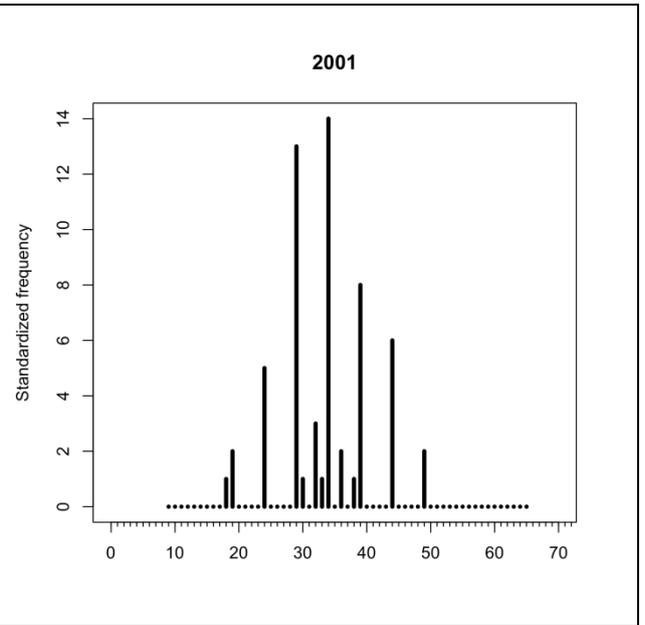
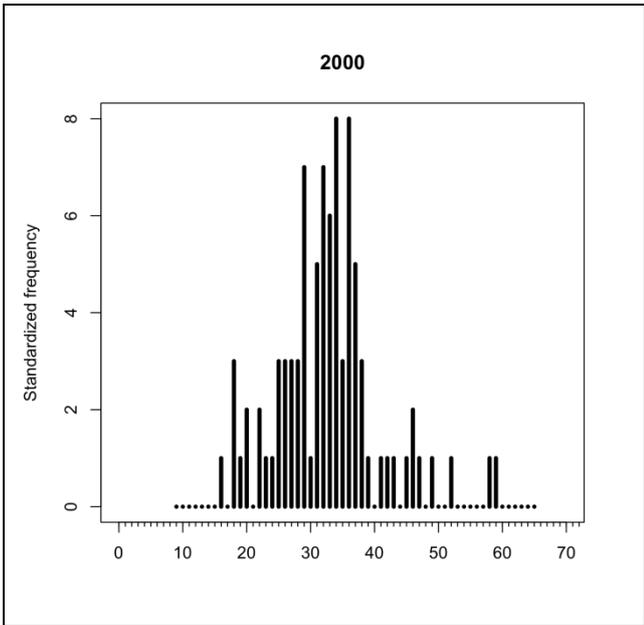
Fig. 6.2.3.1.3.1. Abundance and biomass indices of *Nephrops norvegicus* in GSA 01 from MEDITS surveys (mean and 95% confidence intervals).

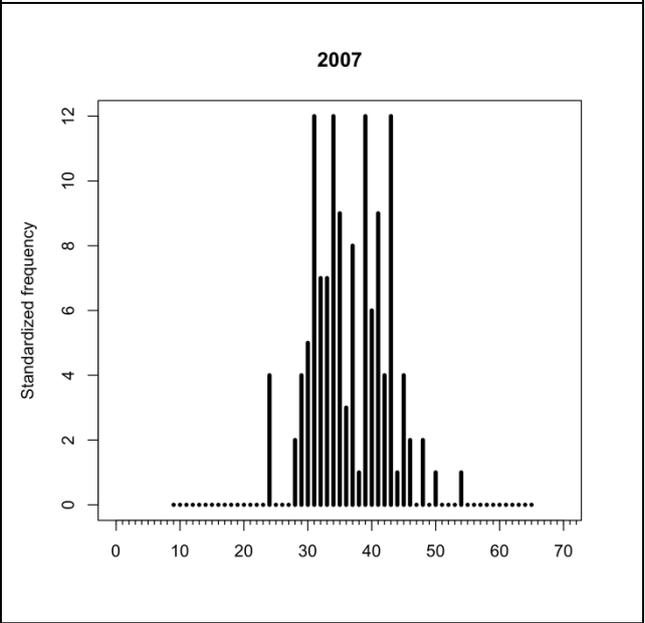
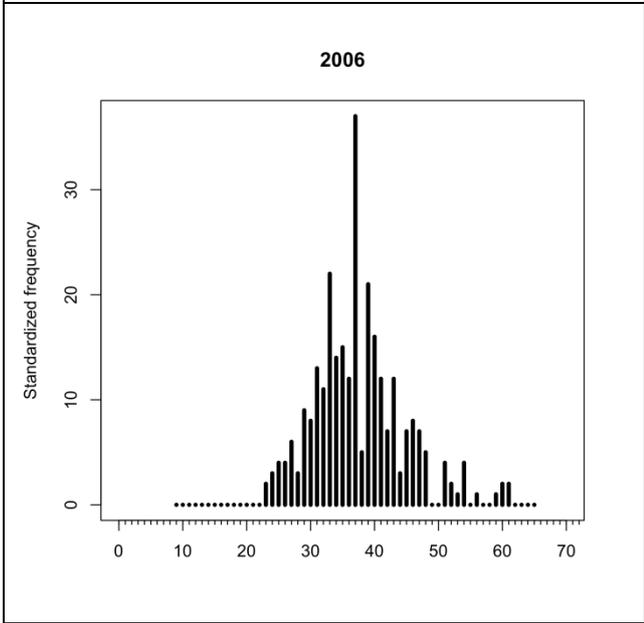
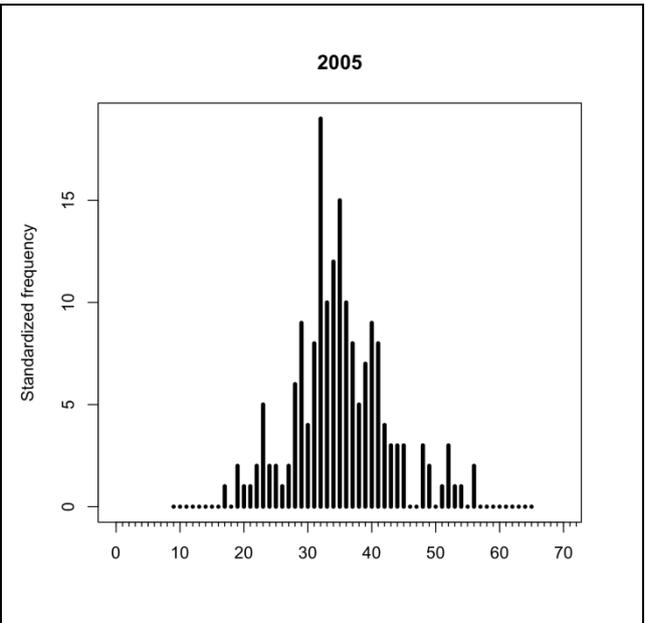
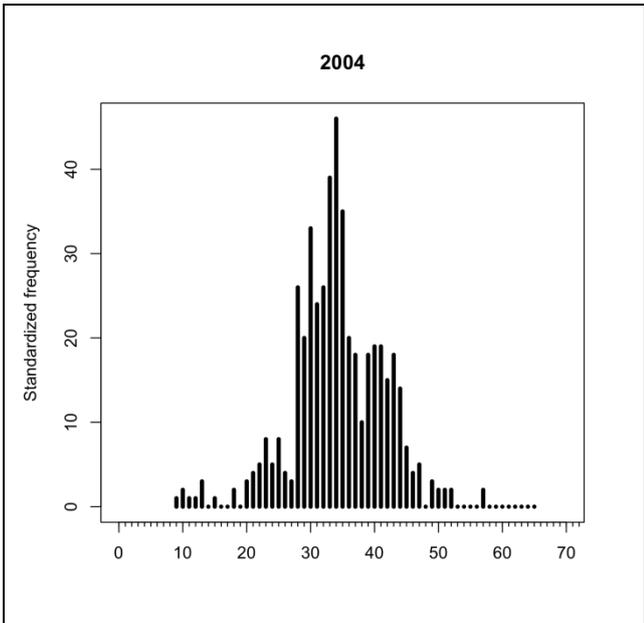
6.2.3.1.4. Trends in abundance by length or age

The following figures show the standardized size frequencies of Norway lobster in GSA 01 in the period 1994-2011. Although the modal size in the samples is around 35 mm CL in all years, some changes in the size composition of the samples are apparent, especially at sizes below 20 mm CL, which could be indicative of strong recruitment in the years 1997-2002. The number of specimens measured in 2001 was very low.









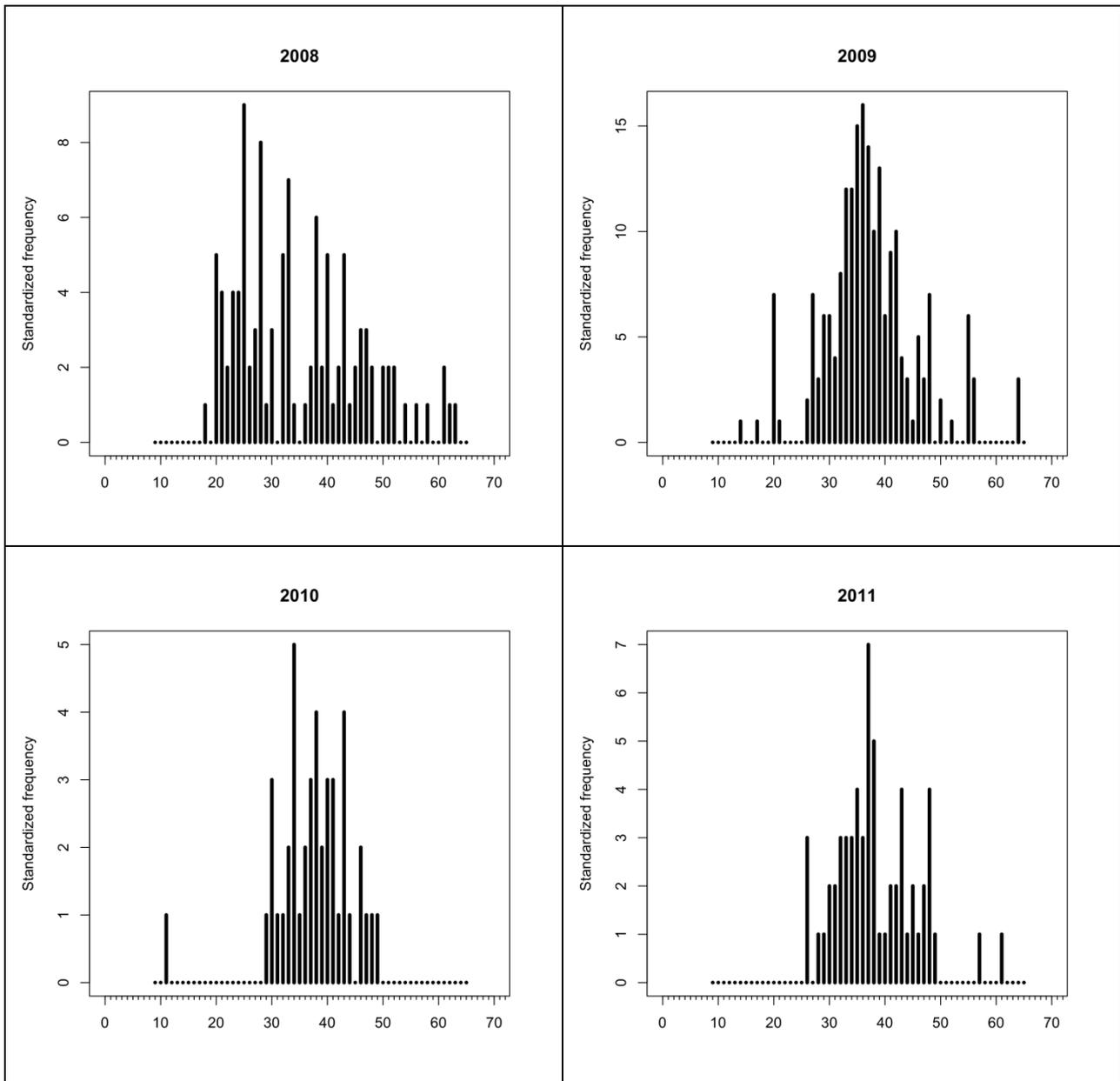


Fig. 6.2.3.1.4.1. Standardized size frequencies of *Norway lobster* in GSA06 1994-2011 from MEDITS surveys.

6.2.3.1.5. Trends in growth

No information is available to assess trends in growth.

6.2.3.1.6. Trends in maturity

No information is available to assess trends in maturity.

6.2.4. Assessments of historic stock parameters

6.2.4.1. Method 1: pseudo-cohort VPA (VIT)

6.2.4.1.1. Justification

Frequency data of landings was available only for the years 2009-2011 because Norway lobster was not a priority species in GSA 01. For this reason, three pseudo-cohort analyses for 2009, 2010 and 2011 separately, were performed, using VIT software (Leonart and Salat 1997).

6.2.4.1.2. Input parameters

Analyses were performed using number at age obtained from length from the 2012 DCF data call.

The set of growth parameters used for the assessment of Norway lobster in GSA 01 were taken from the parameters used in the stock assessment of GSA 05 (EWG12-10): $L_{inf}=72.1$ cm CL, $K=0.169$, $t_0=0$. Length-weight relationships: $a=0.000373$, $b=3.1576$.

Natural mortality by age, calculated using PROBIOM (Abella et al, 1997), was:

age	1	2	3	4	5	6	7	8	9	10	11	12	13+
M	0.47	0.37	0.29	0.26	0.24	0.23	0.22	0.21	0.21	0.21	0.21	0.21	0.21

The same maturity ogive as in GSA05 was assumed:

age class	1	2	3	4	5	6	7	8	9	10	11	12	13+
proportion mature	0.05	0.14	0.32	0.58	0.8	0.92	0.97	0.99	1	1	1	1	1

The terminal fishing mortality was set at 0.25 (after performing sensitivity analysis over a wide range of values: 0.05 – 1).

The age composition of the landings is shown in the following table. No Norway lobsters of age 0 are reported and specimens of age 1 are scarce. The bulk of the catches are composed of ages 3-6. Frequency of catches from 13 to 19 years old was very low and the data were pooled in a plus class. The following table shows the raised frequency of individuals in the catches by age (000s):

age / yr	2009	2010	2011
0	0	0	0
1	54.1	1.6	4
2	51.3	34.1	19.7
3	200.2	128.4	242.1
4	349.2	222.6	514.3
5	303.1	311.6	294.4
6	138.7	126.8	136.3
7	73.4	89.1	52.6
8	13.8	40.6	29.5
9	23.1	23	15.7

10	15	14.2	11.3
11	8.4	8.5	9.6
12	5.5	10	3.3
13+	7.9	7.2	9.3

6.2.4.1.3.Results

Three independent annual VIT assessments were carried in 2009, 2010 and 2011 based on 13 age classes (1 to 13+). The catches were composed mainly of individuals in ages 3-6 in the 3 years.

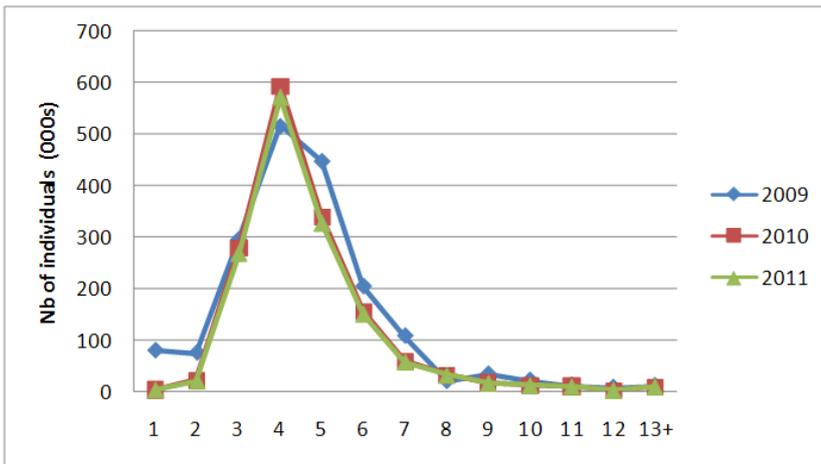


Fig. 6.2.4.1.3.1. Numbers at age of *Nephrops norvegicus* in the total catches of OTB for 2009-2011 (GSA 01)

The catches in weight were dominated by ages 3-7 in all three years.

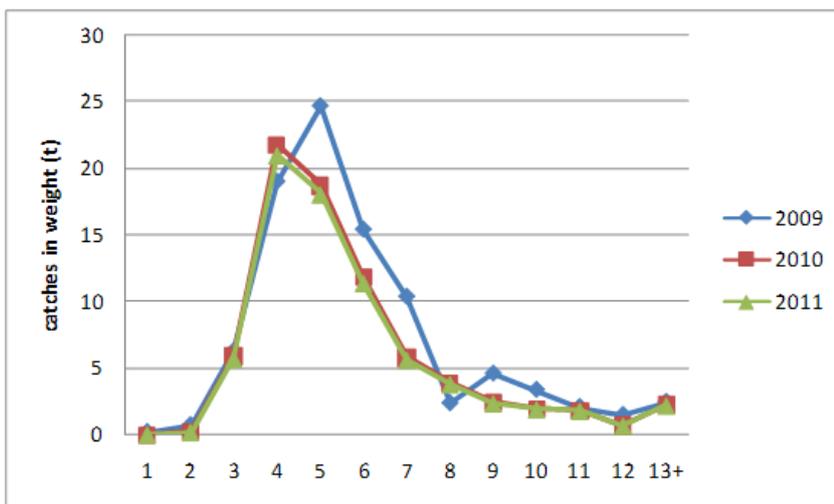


Fig. 6.2.4.1.3.2. Catch at age of *Nephrops norvegicus* in the total catches of OTB for 2009-2011 (GSA 01)

The population of Norway lobster was fairly stable in numbers from 2009 to 2011, as deduced from the following figure:

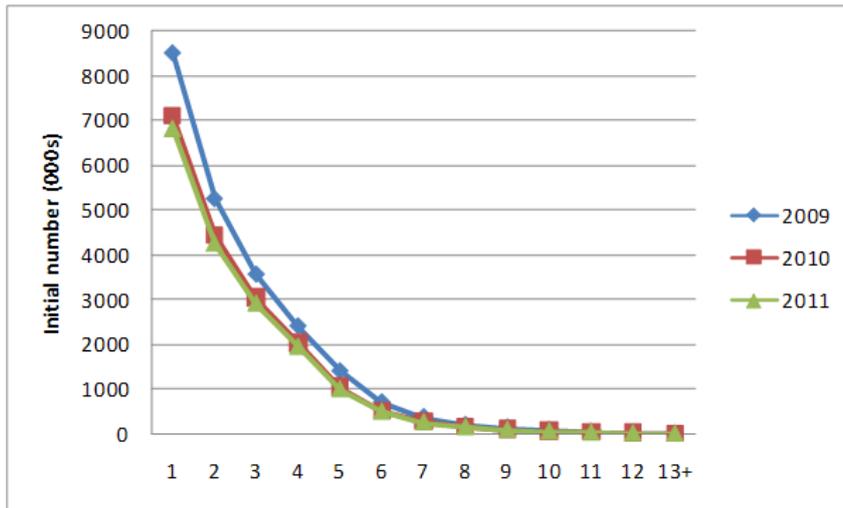


Fig. 6.2.4.1.3.3. Number of individuals in the stock of *Nephrops norvegicus* for 2009-2011 (GSA 01)

Fishing mortality was higher for ages 3 onwards, with F slightly lower for the age classes 7 and older in 2010 and 2011.

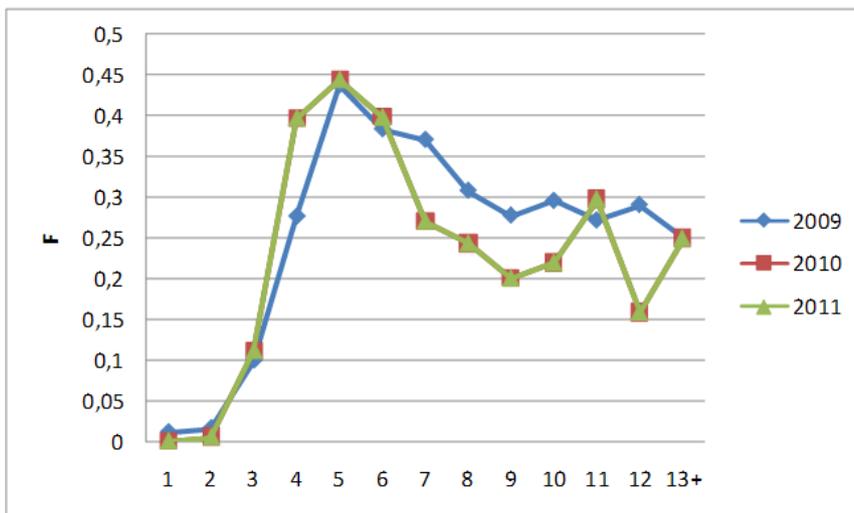


Fig. 6.2.4.1.3.4. Fishing mortality by age class of the stock of *Nephrops norvegicus* for 2009-2011 (GSA 01)

6.2.5. Long term prediction

6.2.5.1. Justification

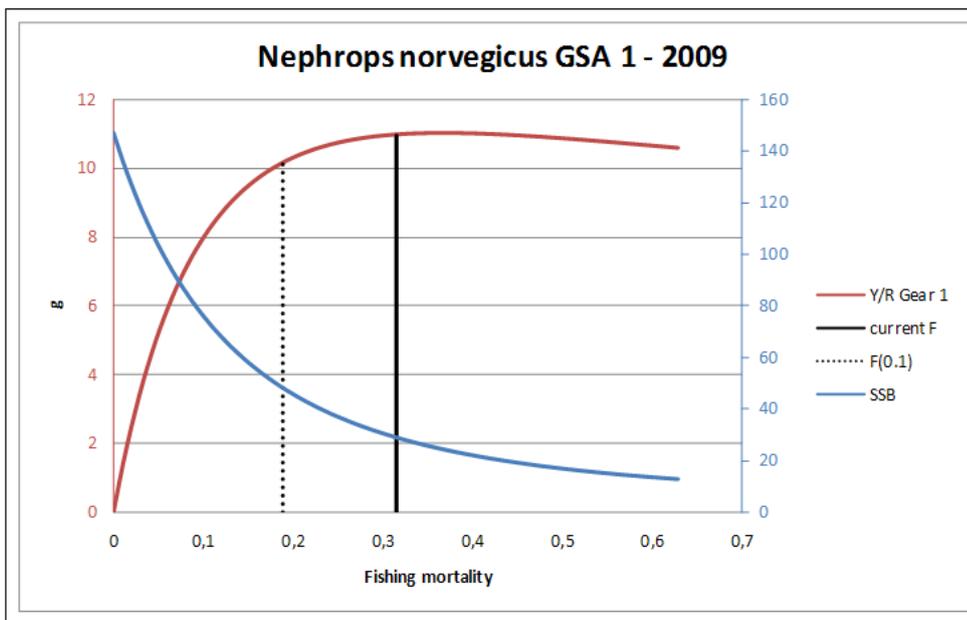
A yield per recruit (Y/R) analysis was carried out using the VIT program (Windows version 1.3).

6.2.5.1.1. Input parameters

The same input parameters used for VIT were used in the YPR analysis.

6.2.5.1.2. Results

The yield curves were relatively flat shaped for all three years, but with maximum yield located close and to the right of current F. Maximum production (ca. 11 g / recruit) would be obtained at F 19% higher than current F ($F_{cur}=0.32$, $F_{max}=0.39$). $F_{0.1}$ is about one third lower than F_{cur} , as shown in the following figures:



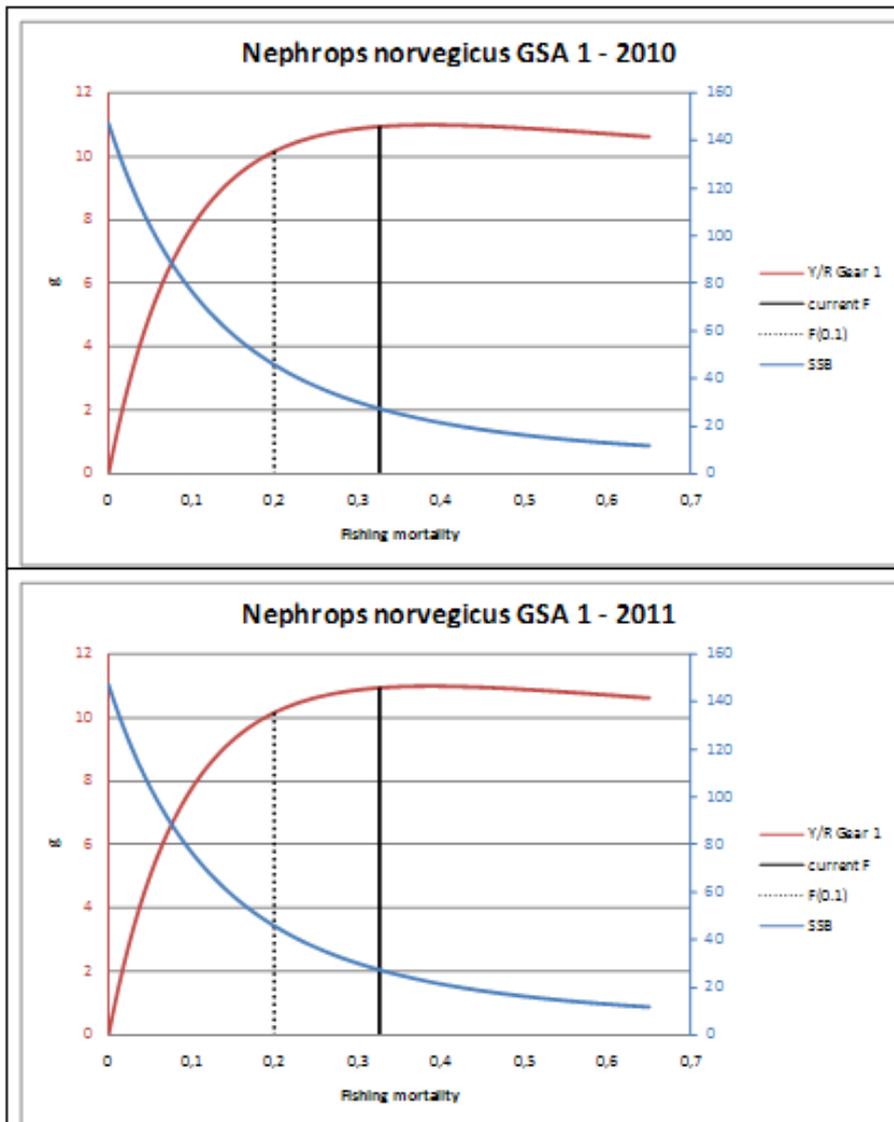


Fig. 6.2.5.1.2.1. Annual YPR and SSBPR of *Nephrops norvegicus* in the period 2009-2011 in GSA 06, with current F and $F_{0.1}$.

Table 6.2.5.1.2.1 shows the summary results of the YPR analysis. Note that average fishing mortality has remained relatively constant throughout the 3 years (average $F_{[3-7]}=0.32$) and the exploitation pattern is essentially the same. Current F is above F_{MSY} . Fishing mortality should be reduced by 40% approximately to reach F_{MSY} ($F_{0.1}=0.20$).

Table 6.2.5.1.2.1. Results summarising the YPR analyses performed for the 2009 - 2011 assessments of Norway lobster in GSA 01.

		Factor	Absolute F	Y/R	B/R	SSB/R
2009	Virgin	0.00	0.00	0.00	167.09	147.04
	F(0.1)	0.60	0.19	10.15	65.72	48.24
	Fcurr	1.00	0.31	10.96	45.32	29.09

	F(Max)	1.18	0.37	11.01	40.16	24.39
2010	Virgin	0.00	0.00	0.00	167.09	147.04
	F(0.1)	0.61	0.20	10.13	63.10	45.83
	Fcurr	1.00	0.33	10.92	43.21	27.17
	F(Max)	1.20	0.39	10.98	37.57	22.03
2011	Virgin	0.00	0.00	0.00	167.09	147.04
	F(0.1)	0.61	0.20	10.13	63.10	45.83
	Fcurr	1.00	0.33	10.92	43.21	27.17
	F(Max)	1.20	0.39	10.98	37.57	22.03
Average	F(0.1)	0.61	0.20	10.13	63.97	46.63
	Fcurr	1.00	0.32	10.93	43.91	27.81
	F(Max)	1.19	0.38	10.99	38.43	22.82

Reference F from the YPR analysis for the fully recruited ages 3-7, averaged over 2009-2011 is $F_{ref}(2009-2011; 3-7) = 0.32$ and the corresponding $F_{01}=0.20$.

6.2.6. Data quality

Data from DCF 2012 were used. The data available are of sufficient quality to perform a VPA on pseudocohorts at an annual scale, but the biological parameters used come from a different GSA.

6.2.7. Scientific advice

6.2.7.1. Short term considerations

6.2.7.1.1.State of the spawning stock size

Survey indices and commercial catches indicate a relatively constant exploitation status of Norway lobster and fishing mortality is not particularly high, compared to other Norway lobster Mediterranean stocks. Estimates of SSB (see Table) show a decrease over the 3 years assessed. In the absence of proposed biomass management reference points, EWG 12-19 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

Table 6.2.7.1.1.1. Spawning stock biomass of *Nephrops norvegicus* in GSA 01.

	2009	2010	2011
SSB(t)	247.2	192.6	186.0

6.2.7.1.2.State of recruitment

Recruitment of Norway lobster has steadily decreased from 2009 to 2011, as shown in the following table. However, in the absence of proposed management reference points, EWG 12-19 is unable to fully evaluate the status of the recruitment in relation to these.

Table 6.2.7.1.2.1. Recruitment of *Nephrops norvegicus* in GSA01.

	2009	2010	2011
R (000s)	8498.2	7087.7	6833.1

6.2.7.1.3.State of exploitation

EWG 12-19 proposed $F_{0.1} = 0.20$ as proxy for F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analyses (current $F_{bar}[3-7]$ is around 0.32) the stock is exploited unsustainably.

EWG 12-19 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, 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 considerations. Catches and effort consistent with F_{MSY} should be estimated.

6.3. Stock assessment of Black bellied anglerfish in GSA 5

6.3.1. Stock identification and biological features

6.3.1.1. Stock Identification

GSA05 is considered as a separate area for assessment and management purposes in the western Mediterranean (Quetglas *et al.*, 2012) due to its peculiar features. These include: 1) Geomorphologically, the Balearic Islands (GSA05) are clearly separated from the Iberian Peninsula (GSA06) by depths between 800 and 2000 m, which would constitute a natural barrier to the interchange of adult stages of demersal resources; 2) Physical geographically-related characteristics, such as the lack of terrigenous inputs from rivers and submarine canyons in GSA05 compared to GSA06, give rise to differences in the structure and composition of the trawling grounds and hence in the benthic assemblages; 3) Owing to these physical differences, the faunistic assemblages exploited by trawl fisheries differ between GSA05 and GSA06, resulting in large differences in the relative importance of the main commercial species; 4) There are no important or general interactions between the demersal fishing fleets in the two areas, with only local cases of vessels targeting red shrimp in GSA05 but landing their catches in GSA06; 5) Trawl fishing exploitation in GSA05 is much lower than in GSA06; the density of trawlers around the Balearic Islands is one order of magnitude lower than in adjacent waters; and 6) Due to this lower fishing exploitation, the demersal resources and ecosystems in GSA05 are in a healthier state than in GSA06, which is reflected in the population structure of the main commercial species (populations from the Balearic Islands have larger modal sizes and lower percentages of small-sized individuals), and in the higher abundance and diversity of elasmobranch assemblages. Thus, the stock of *Lophius budegassa* in the GSA 05 is considered to be confined with the borders of GSA 05.

6.3.1.2. Growth

In the absence of stock specific parameters, the growth parameters used for the assessment of *Lophius budegassa* in the GSA 05 are taken from GSA 06. The length data have been converted to age using the L2Age program (i.e. knife edge slicing). The growth parameters used during the EWG 12-19 were:

L_{inf}	103
K	0.15
t_0	-0.05
a	0.0244
b	2.8457

6.3.1.3. Maturity

Age	0	1	2	3	4	5	6	7+
Prop. matures	0.09	0.14	0.21	0.30	0.41	0.54	0.66	0.91

Natural mortality

Age	0	1	2	3	4	5	6	7+
M	0.960	0.477	0.375	0.293	0.260	0.241	0.230	0.222

6.3.2. Fisheries

6.3.2.1. General description of the fisheries

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: (i) *Spicara smaris*, *Mullus surmuletus*, *Octopus vulgaris* and a mixed fish category on the shallow shelf (50-80 m); (ii) *Merluccius merluccius*, *Mullus* spp., *Zeus faber* and a mixed fish category on the deep shelf (80-250 m); (iii) *Nephrops norvegicus*, but with an important by-catch of big *M. merluccius*, *Lepidorhombus* spp., *Lophius* spp. and *Micromesistius poutassou* on the upper slope (350-600 m) and (iv) *Aristeus antennatus* on the middle slope (600-750 m). The black bellied anglerfish, *L. budegassa*, is an important by-catch species in the upper slope although it is also caught in the shallow and deep shelf.

6.3.2.2. Management regulations applicable in 2010 and 2011

Fishing license: number of licenses observed

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

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

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

Minimum landing size (EC regulation 1967/2006, 30 cm TL): not fully observed

6.3.2.3. Catches

6.3.2.3.1. Landings

Black-bellied anglerfish landings came exclusively from bottom trawlers (OTB) in GSA 5. The following table shows the annual landings (t, DCF data, 2002-2011; other projects: 2001):

2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
13.353	15.921	16.061	18.422	19.054	19.131	24.485	22.138	15.246	17.366	21.755

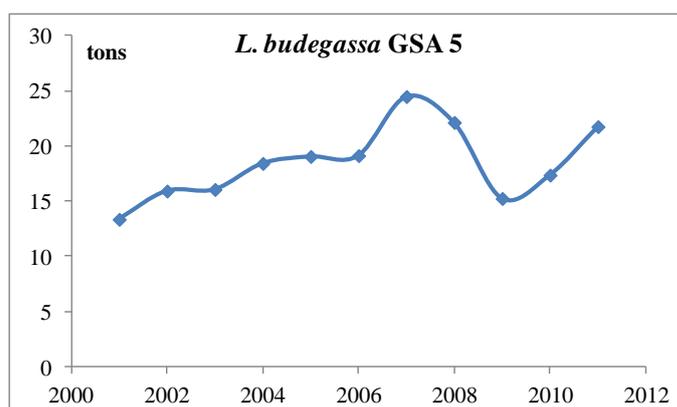


Fig. 6.3.2.3.1.1. Black-bellied anglerfish landings from bottom trawlers (OTB) in GSA 5

6.3.2.3.2.Discards

No information on discards was available from the Data Call.

6.3.2.3.3.Fishing effort

The number of fishing trips has oscillated between 3500 and 4300 between 2001 and 2011.

2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
4628	4257	3689	3962	3666	3798	3768	3955	3533	3982	4303

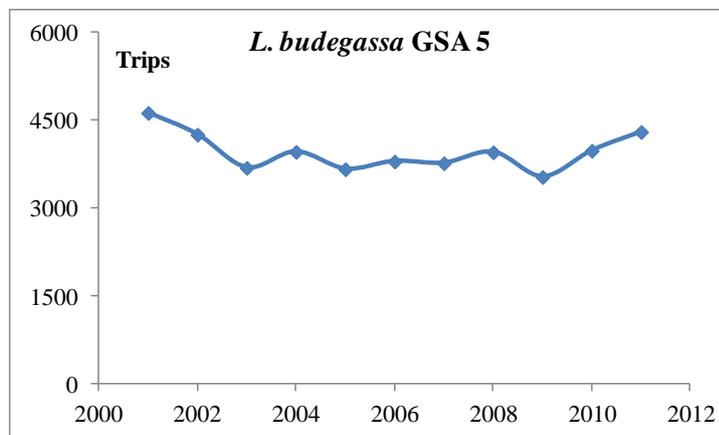


Fig. 6.3.2.3.3.1. Black-bellied anglerfish fishing trips in GSA 5.

6.3.3. Scientific surveys

6.3.3.1. BALAR and MEDITS surveys

6.3.3.1.1.Methods

Between 2001 and 2006, the Spanish Institute of Oceanography performed annual bottom trawl surveys following the same methodology and sampling gear described in the MEDITS protocol. Since 2007, they were included in the MEDITS program.

6.3.3.1.2.Geographical distribution patterns

6.3.3.1.3.Trends in abundance and biomass

Fishery independent information regarding the state of the *L. budegassa* in GSA 05 was derived from the BALAR (2001-2006) and MEDITS (2007-2011) surveys. Figure 6.3.3.1.3.1. displays the biomass trends in GSA 05. Biomass showed a maximum in 2002 and a decreasing trend since then.

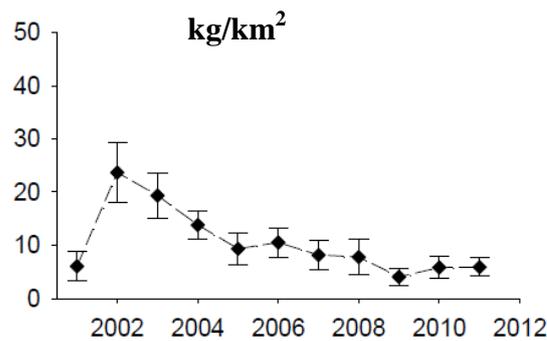


Fig. 6.3.3.1.3.1. Biomass indices of *Lophius budegassa* in GSA 05 from BALAR and MEDITS surveys.

6.3.3.1.4. Trends in abundance by length or age

No analyses were conducted during EWG12-19 meeting.

6.3.3.1.5. Trends in growth

No analyses were conducted during EWG12-19 meeting.

6.3.3.1.6. Trends in maturity

No analyses were conducted during EWG12-19 meeting.

6.3.4. Assessment of historic stock parameters

6.3.4.1. Method 1: XSA

6.3.4.1.1. Justification

This is the first assessment performed for black-bellied anglerfish in GSA 5. The method was used as the number of available years is now considered as long enough (11 years, 2001-2011) for this type of modelling.

6.3.4.1.2. Input parameters

Landings time series 2001-2011 from GSA 05.

Age distributions (from sliced length distributions) 2001-2011.

Biological parameters used correspond to those available from GSA 06.

BALAR-MEDITS survey used as tuning fleet.

Mean weight in catch							
0	1	2	3	4	5	6	7+
0.036	0.222	0.494	0.986	1.681	2.475	3.306	4.589

Growth parameters		
L_{∞}	k	t_0
103	0.15	-0.05

Length-weight relationship	
a	b
0.0244	2.8457

Maturity oogive								
Age	0	1	2	3	4	5	6	7+
Prop. Matures	0.09	0.14	0.21	0.30	0.41	0.54	0.66	0.91

Natural mortality (PROBIOM; Abella et al., 1997)								
Age	0	1	2	3	4	5	6	7+
M	0.960	0.477	0.375	0.293	0.260	0.241	0.230	0.222

Different sensitivity analyses were performed before running the final XSA, considering different weights and ages for shrinkage. For weight shrinkage, results were quite robust for recruitment and F (except fse=2.5), while for SSB, results were consistent in the last years (except for fse= 2.5), while for the first period of the data series, there were some differences. For the ages shrinkage, results were quite robust except when considering age one for F and recruitment.

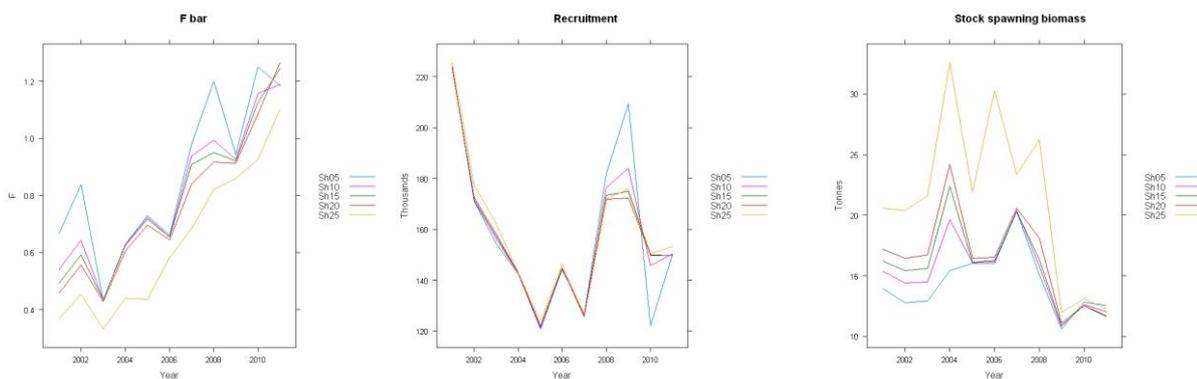


Fig. 6.3.4.1.2.1. Sensitivity analysis considering different weights for shrinkage for F, R and SSB.

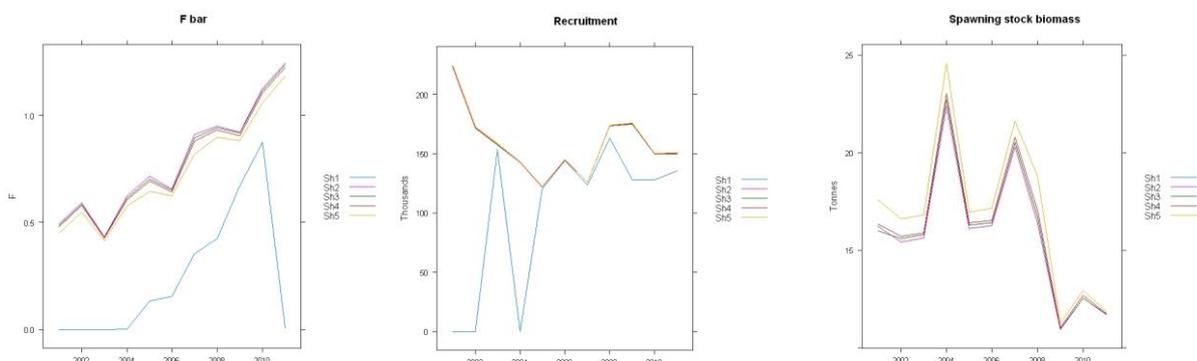


Fig. 6.3.4.1.2.2. Sensitivity analysis considering different ages for shrinkage for F, R and SSB.

For the final XSA run, the following settings were used:

fse	rage	qage	shk.n	shk.f	shk.yrs	shk.ages
1.5	1	5	TRUE	TRUE	3	4

6.3.4.1.3.Results

Results obtained using XSA showed an increasing trend in F during the period analysed. Recruitment showed fluctuations, with a maximum in 2009. SSB showed a certain decreasing trend, with the lowest values of the data series observed in the last three years. (Figure 6.3.4.1.3.1, Table 6.3.4.1.3.1).

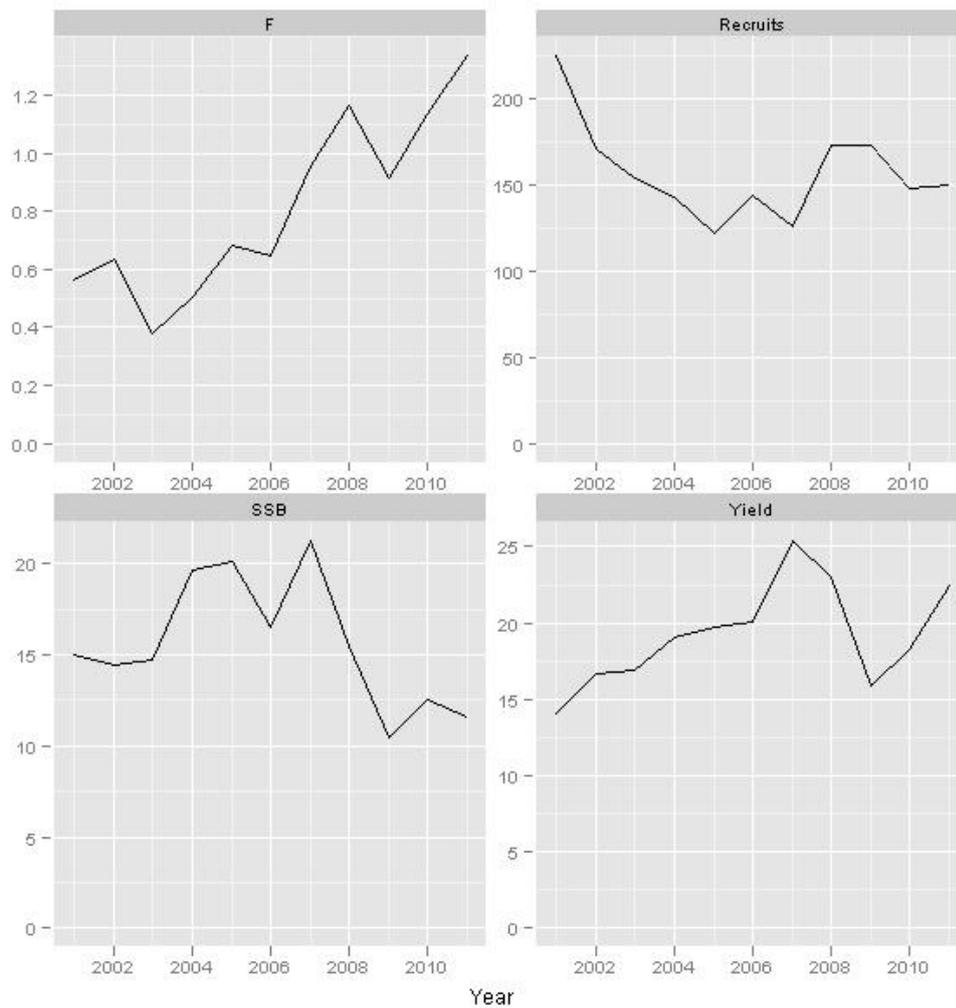


Fig. 6.3.4.1.3.1. XSA results for *L. budegassa* in GSA 05.

Residuals from the BALAR-MEDITS tuning fleet did not show any particular trend in the residuals.

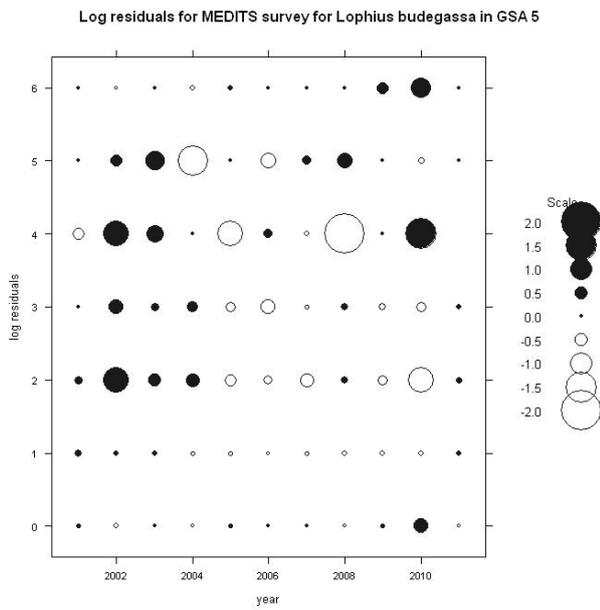


Fig. 6.3.4.1.3.2. Residuals from the BALAR-MEDITS tuning fleet (2001-2011).

Table 6.3.4.1.3.1. XSA results for *L. budegassa* in GSA 5.

	Population in number (thousands)	Population in weight (tons)	Recruitment number (thousands)	SSB	F ₁₋₅
2001	310.11	52.62	224.89	15.04	0.56
2002	297.70	57.31	171.29	14.42	0.63
2003	276.97	59.24	154.48	14.71	0.38
2004	258.85	65.68	142.72	19.65	0.51
2005	233.61	65.75	121.70	20.12	0.68
2006	244.45	59.83	144.49	16.55	0.64
2007	228.47	61.92	125.93	21.29	0.95
2008	268.64	54.88	173.42	15.52	1.16
2009	277.21	46.99	172.87	10.48	0.91
2010	259.26	54.80	147.60	12.57	1.14
2011	257.03	55.09	149.68	11.60	1.33

Retrospective analysis was performed, showing quite robust results for R and F, but with some differences in SSB at the beginning of the data series.

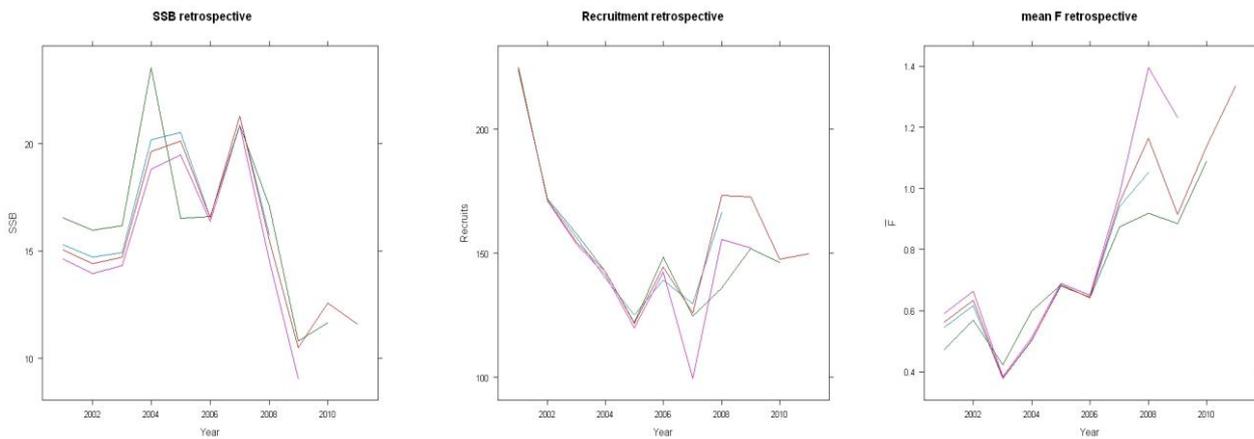


Fig. 6.3.4.1.3.3. Retrospective analysis for *L. budegassa* in GSA 5.

6.3.5. Long term prediction

6.3.5.1. Justification

6.3.5.1.1. Input parameters

Reference F was estimated using FLR, considering averages input values for 2009-2011.

6.3.5.1.2. Results

The estimated fishing mortality (F_{ref}) is displayed in the following table, along with the reference points $F_{0.1}$.

$F_{0.1}$	0.18
F_{ref} (2009-2011; ages 1-5)	1.13

6.3.6. Data quality

Landings data by species for both *Lophius* (*L. budegassa* and *L. piscatorius*) have been computed from the information obtained by observers on board. Although this implies a certain level of uncertainty in these values, this is probably the best option available for the two species which are landed jointly.

6.3.7. Scientific advice

6.3.7.1. Short term considerations

6.3.7.1.1. State of the stock size

SSB showed oscillations between 2001 and 2007, with a decreasing trend since then, and the minimum values observed at the end of the data series (2009-2011).

6.3.7.1.2. State of recruitment

Recruitment showed maximum values at the beginning of the series (2001) with a decreasing trend since then and a moderate recovere during the last 4 years (2008-2011).

6.3.7.1.3.State of exploitation

The current F_{1-5} (1.13) is larger than $F_{0.1}$ (0.18), which indicates that black-bellied anglerfish in GSA 05 is exploited unsustainably.

6.4. Stock assessment of Norway lobster in GSA 06

6.4.1. Stock identification and biological features

6.4.1.1. Stock Identification

Due to the lack of specific information on stock structure of the Norway lobster (*Nephrops norvegicus*) populations in the western Mediterranean, this stock was assumed to be confined within GSA 06 boundaries. The species is of high economic importance in the area because despite its relatively low level of catches (ca. 500 t / year) the price at first sale is high (25-35 €/kg).

N. norvegicus is a mud-burrowing species that prefers sediments with mud mixed with silt and clay in variable proportions. In GSA06 the species is found over a wide range of depths (80 to 550 m), although it is more abundant between 350 and 600 m.

6.4.1.2. Growth

Maximum observed size in GSA 06 was 89 mm CL in a single male and 57 mm CL in one female. 95% of the length samples were comprised between 20 and 55 mm CL in males and 19 and 45 mm CL in females. Due to the lack of recent growth estimates for this species in the area, the biological parameters from GS05 used in EWG12-10 were used:

$$L_{\infty} = 72.1$$

$$K = 0.169$$

Length-weight relationships: $a = 0.000373$, $b = 3.1576$.

6.4.1.3. Maturity

Due to the lack of specific biological information for GSA 06, the maturity curve was obtained from the stock assessments parameters corresponding to GSA 05 in EWG12-10:

age class	1	2	3	4	5	6	7	8	9+
proportion mature	0.05	0.14	0.32	0.58	0.8	0.92	0.97	0.99	1

6.4.2. Fisheries

6.4.2.1. General description of the fisheries

Norway lobster catches are produced exclusively with otter bottom trawl in GSA 06, by the fleet in length classes VL1224 and VL2440 fishing in deep waters (350-600 m depth).

6.4.2.2. Management regulations applicable in 2010 and 2011

Fishing license: number of licenses observed

Engine power limited to 316 KW or 500 HP: partial compliance (in some cases real HP is at least the double)

Mesh size in the codend (before June 1st 2010: 40 mm diamond; after June 1st 2010: 40 mm square or 50 mm diamond -by derogation-): full compliance

Time at sea (12 hours per day and 5 days per week): full compliance

Minimum landing size (EC regulation 1967/2006, 20 mm CL): mostly full compliance.

6.4.2.3. Catches

6.4.2.3.1.Landings

Landings of Norway lobster in GSA 06 come exclusively from bottom otter trawl. In the period 2002-2011 landings of *N. norvegicus* in GSA 06 increased from ca. 200 t to ca. 500 t.

Table 6.4.2.3.1.1. Landings of *Nephrops norvegicus* in GSA 06 from the DCF 2012 data call.

2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
187.48	381.79	370.83	189.42	256.79	224.98	313.99	355.51	406.36	496.76

6.4.2.3.2.Discards

Discards of Norway lobster in GSA06 can be considered negligible due to the high market value of the species and none is reported in the DCF 2012 data call. Undersized individuals (less than 20 mm CL) are scarce in the landings.

6.4.2.4. Fishing effort

Fishing effort has decreased steadily over the last years, due to the effort reduction programs in the Mediterranean, from a maximum in the years 2004-2005. Catches are produced by demersal otter trawlers in the categories 12-24 m and 24-40 m (fleet segments VL1224 and VL2440) and the trends in 3 fishing effort indicators between 2002 and 2011 are shown below:

yr	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Nb of Vessels	574	621	643	648	620	608	612	558	546	540
Nominal effort (000s)	20079	21850	23997	22914	23124	22261	22506	20768	19487	19012
GT_days at sea (000s)	5397	6006	6695	6596	6736	6556	6705	6221	5895	5678

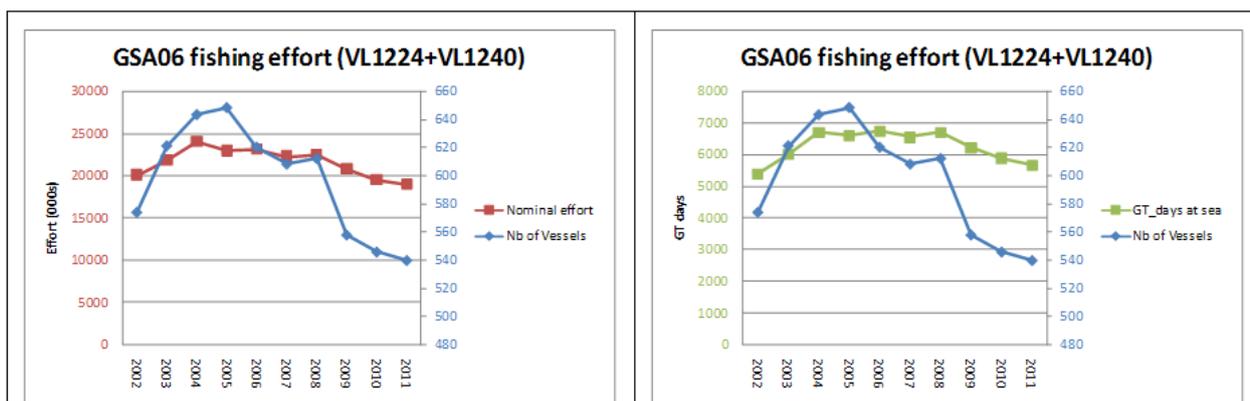


Fig. 6.4.2.4.1. Trend of number of vessels (OTBvessels VL1224 and VL2440), nominal effort and GT_days_at_sea in the period 2002- 2011 in GSA 06.

6.4.3. Scientific surveys

6.4.3.1. MEDITS

6.4.3.1.1. Methods

Since 1994 standard bottom trawl surveys have been conducted in GSA 06 in spring, following the general methodology of the MEDITS protocol described in Bertrand et al. (2002). In GSA 06 the following number of hauls was reported per depth stratum in the DCF 2012 data call.

Table 6.4.3.1.1.1. Number of hauls per year and depth stratum in GSA06, 1994-2011.

STRATUM	GSA06_010-050	GSA06_050-100	GSA06_100-200	GSA06_200-500	GSA06_500-800
1994	7	19	10	9	7
1995	8	25	16	14	11
1996	7	26	16	9	10
1997	7	25	14	10	8
1998	7	27	12	6	4
1999	8	27	16	12	10
2000	9	29	17	11	7
2001	7	29	18	15	8
2002	10	34	19	16	7
2003	8	36	20	17	11
2004	8	30	16	15	11
2005	11	31	17	14	8
2006	10	33	17	17	12
2007	5	26	14	10	9
2008	7	29	20	13	8
2009	6	28	20	14	7
2010	5	19	12	10	7
2011	7	28	20	15	8

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Y_{st} = \sum (Y_i * A_i) / A$$

$$V(Y_{st}) = \sum (A_i^2 * s_i^2 / n_i) / A^2$$

Where:

A=total survey area

A_i=area of the i-th stratum

s_i=standard deviation of the i-th stratum

n_i=number of valid hauls of the i-th stratum n=number of hauls in the GSA

Y_i=mean of the i-th stratum

Y_{st}=stratified mean abundance V(Y_{st})=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = $Y_{st} \pm t(\text{student distribution}) * V(Y_{st}) / n$

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.4.3.1.2. Geographical distribution patterns

Norway lobster is distributed from 80 to 600 m depth approximately in GSA 06, with higher densities on deep soft muddy bottoms (350-600 m) and, locally, on the continental shelf off the Ebro delta (Maynou and Sardà, 1997).

6.4.3.1.3. Trends in abundance and biomass

Fishery independent information from the MEDITS surveys in the period 1994-2011 was used to derive indices of abundance and biomass for Norway lobster in GSA 06. Both abundance and biomass have fluctuated in the area during this period with no clear trend.

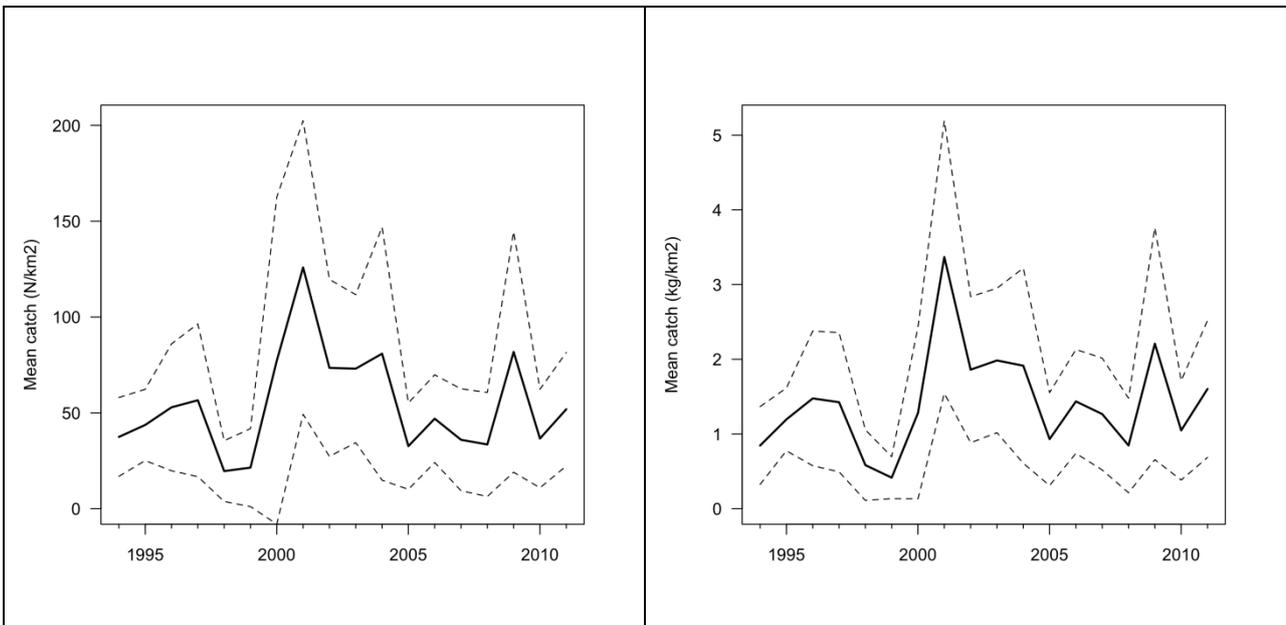
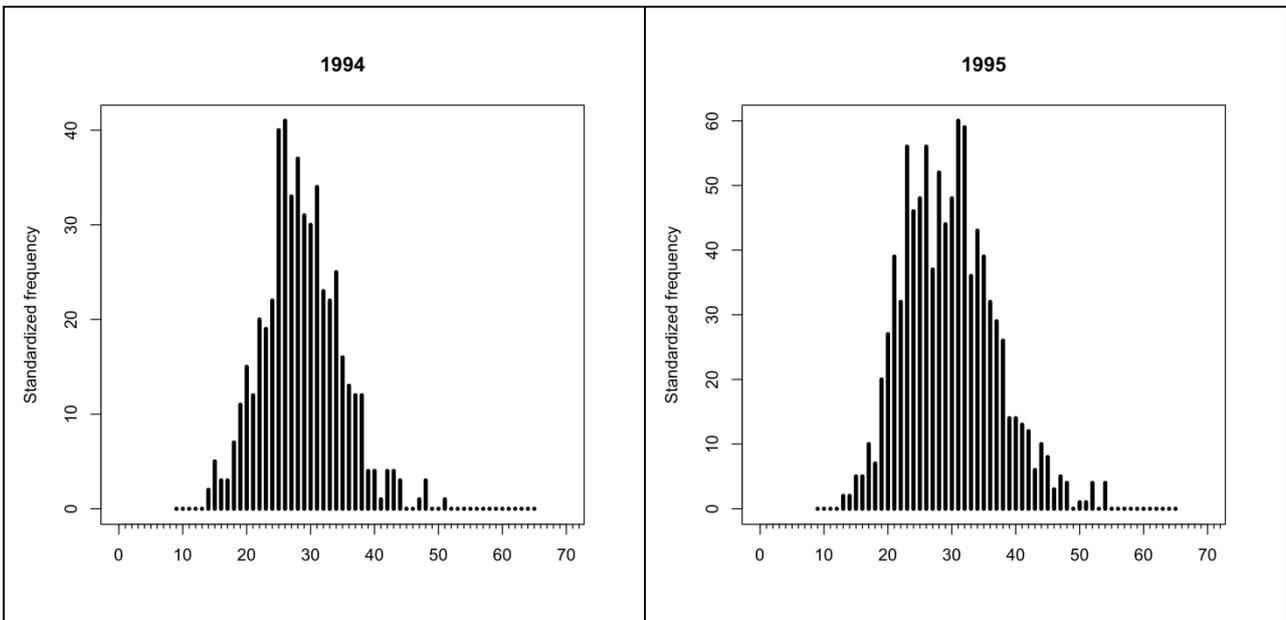
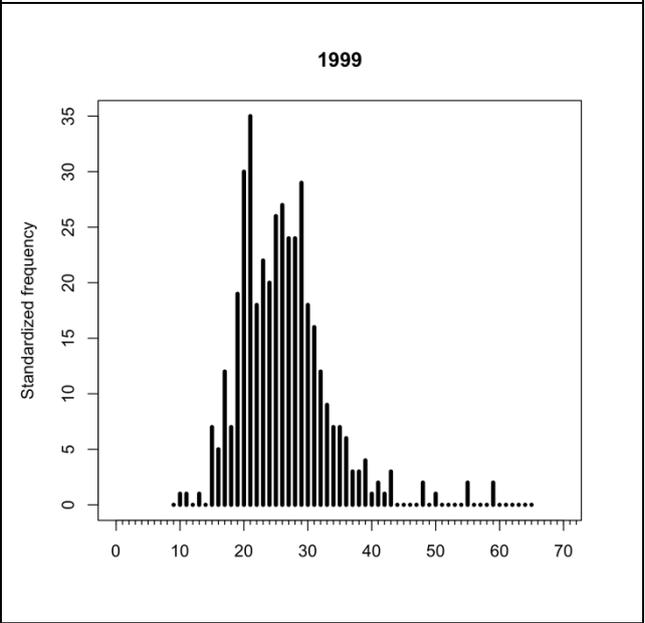
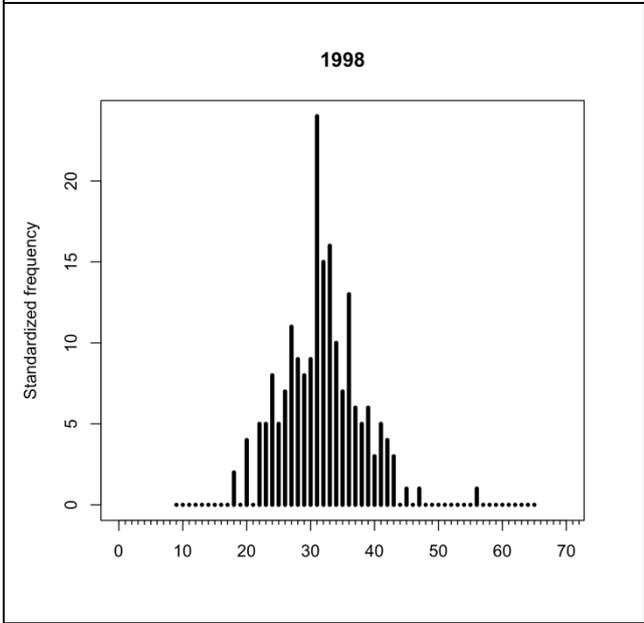
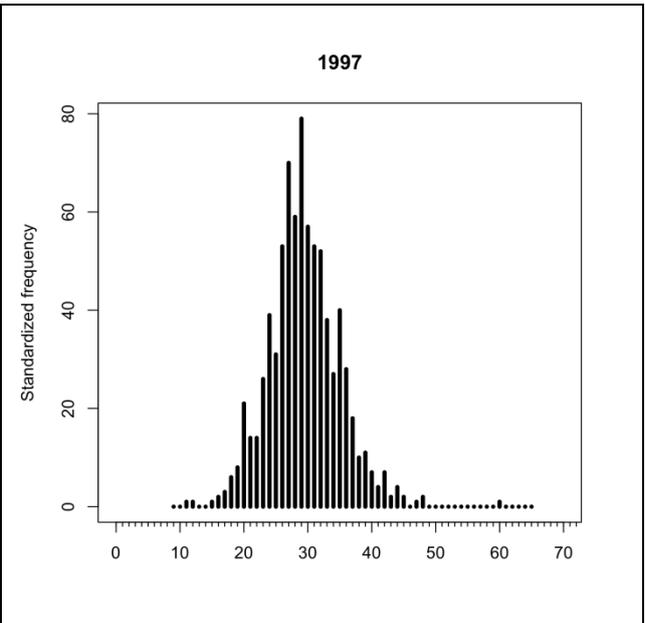
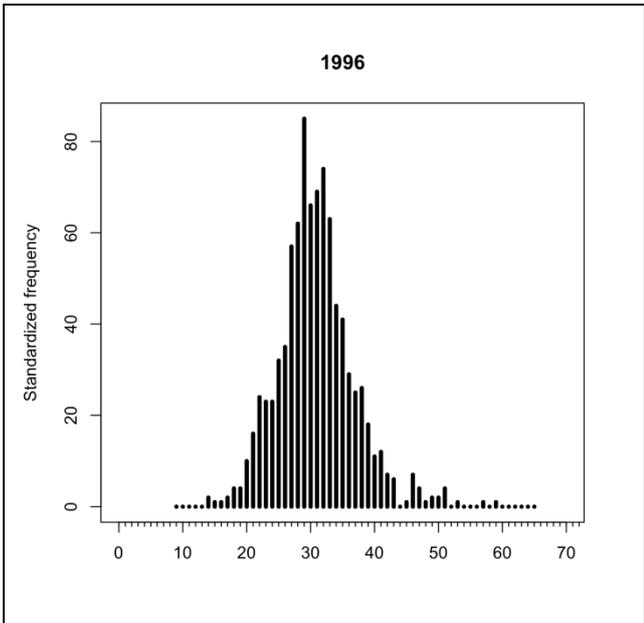


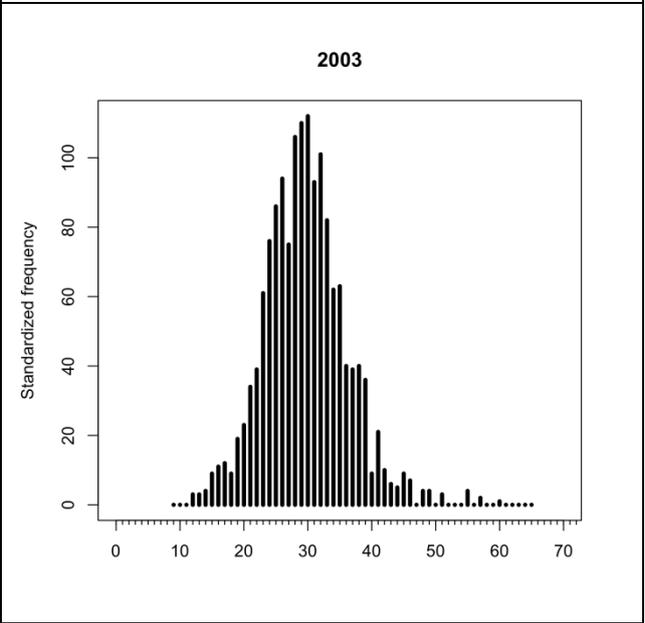
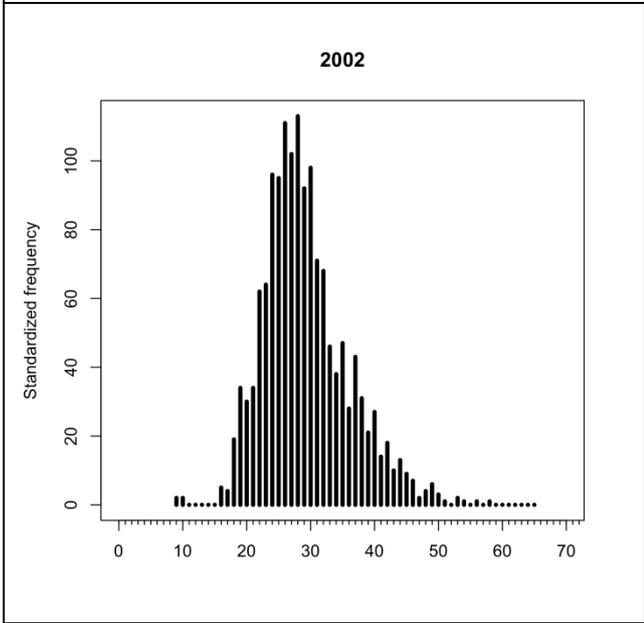
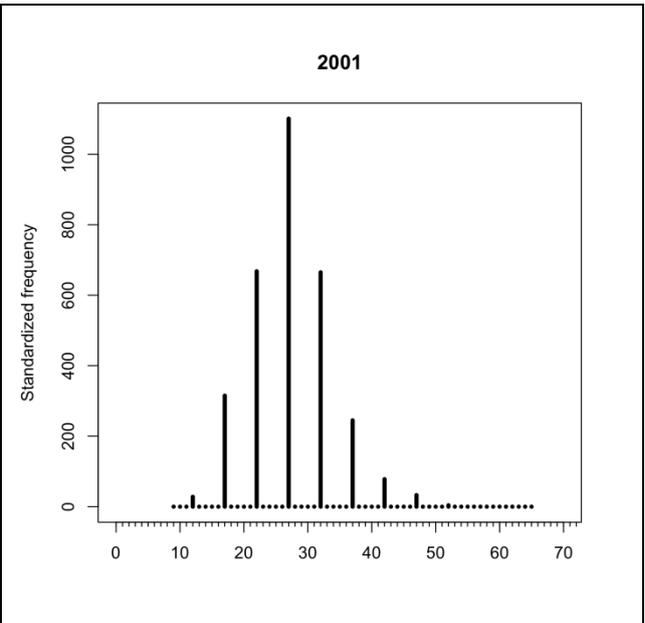
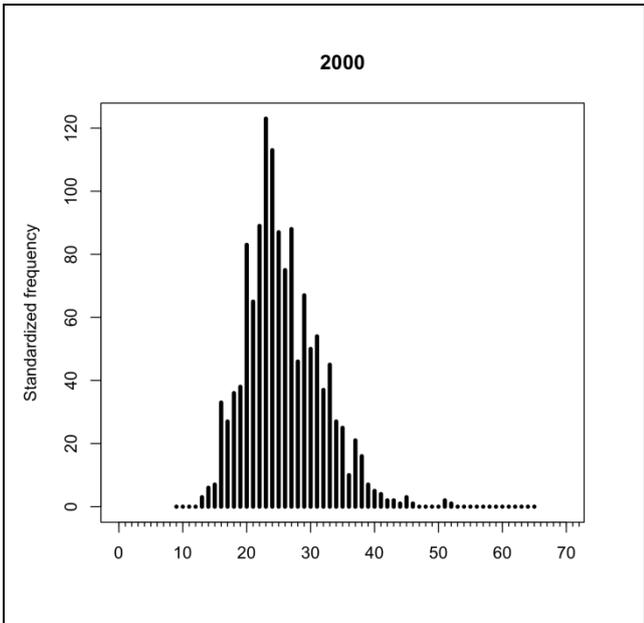
Fig. 6.4.3.1.3.1. Abundance and biomass indices of *Nephrops norvegicus* in GSA06 from MEDITS surveys (mean and 95% confidence intervals).

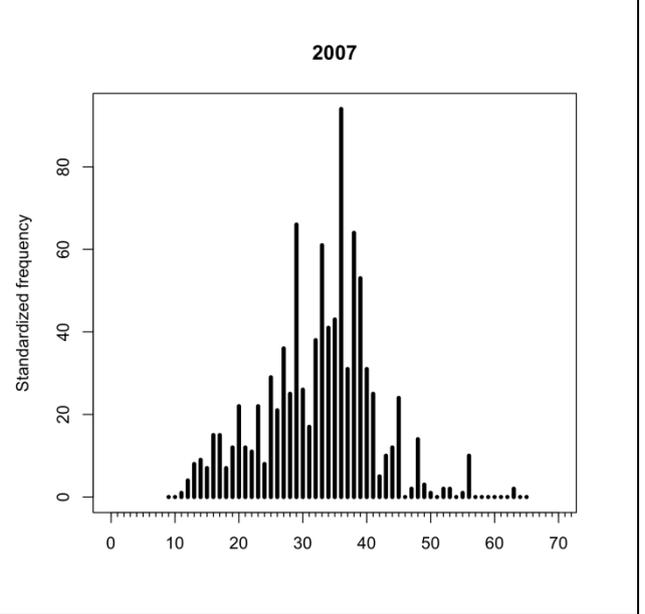
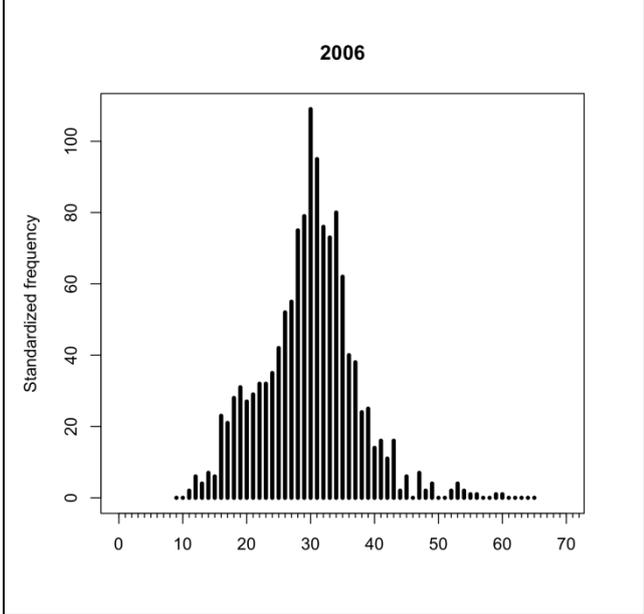
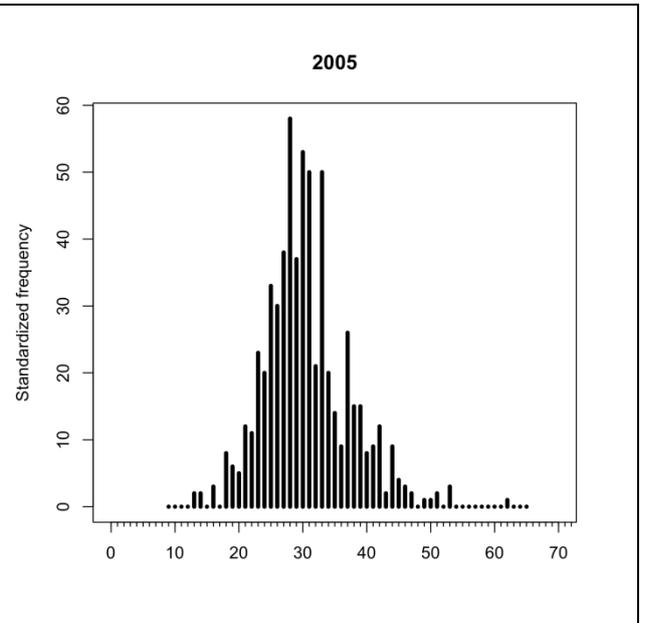
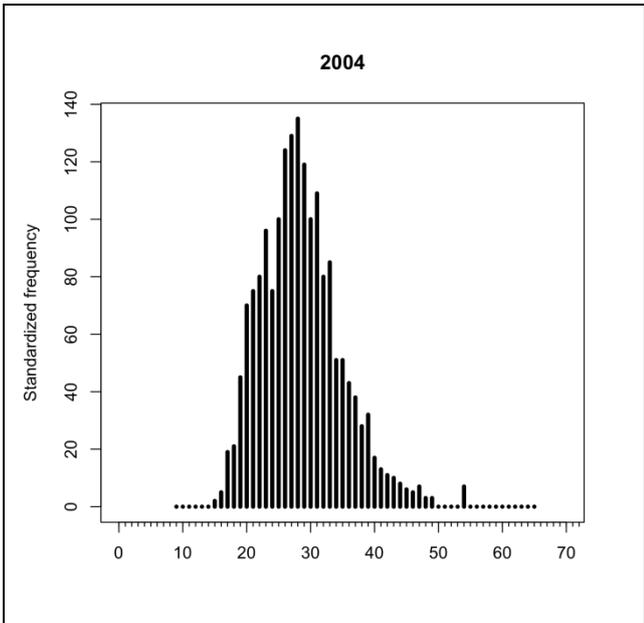
6.4.3.1.4. Trends in abundance by length or age

The following Figure 6.4.3.1.4.1 show the standardized size frequencies of Norway lobster in GSA 06 in the period 1994-2011. Although the modal size in the samples is around 30 mm CL in all years, some changes in the size composition of the samples are apparent, especially at sizes below 20 mm CL, which could be indicative of strong recruitment in the years 1994-95, 2003 and 2005-2007. The number of specimens measured in 2001 was very low.









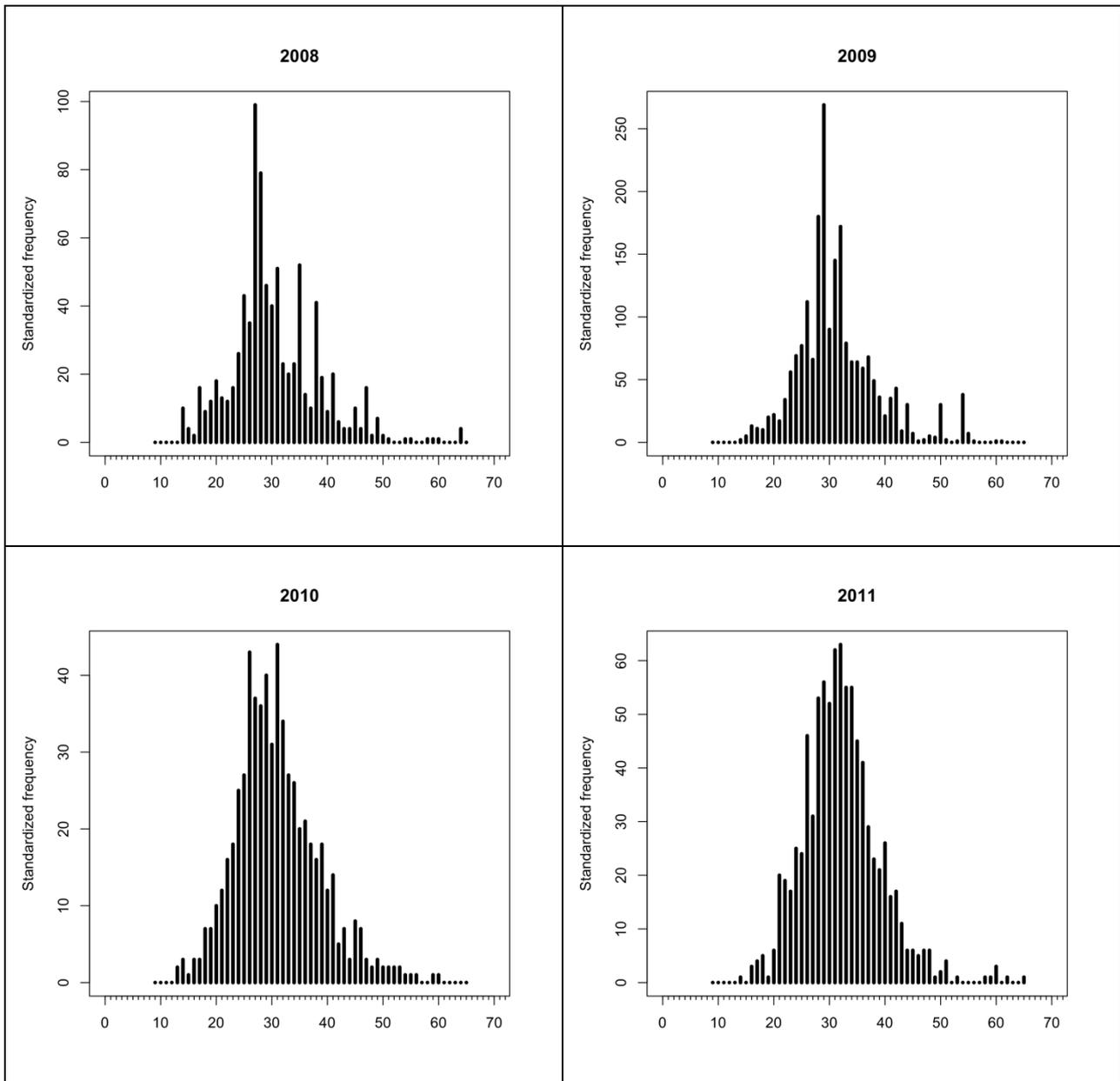


Fig. 6.4.3.1.4.1. Standardized size frequencies of *Norway lobster* in GSA06 1994-2011 from MEDITS surveys.

6.4.3.1.5. Trends in growth

No information is available to assess trends in growth.

6.4.3.1.6. Trends in maturity

No information is available to assess trends in maturity.

6.4.4. Assessments of historic stock parameters

6.4.4.1. Method 1: pseudo-cohort VPA (VIT)

6.4.4.1.1. Justification

Frequency data of landings was available only for the years 2009-2011 because Norway lobster was not a priority species in GSA 06. For this reason, three pseudo-cohort analyses, for 2009, 2010 and 2011 separately, were performed, using VIT software (Leonart and Salat 1997).

6.4.4.1.2. Input parameters

Analyses were performed using number at age obtained from length from the 2012 DCF data call.

The set of growth parameters used for the assessment of Norway lobster in GSA 06 were taken from the parameters used in the stock assessment of GSA 05 (EWG12-10): $L_{inf}=72.1$ cm CL, $K=0.169$, $t_0=0$. Length-weight relationships: $a=0.000373$, $b=3.1576$.

Natural mortality by age, calculated using PROBIOM (Abella et al, 1997), was:

age	1	2	3	4	5	6	7	8	9+
M	0.47	0.37	0.29	0.26	0.24	0.23	0.22	0.21	0.21

The same maturity ogive as in GSA05 was assumed:

age class	1	2	3	4	5	6	7	8	9+
proportion mature	0.05	0.14	0.32	0.58	0.8	0.92	0.97	0.99	1

The terminal fishing mortality was set at 0.5 (after performing sensitivity analysis over a wide range of values: 0.05 – 1).

The age composition of the landings is shown in the following table. No Norway lobsters of age 0 are reported and specimens of age 1 are scarce. The bulk of the catches are composed of ages 2-4. Frequency of catches from 10 to 19 years old was very low and the data were pooled in a plus class (9+).

age / yr	2009	2010	2011
0	0	0	0
1	322	244	364
2	5307	7184	6732
3	5551	7935	9592
4	1969	2449	3154
5	746	728	788
6	243	262	347
7	93	131	191
8	33	61	66

9+	61	45	197
----	----	----	-----

6.4.4.1.3. Results

Three independent annual VIT assessments were carried in 2009, 2010 and 2011 based on 9 age classes (1 to 9+). The catches were composed mainly of individuals in ages 2-4 in the 3 years analysed.

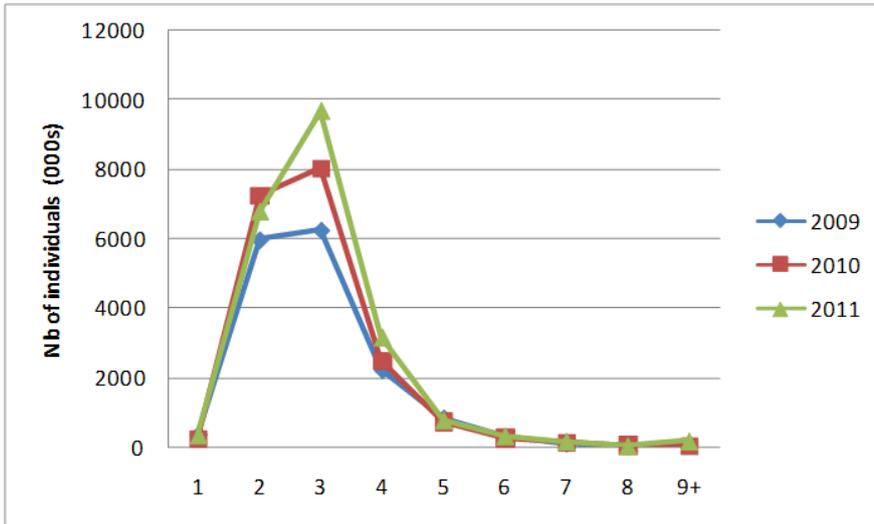


Fig. 6.4.4.1.3.1. Numbers at age of *Nephrops norvegicus* in the total catches of OTB for 2009-2011 (GSA 06)

The catches in weight are likewise dominated by ages 2-4 in all three years.

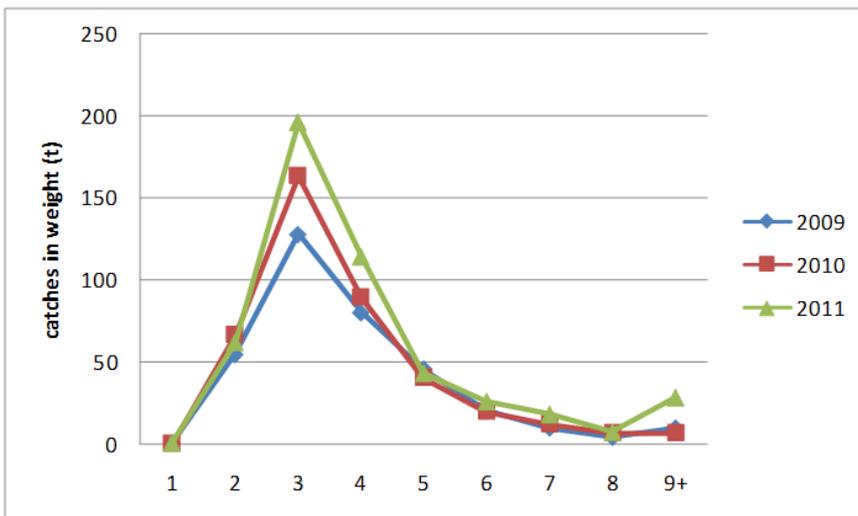


Fig. 6.4.4.1.3.2. Catch at age of *Nephrops norvegicus* in the total catches of OTB for 2009-2011 (GSA 06)

The population of Norway lobster shows an increase in numbers from 2009 to 2011, as deduced from the following figure:

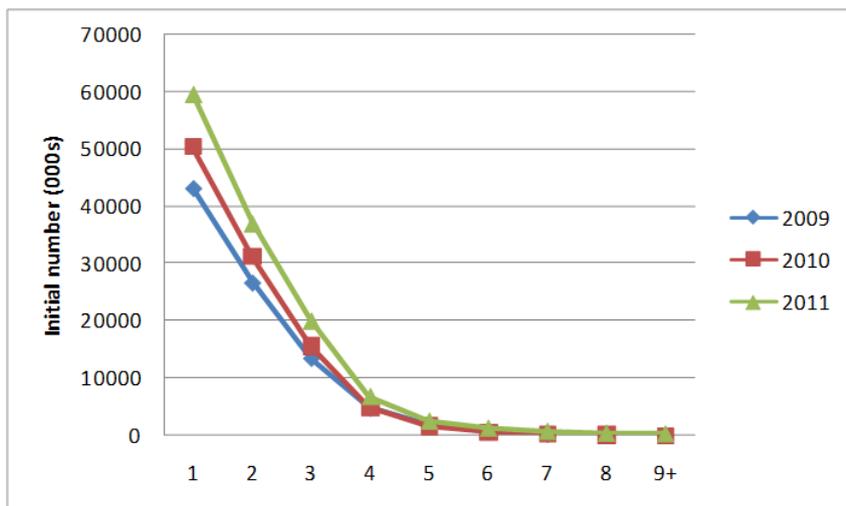


Fig. 6.4.4.1.3.3. Number of individuals in the stock of *Nephrops norvegicus* for 2009-2011 (GSA 06)

Fishing mortality was higher for ages 3 onwards, with an apparent reduction in fishing mortality in 2011.

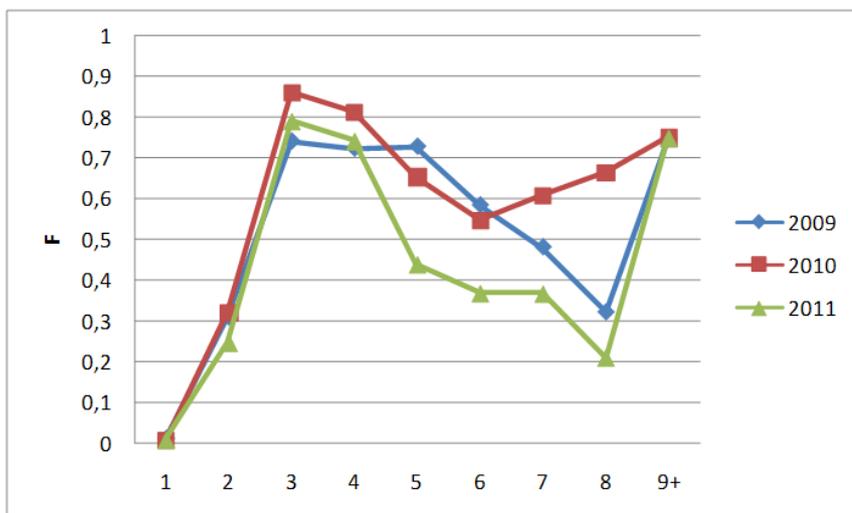


Fig. 6.4.4.1.3.4. Fishing mortality by age class of the stock of *Nephrops norvegicus* for 2009-2011 (GSA 06)

6.4.5. Long term prediction

6.4.5.1. Justification

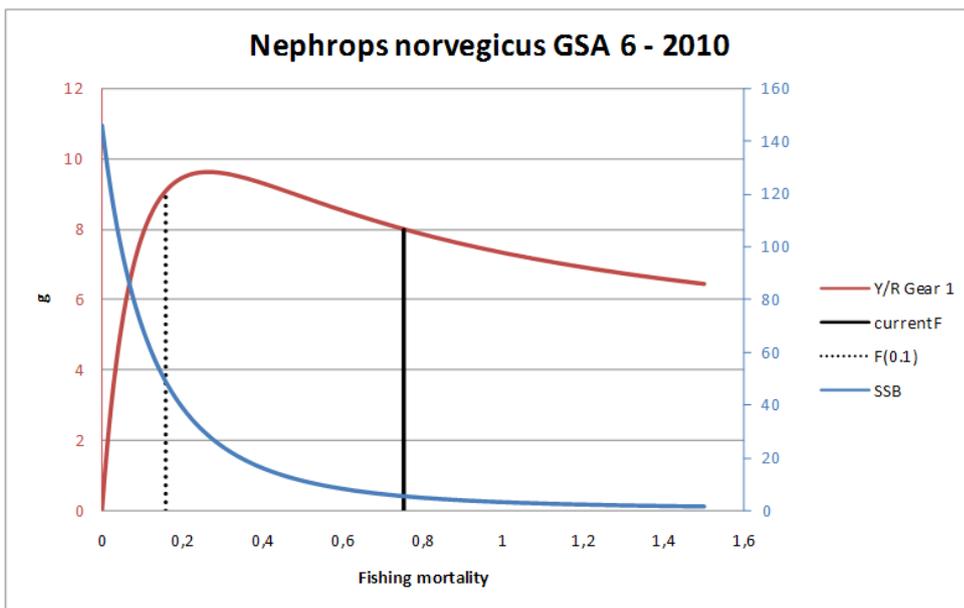
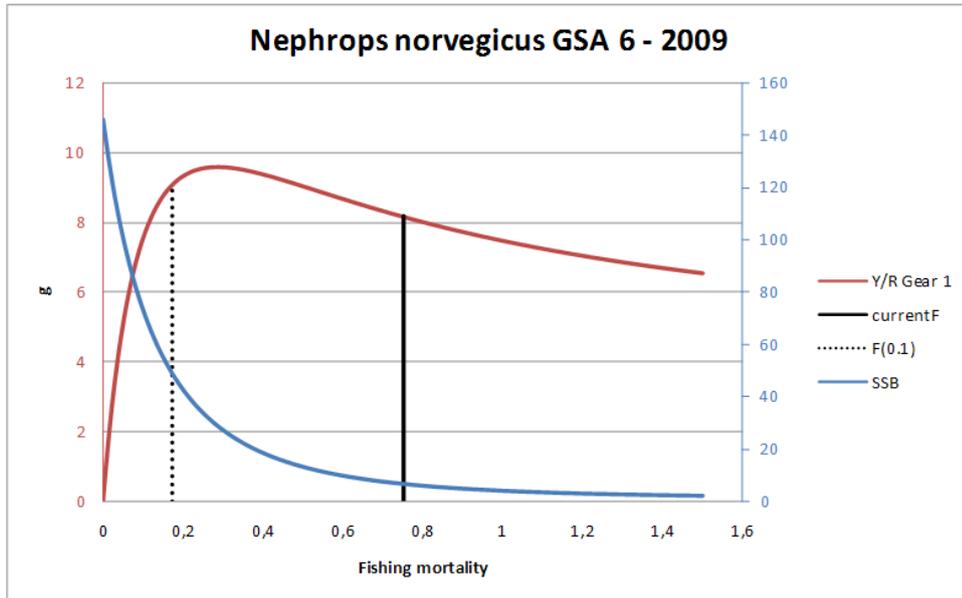
A yield per recruit (Y/R) analysis was carried out using the VIT program (Windows version 1.3).

6.4.5.1.1. Input parameters

The same input parameters used for VIT were used in the Y/R analysis.

6.4.5.1.2.Results

The yield curves were dome shaped for all three years, with maximum yield found at considerably lower F than current F . Maximum production (ca. 10 g / recruit) would be obtained at 35% of current F (average for all ages ca. 0.75), as shown in the following figures:



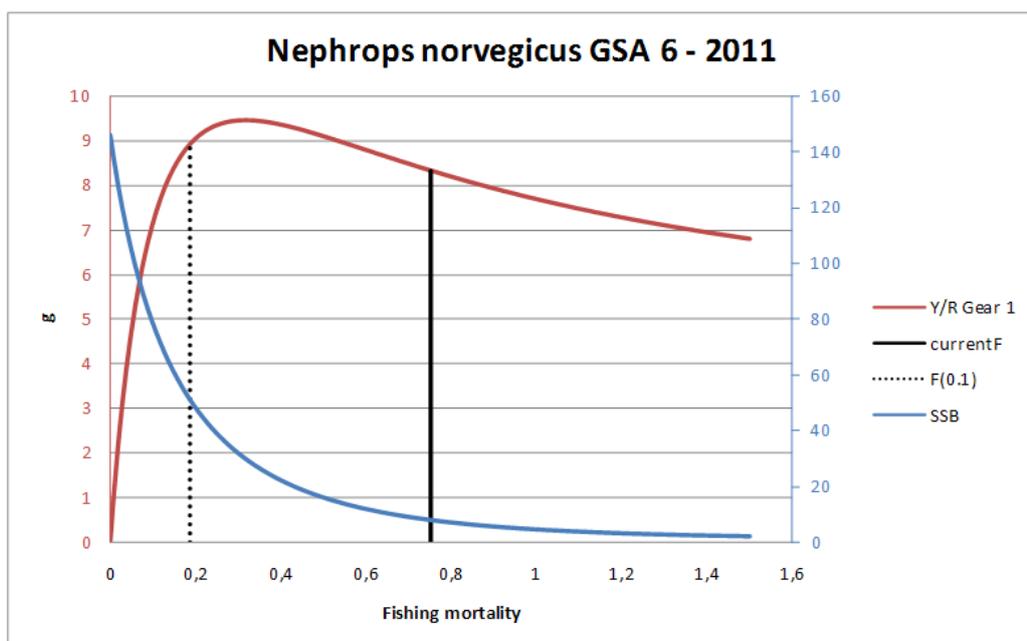


Fig. 6.4.5.1.2.1. Annual YPR and SSBPR of *Nephrops norvegicus* in the period 2009-2011 in GSA 06, with current F and $F_{0.1}$.

Table 6.4.5.1.2.1 shows the summary results of the YPR analysis. Note that average fishing mortality has remained constant throughout the 3 years (average $F=0.75$) and the exploitation pattern is essentially the same. Current F is from the F_{MSY} . Fishing mortality should be reduced by 75% approximately to reach F_{MSY} .

Table 6.4.5.1.2.1. Results summarising the YPR analyses performed for the 2009 - 2011 assessments of Norway lobster in GSA 06.

		Factor	Absolute F	Y/R	B/R	SSB/R
2009	Virgin	0	0	0	165.75	145.86
	F(0.1)	0.23	0.17	9.08	64.70	48.78
	Fcurr	1.00	0.75	8.17	15.90	6.40
	F(Max)	0.39	0.29	9.59	42.82	28.77
2010	Virgin	0	0	0	165.75	145.86
	F(0.1)	0.21	0.16	9.05	65.19	49.25
	Fcurr	1.00	0.75	7.99	14.63	5.52
	F(Max)	0.36	0.27	9.60	42.83	28.79
2011	Virgin	0	0	0	165.75	145.86
	F(0.1)	0.25	0.19	8.917	66.853	50.978
	Fcurr	1.00	0.75	8.327	17.823	7.979
	F(Max)	0.43	0.32	9.449	44.073	30.161

Average	F(0.1)	0.23	0.17	9.02	65.58	49.67
	Fcurr	1.00	0.75	8.16	16.12	6.63
	F(Max)	0.38	0.29	9.55	43.24	29.24

Reference F from the YPR analysis for the fully recruited ages 3-7, averaged over 2009-2011 is $F_{ref}(2009-2011; 3-7) = 0.63$ and the corresponding $F_{01}=0.15$.

6.4.6. Data quality

Data from DCF 2012 were used. The data available are of sufficient quality to perform a VPA on pseudocohorts at an annual scale, but the biological parameters used come from a different GSA.

6.4.7. Scientific advice

6.4.7.1. Short term considerations

6.4.7.1.1.State of the spawning stock size

Survey indices and commercial catches indicate a relatively constant exploitation status of Norway lobster, although due to the high fishing pressure, SSB has probably been at a low level for the past 2 decades. Estimates of SSB (see Table 6.4.7.1.1.1) show an increase in the last year assessed. In the absence of proposed biomass management reference points, EWG 12-19 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

Table 6.4.7.1.1.1. Spawning stock biomass of *Nephrops norvegicus* in GSA06.

	2009	2010	2011
SSB(t)	278.5	281.0	476.0

6.4.7.1.2.State of recruitment

Recruitment of Norway lobster has steadily increased in the period 2009-2011, as shown in the following table. However, in the absence of proposed management reference points, EWG 12-19 is unable to fully evaluate the status of the recruitment in relation to these.

Table 6.4.7.1.2.1. Recruitment of *Nephrops norvegicus* in GSA06.

	2009	2010	2011
R (000s)	43,171	50,450	59,653

6.4.7.1.3.State of exploitation

EWG 12-19 proposed $F_{0.1} = 0.15$ as proxy for F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analyses (current $F_{bar[3-7]}$ is around 0.63) the stock is exploited unsustainably.

EWG 12-19 recommends the relevant fleets' effort and/or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, 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 considerations. Catches and effort consistent with F_{MSY} should be estimated.

6.5. Stock assessment of Red mullet in GSA 09

6.5.1. Stock identification and biological features

6.5.1.1. Stock Identification

Red mullet is distributed along the narrow Mediterranean shelves at depths up to 200m, but is mainly concentrated in the depth range 0-100m. No definition of unit stocks neither based on genetics, biochemistry, fishery-based nor on morphometrics is currently available. Under a management point of view, when the lack of any evidence does not allow suggesting an alternative hypothesis, it is assumed that inside each one of the GSAs boundaries inhabits a single, homogeneous red mullet stock that behaves as a single well-mixed and self-perpetuating population. The GSA boundaries are however arbitrary and certainly do not take under consideration neither the existence of local biological features nor of differences in the spatial allocation in fishing pressure within it. The hypothesis of a single stock of red mullet in GSA 09, which includes waters belonging to 2 different seas (Ligurian and Tyrrhenian) separated by the Elba Island and fleets that does not show any spatial overlapping is almost unlikely. The inability to account for spatial structure reduces flexibility and can lead to uncertainty in the definition of the status of the stocks, due to the possibility of local depletions and to a worse utilization of the potential productivity of the resources.

6.5.1.2. Growth

The species is fast growing, and reaches half of its total size when is one year old. Some light differences in growth speed has been observed within different zones within the GSA9. In zones where the species is less exploited, individuals more densely concentrated or available food is lower, the mean size of 6 months old individuals is from 1 to 1.5 cm lower than in other areas of the same GSA were the species is more highly exploited and hence less abundant. In any case, the parameters reported as follows may be considered suitable for the description of an average growth performance valid for the whole GSA 09.

$L_{\infty}=29$, $K=0.6$, $t_0=-0.1$ L/W relationship $a=0.00053$ $b=3.12$

An M vector (age0=1.30, age1 0.79, age 2 0.62, age $\geq 3= 0.54$) and a weighted mean value of M of 0.75

6.5.1.3. Maturity

The species reaches massively the sexual maturity at one year old. Observations of proportion of mature individuals by size and analysis with the standard procedure have produced the following sizes at age maturity by sex.

The classical approach for the definition of L_m , as expected, produces a light underestimation of this size. In fact, the bulk of the females spawn at a size of about 14 cm.

In GSA 09 there have been performed studies on fecundity. The following relationship of fecundity at size (in cm) was defined in the area:

$$\text{Fec} = 0.7599 * \text{TL}^{3.336}$$

The generation time G corresponding to the weighted mean age of spawners in a not exploited population (Goodyear 1995) was estimated to be 2.75 years assuming a mean $M=0.8$

6.5.2. Fisheries

6.5.2.1. General description of fisheries

Mullus barbatus is among the most commercially valuable species in the area and is an important component of a species assemblage that is the target of the bottom trawling fleets operating near shore. It becomes a first order target of part of the fleet specially in late summer-autumn when the juveniles of the species are densely concentrated near the coast. The species in GSA 09 is mainly caught with three different variants of the Italian bottom trawl net (tartana, volantina and francese). Differences among gears mainly regard gear vertical opening. The small mesh size of the cod end in all cases potentially defines a very precocious size/age of first capture. For the 40mm stretched mesh size selectivity was estimated as $L_c=9.3$ cm; $SF=2.44$ (Voliani & Abella, 1998)

Set nets used by artisanal fleets catch modest quantitatives of relatively large individuals, in general over 12 cm TL.

The exerted fishing pressure on this species on different zones of GSA9 is quite variable. Such variations depend on spatial differences on structural composition of the operating fleets, characteristics of the grounds and on the choices of target among fleets and zones.

Mullus barbatus catch rates are higher during the post-recruitment period (from September to November). About 200 of the 350 trawlers and a small number of artisanal vessels exploit the species in the GSA 09. Annual landings, mostly proceeding from trawling, ranged from 727 to 760 tons from 2008 and 2010. Discards of undersized individuals is in general limited (10% in weight was estimated in 2006), mainly occurring in autumn when new recruits are concentrated near the shore. Illegal landings of juveniles may occur but can be considered of limited importance and less important in recent years.

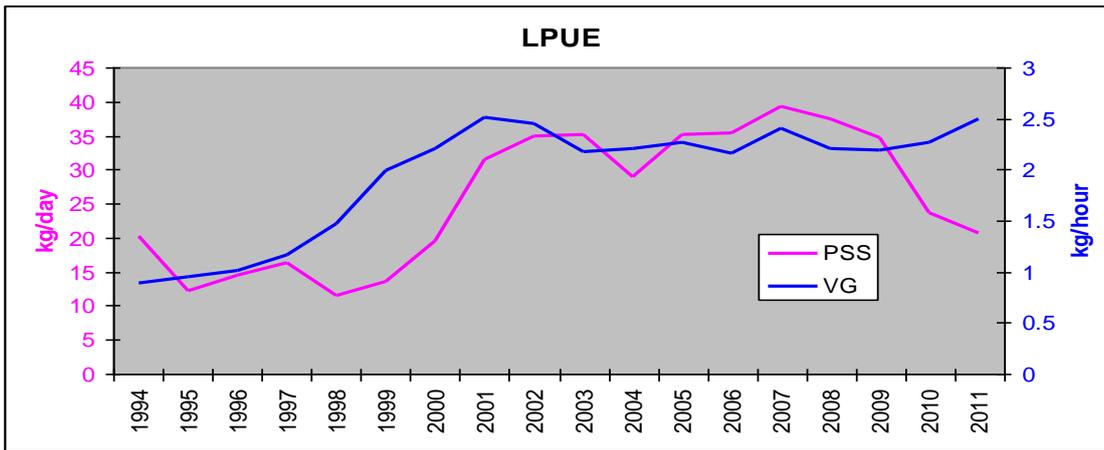


Fig. 6.5.2.1.1. Landings per unit of effort by year in two of the more important ports of the area PSS=Porto Santo Stefano and VG=Viareggio.

6.5.2.2. Management regulations applicable in 2011

Fishing closure for trawling: a 45 days trawling ban has been enforced in GSA 09 in late summer. The measure was compulsory in the more recent years.

Minimum landing sizes: EC regulation 1967/2006 defined 12 cm TL as minimum legal landed size for red mullet.

Codend mesh size of trawl nets: the 50 mm (stretched, diamond meshes) or alternatively a 40 mm codend with square mesh geometry. It was not observed a noticeable increase in the size of entering to the fishery with the new introduced changes because the exploitation pattern is only partially conditioned by the gear selectivity but mainly due to a reduced availability of juveniles considering their spatial distribution.

Trawling is not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.

6.5.2.3. Catches

6.5.2.3.1. Landings

Landings reported through the Data collection regulation are listed in Table 6.5.2.3.1.1 Since 2002 annual landings varied between 620 and 1,100 tons. Demersal bottom trawlers landings dominate by far. Landings size shows a very high seasonal variability, with peaks at the end of summer (september) determined by the increase in availability after the massive recruitment on the coastal area.

Table 6.5.2.3.1.1. Annual landings (t) by fishing technique as reported through the DCR data call.

	Nets	Trawlers	Longliners	Miscellaneous	Seines	Total
2004	59.9	521.1		2.3		583.3
2005	30.8	648			0.1	678.9
2006	16.4	1033.2		0.5		1050.1
2007	8.6	1087.4				1096
2008	11.2	716.3				727.5
2009	10.2	728.1				738.3
2010	12.3	748.2				760.5
2011	10	865.3				875.3

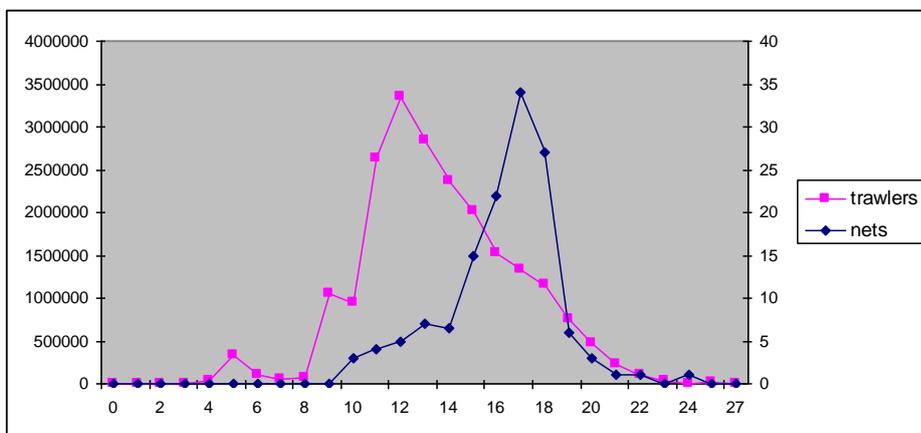


Fig. 6.5.2.3.1.1. Size structure of landings for trawlers and artisanal fleet (10^3 individuals) for year 2011

6.5.2.3.2. Discards

158 t of discards in 2006 were reported to SGMED-08-04.

6.5.2.4. Fishing effort

Fishing effort deployed in GSA 09 has shown a decrease for the main gear demersal otter trawl. It is however difficult to extract from the official data the real number of vessels that target red mullet over the whole GSA 09.

In the last 26 years, a general decrease in the size of the fishing fleets operating in the GSA 09 targeting demersal species was observed. The detailed number of vessels targeting the species in question and the changes (reduction) in number along the time interval 1985-2011 is only known for some ports of the GSA. The reduction of number of vessels has been particularly important in Porto Santo Stefano fleet (about 50%

of reduction) in the South and in Viareggio (about 30%) in the North. It is likely that this general reduction in numbers of vessels also apply for the fraction of the fleet that exerts its fishing effort on *M. barbatus* over all the other GSA 09 fleets.

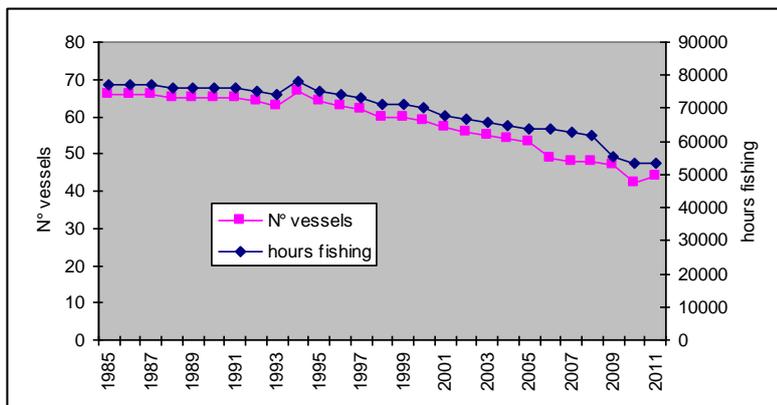


Fig. 6.5.2.4.1. Number of vessels and fishing activity in the port of Viareggio (1990-2011)

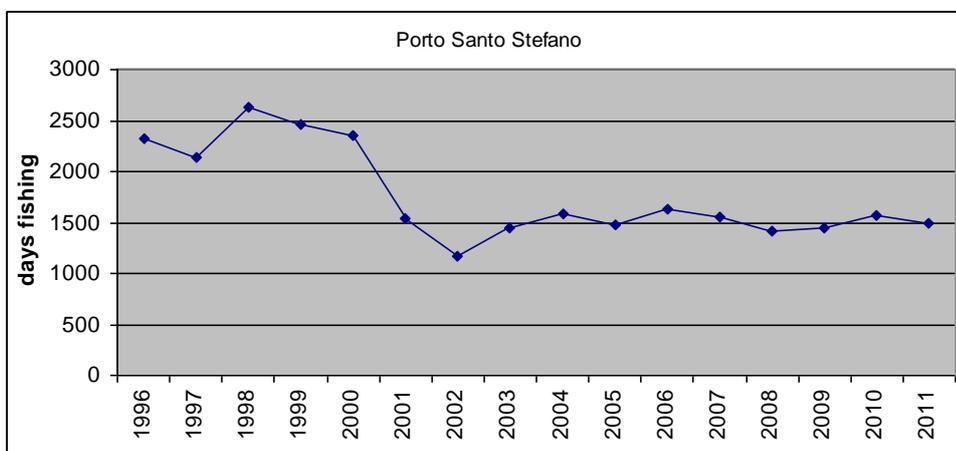


Fig. 6.5.2.4.2. Effort expressed as days fishing/year in the port of Porto Santo Stefano (1996-2011).

6.5.3. Scientific surveys

6.5.3.1. MEDITS

6.5.3.1.1. Methods

Data were assigned to bathymetric strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes trawling duration. Only hauls considered valid were used in the computations. Valid hauls include the cases of null catches of the species.

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Y_{st} = \frac{\sum (Y_i * A_i)}{A}$$

$$V(Y_{st}) = \sum (A_i^2 * s_i^2 / n_i) / A^2$$

Where:

A=total survey area

A_i=area of the i-th stratum

s_i=standard deviation of the i-th stratum

n_i=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Y_i=mean of the i-th stratum

Y_{st}=stratified mean abundance

V(Y_{st})=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = $Y_{st} \pm t(\text{student distribution}) * V(Y_{st}) / n$

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution or quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (sub-samples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.5.3.1.2. Geographical distribution patterns

The species is distributed all along the continental shelf of the GSA 09, with major abundance in the depth range 0-100m. The species is highly concentrated along the coastal stripe 0-30m when in late summer-early autumn juveniles massively settle to the bottom. The major nursery areas are allocated in the northern portion of the GSA 09, Northwards the Elba Island (yellow areas in Figure 6.5.3.1.2.1).

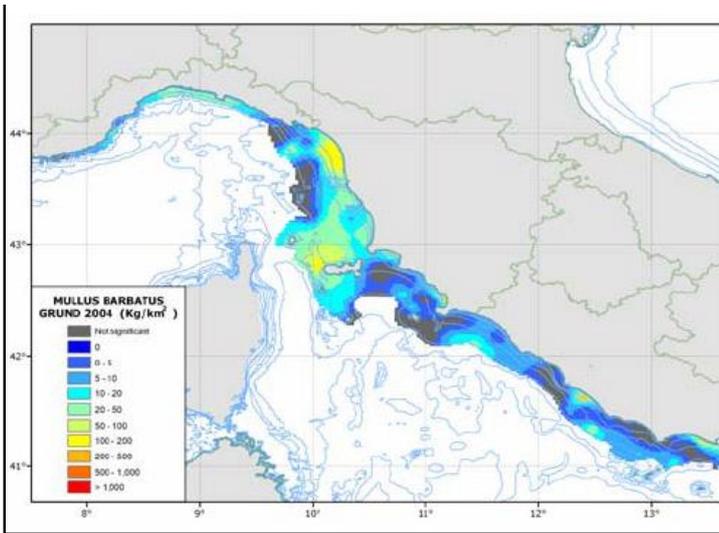


Fig. 6.5.3.1.2.1. Distribution of juveniles of red mullet in autumn (GRUND survey) in kg/km². Also mature individuals are more abundant in the Northern portion of the GSA 09.

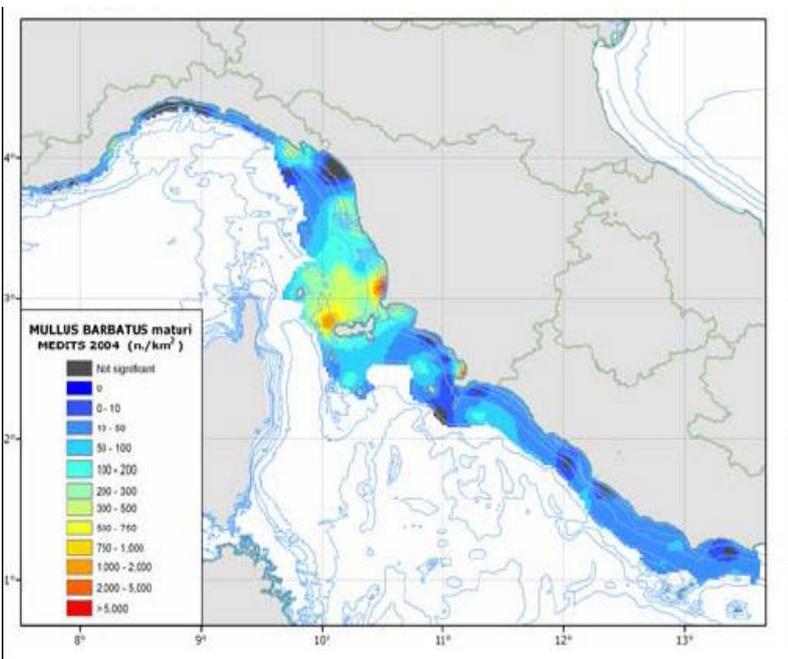


Fig. 6.5.3.1.2.2. Distribution of mature adults of red mullet in spring (MEDITS survey) in numbers/km²

The nursery concentrations show a marked spatial stability. Figure 6.5.3.1.2.3 shows the areas where a major stability along time has been observed (in dark brown)

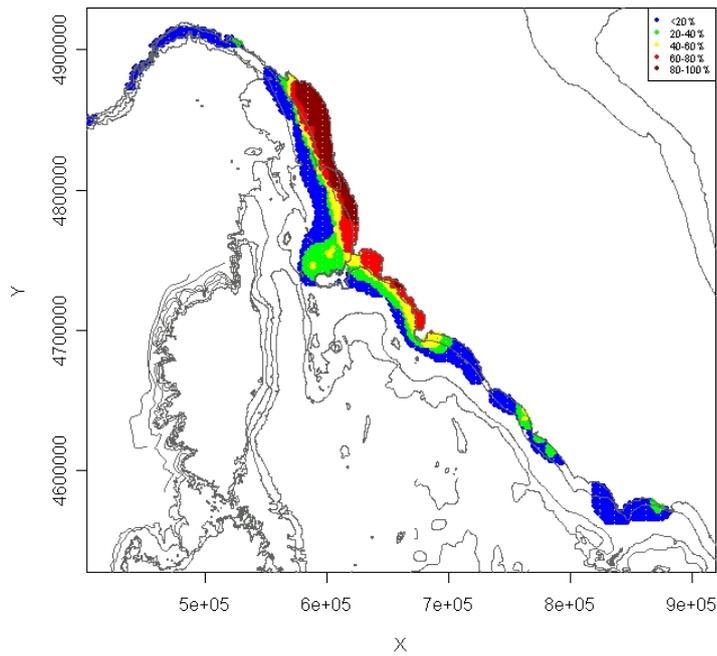


Fig. 6.5.3.1.2.3. Stability of the nursery areas of red mullet.

6.5.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 09 was derived from the international survey Medits. Figure 6.5.3.1.3.1 displays the estimated trend in abundance.

The estimated abundance index shows an increasing trend since 1994 up to 2002 from 7 to 24 kg/km². After this year the abundance drop up to about 17kg/km² and along the successive years the index shows a steady status.

The following Figure 6.5.3.1.3.1 displays the abundance indices of GSA 09 from 1994 to 2011.

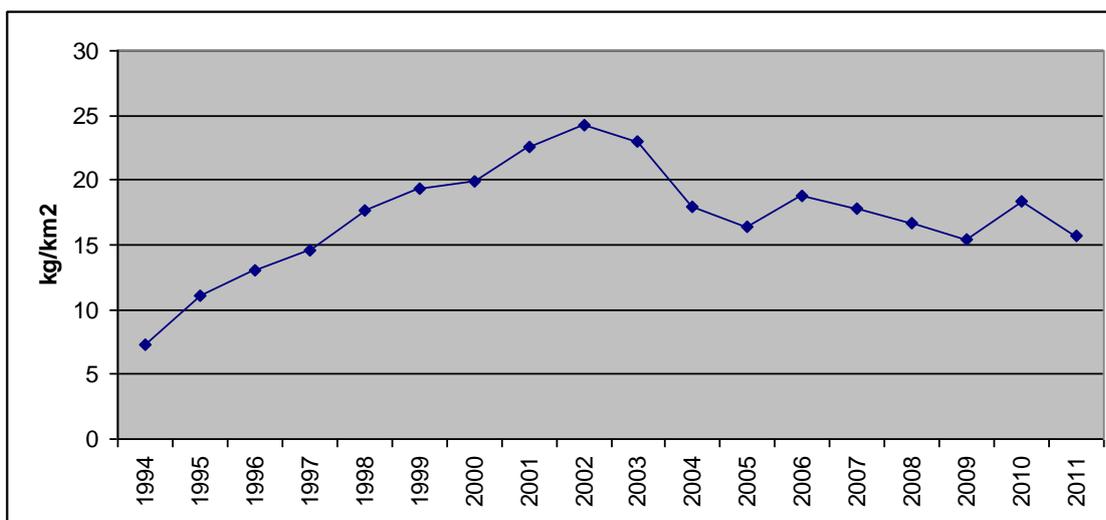


Fig. 6.5.3.1.3.1. Biomass indices by year of red mullet in GSA 09.

6.5.3.1.4. Trends in abundance by length or age

No analyses were conducted during SGMED-09-06.

6.5.3.1.5. Trends in growth

No analyses were conducted during SGMED-09-06.

6.5.3.1.6. Trends in maturity

No analyses were conducted during SGMED-09-06.

6.5.4. Assessment of historic stock parameters

6.5.4.1. VPA Methods 1: XSA and ADAPT

6.5.4.1.1. Justification

VPA use was tested using two different approaches, the first one was a traditional XSA and the second was a new version of ADAPT.

Traditional Virtual Population Analysis uses a deterministic algorithm to sequentially calculate a matrix of stock numbers at age and a matrix of fishing mortality rates at age given a matrix of catch at age and a matrix of natural mortality at age. The algorithm back-calculates previous stock sizes using catch at age data, current-year stock size estimates, and assumptions about fishing mortality relationships between age groups. The XSA (Shepherd 1992, Darby and Flatman 1994) was performed aimed at the estimation of a vector of F at size, using data on total annual catches by size, including discard. The procedure does not define an object function, but based on an iteration procedure of the functional type.

Other than XSA, the use of the ADAPT assessment approach was also tested. Such approach combines deterministic virtual population analysis with a nonlinear least squares (NLS) objective function to estimate model parameters such as stock size at age through time. As generally implemented, the ADAPT method is a measurement error model in which observed indices of relative abundance are modeled as random deviations from the true values of the abundance indices. VPA/ADAPT 3.0 is a new implementation of the age structured estimation model first introduced by Gavaris (1988) that allows the user to estimate multiplicative factors to be applied to all ages in the catch over a user specified year range simultaneously with the stock estimates. This feature is similar to B-Adapt (C. Darby, CEFAS). The underlying assumption is that the surveys provide the correct population trend and the catch multipliers will act to change the catch in some years to more closely fit the surveys. This option should be considered when retrospective patterns are

observed in base runs. Population estimates are chosen so as to minimize the sum of squares difference between the population abundance and a set of one or more abundance indices. The IMSL Numerical Library implementation of the Levenburg-Marquardt method is used to solve the nonlinear least squares problem. Bootstrapping is used to estimate the precision of all model parameters and all quantities that are functions of model parameters. Considering the short time series available, results of such approaches have to be considered preliminary.

6.5.4.1.2. Input parameters

Catch of red mullet proceeding from two fisheries (bottom trawlers targeting a coastal demersal assemblage and artisanal fisheries using trammel nets) were used. As the catch of trammel nets is quite modest (<2% in numbers) it was not considered. A reasonable hypothesis of a declining rate of M at age derived from ProdBiom was used in the computations (mean values for age 0 = 1.30, age 1 = 0.79, age 2 = 0.62, age 3 => 0.54).

6.5.4.1.3. Results

The VPA analyses did not allow to obtain reliable estimates of the parameters as F vectors, numbers and biomass of the stock by ages for each year. This is related to inconsistencies observed in the data set, regarding weights of the reconstructed numbers by age and official total landings and catches, and unreliable catch-at-age structure in some years.

6.5.4.2. Method 2: Stock-Production model

6.5.4.2.1. Justification

As an alternative way for the assessment of the stock status, it was performed an analysis using the ASPIC.5 software (A Stock-Production model Incorporating Covariates) (Prager, 1994, 2005) assuming a Schaefer (1954) model. This program implements a non-equilibrium, continuous-time, observation-error estimator for the dynamic production model (Schnute, 1977; Prager, 1994). The model was used to estimate MSY , the ratios of both current biomass or F to the biomass or F at which MSY can be attained, and q (the catchability coefficient, the proportion of total stock removed by one unit of fishing effort).

6.5.4.2.2. Input parameters

Input data consist in 2 sets of time series of total landings (in kg) and fishing effort expressed as kg/hour and kg/day for two of the main ports of the GSA9 respectively (Viareggio and Porto Santo Stefano) which are considered representative for the area and a time series of an index of abundance (kg/km²) for the whole

GSA9 derived from MEDITS surveys. This is feasible using a new extension incorporated in ASPIC new versions.

"Series 1"

Catch and Effort

1994	1.92800d03	3.90290d04
1995	2.25000d03	2.73570d04
1996	2.32000d03	3.36430d04
1997	2.13700d03	3.47150d04
1998	2.62600d03	3.00910d04
1999	2.45400d03	3.31610d04
2000	2.35400d03	4.60630d04
2001	1.53200d03	4.80690d04
2002	1.17400d03	4.09930d04
2003	1.44800d03	5.10270d04
2004	1.59100d03	4.60480d04
2005	1.47500d03	5.19490d04
2006	1.62900d03	5.75110d04
2007	1.55000d03	6.09360d04
2008	1.42300d03	5.34110d04
2009	1.44900d03	5.03960d04
2010	1.48900d03	4.22100d04
2011	1.45100d03	3.62780d04

"Series 2"

Catch and Effort

1994	7.83750d04	6.96500d04
1995	7.52400d04	7.13260d04
1996	7.41950d04	7.46630d04
1997	7.31500d04	8.51100d04
1998	7.10600d04	1.04051d05
1999	7.10600d04	1.41873d05
2000	7.00150d04	1.54654d05
2001	6.79250d04	1.70953d05
2002	6.68800d04	1.63647d05
2003	6.58350d04	1.43018d05
2004	6.47900d04	1.42679d05
2005	6.37450d04	1.44629d05
2006	6.35560d04	1.37005d05
2007	6.26320d04	1.50682d05
2008	6.17260d04	1.35800d05
2009	5.94030d04	1.20991d05
2010	5.51870d04	1.20734d05
2011	5.45800d04	1.36000d05

"Series 3"

Index of Abundance

1994	7.35060d00
1995	1.10108d01
1996	1.29917d01
1997	1.45988d01
1998	1.76335d01
1999	1.92935d01
2000	1.98471d01
2001	2.25128d01
2002	2.42151d01
2003	2.30405d01
2004	1.79391d01
2005	1.64171d01
2006	1.88141d01
2007	1.77500d01
2008	1.66300d01
2009	1.54800d01
2010	1.83500d01
2011	1.56900d01

The results of the Biomass Dynamic Model suggest that the species in the GSA 09 is on average in overexploitation status ($F_{curr}/F_{MSY}=1.13$). Data of abundance index of Porto Santo Stefano have shown a

lower correlation with surveys data, probably due to the fact that in this port, the fleet has a lightly different and more variable spatial allocation of effort (they operate on average at higher depths and red mullet is not a priority commercial species. A reference value of F_{MSY} of 0.61 was estimated while the model estimated for the more recent year an F rate of about 0.68. It is important to highlight, as evidenced in Figure 6.5.4.2.2.2, that biomass shows a general increasing trend while F decreases along the analysed period.

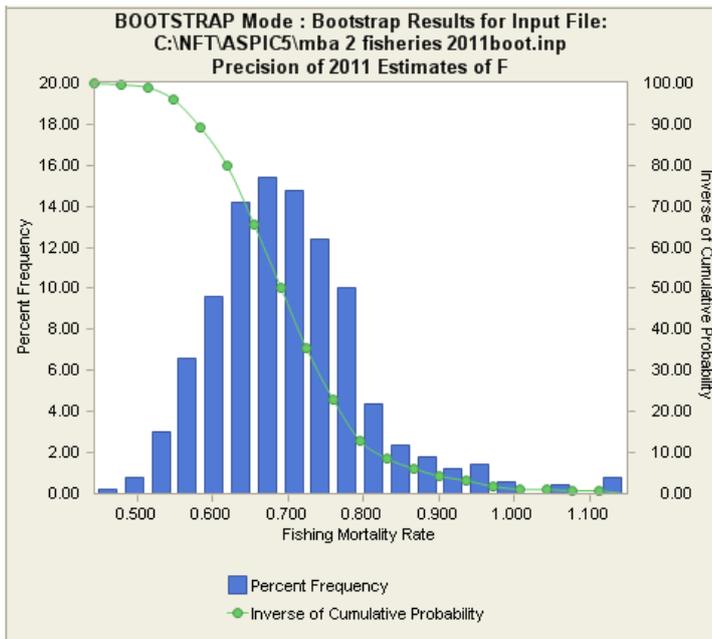


Figure 6.5.4.2.2.1. Precision of estimated value of F for 2011 with bootstrapping with ASPIC. Bars display the range of the bootstrapped estimates; the percent confidence intervals can be derived from the inverse cumulative frequency.

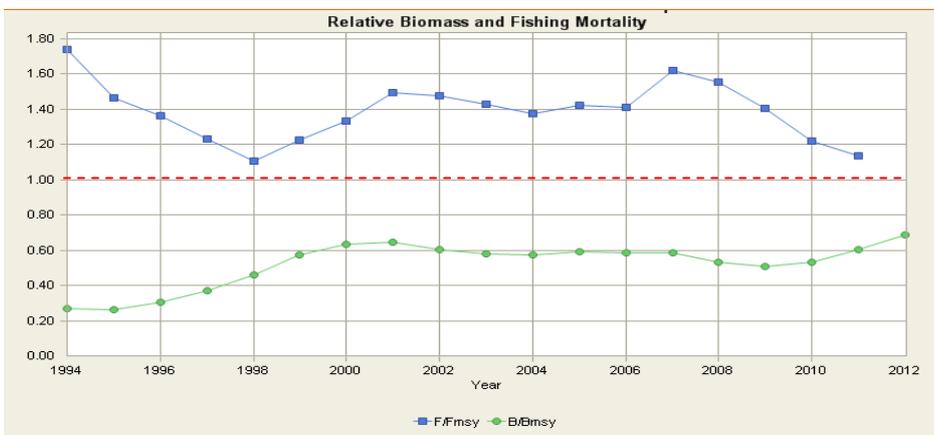


Fig. 6.5.4.2.2.2. Historic trend in estimated relative fishing mortality as F/F_{MSY} ratio (upper panel) and biomass as B/B_{MSY} ratio (lower panel). The dotted red line corresponds to the MSY levels

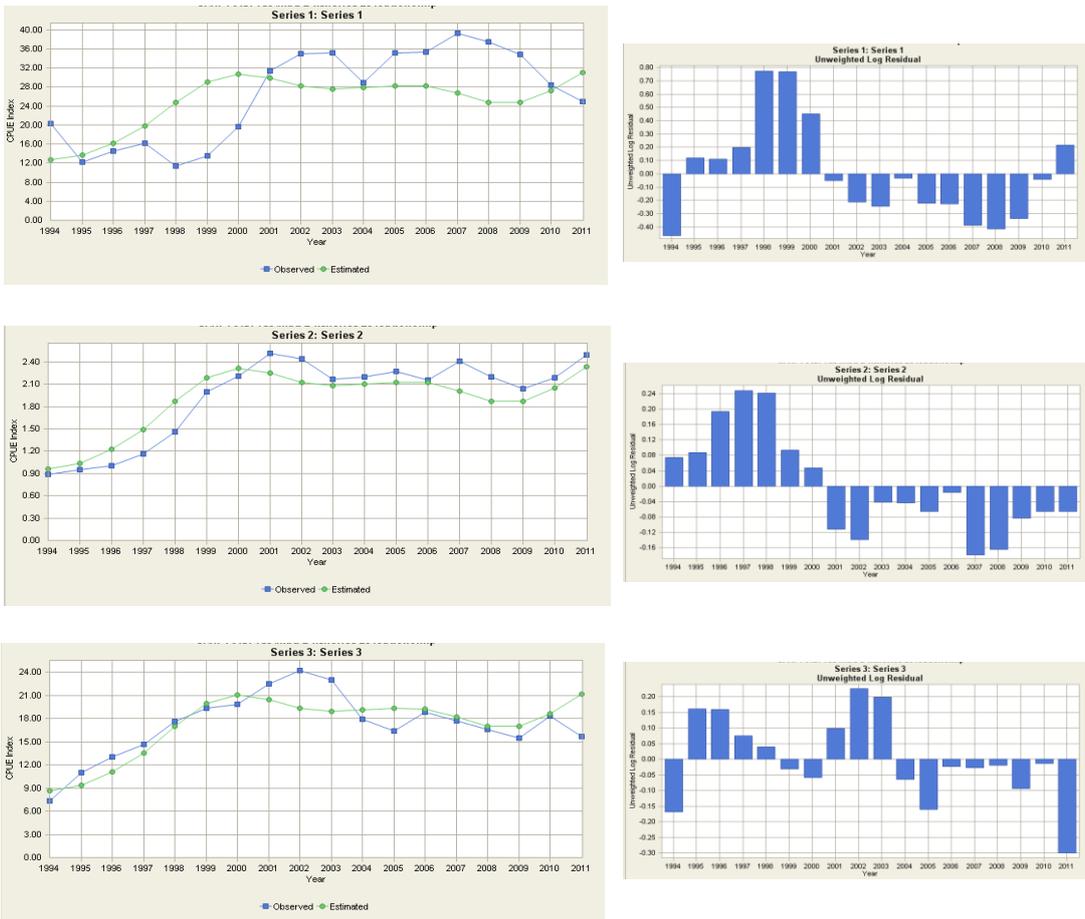


Fig. 6.5.4.2.2.3. Fitting of the 3 time series (in the left) from top to bottom Porto Santo Stefano, Viareggio and surveys index (green line estimated and blue line observed values) and correspondent residuals (in the right).

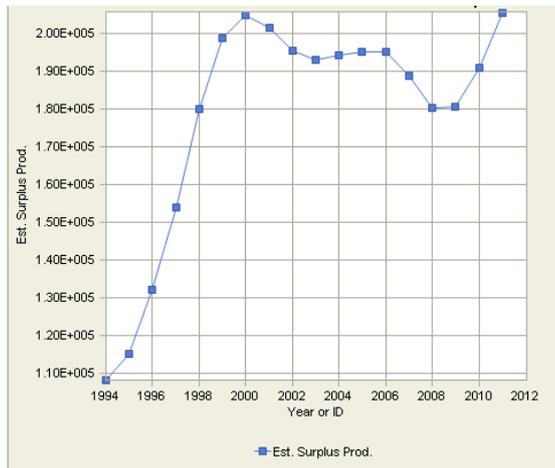


Fig. 6.5.4.2.2.4. Estimated surplus production of *Mullus barbatus* in GSA9 using the logistic Schaefer model for the period 1994-2011.

Table 6.5.4.2.2.1. Aspic output main results.

ASPIC -- A Surplus-Production Model Including Covariates (Ver. 5.33)
 FIT program mode LOGISTIC model mode
 YLD conditioning
 SSE optimization

CONTROL PARAMETERS (FROM INPUT FILE) Input file: f:\ancona stecf 2012\mba 2 fisheries 2011fit.inp

Operation of ASPIC: Fit logistic (Schaefer) model by direct optimization.
 Number of years analyzed: 18 Number of bootstrap trials: 0
 Number of data series: 3 Bounds on MSY (min, max): 1.500E+05 1.000E+06
 Objective function: Least squares Bounds on K (min, max): 4.000E+05 1.000E+07
 Relative conv. criterion (simplex): 1.000E-08 Monte Carlo search mode, trials: 1 50000
 Relative conv. criterion (restart): 3.000E-08 Random number seed: 657438223
 Relative conv. criterion (effort): 1.000E-04 Identical convergences required in fitting: 6
 Maximum F allowed in fitting: 8.000

PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS)

Normal convergence
 Number of restarts required for convergence: 695

CORRELATION AMONG INPUT SERIES EXPRESSED AS CPUE (NUMBER OF PAIRWISE OBSERVATIONS BELOW)

1 Series 1		1.000		
		18		
2 Series 2		0.729	1.000	
		18	18	
3 Series 3		0.451	0.772	1.000
		18	18	18
		1	2	3

GOODNESS-OF-FIT AND WEIGHTING (NON-BOOTSTRAPPED ANALYSIS)

	Weighted LAV	N	Weighted MSE	Current weight	Inv. var. weight	R-squared in CPUE
Loss(-1) SSE in yield	0.000E+00					
Loss(0) Penalty for B1 > K	0.000E+00	1	N/A	0.000E+00	N/A	
Loss(1) Series 1	2.362E+00	18	1.476E-01	1.000E+00	1.843E-01	0.211
Loss(2) Series 2	2.984E-01	18	1.865E-02	1.000E+00	1.458E+00	0.827
Loss(3) Series 3	3.206E-01	18	2.003E-02	1.000E+00	1.358E+00	0.661

TOTAL OBJECTIVE FUNCTION, MSE, RMSE: 2.98073136E+00 6.210E-02 2.492E-01
 Estimated contrast index (ideal = 1.0): 0.7115 C* = (Bmax-Bmin)/K
 Estimated nearness index (ideal = 1.0): 0.8439 N* = 1 - |min(B-Bmsy)|/K

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter	Estimate	User/pgm guess	2nd guess	Estimated	User guess
B1/K Starting relative biomass (in 1994)	1.331E-01	4.000E-01	5.604E-01	1	1
MSY Maximum sustainable yield	2.350E+05	3.500E+05	3.200E+05	1	1
K Maximum population size	7.758E+05	2.500E+06	8.643E+05	1	1
phi Shape of production curve (Bmsy/K)	0.5000	0.5000	----	0	1

----- Catchability Coefficients by Data Series -----

q(1) Series 1	1.235E-04	5.000E-04	4.750E-02	1	1
q(2) Series 2	9.301E-06	8.000E-04	7.600E-02	1	1
q(3) Series 3	8.441E-05	4.000E-04	3.800E-02	1	1

MANAGEMENT and DERIVED PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter	Estimate	Logistic formula	General formula
-----------	----------	------------------	-----------------

Bmsy	Stock biomass giving MSY	3.879E+05	K/2	$K*n^{**}(1/(1-n))$
Fmsy	Fishing mortality rate at MSY	6.058E-01	MSY/Bmsy	MSY/Bmsy
n	Exponent in production function	2.0000	----	----
g	Fletcher's gamma	4.000E+00	----	$[n^{**}(n/(n-1))]/[n-1]$
B./Bmsy	Ratio: B(2012)/Bmsy	6.879E-01	----	----
F./Fmsy	Ratio: F(2011)/Fmsy	1.133E+00	----	----
Fmsy/F.	Ratio: Fmsy/F(2011)	8.823E-01	----	----
MSY	Maximum sustainable yield	2.350E+05	----	----
Y.(Fmsy)	Approx. yield available at Fmsy in 2012	1.617E+05	MSY*B./Bmsy	MSY*B./Bmsy
	...as proportion of MSY	6.879E-01	----	----
Ye.	Equilibrium yield available in 2012	2.121E+05	$4*MSY*(B/K-(B/K)^{**}2)$	$g*MSY*(B/K-(B/K)^{**}n)$
	...as proportion of MSY	9.026E-01	----	----
Fishing effort rate at MSY in units of each CE or CC series -----				
fmsy(1)	Series 1	4.907E+03	Fmsy/q(1)	Fmsy/q(1)
fmsy(2)	Series 2	6.513E+04	Fmsy/q(2)	Fmsy/q(2)

ESTIMATED POPULATION TRAJECTORY (NON-BOOTSTRAPPED)

Obs	Year or ID	Estimated total F mort	Estimated starting biomass	Estimated average biomass	Observed total yield	Model total yield	Estimated surplus production	Ratio of F mort to Fmsy	Ratio of biomass to Bmsy
1	1994	1.055	1.032E+05	1.030E+05	1.087E+05	1.087E+05	1.082E+05	1.742E+00	2.661E-01
2	1995	0.888	1.028E+05	1.111E+05	9.868E+04	9.868E+04	1.153E+05	1.466E+00	2.649E-01
3	1996	0.825	1.194E+05	1.314E+05	1.083E+05	1.083E+05	1.321E+05	1.361E+00	3.078E-01
4	1997	0.747	1.432E+05	1.604E+05	1.198E+05	1.198E+05	1.540E+05	1.233E+00	3.692E-01
5	1998	0.669	1.774E+05	2.007E+05	1.341E+05	1.341E+05	1.800E+05	1.104E+00	4.574E-01
6	1999	0.743	2.233E+05	2.356E+05	1.750E+05	1.750E+05	1.987E+05	1.226E+00	5.755E-01
7	2000	0.806	2.469E+05	2.491E+05	2.007E+05	2.007E+05	2.049E+05	1.330E+00	6.365E-01
8	2001	0.906	2.511E+05	2.418E+05	2.190E+05	2.190E+05	2.016E+05	1.495E+00	6.473E-01
9	2002	0.894	2.337E+05	2.288E+05	2.046E+05	2.046E+05	1.955E+05	1.476E+00	6.024E-01
10	2003	0.866	2.245E+05	2.240E+05	1.940E+05	1.940E+05	1.930E+05	1.430E+00	5.788E-01
11	2004	0.833	2.235E+05	2.264E+05	1.887E+05	1.887E+05	1.943E+05	1.376E+00	5.762E-01
12	2005	0.861	2.290E+05	2.283E+05	1.966E+05	1.966E+05	1.952E+05	1.421E+00	5.904E-01
13	2006	0.853	2.277E+05	2.280E+05	1.945E+05	1.945E+05	1.951E+05	1.408E+00	5.870E-01
14	2007	0.980	2.283E+05	2.160E+05	2.116E+05	2.116E+05	1.888E+05	1.617E+00	5.884E-01
15	2008	0.943	2.054E+05	2.007E+05	1.892E+05	1.892E+05	1.802E+05	1.557E+00	5.295E-01
16	2009	0.852	1.964E+05	2.012E+05	1.714E+05	1.714E+05	1.806E+05	1.406E+00	5.064E-01
17	2010	0.740	2.056E+05	2.201E+05	1.629E+05	1.629E+05	1.909E+05	1.222E+00	5.300E-01
18	2011	0.687	2.336E+05	2.509E+05	1.723E+05	1.723E+05	2.055E+05	1.133E+00	6.021E-01
19	2012		2.668E+05						6.879E-01

6.5.4.3. Method 3: Yield-per-Recruit model



Fig. 6.5.4.3.1. Yield-per-Recruit and Spawning Stock Biomass-per Recruit results.

Yield per recruit model was used to predict the effects of changes in the fishing effort on future yields and for defining the Reference Points F_{max} (the fully-recruited fishing mortality rate which produces the maximum yield per recruit, $F_{40\%MSP}$ (the F rate that reduces spawning stock biomass per recruit relative to the unfished level to 40% of the maximum spawning potential MSP), (Mace & Sissenwine, 1993; Gabriel & Mace, Clark, 1991) and $F_{0.1}$, the fishing mortality rate corresponding to 10% of the slope of the yield-per-recruit curve at the origin (Gulland & Boerema, 1973).

With the yield-per-recruit model, there were estimated the values of the following RPs:

$$F_{0.1}=0.54$$

$$F_{max}=0.84$$

$$F_{40\%MSP} =0.58$$

The model sensibility regarding the estimate of $F_{0.1}$ by changing the input value of M was tested.

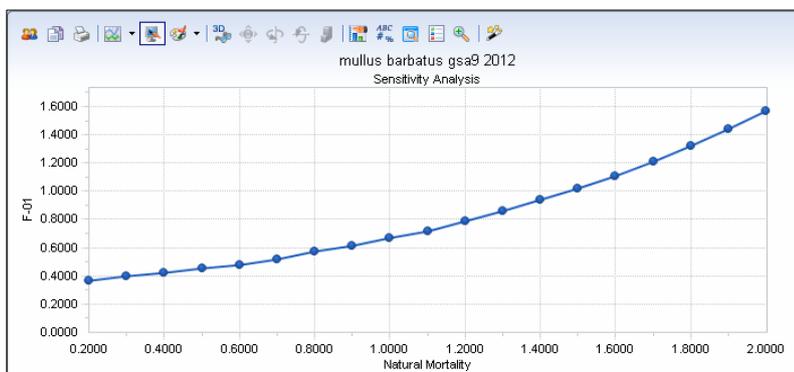


Fig. 6.5.4.3.2. Sensitivity of the model for changes in M as input regarding the estimate of $F_{0.1}$

6.5.4.4. Comparisons of results with Reference Points derived from Y/R and Production model

The current level of F estimated with ASPIC is about 27% higher than the $F_{0.1}$ value, considered here as a proxy of F_{MSY} .

With ASPIC it was estimated the current F/F_{MSY} rate to be 1.13 ($F_{2011}=0.69$, $F_{MSY}=0.61$)

In the case of Y/R, the proxy of F_{MSY} derived from Y/R analysis ($F_{0.1}=0.54$), the F_{2011} derived from ASPIC estimate a higher value of the rate F/F_{MSY} (1.27). In any case, we can state that results with these two alternative reference points produced similar results and perception of the stock status.

6.5.5. Short term prediction for 2009-2010

6.5.5.1. Justification

See medium term prediction.

6.5.6. Medium term prediction

6.5.6.1. Justification

The ASPIC forecasting model (ASPIC-P) was run to estimate future 8 years stock parameters under status quo fishing mortality. Projections suggest that a light increase in biomass should occur in a medium term (up to 2020) if F is kept at the current rate. The new biomass level that is assumed to be obtained at medium term keeping F unchanged is however lower (about 80% of B_{MSY}), than the level of biomass that maximizes the sustainable yields).

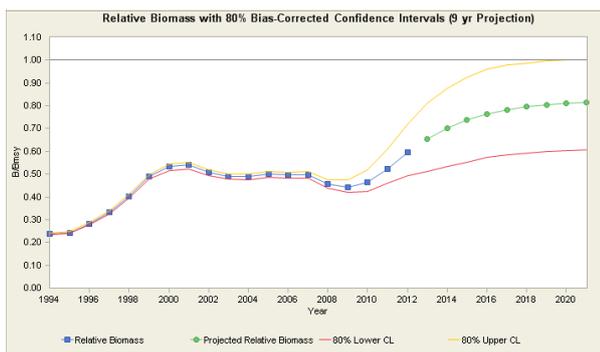


Fig. 6.5.6.1.2.1. Historic and forecasting of B/B_{MSY} assuming F unchanged for the next 8 years with 80% confidence intervals derived from bootstrapping.

An annual reduction of about 13% has to be applied in order to drive the current Biomass close to the B_{MSY} level. In this case, B_{MSY} will be reached in 2020.

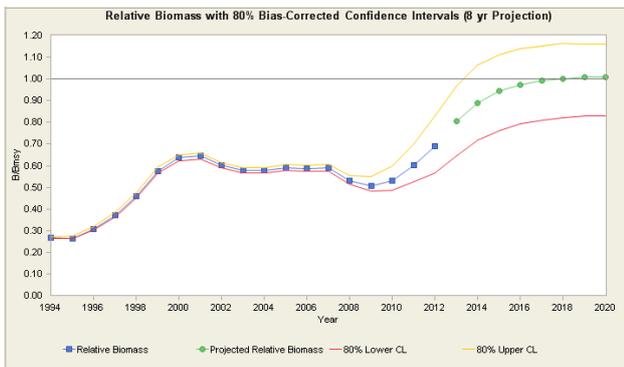


Fig. 6.5.6.1.2.2. Forecasting for B/B_{MSY} assuming an annual reduction of F of 13% with bootstrapped 80% confidence limits.

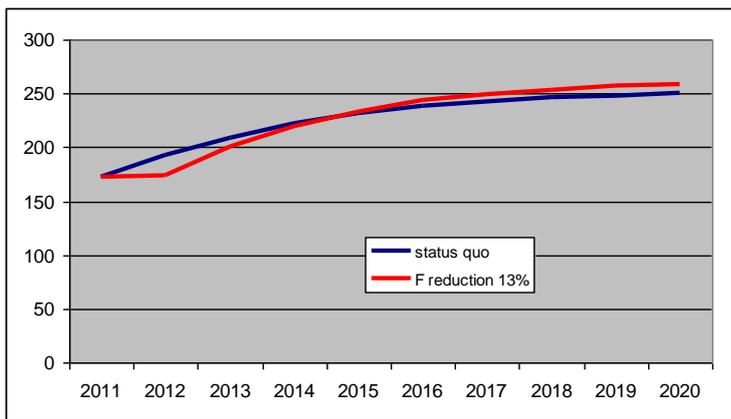


Fig. 6.5.6.1.2.3. Yields projection under two different scenarios.

Table 6.5.6.1.2.1. Expected changes in yield up to 2020 assuming two different scenarios: by keeping F unchanged and by reducing current F of 13%

	Yields Projection		% Changes	
	status quo	F Reduction 13%	status quo	F Reduction 13%
2011	875.00	875.00	0.00%	0.00%
2012	976.74	885.17	11.63%	1.16%
2013	1063.23	1017.44	21.51%	16.28%
2014	1129.36	1114.10	29.07%	27.33%
2015	1175.15	1185.32	34.30%	35.47%
2016	1210.76	1236.19	38.37%	41.28%
2017	1231.10	1266.72	40.70%	44.77%
2018	1251.45	1287.06	43.02%	47.09%
2019	1261.63	1307.41	44.19%	49.42%
2020	1271.80	1312.50	45.35%	50.00%

TRAJECTORY OF RELATIVE BIOMASS B/B_{msy} (BOOTSTRAPPED) F status quo

Year	Point estimate	Estimated bias	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	quartile range	Relative IQ range
2011	5.234E-01	3.129E-03	0.60%	4.594E-01	6.098E-01	4.917E-01	5.683E-01	7.667E-02	0.146
2012	5.956E-01	1.683E-03	0.28%	4.922E-01	7.214E-01	5.418E-01	6.627E-01	1.209E-01	0.203
2013	6.559E-01	-7.559E-04	-0.12%	5.124E-01	8.114E-01	5.829E-01	7.393E-01	1.565E-01	0.239
2014	7.034E-01	-3.992E-03	-0.57%	5.330E-01	8.788E-01	6.182E-01	7.991E-01	1.809E-01	0.257
2015	7.390E-01	-7.458E-03	-1.01%	5.513E-01	9.247E-01	6.454E-01	8.401E-01	1.947E-01	0.263
2016	7.649E-01	-1.065E-02	-1.39%	5.724E-01	9.595E-01	6.706E-01	8.737E-01	2.031E-01	0.266
2017	7.831E-01	-1.330E-02	-1.70%	5.843E-01	9.792E-01	6.872E-01	8.930E-01	2.059E-01	0.263
2018	7.958E-01	-1.534E-02	-1.93%	5.925E-01	9.870E-01	6.985E-01	9.062E-01	2.077E-01	0.261
2019	8.045E-01	-1.683E-02	-2.09%	5.987E-01	9.959E-01	7.063E-01	9.148E-01	2.085E-01	0.259
2020	8.103E-01	-1.789E-02	-2.21%	6.034E-01	9.996E-01	7.118E-01	9.191E-01	2.074E-01	0.256

TRAJECTORY OF RELATIVE BIOMASS B/B_{msy} (BOOTSTRAPPED) F reduction of 13%

Year	Point estimate	Estimated bias	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	quartile range	Relative IQ range
2012	5.956E-01	1.683E-03	0.28%	4.922E-01	7.214E-01	5.418E-01	6.627E-01	1.209E-01	0.203
2013	6.996E-01	-2.648E-04	-0.04%	5.507E-01	8.462E-01	6.249E-01	7.808E-01	1.559E-01	0.223
2014	7.843E-01	-3.872E-03	-0.49%	6.025E-01	9.467E-01	6.961E-01	8.722E-01	1.760E-01	0.224
2015	8.478E-01	-7.948E-03	-0.94%	6.565E-01	1.018E+00	7.543E-01	9.452E-01	1.909E-01	0.225
2016	8.924E-01	-1.150E-02	-1.29%	6.951E-01	1.066E+00	7.968E-01	9.910E-01	1.942E-01	0.218
2017	9.224E-01	-1.412E-02	-1.53%	7.230E-01	1.094E+00	8.248E-01	1.019E+00	1.939E-01	0.210
2018	9.420E-01	-1.583E-02	-1.68%	7.508E-01	1.113E+00	8.512E-01	1.041E+00	1.895E-01	0.201
2019	9.745E-01	-1.684E-02	-1.76%	7.660E-01	1.124E+00	8.659E-01	1.053E+00	1.867E-01	0.196
2020	9.984E-01	-1.738E-02	-1.81%	7.757E-01	1.129E+00	8.748E-01	1.059E+00	1.841E-01	0.191

6.5.7. Scientific advice

6.5.7.1. Short term considerations

6.5.7.1.1.State of the spawning stock size

6.5.7.1.2.State of recruitment

6.5.7.1.3.State of exploitation

The current exploitation rate of the stock is higher than the maximum exploitation rate threshold, with current fishing mortality $F_{2011}=0.68$ estimated with ASPIC which is higher than the value considered as limit reference points ($F_{MSY}=0.61$) and also higher than $F_{0.1}=0.54$ estimated with the Y/R analysis.

6.5.7.2. Medium term considerations

SGMED-08-04 concludes that the red mullet stock in GSA 09 has still no significant recovery potential under the current fishing strategy. Instead, a reduction of about 13% of F is likely to drive at a medium term the stock biomass close to the B_{MSY} level.

6.6. Stock assessment of Greater forkbeard in GSA 09

6.6.1. Stock identification and biological features

6.6.1.1. Stock Identification

Due to a lack of enough information about the stock structure of the greater forkbeard (*Phycis blennoides*) in the western Mediterranean, this stock was assumed to be confined within the GSA 09 boundaries.

Greater forkbeard is distributed throughout the Mediterranean and in the Atlantic Ocean from the coasts of Norway and Iceland to Cap Blanc in West Africa (Cohen et al., 1990). This species displays benthic characteristics and lives on sandy and muddy bottoms, chiefly between 100 and 450 m, even if large specimens are frequently found at depths of up to 1000-1200 m. *P. blennoides* is present in all Italian seas with a broad vertical distribution from 85 to over 700 m (Sartor et al., 1990; Repetto et al., 1991). The bathymetric distribution of the greater forkbeard varies according to age: adult and subadult individuals are distributed at the greatest depths while the younger individuals are present at all depths, with the greatest abundances at the shallowest waters. The population that lives at depths affected by trawl fishing is chiefly composed of small-sized individuals belonging to 0 and 1 age classes. This species displays the greatest yields among teleosts living on mesobathyal seabeds (Relini Orsi & Fanciulli, 1979; Sartor et al., 1990). Research conducted in the Ligurian Sea (Relini Orsi & Fanciulli, 1980) and in the northern Tyrrhenian Sea (Sartor & Biagi, 1992; Sartor, 1995), has shown the benthophagy of this species. Most of their prey live in close contact with the bottom and some of them habitually bury themselves. Predation is principally at the expense of decapod crustaceans and secondarily of Mysidacea, isopods and amphipods. No particular seasonal differences exist in the trophic spectrum, which changes significantly with size: decapod crustaceans constitute the main resource in all size classes; Mysidacea and amphipods play an important role for the youngest individuals (<20 cm), while they are poorly represented in the adults. Isopods are important only for specimens larger than 20 cm (Sartor, 1995).

6.6.1.2. Growth

Despite a set of growth parameters by sex was available for the northern part of the GSA9 (Ligurian Sea) in the following analysis growth parameters proposed by Ragonese et al. (2004) was adopted because the slicing analysis fitted better with catches which are represented mainly by specimens belonging to age 0 and 1. In table 1.1.1.2.1, 2 set of growth parameters and length and weight relationship are reported.

Table 6.6.1.2.1 Greater forkbeard growth parameters.

References	Method	Sex	L_{∞}	K	t0
Ragonese et al. (2004)	LFD analysis and otoliths reading	M	47.1	0.380	-0.030
Ragonese et al. (2004)	LFD analysis and otoliths reading	F	68.1	0.220	-0.150
Orsi Relini and Fanciulli (1980)	LFD analysis	M	26.0	0.898	0.285

Orsi Relini and Fanciulli (1980)	LFD analysis	F	66.0	0.228	0.033
----------------------------------	--------------	---	------	-------	-------

Table 6.6.1.2.2 Greater forkbeard length-weight relationship parameters.

References	Sex	a	b
GSA09	M	0.00299	3.29
GSA09	F	0.00381	3.21

6.6.1.3. Maturity

Identification of the reproductive period of *P. blennoides* is still uncertain given the low number of sexually mature females found. In the Ligurian Sea, the reproduction period was identified as mid-summer, when more than 95% of males larger than 21 cm proved to be maturing (Fanciulli & Relini Orsi, 1979) as it has also been hypothesised for the Tyrrhenian Sea (Biagi & Farnocchia, 1994). The eggs are found in the surface in the period January-May (Lo Bianco, 1909, 1931-33). In the Ligurian Sea the recruitment was observed in April on epibathyal fishing grounds. The sex structure of the population is 1:1 (Fanciulli & Relini Orsi, 1979); however, the largest individuals are mostly females. In the following table (6.6.1.3.1) the proportion of matures by age adopted in the following analysis and based on FISHBASE information are reported.

Table 6.6.1.3.1 Greater forkbeard maturity vector by age and sex

	Age			
Sex	0	1	2	3+
M	0	0	0.2	1
F	0	0	0.2	1

A vector of natural mortality by age (table 6.6.1.3.2) was estimated by ProdBiom using the set of growth parameters and length weight coefficient listed above.

Table 6.6.1.3.2 Greater forkbeard natural mortality vector by age and sex

	Age			
Sex	0	1	2	3+
Female	1.01	0.46	0.35	0.27
Male	1.18	0.54	0.41	0.32

6.6.2. Fisheries

6.6.2.1. General description of the fisheries

P. blennoides is caught almost exclusively by bottom trawling and occasionally with bottom set longlines and deep set nets.

6.6.2.2. Management regulations applicable in 2010 and 2011

EC regulation 1967/2006 do not provide a minimum length size for this species.

6.6.2.3. Catches

6.6.2.3.1. Landings

Most of the landings are taken by the OTB fleet. Total landings of greater forkbeard, based both on National statistics and DCF, increased from 2007 to 2010 and remained stable in the last year with about 30t (Table 6.6.2.3.1.1). Despite the seasonality fluctuations are a proper characteristic of the landings of this species, as shown by the LPUE (kg/boat/day) produced by the fleet of Santa Margherita Ligure in the period 1987-1996 and in more recently years (2009-2010 and 2011-2012) the mean LPUE values decrease respect to the past (Figure 6.6.2.3.1.1 and Figure 6.6.2.3.1.2).

Table 6.6.2.3.1.1 The annual landings (t) of greater forkbeard in the GSA 09 by gear (National statistics and DCF data).

Metier	2007	2008	2009	2010	2011
GNS	0.65	3.91	4.06	2.38	1.22
GTR	2.62	5.74	7.33	4.57	6.77
OTB	17.50	26.87	27.88	39.57	32.87

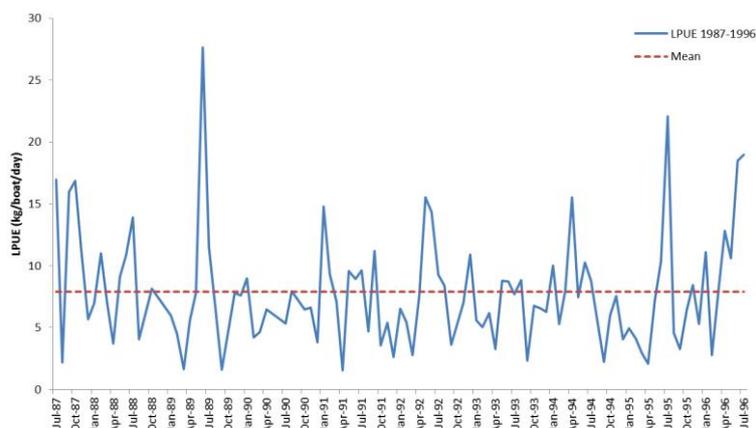


Fig. 6.6.2.3.1.1. Time series of greater forkbeard LPUE of Santa Margherita Ligure from July 1987 to October 1996 (red dashed line is the mean of the period) .

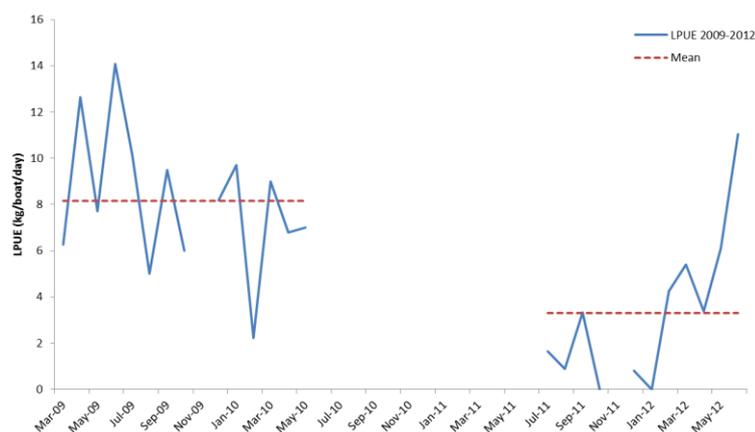


Fig. 6.6.2.3.1.2. Time series of greater forkbeard LPUE of Santa Margherita Ligure from March 2009 to May 2010 and from July 2011 and June 2012 (red dashed line is the mean of the period).

6.6.2.3.2. Discards

Discards are represented by young specimens (mainly under 20 cm of total length) and represents more than 91% of the total catch. In Table 6.6.2.3.2.1 are reported discards values by métier and percentage respect on total catch.

Table 6.6.2.3.2.1 Discards value of greater forkbeard by métier.

Country	Area	Year	Gear	Species	Landings (t)	Discards (t)	% Discards on total catch
ITA	SA9	2011	OTB	GFB	32.9	351	91.43
ITA	SA9	2011	GNS	GFB	1.2	-	
ITA	SA9	2011	GRT	GFB	6.8	-	

6.6.2.4. Fishing effort

The fishing effort by fishing technique is listed in Table 6.6.2.4.1. A decreasing trend is recognizable from 2004 until now (Figure 6.6.2.4.1).

Table 6.6.2.4.1 Fishing effort (GT*days and kw*days) by OTB for GSA9, 2004-2011

Country	Area	Year	Gear	GT days at sea	Nominal effort
ITA	GSA9	2004	OTB	2560791	15625026
ITA	GSA9	2005	OTB	2411430	14609930
ITA	GSA9	2006	OTB	2213795	12288869
ITA	GSA9	2007	OTB	2178393	12891442
ITA	GSA9	2008	OTB	1849826	10567382
ITA	GSA9	2009	OTB	1939715	11668537
ITA	GSA9	2010	OTB	1788242	10515499
ITA	GSA9	2011	OTB	1734356	10069537

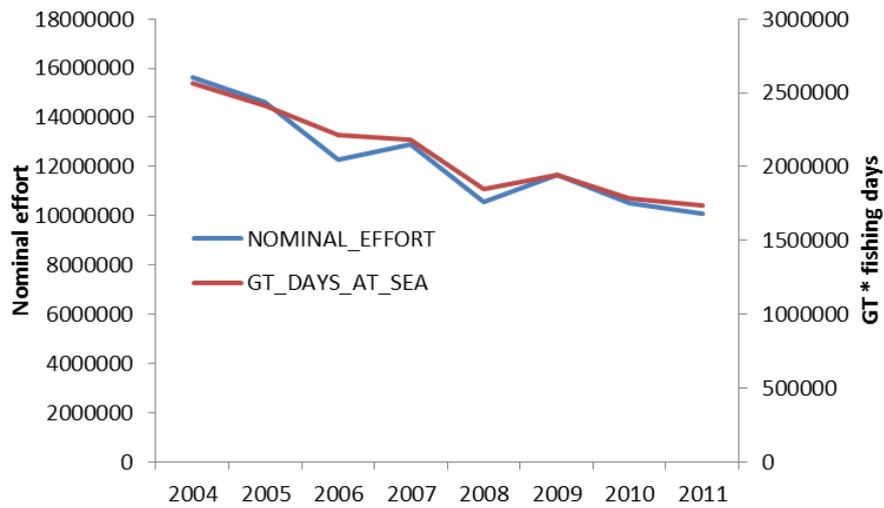


Fig. 6.6.2.4.1. Trends in annual fishing effort as nominal effort (kw*days) and GT*days at sea deployed in GSA09 from 2004 to 2011.

6.6.3. Scientific surveys

6.6.3.1. MEDITS

6.6.3.1.1. Methods

Since 1994 MEDITS trawl surveys has been regularly carried out each year during the spring season. Greater forkbeard density and biomass indexes showed fluctuations with an important peak recognized in 1999 both in term of density and biomass index (Figure 6.6.3.1.1.1).

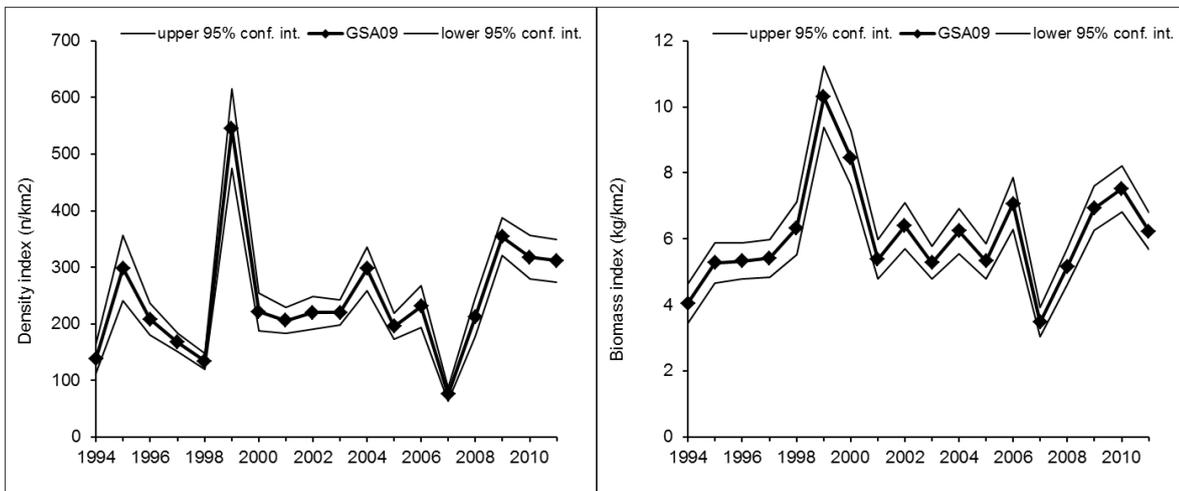


Fig. 6.6.3.1.1.1 *P. blennoides*: MEDITS trends in density and biomass indexes from 1994 to 2011 in GSA09.

Based on the DCF data, abundance and biomass indices were recalculated. In GSA09 the following number of hauls was reported per depth stratum (Table 6.6.3.1.1.1).

Table 6.6.3.1.1.1. Number of hauls per year and depth stratum in GSA09 (1994-2011).

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
GSA09_010-050	21	20	20	20	21	20	20	19	15	14	15	16	15	15	16	16	15	15
GSA09_050-100	21	21	20	20	20	21	22	23	17	18	17	16	18	18	16	16	19	19
GSA09_100-200	38	40	40	40	39	39	38	38	30	30	30	31	29	30	31	31	29	29
GSA09_200-500	40	40	42	42	41	41	42	41	32	33	36	35	36	37	34	34	35	35
GSA09_500-800	33	32	31	31	32	32	31	32	26	25	22	22	22	20	23	23	22	22
Total	153	153	153	153	153	153	153	153	120	120	120	120	120	120	120	120	120	120

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Y_{st} = \sum (Y_i * A_i) / A$$

$$V(Y_{st}) = \sum (A_i^2 * s_i^2 / n_i) / A^2$$

Where:

A=total survey area

A_i=area of the i-th stratum

s_i=standard deviation of the i-th stratum

n_i=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Y_i=mean of the i-th stratum

Y_{st}=stratified mean abundance

V(Y_{st})=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval:

$$\text{Confidence interval} = Y_{st} \pm t(\text{student distribution}) * V(Y_{st}) / n$$

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations in each stratum. Aggregated length frequencies were then raised to stratum abundance 100 (because of the low numbers in most strata) and finally aggregated (sum) over the strata of the entire GSA.

6.6.3.1.2. Geographical distribution patterns

The stock is present in the whole area but is more abundant in the northern part of the GSA 09 (Ligurian Sea) as showed in Figure 6.6.3.1.2.1-4 (from Ardizzone *et al.*, Eds. CD-ROM Version).

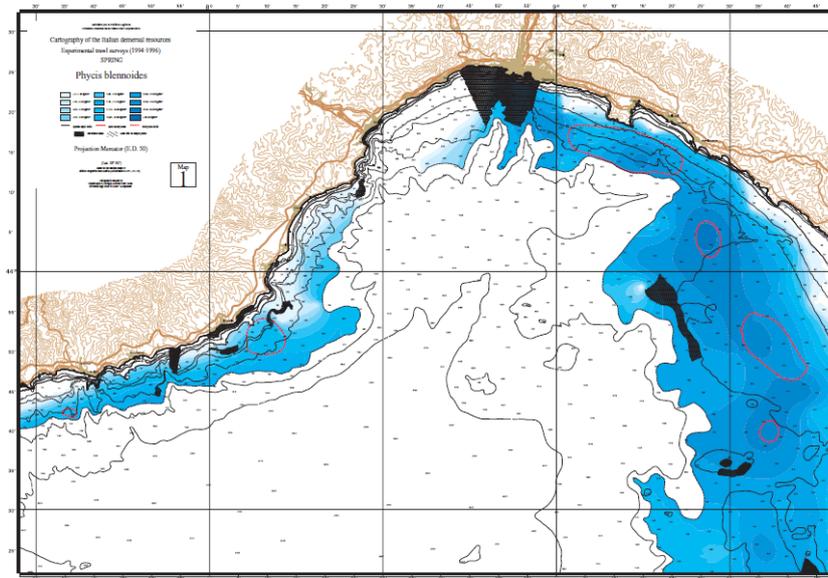


Fig. 6.6.3.1.2.1. Spring biomass index of *P. blennoides* from 1994-1996 in GSA 09 (Northern Ligurian Sea).

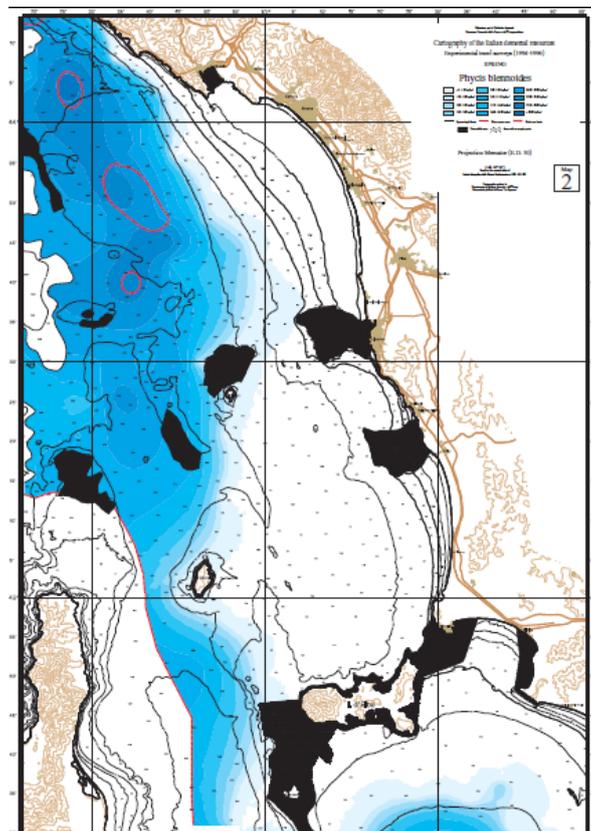


Fig. 6.6.3.1.2.2. Spring biomass index of *P. blennoides* 1994-1996, GSA 09 (Southern Ligurian Sea).

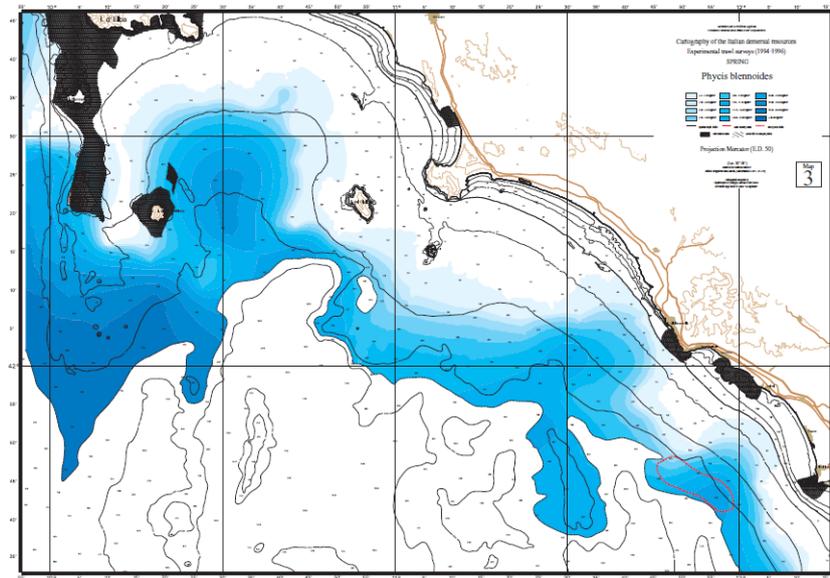


Fig. 6.6.3.1.2.3. Spring biomass index of *P. blennoides* 1994-1996, GSA 09 (Northern Tyrrhenian Sea).

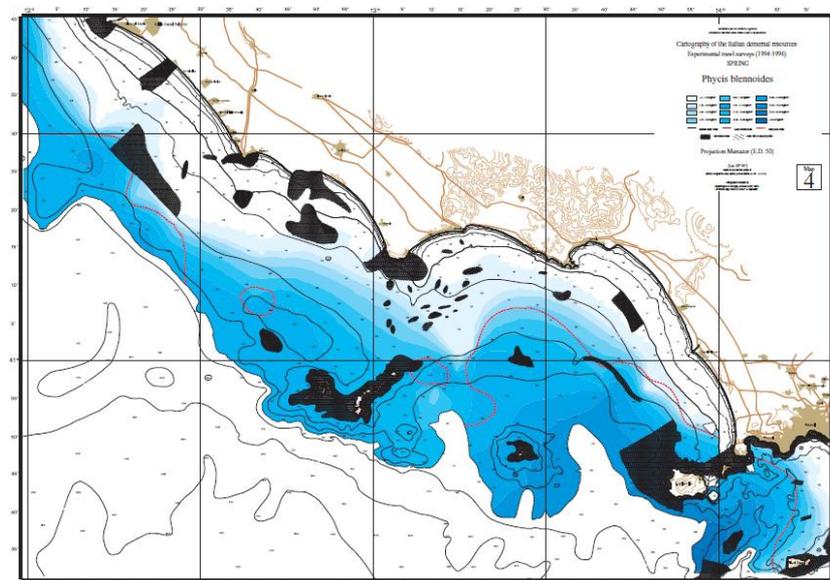


Fig. 6.6.3.1.2.4. Spring biomass index of *P. blennoides* 1994-1996, GSA 09 (Central Tyrrhenian Sea).

6.6.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of greater forkbeard in GSA 09 was derived from the international survey MEDITS. Figure 6.6.3.1.3.1 displays the estimated trend in *P. blennoides* abundance and biomass in GSA 09. The estimated abundance and biomass indices do not reveal a clear trend but a series of peaks followed by a rather stable trend.

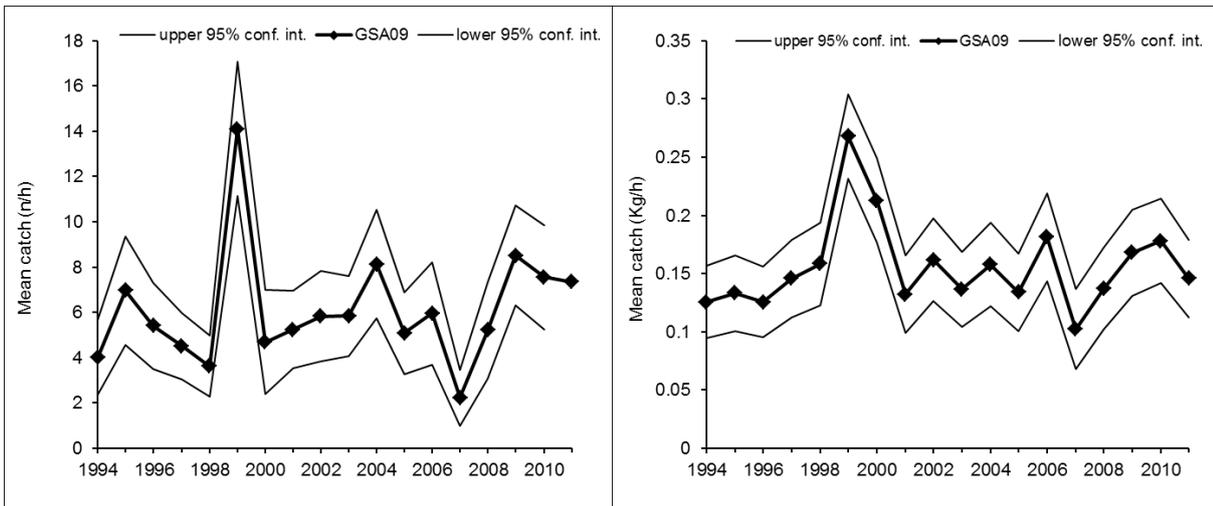


Fig. 6.6.3.1.3.1. Abundance and biomass indices of greater forkbeard in GSA 09.

6.6.3.1.4. Trends in abundance by length or age

The following figures 6.6.3.1.4.1-3 display the stratified abundance indices of GSA 09 in 1994-2011.

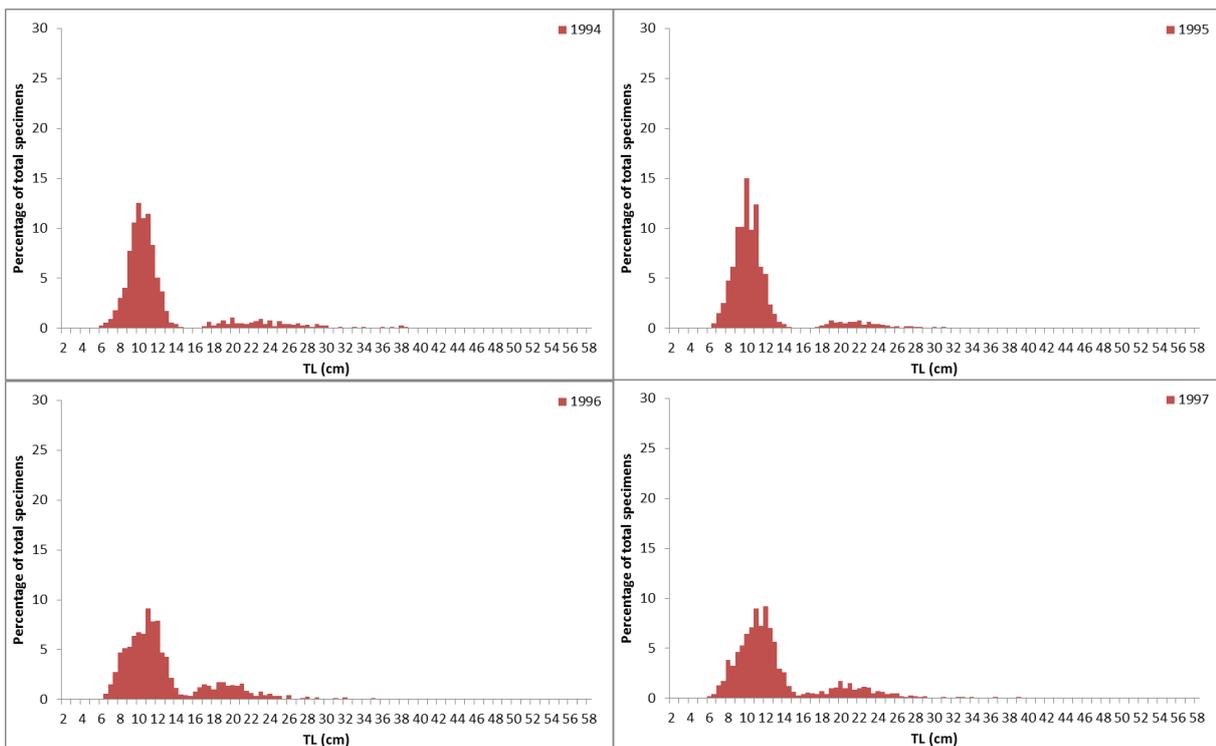
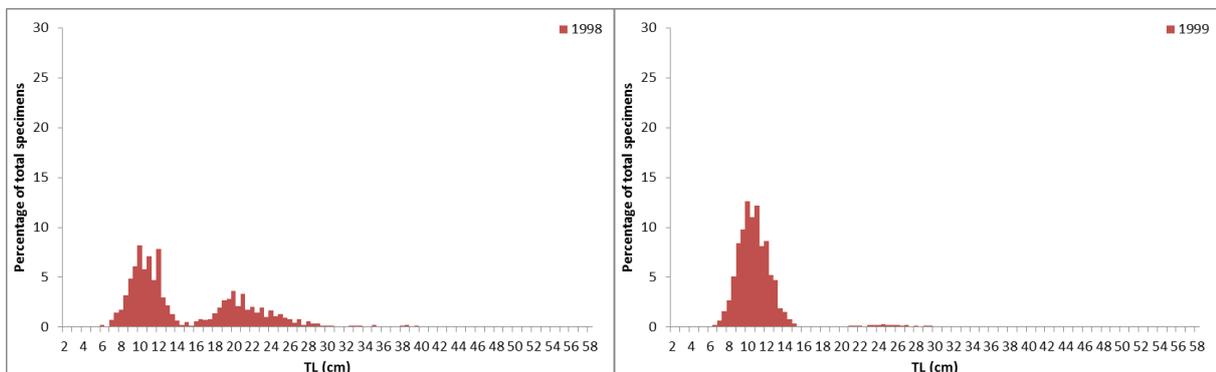


Fig. 6.6.3.1.4.1 Stratified abundance indices by size, 1994-1997 of *P. blennoides* in GSA09.



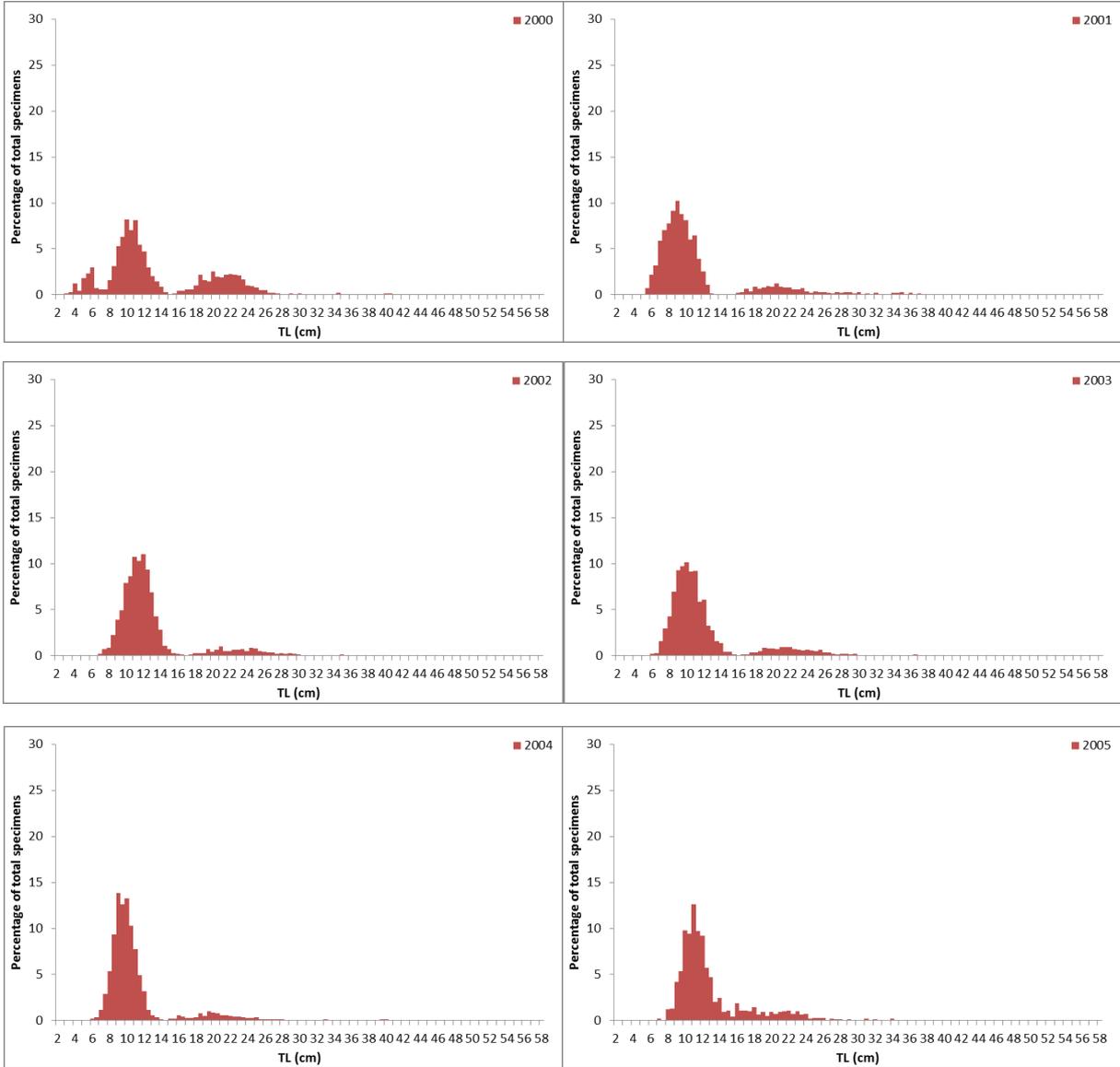
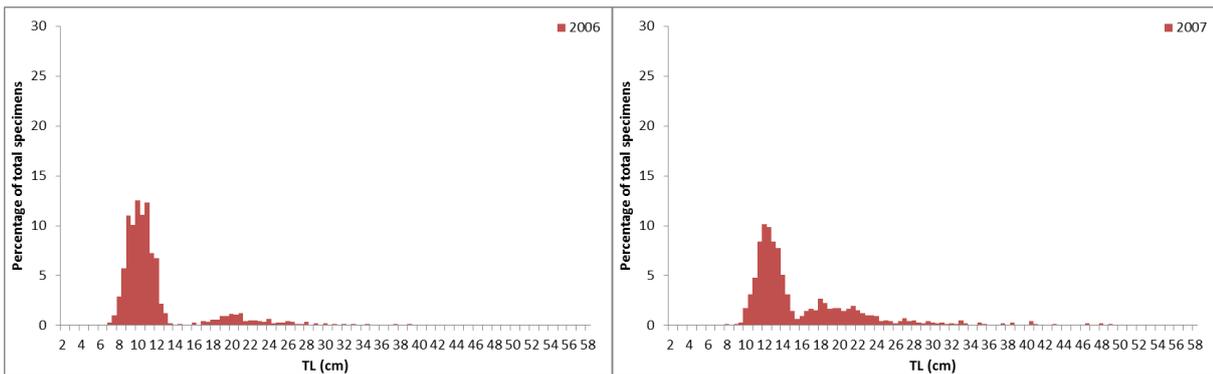


Fig. 6.6.3.1.4.2 Stratified abundance indices by size, 1998-2005 of *P. blennoides* in GSA09.



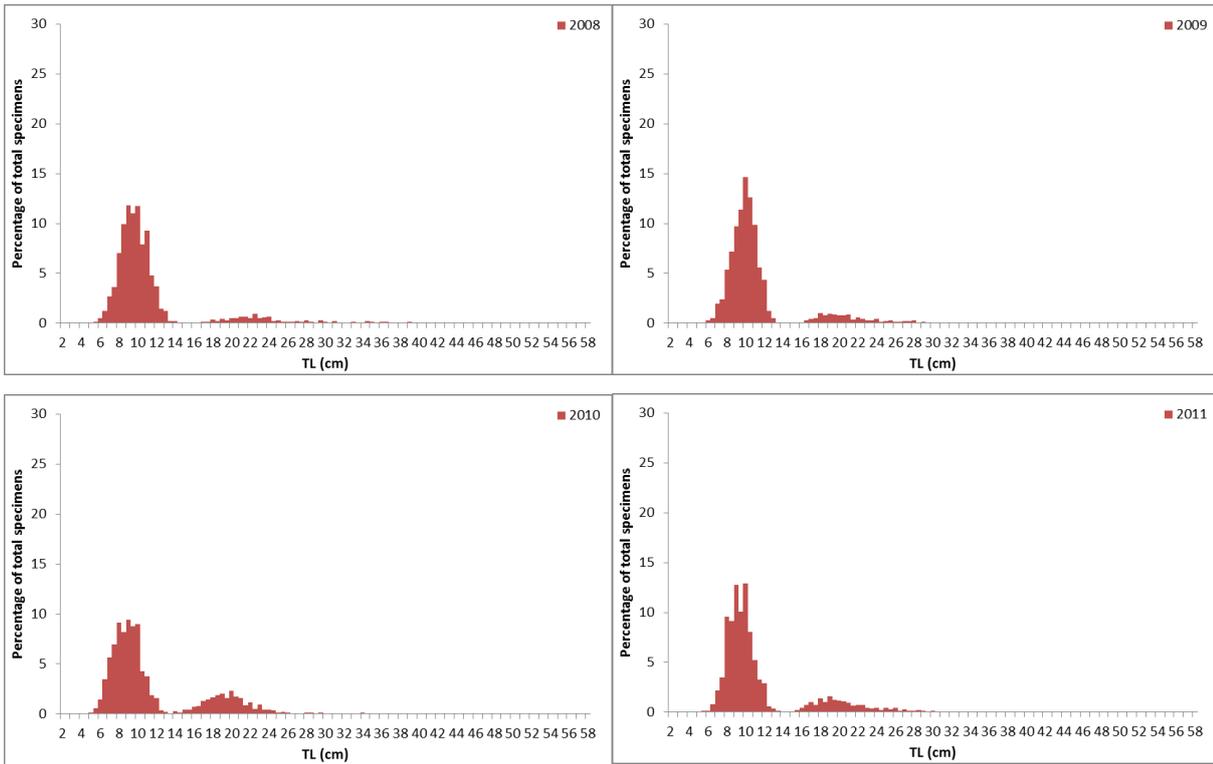


Fig. 6.6.3.1.4.3. Stratified abundance indices by size, 2006-2011 of *P. blennoides* in GSA09.

The boxplot of the MEDITS length frequencies distributions (LFD) is shown in Figure 6.6.3.1.4.4. It is evident a quite stable demographic structure of the catches.

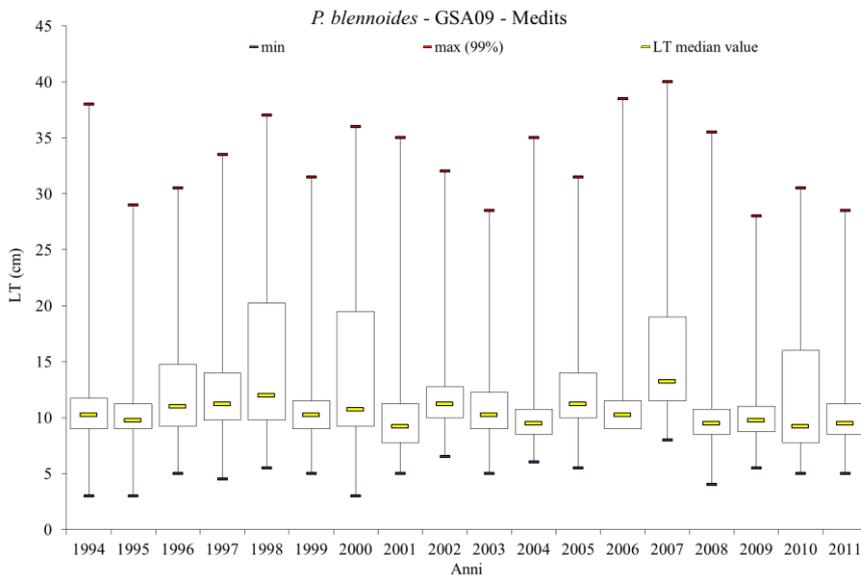


Fig. 6.6.3.1.4.4. Boxplot of the length frequency distributions of greater forkbeard in GSA09 obtained in the MEDITS surveys.

6.6.3.1.5. Trends in growth

No analyses were conducted during EWG12-19 meeting.

6.6.3.1.6. Trends in maturity

No analyses were conducted during EWG-12-19.

6.6.4. Assessment of historic stock parameters

6.6.4.1. Method 1: LCA

6.6.4.1.1. Justification

The pseudo-cohort analysis VIT was applied using data of 2011.

6.6.4.1.2. Input parameters

DCF data provided at EWG12-19 contained information on greater forkbeard landings and the respective size structure for 2011. A VPA analysis was performed using a Length Cohort Analysis (LCA) and applying the routine included in the VIT package designed by Lleonart and Salat (1992) for each sex separately. Biological parameters are listed in Table 6.6.4.1.2.1 and data used are reported in Table. 6.6.4.1.2.2. A natural mortality vector was computed using ProdBiom (Abella, 1998) and a terminal fishing mortality $F_{term} = 0.2$, corresponding to the mean of natural mortality values of the older age class, was assumed. Total length frequency of undetermined specimens was splitted by sex using a sex-ratio vector per length class.

Table 6.6.4.1.2.1. Input data for the LCA; landings and discards at length (2011) of greater forkbeard in GSA 09.

	Growth (Ragonese et al.2004)	Length-weight relationships (GSA9)	Natural mortality vector (ProdBiom)	Proportion of matures (Fishbase)
Female	$L_{\infty}=68.1\text{cm TL}$ $K=0.22$ $t_0=-0.15$	$a=0.00381$ $b=3.21$	Age(0)=1.01, Age(1)=0.46, Age(2)=0.35, Age(3+)=0.27	Age(0)=0, Age(1)=0, Age(2)=0.2, Age(3+)=1
Male	$L_{\infty}=47.1\text{cm TL}$ $K=0.38$ $t_0=-0.03$	$a=0.00299$ $b=3.29$	Age(0)=1.18, Age(1)=0.54, Age(2)=0.41, Age(3+)=0.32	Age(0)=0, Age(1)=0, Age(2)=0.2, Age(3+)=1

Table 6.6.4.1.2.2. Input data for the LCA of greater forkbeard in GSA 09 in 2011 by sex.

Total length (cm)	Female	Male	Total length (cm)	Female	Male
4	3932	3932	29	5304	995
5	3932	3932	30	7884	1690
6	31457	31457	31	3337	681
7	24326	24326	32	8415	1923
8	58103	58103	33	1781	458
9	77706	77706	34	3530	588
10	614899	614899	35	1144	140
11	1755537	1755537	36	2456	0
12	2218182	2218182	37	3564	509
13	1157275	1157275	38	3471	548
14	1065743	1065743	39	1736	139
15	1017043	1017043	40	2004	0
16	763854	763854	41	1899	0
17	673734	673734	42	0	0
18	391935	391935	43	2515	0
19	70448	70448	44	266	24
20	39591	39591	45	6499	0
21	4859	4859	46	145	0
22	21474	19232	47	121	24
23	21894	15563	48	0	0
24	19719	13691	49	0	0
25	16912	9323	50	0	0
26	14950	6307	51	0	0
27	3795	1058	52	0	0
28	8841	2302	53	145	0

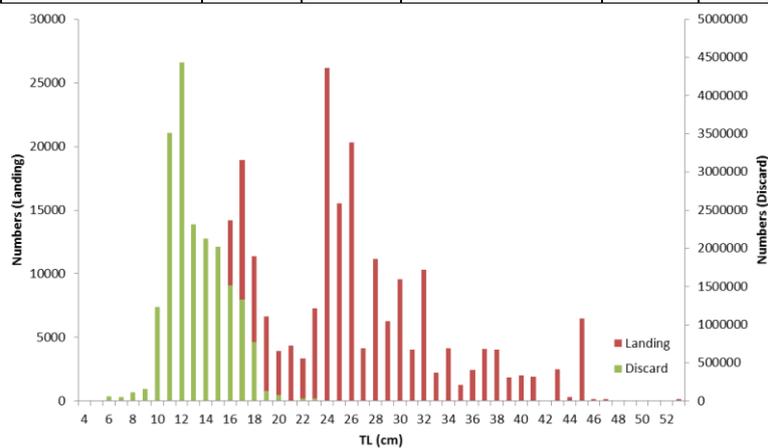


Fig. 6.6.4.1.2.1. Input data for the LCA; landings and discards at length (2011).

6.6.4.1.3. Results

Fishing mortality is mainly concentrated on specimens belonging to age class 1 (Figure 6.6.4.1.3.1).

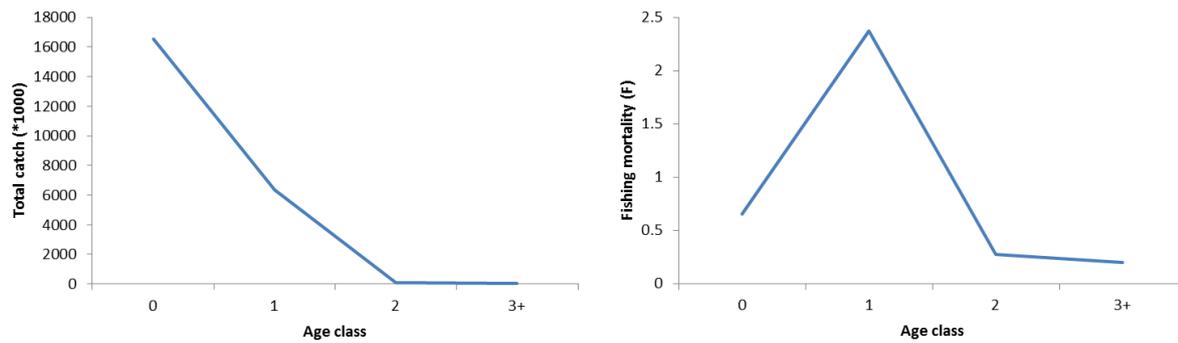


Fig.6.6.4.1.3.1 LCA outputs: catch numbers and fishing mortality at age of *P. blennoides* in the GSA 09.

6.6.4.2. Method 2: SURBA

6.6.4.2.1. Justification

The MEDITS survey provided the longer standardized time-series on abundance and population structure of *P. blennoides* in the GSA 09.

6.6.4.2.2. Input parameters

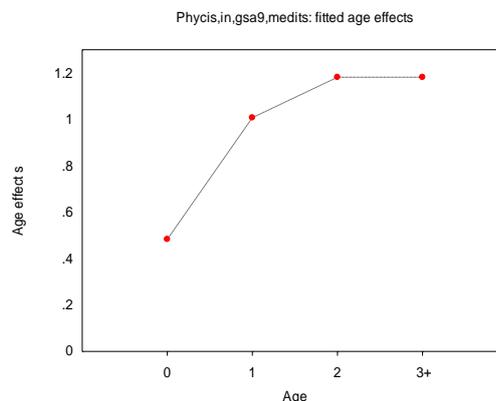
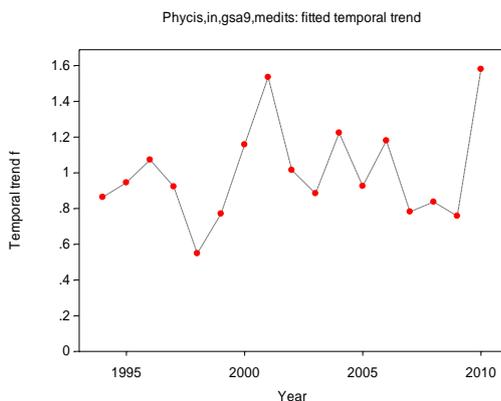
The survey-based stock assessment model SURBA (Needle, 2003) was used to reconstruct trend in the population size and fishing mortality. The parameters used are the same as for the LCA (Table 6.6.4.2.1-2) while in the Figure 6.6.4.2.2.1 the set of input data are reported. LFD were splitted in age classes by LFDA package using a knife edge slicing approach.

---,Title,-----	---,Default,age,weightings,-----	---,Proportion,mature-at-age,-----
Phycis,in,gsa9,medits	1,1,1,0.5	0,0,0.2,1
---,Number,of,ages,-----	---,Default,catchabilities,-----	0,0,0.2,1
4	1,1,1,1	0,0,0.2,1
---,Number,of,years,-----	---,Mean,F,range,-----	0,0,0.2,1
18	0,3	0,0,0.2,1
---,First,age,-----	---,Number,of,years,for,mean,F,M,W,Mat,Rec,Forecasts	0,0,0.2,1
0	3,3,3,3,10,10,10	0,0,0.2,1
---,First,year,-----	---,Natural,mortality-at-age,-----	0,0,0.2,1
1994	1.10,0.50,0.38,0.30	0,0,0.2,1
---,Plus-group,flag,(1,=,plus-gp,0,=,not),-----	1.10,0.50,0.38,0.30	0,0,0.2,1
1	1.10,0.50,0.38,0.30	0,0,0.2,1
---Start and end period of survey-----	1.10,0.50,0.38,0.30	0,0,0.2,1
0.75,0.90	1.10,0.50,0.38,0.30	0,0,0.2,1
---,Index,-----	1.10,0.50,0.38,0.30	0,0,0.2,1
1672.0,195.8,78.4,38.7	1.10,0.50,0.38,0.30	0,0,0.2,1
3764.5,336.4,69.3,22.8	1.10,0.50,0.38,0.30	0,0,0.2,1
2540.4,652.8,64.4,19.4	1.10,0.50,0.38,0.30	0,0,0.2,1
2180.7,450.3,73.4,27.6	1.10,0.50,0.38,0.30	0,0,0.2,1
1257.8,707.7,113.7,33.9	1.10,0.50,0.38,0.30	0,0,0.2,1
8558.8,184.9,163.7,73.6	1.10,0.50,0.38,0.30	---,Stock,weights-at-age,-----
2375.5,968.7,80.0,50.8	1.10,0.50,0.38,0.30	4.188597017,36.77767609,102.7347358,218.4849504
2687.0,384.5,97.0,58.5	1.10,0.50,0.38,0.30	3.975916036,35.09423482,72.61160969,206.9345406
2364.6,270.4,88.2,23.8	1.10,0.50,0.38,0.30	4.830805723,27.3702539,89.71764092,324.8744761
2423.8,331.4,72.0,13.8	1.10,0.50,0.38,0.30	5.574273297,30.65750195,77.99887428,362.3723334
3408.8,388.1,48.3,45.8	1.10,0.50,0.38,0.30	4.745067411,36.51263747,62.06112836,206.573063
1797.5,402.5,42.5,18.6	1.10,0.50,0.38,0.30	4.820969396,12.35590444,141.3965696,268.8127436
2358.3,301.1,72.2,46.2	1.10,0.50,0.38,0.30	4.069173677,42.11640211,35.02802525,345.5419523
613.7,280.2,53.0,20.0		3.01018485,42.67486058,94.54873718,193.8274112
2355.0,199.9,57.2,42.9		6.185113102,24.44712398,98.84090209,241.887162
3700.0,424.2,72.8,22.0		4.312606408,38.05717503,64.93896516,234.6024252
2891.0,858.6,45.9,32.6		3.564758718,42.65768503,98.90444953,466.9497542
3002.5,568.4,74.3,20.8		5.65608101,23.58246413,61.8054861,211.6472289
		4.055380344,37.31278133,79.74289179,421.3603817
		9.2422251,24.62008486,124.0424002,438.5094072
		3.501214648,43.19685123,93.79928336,324.9906752
		3.669075117,38.78884825,78.91088626,480.9396121
		2.915826125,33.94214607,60.12376635,390.140839
		3.257831996,39.49102286,70.10168282,194.3685237

Fig. 6.6.4.2.2.1 Input data for SURBA model of *P.blennoides* in GSA09.

6.6.4.2.3.Results

Fishing mortality estimated over age classes 0 to 3+ showed high fluctuation in the period with a mean value of about 0.9. Also SSB showed high fluctuations and in the last year the lowest level in the time series was observed.



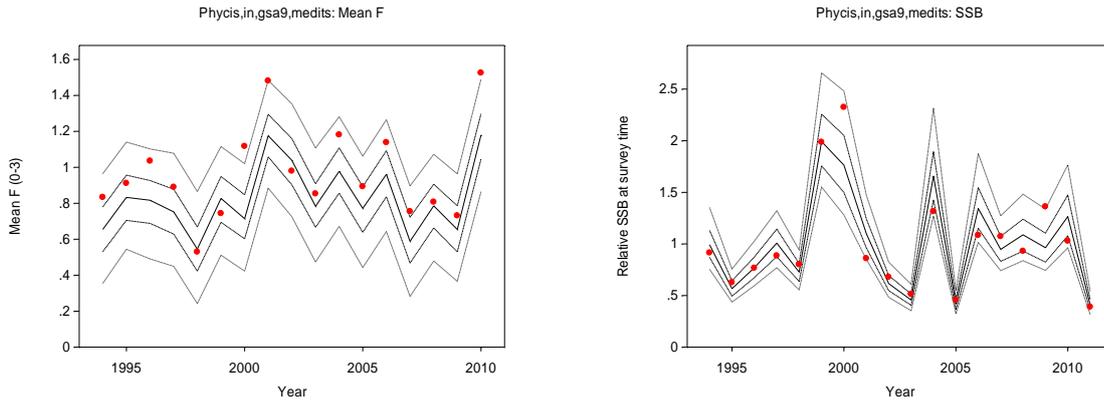


Fig. 6.6.4.2.3.1 MEDITS survey. Mean F and relative SSB at survey time estimated by SURBA for greater forkbeard in GSA 09.

Model diagnostics

The SURBA model for *P. blennoides* fits quite well on MEDITS survey data as showed in Figure 6.6.4.2.3.2.

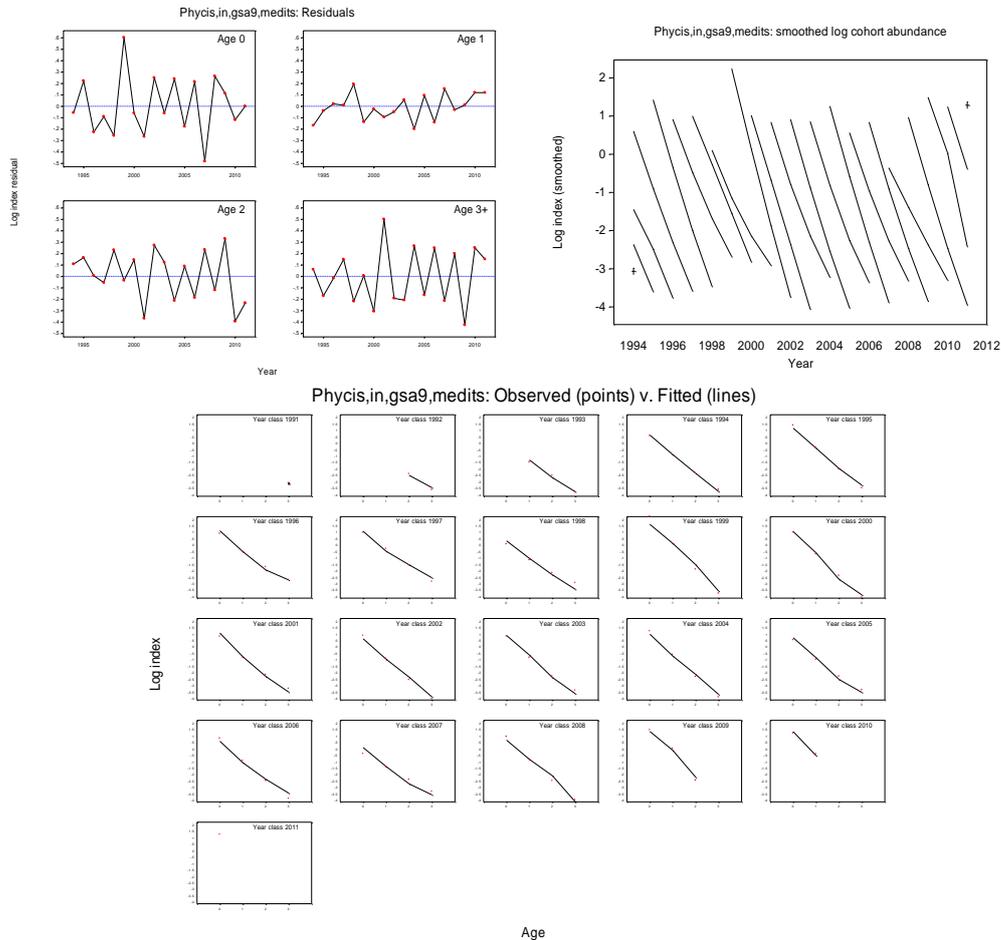


Fig. 6.6.4.2.3.2. Model diagnostic for SURBA of *P. blennoides* in the GSA 09; 1) Residual by age, 2) Log survey abundance indices by cohort. Each line represents the log index abundance of a particular cohort throughout its life and 3) Comparison between observed (points) and fitted (lines) MEDITS survey abundance indices, for each year.

6.6.5. Long term prediction

6.6.5.1. Justification

The yield per recruit (YPR) analysis was run using the results of the LCA using VIT.

6.6.5.2. Input parameters

Length frequency data (2011) and the biological parameters used were the same used for the LCA.

6.6.5.3. Results

YPR and Spawning Stock Biomass per recruit (SSBPR) output curves are illustrated in the Figure 6.6.5.3.1 while in Table 1.1.5.3.1 are reported the main results of the LCA analysis.

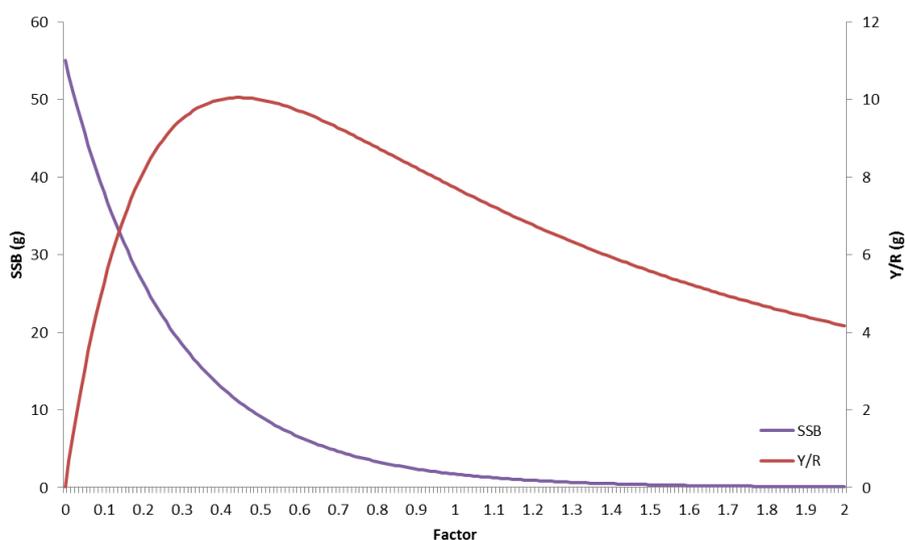


Fig. 6.6.5.3.1. LCA outputs: YPR and SSBPR curves of *P. blennoides* in the GSA 09.

Table 6.6.5.3.1. Main outputs of the LCA for greater forkbeard in GSA 09.

		Factor	Absolute F	Y/R	SSB/R	B/R
2011	F _{virgin}	0	0.00	0	102.6	55.07
	F _{0.1}	0.37	0.32	10.00	31.078	13.80
	F _{max}	0.46	0.40	10.14	24.40	10.19
	F _{current}	1.01	0.89	7.72	6.78	1.74

6.6.6. Data quality

MEDITS survey data were available from 1994 to 2011 as mean density and biomass per hour. Abundance trends per hour appear very consistent with those for square kilometers estimated for greater forkbeard in GSA 09. No particular problem was recognized concerning commercial data.

6.6.7. *Scientific advice*

6.6.7.1. Short term considerations

6.6.7.1.1.State of the stock size

Stock assessment has been computed using a Length Cohort Analysis (VIT software) run with DCF data of landings at age (2011). Results obtained did not show a clear trend in stock size. MEDITS survey indices show a variable pattern of abundance (n/h) and biomass (kg/h) without a clear trend. Spawning Stock Biomass trend obtained by SURBA show many variations in time with phase of high values followed by period of lower ones. In the last year SSB appear in a very low level condition. Since no stock size reference level for great fork beard in GSA09 has been proposed, EWG 12-19 cannot evaluate the stock status in relation to these.

6.6.7.1.2.State of recruitment

Yearly MEDITS length frequency distributions showed the presence of a first modal component, attributable to the young of the year, which was very stable over time.

6.6.7.1.3.State of exploitation

EWG 12-19 proposed $F_{0.1} = 0.32$ as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields. Taking into account the results obtained by the VIT analysis (current F is around 1.01), the stock is considered to be exploited unsustainably.

6.7. Stock assessment of Giant red shrimp in GSA 10

6.7.1. Stock identification and biological features

6.7.1.1. Stock Identification

The stock of giant red shrimp, *Aristaeomorpha foliacea* was assumed in the boundaries of the whole GSA10, lacking specific information on stock identity. This species and the blue-red shrimp, *Aristeus antennatus*, are deep-water decapods characterised by seasonal variability and annual fluctuations of abundance (Spedicato et al., 1994), as reported for different geographical areas (e.g. Relini and Orsi Relini, 1987). The giant red shrimp *A. foliacea* is distributed beyond 350 m depth, but mainly in water deeper than 500 m. Generally mean length estimated using trawl survey data varies remarkably with depth, for the whole population and the two sexes, increasing at deeper waters.

In the recent years *A. foliacea* was ranked among the more abundant species (in number and weight) in the trawl survey catches. Higher biomass indices occur particularly southwards the Gulf of Naples (Spedicato et al., 1994).

This species has a discrete recruitment pattern and during spring trawl surveys (MEDITS) the recruitment pulse is observed. Since the reproduction takes place in the late spring-summer, recruits could be attributed to the spawning events of the previous year (Spedicato et al., 1999). *A. foliacea* is considered fully recruited to grounds at ~24 mm CL (from Samed, AAVV, 2002). Recently a study at Mediterranean scale, using Medits data from 1994 to 2004, has evidenced that the higher abundance indices of recruits were observed in the central-southern Tyrrhenian Sea (AAVV, 2008).

In general the length frequency distributions of the giant red shrimp have a polymodal pattern, with 4-5 components for females (the modes of adults are less defined) and 2-3 components for the males. For the females a life span of 6-8 years was estimated. The structure of the sizes of *A. foliacea* is characterised by marked differences in growth between the sexes. The larger individuals are females and inhabit deeper waters.

Sex ratio values of ~0.5 show that males and females are not segregated into different bathymetric ranges (Spedicato et al., 1994). The reproduction period extends from May to September, with a peak in the summer (July-August) (Spedicato et al., 1999). Mature males have been observed all year round.

According to the benthic bionomic classification of Pérès and Picard (1964) *P. longirostris*, *N. norvegicus* and red-shrimps typify the populations of slope and bathyal bottoms in the GSA 10. Depending on the depth and zone, this fauna is accompanied by characteristic benthic species as *Funiculina quadrangularis*, *Geryon longipes*, *Polychaetes typhlops*, *Isidella elongata*, *Griphus vitreus*.

In the central-southern Tyrrhenian Sea the giant red shrimp represents a specific target of deep-waters trawling fishery given its high economic value (Spedicato et al., 1994).

6.7.1.2. Growth

Estimates of the growth pattern of the giant red shrimp in the GSA 10 were previously obtained using GRUND length frequency distributions from 1991 to 1995 and methods as Elefan and Batthacharya for the analysis of LFDs. Parameters of females were as follows: $CL_{\infty}=73.24$ mm; $K=0.483$; $t_0= -0.435$ (Spedicato et al., 1998). In the Samed project (AAVV, 2002) and using the Medits data from 1994 to 1999 a new set of parameters was estimated for the Tyrrhenian sea down the Strait of Messina (females: $L_{\infty}=73$ mm; $K=0.44$; $t_0= -0.05$; males: $L_{\infty}=48$ mm; $K=0.59$; $t_0= -0.2$). The observed maximum carapace length of females and males were 72 and 46 mm respectively.

Growth has been also studied in the DCF framework and in the Red Shrimps project (AAVV, 2008) through the analysis of the LFDs and the separation of modal components. These estimates have been done using both MEDITS and GRUND average length at putative age, where age was set according to the date of each survey with a birthday on 1st July.

Table 6.7.1.2.1 reports putative ages, mean carapace lengths with relative standard deviations for females.

The following 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 and fixing the asymptotic length on the basis of the observed maximum values: females $CL_{\infty}=72.5$ mm, $K=0.438$, $t_0= -0.1$; males: $CL_{\infty}=44$ cm, $K=0.5$, $t_0= -0.1$. These estimates are more accurate, although very close, to those previously obtained.

Average parameters of the length-weight relationship were $a=0.0014$, $b=2.622$ for females and $a=0.000848$, $b=2.78$ for males, for length expressed in mm.

Table 6.7.1.2.1. Putative age, mean length of modal components of the LFD of Medits and Grund survey and relative standard deviations.

putative age	mean CL	st. dev.	putative age	mean CL	st. dev.	putative age	mean CL	st. dev.
0.8	21.9	2.29	2.0	45.5	2.58	3.1	54.3	1.01
0.8	22.5	2.36	2.0	47.5	2.05	3.2	54.5	2.11
0.9	23.0	3.38	2.0	44.9	1.8	3.2	53.5	1.33
0.9	24.6	2.78	2.0	46.7	3.06	3.2	55.3	1.52
0.9	23.0	3.75	2.0	45.9	3.76	3.2	57.0	1.53
1.0	26.6	2.96	2.1	46.2	1.85	3.2	57.2	2.1
1.0	25.0	3.16	2.2	45.1	2.59	3.2	54.3	2.23
1.0	26.0	1.95	2.2	46.6	1.55	3.2	53.5	1.71
1.0	24.8	2.26	2.2	49.2	2.23	3.2	52.9	1.97
1.0	29.1	2.79	2.2	45.6	2.98	3.3	56.0	1.47
1.1	28.2	3.82	2.2	49.1	3.31	3.3	53.6	1.25
1.2	31.0	2.58	2.2	45.8	2.3	3.8	60.3	2.46
1.2	33.3	2.68	2.2	45.9	2.62	3.8	57.9	2.14
1.2	32.8	2.37	2.2	46.6	1.98	3.9	60.0	2.38
1.2	33.4	2.65	2.3	46.1	1.8	3.9	57.6	2.15
1.2	33.7	3.05	2.3	46.2	2.39	4.0	63.1	2.54
1.2	31.1	2.66	2.8	54.7	2.38	4.0	60.3	1.55
1.2	32.1	3.55	2.8	52.6	1.84	4.0	63.8	1.3
1.2	32.0	2.81	2.9	55.0	3.16	4.0	61.1	2.35
1.3	32.9	3.07	2.9	54.0	2.05	4.1	60.5	4.56
1.3	33.5	3.16	2.9	50.9	1.81	4.2	61.3	2.35
1.8	42.6	2.77	3.0	54.8	3.05	4.2	62.0	1.14
1.8	43.8	2.42	3.0	54.9	2.74	4.2	60.4	3.37
1.9	44.4	2.38	3.0	55.7	2.9	4.2	58.8	2.05
1.9	45.2	2.53	3.0	54.8	3.53	4.2	59.6	1.03
1.9	43.8	3.6	3.0	55.6	3.18	4.3	57.8	1.37

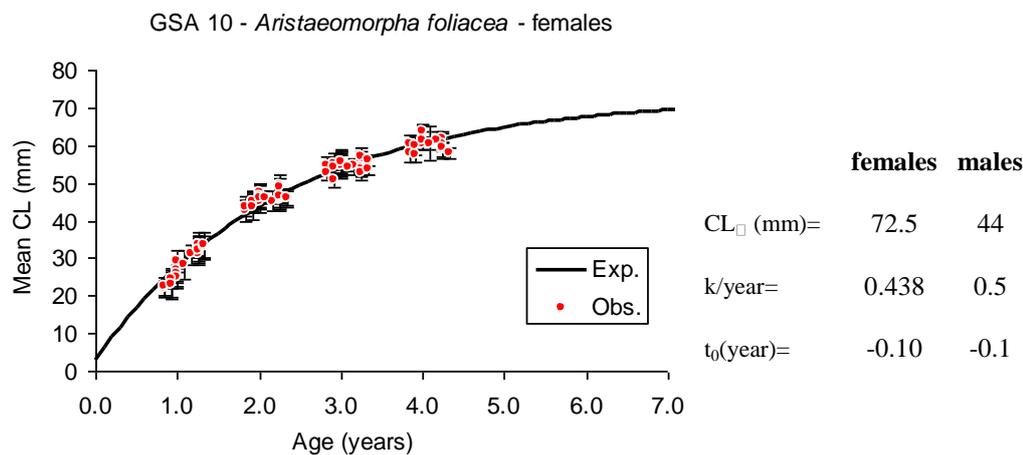


Fig. 6.7.1.2.1 . V. Bertalanffy growth functions and parameters for female of giant red shrimp in GSA10.

6.7.1.3. Maturity

The maturity ogive Figure 6.7.1.3.1 was obtained from a maximum likelihood procedure applied grouping as mature individuals belonging to the maturity stage 2b (according to the MEDITS maturity scale) onwards. The fitting of the curve was fairly good, however the estimates of the size at first maturity $L_{m50\%}$ (3.5 cm ± 0.023 cm) and of the maturity range (0.36 cm ± 0.020 cm), reported in the figure below, seem slightly lower if compared with literature values (average of the smallest females in the GSA ~34 mm CL; 39.6 mm carapace length according to Ragonese & Bianchini, 1995).

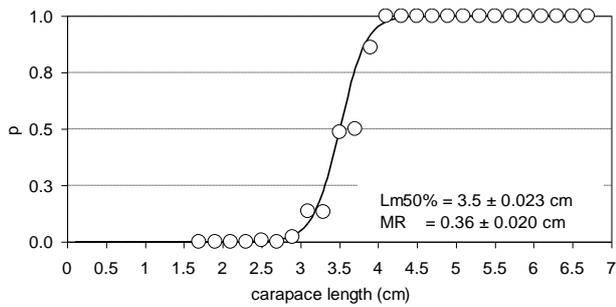


Fig. 6.7.1.3.1. Maturity ogive and proportions of mature female of giant red shrimp in the GSA10 (MR indicates the difference $Lm_{75\%} - Lm_{25\%}$).

The sex ratio from DCR evidenced the prevalence of males in the size class from 3.4 to 3.8 cm while from 4 cm onwards the proportion of females was dominant.

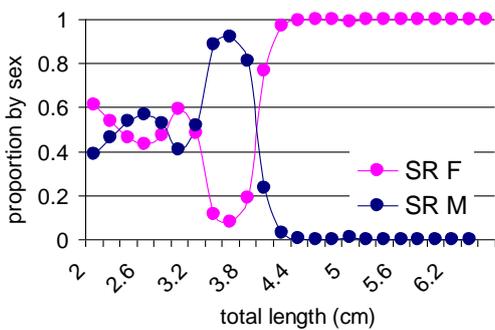


Fig. 6.7.1.3.2. Sex ratio of giant red shrimp in the GSA10

6.7.2. Fisheries

6.7.2.1. General description of fisheries

The Giant red shrimp is only targeted by trawlers and fishing grounds are located offshore 200 m depth, mainly southward Salerno Gulf. Catches from trawlers are from a depth range between 400 and 700 m depth and giant the red shrimp occurs with *A. antennaus*, *P. longirostris* and *N. norvegicus*, *P. blennoides*, *M. merluccius*, depending on operative depth and area.

6.7.2.2. Management regulations applicable in 2011 and 2012

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. Other measures on which the management regulations are based regard technical measures (mesh size) and minimum landing sizes (EC 1967/06).

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. 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, whilst in the last years it was mandatory.

In 2008 a management plan was adopted, that foresaw the reduction of fleet capacity associated with a reduction of the time at sea. Two biological conservation zone (ZTB) were permanently established in 2009 (Decree of Ministry of Agriculture, Food and Forestry Policy of 22.01.2009; GU n. 37 of 14.02.2009). One is located along the mainland, in front of Sorrento peninsula in the vicinity of the MPA of Punta Campanella (Napoli Gulf, 60 km², within 200 m depth)) and a second one is along the coasts of Amantea (Calabrian coasts, 75 km² up to 250 m depth)). In these areas trawling is forbidden and other fishing activities are allowed under permission. Since June 2010 the rules implemented in the EU regulation (EC 1967/06) regarding the cod-end mesh size and the operative distance of fishing from the coasts are enforced.

6.7.2.3. Catches

6.7.2.3.1. Landings

Available landing data are from DCF regulations. EWG 12-19 received Italian landings data for GSA 10 by fisheries which are listed in Table 6.7.2.3.1.1.

In general, demersal trawlers account for the total landing quantity. Landings are decreasing from 2006 to 2008 and then slightly increasing from 2008 to 2010. A new slight decrease is observed to 2011.

Table 6.7.2.3.1.1. Annual landings (tons) by fishery, from 2006 to 2011.

YEAR	GEAR	FISHERY	LANDINGS
2006	OTB		412
2007	OTB		291
2008	OTB		113
2009	OTB	DWSP	59
2009	OTB	MDDWSP	148
2010	OTB	DWSP	62
2010	OTB	MDDWSP	127
2011	GNS		6
2011	OTB		135

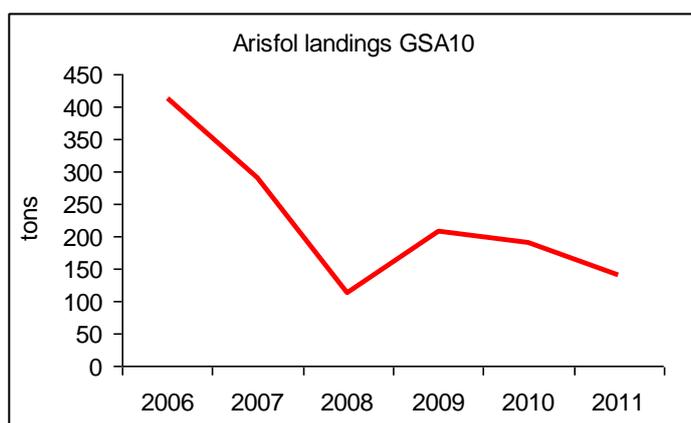


Fig. 6.7.2.3.1.1. Annual landings (tons) by fishery, from 2006 to 2011, giant red shrimp GSA10.

6.7.2.3.2. Discards

Discards data of 2009, 2010 and 2011 were available. The proportion of the discards of giant red shrimp in the GSA 10 was generally negligible.

6.7.2.4. Fishing effort

The trends in fishing effort by year and major gear type in terms of kW*days are listed in Table 6.7.2.4.1 and in Figure 6.7.2.4.1.

Table 6.7.2.4.1. Effort (kW*days) for GSA 10 by gear type, 2004-2011 as reported through the DCF official data call.

AREA	COUNTRY	GEAR	2004	2005	2006	2007	2008	2009	2010	2011
SA 10	ITA	DRB	86505	294424	312180	144186	238122	188909	209574	196692
SA 10	ITA	FPO		314508	153589					156
SA 10	ITA	GND	369729	128153	676640	443277	496680	435913	112632	44621
SA 10	ITA	GNS	4362276	5038906	3024622	2226520	2506323	2525668	2782604	2963679
SA 10	ITA	GTR	3671219	1745574	4394209	3883167	3208597	2450304	2689599	2611624
SA 10	ITA	LLD	1823662	1138482	1013389	361358	387768	1471790	2469932	2130245
SA 10	ITA	LLS	7079323	1811552	1493720	1185423	1399622	1010226	1272999	1695680
SA 10	ITA	LTL								6324
SA 10	ITA	none	7799360	4540824	3986171	3370493	2539043	3487970	2681538	2106037
SA 10	ITA	OTB	6970928	8028733	7156787	7112581	5724631	5997764	5603044	5234759
SA 10	ITA	PS	5807234	2502000	1781508	1783526	1188917	1903718	1652686	1567061
SA 10	ITA	PTM	6995							

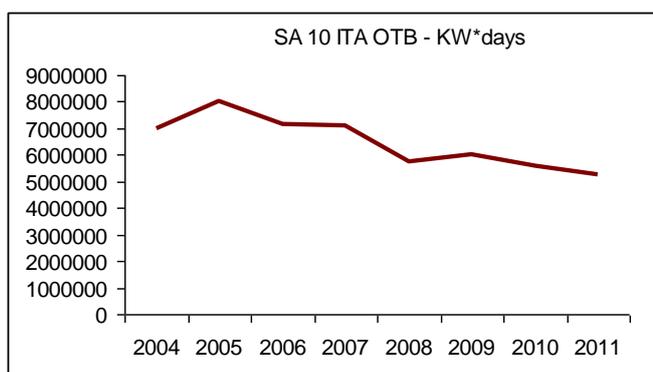


Fig. 6.7.2.4.1. Fishing effort of trawlers (KW*days)

The fishing effort of trawlers that is the major component of fishing in the area is decreasing.

6.7.3. Scientific surveys

6.7.3.1. MEDITS

6.7.3.1.1. Methods

According to the MEDITS protocol (Bertrand et al., 2002), trawl surveys were yearly (May-July) carried out, applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small sub-areas and maintained fixed throughout the time). Haul allocation was proportional to the stratum area. The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end, was employed throughout the years. Detailed data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention was assumed. All the abundance data (number of fish and weight per surface unit) were standardised to square kilometre, using the swept area method.

Based on the DCF data call, abundance and biomass indices were recalculated with a standardization to the hour. In GSA 18 the following number of hauls was reported per depth stratum (Table 6.7.3.1.1.1).

Table 6.7.3.1.1.1. Number of hauls per year and depth stratum in GSA 18, 1994-2011.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
GSA10_010-050	7	8	8	8	8	8	8	8	7	7	7	7	7	7	7	7	7	7
GSA10_050-100	10	10	10	10	10	10	10	10	8	8	8	8	8	8	8	8	8	8
GSA10_100-200	17	17	17	17	17	17	17	17	14	14	14	14	14	14	14	14	14	14
GSA10_200-500	22	23	22	22	22	22	22	24	18	18	18	18	18	18	18	19	18	18
GSA10_500-800	28	27	28	28	28	27	28	26	23	23	23	23	23	23	22	23	23	23

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Y_{st} = \sum (Y_i * A_i) / A$$

$$V(Y_{st}) = \sum (A_i^2 * s_i^2 / n_i) / A^2$$

Where:

A=total survey area

A_i=area of the i-th stratum

s_i=standard deviation of the i-th stratum

n_i=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Y_i=mean of the i-th stratum

Y_{st}=stratified mean abundance

V(Y_{st})=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = $Y_{st} \pm t(\text{student distribution}) * \sqrt{V(Y_{st}) / n}$

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution and/or quasi-poisson. Indeed, data may be better modeled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represent the number of individual per km² (Cochran, 1977).

6.7.3.2. Grund

6.7.3.2.1.Methods

Since 2003 GRUND surveys (Relini, 2000) was conducted using the same sampler (vessel and gear) in the whole GSA. Sampling scheme, stratification and protocols were similar as in MEDITS. All the abundance and biomass data were standardised to the square kilometre, using the swept area method.

6.7.3.2.2.Geographical distribution patterns

The geographical distribution pattern of the giant red shrimp has been studied in the area using trawl-survey data, length frequency distribution analyses via modal component separation techniques and geostatistical methods. The abundance of the whole population, as derived from both Medits and Grund surveys, was higher in the southern part of the GSA along the Calabrian coasts as well as the abundance of recruits (Figure 6.7.3.2.2.1). The probability of find a nursery area was the highest in the same zone with a high temporal continuity.

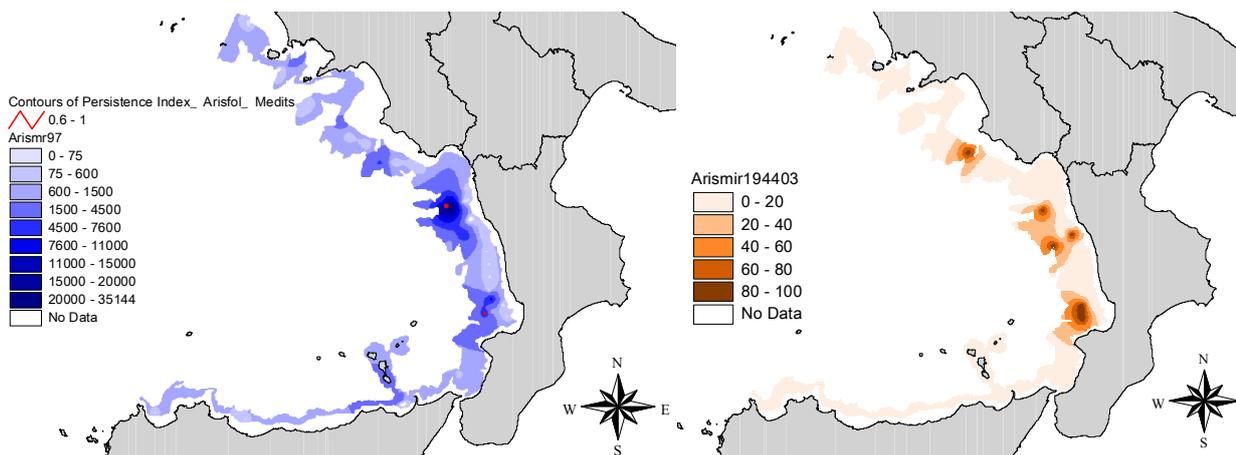


Fig. 6.7.3.2.2.1. Maps of the abundance of the giant red shrimp recruits (left) and of the probability of nursery localization (right) from MEDITS survey of 1997 and 2003 respectively. The contour of persistence is also evidenced in the map of abundance.

6.7.3.2.3. Trends in abundance and biomass

Fishery independent information regarding the state of the giant red shrimp in GSA 10 was obtained from the international survey MEDITS. Figure 6.7.3.2.3.1 displays the estimated trend of *A. foliacea* abundance and biomass standardized to the surface unit in GSA 10. Indices from MEDITS trawl-surveys show a fluctuating pattern with two peaks in 1997, 2005 and 2010, but without any trend (Figure 6.7.3.2.3.1). The more recent values are decreasing.

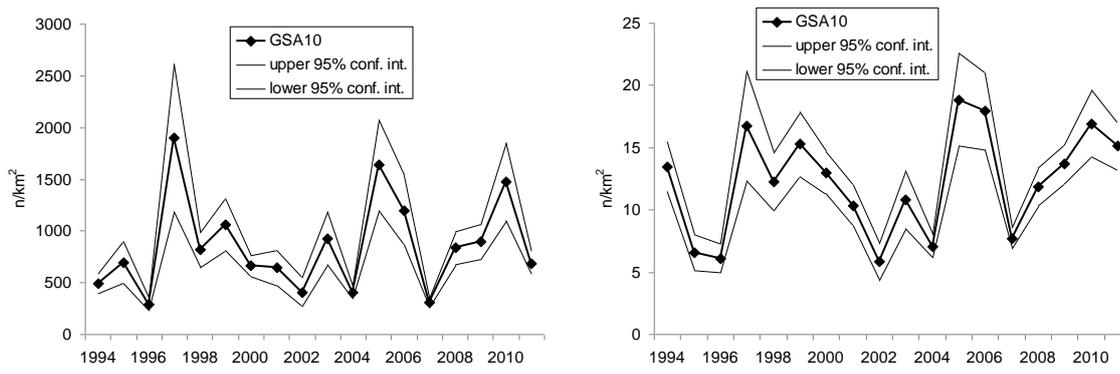


Fig. 6.7.3.2.3.1. Abundance and biomass indices of pink shrimp in GSA 10.

Trends derived from the GRUND surveys are shown in the following figure. Abundance and biomass indices show some peaks and fluctuations, but without any trend, as well as recruitment indices (Figure 6.7.3.2.3.2). Higher values are recorded in 2003 and 2005. Although less variable, the pattern is similar to that observed in the MEDITS series.

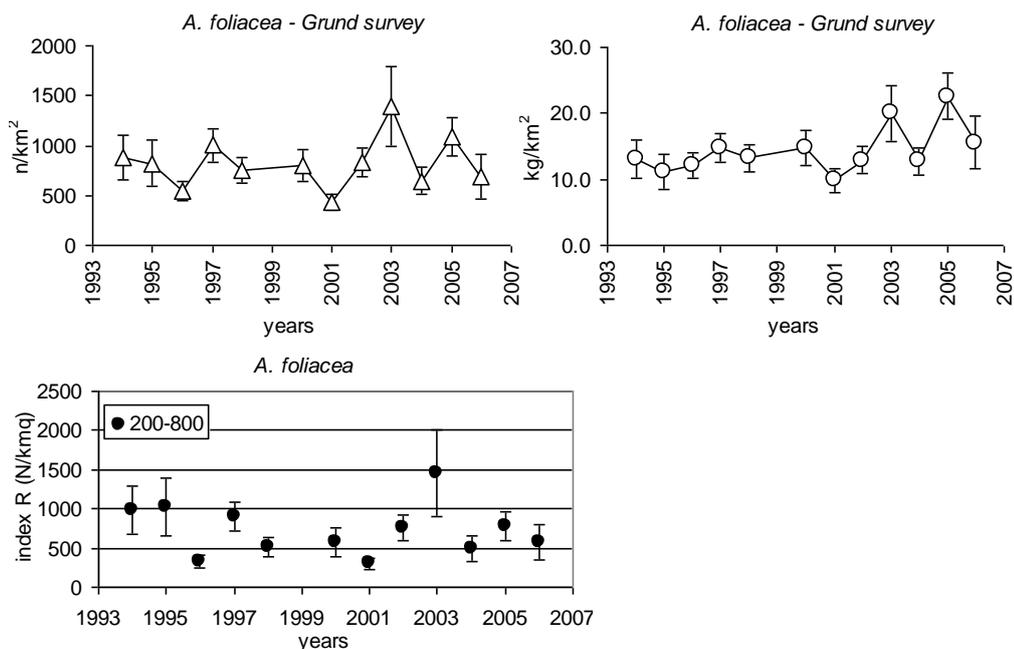
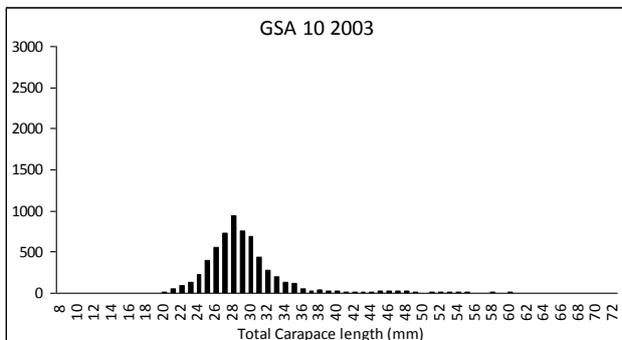
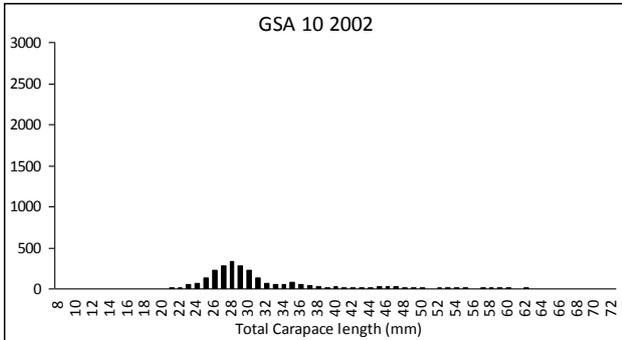
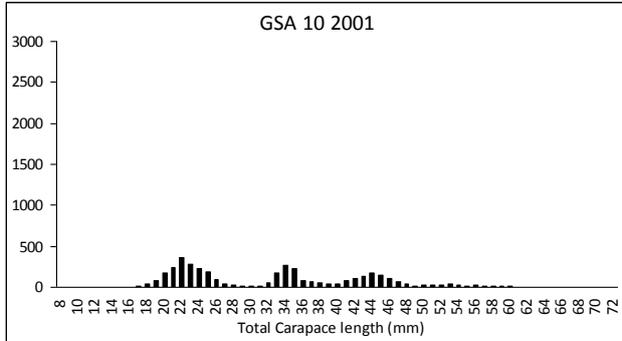
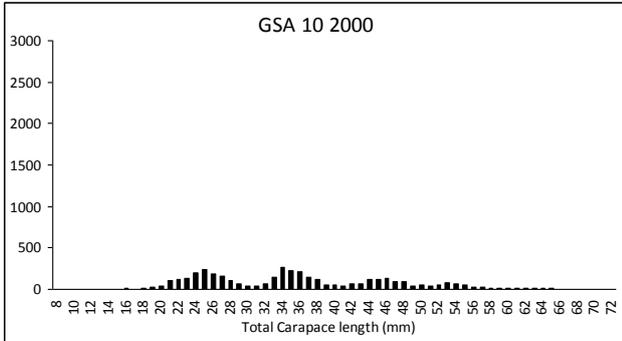
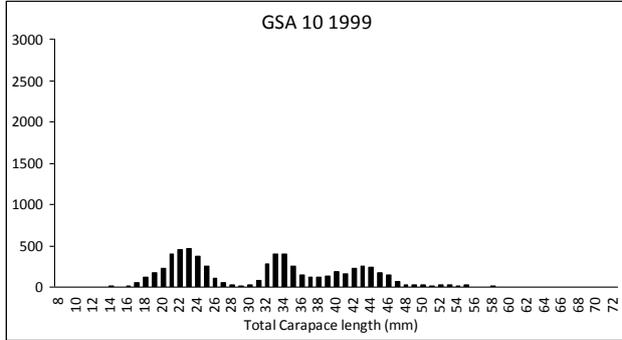
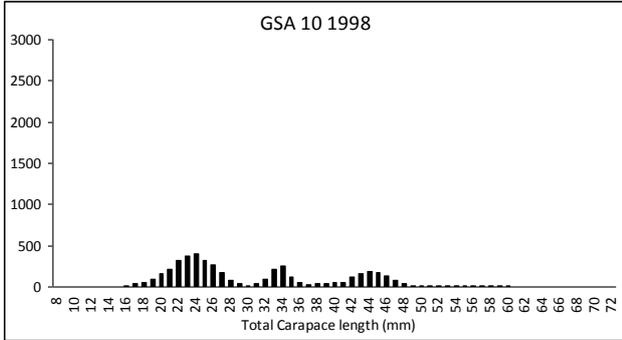
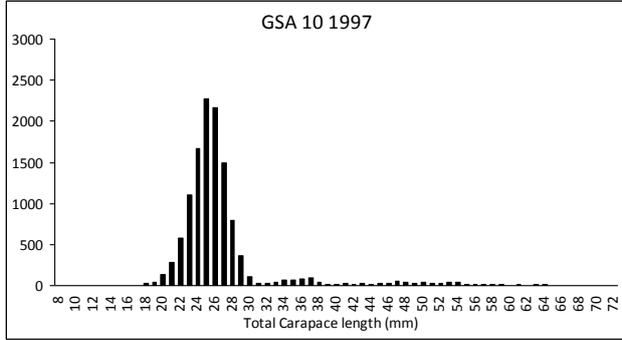
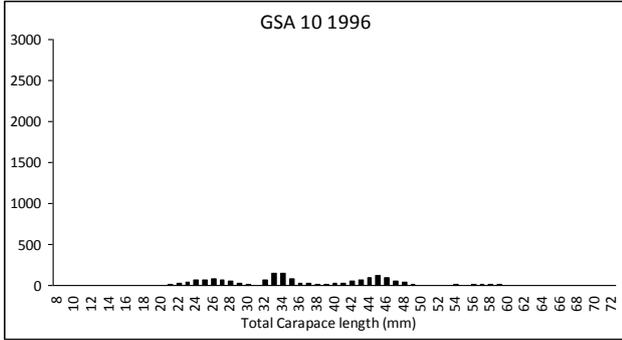
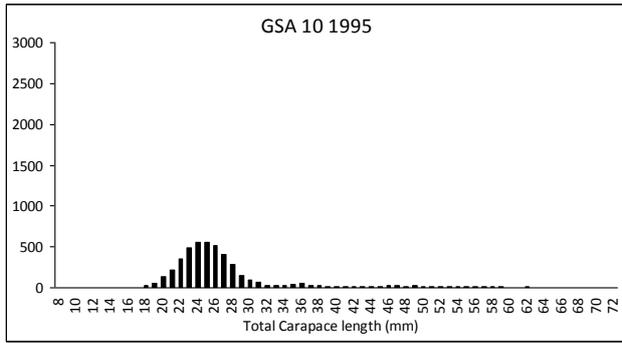
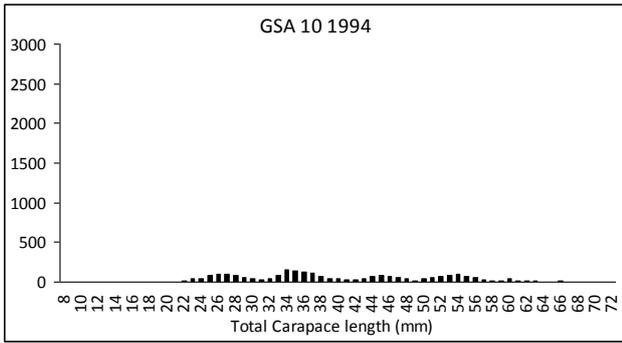


Fig. 6.7.3.2.3.2. Abundance and biomass indices of giant red shrimp in GSA 10 (bars indicate standard deviations) derived from GRUND surveys. Recruitment indices (N/km^2) computed in the stratum 200-800 m depth with standard deviation are also reported.

6.7.3.2.4. Trends in abundance by length or age

No trend in the mean length was observed. The LFDs are rather varying throughout the MEDITS surveys, mainly for the recruitment strength that determines a dominance of the juvenile component in the LFDs of 1997, 2005, 2008, and 2010.

The following Figure 6.7.3.2.4.1 displays the stratified abundance indices of GSA 10 in 1994-2011.



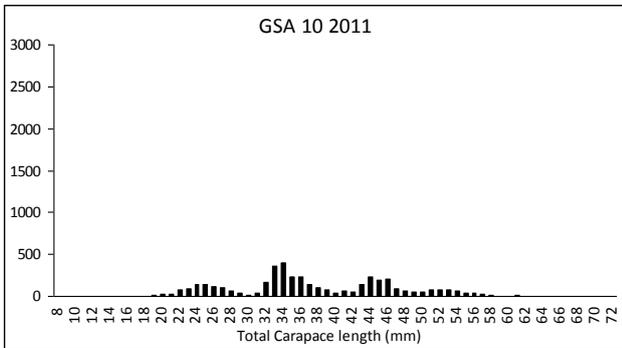
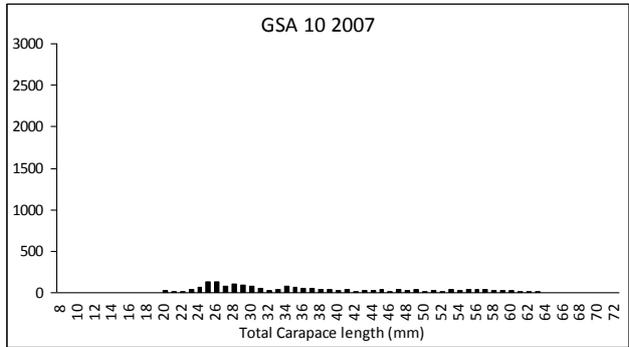
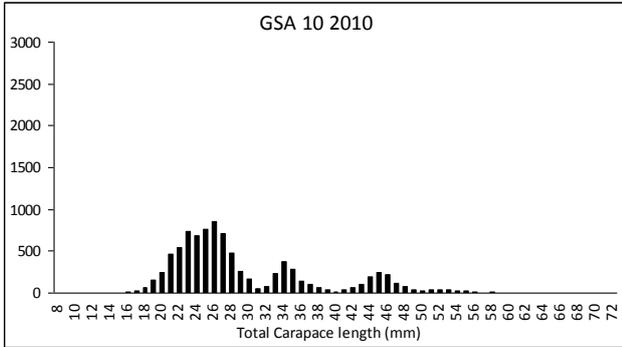
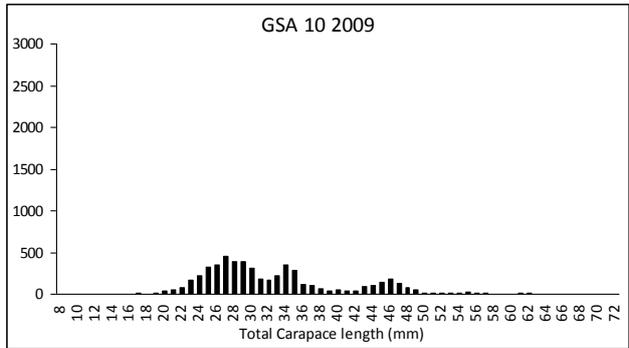
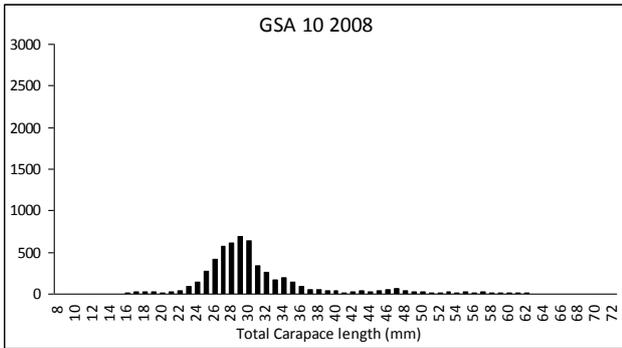
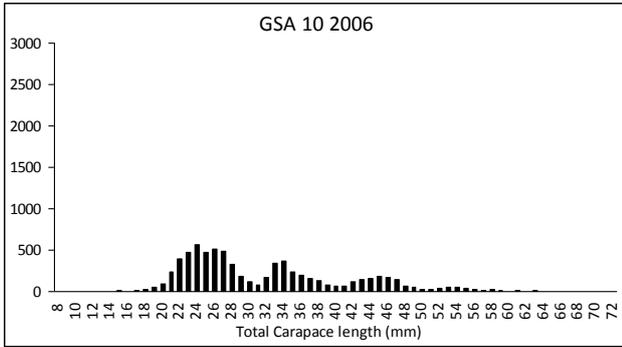
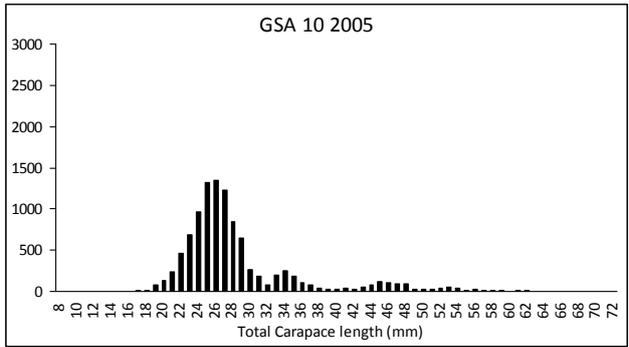
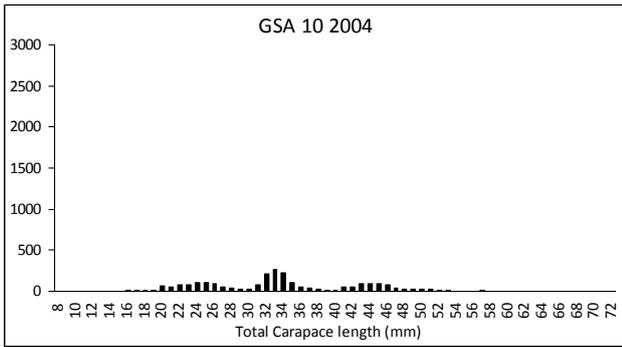


Fig. 6.7.3.2.4.1. Stratified abundance indices by size, 1994-2011.

6.7.3.2.5.Trends in growth abundance by length or age

No analyses were conducted during EWG-12-19.

6.7.3.2.6.Trends in maturity

No analyses were conducted during EWG-12-19.

6.7.4. Assessment of historic stock parameters

6.7.4.1. Method 1: Surba

6.7.4.1.1.Justification

SURBA software was applied using MEDITS abundance estimates by length to get indicative pattern of mortalities from fishery-independent data source (MEDITS survey).

6.7.4.1.2.Input parameters

The age groups were estimated from the age slicing (LFDA algorithm) using the following growth parameters:

Females: CL_{∞} =73 mm, K/year=0.438; t_0 (year)= -0.10; Males: CL_{∞} =50 mm, K/year=0.5; t_0 (year)= -0.10.

Age slicing was conducted on separate sexes and numbers were combined thereafter. A 4+ group was used.

Table 6.7.4.1.2.1. Age groups obtained after the statistical age slicing procedure and used as input in SURBA

Year	age groups			
	1	2	3	4+
1994	50	124	91	18
1995	168	39	20	3.7
1996	42	97	20	3.9
1997	529	81	40	8.4
1998	146	154	31	6
1999	214	226	47	4.9
2000	81	156	88	10.2
2001	99	136	45	3.2
2002	122	67	25	6.8
2003	288	161	23	4.8
2004	59	136	19	0.5
2005	497	181	44	6.9
2006	242	227	86	8.4
2007	56	56	42	13.6
2008	261	153	34	7.7
2009	197	214	56	10.8
2010	333	223	56	4.8
2011	71	234	86	8.1

The age group 0 was removed in the analysis because of a noising effect partly due to a not fully recruitment to the gear/survey and partly to the recruitment pattern of the species.

The other settings of the model, regarding natural mortality, catchability, maturity and weight at age, are reported in the table below. Natural mortality vector for the two scenarios were obtained applying the Prodbiom method (Abella et al., 1997) and calculation sheet provided by the author.

Table 6.7.4.1.2.2. SURBA settings related to the natural mortality (M), the catchability coefficient q, the proportion of mature and the weight at age in the slow and fast growth scenarios.

Age	1	2	3	4+
M	0.44	0.3	0.23	0.2
q	1	1	1	1
Proportion mature	0.1	1	1	1
Weight (kg)	0.012583	0.020861	0.025111	0.032549

The setting for F range was 1-3.

6.7.4.1.3.Results

Estimates of total mortality from SURBA, for sex combined presented in Table 6.7.4.1.3.1.

Table 6.7.4.1.3.1. Relative estimates of total mortality Z and spawning stock biomass SSB from SURBA, for sex combined.

Year	Original		Smoothed	
	SSB	Z	SSB	Z
1994	1.161	1.759	1.423	1.845
1995	0.346	0.951	0.409	1.045
1996	0.569	0.366	0.626	0.712
1997	0.764	1.364	0.692	1.103
1998	0.919	0.865	1.126	1.032
1999	1.329	0.929	1.148	1.167
2000	1.24	1.346	0.999	1.214
2001	0.882	1.325	0.698	1.215
2002	0.505	0.814	0.549	1.277
2003	0.937	2.239	0.637	1.462
2004	0.716	0.34	0.84	0.825
2005	1.205	1.061	1.012	1.037
2006	1.571	1.665	1.432	1.14
2007	0.575	0.397	0.882	0.942
2008	0.972	0.783	0.787	0.904
2009	1.36	1.224	1.151	0.8
2010	1.395	1.08	1.665	0.91
2011	1.555	NA	1.925	NA

The temporal trend of f and the mean F estimates in the age range 1-3 years showed a high variable pattern, also reflected in the Z estimates and in the SSB indices.

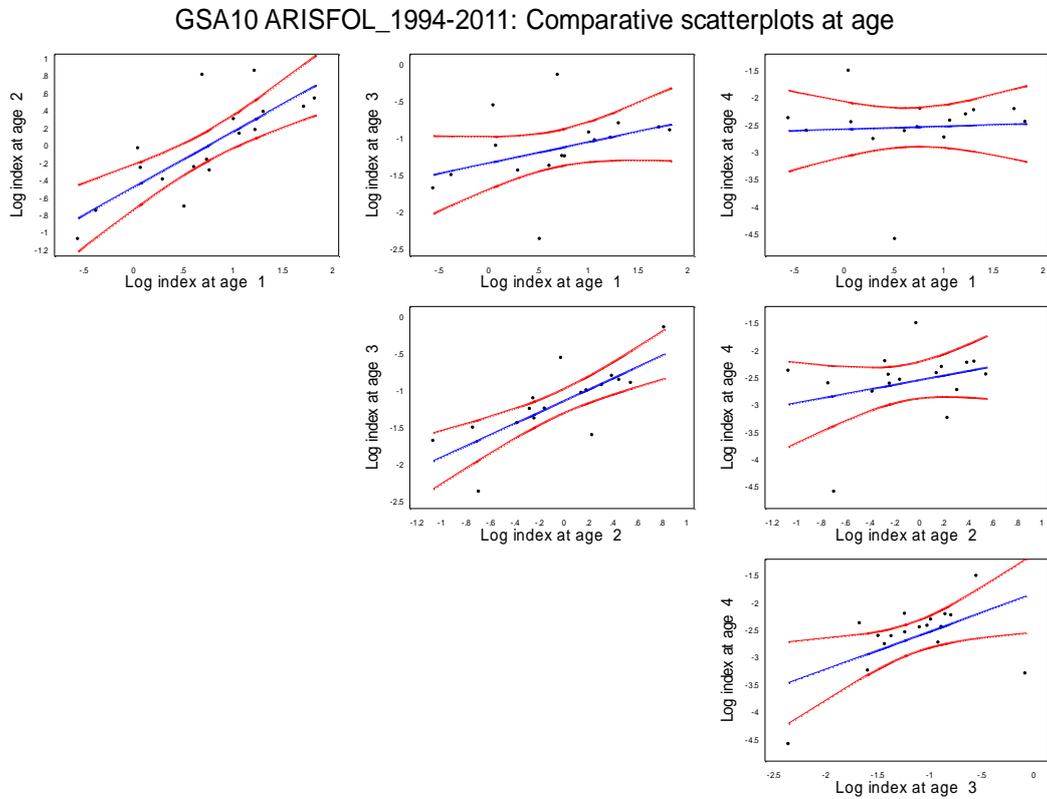


Fig. 6.7.4.1.3.1. Scatter plots of log indices at consecutive ages from SURBA, giant red shrimp GSA10.

GSA10 ARISFOL_1994-2011

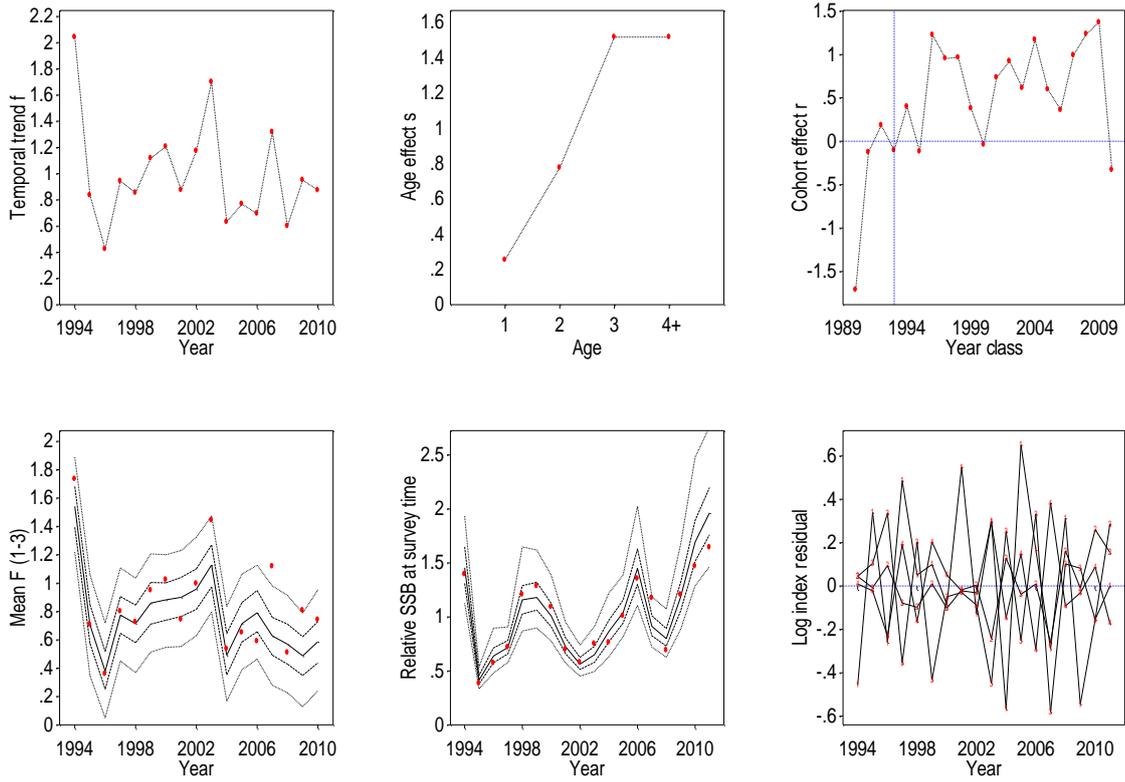


Fig. 6.7.4.1.3.2. Trends in various stock parameters from SURBA, giant red shrimp GSA10.

GSA10 ARISFOL_1994-2011

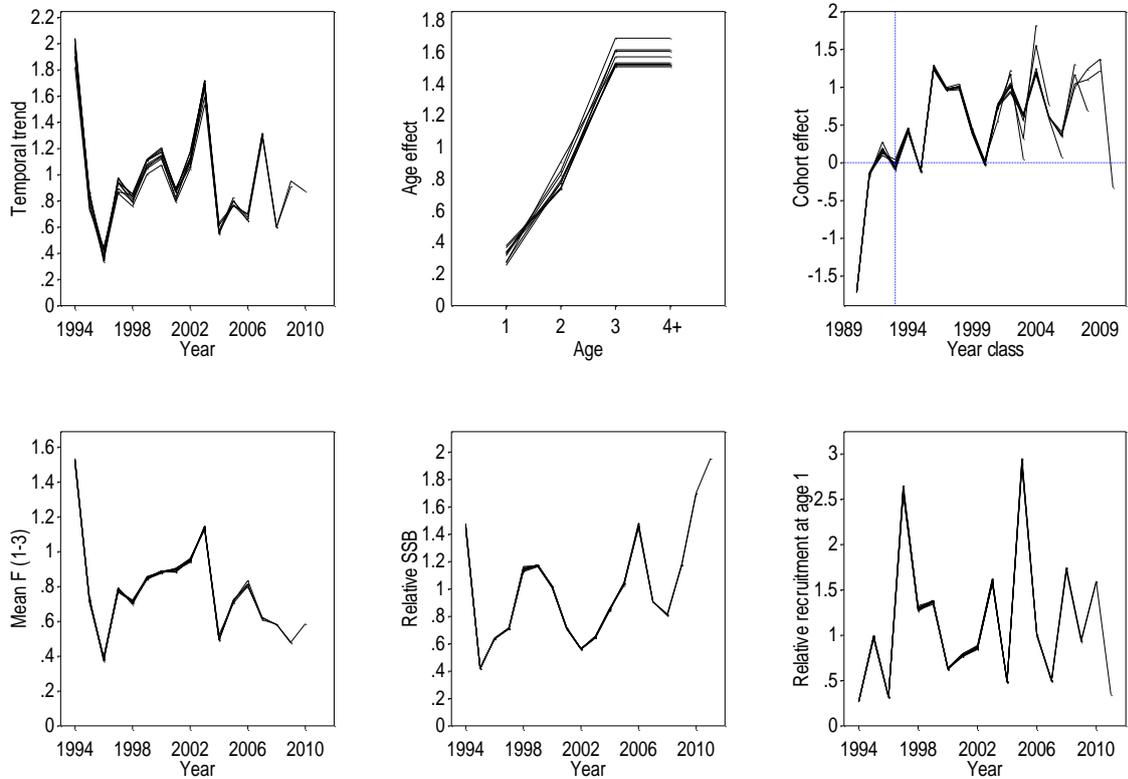


Fig. 6.7.4.1.3.3. Retrospective analysis from SURBA, giant red shrimp GSA10.

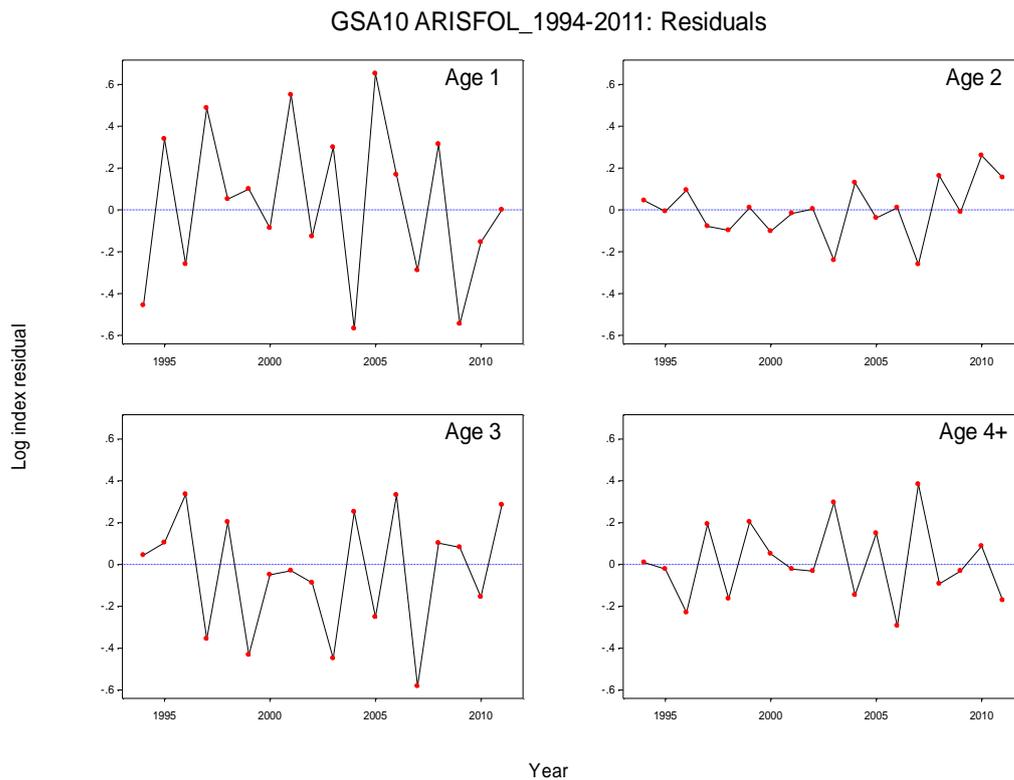


Fig. 6.7.4.1.3.4. Residuals from SURBA, giant red shrimp GSA10.

The retrospective analysis showed also a highly variable pattern of the recruitment with several peaks, especially in 1997 and 2005. Residuals varied without any trend and showed more variability for older ages. Comparative age scatterplots showed consistent patterns between consecutive ages.

6.7.4.2. Method 2:XSA

6.7.4.2.1.Justification

The assessment of giant red shrimp in GSA 10 has been performed during this EWG for the first time. In the last 2012 data call the data from 2006 to 2011 have been provided; the time series from 2006 to 2011 has been considered covering the mean life span of the species, allowing to assess the stock using XSA method. The age distributions from age class 1 to 4+ have been used.

6.7.4.2.2.Input parameters

For the assessment of giant red shrimp stock in GSA 10 the DCF official data on the length structure has been divided in males and females length structures by means of sex ratio by length; the age distributions by sex have been estimated using the age slicing method (LFDA algorithm) and then the resulting distributions were summed up. The DCF official landing data of commercial catch have been used. A sex combined analysis was carried out. The maturity at age has been estimated using the maturity at length transformed to ages by slicing procedure. The natural mortality has been calculated using PRODBIOM (Abella, 1998). The survey indices from MEDITS data from 2006 to 2011 have been used for the tuning.

The age distribution is showed in the graph and in the table below:

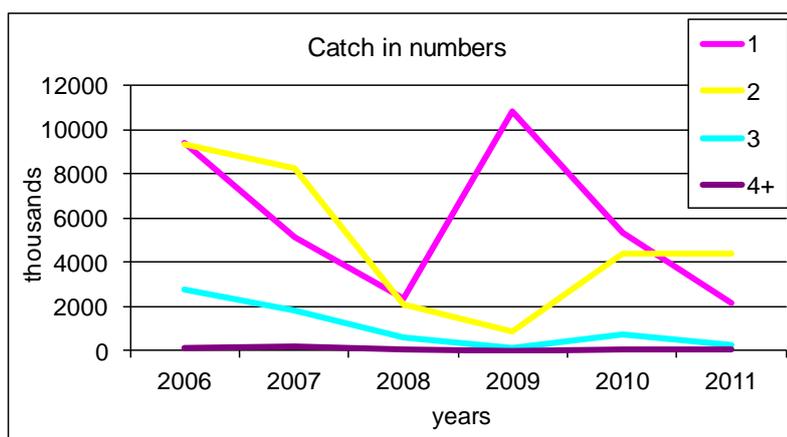


Fig. 6.7.4.2.2.1. Catch in numbers by age and year used in the XSA.

The other inputs are reported in the tables below:

Table 6.7.4.2.2.1. Catch in numbers by age and year used in the XSA.

Catch in numbers (thousands)	age 1	age 2	age 3	age 4+
2006	9434	9342	2755	155
2007	5140	8294	1803	216
2008	2399	2117	578	79
2009	10866	855	160	32
2010	5379	4421	766	70
2011	2200	4386	294	49

Table 6.7.4.2.2.2. Weights at age used in the XSA (used for the stock and the catch).

Weight at age (kg)	age 1	age 2	age 3	age 4+
2006	0.012	0.020	0.021	0.032

2007	0.012	0.019	0.027	0.032
2008	0.011	0.029	0.022	0.025
2009	0.014	0.032	0.052	0.056
2010	0.012	0.020	0.025	0.032
2011	0.012	0.024	0.029	0.035

Table 6.7.4.2.2.3. Indices from MEDITS survey used in the XSA.

Survey indices (n/km ²)	age 1	age 2	age 3	age 4+
2006	242	227	86	7
2007	56	56	42	12
2008	261	153	34	7
2009	197	214	56	9
2010	333	224	56	4
2011	71	234	86	7

Table 6.7.4.2.2.4. Proportion of matures at age used in the XSA.

Maturity	age 1	age 2	age 3	age 4+
0.1	1	1	1	1

Table 6.7.4.2.2.5. Natural mortality at age used in the XSA.

Natural mortality			
age 1	age 2	age 3	age 4+
0.44	0.30	0.23	0.20

Table 6.7.4.2.2.6. Growth parameters and length-weight relationship coefficient used in PRODBIOM.

Growth parameters	
CLinf	73
K	0.438
t ₀	-0.1
a	0.0014
b	2.62

6.7.4.2.3. Results

A separable VPA as exploratory analysis has been performed in order to detect the presence of conflicts among the ages under the assumption that the exploitation pattern is constant. The log-catchability residuals in Table 6.7.4.2.3.1 and Figure 6.7.4.2.3.1 do not show particular conflicts.

Table 6.7.4.2.3.1. Log-catchability residuals of the separable VPA.

Log-catchability residuals	2006	2007	2008	2009	2010
1/2	-0.097	-0.134	-0.051	0.64	-0.357
2/3	0.222	0.304	0.117	-1.452	0.81

Separable VPA - Residuals

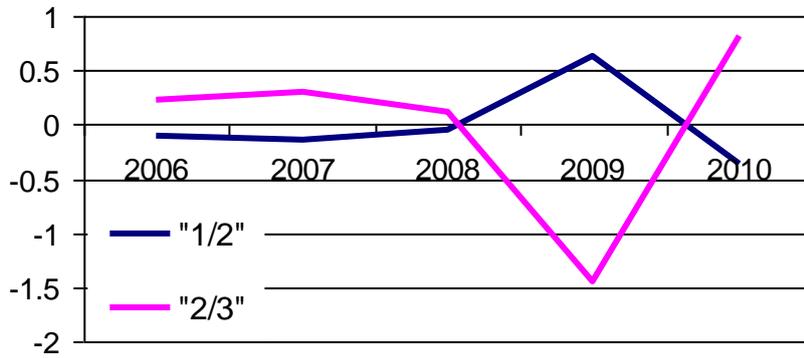


Fig. 6.7.4.2.3.1. Log-catchability residuals of the separable VPA.

The XSA run with the following settings has been performed:

- Catchability independent on stock size for all ages;
- Catchability independent of age for ages ≥ 2 ;
- Minimum standard error for population estimates derived from each fleet = 0.300.

Three runs have been performed with S.E. of the mean to which the estimates are shrunk equal to 1, 1.5 and 2 and the run with 1.5 has been chosen on the basis of the residuals and of the retrospective analysis.

The log-catchability residuals are listed in the table below:

Tab. 6.7.4.2.3.2. Log-catchability residuals of XSA.

Age	2006	2007	2008	2009	2010	2011
1	-0.27	-0.817	0.94	-0.206	0.237	0.017
2	-0.117	-0.953	0.389	0.475	0.248	-0.144
3	-0.065	-0.052	0.019	0.067	-0.157	0.057

Log-catchability residuals at age by year Sh15_MEDITS survey

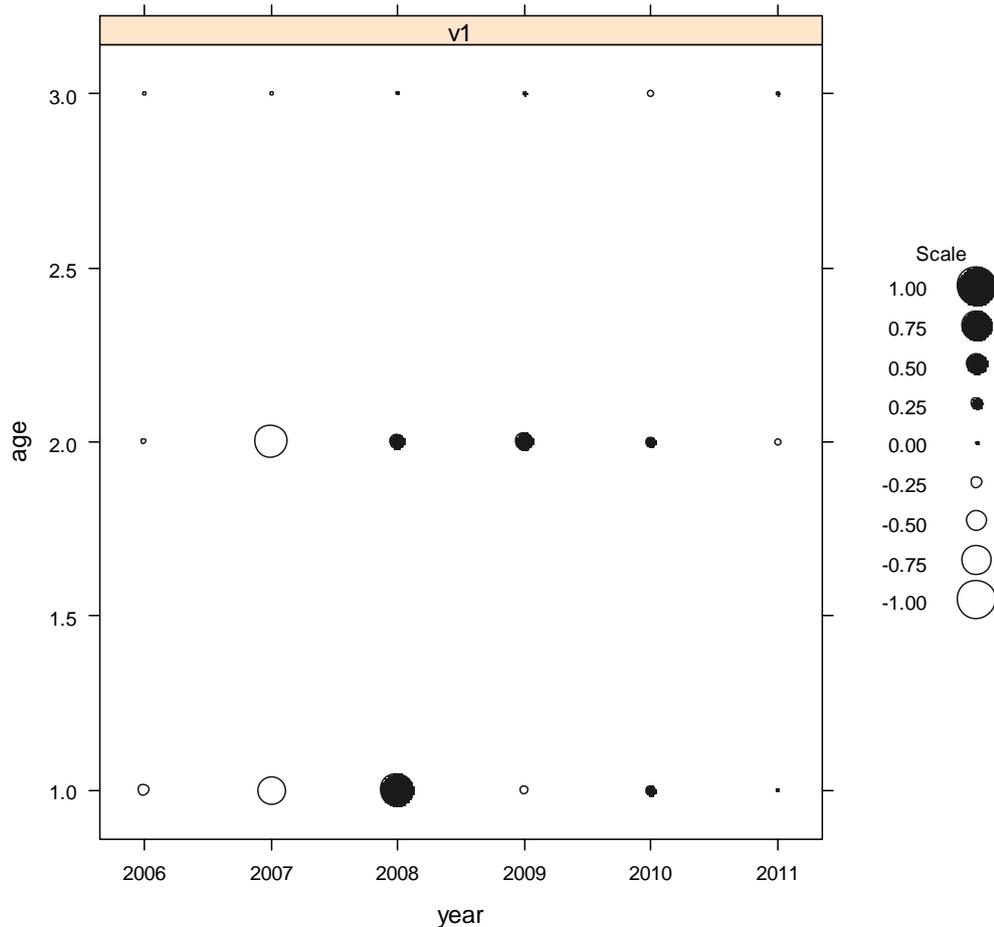


Fig6.7.4.2.3.2. Log-catchability residuals of the XSA.

The residuals do not show any particular trend. The other results produced by XSA are:

Tab. 6.7.4.2.3.3 Fishing mortality by year estimated with XSA.

Fishing mortality	2006	2007	2008	2009	2010	2011
1	0.51	0.68	0.41	0.75	0.36	0.54
2	1.41	1.93	0.88	0.31	1.06	0.72
3	1.22	1.52	0.76	0.15	0.54	0.18
4+	1.22	1.52	0.76	0.15	0.54	0.18
$F_{\text{bar}}(1-3)$	1.05	1.38	0.69	0.40	0.65	0.48

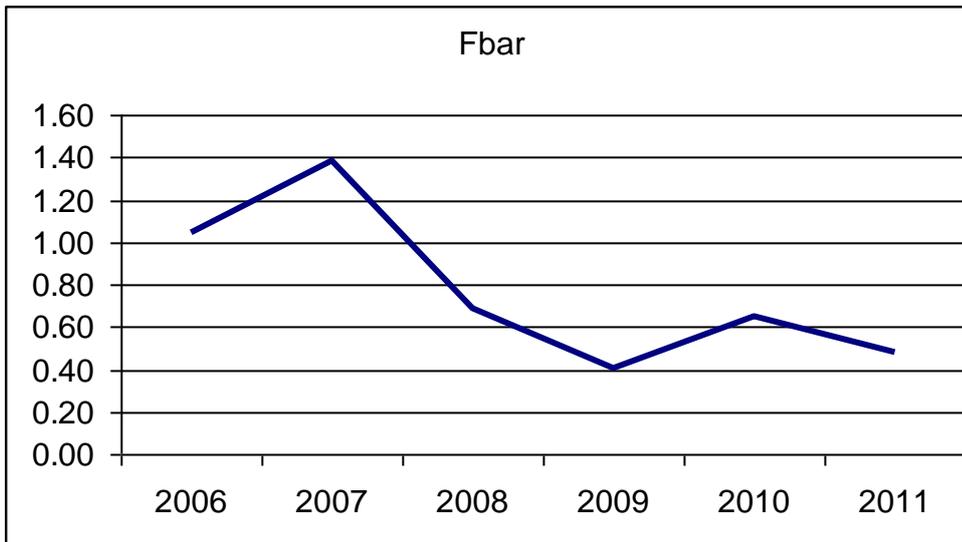


Fig. 6.7.4.2.3.3. Estimated fishing mortality by year ($F_{\text{bar}(1-3)}$).

Tab. 6.7.4.2.3.4. Stock in numbers (thousands) estimated by age and year.

Stock numbers (thousands)	2006	2007	2008	2009	2010	2011
1	29262	12923	8861	25775	22098	6552
2	14346	11275	4198	3781	7880	9916
3	4393	2587	1214	1288	2065	2033
4+	242	301	163	256	239	335
TOTAL	48243	27086	14436	31100	32282	18836

Sh1.5

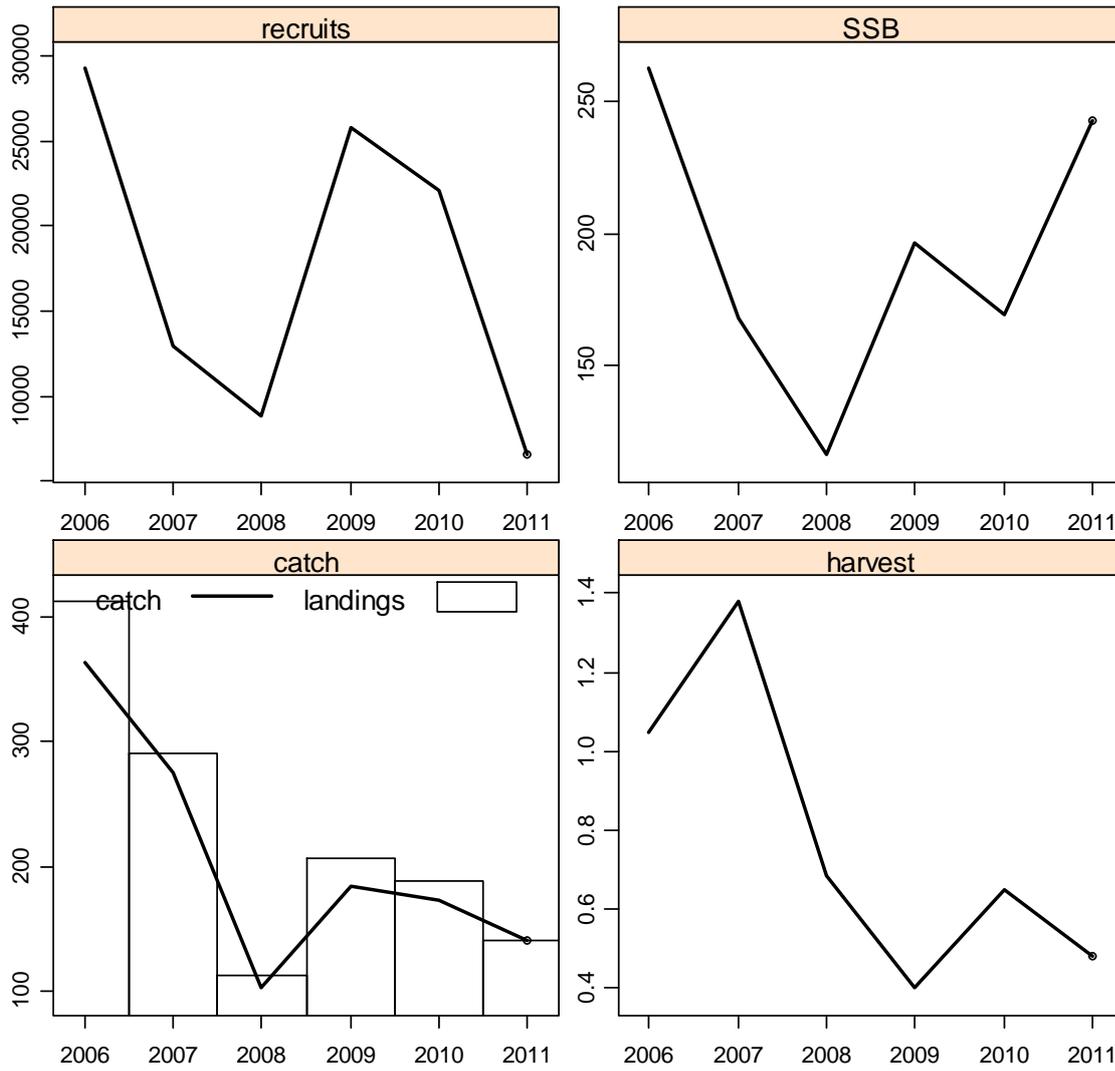
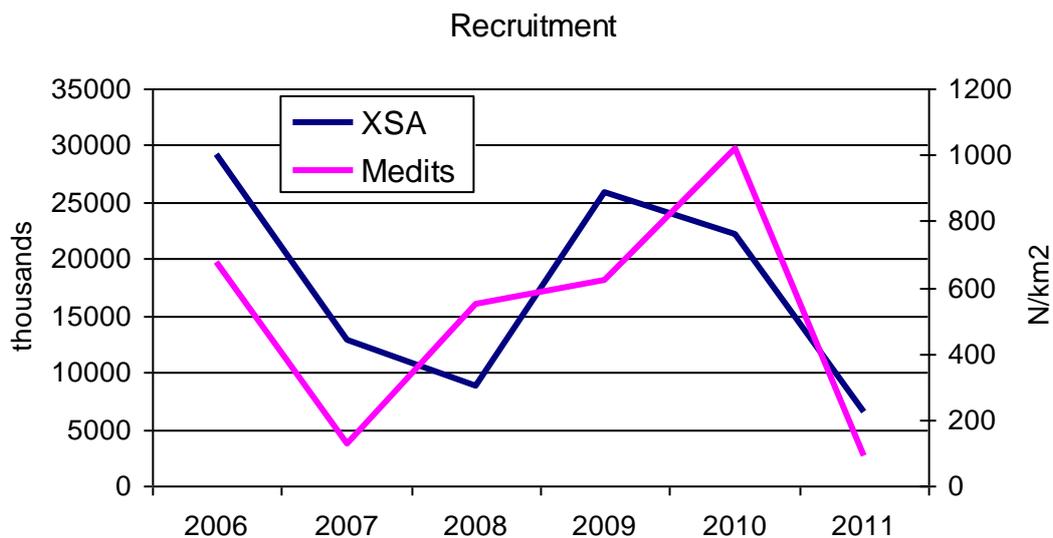


Fig. 6.7.4.2.3.4. Estimated recruitment, $F_{\text{bar}}(1-3)$ and SSB by year.



6.7.4.2.3.5. Trends in recruitment from MEDITS survey and estimated from XSA.

Moreover, the recruitment estimated by XSA and recruitment indices by MEDITS survey present mainly a shape quite consistent, as well as the fishing mortality estimated by SURBA and XSA show the same decreasing pattern.

The retrospective analysis shows a decreasing SSB until 2008 followed by an increase until 2011, also truncating one and two years. Moreover, the same shape for F is reconstructed truncating one and two years. More variability there is in the recruitment estimates, though the same shape characterizes the two cases.

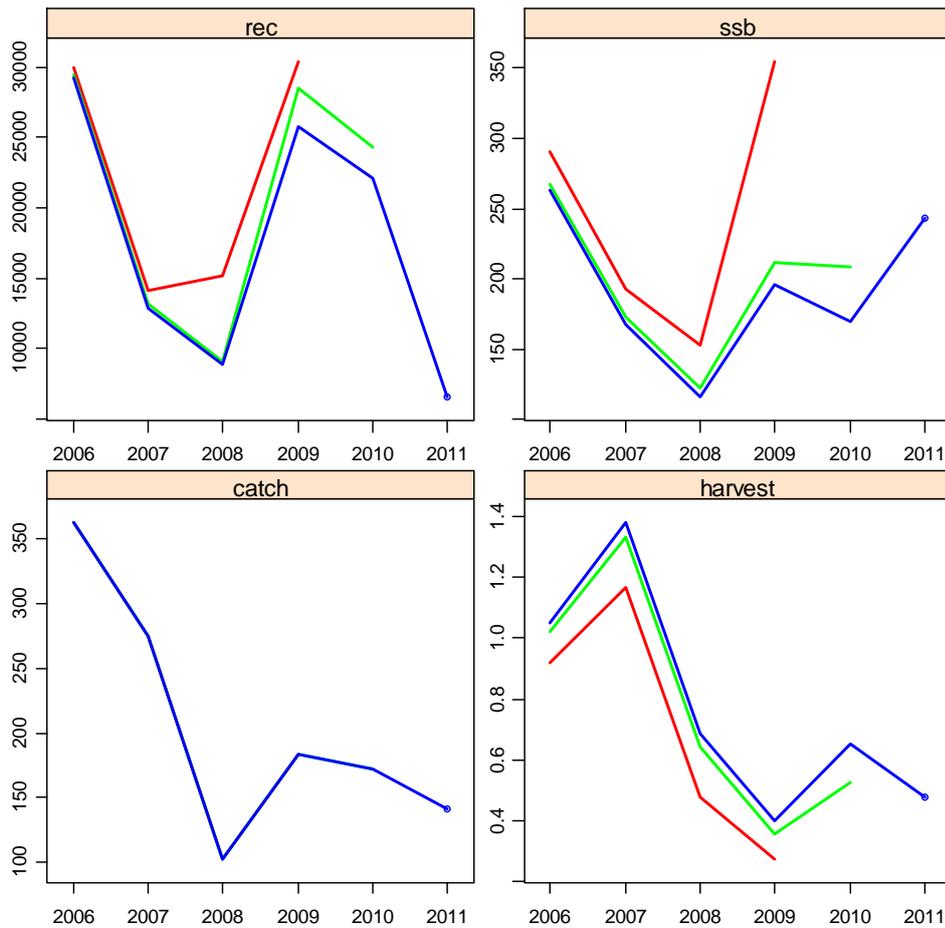


Fig. 6.7.4.2.3.6. Retrospective analysis of the XSA.

From the results obtained with XSA method, the recruitment shows, as the SSB, a decrease until 2008 with one important peak in 2009 followed by a new decrease until 2011. The fishing mortality shows the same pattern among the years until the value of 0.48 in 2011.

6.7.5. Long term prediction

6.7.5.1. Justification

Yield per recruit analysis has been conducted by means of VIT software using the data of 2011 to estimate BRPs.

6.7.5.1.1. Input parameters

The same input parameters used for XSA have been used in VIT to perform the Y/R analysis.

6.7.5.1.2. Results

The $F_{0.1}$ and F_{max} obtained by VIT software are respectively 0.4 and 0.74 although the estimated Yield-per-Recruit curve is not well dome-shaped. $F_{0.1}$ is used in the advice as proxy of F_{msy} .

6.7.6. *Data quality and availability*

Data from DCF 2011 were used. Assessments were performed for the submitted time series 2006-2011. A consistent sum of products compared with landing and discard was observed (difference less than 10%). Discards data of 2009, 2010 and 2011 were available. In 2009, 2010 and 2011 data were provided by year and metier, in 2007 and 2008 by fleet segment. Information on number of samples for landings, discards and catches, as well as the number of measurements by length for landings, discards and catches were also available.

6.7.7. *Scientific advice*

6.7.7.1. Short term considerations

6.7.7.1.1.State of the spawning stock size

EWG 12-19 is unable to fully evaluate the state of the spawning stock due to the absence of proposed or agreed management reference points. However, survey indices indicate an increasing pattern of biomass in the recent years.

6.7.7.1.2.State of recruitment

In 1997, 2005 and 2010 the MEDITS surveys indicated peaks in recruitment.

6.7.7.1.3.State of exploitation

EWG 12-19 proposes $F_{msy} \leq 0.4$ as limit management reference point consistent with high long term yields. Thus, given the results of the present analysis ($F_{current}=0.48$), the stock appeared to have been exploited unsustainably during 2006-2011. A reduction of F of about 20% would be thus necessary in order to avoid future loss in stock productivity and landings.

6.8. Stock assessment of Blue and red shrimp in GSA 10

6.8.1. Stock identification and biological features

6.8.1.1. Stock Identification

Recent studies based on microsatellite DNA analysis have evidenced genetic differences between the central-southern Tyrrhenian Sea (Sardinia and north Sicily) populations and north Tyrrhenian-Ligurian Sea and Algeria populations (AAVV, 2008, EU Project, Ref. Fish/2004/03-32). Given the preliminary state of these outcomes and in the lack of other specific analyses, the stock of blue and red shrimp *Aristeus antennatus* was assumed to be confined in the boundaries of the whole GSA10. This species and the giant red shrimp *Aristaeomorpha foliacea* are deep-water decapods characterised by seasonal variability and large annual fluctuations of abundance (Spedicato et al., 1995) as reported for different geographical areas (e.g. Orsi Relini and Orsi Relini, 1987). The blue and red shrimp is mainly distributed beyond 500 m depth.

The depth factor appears to influence the sex ratio, which is generally dominated by the females (sex ratio ~0.8-0.9) at 500-700 m depth, as sexes are partially segregated into different bathymetric ranges (e.g. Sardà et al., 2004). The spawning period extends from April to October-November with a peak in July-August (Spedicato et al., 1995). Males are matures all year round. The smallest mature female observed in the area was 18 mm carapace length.

Considering the length of the spawning season, the recruitment has an almost continuous pattern, although there are no clear and well separated peaks of recruit abundance in the LFDs, because this fraction of the population is not fully recruited to the fishery. Indeed, from MEDITS and GRUND surveys, individuals less than 20 mm are in general about 2% and, according to the current literature knowledge on the growth pattern, they should already been older than 1 year (16 mm average length at 1 year; e.g. Orsi Relini and Relini, 1998; Orsi Relini et al., 2012).

In general the length frequency distributions of the blue and red shrimp have a pattern with overlapping modes and poorly separable components. For the females a life span of 6-10 years was estimated. The structure of the sizes of *A. antennatus* is characterised by marked differences in growth between the sexes. The larger individuals are females.

According to the benthic bionomic classification of Pérès and Picard (1964) *P. longirostris*, *N. norvegicus* and red-shrimps characterize the populations of slope and bathyal bottoms in the GSA 10. Depending on the depth and zone, this fauna is accompanied by characteristic bentic species as *Funiculina quadrangularis*, *Geryon longipes*, *Polychaetes typhlops*, *Isidella elongata*, *Griphus vitreus*.

In the central-southern Tyrrhenian Sea the blue and red shrimp is part of the deep-waters fishery assemblage targeted by trawling.

6.8.1.2. Growth

In the central-southern Tyrrhenian the maximum carapace length (CL) observed in females and males was 65 mm and 39.7 mm (Spedicato et al., 1995). After estimates of VBGF obtained in the past, growth has been also recently re-assessed in the DCR framework and in the Red Shrimps project (AA.VV., 2008) through the analysis of the LFDs. Given their characteristics, that makes difficult the separation of the LFDs into normal components and the use of methods as Elefan, the LFDs have been analysed according to the procedure first adopted in the SAMED project (AA.VV., 2002). Thus, a L_{max} (predicted maximum length; procedure implemented in FiSAT) value to be used as guess estimate of L_{∞} was computed. This value was then tuned with that obtained from the Powell and Wetherall approach, which gives also estimates of the Z/K ratio. According to the hypothesis of a slow growth pattern (Orsi Relini and Relini, 1998; 2012) age 1 at a mean size of 16 mm was assumed and a first estimate of K derived from the ratio: average length at age 1/ L_{∞} . Thus also a first value of Z was obtained. These parameters were finally calibrated through the Length Converted Catch Curve (LCCC) and the set giving the better determination coefficient was adopted: females CL_{∞} =66 mm, K =0.243, t_0 = -0.2. Parameters of the length-weight relationship were a =0.85, b =2.41 for females and a =0.77, b =2.47 for males, for length expressed in cm.

6.8.1.3. Maturity

The maturity ogive was estimated using a binomial generalized linear models (GLMs) with logistic link to model the proportion of adult individuals on the length as independent variable (ICES, 2008). Individuals with maturity stage 2b onwards were considered as mature. The value of $CL_{m50\%}$ was 25.58 cm (± 0.015 cm) (Figure 6.8.1.3.1).

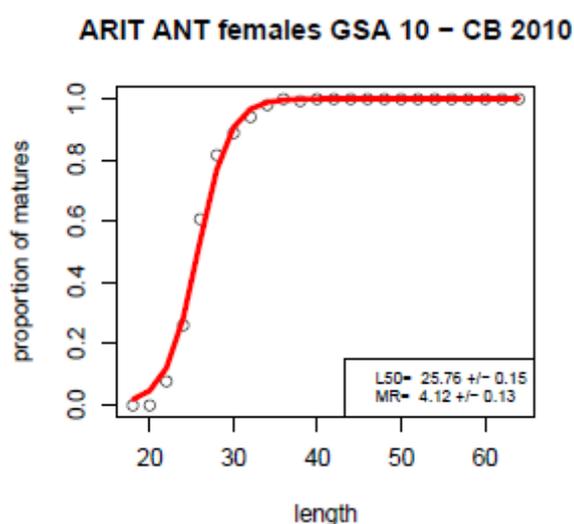


Fig. 6.8.1.3.1. Maturity ogive of blue and red shrimp in the GSA10 (MR indicates the difference $L_{m75\%}$ - $L_{m25\%}$).

The sex ratio evidenced the prevalence of males in the first two size classes (1.8-2.0 cm) while from 2.4 cm onwards the proportion of females was dominant.

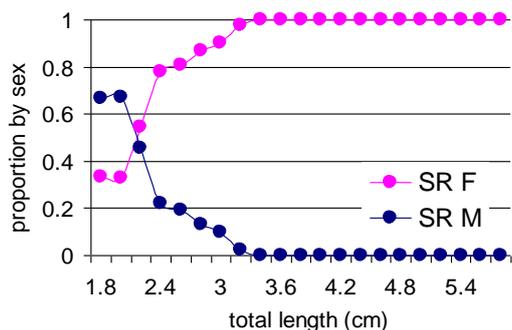


Fig. 6.8.1.3.2. Sex ratio blue and red shrimp in the GSA10.

6.8.2. Fisheries

6.8.2.1. General description of fisheries

The blue and red shrimp is only targeted by trawlers and fishing grounds are located offshore 200 m depth. Catches from trawlers are from a depth range between 400 and 700 m depth; the blue and red shrimp occurs with *A. foliacea*, *P. longirostris* and *N. norvegicus*, *P. blennoides*, *M. merluccius*, depending on operative depth and area.

6.8.2.2. Management regulations applicable in 2011 and 2012

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. Other measures on which the management regulations are based regard technical measures (mesh size) and minimum landing sizes (EC 1967/06).

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.

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, whilst in the last years it was mandatory.

In 2008 a management plan was adopted, that foresaw the reduction of fleet capacity associated with a reduction of the time at sea. Two biological conservation zone (ZTB) were permanently established in 2009 (Decree of Ministry of Agriculture, Food and Forestry Policy of 22.01.2009; GU n. 37 of 14.02.2009). One is located along the mainland, in front of Sorrento peninsula in the vicinity of the MPA of Punta Campanella (Napoli Gulf, 60 km², within 200 m depth) and a second one is along the coasts of Amantea (Calabrian

coasts, 75 km² up to 250 m depth)). In these areas trawling is forbidden and other fishing activities are allowed under permission. Since June 2010 the rules implemented in the EU regulation (EC 1967/06) regarding the cod-end mesh size and the operative distance of fishing from the coasts are enforced.

6.8.2.3. Catches

6.8.2.3.1. Landings

Available landing data are from DCF regulations. EWG 12-19 received Italian landings data for GSA 10 by level 4 which are listed in Table 6.8.2.3.1.1. Data of 2011 were provided off-line by the team in charge of DCF data collection in the area.

In general, demersal trawlers account for the total landing quantity. Landings are decreasing from 2006 to 2008 and then slightly increasing from 2008 to 2009. After a new slight decrease is observed in 2010 followed by a remarkable increase in 2011 (a value close to that of 2006).

Table 6.8.2.3.1.1. Annual landings (tons) by fishery, from 2006 to 2011.

YEAR	Level 4	LANDINGS
2006	OTB	51.6
2007	OTB	39.5
2008	OTB	23.0
2009	OTB	27.4
2010	OTB	20.1
2011	OTB	48.5

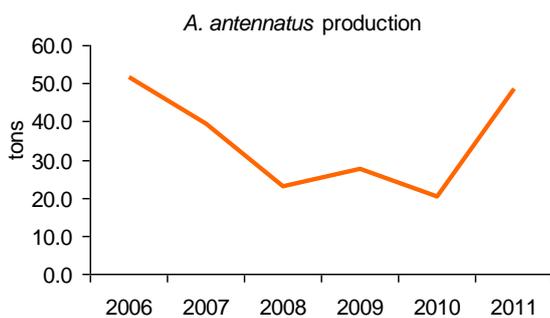


Fig. 6.8.2.3.1.1. Annual landings (tons) by fishery, from 2006 to 2011, blue and red shrimp GSA10.

6.8.2.3.2. Discards

Discards are not occurring for this species in the area.

6.8.2.4. Fishing effort

The trends in fishing effort by year and major gear type in terms of kW*days are listed in Table 6.8.2.4.1 and in Figure 6.8.2.4.1.

Table 6.8.2.4.1. Effort (kW*days) for GSA 10 by gear type, 2004-2011 as reported through the DCF official data call.

AREA	COUNTRY	GEAR	2004	2005	2006	2007	2008	2009	2010	2011
SA 10	ITA	DRB	86505	294424	312180	144186	238122	188909	209574	196692
SA 10	ITA	FPO		314508	153589					156
SA 10	ITA	GND	369729	128153	676640	443277	496680	435913	112632	44621
SA 10	ITA	GNS	4362276	5038906	3024622	2226520	2506323	2525668	2782604	2963679
SA 10	ITA	GTR	3671219	1745574	4394209	3883167	3208597	2450304	2689599	2611624
SA 10	ITA	LLD	1823662	1138482	1013389	361358	387768	1471790	2469932	2130245
SA 10	ITA	LLS	7079323	1811552	1493720	1185423	1399622	1010226	1272999	1695680
SA 10	ITA	LTL								6324
SA 10	ITA	none	7799360	4540824	3986171	3370493	2539043	3487970	2681538	2106037
SA 10	ITA	OTB	6970928	8028733	7156787	7112581	5724631	5997764	5603044	5234759
SA 10	ITA	PS	5807234	2502000	1781508	1783526	1188917	1903718	1652686	1567061
SA 10	ITA	PTM	6995							

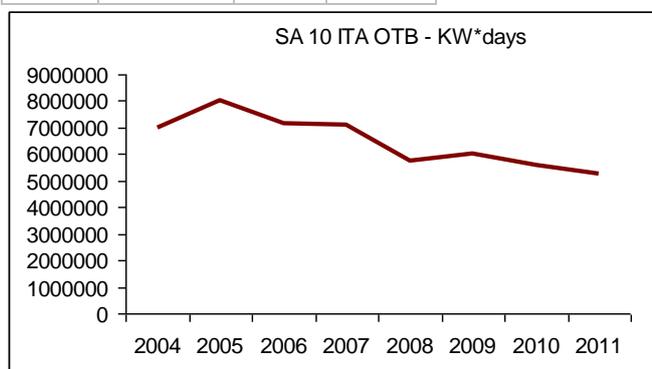


Fig. 6.8.2.4.1. Fishing effort of trawlers (KW*days)

The fishing effort of trawlers that is a major component of fishing in the area is decreasing.

6.8.3. Scientific surveys

6.8.3.1. MEDITS

6.8.3.1.1. Methods

According to the MEDITS protocol (Bertrand et al., 2002), trawl surveys were yearly (May-July) carried out, applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m;

each haul position randomly selected in small sub-areas and maintained fixed throughout the time). Haul allocation was proportional to the stratum area. The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end, was employed throughout the years. Detailed data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention was assumed. All the abundance data (number of fish and weight per surface unit) were standardised to square kilometre, using the swept area method.

Based on the DCF data call, abundance and biomass indices were recalculated with a standardization to the hour. In GSA 18 the following number of hauls was reported per depth stratum (Table 6.8.3.1.1.1).

Table 6.8.3.1.1.1. Number of hauls per year and depth stratum in GSA 10, 1994-2011.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
GSA10_010-050	7	8	8	8	8	8	8	8	7	7	7	7	7	7	7	7	7	7
GSA10_050-100	10	10	10	10	10	10	10	10	8	8	8	8	8	8	8	8	8	8
GSA10_100-200	17	17	17	17	17	17	17	17	14	14	14	14	14	14	14	14	14	14
GSA10_200-500	22	23	22	22	22	22	22	24	18	18	18	18	18	18	19	18	18	18
GSA10_500-800	28	27	28	28	28	27	28	26	23	23	23	23	23	23	22	23	23	23

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Y_{st} = \sum (Y_i * A_i) / A$$

$$V(Y_{st}) = \sum (A_i^2 * s_i^2 / n_i) / A^2$$

Where:

A=total survey area

A_i=area of the i-th stratum

s_i=standard deviation of the i-th stratum

n_i=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Y_i=mean of the i-th stratum

Y_{st}=stratified mean abundance

V(Y_{st})=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = $Y_{st} \pm t(\text{student distribution}) * V(Y_{st}) / n$

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution or a quasi-poisson. Indeed, data may be better modeled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represent the number of individual per km² (Cochran, 1977).

6.8.3.2. Grund

6.8.3.2.1.Methods

Since 2003 GRUND surveys (Relini, 2000) was conducted using the same sampler (vessel and gear) in the whole GSA. Sampling scheme, stratification and protocols were similar as in MEDITS. All the abundance and biomass data were standardised to the square kilometre, using the swept area method.

6.8.3.2.2.Geographical distribution patterns

The geographical distribution pattern of the blue and red shrimp has been studied in the area using trawl-survey data. The abundance of the female population, as estimated from both MEDITS and GRUND surveys, was higher in the southern part of the GSA along the Cilento and Calabrian coasts (Figure 6.8.3.2.2.1).

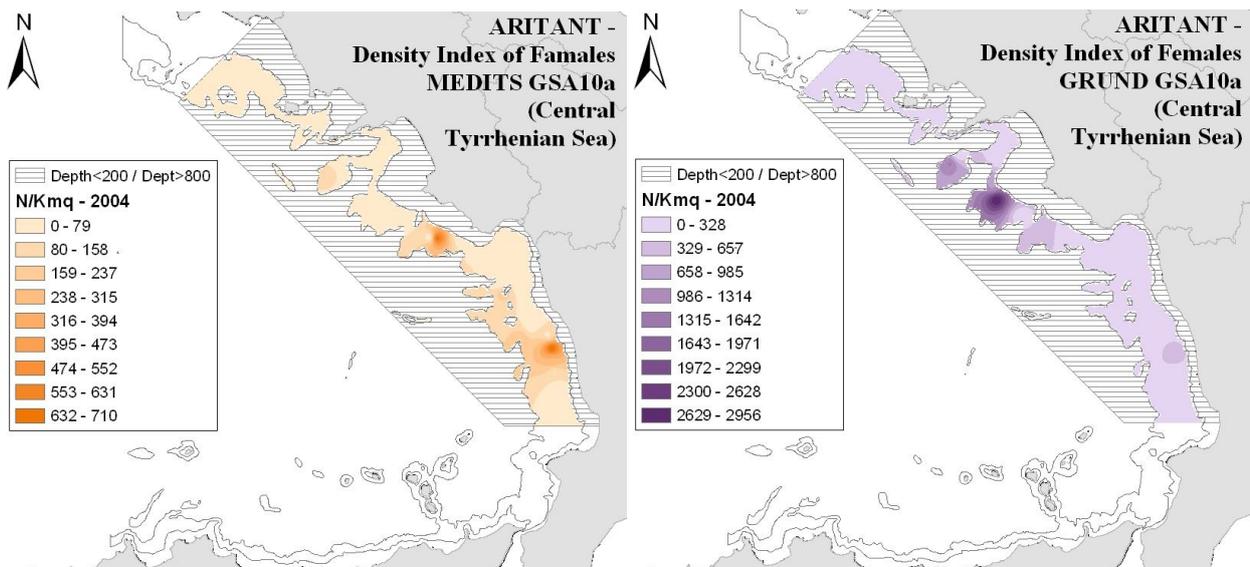


Fig. 6.8.3.2.2.1. Maps of the abundance of the blue and red shrimp females obtained by MEDITS (left) and GRUND data (right) on the continental part of the GSA10.

6.8.3.2.3. Trends in abundance and biomass

Fishery independent information regarding the state of the blue and red shrimp in GSA 10 was obtained from the international survey MEDITS. The estimated abundance indices (Figure 6.8.3.2.3.1) show variable trend with peaks in 1994 and 1997. Biomass indices show a considerable peak also in 2001. The lower values were recorded in 1995 and 1996. The most recent biomass index (2011) is among the highest of the time series.

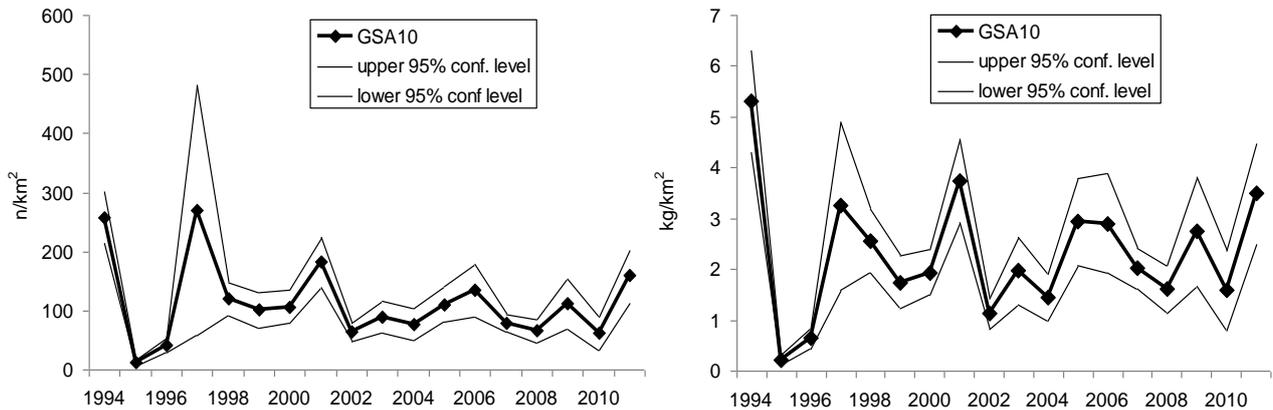


Fig. 6.8.3.2.3.1. Trends in survey abundance and biomass indices (MEDITS) of blue and red shrimp in GSA 10.

Trends derived from the GRUND surveys are shown in Figure 6.8.3.2.3.2.

Abundance and biomass indices show some fluctuations with peaks in different years from MEDITS (Figure 6.8.3.2.3.1). Higher values were recorded in 1996 and 2005. The analyses of GRUND indices also showed fluctuations with higher values in 1996 and 2005.

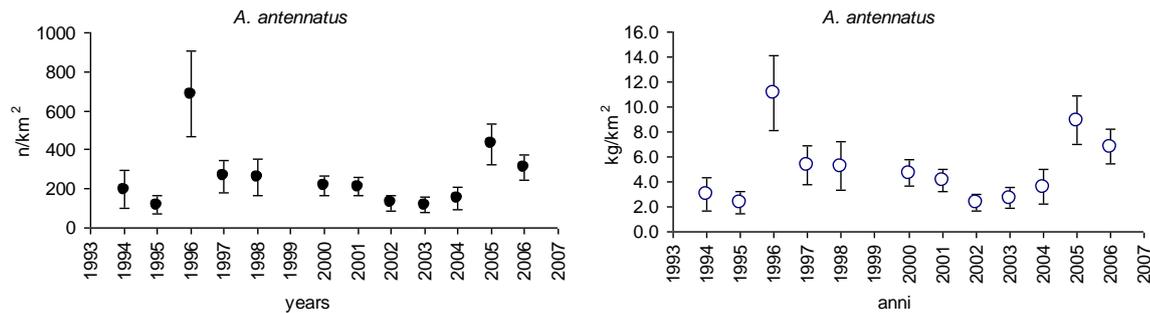
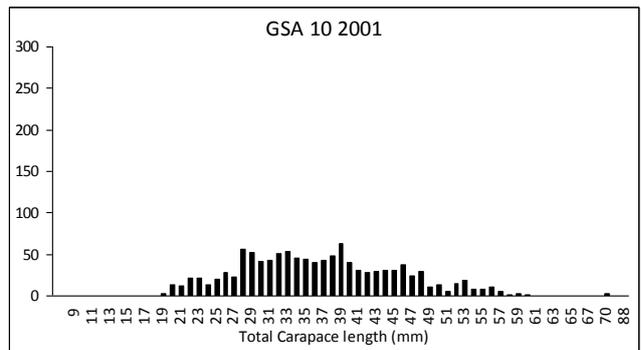
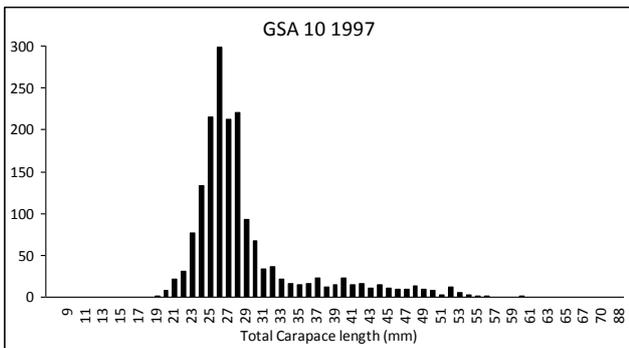
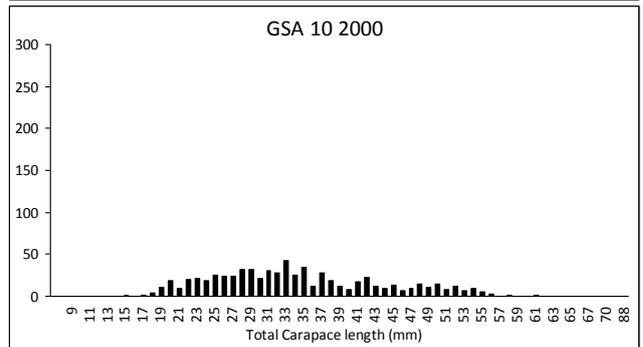
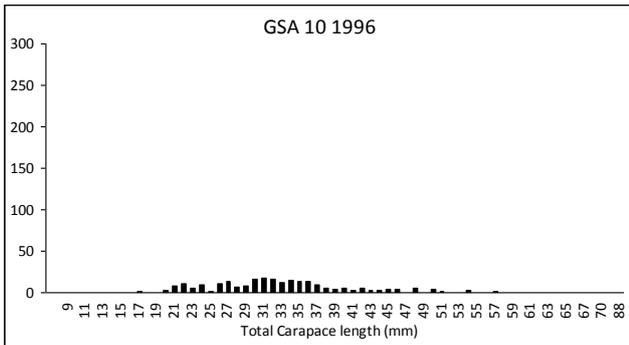
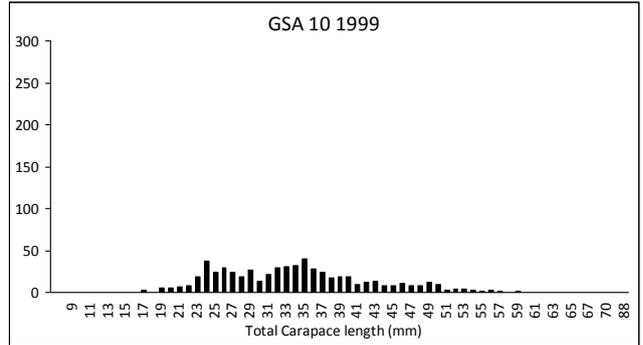
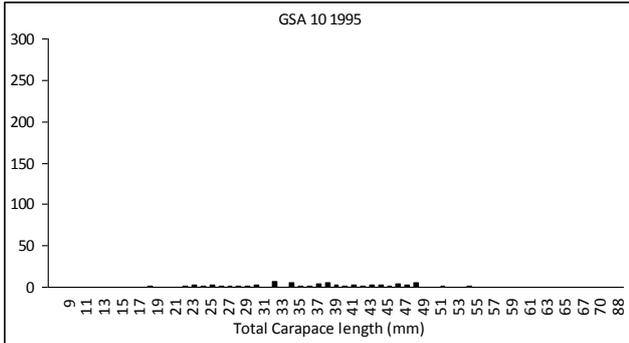
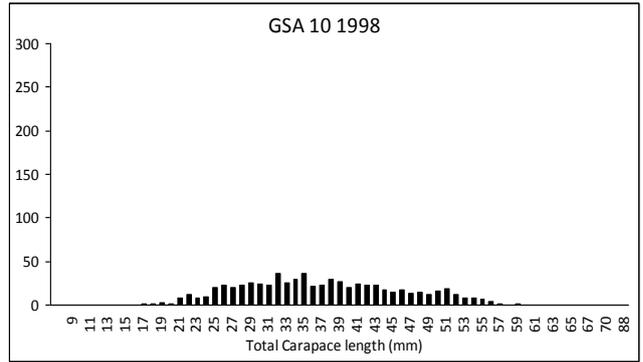
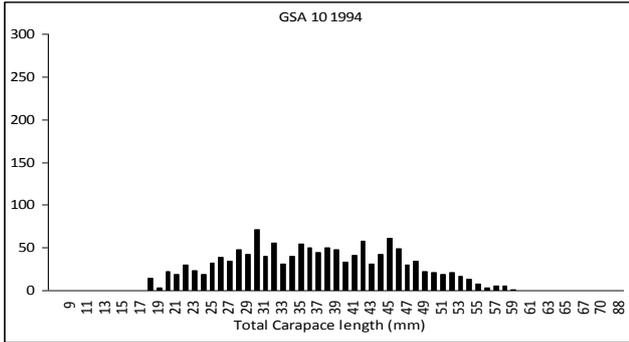
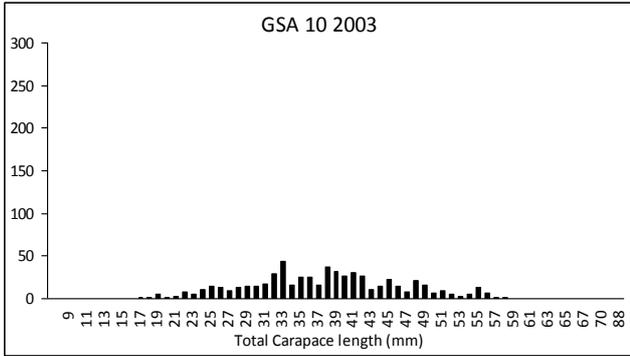
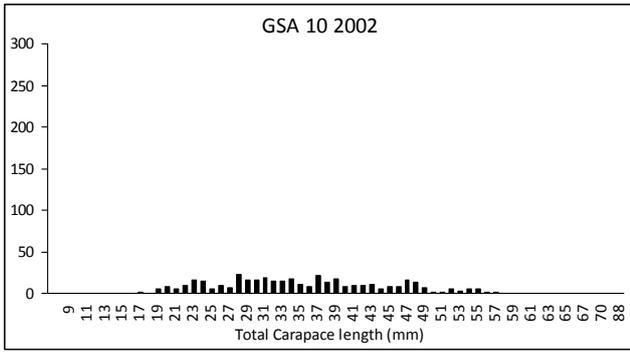


Fig. 6.8.3.2.3.2. Abundance and biomass indices of blue and red shrimp in GSA 10 (bars indicate standard deviations) derived from GRUND surveys.

6.8.3.2.4. Trends in abundance by length or age

The following Figure 6.8.3.2.4.1 displays the stratified abundance indices of GSA 10 in 1994-2011.





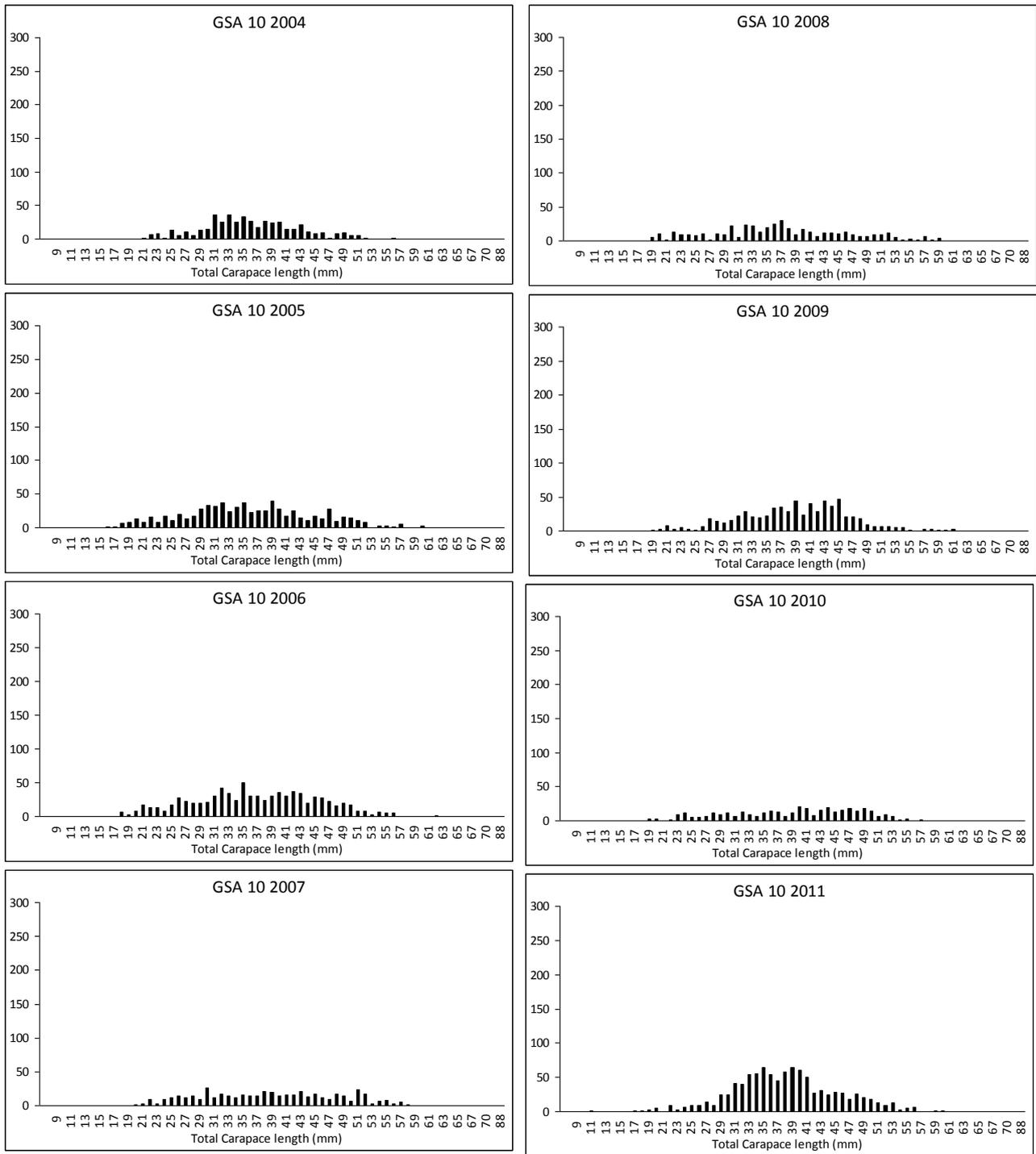


Fig. 6.8.3.2.4.1. Stratified abundance indices by size, 1994-2011.

6.8.3.2.5. Trends in growth abundance by length or age

No analyses were conducted during EWG-12-19.

6.8.3.2.6. Trends in maturity

No analyses were conducted during EWG-12-19.

6.8.4. Assessment of historic stock parameters

6.8.4.1. Method 1: VIT

6.8.4.1.1. Justification

Considering the growth pattern of the species and the available time series of catches VIT software was applied using the landing structures at age from 2006 to 2011 from DCF. Six separate analyses were performed (one for each year).

6.8.4.1.2. Input parameters

The set of parameters used in VIT were:

$CL_{\infty} = 6.6$ cm, $K = 0.243$, $t_0 = -0.2$; length-weight relationship: $a = 0.86$, $b = 2.37$.

Natural mortality at age was obtained using Prodbiom (Tab. 6.8.4.1.2.1). A terminal fishing mortality $F_{term} = 0.3$ was used.

Tab. 6.8.4.1.2.1 - Inputs of natural mortality and maturity at age of *A. antennatus* in the GSA10.

Age	0	1	2	3	4	5	6	7	8	9
M	1.07	0.51	0.39	0.34	0.32	0.3	0.29	0.28	0.27	0.27
Proportion of mature	0	0.31	0.77	0.95	0.99	1	1	1	1	1

The number of individuals in the landing at age used as input in VIT is showed below. In 2006 the age 2 group was more abundant in the catches, while in the successive years the age group 3 was more abundant.

The F current was calculated in the age range 2-6 years.

Table 6.8.4.1.2.2 Landings in numbers at age in 2006-2011.

Age	2006	2007	2008	2009	2010	2011
1	699.266	250.118	248.469	31.700	401.753	120.363
2	1610.419	546.297	272.192	237.301	399.509	396.085
3	468.007	991.802	266.933	466.836	213.110	805.746
4	321.383	165.328	197.788	329.759	105.781	537.259
5	59.509	42.645	77.827	55.131	53.042	116.133
6	78.727	29.239	43.399	16.456	22.066	67.420
7	10.881	17.068*	9.821	7.393	7.631	19.897
8	2.172		3.822	4.013	6.762	8.201

* the last class is a plus group.

6.8.4.1.3. Results

Reconstructed catch in number and weight at age as estimated by the pseudocohort analysis using VIT and the estimates of total and fishing mortality at age for sex combined are plotted in the Figure 6.8.4.1.3.1. Z current is decreasing and varying from 1.02 in 2006 to 0.84 in 2011 (average over ages 2-6). The average fishing mortality was ~0.7 in 2006 and 0.51 in 2011.

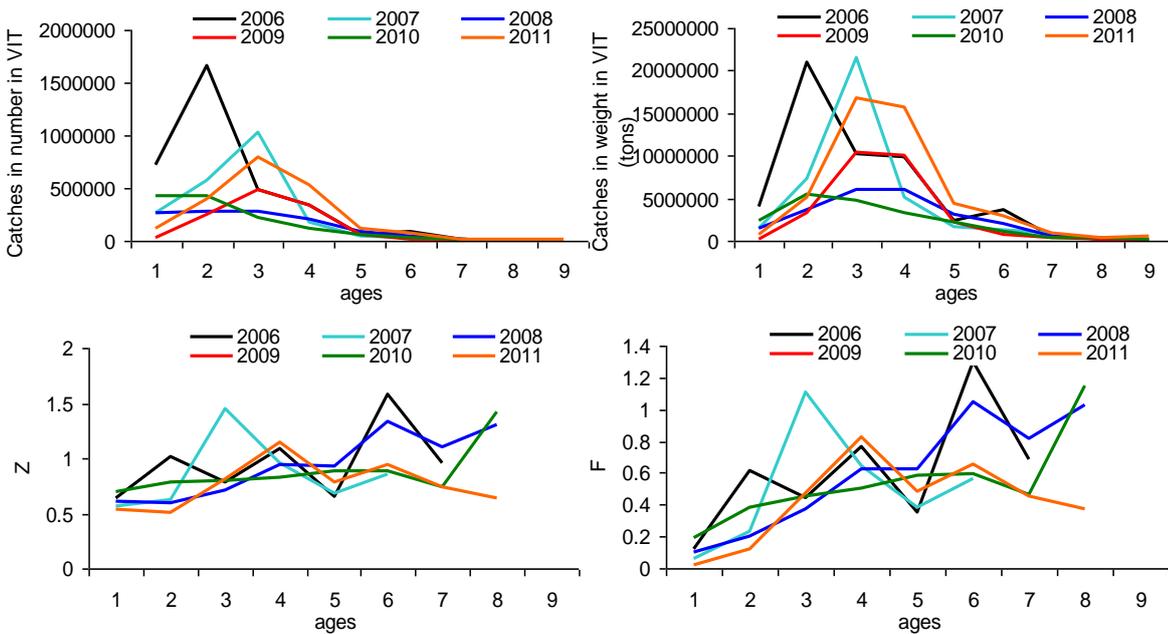


Fig. 6.8.4.1.3.1. Reconstructed catch in number and weight at age and total and fishing mortality at age as estimated by the pseudocohort analysis using VIT, by year (2006-2011). Blue and red shrimp GSA10.

6.8.5. Long term prediction

Y/R analysis has been applied for long term predictions using VIT software.

6.8.5.1. Method 1: VIT

6.8.5.1.1. Justification

The Y/R approach as implemented in the VIT software under equilibrium conditions was used to estimate limit and target reference points for the stock. The last three years were retained for the Y/R analysis.

6.8.5.1.2. Input parameters

Input parameters are given in section 6.8.4.1.2 on the VIT assessment above.

6.8.5.1.3.Results

Results of the YPR results from VIT are shown in the Figure 6.8.5.1.3.1. The Yield per Recruit analyses indicate that the reference point $F_{0.1}$ (proxy of F_{msy}) is 0.31 (average of the last three years).

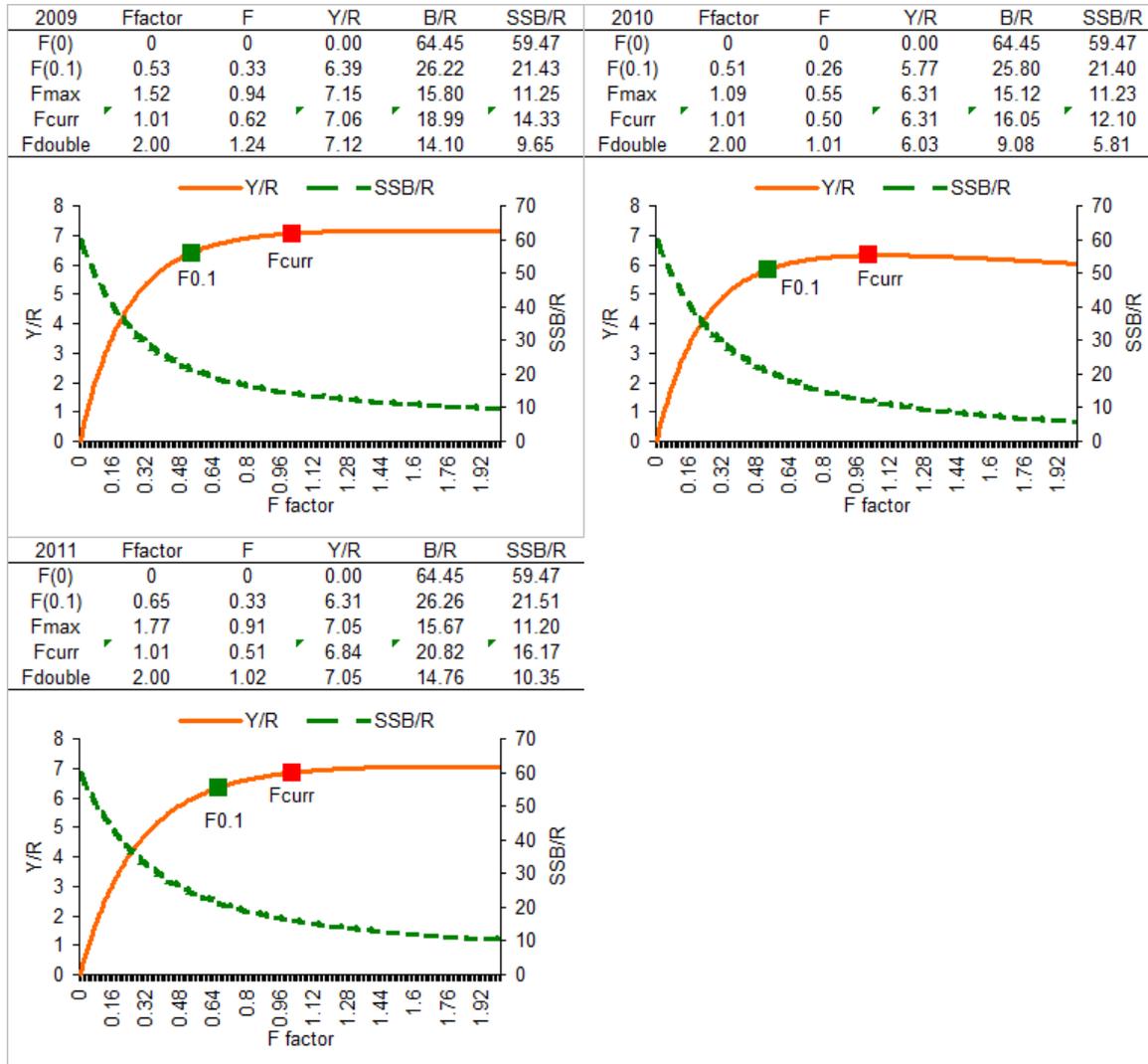


Fig. 6.8.5.1.3.1. - Overall results and graphs of Y/R analysis using VIT software, years 2009-2011. Blue and red shrimp, GSA10.

6.8.6. Data quality and availability

Data from DCF 2012 were used. A consistent sum of products compared to landings was observed (differences less than 10% for age data and lesser than 5% for length data). In 2006-2010 data were provided by year and gear type. Information on number of samples for landings, discards and catches, as well as the number of measurements by length for landings, discards and catches were also available.

6.8.7. Scientific advice

6.8.7.1. Short term considerations

6.8.7.1.1.State of the spawning stock size

In the absence of proposed and agreed precautionary management references, EWG 12-19 is unable to fully evaluate the status of SSB. Survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h), with the current levels in the average of the time series.

6.8.7.1.2.State of recruitment

Recruitment estimates from MEDITS surveys (individuals at age 1 were considered as recruits) in the GSA 10 indicate annual variations with an exceptional peak in 1997 (Figure 6.8.7.1.2.1). Higher values were observed in 1994, in 1999-2001 and in 2005-2006. The current value is around the average of the time series.

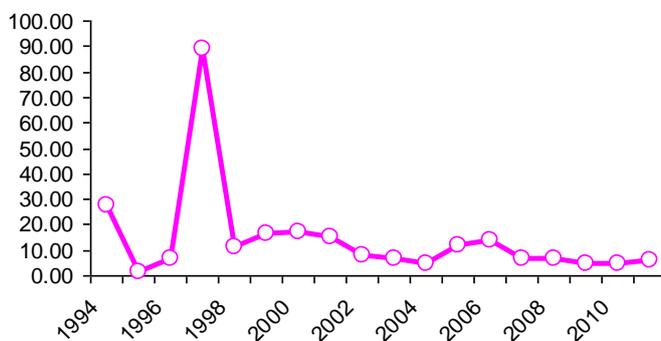


Fig. 6.8.7.1.2.1. Recruitment estimates from MEDITS surveys.

A scatter plot of the abundance indices of recruits (individuals at age 1) vs. abundance indices of spawners (individuals \geq age 2) from MEDITS is reported in the Figure 6.8.7.1.2.2.

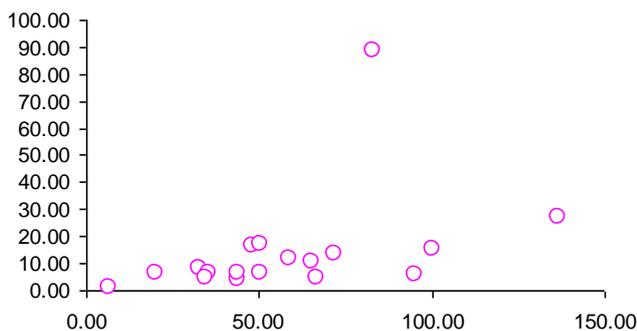


Fig. 6.8.7.1.2.2. Scatter plot of the abundance indices of recruits (individuals at age 1) vs. abundance indices of spawners (individuals \geq age 2) from MEDITS.

6.8.7.1.3.State of exploitation

EWG 12-19 proposes $F_{0.1}$ as a proxy of $F_{msy} \leq 0.31$ as limit management reference point of exploitation consistent with high long term yield. Given the results of the present analysis ($F_{current} (2011) = 0.43$), the stock is considered to be exploited unsustainably during the period 2006-2011. EWG 12-19 recommends the relevant fleets' effort and/or catches to be reduced to reach the proposed F_{msy} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan.

6.9. Stock assessment of European Hake in GSA 11

6.9.1. Stock identification and biological features

6.9.1.1. Stock Identification

This stock is assumed to be confined within the GSA 11 boundaries, where it is distributed between 30 and 650 m of depth, with a peak in abundance (due to high number of recruits) over the continental shelf-break (between 150 and 250 m depth). The stock is mainly exploited by the local fishing fleet, although seasonally and occasionally some other Italian fleet use to fish in some areas of the GSA 11. Spawning is taking place almost all year round, with a peak during winter–spring.

Juveniles showed a patchy distribution with some main density hot spots (nurseries) showing a high spatio-temporal persistence (Murenu *et al.*, 2007) in western areas.

6.9.1.2. Growth

The same fast growth of the previous SGMED meetings have been used in this assessment ($L_{\infty}=100,7$ cm, $K=0.248$, $t_0=-0.01$).

6.9.1.3. Maturity

Due to the low catchability of large hake in the trawl, the catch rate of mature specimens during the MEDITS trawl survey is usually very low, influencing the identification of gonad development and growth rate for large individuals. Female length at first maturity is estimated at around 36 cm. Although spawning around Sardinian coasts (GSA 11) occurs nearly all over the year (January to September), a maturity peak is usually observed in winter and spring (February-May).

6.9.2. Fisheries

6.9.2.1. General description of fisheries

Hake is one of the most important commercial species in the Sardinian seas. In this area, the biology and population dynamics have been studied intensively in the past fifteen years. Although hake is not a target of a specific fishery, such as for example red shrimp, it is the third species in terms of biomass landed in GSA 11 (Murenu M., pers. com.). In the GSA 11 hake is caught exclusively by a mixed bottom trawl fishery at depth between 50 and 600 m. No gillnet or longline fleets target this species. Although different nets are used in shallow, mid and deep water (“terra” mainly targeting *Mullus* spp., “mezzo fondo” targeting fish and “fondale” net targeting deep shrimp) the main trawl used is an “Italian trawl net” type with a low vertical opening (max up to 1.5 m). The dimensions of the trawl change in relation to the trawlers engine power. Important by catch species are *Eledone cirrhosa*, *Loligo* spp., *Trisopterus minutus*, *Chlorophthalmus agassizi*, *Phycis blennoides* and *Parapaeneus longirostris*. Detailed maps of the fishing-grounds are reported in Murenu *et al.* (2006). Most of the effort is concentrated within a relative short distance around the major

fishing ports (Cagliari, Alghero, Porto Torres, La Caletta, Sant’antioco, Oristano, Alghero). Moreover, some large trawlers move seasonally in different fishing grounds far from the usual ports.

From 1994 to 2004, the trawl fleet showed remarkable changes in GSA 11. Those mostly consisted of a general increase in the number of vessels and by the replacement of the old, low tonnage wooden boats by larger steel boats. For the entire GSA an increase of 85% for boats >70 tons class occurred. A decrease of 20% for the smaller boats (<30 GRT) was also observed.

6.9.2.2. Management regulations applicable in 2010 and 2011

As in other areas of the Mediterranean, management is based on the control of fishing capacity (licenses), fishing effort (fishing activity), technical measures (mesh size and area closures), and minimum landing sizes (EC 1967/06). Two small closed areas were also established along the mainland (west and east coast respectively) although these are defined to mainly protect Norway lobster. Since 1991, a fishing closure for 45 trawling days has been enforced almost every year.

Towed gears are not allowed within the three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.

6.9.2.3. Catches

6.9.2.3.1. Landings

Landings available for GSA 11 by major fishing gears are listed in Table 6.9.2.3.1.1.

Landings decreased from 866 t (2005) to 389 t in 2011 (Figure 6.9.2.3.1.1). Landings of hake are mostly taken by the demersal trawl fisheries (OTB), which in average account for about 86% of the total. The remaining landings is taken by the GTR segment (Table 6.9.2.3.1.1).

Table 6.9.2.3.1.1 Landings (t) by year and major gear types, 2005-2011 as reported through DCF in 2012.

GEAR	2005	2006	2007	2008	2009	2010	2011
GTR (LLS 2009)	101	206		28,6	7,02	87,9	102
OTB	765	594	442	279	261	330	287
Total landings	866	800	442	307	268	418	389

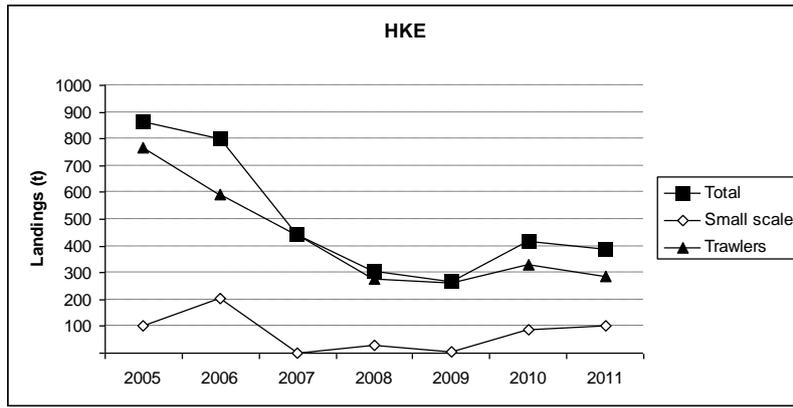
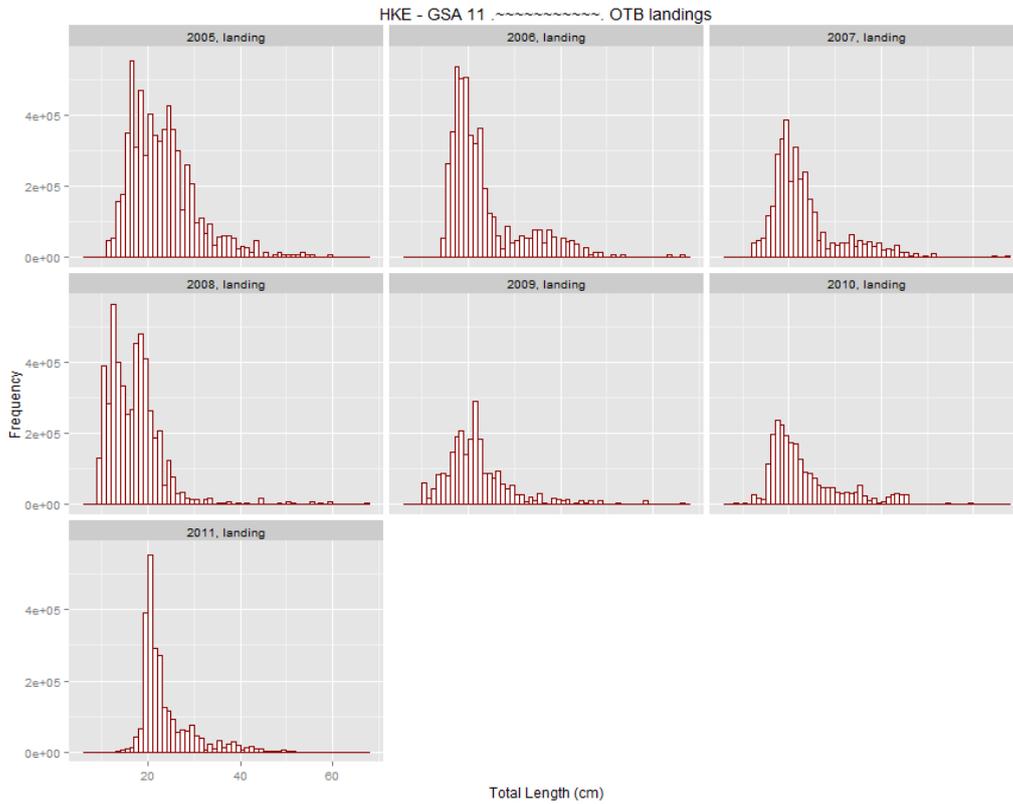
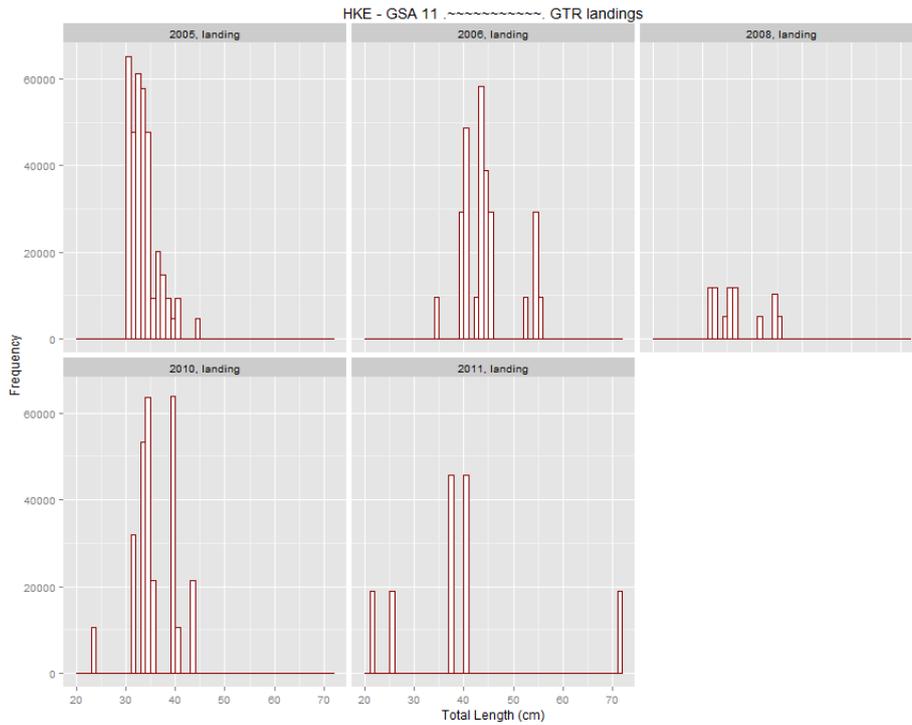


Fig. 6.9.2.3.1.1. Landings (t) of hake in GSA 11 by year and major gear types, 2005-2011 as reported through DCF.

Data at length, shows for the OTB a variable structure of the landings LFD and relative quantities. In particular, in 2008 is clear a peak of small sizes in 2008, and differences of mean and dispersion. (Figure 6.9.2.3.1.2).



A



B

Fig. 6.9.2.3.2.1. Landings by length, gear(A=OTB, B=GTR) and year (2005-2011) as reported through DCF.

6.9.2.3.2.Discards

Discards reported to STECF EGW 12-10 were null for 2007 and 2008 as shown in Table 6.9.2.3.2.1. The decrease in discards observed in 2010 reflect the drop observed in the same period for the total landings, while the very high increase in 2011 seems to be not realistic: it is more than 10 times greater of previous years and looking to the pattern on abundances in the survey (MEDITS) for this year nor a peak in recruitment nor an increase in abundances is observed. Moreover, seem to be not reliable that in 2011 OTB discards are 90% and OTB landings account for a quota of 10% only.

Table 6.9.2.3.2.1 Discards (t) by year, 2005-2010, as reported through DCF in 2011.

	2005	2006	2007	2008	2009	2010	2011
total discards	387	234	0	0	168	125	1946

Looking to discard at length (Figure 6.9.2.3.2.1), data were neither continuous by gear nor by year. Moreover the discard from GTR belongs only to large size specimens, which usually are not discarded by commercial fleets as shown by trawlers' discards data (Figure 6.9.2.3.2.1).

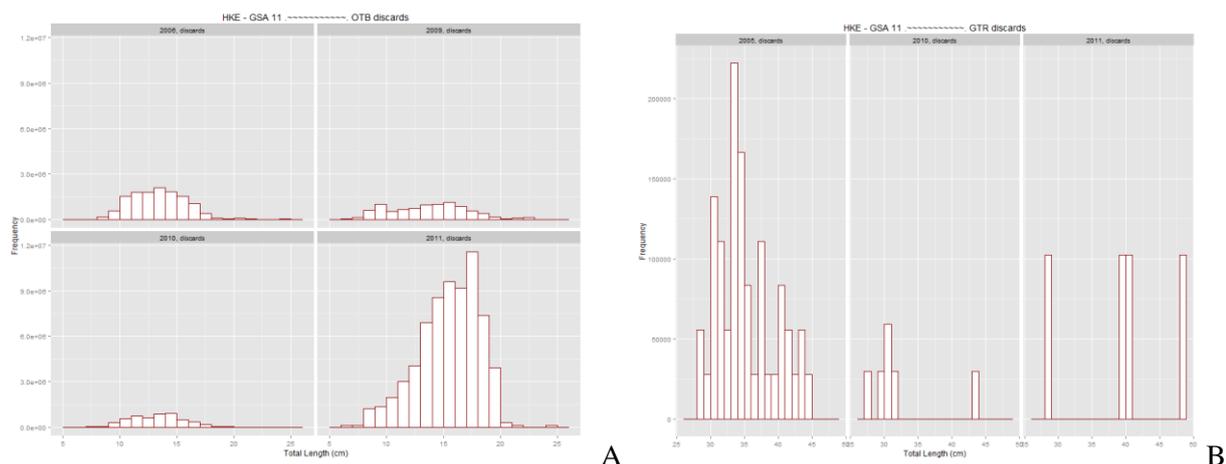


Fig. 6.9.2.3.2.1. Discards (t) by length, year (2005-2011) and major gear types(A=OTB, B=GTR), as reported through DCF.

6.9.2.4. Fishing effort

The reported fishing effort values through the DCF data call were modified and updated for 2011.

Using data available to EWG 12-19, the trends in fishing effort by year and major gear type is listed in Table 6.9.2.4.1 and shown in Figure 6.9.2.4.1 in terms of kW*days. The trend analysis show a major drop of total fishing effort in 2008, when both the trawlers and the small scale fishery effort decrease (of 25 and 31 % respectively). In the last three years the total effort was almost stable, even if minor increases in small scale fishery occur.

Table 6.9.2.4.1. Trend in nominal effort (kW*days) for GSA 11 by major gear types, 2004-2011. Data submitted through the DCF data call in 2012.

AREA	GEAR	2004	2005	2006	2007	2008	2009	2010	2011
SA 11		48666	77107	76288	14990	46792	61601	60063	76625
					4611				720
		78699	68693	15992	85702	69361	103413	104642	20583
		13778	104105	61556	68262	65417	10927	78336	25145
		69657	80487	90653	69465	27107	60887	95218	25271
		82251	46753	64505	72901	61573	73775	42250	42194
				7099	2914	589	566		
		21421	798	70267	64312	65247	44038	9259	17027
		34441	84509	27750	60565	26313	70758	86734	88057
		38988							

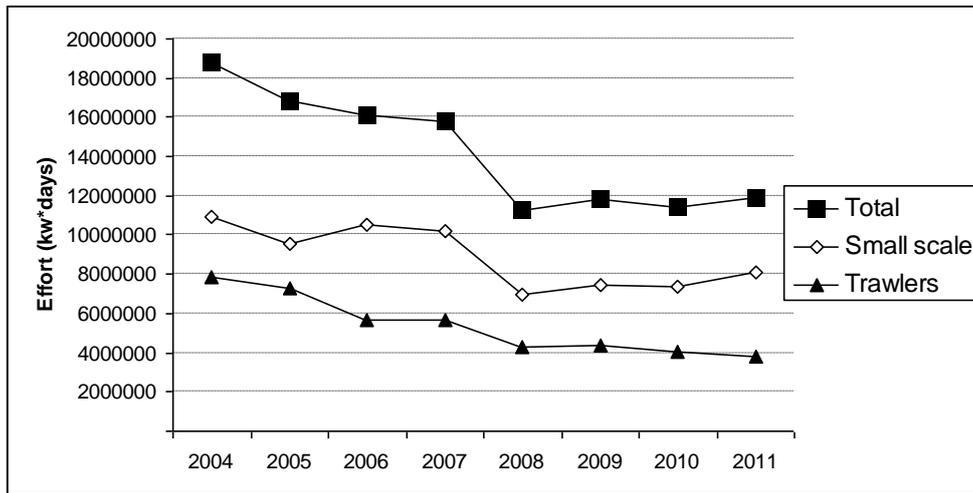


Fig. 6.9.2.4.1. Trend in fishing effort (kW*days) for the Italian fleet in GSA 11 for the major gear types in 2004-2011.

6.9.3. Scientific surveys

6.9.3.1. MEDITS

6.9.3.1.1. Methods

Since 1994 the MEDITS trawl surveys have been yearly carried out between May and July (except in 2007).

According to the MEDITS protocol (Relini, 2000; Bertand *et al.*, 2002) a stratified random sampling design with allocation of hauls proportional to depth strata extension (depth strata: 10–50 m, 51–100 m, 101–200 m, 201–500 m, 501–800 m) was adopted. A specific gear (GOC 73, with a 20 mm stretched mesh size in the cod-end) was always used following the instruction stated and reported in Dremière and Fiorentini (1996).

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 11 the following number of hauls was reported per depth stratum (s. Table 6.9.3.1.1.1).

Table 6.9.3.1.1.1. Number of hauls per year and depth stratum in GSA 11, 1994-2011.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
GSA11_010-050	17	19	21	21	21	21	19	18	20	18	17	17	19	19	17	18	19	20
GSA11_050-100	28	21	23	23	21	22	22	24	19	19	18	22	19	20	19	20	19	19
GSA11_100-200	22	23	30	31	31	30	31	30	24	24	24	24	24	24	22	24	24	24
GSA11_200-500	35	29	29	26	25	27	24	25	20	24	21	20	20	20	21	19	20	21
GSA11_500-800	23	16	22	25	25	24	27	26	16	14	15	14	16	17	16	16	17	17

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Y_{st} = \sum (Y_i * A_i) / A$$

$$V(Y_{st}) = \sum (A_i^2 * s_i^2 / n_i) / A^2$$

Where:

A=total survey area

A_i=area of the i-th stratum

s_i=standard deviation of the i-th stratum

n_i=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Y_i=mean of the i-th stratum

Y_{st}=stratified mean abundance

$V(Y_{st})$ =variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = $Y_{st} \pm t(\text{student distribution}) * V(Y_{st}) / n$

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution or a quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.9.3.1.2. Geographical distribution patterns

The spatial distribution of European hake has been described by modeling the spatial correlation structure of the abundance indices using geostatistical techniques (i.e. kriging). In different studies either total abundance index or abundances of recruits and adults were analysed (Murenu *et al.*, 2007).

On average, considering the analyzed yearly distributions (1994-2005), the recruits were considered individuals smaller than 12.3 cm (± 1.41). These individuals are belonging to the age 0 group. Persistence of the nursery areas along the years was studied by applying indicator kriging technique (Journel 1983, Goovaerts, 1997) to abundance estimations of recruits (Murenu *et al.*, 2008).

Main results and maps are reported in the “nursery section” of the SGMED 09-02 report.

6.9.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of hake in GSA 11 was derived from the international survey MEDITS. Figure 6.9.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 11. As shown below both for biomass and abundance in some years a high level of uncertainty is evident.

The estimated abundance and biomass indices since 1999 show high variation without any trend.

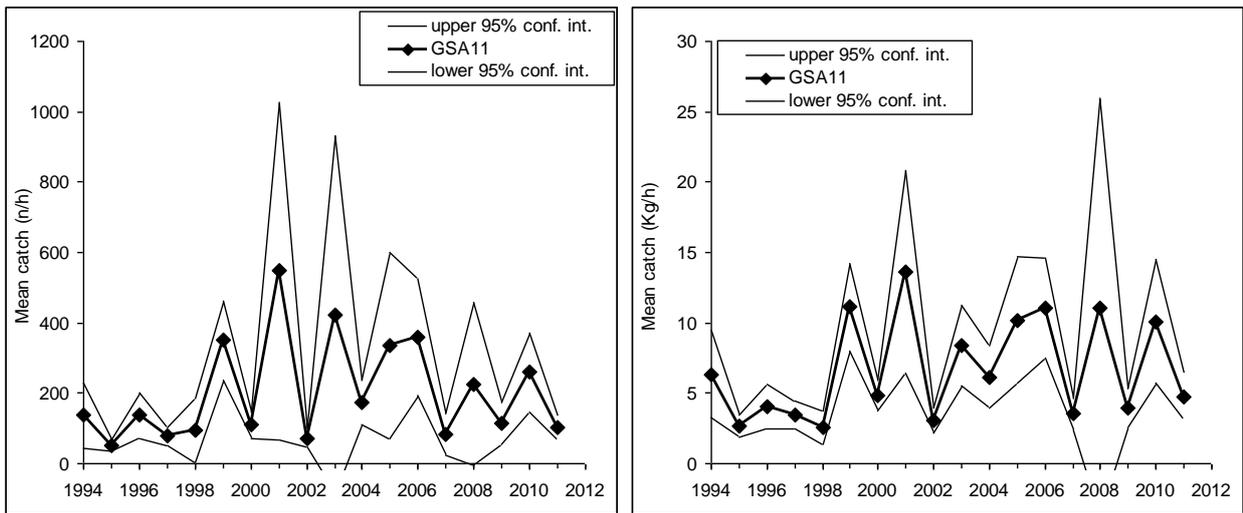


Fig. 6.9.3.1.3.1. Abundance and biomass indices of hake in GSA 11.

6.9.3.1.4. Trends in abundance by length or age

Boxplots and histograms of the MEDITS standardized length frequencies distributions (LFD) are shown in Figure 6.9.3.1.4.1. All distributions are characterized by a various numbers of superior outliers. The median show a small variability, as well as a small variation of the degree of dispersion along the time series. The greater variability is to account to the total abundances (box sizes are proportional to numbers).

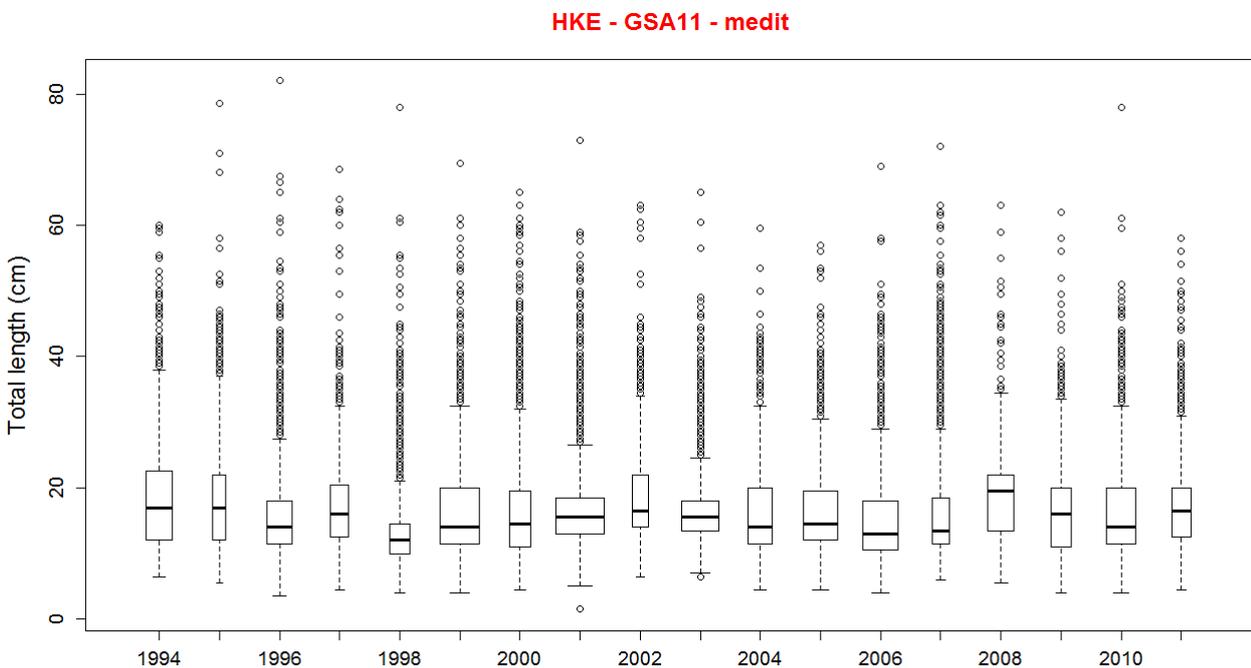


Fig. 6.9.3.1.4.1. *M. merluccius*: Boxplot of the stratified length frequency distributions in GSA11 (MEDITS)

The following Figure 6.9.3.1.4.2 display the stratified abundance indices of GSA 11 (1994-2011).

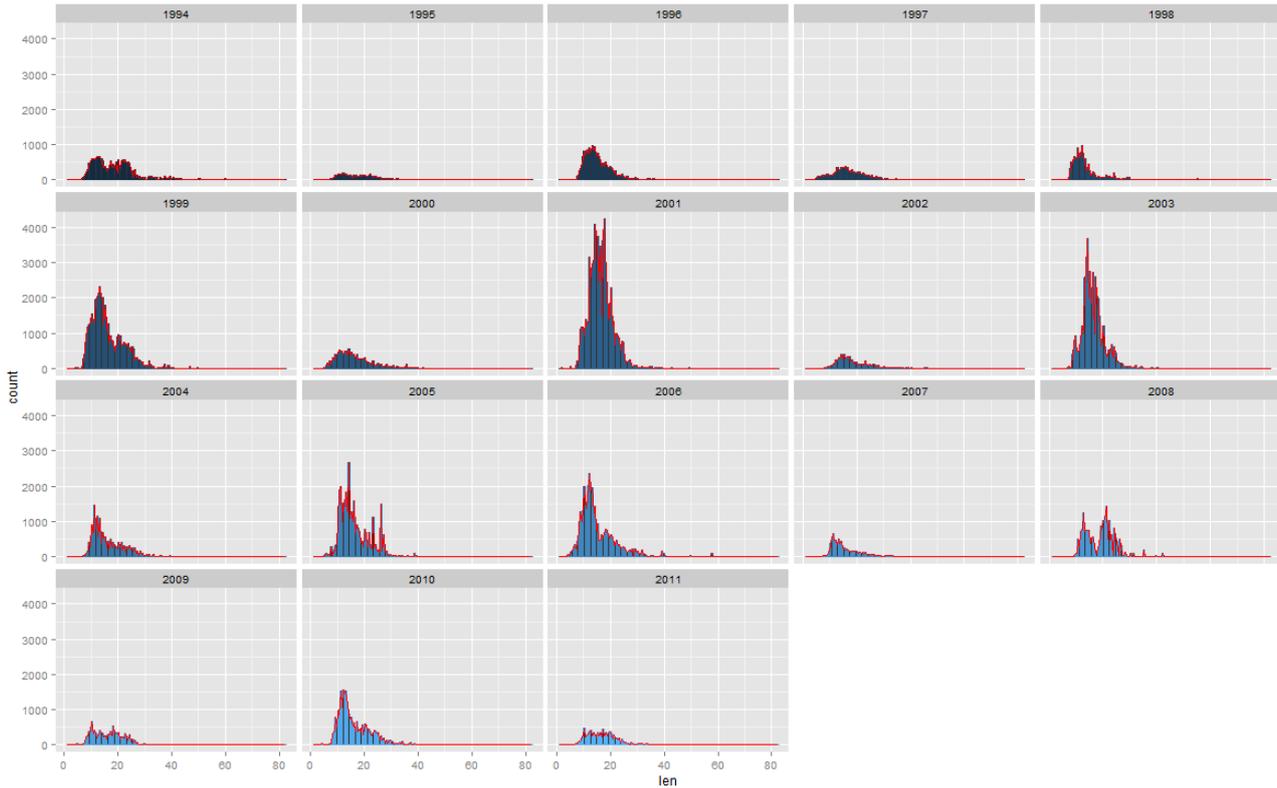


Fig. 6.9.3.1.4.2 Stratified abundance indices by size, 1994-2011.

6.9.3.1.5. Trends in growth

No analyses were conducted.

6.9.3.1.6. Trends in maturity

No analyses were conducted.

6.9.4. Assessment of historic stock parameters

6.9.4.1. Method 1: SURBA

6.9.4.1.1. Justification

The MEDITS survey provided the longer standardized time-series on abundance, biomass and population structure of *M. merluccius* in the GSA 11 which allows utilizing the SURBA software for the assessment. The SURBA assessment tool reconstructs the trend in F from length frequency distribution (LFD). The SURBA was applied to the MEDITS survey data.

6.9.4.1.2. Input parameters

Data from trawl surveys (time series of MEDITS from 1994 to 2011) from DCF have been used for the analysis. The SURBA software package (Needle, 2003) use trawl surveys data available from MEDITS to reconstruct trend in population structure and fishing mortality of hake in GSA 11.

The LFDs were converted in numbers at age using the “age slicing” (i.e. statistical slicing) subroutine as implemented in the R program introduced by the working group last year (Finley et al., 2011).

The VBGF parameters used to split the LFD has not been changed from those used in the previous SGMED and correspond to a fast growth scenario, $L_{\infty}=100,7$ cm, $K=0.248$, $t_0=-0.01$.

According to the PRODBIOM approach developed by Caddy and Abella (1999), a vectorial natural mortality at age was estimated (Table 6.9.4.1.2.1). Guess-estimates of catchability (q) by age are also given in Table 6.9.4.1.2.1.

The data and parameters used are the same as for the XSA and are summarized in Table 6.9.4.1.2.1.

Table 6.9.4.1.2.1 Input data used in the SURBA model (MEDITS survey).

Number of years	18 (1994-2011)
Number of ages	5 (0-4+)
Mean F range	1-3
age weightings	
Age01234+	w11111
catchabilities	
Age01234+	q0.81110.75
Survey index data (CPUE)	
Age	
Year01234+	
1994	99178471317231
1995	283621743611
1996	14652313967212
1997	515842372361
1998	9733179670181
1999	280461519741461
2000	904737205341
2001	452672186335481
2002	4600227611733
2003	306761131222311
2004	1197851673021
2005	226081073820621
2006	267438440218231
2007	6234171111941
2008	84131175232041
2009	545557145641
2010	1723083098511

2011673832803611

Natural mortality

Age

Year01234+

1994-20111.10.510.390.330.31

Proportion mature

Age

Year01234+

1994-201100.10.911

Stock weights

Age

Year01234+

19940.0120.0840.5340.8560.888

19950.0130.0820.5671.3342.913

19960.0140.0730.7481.1151.258

19970.0130.0570.4560.9991.222

19980.0080.0811.0041.0481.097

19990.0110.0630.4610.7652.339

20000.0120.080.4960.8481.022

20010.0160.0470.3420.7872.373

20020.0190.0920.6082.0073.412

20030.0170.0530.2921.5092.406

20040.0120.0940.632.5822.582

20050.0130.0680.3441.0851.925

20060.010.0750.7140.8281.358

20070.0130.0840.5730.8341.1

20080.0150.0710.5341.4242.398

20090.010.0530.5240.8063.372

20100.0110.0750.4611.0162.311

20110.0160.0750.5920.931.184

6.9.4.1.3. Results

The fitted year effect show high fluctuations in the whole time series (Figure 6.9.4.1.3.1). The age effect show a decreasing trend with high values for age 2 and 3. The Fitted cohort effects are slightly increasing from 1997.

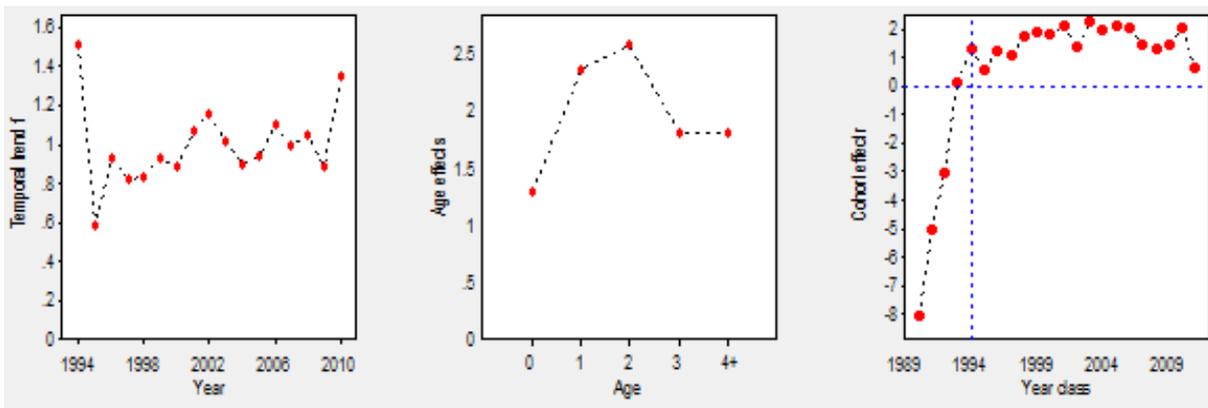


Fig. 6.9.4.1.3.1. MEDITS survey. Fitted year, age and cohort effects estimated by SURBA.

As shown in Figure 6.9.4.1.3.2 relative indices of spawning stock biomass (SSB) showed a peak in 1994 and 2006. Relative indices estimated by SURBA indicated very high fluctuations of recruitment in the period 1994-2011, with large recruitment observed in 2001, 2003 and 2005 and a decreasing trend in the last 6 years.

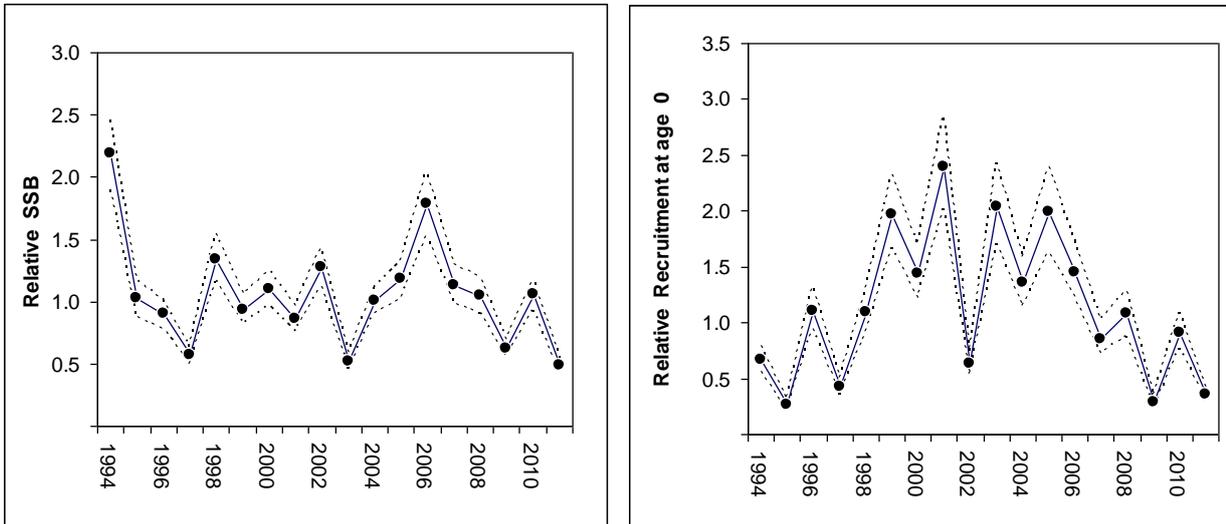


Fig. 6.9.4.1.3.2. Relative SSB, relative recruitment index at age 1 and estimated trend in F_{1-3} of *M. merluccius* in the GSA 11. Dotted lines are 2.5% and 97.5% confidence intervals.

Average fishing mortality (F_{1-3}) estimated from trawl survey data (MEDITS) range between 1.0 and 3.5 with a mean value of 2.2 (Figure 6.9.4.1.3.3). These SURBA results also show that the mean F for ages 1-3 was high and increasing up to the maximum value in the last year.

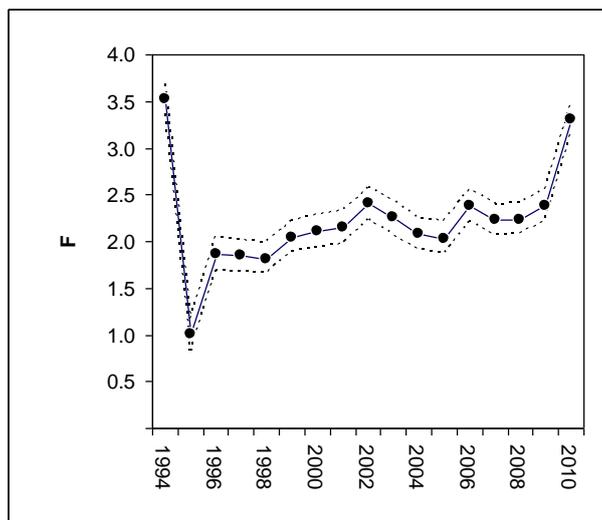
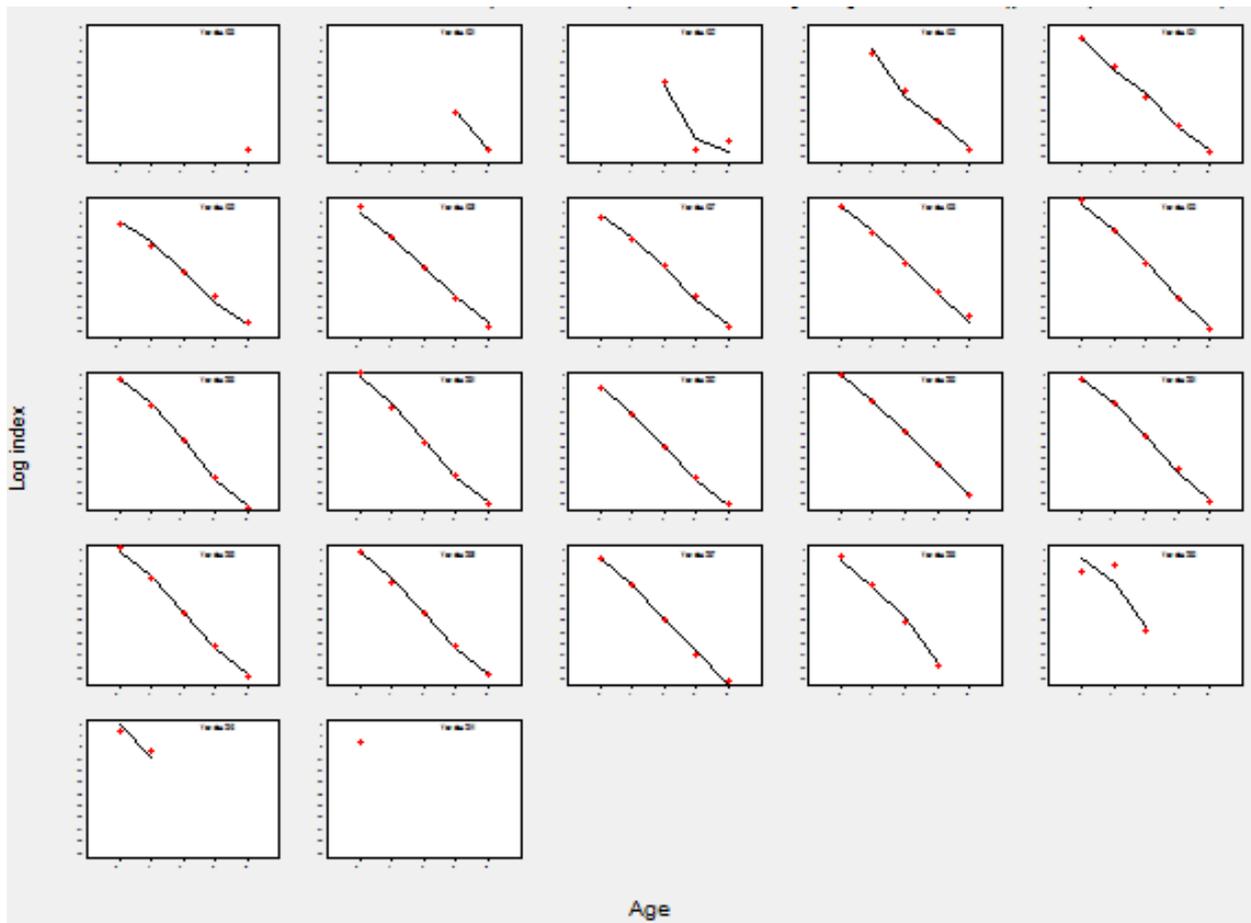


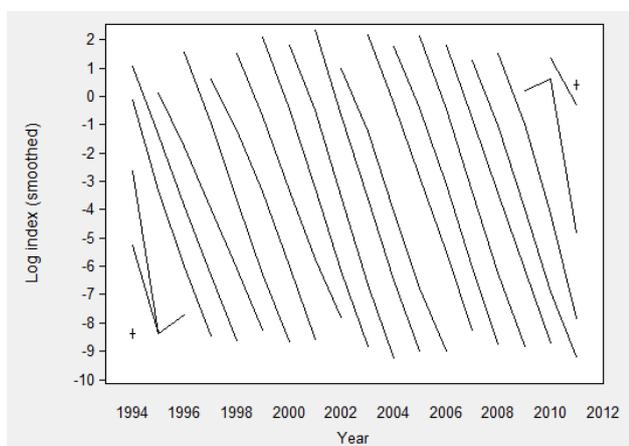
Fig. 6.9.4.1.3.3. Estimated trend in F_{1-3} of *M. merluccius* in the GSA11. Dotted lines are 2.5% and 97.5% confidence intervals.

Model diagnostics

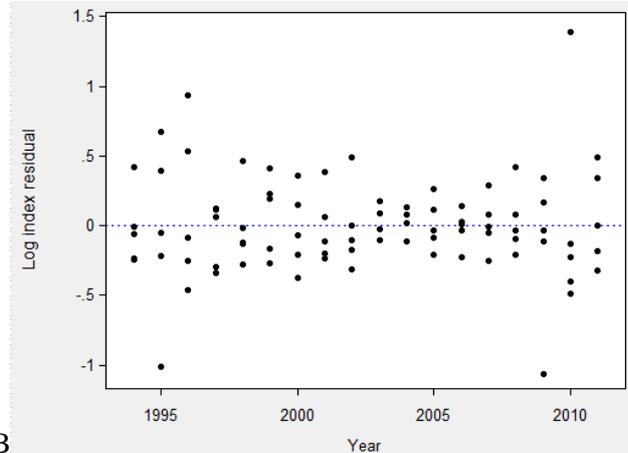
The *M. merluccius* SURBA model diagnostic highlight a good fitting of the log index abundance by year class, although small differences were detected between observed (points) and fitted values (lines) (panel A). Except for some of the choorts, the diagnostic for the smoothed log choort abundace was acceptable (panel B). A poorer diagnostic was observed in the Log index residuals over time (panel C) and in the comparative scatterplots at age (panel D) (Figure 6.9.4.1.3.4).



A



B



C

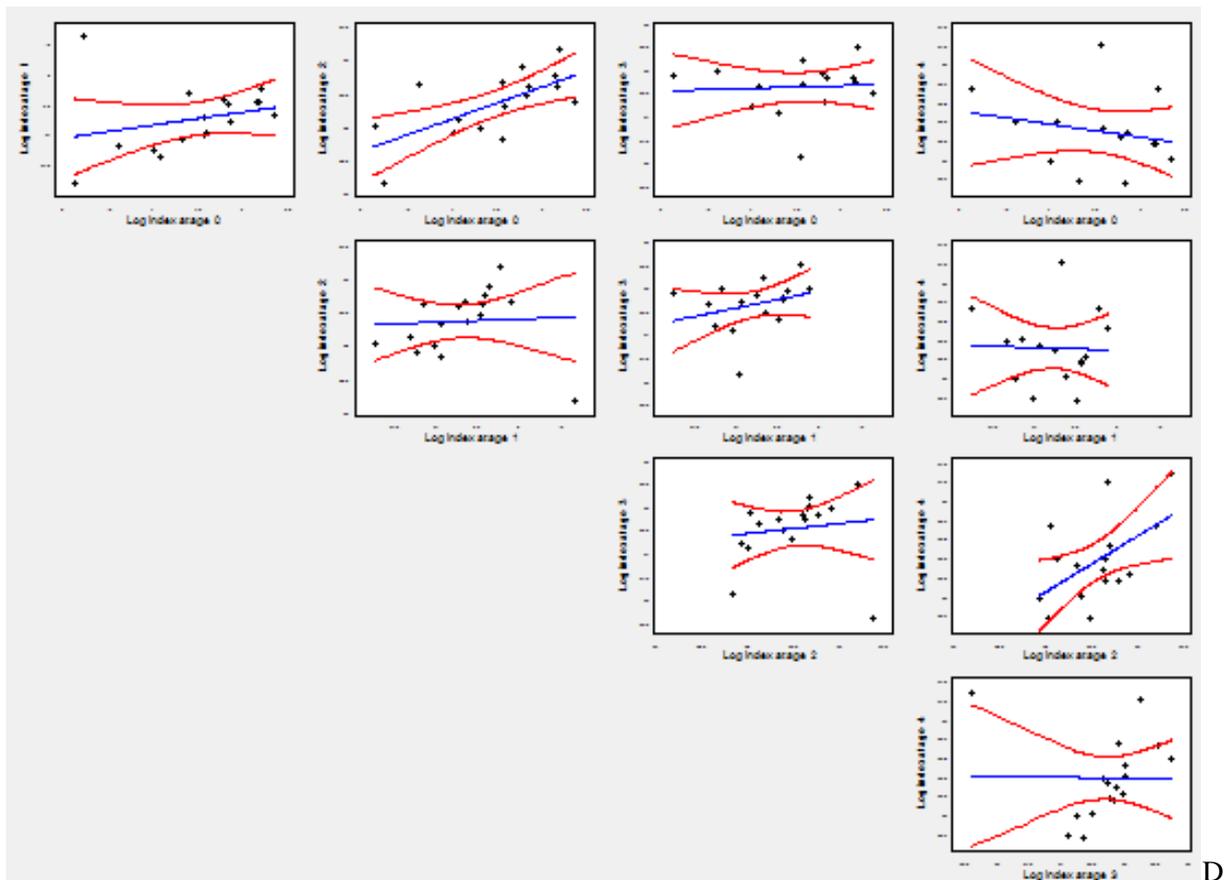


Fig. 6.9.4.1.3.4. Model diagnostic for SURBA model in the GSA 11 (MEDITS survey). A) Comparison between observed (points) and fitted (lines) survey abundance indices, for each year; B) Log survey abundance indices by cohort. Each line represents the log index abundance of a particular cohort throughout its life; C) Log index residuals over time and D) Comparative scatterplots at age.

6.9.4.2. Method 2: XSA -HKE

6.9.4.2.1. Justification

An XSA based assessment (Darby and Flatman 1994) was performed using DCF data from 2005 to 2011 tuned with fishery independent survey abundance indices (MEDITS).

6.9.4.2.2. Input parameters

As mentioned in the landing section (6.9.2.3.1) discard at length only for three years (2009-2011). Moreover discard seems to be unreliable in some years.

After several trials with poor results, EWG 12-19 decide to take in to account only the landing data for the assessment.

LFD of catches (Figure 6.9.4.2.2.1) were pooled by year and splitted in age classes using the statistical slicing procedure developed by Scott et al. (2012, EWG 11-12). The same slicing routine was used for LFD

of MEDITS survey (Figure 6.9.4.2.2.2) In both cases the analysis was performed by sex combined using the VBGF parameters specified below.

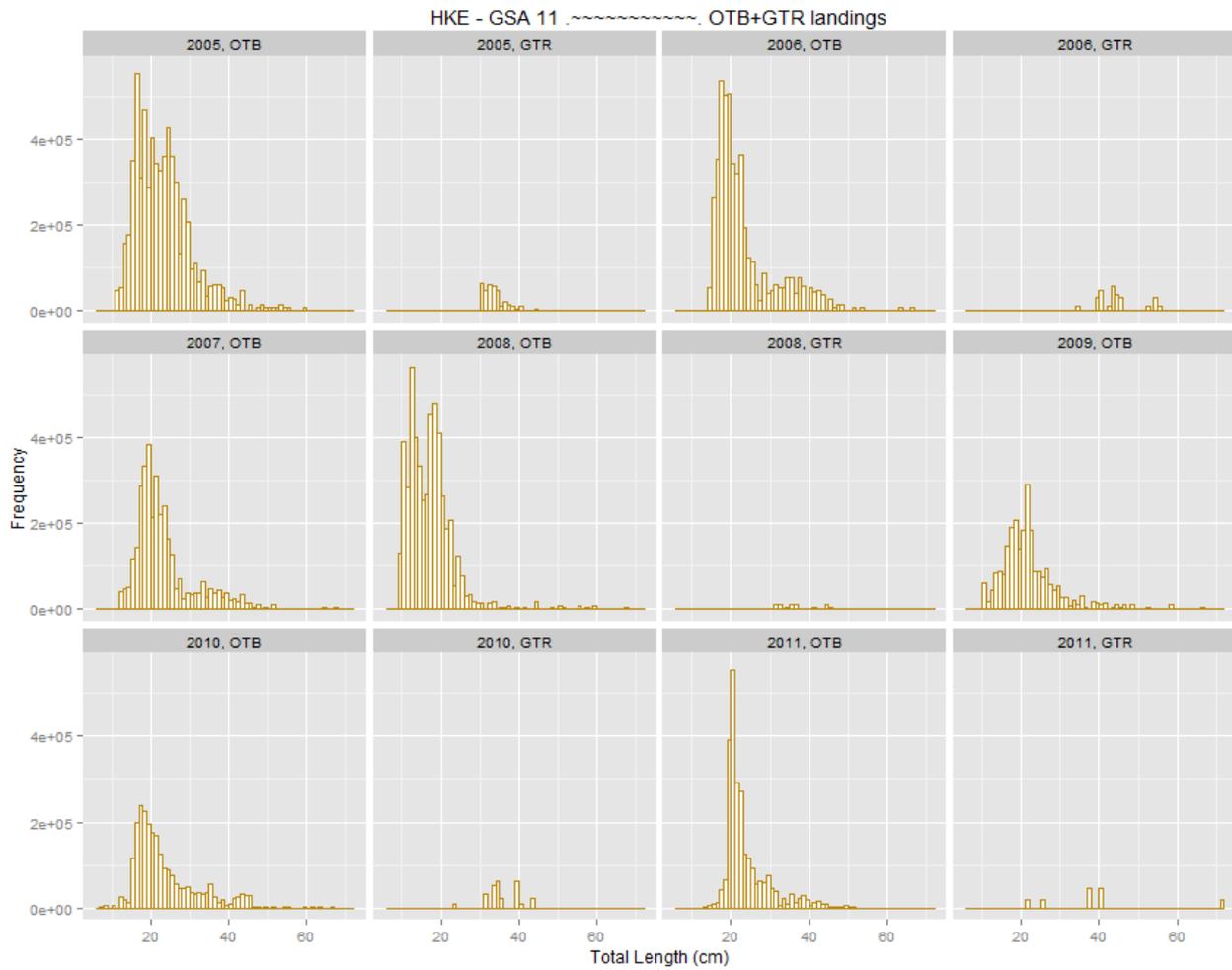


Fig. 6.9.4.2.2.1. LFD of landings *M. merluccius* in the GSA11

The best model selected was the lognormal (Figures 6.9.4.2.2.2 and 6.9.4.2.2.3) and is shown below.

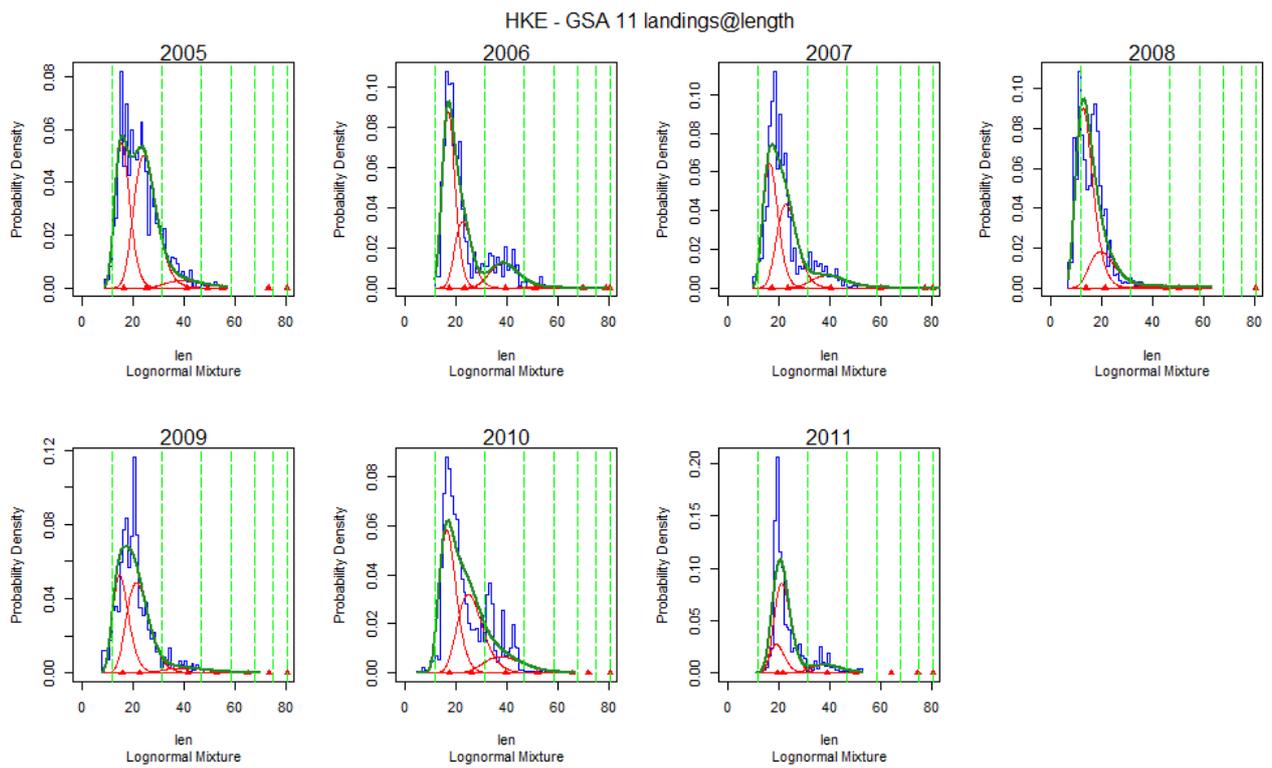
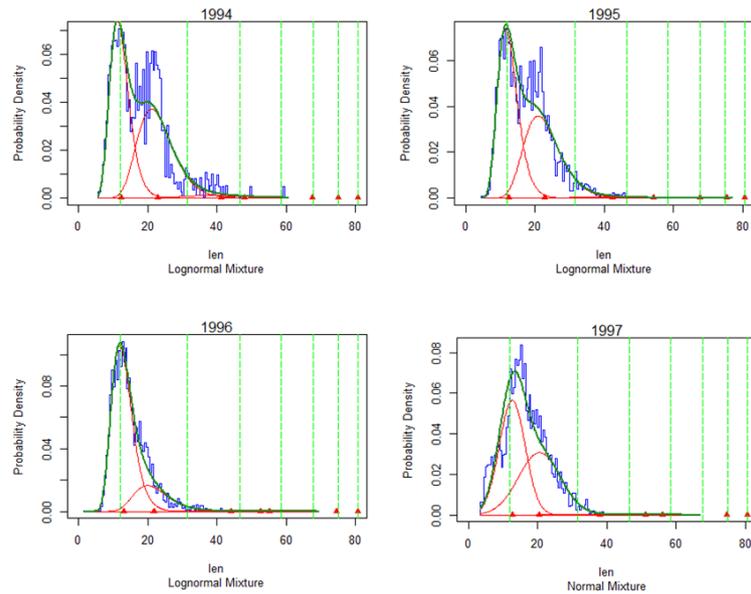
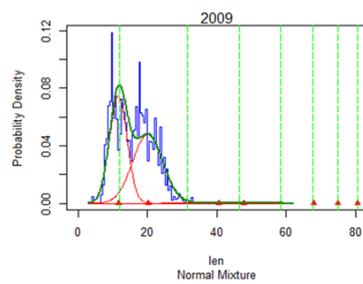
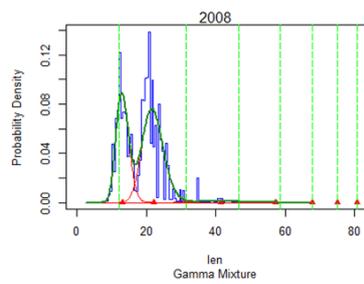
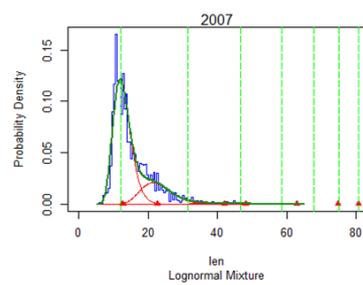
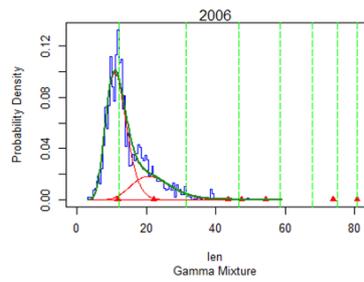
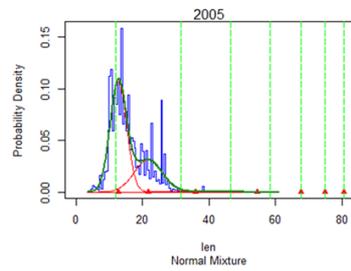
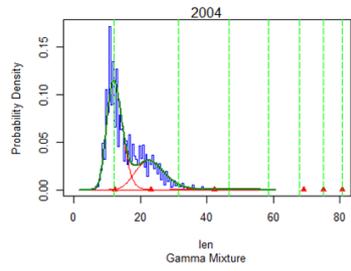
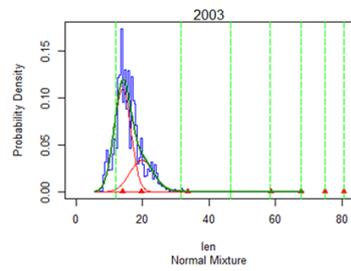
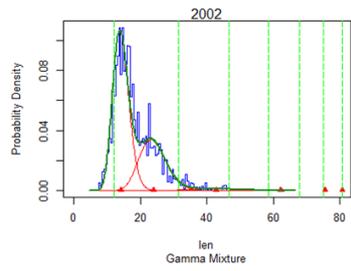
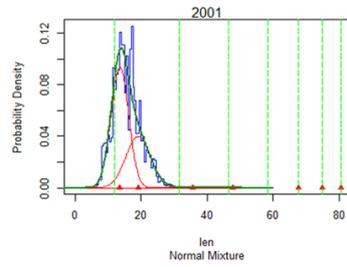
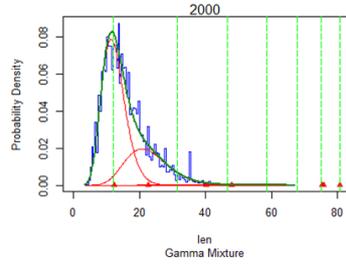
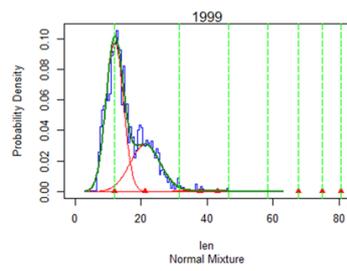
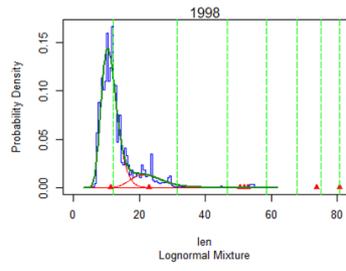


Fig. 6.9.4.2.2.2. Statistical age slicing of the catch at length frequency data of *M. merluccius* (2005-2011, OTB and GTR).





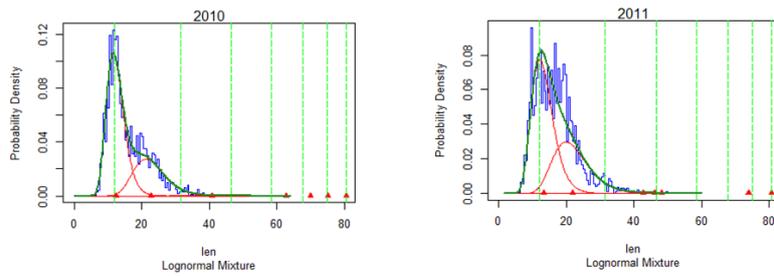


Fig. 6.9.4.2.2.3. Statistical age slicing of the MEDITS length frequency distributions of *M. merluccius* (1994-2011).

Sensitivity analyses were conducted to assess the effect of the main settings of the XSA. As a result the setting that minimize the residuals and shows the best XSA diagnostic output were used for the final assessment (Fbar 0-3, fse=0.5, rage=0, qage=1, shk.yrs= 2, shk.ages=3, min.nse=0.3).

As regard the input data and parameters (i.e. catch at age, weight at age, maturity at age, natural mortality at age, tuning) the list is reported here below (Table 6.9.4.2.2.1).

Table 6.9.4.2.2.1. Input parameters used for the XSA.

```

# min,max, plusgroup, minyear, maxyear, minfbar, maxfbar
min  max  plusgroup  minyear  maxyear  minfbar  maxfbar
0    4    4          2005    2011    0        3
# M vectors at age
age   0    1    2    3    4
M     1.1  0.51  0.39  0.33  0.31
# Maturity at age
age   0    1    2    3    4
%     0    0.1  0.9    1    1
# Mean weight in stock at age(kg)
age   2005  2006  2007  2008  2009  2010  2011
0     0.01  0.01  0.01  0.01  0.01  0.01  0.02
1     0.07  0.07  0.08  0.07  0.05  0.08  0.07
2     0.34  0.71  0.57  0.53  0.52  0.46  0.59
3     1.08  0.83  0.83  1.42  0.81  1.02  0.93
4     1.93  1.36  1.1   2.4   3.37  2.31  1.18
# catch in numbers by year
age   2005  2006  2007  2008  2009  2010  2011
all   866   800   442   307   261   418   389
# Catch at age in numbers (thousands) ##
age   2005  2006  2007  2008  2009  2010  2011
0     3431  4473  1887  5846  1006  1352  870
1     4693  2279  1727  1817  1633  1473  3061
2     472   941   425   80    167   392   318
3     16    11    3     32    16    10    0
4     0     8     5     4     3     2     0
# Mean weight in catch at age (kg)
age   2005  2006  2007  2008  2009  2010  2011
0     0.028  0.035  0.033  0.017  0.025  0.034  0.05
1     0.111  0.085  0.089  0.065  0.077  0.123  0.069
2     0.502  0.447  0.479  0.675  0.525  0.45  0.427
3     0.89   0.996  1.657  0.946  1.108  1.053  0.947
4     1.264  2.675  3.704  1.428  2.113  2.179  2.022
# Tuning data (MEDITS survey)
age   2005  2006  2007  2008  2009  2010  2011
0     22608  26743  6234  8413  5455  17230  6738
1     10738  8440  1711  11752  5714  8309  3280
2     206    218   119   320   56    85    36
3     2      23    4     4     4     1     1
4     0.43  0.83  0.32  0.1   0.09  0.14  0.06

```

6.9.4.2.3.Results

The residuals from the survey and the retrospective analyses do not show any particular trend (Figure 6.9.4.2.3.1).

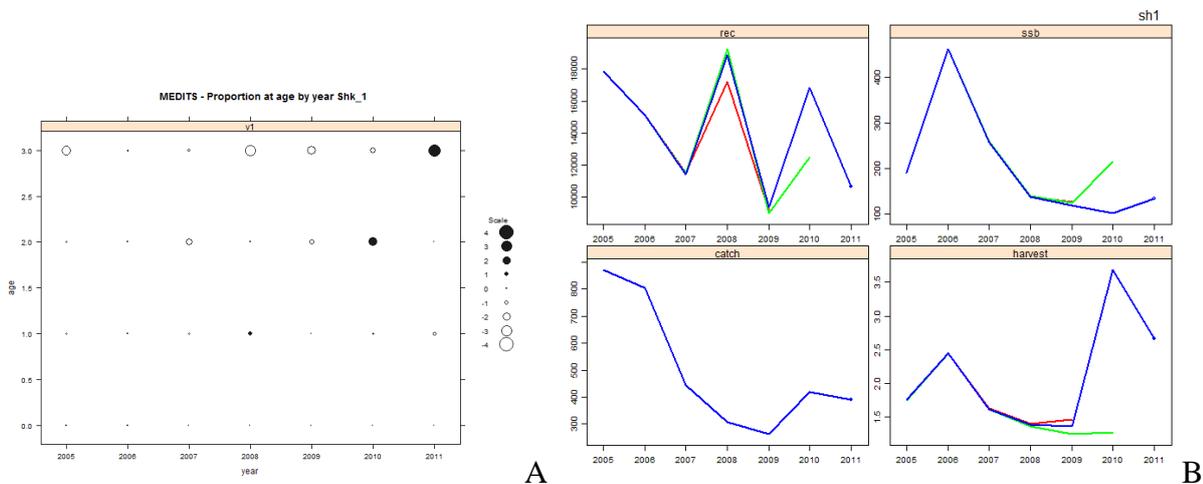


Fig. 6.9.4.2.3.1. A) Residuals by survey and B) retrospective analysis.

As shown in the result of the XSA (Figure 6.9.4.2.3.2, Table 6.9.4.2.3.1), the total biomass and the SSB both decreased from 2006 to the minimum value in 2010, and then slightly increase again in the last year (2011).

Recruitment was variable, with values in the range from 10^4 and 1.9×10^4 .

Mean F_{0-3} ranged between 1.36- 3.67 with the maximum values in the last 2 years (2010-11).

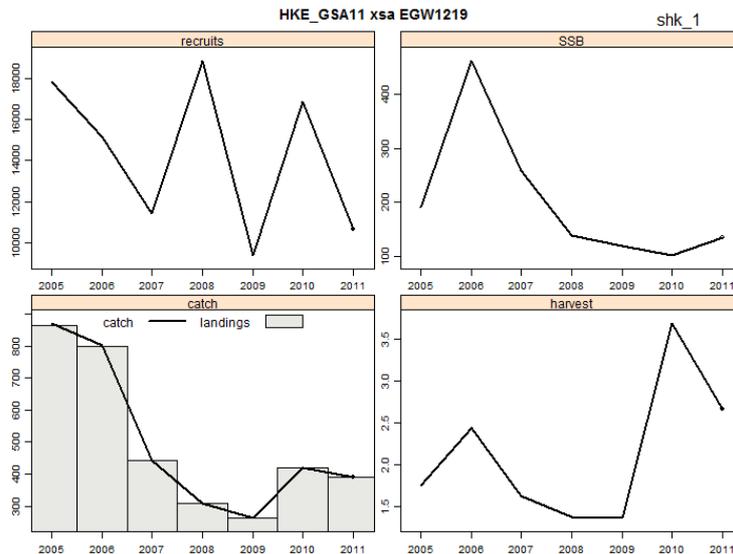


Fig. 6.9.4.2.3.2. XSA results (recruitment fishing mortality, spawning stock, total biomass biomass and relative F at age).

Table 6.9.4.2.3.1. XSA results.

hke XSA # assessments

	age	2005	2006	2007	2008	2009	2010	2011
SSB	all	191	462.6	260.6	140.9	119.5	102.2	136.5
R	0	17840	15121	11419	18847	9392	17624	10329
F at age	0	0.414	0.719	0.337	0.771	0.205	0.143	0.158
	1	1.426	1.384	2.394	1.998	1.296	1.373	1.499
	2	3.348	5.179	2.078	1.284	2.516	9.45	6.115
	3	1.781	2.485	1.643	1.402	1.381	3.74	2.646
	4	1.781	2.485	1.643	1.402	1.381	3.74	2.646
Fbar	all	1.742	2.442	1.613	1.364	1.35	3.676	2.604

6.9.4.3. Method 3: Yield-per-Recruit model

6.9.4.3.1. Justification

To predict the effects of changes in the fishing effort on future yields and to define the Reference Points $F_{0.1}$, (as a proxy of F_{MSY}) and F_{max} a yield per recruit analyses (YPR) was carried out. As input the same population parameters used for the XSA and its output of the exploitation pattern were utilized.

6.9.4.3.2.Results

The results of the YPR in terms of $F_{0.1}$, F_{max} and F_{cur} showed in the Figure 6.9.4.3.2.1 were respectively:

$$F_{0.1}=0.19$$

$$F_{max}=0.29$$

$$F_{cur}=2.5$$

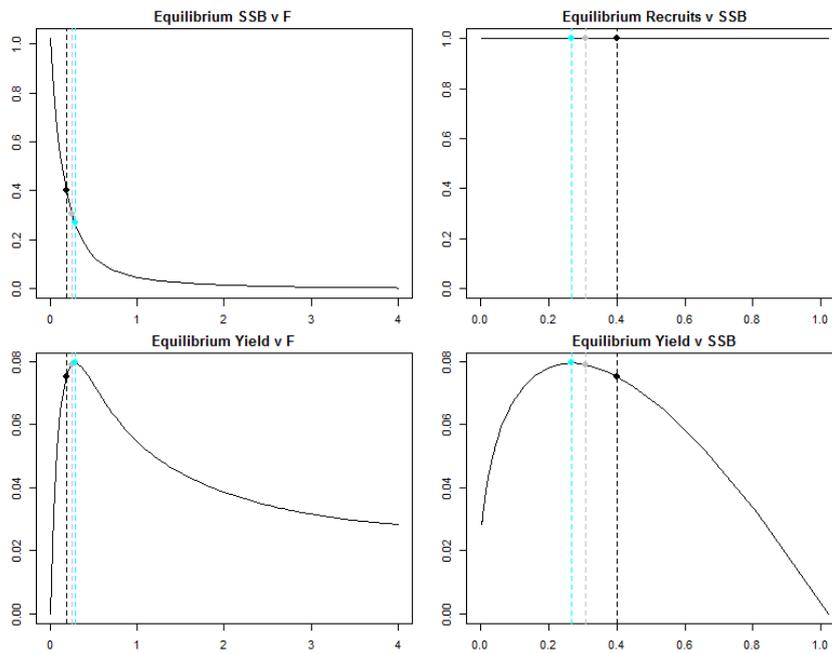


Fig. 6.9.4.3.2.1. Results summarising the yield per recruit analysis performed by XSA on 2011 data.

6.9.5. *Data quality and data consistency of 2012 data call*

MEDITS survey data were available from 1994 to 2011. Landing and discard from 2005.

EGW 12-19 noted that landing and discard seems to be misreported. GTR landings at length in some year are represented by few classes and in others lengths have a wide range (from 27 to 48 cm) and sizes unusual for discards. Moreover the GSA 11 is the only SA in the mediterranean region where discard have been reported for this gear. It is not clear to EGW 12-19 if this information is real or if data are erroneously reported. A different problem seems to occur for OTB discards in 2011, in which values are more than 10 times larger than previous years and about 4.5 times of commercial catches in 2011. In the survey (MEDITS), abundances in 2011 do not show a peak nor a high number of recruitment that can justify in some way the discards data submitted.

6.9.6. *Scientific advice*

6.9.6.1. Short term consideration

6.9.6.1.1. State of the spawning stock size

The comparison of the estimates of SSB index from XSA and SURBA models in the same time frame showed a decreasing trend in both the analysis.

However, in the absence of proposed biomass management reference points, EWG 12-19 is unable to fully evaluate the status of the stock spawning biomass in relation to these.

6.9.6.1.2. State of recruitment

Relative indices estimated by SURBA and XSA indicated very high fluctuations of recruitment in the period analysed, with a clear decreasing trend in the last 6 years for SURBA and the lowest value in 2009 and 2011 for XSA. However, in the absence of proposed management reference point for recruitment, EWG 12-19 is unable to fully evaluate the status of the recruitment in relation to these.

6.9.6.1.3. State of exploitation

The values of F_{bar} range from 1.3 to 3.7 (XSA, $F_{0.3}$) and range between 1.0 and 3.5 with a mean value of 2.2 in SURBA ($F_{1.3}$). Value of $F_{0.1}$ as a proxy of F_{MSY} is 0.25. Taking into account the results obtained by the XSA analysis (current F is around 2.5), the stock of hake in GSA11 should be considered as exploited unsustainably.

EWG 12-19 recommends the relevant fleets' effort or catches to be reduced until fishing mortality is below or at the proposed F_{MSY} level, 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 considerations. Catches and effort consistent with F_{MSY} should be estimated.

6.10. Stock assessment of Red Mullet in GSA 11

6.10.1. Stock identification and biological features

6.10.1.1. Stock Identification

This stock was assumed to be confined within the GSA boundaries, but no scientific evidence is available to confirm this hypothesis. Under a management point of view, in the frame of GFCM, it has been decided that, when the lack of any evidence does not allow suggesting an alternative hypothesis, inside each one of the GSAs boundaries inhabits a single, homogeneous stock that behaves as a single well-mixed and self-perpetuating population.

In the GSA11, red mullet (*Mullus barbatus*) is distributed between 0 and 300 m of depth, even though is generally found on shelf bottoms (within 200m of depths) where the bulk of abundance and biomass is up to 100 m.

The stock is mainly exploited by the local fishing fleet only, both with trawl and net gears.

Juveniles showed a patchy distribution with some main density hot spots (nurseries) showing a high spatio-temporal persistence in western and southern areas.

6.10.1.2. Growth

Data coming from LFDA showed a slow growth pattern both in male and female (Samed, 2002) while data from otolith readings (DCR, 2011) show a faster growth pattern (sex combined).

Since the species reaches 50% of its total size at one year and half, it has been treated here as fast growing. The growth parameters used during the EWG 12-19 were the same used for SGMED-10-02:

Growth parameters

L_{∞}	29.1
K	0.41
to	-0.39
L/W a	0.01
L/W b	3.02

6.10.1.3. Maturity

The species reaches massively the sexual maturity at one year old. Observations of proportion of mature individuals by size and analysis with the standard procedure show the bulk of the females spawn at a size of about 10 cm.

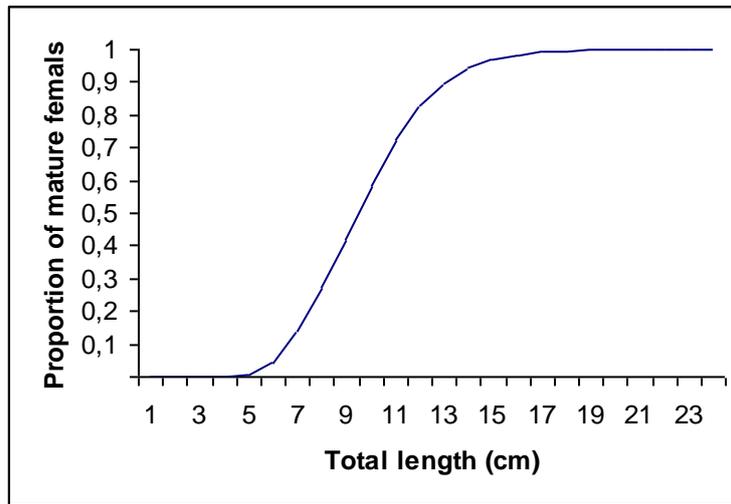


Fig. 6.10.1.3.1. Proportion of mature females.

Data on spawning (DCR) confirm that is taking place in spring (April-June), with a peak during May.

PERIOD	Age	0	1	2	3+
1994-2011	Prop. matures	0	1	1	1
1994-2011	M	1.3	0.45	0.27	0.24

6.10.2. Fisheries

6.10.2.1. General description of the fisheries

Red mullet (*Mullus barbatus*) is one of the most important demersal target species for the commercial fisheries in Sardinia (GFCM-GSA11). In this area red mullet is exploited by trawlers and gillnetters, which operate near shore. Particularly, during the period of post-recruitment (September-October), small trawlers target this species on shallower waters, near the coast.

Around 1300 boats are involved in this fishery and, according to official statistics, the total annual landings for all species during the period 2005-2011 were on average around 1500 tons of which *Mullus barbatus* constituted about 16.4 %.

In the GSA 11, the trawling-fleet has remarkably changed from 1994 to 2004. The change has mostly consisted of a general increase of the number of vessels and by the replacement of the old, low tonnage wooden boats by larger steel boats. For the entire GSA a decrease of 20% for the smaller boats (<30 GRT), which principally exploit this species, has been observed.

6.10.2.2. Management regulations

As in other areas of the Mediterranean, the stock management is based on control of fishing capacity (licenses), fishing effort (fishing activity), technical measures (mesh size and area closures), and minimum landing sizes (EC 1967/06).

Two small closed areas were also established along the mainland (west and east coast respectively), although these are finalised to protected mainly lobsters.

Since 1991, a fishing ban for trawling 45 day was have been almost every year enforced in different periods for the small scale fishery (march, TSL<=15 m) and for the larger vessels, mostly trawlers (September, TSL<15 m).

Furthermore, (2006) the closure was recently differentiate also considering the different coasts (west and east mainly) with a shift of 15 day of the fishing ban period. Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.

6.10.2.3. Catches

6.10.2.3.1.Landings

The following table shows the annual landings (t) by gear (DCF data, 2012):

Gear	2005	2006	2007	2008	2009	2010	2011
OTB	253	249	346	263	222	235	171
GTR				1			

According to data submitted to EGW the amount of GTR landing was considered negligible. Values shows a peak in 2007, and a decrease of about 30% in the last year (2011).

6.10.2.3.2.Discards

The following table shows the annual discards (t) by gear (DCF data, 2012):

Gear	2005	2006	2007	2008	2009	2010	2011
OTB		35			17	32	59
GTR						2	

No discards data was available for 2005, 2007 and 2008. The percentage of discards show an increasing trend in the last period. In 2009 discard were around the 7% of the OTB landings and rise up to 25% in 2011 (mean 14.2% \pm 4 s.e.).

6.10.2.4. Fishing effort

Using data available to EWG 12-19, the fishing effort by year and major gear type was estimated (Table 6.10.2.4.1).

The analysis show a major drop of total fishing effort in 2008, when both the trawlers and the small scale fishery effort decrease (of 25 and 31 % respectively). In the last three years, the total effort was almost stable, even if a minor increase in the small scale fishery did occur.

Fishing effort (kW*days) for GSA 11 by gear on yearly basis (2004-2011) as reported through the DCF official data call is shown in Table 6.10.2.4.1.

Table 6.10.2.4.1. Nominal effort (kW*days) for GSA 11 by major gear types, 2004-2011. Data submitted through the DCF data call in 2012.

AREA	GEAR	2004	2005	2006	2007	2008	2009	2010	2011
SA 11	FPO	48666	77107	976288	1514990	946792	1061601	1060063	1776625
SA 11	FYK				4611				720
SA 11	GNS	1378699	1068693	215992	785702	469361	1003413	604642	320583
SA 11	GTR	8013778	7204105	7361556	5058262	3765417	4110927	4478336	4425145
SA 11	LLD	169657	280487	490653	1469465	1027107	560887	695218	1125271
SA 11	LLS	1282251	946753	1364505	1172901	661573	673775	542250	442194
SA 11	LTL			7099	2914	589	566		
SA 11	none	21421	798	70267	154312	65247	44038	9259	17027
SA 11	OTB	7834441	7284509	5627750	5660565	4326313	4370758	4036734	3788057
SA 11	PS	38988							

6.10.3. Scientific surveys

6.10.3.1. MEDITS

6.10.3.1.1. Methods

Since 1994, MEDITS trawl surveys has been regularly carried out each year during the spring season. Red mullet density and biomass indexes showed large fluctuations, and peaks were detected in 2005 and 2007 (Figure 6.10.3.1.1.1).

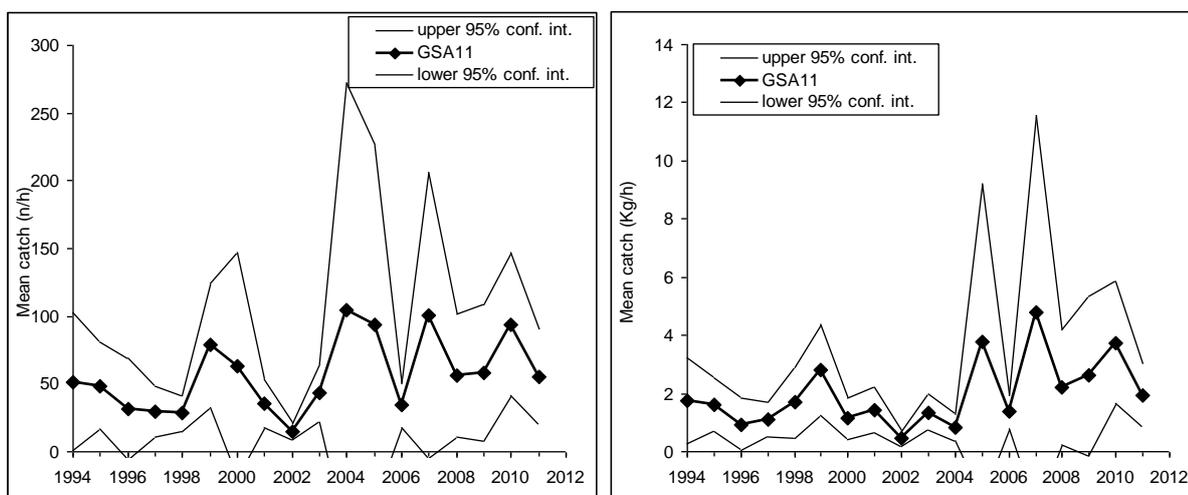


Fig. 6.10.3.1.1.1. *M. barbatus*: MEDITS trends in density and biomass indexes from 1994 to 2011 in GSA 11

Based on the DCF data, abundance and biomass indices were recalculated. In GSA 11 the following number of hauls was reported per depth stratum (Table 6.10.3.1.1.1).

Table 6.10.3.1.1.1. Number of hauls per year and depth stratum in GSA11, 1994-2011.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
GSA11_010-050	17	19	21	21	21	21	19	18	20	18	17	17	19	19	17	18	19	20
GSA11_050-100	28	21	23	23	21	22	22	24	19	19	18	22	19	20	19	20	19	19
GSA11_100-200	22	23	30	31	31	30	31	30	24	24	24	24	24	24	22	24	24	24
GSA11_200-500	35	29	29	26	25	27	24	25	20	24	21	20	20	20	21	19	20	21
GSA11_500-800	23	16	22	25	25	24	27	26	16	14	15	14	16	17	16	16	17	17

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Y_{st} = \sum (Y_i * A_i) / A$$

$$V(Y_{st}) = \sum (A_i^2 * s_i^2 / n_i) / A^2$$

Where:

A=total survey area

A_i=area of the i-th stratum

s_i=standard deviation of the i-th stratum

n_i=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Y_i=mean of the i-th stratum

Y_{st}=stratified mean abundance

V(Y_{st})=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval:

$$\text{Confidence interval} = Y_{st} \pm t(\text{student distribution}) * V(Y_{st}) / n$$

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations in each stratum. Aggregated length

frequencies were then raised to stratum abundance * 100 (because of the low numbers in most strata) and finally aggregated (sum) over the strata of the entire GSA.

6.10.3.1.2. Geographical distribution patterns

The stock is present in the whole area but is more abundant in the western and southern part of the GSA 11 as showed in Figure 6.10.3.1.2.1 (Ardizzone e Corsi, 1997 Eds. CD-ROM Version).

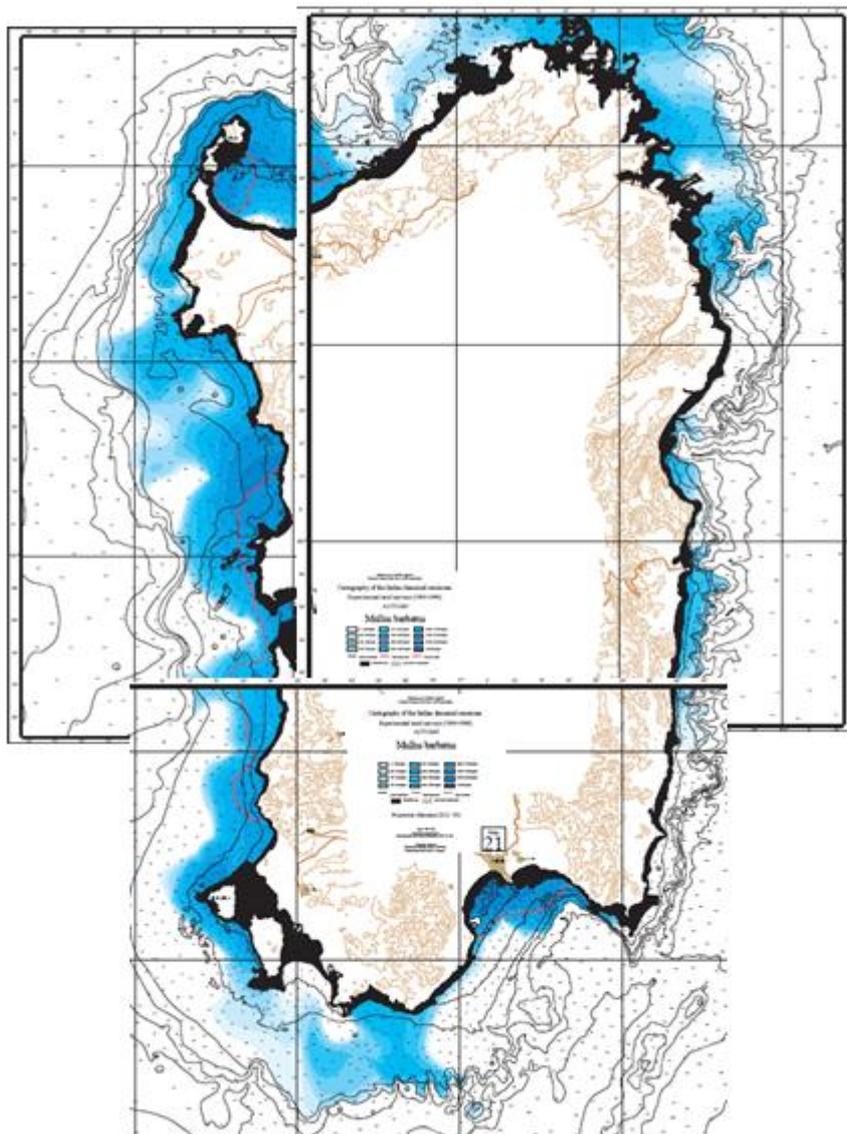


Fig. 6.10.3.1.2.1 Mean biomass index of *Mullus barbatus* in GSA 11 (Autumn, 1994-1996, modified from Ardizzone e Corsi, 1997).

The spatial structure of red mullet have been achieved by modelling the spatial correlation structure of the abundance indices through geostatistical techniques (i.e. kriging), showing clear areas of persistence in the

south (Gulf of Cagliari) and western coasts (Carloforte and coast between Bosa Marina and Capo Mannu). Main results and maps are reported in the “nursery section” of SGMED-09-02 report.

6.10.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of red mullet in GSA11 was derived from the international survey MEDITS. Figure 6.10.3.1.3.1 displays the estimated trend in *M. barbatus* abundance and biomass in GSA 11. The estimated abundance and biomass indices do not reveal a clear trend but a series of peaks particularly in the last part of the time series.

6.10.3.1.4. Trends in abundance by length or age

Boxplots and histograms of the MEDITS standardized length frequencies distributions (LFD) are shown in Figure 6.10.3.1.4.1. Whereas a low variability in the second quartile (median) of the LFD is observed along the time series, the degree of dispersion and the total abundances (box are proportional) is more variable in the years. Moreover, in 2004, a peak of recruitment is evident.

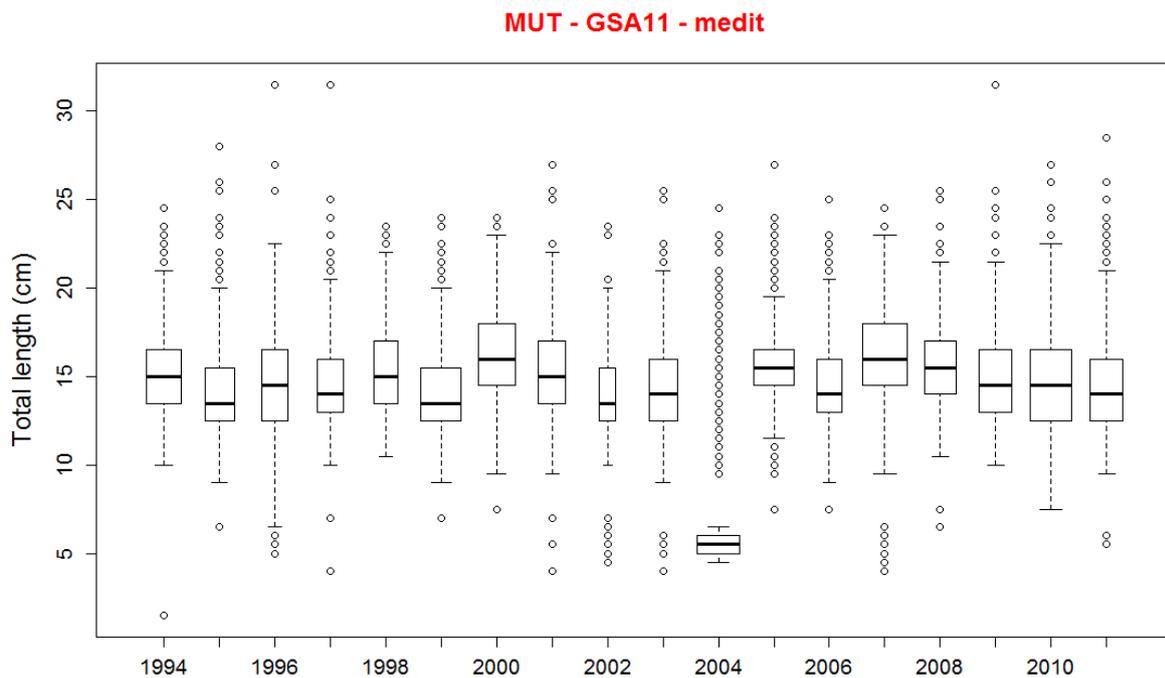


Fig. 6.10.3.1.4.1 Red mullet: Boxplot of the stratified length frequency distributions in GSA 11 (MEDITS)

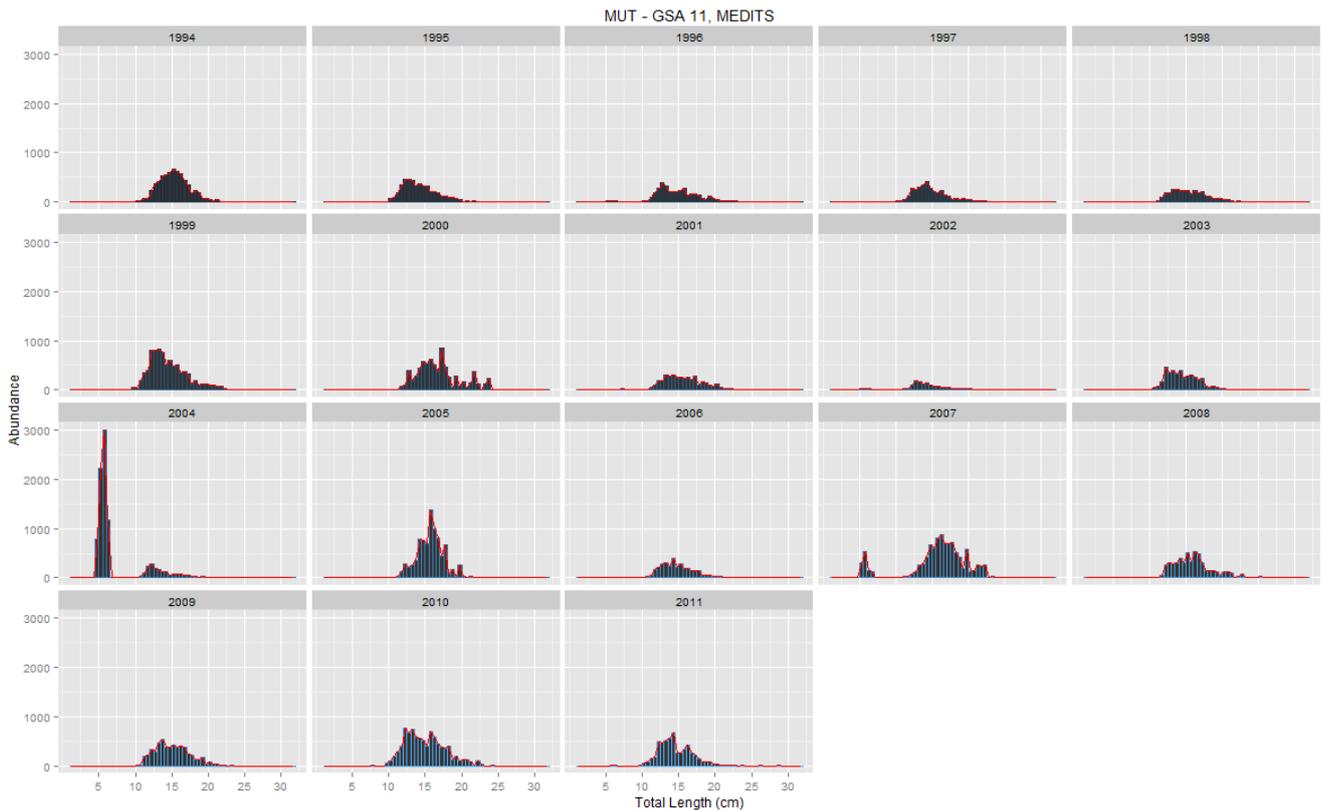


Fig. 6.10.3.1.4.2 Stratified abundance indices by size, 1994-2011.

6.10.3.1.5. Trends in growth

No analyses were conducted during EWG12-10 meeting.

6.10.3.1.6. Trends in maturity

No analyses were conducted during EWG-12-10.

6.10.4. Assessment of historic stock parameters

6.10.4.1. Method 1: XSA - MUT

6.10.4.1.1. Justification

An XSA was performed using DCF data from 2005 to 2011 tuned with fishery independent survey abundance indices (MEDITS).

6.10.4.1.2. Input parameters

As mentioned in the landing section (6.10.2.3.1) catch at length data (DCR, 2012) were available respectively for a continuous time series (2005-2011) while discard at length data were available only for the last three years (2009-2011). Moreover they are mainly derived from the trawling fleet (OTB).

To obtain the input data to run the XSA EWG 12-19 calculate the mean ratio landing/discards for all the years when both information were reported in order to fill the gap on discard data for the first period using the landing information 2005-2008. Moreover, due to the discrepancy between catch and landings EWG 12-19 decide to adjust the data scaling the DCR landings' length composition to the total catch.

This aspect underlines both the need of some improvements of the data collection, paying particular attention to the sampling design and the importance of routinely check of the official data made by experts.

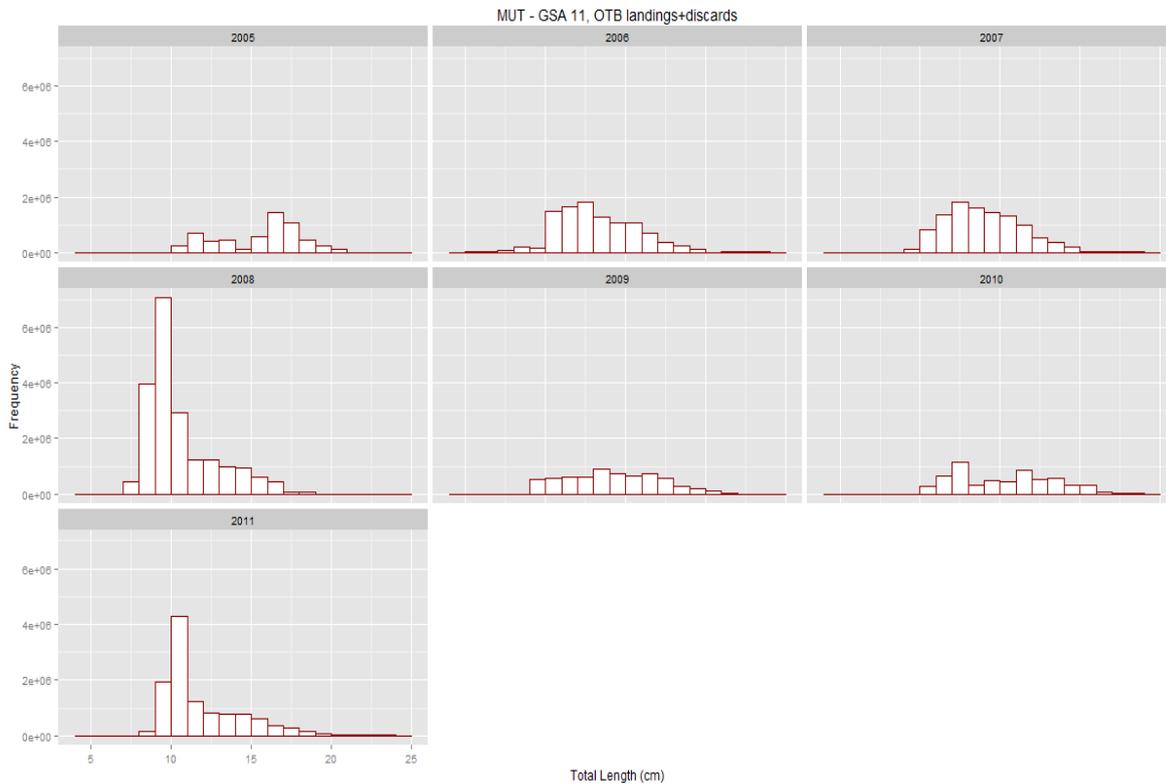


Fig. 6.10.4.1.2.1 LFD of OTB catches of *M. barbatus* in the GSA11

LFD of catches (Figure 6.10.4.1.2.1) and MEDITS survey (Figure 6.10.3.1.4.2) were splitted in age classes using the statistical slicing procedure developed by Scott et al. (2012, EWG 11-12). The analysis was performed by sex combined using the VBGF parameters and is shown below. In Figures 6.10.4.1.2.2 and 6.10.4.1.2.3 the best mixtures (minimum chisquare) are reported for each year separately for commercial catches, discard data and MEDIT survey.

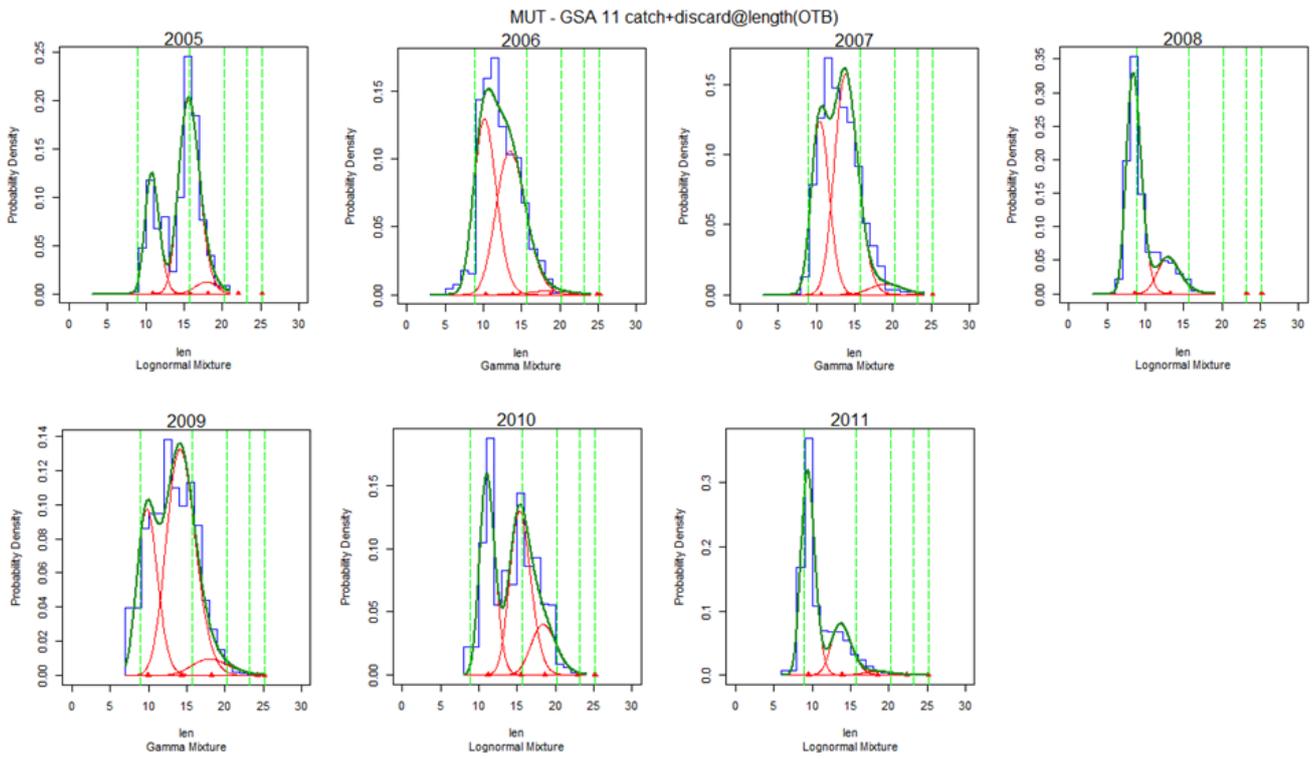
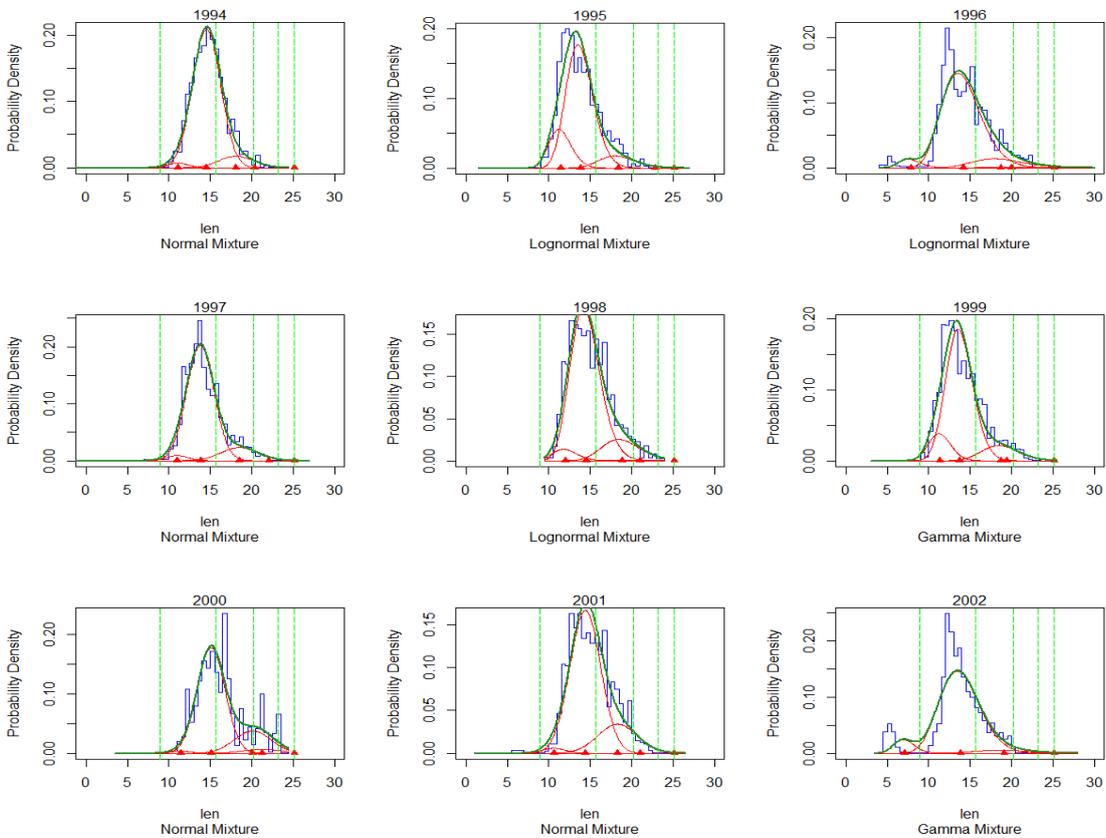


Fig. 6.10.4.1.2.2. Statistical age slicing of the catch at length frequency OTB data of *M. barbatus* (2005-2011).



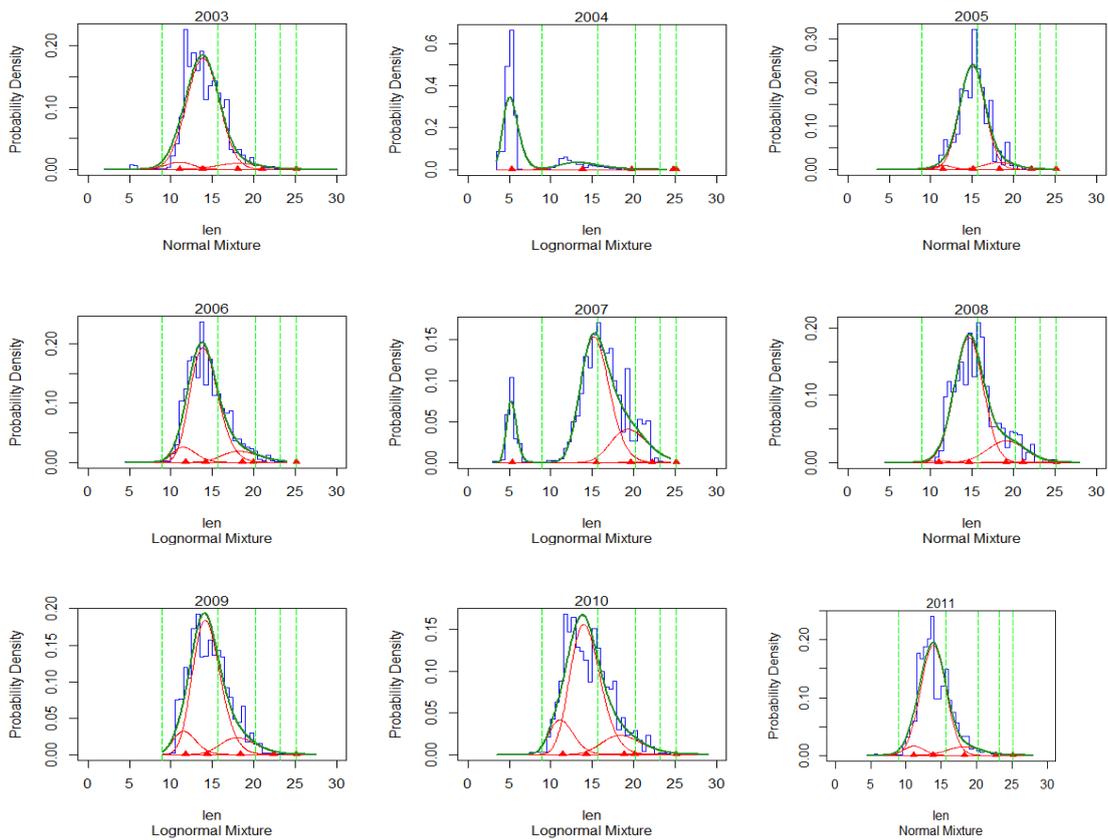


Fig. 6.10.4.1.2.3. Statistical age slicing of the MEDITS length frequency distributions of *M. barbatus* (1994-2011).

For the XSA the main settings used were: F_{bar} 1-3, $f_{\text{se}}=0.5$, $r_{\text{age}}=0$, $q_{\text{age}}=1$, $\text{shk.yrs}=3$, $\text{shk.ages}=2$, $\text{min.nse}=0.3$.

As regards the input data and parameters (i.e. catch at age, weight at age, maturity at age, natural mortality at age, tuning) the list is reported here below (Table 6.10.4.1.2.1).

Table 6.10.4.1.2.1 Input parameters used for the XSA.

Maturity and M vectors

PERIOD	Age	0	1	2	3
2005-2011	Prop. Matures	0.0	1.0	1.0	1.0

PERIOD	Age	0	1	2	3
2005-2011	M	1.3	0.45	0.27	0.24

Weight-at-age in the catch

Mean weight in catch (kg)	0	1	2	3
2005	0.014	0.042	0.063	0.115
2006	0.012	0.027	0.070	0.164
2007	0.013	0.029	0.076	0.170
2008	0.007	0.024	0.133	0.133
2009	0.010	0.031	0.065	0.152
2010	0.015	0.039	0.068	0.128
2011	0.009	0.028	0.068	0.119

Number at age in the catch (thousands)

Catch at age in numbers	0	1	2	3
2005	3745	5035	507	17
2006	7111	3623	1495	29
2007	7099	6495	1597	30
2008	18216	5662	250	111
2009	3457	5615	575	63
2010	3491	3806	1012	31
2011	1489	5238	545	0.04

Tuning (MEDITS)

Year	0	1	2	3
2005	216	7685	637	2
2006	298	2724	343	3
2007	1144	6792	2281	34
2008	41	4191	954	45
2009	597	4236	680	2
2010	1379	6519	1257	27
2011	319	4754	489	9

6.10.4.1.3.Results

Residuals from the survey do not show any particular trend (Figure 6.10.4.1.3.1A) as well as the retrospective analysis (Figure 6.10.4.1.3.1B).

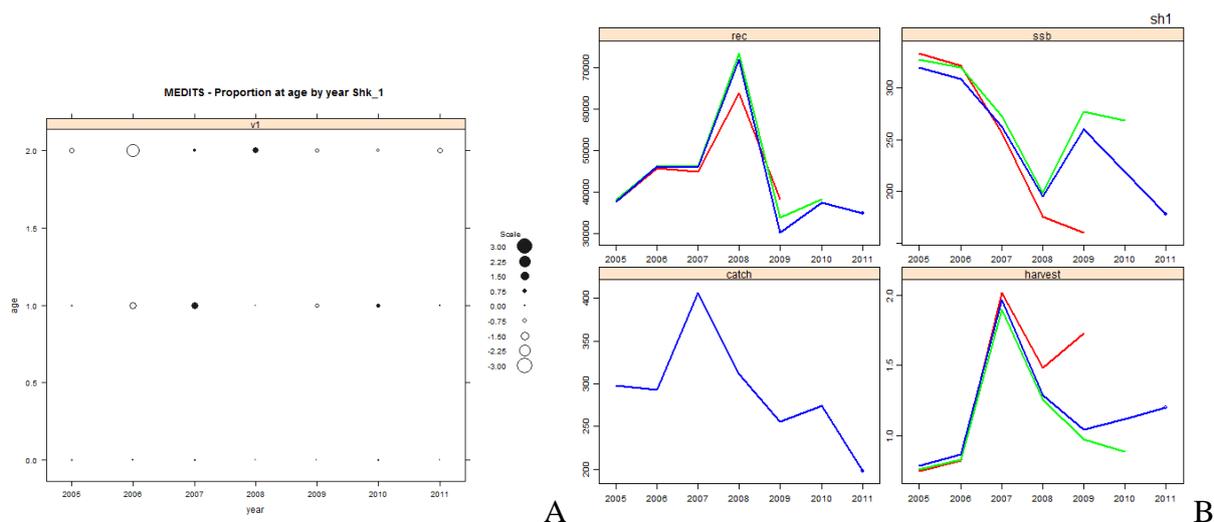


Fig. 6.10.4.1.3.1. Residuals of the survey (A) and retrospective analysis (B).

From the results of the XSA (Figure 6.10.4.1.3.2), SSB oscillated between 180 and 250 t during the first period (2005-2008), peak up to 300 t in 2009, then progressively drop down to the minimum value of 150 t in the last year (2011).

Recruitment as well shows a strong decrease in the last 4 years. Estimates ranged between about 6.5×10^5 (2008) and 10^5 (2011).

Mean F_{1-3} ranged between 0.8- 2.5 from 2005 to 2011.

Once a period (2006-2009) of decrease the level of fishing exploitation increase in the last years.

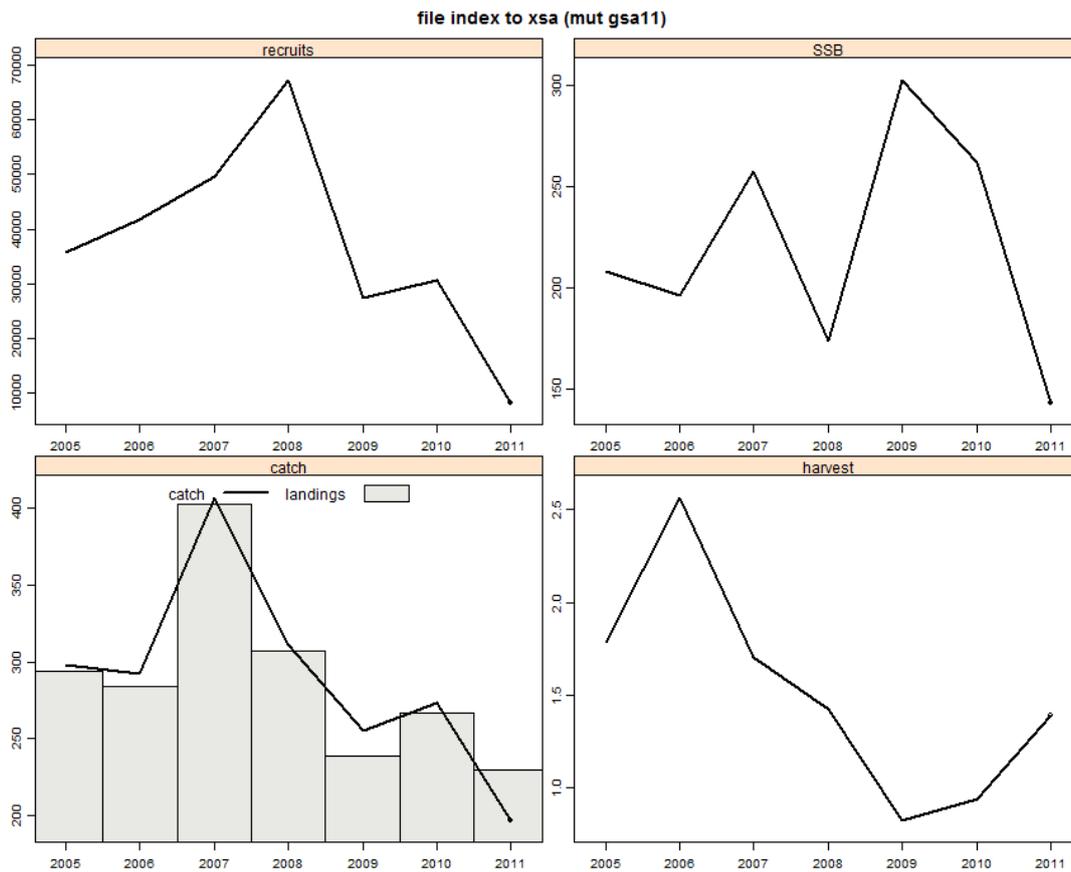


Fig. 6.10.4.1.3.2. XSA results (recruitment fishing mortality, spawning stock, total biomass biomass and relative F at age).

6.10.4.2. Method 2: SURBA

6.10.4.2.1. Justification

The SURBA analyses was applied to the MEDITS survey estimates.

The MEDITS survey provided the longer standardized time-series data on abundance and population structure of *M. barbatus* in the GSA 11.

6.10.4.2.2. Input parameters

DCF data provided at EWG12-19 contained information on abundances and length structure of both trawl surveys (time series of MEDITS from 1994 to 2008) and landings have been used for the analysis. The SURBA software package (Needle, 2003) lets to take advantage of the trawl surveys data time series available from the MEDITS research program. Using SURBA the trend in fishing mortality rates of red mullet in the GSA 11 was reconstruct starting from the analysis of the length frequency distribution (LFD).

The LFDs (cfr Figure 6.10.4.1.2.2.). were splitted and converted in numbers by age classes by means of the statistical slicing (assuming the normal distribution of the cohorts) developed by Scott et al., (2012) during EWG 12-02. The LFD were splitted up to the age class 3+ and the analysis was performed by sex combined.

According to the ProdBiom approach by Caddy and Abella (1999), a vectorial of natural mortality at age was computed for the stock analysis (Table 6.10.4.2.2.1).

Table 6.10.4.2.2.1. Input parameters used in the SURBA analysis (sex combined) in the (GSA 11).

VBGF	$L_{\infty}=29.1$ cm, $K=0.41$, $t_0=-0.39$
M vector	$Age_1=0.41$, $Age_2=0.27$, $Age_3=0.24$, $Age_4=0.21$
Catchability (q)	$q_{1-4} = 1$
Length at maturity (L50)	13 cm (sex combined)

6.10.4.2.3.Results

The model proxy for the combination of fishing effort and mean natural mortality in the population (temporal trend of F) shows high fluctuation along the considered time series; after a decreasing trend from 1999 to 2007, a peak of F was observed in 2008 (Figure 6.10.4.2.3.1). Fitted age effect shows an increasing from age 0 to age 2, while fitted cohort effects show large fluctuations.

Fishing mortality estimated over age classes 1 to 3 showed high fluctuation along the time series, and shows a decreasing trend in the last 10 years. SSB also shows wide fluctuation.

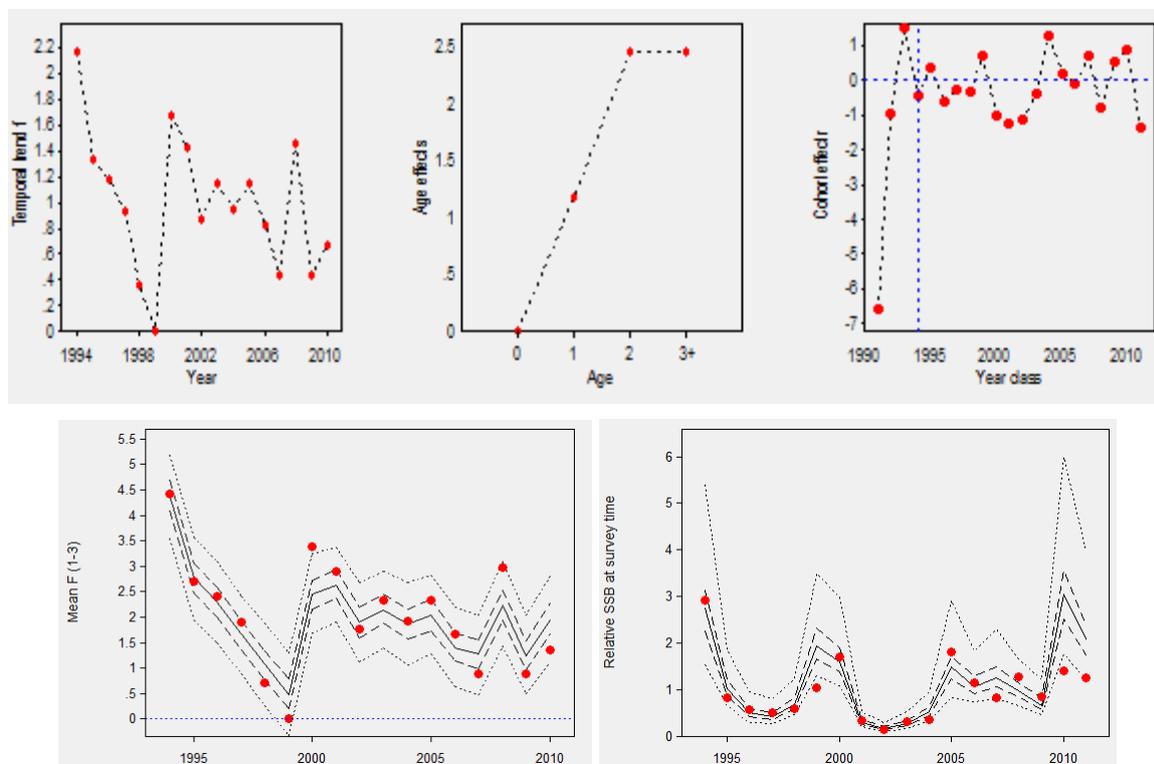
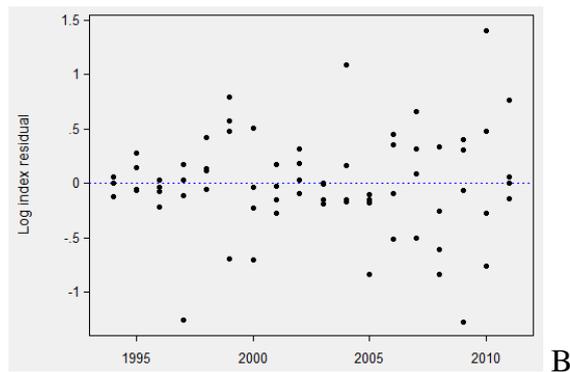
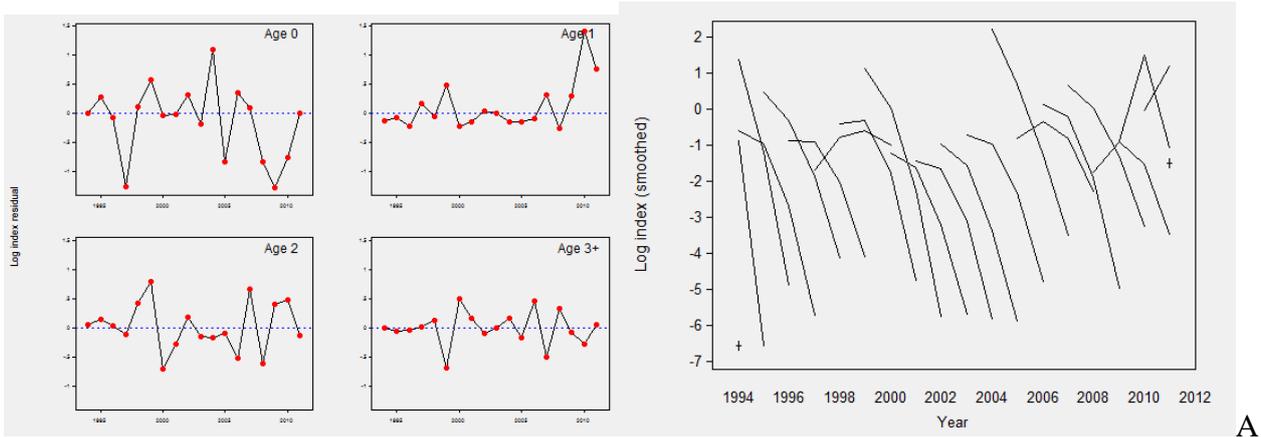
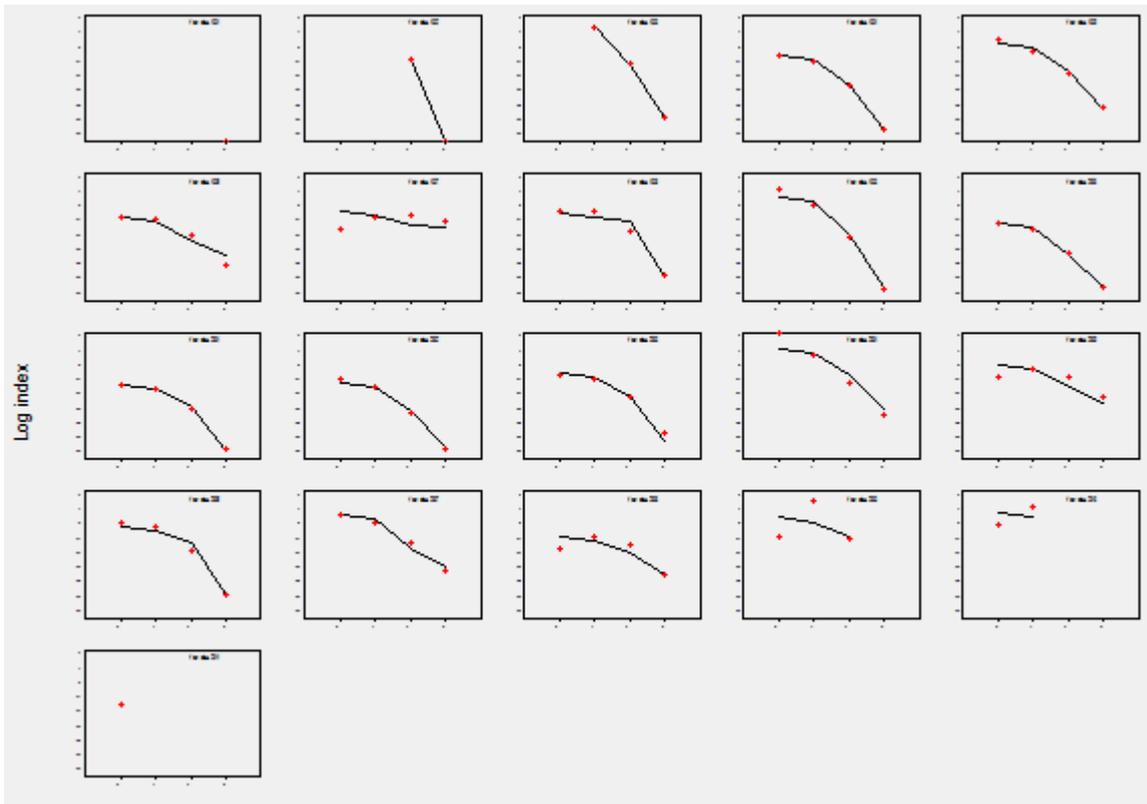


Fig. 6.10.4.2.3.1 MEDITS survey. Mean F and relative SSB at survey time estimated by SURBA.

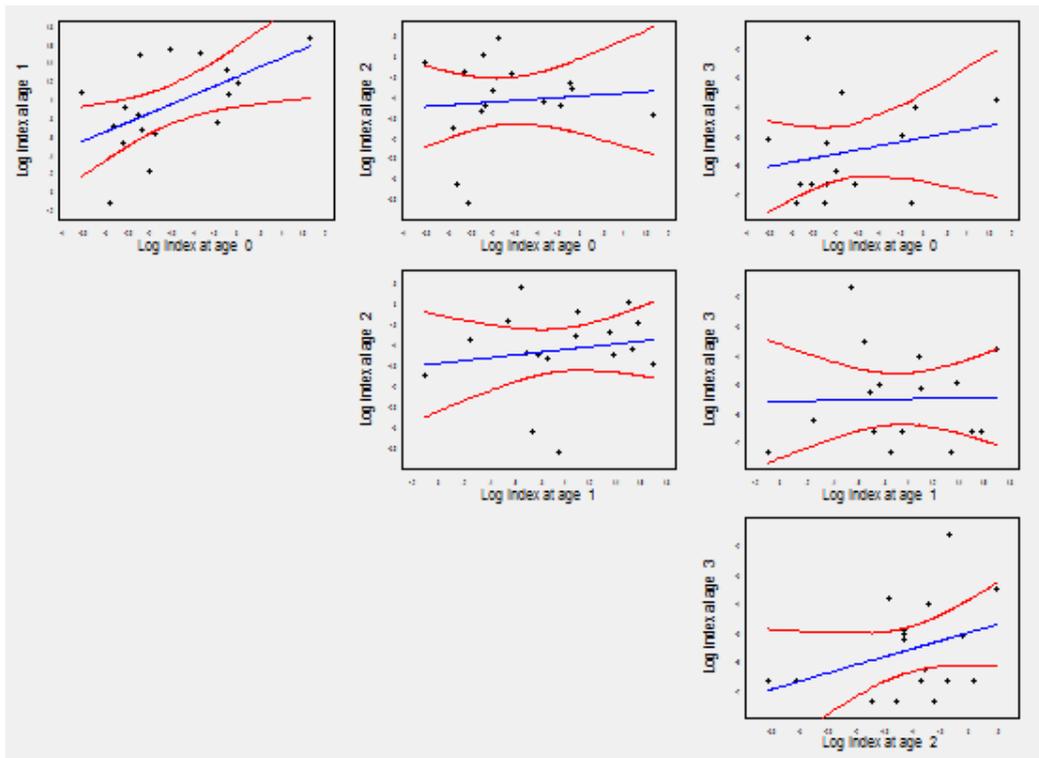
Model diagnostics

As showed in Figure 6.10.4.2.3.2 the SURBA model diagnostic shows some discrepancy in the fitting of the smoothed log choort abundace (panel A). However, no trends were detected in the analysis of the residuals of the log abundance index over time (panel B). The diagnostic of the log index abundance by year class, was inadequate in some years showing small differences between the observed (points) and fitted values (lines) (panel C). Finally, the fitting of the comparative scatterplots at age was acceptable (panel D).





C



D

Figure 6.10.4.2.3.2. Model diagnostic for SURBA of *M. barbatus* in the GSA 11; A) Residual by age, and log survey abundance indices by cohort. Each line represents the log index abundance of a particular cohort throughout its life; B) Log index residuals over time; C) Comparison between observed (points) and fitted (lines) MEDITS survey abundance indices, for each year; D) Comparative scatterplots at age.

6.10.4.3. Method 3: Yield-per-Recruit model

6.10.4.3.1. Justification

Yield per recruit analyses (YPR) were based on the output of the exploitation pattern coming from XSA. As input the same population parameters of the XSA were used (Table 6.10.4.1.2.1)

The analysis aims to predict the effects of changes in the fishing effort on future yields and to define the Reference Points $F_{0.1}$, (as a proxy of F_{MSY}) and F_{max} .

6.10.4.3.2. Results

The results of the YPR analysis are showed in the Figure 6.10.4.3.2.1 and the obtained reference points $F_{0.1}$, F_{max} and the F_{cur} are summarized in Table 6.10.4.3.2.1.

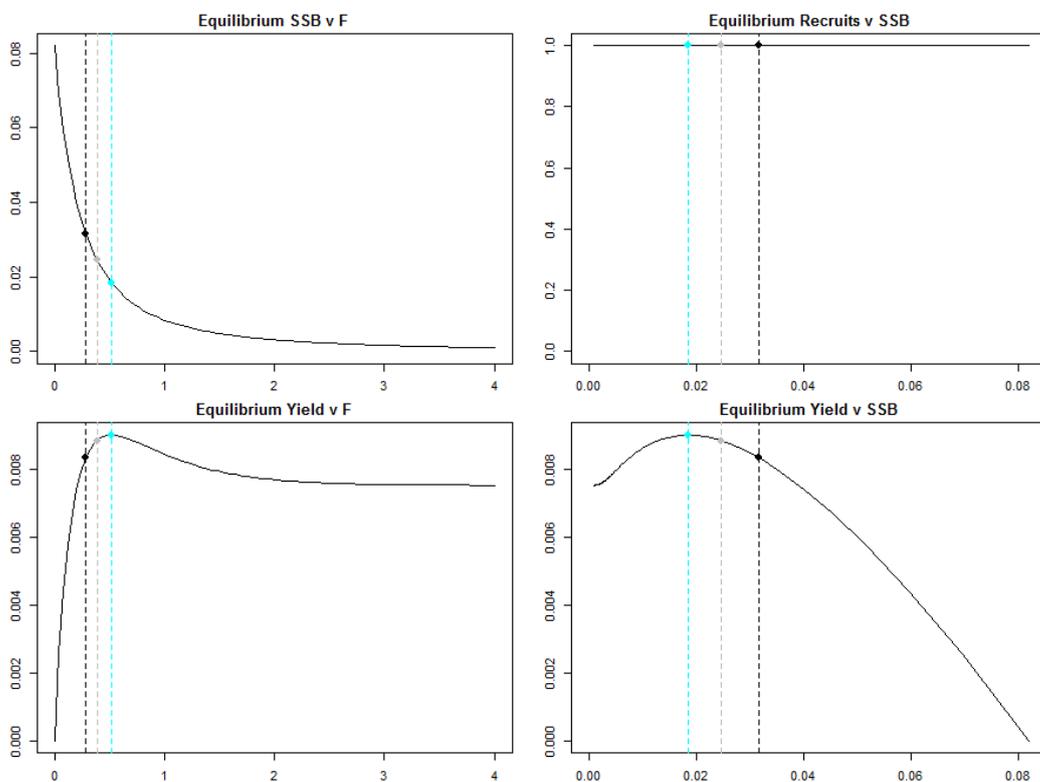


Fig. 6.10.4.3.2.1. Results summarising the yield per recruit analysis performed by XSA on 2011 data.

Table 6.10.4.3.2.1. Reference points estimated with the YPR analyses.

	F_{ref}
$F_{0.1}$	0.29
F_{max}	0.53
$F_{current}$	0.97

6.10.5. Data quality

The MEDITS survey data series (1994 to 2011) in comparison to landing and discard is much longer and has been improved in quality in the last years. The landing data series is continuous from 2005 while discards are more discontinuous. Red mullet is a fast growing species that settle at less than one year old and group in nursery ground near the shore. So that recruits are very vulnerable at this time. The lacking of the discard information that essentially belongs to this component of the stock underlines the need of some improvements of the data collection.

Moreover the discrepancy between catch and landings suggest particular attention to the sampling design and the importance of a routinely check of the official data made by experts.

6.10.6. Scientific advice

6.10.6.1. Short term considerations

6.10.6.1.1.State of the spawning stock size

The spawning stock biomass estimated by XSA shows a clear decreasing trend. The SURBA models show an increase of SSB in the last two years but the estimation was associated to a high level of uncertainty. In the years where the models fit better a decline of SSB is detectable.

The level of the spawning stock biomass in the last years is about 150 t. A main peak was observed in 2009 (300 t). From 2005 to 2008 SSB oscillated between 180 and 250 t.

Since any biomass reference proposed or agreed, EWG 12-19 is unable to fully evaluate the state of the stock size in respect to these.

6.10.6.1.2.State of recruitment

The recruitment estimated by XSA shows a decreasing pattern. However without any recruitment reference proposed or agreed, EWG 12-19 is unable to fully evaluate the state of the recruitment in respect to these.

6.10.6.1.3.State of exploitation

In the three methods used, the values of the most recent F_{bar} range from 0.8 to 1.5 and the values of $F_{0.1}$ as a proxy of F_{MSY} is 0.29. Taking into account the results obtained by the XSA analysis (current F is around 0.97), the stock should be considered as exploited unsustainably.

6.11. Stock assessment of giant red shrimp in GSAs 12-16

6.11.1. Stock identification and biological features

6.11.1.1. Stock Identification

Only limited information is available on population structure, migration patterns and larval mixing of *Aristaeomorpha foliacea* in the Central Mediterranean. Bianchini (1999) hypothesized that giant red shrimp in the Strait of Sicily have two main distribution zones based on the bathymetry of the Strait of Sicily: one on the eastern side and one on the western side of the Sicilian Channel, connected with a passage which allows for the movement of individuals. A more recent study on the genetic connectivity between giant red shrimp populations however found no significant genetic variability between individuals sampled in Sardinia and in the Strait of Sicily (Marcia et al., 2010).

Based on the available information and the distribution of fishing ground targeted by the Sicilian long distance trawl fleet (see Figure 6.11.1.1 below for details), giant red shrimp found in the Central Mediterranean GSAs 12-16 were considered to form a single stock for the purpose of this assessment.

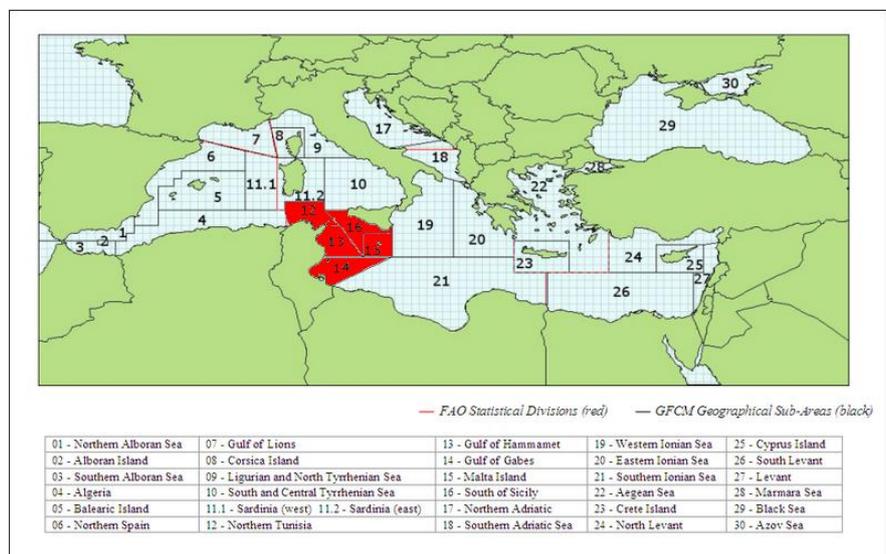


Fig. 6.11.1.1.1. Stock distribution map of *A. foliacea* in the Central Mediterranean; GSAs 12-16

6.11.1.2. Growth and natural mortality

A maximum age of 4-6 years has been estimated for female giant red shrimp (Ragonese et al. 1994, Cau et al. 2002, CNR-IAMC 2009). For male individuals estimates range between 5-10 years (Ragonese et al. 1994, Ragonese et al. 2012). Natural mortality estimates range between 0.4-0.5 for females (Ragonese et al. 1994, Binachini 1999, Ragonese et al. 2004) and 0.4-0.6 for males (Ragonese et al., 2012). Von Bertalanffy growth parameters estimated to date for the Strait of Sicily are reported in Table 6.11.1.2.1 below.

Table 6.11.1.2.1. Von Bertalanffy growth function estimated for the Strait of Sicily; L_{∞} , k and t_0 refer to the asymptotic carapace length (CL; mm), the curvature coefficient (year^{-1}) and the theoretical age at size 0.

Author	Sex	L_{∞}	k	t_0
Ragonese et al. (1994)	F	65.5	0.67	0.28
Ragonese et al. (1994)	M	41.5	0.96	0.28
Bianchini (1999)	M	40-41	1.08	/
Cau et al. (2002)	F	65.5	0.67	/
Bianchini and Ragonese (2002)	F	60 - 61	0.63 - 0.66	/
Ragonese et al. (2004)	F	65.8	0.52	-0.23
AAVV (2008); Red's Project	F	62.24	0.65	0.05
AAVV (2008); Red's Project	M	40.31	0.79	-0.44
CNR-IAMC (2009)	F	61.66	0.78	-0.22
CNR-IAMC (2009)	M	41.95	0.7	-0.18
SGMED 02-09 (2009)	F	68.9	0.61	-0.2
Ragonese et al. (2012)*	M	41.9	1.40 / 0.56	0.2 / -0.99

* Double phased VBGF: coefficients before / after transitional age

6.11.1.3. Maturity

Juveniles recruiting in spring are immature, with only a few individuals reproducing during their first year. Gonadic development begins in winter and individuals reach sexual maturity during the summer of their second year (Bianchini, 1999; Politou et al., 2004). Once they have reached maturity male giant red shrimp have a protracted reproductive capacity and are ready to mate throughout the year, whilst females mature seasonally (Bianchini 1999; Perdichizzi et al., 2012). In the Strait of Sicily maturation of female *A. foliacea* and subsequent spawning occurs from spring until autumn, with a marked maturity peak in summer-autumn (Ragonese et al. 2004).

Levi and Vacchi (1988) found the smallest mature female caught in the Strait of Sicily to measure 42 mm length. Bianchini (1999) reported males reaching maturity at 30-33 mm carapace length and that all females larger than 40 mm carapace length had spermatophores. Ragonese et al. (2004) report a length at 50% maturity of 30-33 mm carapace length for males and of 42 mm for females. The most recent maturity ogive available was estimated by CNR-IAMC based on 2009 data, with a length at 50% maturity for females of 37.17 mm carapace length / a slope g of 0.541 and a length at 50% maturity of 27.41 mm carapace length / a slope g of 0.988 in males.

6.11.2. Fisheries

6.11.2.1. General description of fisheries

Giant red shrimp are a key target species for the Sicilian and Maltese bottom otter trawl fleets operating on the slope of the continental shelf in the Strait of the Sicily. The species is fished throughout the year; a slight decrease in total landings during the first quarter of the calendar year (January-April) is generally followed by a peak in landings in the second quarter (May-August).

A. foliacea is fished exclusively by otter trawl, mainly in the central – eastern side of the Strait of Sicily, whereas in the western side it is substituted by the violet shrimp, *Aristeus antennatus*. Other commercial species frequently caught together with giant red shrimp are the deep water rose shrimp (*Parapenaeus longirostris*), Norway lobster (*Nephrops norvegicus*), blue and red shrimp (*Aristeus antennatus*), greater forkbeard (*Phycis blennoides*) and hake (*Merluccius merluccius*). Numerically, deep water rose shrimp and Norway lobster, together with giant red shrimp, make up the bulk of catches (Bianchini, 1999).

Information on the location of fishing zones targeted by the Sicilian trawl fleets is available from Ragonese (1995) as well as Bianchini et al. (2003), who give an outline of the most important *A. foliacea* target areas in the Strait of Sicily.

During a survey of demersal fisheries resources along the Tunisian coast carried out in 1979, Bonnet (1980) only found significant number of *A. foliacea* at depths of ~500 m off the coast of Tabarka, in the north of Tunisia. More recently, Missaoui (2004) list giant red shrimp as one of about twenty commercial crustacean target species caught in Tunisian fisheries, stating that *A. foliacea* is concentrated on the northern side of Tunisia. However compared to the large volumes of giant red shrimp caught by the Sicilian trawl fleet, landings by Tunisian vessels can be considered negligible.

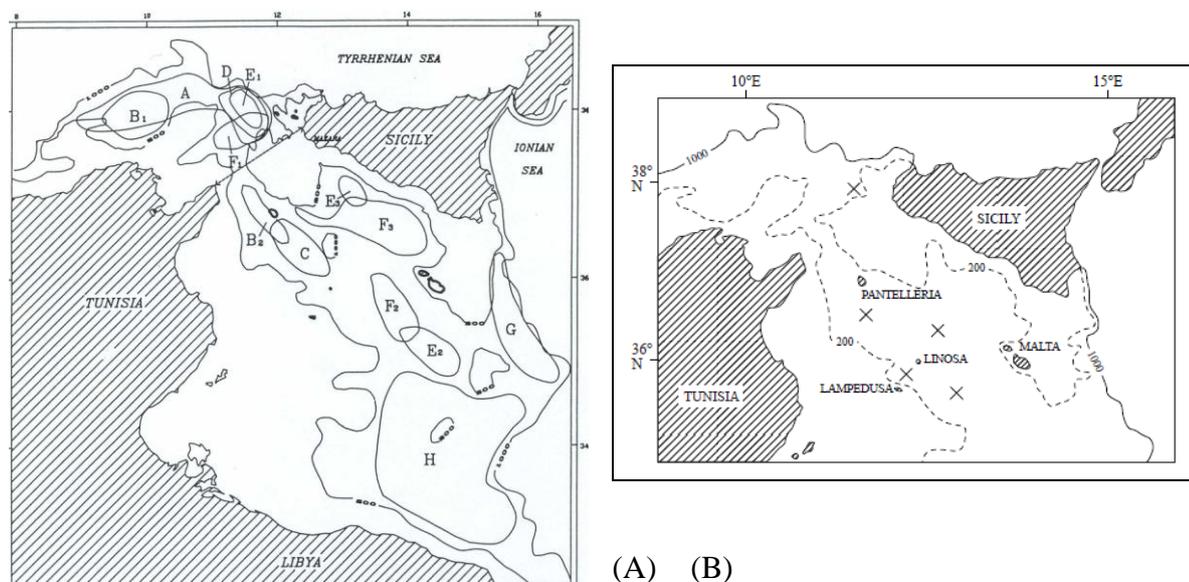


Fig. 6.11.2.1.1. Main fishing grounds of *Aristaeomorpha foliacea* targeted by Sicilian fishermen; (A) after Ragonese (1995), (B) after Bianchini et al. (2003).

In Maltese waters, trawlers targeting the giant red shrimp *A. foliacea* within the 25nm fisheries management zone trawl either to the north / north-west of the Island of Gozo, or to the west / south-west of Malta, at depths of about 600-700m.

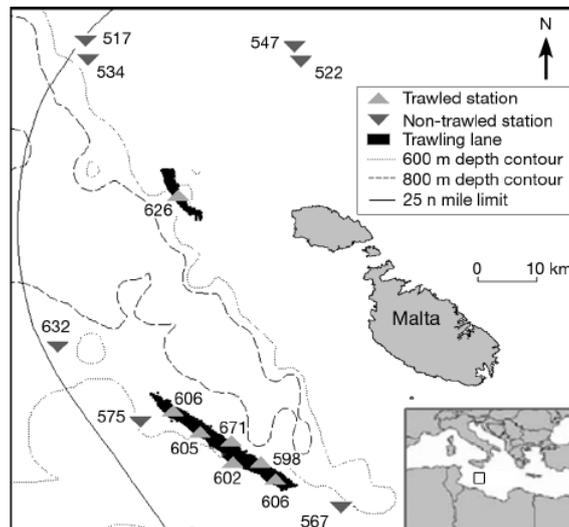


Fig. 6.11.2.1.2. Trawl lanes within the Maltese 25 nautical mile Fisheries Management Zone (after Dimech et al., 2012).

6.11.2.2. Management regulations applicable in 2010 and 2011

At present there are no formal management objectives for giant red shrimp fisheries in the Strait of Sicily. As in other areas of the Mediterranean, the stock management in Italy and Malta is based on control of fishing capacity (licenses), fishing effort (fishing activity), technical measures (mesh size and area/season closures).

In order to limit the over-capacity of fishing fleet, no new fishing licenses have been assigned in Italy since 1989 and a progressive reduction of the trawl fleet capacity is currently underway. Maltese fishing capacity licenses had been fixed at a total of 16 trawlers since 2000, but eight new licenses were issued in 2008 and one in 2011, a move made possible by capacity reductions in other segment of the Maltese fishing fleet.

A compulsive fishing ban for 30 days in August-September was recently adopted by Sicilian Government. There is no closed season in place in Malta, but the Maltese Islands are surrounded by a 25 nautical miles fisheries management zone where fishing effort and capacity are being managed by limiting vessel sizes, as well as total vessel engine powers (EC 813/04; EC 1967/06). Trawling is allowed within this designated conservation area, however only by vessels not exceeding an overall length of 24 m and only within designated areas. Vessels fishing in the management zone hold a special fishing permit in accordance with Regulation EC 1627/94. Moreover, the overall capacity of the trawlers allowed to fish in the 25nm zone can not exceed 4 800 kW, and the total fishing effort of all vessels is not allowed to exceed an overall engine

power and tonnage of 83 000 kW and 4 035 GT respectively. The fishing capacity of any single vessel with a license to operate at less than 200m depth can not exceed 185 kW.

In order to protect coastal habitats the use of towed gears is prohibited within 3 nm of the coast or within the 50 m isobath if the latter is reached closer to the coast (EC 1967/2006; Res. GFCM 36/2012/3). In order to protect deep water habitats trawling at depths beyond 1000 m is also prohibited at EU and GFCM level (EC 1967/2006; Rec. GFCM 2005/1).

In terms of technical measures, EC 1967/2006 fixed a minimum mesh size of 40 mm for bottom trawling of EU fishing vessels. Mesh size had to be modified to square 40 mm square or at the duly justified request of the ship owner a 50 mm diamond mesh in July 2008; derogations were only possible up to 2010. Moreover diamond mesh panels can only be used if it is demonstrated that size selectivity is of equivalent or higher than using 40 mm square mesh panels (EC 1343/2011).

There is no minimum landings size for *A. foliacea* in European legislation.

6.11.2.3. Catches

6.11.2.3.1. Landings

Yield for Italian and Maltese trawlers combined in the period 2005-2011 peaked in 2010, at 1684 tonnes. The lowest landings were reported in 2008, at 1287 tonnes. The average of giant red shrimp landings was 1474 tonnes from Sicilian trawlers and 31 tonnes from Maltese trawlers in 2005-2011; the average annual contribution of Maltese catches to the total catch in this period was 2.1%. No information is available on giant red shrimp catches by the Tunisian trawl fleet.

Table 6.11.2.3.1.1. Landings (t) of *A. foliacea* by year for the bottom otter trawl gear in 2005-2011 as reported through the EU DCR / DCF for GSA 15 (Malta, right hand axis) and GSA 16 (Sicily, left hand axis).

Area	Country	2005	2006	2007	2008	2009	2010	2011
15	Malta	18	30	34	27	39	27	41
16	Italy	1270	1424	1541	1260	1616	1657	1553
15&16	Italy & Malta	1288	1454	1575	1287	1655	1684	1594

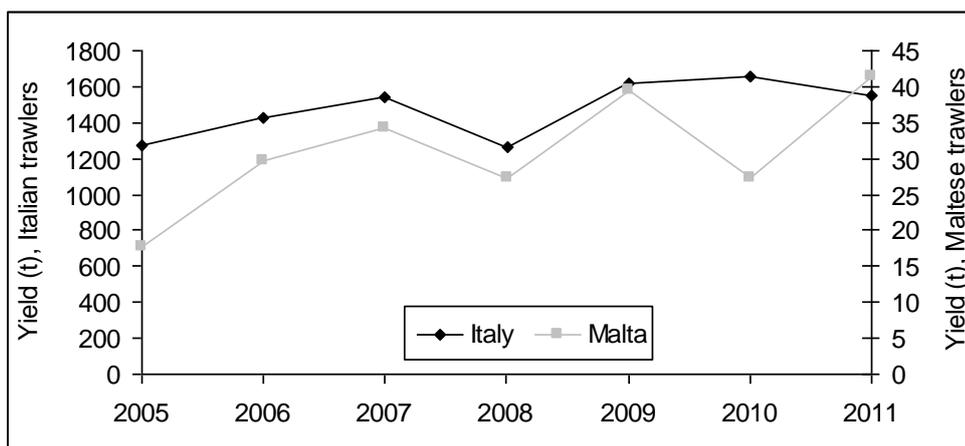


Fig. 6.11.2.3.1.1. Evolution of *A. foliaceae* landings in 2005-2011 for Italian trawlers (left axis) and Maltese trawlers (right axis).

6.11.2.3.2. Discards

Shrimp fisheries generally generate low amounts of discards (Ragonese et al., 2001), mainly due to the fact that a significant part of the by-catch is made up of species with commercial value. Discarded species with no commercial value caught as by-catch in the giant red shrimp fishery include several species of grenadier (*Hymenocephalus italicus*, *Nezumia sclerorhynchus*, *Coelorhynchus coelorhynchus*), argentines (*Argentina sphyraena*, *Glossanodon leioglossus*), shortnose greeneye (*Chlorophthalmus agassizi*) and several species of cartilaginous fish: blackmouth catshark (*Galeus melastomus*), small-spotted catshark (*Scyliorhinus canicula*), velvet belly lanternshark (*Etmopterus spinax*), thornback ray (*Raja clavata*), longnosed skate (*Dipturus oxyrinchus*) and rabbit fish (*Chimaera monstrosa*). In addition, discarding of undersized juveniles of several fish species is an important concern.

Maltese trawlers discarded an average of 0.32 tonnes of *A. foliaceae* in 2009-2011. Information on giant red shrimp discards for Sicilian trawlers was only available for 2010, when 2.1 tonnes of giant red shrimp discards were reported in the official Italian DCF data. It is clear that the majority of individuals discarded by Maltese trawlers are too small to be of commercial value (Figure 6.11.2.3.2.1 below), whilst some larger specimens are crushed during fishing and too damaged to be sold. Italian trawlers discarded larger *A. foliaceae* individuals measuring between 20-28 mm carapace lengths in 2010, with most discarded individuals measuring 26 mm carapace length.

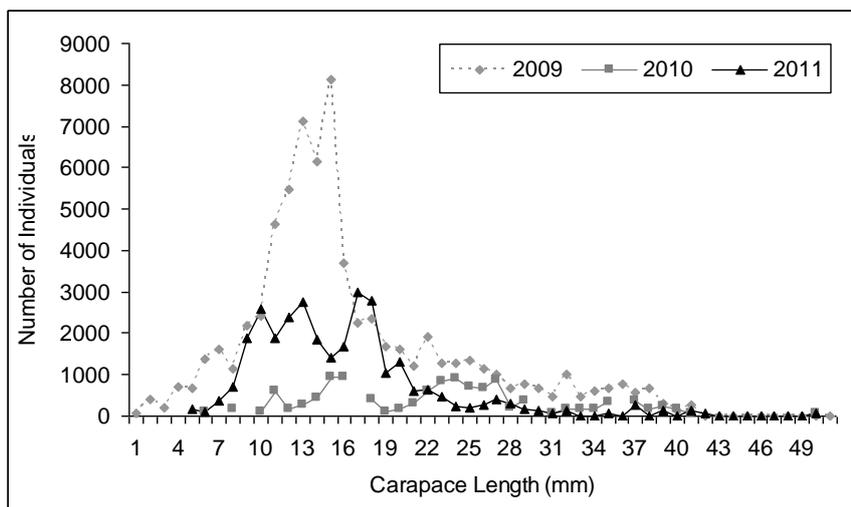


Fig. 6.11.2.3.2.1. Annual length structure of *Aristaeomorpha foliacea* discards in absolute numbers by Maltese trawlers fishing in the Strait of Sicily.

The decrease in discards on Maltese trawlers in 2010 and 2011 compared to 2009 is likely to be due the introduction of larger mesh sizes on Maltese trawlers in line with the Mediterranean Regulation (EC 1967/2006).

6.11.2.4. Fishing effort

Giant red shrimp are caught exclusively by bottom otter trawlers. In 2011 250 Italian trawlers measuring 12-24 m, operating mainly on short-distance fishing trips and fishing on the outer shelf and upper slope, were active. In addition 140 Italian trawlers measuring over 24m in length carrying out longer fishing trips (up to 4 weeks) were active in both the Italian and the international waters of the Central Mediterranean. In the Maltese Islands 14 trawlers measuring 12-24 m and 8 measuring over 24 m in length were active in 2011, 11 of which had a license to operate within the 25 nm Maltese Fisheries Management Zone. Trawlers from Egypt, Tunisia and Libya also operate in the Central Mediterranean, however only few vessels target giant red shrimp.

With regards to fishing effort, data submitted by Italy and Malta in response to the annual EU fisheries Data Collection Framework (DCF) data-call in 2012 revealed a 32% decrease in fishing effort for Italian bottom otter trawl vessels larger than 24 m in the period 2004-2011. Maltese vessels were only responsible for 1.6% of total trawling effort in GSAs 15 and 16 in 2006-2011, however the total nominal effort of Maltese trawlers increased by 67% in 2006-2011.

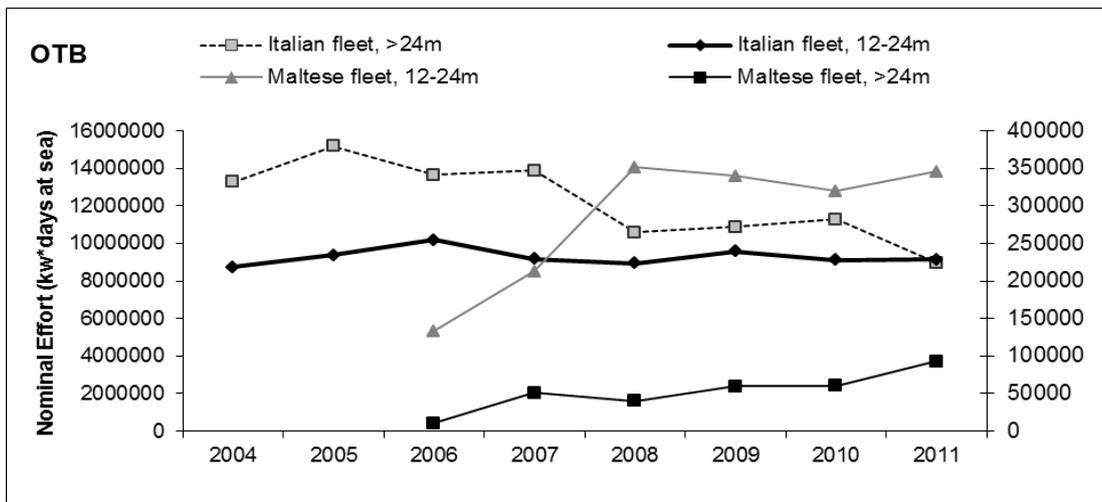


Fig. 6.11.2.4.1. Nominal effort (kW*days at sea) trends of trawlers (OTB) by Italian (left y-axis) and Maltese (right y-axis) fleet segments

6.11.3. Scientific surveys

6.11.3.1. MEDITS

6.11.3.1.1. Methods

In order to collect fisheries independent data, which is a requirement of the EU DCF (Council Regulation 199/2008, Commission Regulation 665/2008, Commission Decision EC 949/2008 and Commission Decision 93/2010); the MEDITS international trawl survey is carried out in GSAs 15 & 16 on an annual basis. The number of hauls was reported per depth stratum in 1994-2011 (GSA 16) and 2002-2011 (GSA 15) is reported below.

Table 6.11.3.1.1.1. Number of hauls per year and depth stratum in GSA 16, 1994-2011.

Depth (m)	1994	1995	1996	1997	1998	1999	2000	2001	2002
10-50	4	4	4	4	4	4	4	4	7
50-100	8	8	8	8	8	8	7	8	11
100-200	4	4	4	4	5	5	6	5	10
200-500	10	11	11	12	11	11	11	11	19
500-800	10	14	14	13	14	14	14	14	19
Depth (m)	2003	2004	2005	2006	2007	2008	2009	2010	2011
10-50	7	7	10	10	11	11	11	11	11
50-100	12	12	20	22	23	23	23	23	23
100-200	8	9	18	19	21	21	21	21	21
200-500	18	19	28	31	27	27	27	27	27
500-800	20	19	32	33	38	38	38	38	38

Table 6.11.3.1.1.2. Number of hauls per year and depth stratum in GSA 15, 2002-2011.

Depth (m)	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
10-50	1	1	2	1	1	0	0	0	0	0
50-100	5	5	4	5	5	12	6	6	6	6

100-200	13	13	13	13	13	12	13	14	14	14
200-500	10	10	10	9	10	4	9	10	10	10
500-800	16	16	15	17	16	17	17	15	15	15

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). A limited number of obvious data errors were corrected and catches by haul were standardized to 60 minutes haul duration. Only hauls noted as valid were used, including stations with no catches of hake, red mullet or pink shrimp (i.e. zero catches were included).

The abundance and biomass indices were subsequently calculated by stratified means (Cochran, 1953; Saville, 1977). This implies weighing average values of the individual standardized catches as well as the variation of each stratum by the respective stratum area:

$$Y_{st} = \sum (Y_i * A_i) / A \quad V(Y_{st}) = \sum (A_i^2 * s_i^2 / n_i) / A^2$$

Where:

A = total survey area

A_i = area of the i-th stratum

s_i = standard deviation of the i-th stratum

n_i = number of valid hauls of the i-th stratum

n = number of hauls in the GSA

Y_i = mean of the i-th stratum

Y_{st} = stratified mean abundance

V(Y_{st}) = variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = $Y_{st} \pm t$ (student distribution) * $V(Y_{st}) / n$

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions about the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution or quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien *et al.* 2004).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.11.3.1.2. Geographical distribution patterns

A. foliacea has a wide geographic distribution. The species has been reported to occur in the Mediterranean, the Atlantic, the Indian Ocean, the western Pacific and South Africa (Perez Farfante and Kensley 1997, Bianchini 1999). In the Mediterranean Sea the distribution of giant red shrimp is patchy in nature, with the highest abundances found in the central, followed by the eastern basins (Politou et al. 2004).

In the Central Mediterranean there is a longitudinal segregation between the two species of red shrimp: *A. foliacea* increases in abundance from the western to the eastern Mediterranean whilst the opposite is true for *A. antennatus* (Bianchini and Ragonese, 1994; Cau et al. 2002; D'Onghia 2003; Company et al. 2004; Guillen 2012). In Tunisian waters the relative abundance of the two species has been reported to be 50% *A. foliacea* and 50% *A. antennatus* at La Galite and 80% *A. foliacea* and 20% *A. antennatus* on the nearby Sentinelle Bank (Ben Meriem, 1994). In Spanish waters, the Gulf of Lions and the Ligurian Sea *A. antennatus* outnumbers individuals of *A. foliacea* (Cau et al. 2002); in the Central Mediterranean, eastern Ionian Sea and waters around Greece *A. foliacea* is dominant (Politou et al. 2004; Ragonese, 1995; Cau et al. 2002). A number of hypotheses have been proposed to explain this pattern, including differences in productivity between the Mediterranean basins (Politou et al., 2004), differences in hydrological conditions (Ghidalia and Bourgeois, 1961; Orsi and Relini, 1985; Bianchini, 1999; Politou et al., 2004), and different levels of fishing pressure being exerted across the Mediterranean.

With regards to the location of nursery areas in the Central Mediterranean, giant red shrimp recruits have been found dispersed widely at depths of 500-700 m in the Strait of Sicily (Garofalo et al. 2011). A persistence analysis found *A. foliacea* recruits were only spatially structured in five years over the eleven year study period. The two stable nursery areas on average supported 30% of the total number of juveniles in the studied years were identified in the middle of the Strait of Sicily.

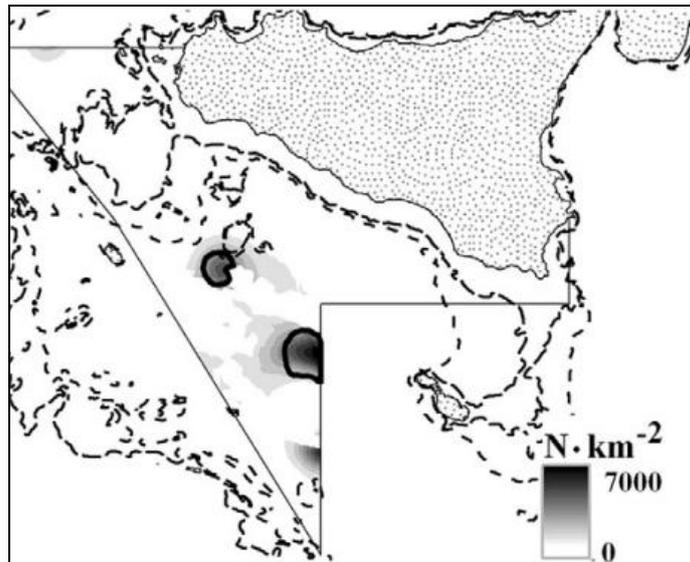


Fig. 6.11.3.1.2.1. Density map of *Aristaeomorpha foliacea* recruits, showing the location of two persistent nurseries (after Garofalo et al., 2011).

6.11.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the giant red shrimp stock in GSAs 15 and 16 can be derived from the international bottom trawl survey MEDITS, which has been carried out in GSA 15 since 2002 and in GSA 16 since 1994.

The patterns recorded in GSA 15 and GSA 16 in 2002-2011 were generally similar except for 2011 when an increase in both abundance and biomass was recorded in GSA 15 but a decrease was recorded in GSA 16. In previous years the stock declined slightly in 2004-2007, before increasing in 2008 and peaking in 2009. In 2010 the population returned to levels similar to those recorded in 2005-2007. Similar peaks in abundance had previously occurred in 2000 and 2004.

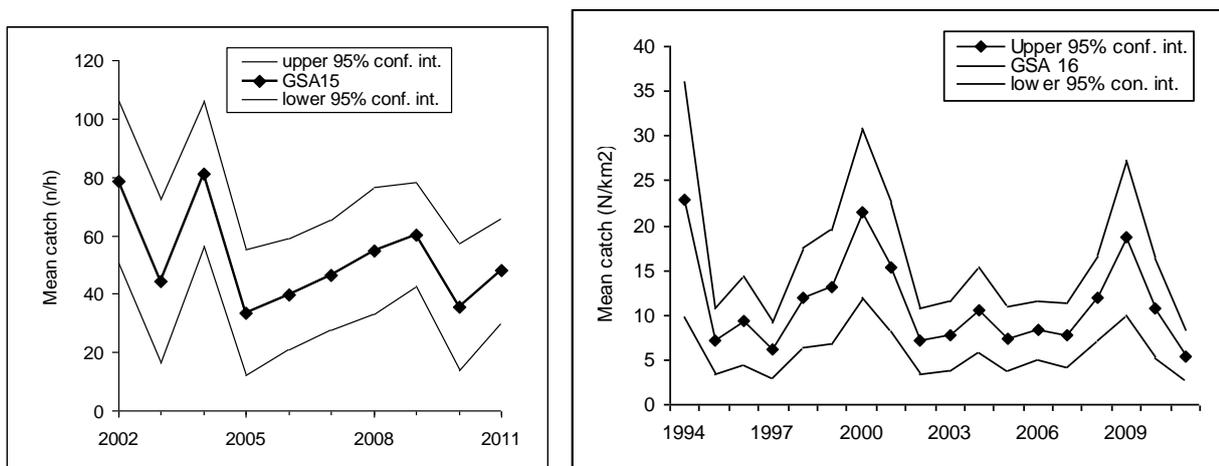
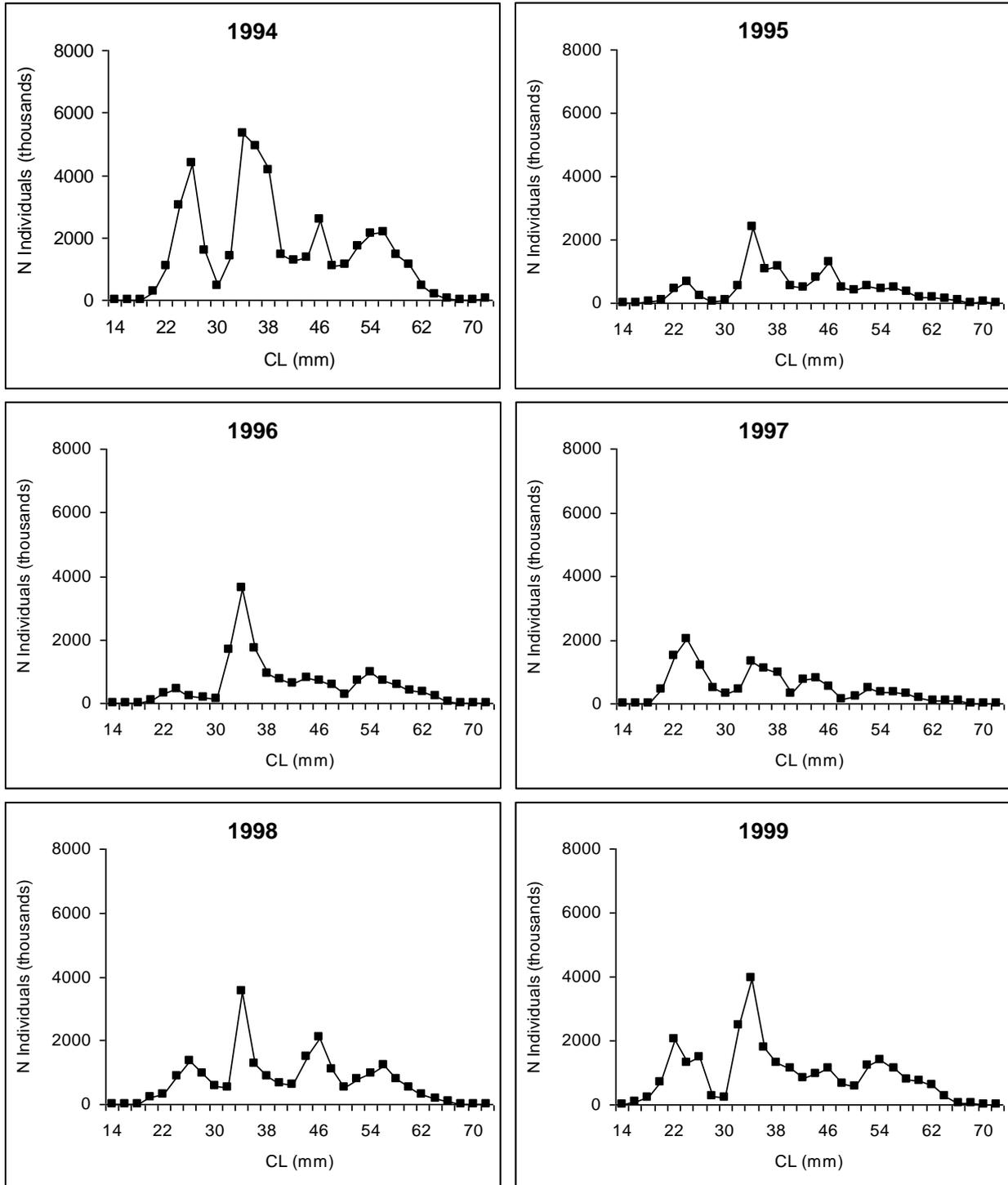


Fig. 6.11.3.1.3.1. Abundance indices of *Aristaeomorpha foliacea* for the years 2002-2011 in GSA 15 (left) and 1994-2011 in GSA 16 (right).

6.11.3.1.4. Trends in abundance by length or age

The following Figure 6.11.3.1.4.1 displays the stratified abundance indices of giant red shrimp in GSA 16 in 1994-2004.



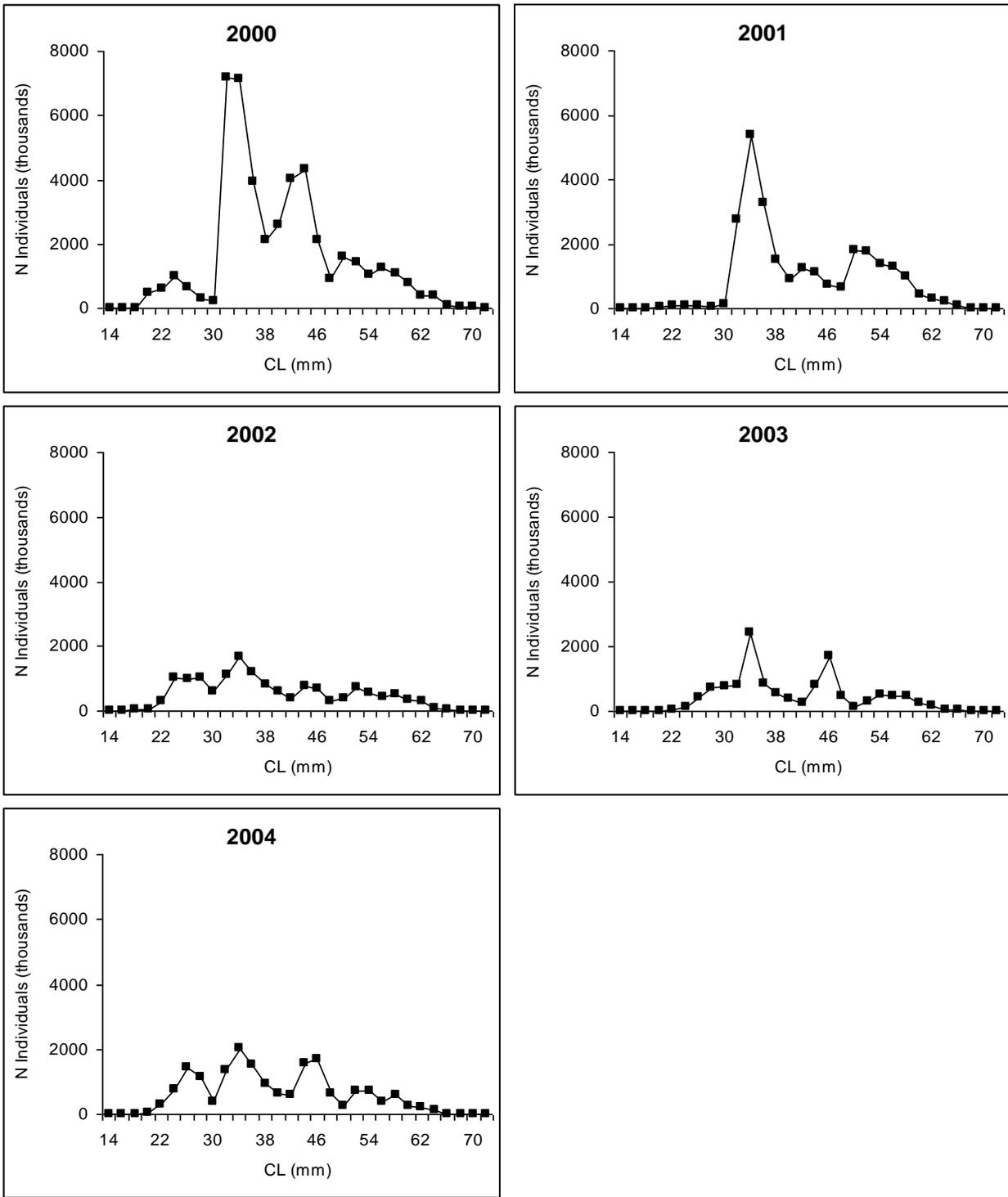
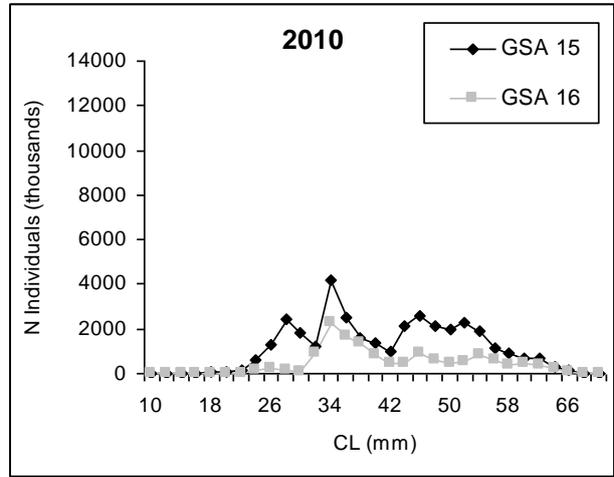
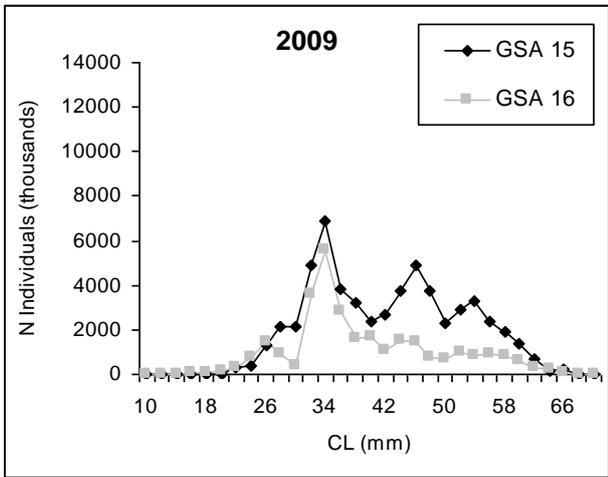
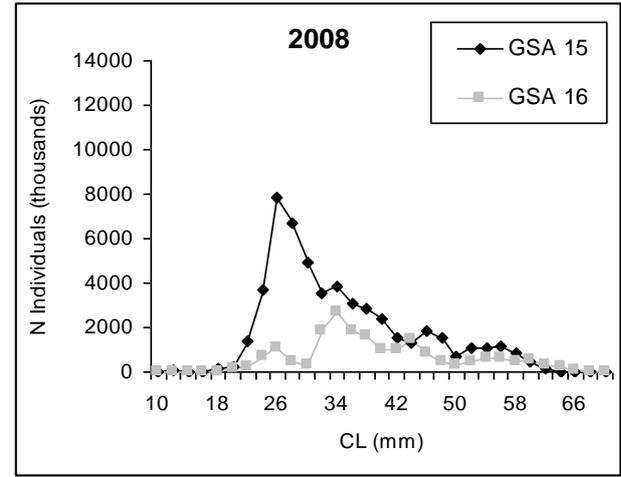
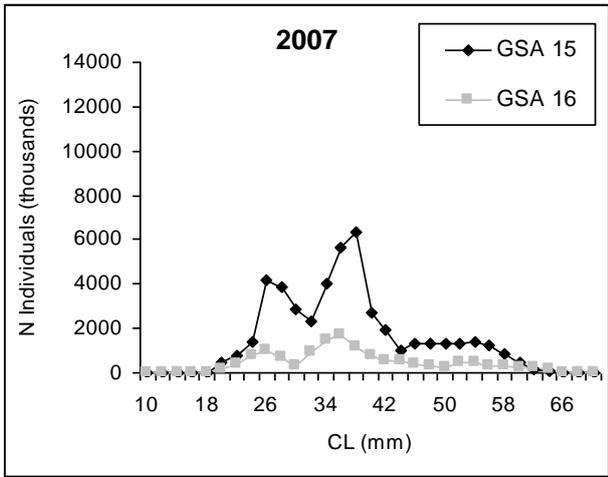
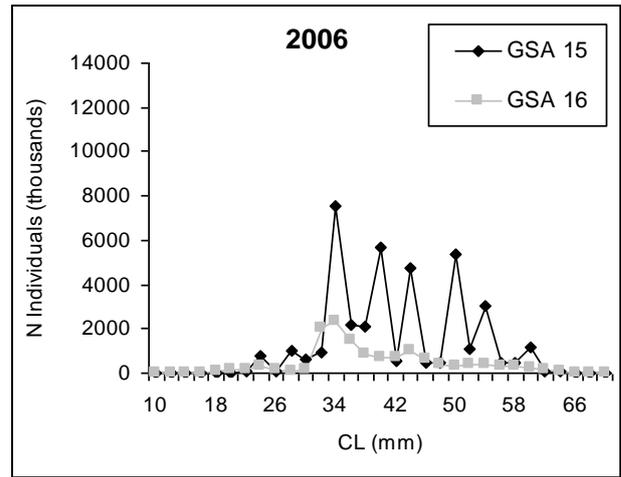
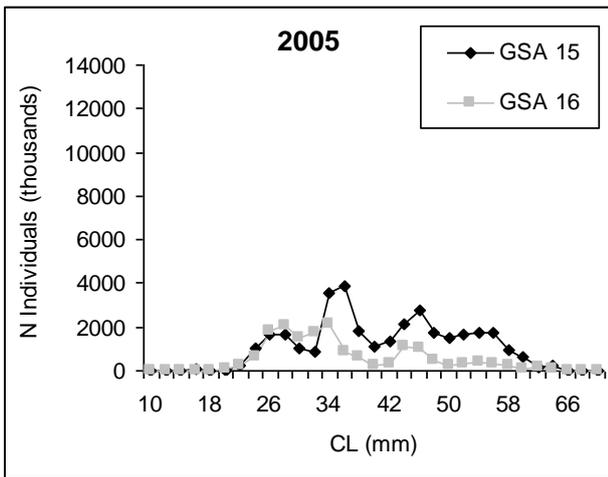


Fig. 6.11.3.1.4.1. Stratified abundance indices by size class in GSA 16, 1994-2004

The following Figure 6.11.3.1.4.2 displays the stratified abundance indices (strata d and e) of giant red shrimp in GSA 15 and 16 in 2005-2011.



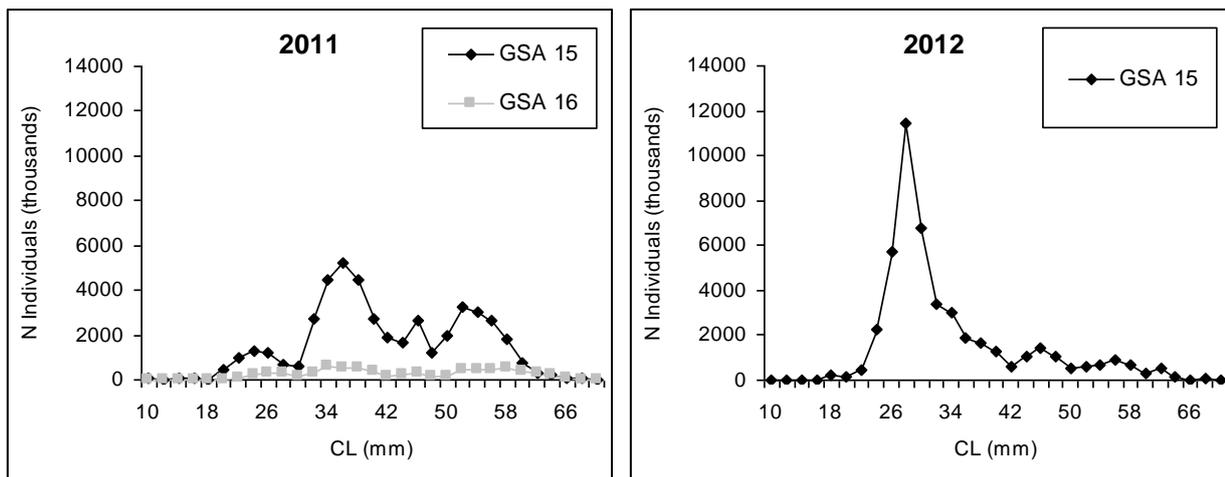


Fig. 6.11.3.1.4.2. Stratified abundance indices by size class in GSA 15 and 16, 2005-2012.

6.11.3.1.5. Trends in growth

No analyses were conducted during EWG 12-19.

6.11.3.1.6. Trends in maturity

No analyses were conducted during EWG 12-19.

6.11.4. Assessment of historic stock parameters

6.11.4.1. Method 1: SURBA

6.11.4.1.1. Justification

The availability of a long time series (1994-2011) of length frequency distribution (LFD) from trawl survey data in GSA 16 allows for the reconstruction of the evolution of main stock parameters (recruitment and spawning stock biomass indices and fishing mortality rates) of giant red shrimps in the GSA 16 by using the SURBA software package. In the other hand GSA 15 survey data is only available for the period 2002-2011. SURBA was used to analyse GSA 15 data by itself, as well as combined indices for GSA 15 and 16 for 2002-2011, but the best model fit was used when running the model for the longer time series. Thus the SURBA analysis using the 1994-2011 GSA 16 data was adopted and is presented below.

Firstly the LFD by sex from the MEDITS trawl surveys was corrected by including the data for the individuals with unidentified sexes. This was based on the sex ratio per size class. The corrected LFDs by sex for each GSA were then converted in numbers by age group using the statistical slicing method approach developed during STECF-EWG 11-12 (Scott et al, 2011). Secondly we estimated the mean weight and

maturity at age using VBGF and a vectorial natural mortality at age (PRODBIOM excel sheet as implemented by Abella in SGMED 01 09) for the SURBA software to run the analysis. Then the numbers at age were used to estimate time series of fishing mortality rates, recruitment and SSB indices.

6.11.4.1.2. Input parameters

The input parameters are reported in Table 6.11.4.1.2.1.

Table 6.11.4.1.2.1. Biological parameters used for SURBA analyses for giant red shrimp in the Strait of Sicily (GSA 16).

Females

growth			weight	
Linf	K	t0	a	b
62.24	0.65	0.05	0.0016	2.5884

Males

growth			weight	
Linf	K	t0	a	b
40.31	0.79	-0.44	0.0010	2.7456

A declining value of M with age instead of a constant value was used based on the outcome of discussions held at SGMED_09_01, where the experts concluded such an approach is necessary considering the early age of first capture and the massive catch of juveniles characterised by higher M rates in most of the Mediterranean fisheries: natural mortality rates by age were calculated according to the ProdBiom model developed by Abella, Caddy and Serena (1997), based on Caddy (1991).

The values by age used in the analysis are given in Table 6.11.4.1.2.2. The age slicing produced only 6 age groups; when running SURBA a 4+ age group was used.

Table 6.11.4.1.2.2. Values by age used for SURBA analyses for giant red shrimp (sex combined) in GSA 16.

Age	2	3	4	5+
Natural mortality at age	0.4649	0.3771	0.3333	0.3069
Maturity at age	1.0	1.0	1.0	1.0
Weight at age	23.27	33.94	57.3	63.8
Catchability coefficient	1.0	1.0	1.0	1.0

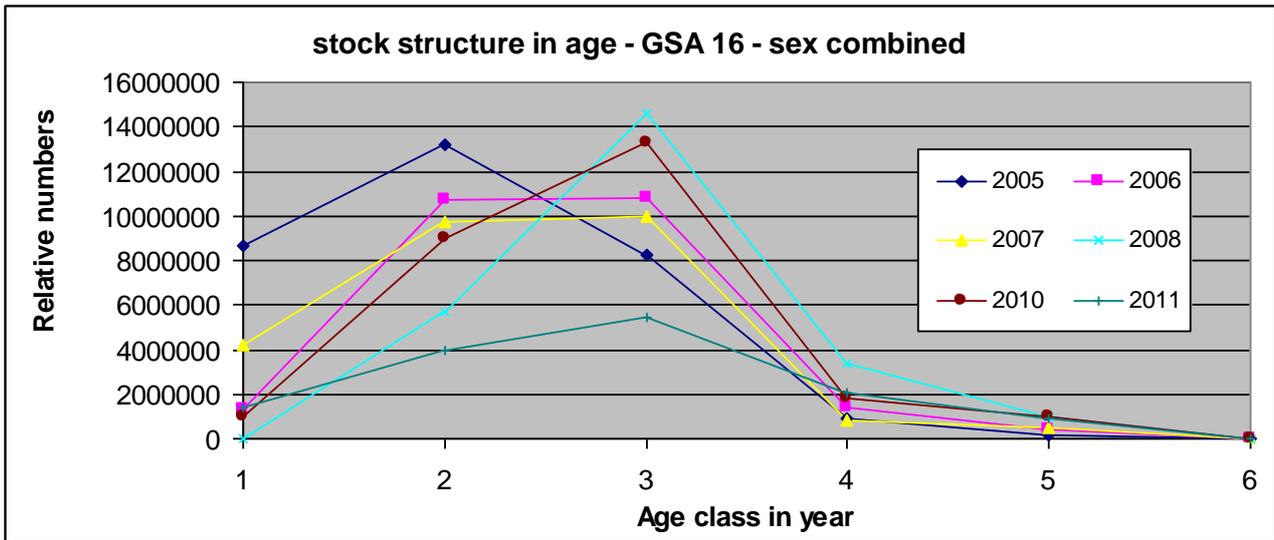


Fig. 6.11.4.1.2.1. SURBA input data: numbers at age of giant red shrimp in GSA 16 based on MEDITS survey data in 2005-2011, sex combined.

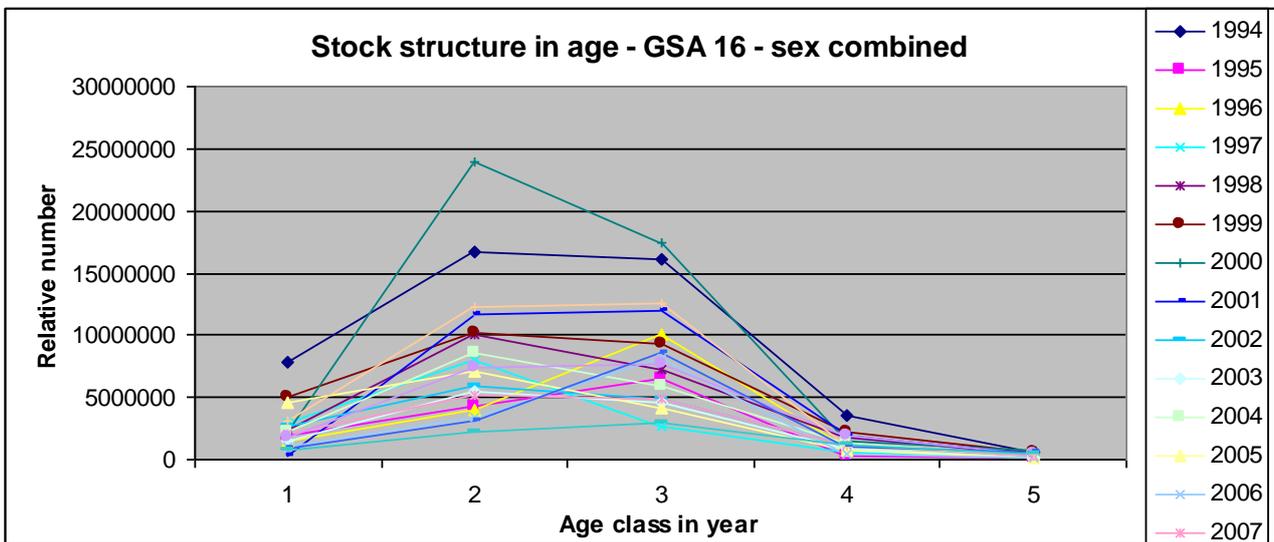


Fig. 6.11.4.1.2.2. SURBA input data: numbers at age of giant red shrimp in GSA 16 based on MEDITS survey data in 1994-2007, sex combined.

6.11.4.1.3. Results

Excluding a very high estimate of fishing mortality in 1994, mean F estimates fluctuated around 1 over the studied period. In 2001-2007 fishing mortality estimates declined, before increasing once again in 2008-2011. Relative spawning stock biomass was at the lowest level ever estimated in 2011.

redshrimpsgsa16meditssgmedsex combined

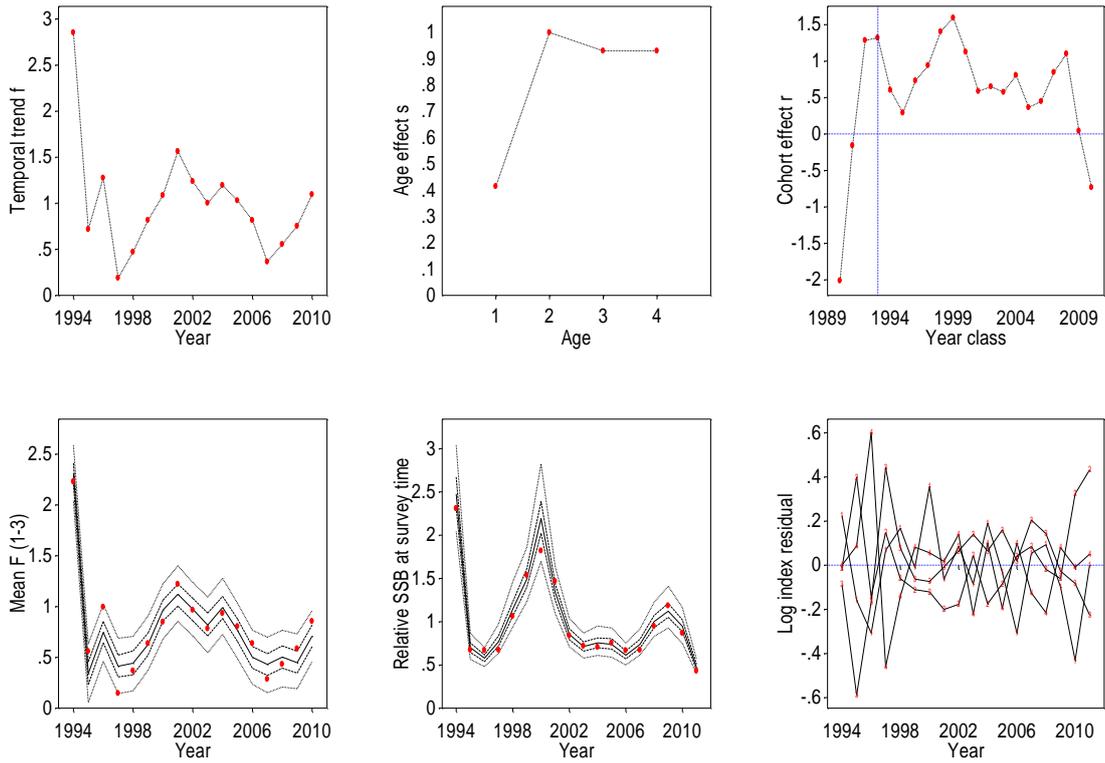


Fig. 6.11.4.1.3.1. SURBA analysis results for GSA 16 data, sex combined.

Model diagnostics

Overall the SURBA model fit well on the GSA 16 MEDITS survey data as shown in Figures 6.11.4.1.3.2, 3, 4, and 5 below.

redshrimpsgsa16meditssgmedsex combined: Residuals

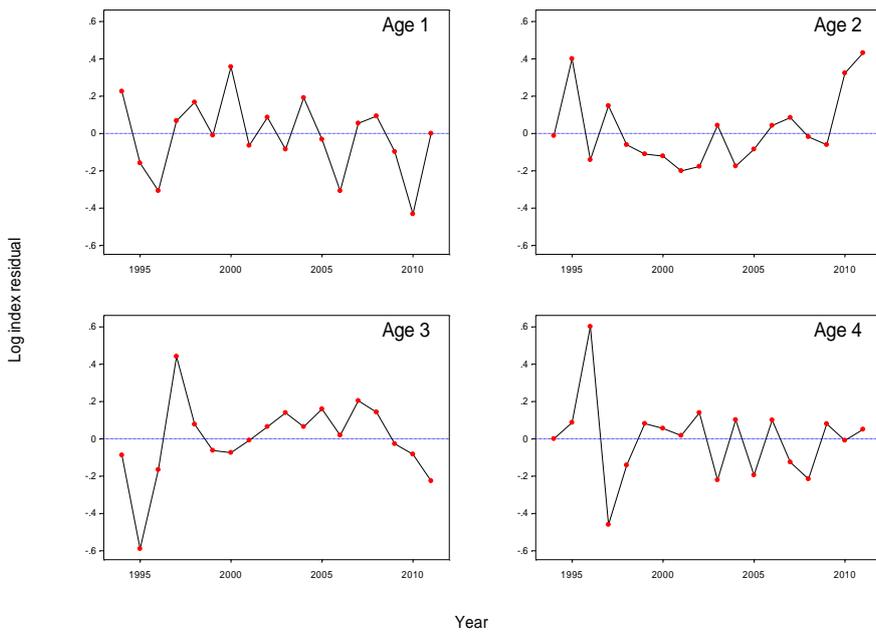


Fig. 6.11.4.1.3.2. Log index residuals by age for giant red shrimp in GSA 16 based on 1994-2011 MEDITS survey data.

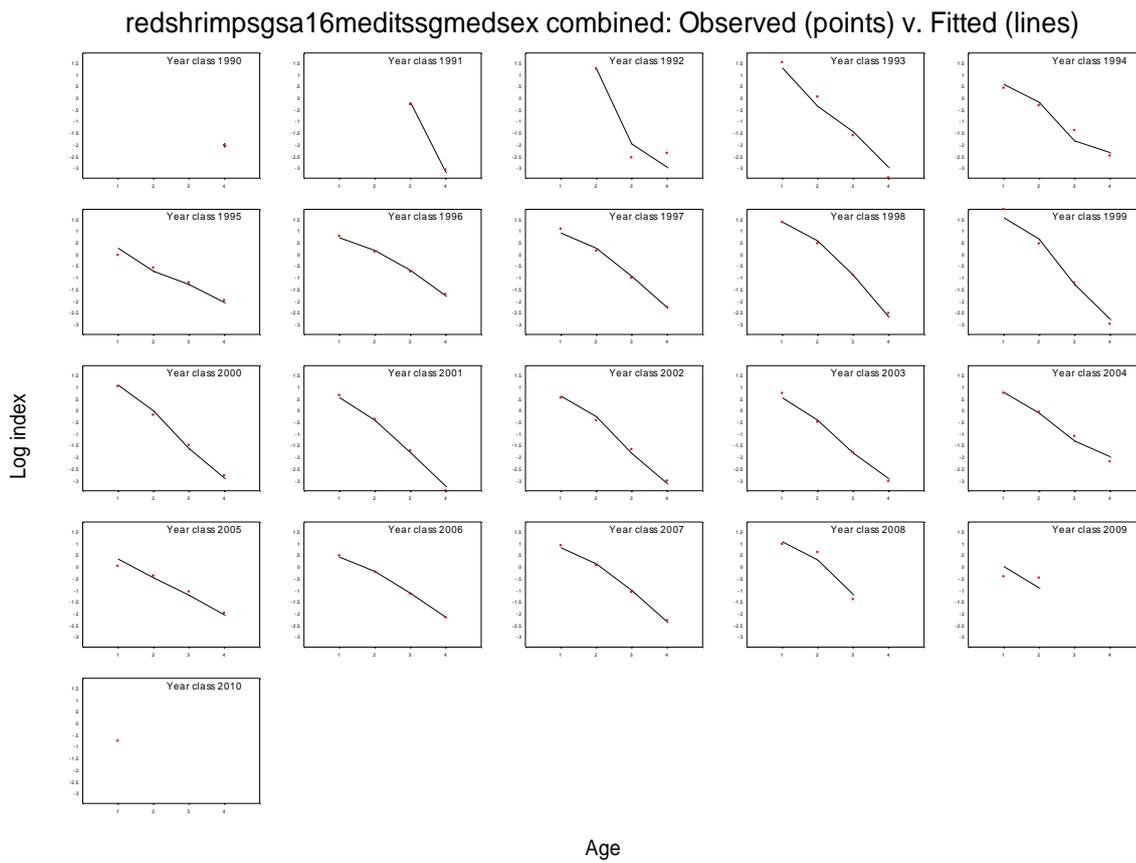


Fig. 6.11.4.1.3.3. Comparison between observed (red points) and fitted (lines) abundance indices for giant red shrimp in GSA 16 based on 1994-2011 MEDITS survey data.

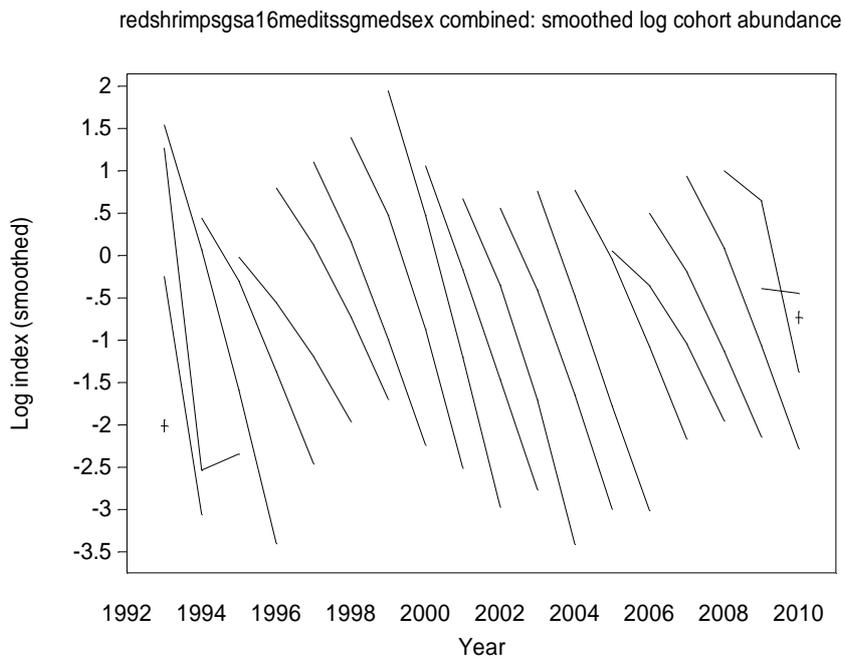


Fig. 6.11.4.1.3.4. Smoothed log cohort abundance for giant red shrimp in GSA 16 based on 1994-2011 MEDITS survey data; each line represents the index of abundance of a cohort throughout its life.

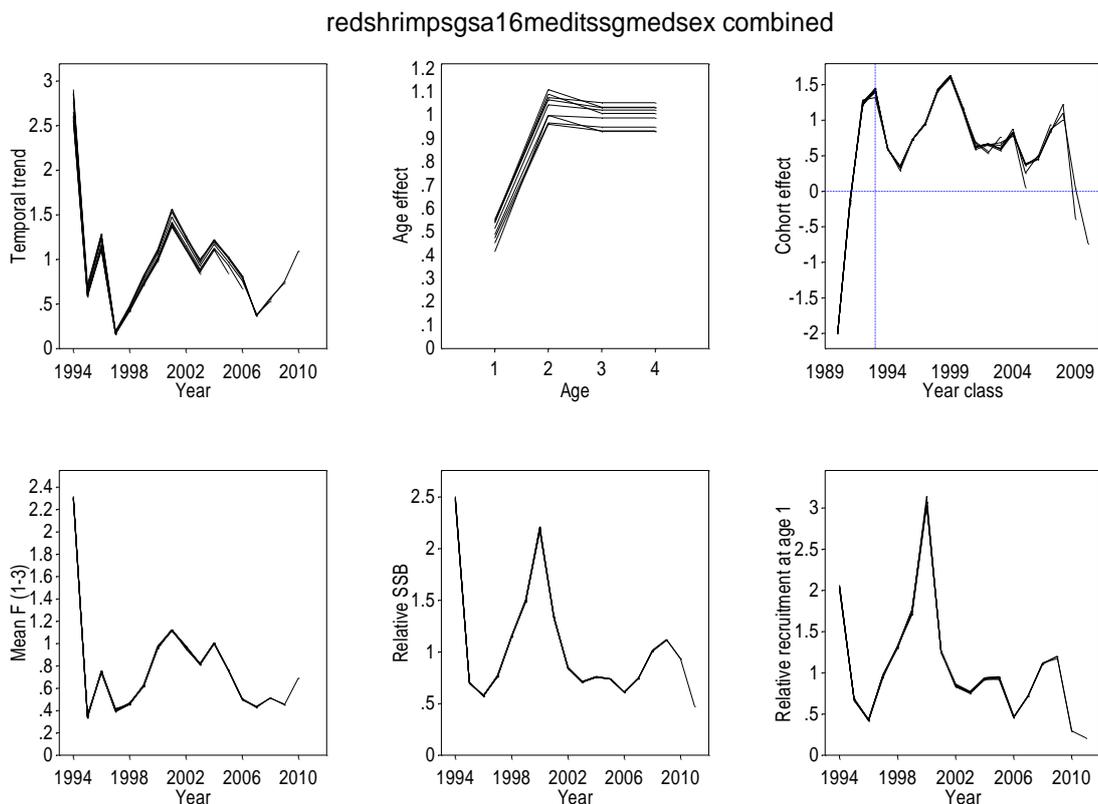


Fig. 6.11.4.1.3.5. Retrospective analysis for SURBA analysis of giant red shrimp in GSA 16 based on 1994-2011 MEDITS survey data.

6.11.4.2. Method 2: XSA

6.11.4.2.1. Justification

The female part of the giant red shrimp stock in the Strait of Sicily was previously assessed using a pseudo-cohort approach (length cohort analysis with VIT) in STECF-EWG 12-19. An XSA assessment was carried out during STECF-EWG 12-19 using the 2006-2011 catch data collected within the Data Collection Regulation (DCR; 2006-2008) and the subsequent Data Collection Framework (DCF; 2009-2011) in GSAs 15 and 16, and calibrated with trawl survey data (MEDITS 2006-2011). Both the male and female part of the stock was included in the analysis.

6.11.4.2.2. Input parameters

Data coming from DCR/DCF in GSA 15 (Malta) and GSA 16 (Sicily) for the period 2006-2011 were used to run an XSA, tuned with fishery independent data (i.e. MEDITS abundance indices for 2006-2011). Total

landings data for bottom otter trawlers (OTB) was available for both GSA 15 and 16 in 2006-2011. Landings at length information for GSA 15 was available for 2009-2011; 2009 data was used to extrapolate this information backwards. Landings at length data for 16 was available for 2006-2011. No discards data were available for bottom trawlers for GSA 16 except for 2010, however discards can be considered negligible for giant red shrimp fisheries.

The annual size distributions of the catch as well as of surveys (MEDITS) were converted in numbers at ages using the statistical slicing method approach developed during STECF-EWG 11-12 (Scott et al. 2011), keeping both sexes and data for GSA 15 and GSA 16 separate. After slicing was completed sexes and data from the two GSAs were combined; the model was run starting at age 2 and with a 5+ age group.

Natural mortality rates by age group but constant for all years were calculated based on ProdBiom (Abella et al. 1997), as recommended by SGMED 09-01. XSA input data as well as model settings are given below.

Table 6.11.4.2.2.1. *A. foliacea* VBGF / length-weight parameters

Sex	L_{∞} (cm, TL)	k	t_0
Females	62.24	0.65	0.05
Males	40.31	0.79	-0.44

Table 6.11.4.2.2.2. Catch at Age (thousands)

	1	2	3	4	5+
2006	1362	26248	10550	576	62
2007	10429	22057	19532	196	10
2008	7048	38413	6303	1204	472
2009	7941	37276	16120	1033	283
2010	8755	41038	17380	865	156
2011	5251	37666	18503	620	100

Table 6.11.4.2.2.3. Catch / Stock Weight at Age (kg)

Age	1	2	3	4	5+
Weight (g)	0.00916	0.02327	0.03394	0.0573	0.0638

Table 6.11.4.2.2.4. Maturity at Age

Age	0	1	2	3	4	5+
Maturity	0	0.8	1	1	1	1

Table 6.11.4.2.2.5. Mortality at Age

Age	1	2	3	4	5+
Mortality	0.728	0.4649	0.3771	0.3333	0.3069

Table 6.11.4.2.2.6. MEDITS Tuning Data (thousands)

	1	2	3	4	5+
2006	3258	17771	28203	2718	390
2007	17076	12703	27904	2522	433
2008	29891	16685	23249	1416	630
2009	8896	40437	33060	3904	1065
2010	8457	15141	22346	2360	940
2011	4856	23101	22839	2435	822

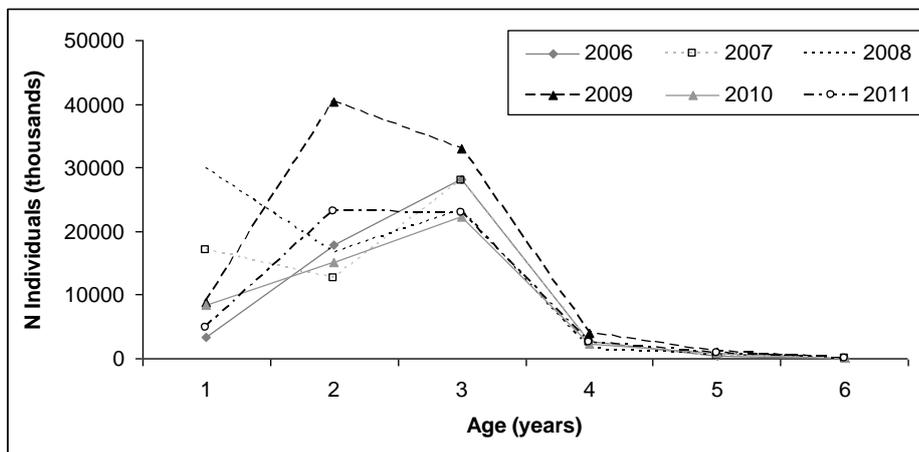


Fig. 6.11.4.2.2.1. MEDITS tuning data: numbers at age for male and female giant red shrimp in GSA 15 and GSA 16 combined.

Table 6.11.4.2.2.7. Settings used for XSA runs

Settings		
fse	Shrinkage	0.5, 1.0, 2.0
rage	The oldest age for which the two parameter model is used for determining catchability at age	1
qage	The age after which catchability is no longer estimated. Catchability at older ages will be set to the value of catchability at this age.	3
shk.yrs	The number of years to be used for shrinkage to the mean F.	3
shk.ages	The ages over which shrinkage to the mean F should be applied.	3

6.11.4.2.3.Results

XSA was run setting shrinkage at 0.5, 1.0, and 2.0. Results were similar with all three settings for spawning stock biomass and recruitment trends, but differed in 2007 and 2008 for the trend in fishing mortality when using shrinkage of 2.0. Although the model with shrinkage of 2.0 had the lowest residuals, the model with shrinkage 1.0 performed better in the retrospective analysis with regards to fishing mortality estimates. The model with shrinkage 1.0 was thus adopted as the final model.

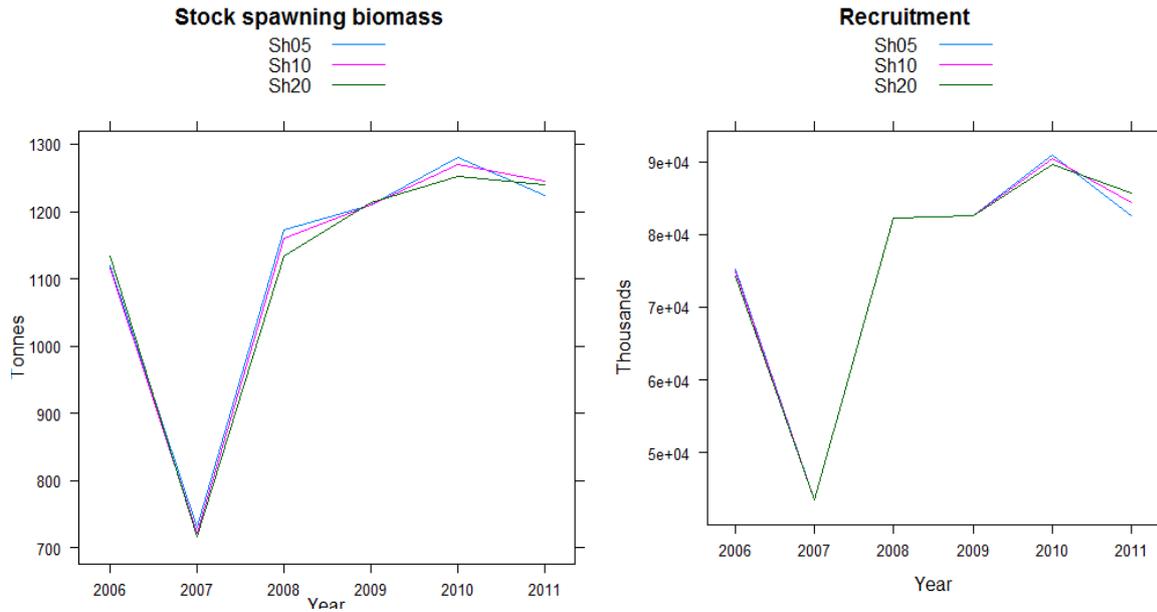


Fig. 6.11.4.2.3.1. Estimates of recruitment and SSB under different shrinkage setting

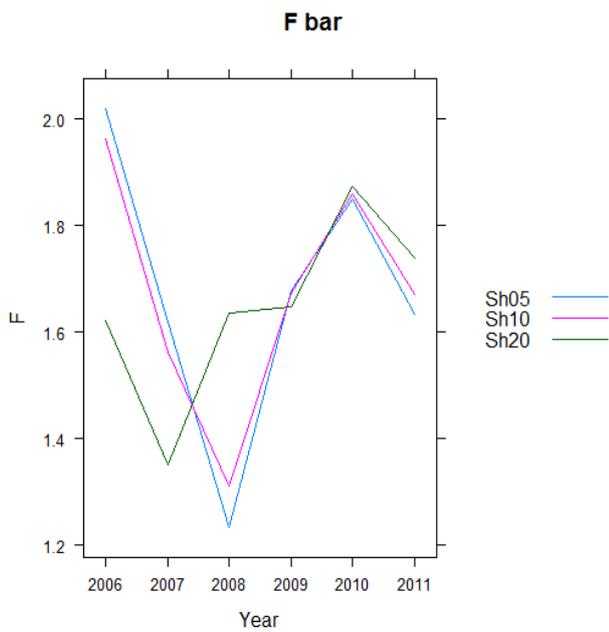
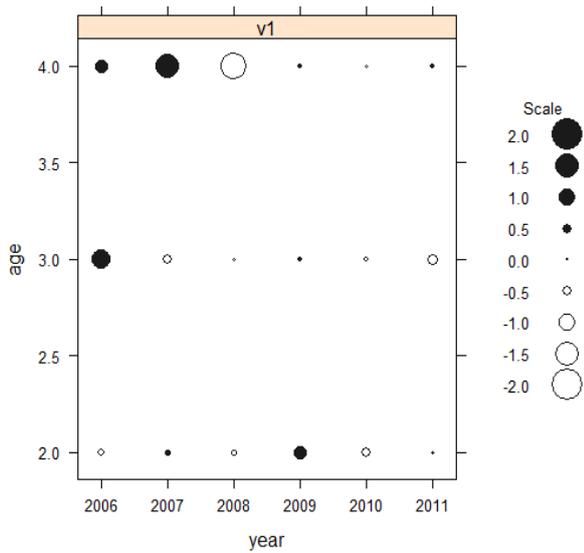


Fig. 6.11.4.2.3.2. Estimates of F_{bar} (ages 2-5) under different shrinkage settings.

0.5

Proportion at age by year Sh05_ars



1.0

Proportion at age by year Sh1_ars

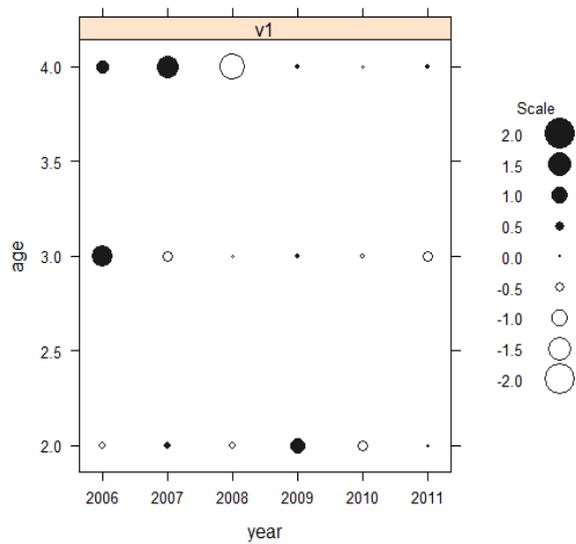


Fig. 6.11.4.2.3.3. Residuals at age obtained with shrinkage settings 0.5 and 1.0.

2.0

Proportion at age by year Sh2_ars

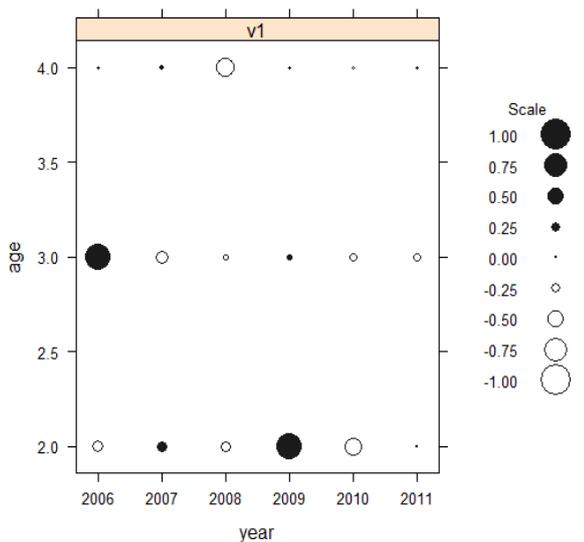


Fig. 6.11.4.2.3.4. Residuals at age obtained with the shrinkage setting 2.0.

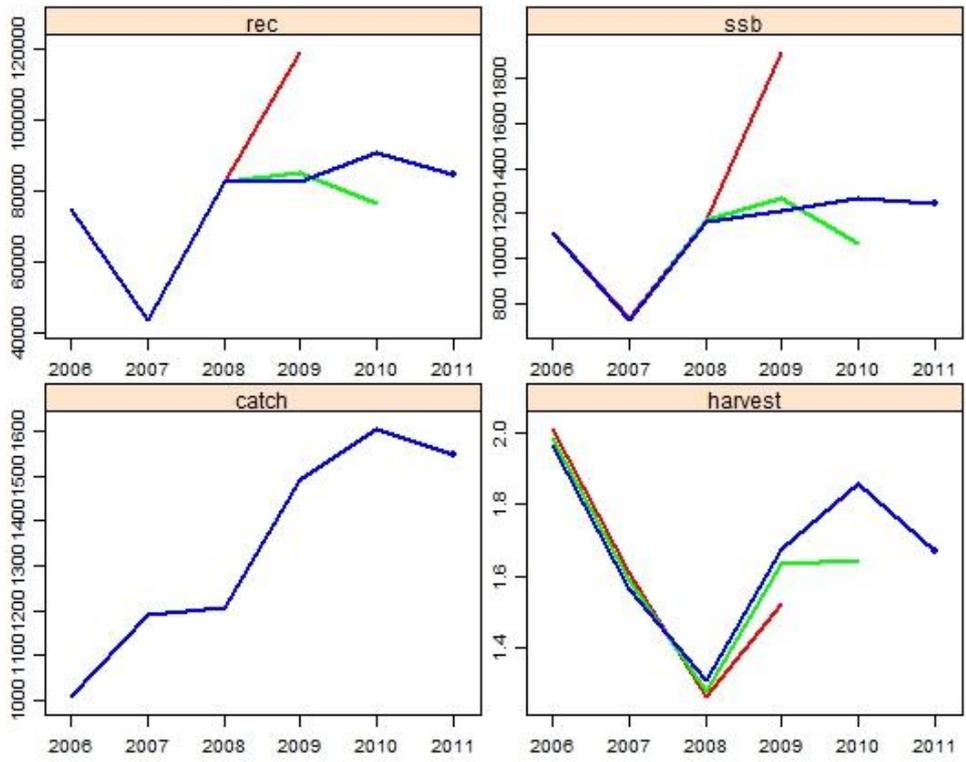


Fig. 6.11.4.2.3.5. Retrospective analysis for model with shrinkage set at 0.5.

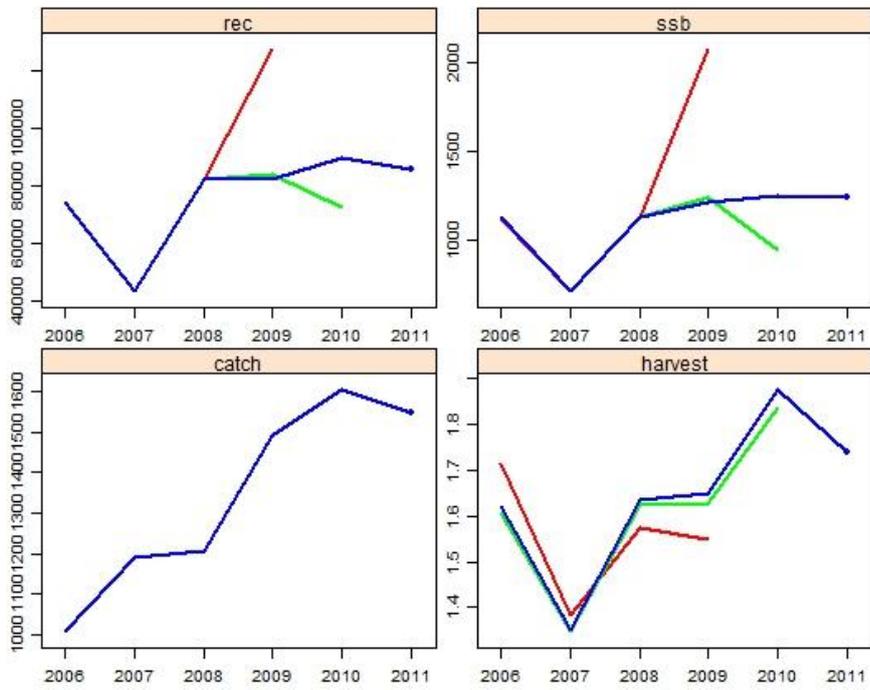


Fig. 6.11.4.2.3.6. Retrospective analysis for model with shrinkage set at 1.

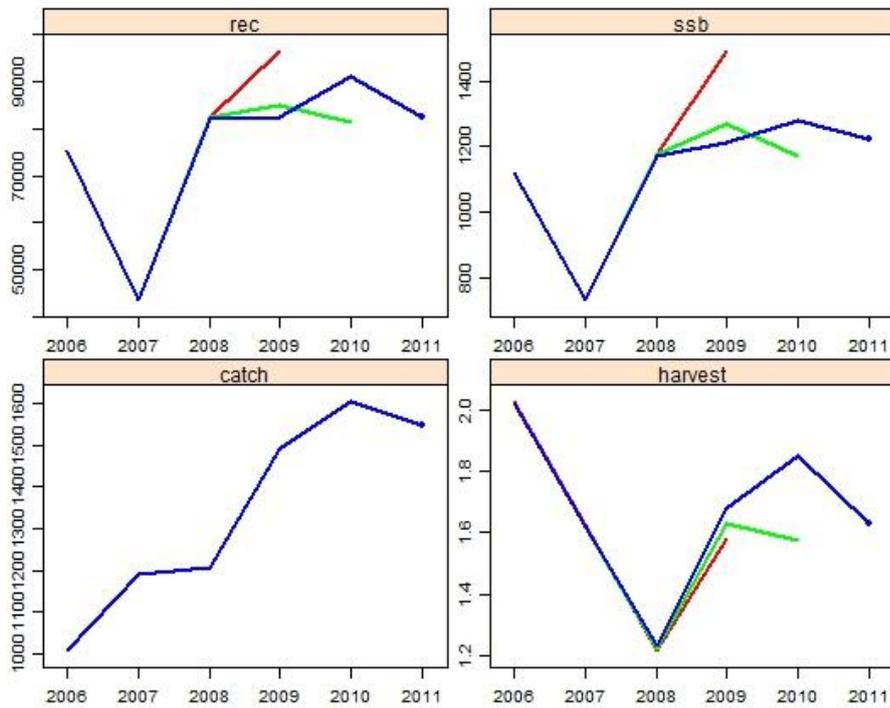


Fig. 6.11.4.2.3.7. Retrospective analysis for model with shrinkage set at 2.

The following table lists F (age 2-5), spawning stock biomass (SSB) and recruitment XSA estimates by from 2006 to 2011.

Table 6.11.4.2.3.1. F, spawning stock biomass (SSB) and recruitment estimates by XSA for *A. foliacea* in GSA 15 and 16 in 2006 to 2011; shrinkage = 1.

F ₂₋₅					
2006	2007	2008	2009	2010	2011
1.96	1.51	1.37	1.68	1.87	1.67
SSB (tons)					
2006	2007	2008	2009	2010	2011
1116	722	1160	1210	1270	1246
Recruitment (thousands)					
2006	2007	2008	2009	2010	2011
74858	43424	82240	82530	90469	84416

XSA estimates of $F_{bar_{2-5}}$ varied between 1.37 (2008) and 1.96 (2006). In 2011 the fishing mortality estimate was 1.67.

During 2006-2011 spawning stock biomass (SSB) fluctuated around an average of 1120 t; a drop to 775 t was recorded in 2007. Recruitment declined from 75 million in 2006 to 43 million in 2007 but increased back to previous levels in 2008-2011, when it fluctuated around an average of 85 million.

Table 6.11.4.2.3.2. Fishing mortality at age as estimated by XSA.

Age	2006	2007	2008	2009	2010	2011
2	0.58411	1.02407	0.8892	0.84364	0.84938	0.82773
3	3.37211	2.29708	1.50007	2.4937	2.83115	2.51595
4	1.93202	1.36942	1.54437	1.68219	1.89778	1.67347
5+	1.93202	1.36942	1.55437	1.68219	1.89778	1.67347

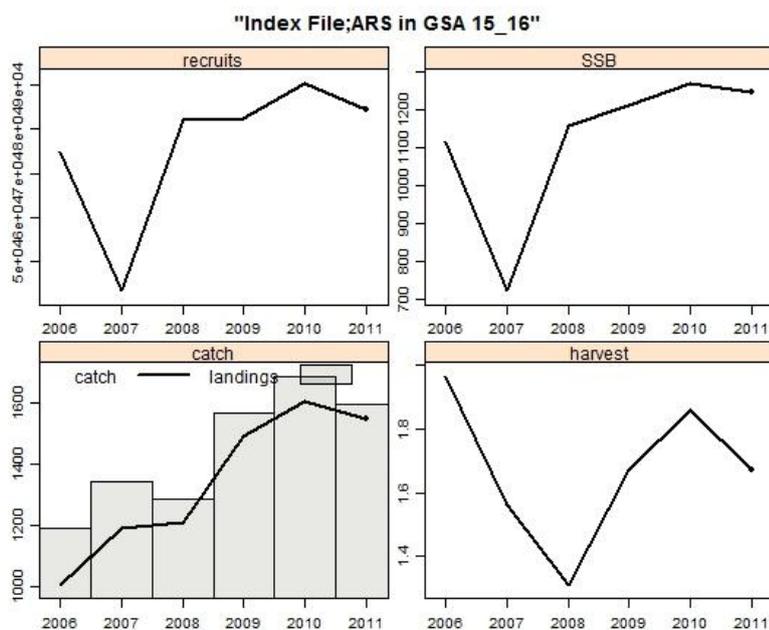


Fig. 6.11.4.2.3.8. Summary of stock parameters (recruitment, SSB, Catch and landing, F mean for ages 2-5) as estimated by XSA with a shrinkage setting of 1.0.

6.11.5. Data quality

There was a discrepancy between the total landings data reported by Italy for GSA 16 and the corresponding landings at length values; whilst landings increased 21% in the period 2009-2011 compared to the period 2006-2008, the total number of individuals declared in catches increased by 60%. Discards data was only available for 2010 for GSA 16.

Although the total amount of Tunisian giant red shrimp catches can be considered insignificant compared to the catches of the Sicilian fleet, it is at this point not possible to verify this assumption based on scientific data. Only anecdotal information on a few Tunisian vessels targeting *A. foliacea* in Northern Tunisia (GSA 12) is available; there are no records of giant red shrimp catches in FAO Fish Stat or GFCM Task 1 datasets.

A long time series of survey data is only available from GSA 16 (1994-2011). No survey data is available from GSAs 12-14, and only a short time series is available from GSA 15 (2005-2011).

6.11.6. Scientific advice

6.11.6.1. Short term considerations

6.11.6.1.1. State of the spawning stock size

SURBA analysis of 1994-2011 GSA 16 MEDITS data showed that the relative spawning stock biomass was at the lowest level ever estimated in 2011. Based on XSA analysis results, spawning stock biomass (SSB) fluctuated around an average of 1120 t in 2006-2011. Whilst the spawning stock biomass estimates were similar for 2006 and 2008-2011, a drop to 775 t was recorded in 2007.

6.11.6.1.2.State of recruitment

Estimates from the XSA analysis showed that recruitment declined from 75 million in 2006 to 43 million in 2007 but increased back to previous levels in 2008-2011, when it fluctuated around an average of 85 million.

6.11.6.1.3.State of exploitation

EWG 12-10 and EWG 12-19 propose $F_{0.1} = 0.30$ as proxy of F_{MSY} as the exploitation reference point. Taking into account the results obtained by the XSA analysis of EWG 12-19 (current F is around 1.67), the giant red shrimp stock is considered exploited unsustainably. Moreover the current fishing mortality exceeds the exploitation limit reference point F_{max} (0.45).

F estimates from the VIT analysis obtained in the past were lower (average of 0.73 in 2006-2009) than those obtained by XSA. This may be due to the fact that the VIT analysis carried out at STECF EWG 11-12 was only carried out on the female part of the stock.

The present SURBA analysis estimates of fishing mortality were similar to those obtained in the past, but also much lower than those obtained by XSA analysis. A potential explanation for this is that only GSA 16 data was used in the SURBA analysis; no MEDITS data is available for GSAs 12-14, and the MEDITS time series for GSA 15 is much shorter (MEDITS surveys including the Maltese 25 nautical mile Fisheries Management Zone started in 2005). Instead for the XSA tuning data from both GSAs was combined.

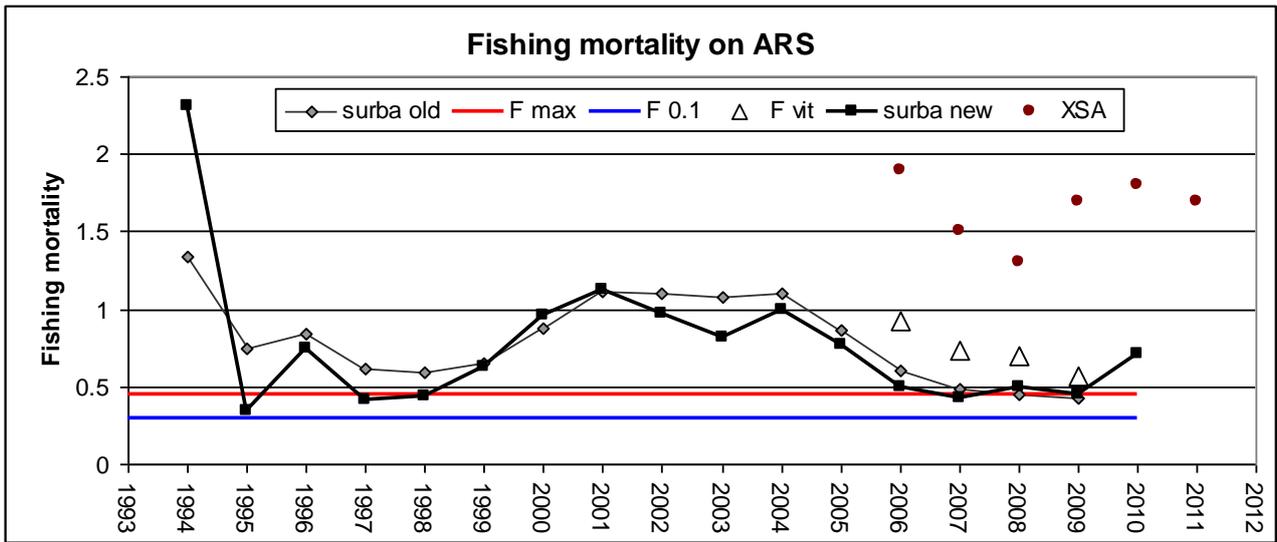


Fig. 6.11.6.1.3.1. Summary of stock assessment results for giant red shrimp in the Central Mediterranean comparing results of analysis carried out at STECF EWG 11-12 ('surba old', and Vit analysis) and STECF EWG 12-19 ('surba new', XSA).

6.12. Stock assessment of anchovy in GSA 16

6.12.1. Stock identification and biological features

6.12.1.1. Stock Identification

The main distribution area of the anchovy stock in GSA 16 is the narrow continental shelf area between Mazara del Vallo and the southernmost tip of Sicily, Cape Passero (Patti *et al.*, 2004; Giannoulaki *et al.*, 2012). Daily Egg Production Method (DEPM) surveys were also carried out starting from 1998, giving also information on spawning areas distribution.

6.12.1.2. Growth

Growth parameters were used for the estimation of natural mortality with the approaches suggested by Pauly (1980), the Beverton & Holt's Invariants method (Jensen, 1996) and Gislason (2010). Von-Bertalanffy growth parameters were estimated by FISAT using DCF data collected in GSA16 over the period 2007-2009. The applied growth parameters are given below in the following table:

L_{∞}	k	t_0
19.83	0.31	-1.95

For BHI method, the equation $M = \beta * k$ was applied, with β set to 1.8.

6.12.1.3. Maturity

PERIOD	Age	0	1	2	3	4+
2004-2011	Prop. matures	0.091	0.911	0.996	0.999	1

Natural mortality (Estimated with Gislason's method)

PERIOD	Age	0	1	2	3	4
2004-2012	M	0.97	0.68	0.54	0.47	0.43

6.12.2. Fisheries

6.12.2.1. General description of fisheries

In Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA 16), accounting for about 2/3 of total landings in GSA 16, two operational units (OU) are presently active, purse seiners and pelagic pair trawlers. The fleet in GSA 16 is composed by about 50 units (17 purse seiners and 30 pelagic pair trawlers were counted up in a census carried out in December 2006). In both OUs, anchovy represents the main target species due to the higher market price.

6.12.2.2. Management regulations applicable in 2010 and 2011

Fisheries practices are affected by EU regulations through the Common Fisheries Policy (CFP), based on the following principles: protection of resources; adjustment of (structure) facilities to the available resources; market organization; and definition of relationships with other countries.

The main technical measures regulating fishing concern minimum landing size (9 cm for anchovy, 11 cm for sardine), mesh regulations (20 mm for pelagic pair trawlers, 14 mm for purse seiners) and restrictions on the use of fishing gear. Towed fishing gears are not allowed in the coastal area in less than 50 m depth, or within a distance of 3 nautical miles from the coastline. A seasonal closure for trawling, generally during summer-autumn, has been established since 1993. In GSA 16, two operational units fishing for small pelagic are based in Sciacca port: purse seiners (lampara vessels, locally known as “Ciancioli”) and midwaters pair trawlers (“Volanti a coppia”). Midwaters trawlers are based in Sciacca port only, and receive a special permission from Sicilian Authorities on an annual basis. Another fleet fishing on small pelagic fish species, based in some northern Sicilian ports, was used to target on juvenile stages (mainly sardines). However this fishery, which in the past was allowed for a limited period (usually one or two months in the winter season) by a special Regional law renewed year by year, was no more authorized starting from 2010 and it is presently stopped.

6.12.2.3. Catches

6.12.2.3.1. Landings

Landings data were obtained within the framework of DCF and from the census data collection carried out by IAMC-CNR (Mazara del Vallo) in Sciacca port since 1998. Information collected in the framework of CA.SFO study project (Patti et al., 2007) showed that landings in Sciacca port account for about 2/3 of the total landings in GSA 16. Average anchovy landings in Sciacca port over the period 1998-2011 were about 2,100 metric tons, with large inter-annual fluctuations.

It is worth noting that, though anchovy biomass was decreasing during the last years (with the only exception of 2010, when the stock experienced a significant increase; see Figure 6.12.2.3.1.1), landings levels over the same period remained relatively high, indicating high levels of vulnerability in the resource (Figure 6.12.2.3.1.1).

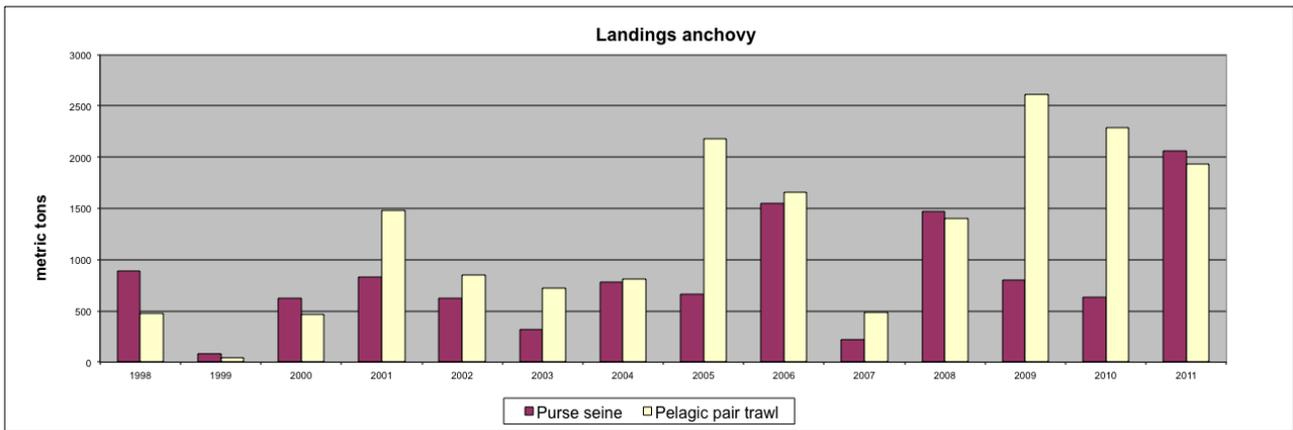


Fig. 6.12.2.3.1.1. Landings data regarding the purse seine and pelagic pair trawl fleets in Sciacca port (GSA 16), 1998-2011.

6.12.2.3.2. Discards

No discards data for anchovy were used for this assessment. However, discards are estimated to be less than 5% of total catch for both the pelagic pair trawl and the purse seine fisheries (Kallianiotis & Mazzola, 2002).

6.12.2.4. Fishing effort

Fishing effort data refer to census data collected in Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA 16), accounting for about 2/3 of total landings in GSA 16.

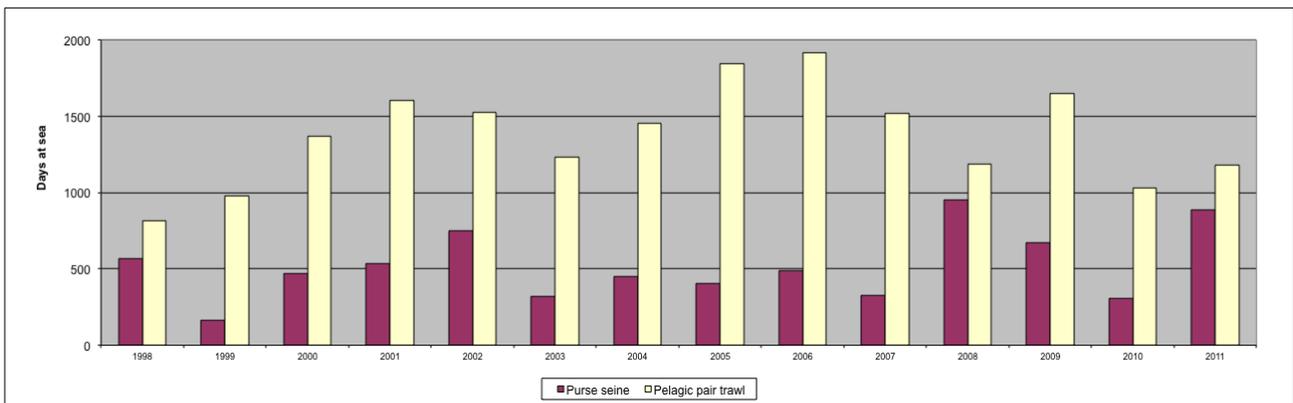


Fig. 6.12.2.4.1. Effort data regarding the purse seine and pelagic pair trawl fleets in Sciacca port (GSA 16), 1998-2011.

Fishing effort officially reported in 2011 through the DCF is also given below.

Table 6.12.2.4.1. Fishing effort (kW*days) as officially reported in 2011 through the DCF.

AREA	COUNTRY	GEAR	2004	2005	2006	2007	2008	2009	2010
SA 16	ITA	-1	510755	166307	326382	322280	244200	19958	162725
SA 16	ITA	FPO		3315	4134	24573		32546	19769
SA 16	ITA	GNS	72911					23354	6919
SA 16	ITA	GTR	2856282	2740397	2061147	2238474	1817880	2332119	1895364
SA 16	ITA	LLD	2445223	1126930	1190370	1986039	968632	1022321	1032262
SA 16	ITA	LLS	791587	788804	701737	729876	469933	592043	430656
SA 16	ITA	LTL		1188	3132				
SA 16	ITA	OTB	22019100	24560236	23812187	23046380	19534052	20447594	20412436
SA 16	ITA	OTM	71350	153833	309326		411995	421505	356224
SA 16	ITA	PS	1069415	848533	1290163	1394781	1533138	883222	616488
SA 16	ITA	PTB		264153	756502	887812	528969	485308	334649

6.12.3. Scientific surveys

6.12.3.1. Acoustics

6.12.3.1.1. Methods

Acoustic surveys methodology

Steps for biomass estimation

- Collection of acoustic and biological data during surveys at sea;
- Extraction of $NASC_{Fish}$ (Fishes Nautical Area Scattering Coefficient [$m^2/n.mi^2$]) by means of Echoview (Sonar Data) post-processing software;
- Link of $NASC$ values to control catches;
- Calculation of Fish density (ρ) from $NASC_{Fish}$ values and biological data;
- Production of ρ distribution maps for different fish species and size classes;
- Integration of density areas for biomass estimation.

Collection of acoustic and biological data

Since 1998 the IAMC-CNR has been collecting acoustic data for evaluating abundance and distribution pattern of small pelagic fish species (mainly anchovy and sardine) in the Strait of Sicily (GSA 16). The scientific echosounder Kongsberg Simrad EK500 was used for acquiring acoustic data until summer 2005; while for the echosurvey in the period 2006-2010 the EK60 echosounder was used. In both cases the echosounder was equipped with three split beam transducers pulsing at 38, 120 and 200 kHz. During the period 1998-2008 acoustic data were collected continuously during day and night time; since the 2009 echosurvey acoustic data are collected during day time, according to the MEDIAS protocol.

Before or after acoustic data collection a standard procedure for calibrating the three transducers was carried out by adopting the standard sphere method (Johannesson & Mitson, 1983).

Biological data were collected by a pelagic trawl net with the following characteristics: total length 78 m, horizontal mouth opening 13-15 m, vertical mouth opening 6-8 m, mesh size in the cod-end 10 mm. The net was equipped with two doors with weight 340 kg. During each trawl the monitoring system SIMRAD ITI equipped with trawl-eye and temp-depth sensors was adopted.

Extraction of $NASC_{Fish}$ by means of Echoview (Sonar Data) post-processing software

The evaluation of the $NASC_{Fish}$ (Fishes Nautical Area Scattering Coefficient [$m^2/n.mi^2$]) and the total $NASC$ for each nautical mile of the survey track was performed by means of the SonarData Echoview software v3.50, taking into account the day and night collection periods.

Link of $NASC$ values to control catches

For the echo trace classification the nearest haul method was applied, taking into account only representative fishing stations along transects.

Calculation of Fish density (ρ) from $NASC_{Fish}$ values and biological data

For each trawl haul the frequency distribution of the j -th species (v_j) and for the k -th length class (f_{jk}) are estimated as

$$v_j = \frac{n_j}{N} \quad \text{and} \quad f_{jk} = \frac{n_{jk}}{n_j}$$

where n_j is the total number of specimens of the j -th species, n_{jk} is the total number of specimens of the k -th length class in the j -th species, and N is the total number of specimens in the sample.

For each nautical mile the densities for each size class and for each fish species are estimated as

$$\rho_{jk} = \frac{NASC_{FISH} * n_{jk}}{\sum_{j=1}^n \sum_{k=1}^m n_{jk} * \sigma_{jk}} \quad (\text{number of fishes / n.mi}^2)$$

$$\rho_{jk} = \frac{NASC_{FISH} * W_{jk} * 10^{-6}}{\sum_{j=1}^n \sum_{k=1}^m n_{jk} * \sigma_{jk}} \quad (\text{t / n.mi}^2)$$

where W_{jk} is the total weight of the k -th length class in the j -th species, and σ_{jk} is the scattering cross section of the k -th length class in the j -th species. σ_{jk} is given by

$$\sigma_{spjk} = 4\pi * 10^{\frac{TS_{jk}}{10}}$$

where the target strength (TS) is

$$TS_{jk} = a_j \cdot \log_{10}(L_k) + b_j$$

L_k is the length of the k -th length class while the a_j and b_j coefficient are linked to the fish species.

For anchovy, sardine and trachurus spp. (*T. trachurus* and *T. mediterraneus*) we adopted respectively the following relationships:

$$TS = 20 \log L_k 76.1 [dB]$$

$$TS = 20 \log L_k 70.51 [dB]$$

$$TS = 20 \log L_k 72 [dB]$$

Integration of density areas for biomass estimation

The abundance of each species was estimated by integrating the density surfaces for each species.

6.12.3.1.2. Geographical distribution patterns

No analyses were conducted during EWG MED 12-19.

6.12.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the anchovy stock in GSA 16 was derived from the acoustics. Figure 6.12.2.4.3.1 displays the estimated trend in anchovy total biomass (estimated by acoustics) for GSA 16. A decreasing trend was observed in biomass during the last years (Fig. 5.44.3.1.3.1). After a series of four consecutive very low values over the period 2006-2009, the stock appeared to partially recover in 2010, when estimated biomass was higher than the average value over the entire time series (about 16,000 t vs. 13,000 t), but current (2011) estimate is close to the lowest values observed in the times series.



Fig. 6.12.3.1.3.1. Estimated anchovy biomass indices for GSA 16, years 1998-2011.

6.12.3.1.4. Trends in abundance by length or age

No analyses were conducted during EWG12-19 meeting.

6.12.3.1.5. Trends in growth

No analyses were conducted during EWG12-19 meeting.

6.12.3.1.6. Trends in maturity

No analyses were conducted during EWG12-19 meeting.

6.12.4. Assessment of historic stock parameters

For the analysis of data, two stock assessment methods were used, a surplus production modelling approach, not requiring age-disaggregated catch data, and a age-based analytical method, namely XSA

6.12.4.1. Method 1: Surplus production modelling

6.12.4.1.1. Justification

The anchovy stock in the area was assessed using a non-equilibrium surplus production model based on the Schaefer (logistic) population growth model.

The model was implemented in an MS Excel spreadsheet, modified from the spreadsheets distributed by FAO under the BioDyn package (P. Barros, pers. comm.). Details about the implementation of the applied logistic modelling approach can be found in a FAO report on the Assessment of Small Pelagic Fish off Northwest Africa (FAO, 2004).

The report is available at the web site <http://www.fao.org/docrep/007/y5823b/y5823b00.htm>.

The model uses four basic parameters: Carrying capacity (or Virgin Biomass) K , population intrinsic growth rate r , initial depletion B/K (starting biomass relative to K) and catchability q . Given the best parameter estimates, the model calculates the MSY , B_{MSY} and F_{MSY} reference points.

Derived reference points B_{Cur}/B_{MSY} (ratio indicating whether the estimated stock biomass, in any given year, is above or below the biomass producing the MSY), and $F_{Cur}/F_{SY_{Cur}}$ (the ratio between the fishing effort in the last year of the data series and the effort that would have produced the sustainable yield at the biomass levels estimated in the same year, indicating whether the estimated fishing mortality coefficient, in any given year, is above or below the fishing mortality coefficient producing the sustainable yield in that year) were also evaluated. Values of $F_{Cur}/F_{SY_{Cur}}$ below 100% indicate that the catch currently taken is lower than the natural production of the stock, and thus that so stock biomass is expected to increase the following year, while values above 100% indicate a situation where fishing mortality exceeds the stock natural production, and thus where stock biomass will decline next year. For comparison purposes, also the series of F_{Cur}/F_{MSY} was evaluated and reported.

The fitting of the model was based on fitting the series of observed abundance indices, assuming an observation error model. The model implementation adopted allows for the optional incorporation of environmental indices, so that the r and K parameters of each year are considered to depend on the corresponding value of the applied index. The objective function, minimised with a non-linear algorithm implemented with the Solver add-in in MS Excel, was the sum of the squared residuals between the logarithms of the observed and predicted indices.

6.12.4.1.2. Input parameters

The input data used for the stock was total yearly catch estimates, and a series of abundance indices. Specifically, the time series of estimated total yearly anchovy landings for GSA 16 between 1998 and 2011 was used as input data for the model, together with the abundance indices from acoustic surveys from the same set of years. The scientific surveys, mainly carried during early summer of each year, were considered to represent the stock abundance the same year. In addition an environmental index, the satellite based estimate of yearly average chlorophyll-a concentration over the continental shelf off the southern sicilian coast, was used in the attempt of improving the performance of the model fitting, as expected because pelagic stocks are known to be significantly affected by environmental variability.

6.12.4.1.3. Results

Using the Excel spreadsheet, several model control settings have been tested. The first run was carried out without the incorporation of the selected environmental index. With this configuration, the best obtained fit was quite poor ($R^2=0.11$; see Figure 6.12.4.1.3.1). It appears that the evolution of the stock biomass cannot be explained solely by the dynamic of the catches or the average stock growth conditions, i.e. the model with constant parameters is not adequate to account for the high fluctuations in the time series. Current knowledge suggests that observed changes could be linked to strong environmental forcings (Basilone et al., 2004; Basilone et al., 2006; Patti et al., 2010). Therefore, a modification of the model was made to include environmental variability (average yearly chlorophyll concentration).

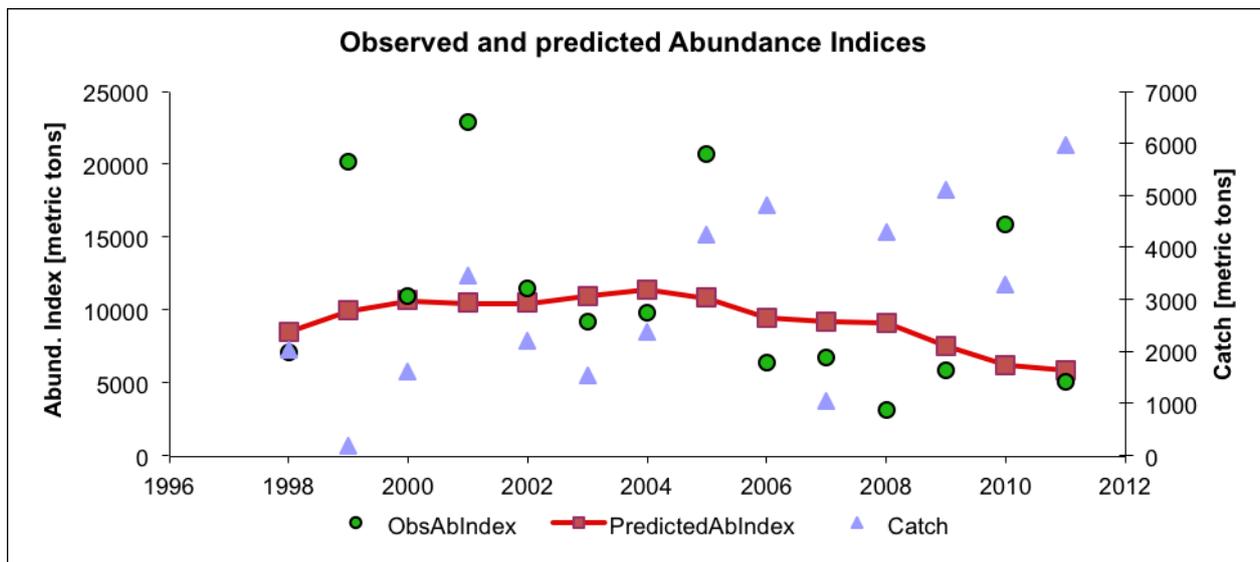


Fig. 6.12.4.1.3.1. Observed (green circles) and predicted sardine biomass in GSA 16, model with constant K and r parameters. Catches (purple triangles) are indicated on the right axis.

Figure 6.12.4.1.3.2 shows the trends in observed and predicted anchovy biomass, model incorporating an environmental index. The best fit, obtained including an exponential environmental effect in the population intrinsic growth rate (r), explained the 40% of total variance.

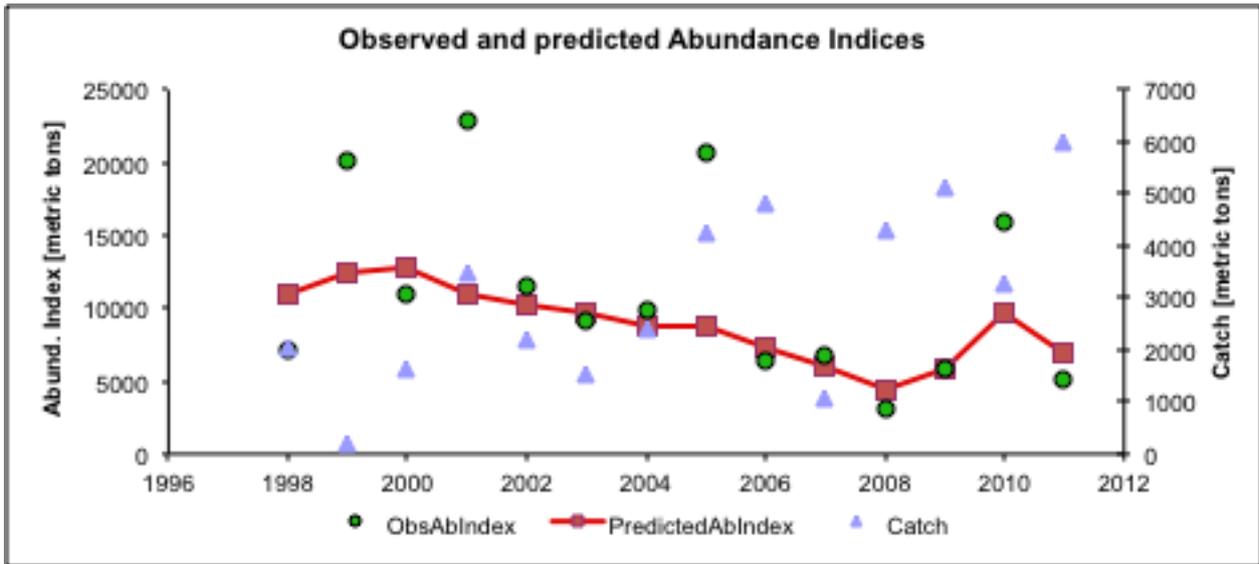


Fig. 6.12.4.1.3.2. Observed (green circles) and predicted anchovy biomass in GSA 16, model with constant K and variable r . Catches (purple triangles) are indicated on the right axis.

Trends in B_{CUR}/B_{MSY} indicate that stock biomass was below the reference limit throughout the entire time series (Figure 6.12.4.1.3.3).

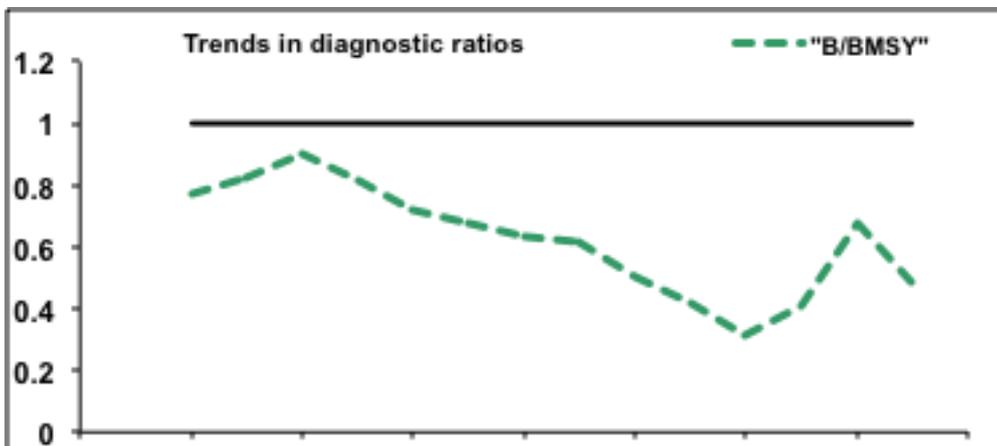


Fig. 6.12.4.1.3.3. Anchovy stock in GSA 16. Trends in B_i/B_{MSY} over the period 1998-2011.

Current fishing mortality is far above the sustainable fishing mortality at current biomass levels (Figure 6.12.4.1.3.4), and trend in fishing mortality is increasing during the considered period (Figure 6.12.4.1.3.5). Finally, current sustainable production is about the 62% of the yields at MSY (Figure 6.12.4.1.3.4).

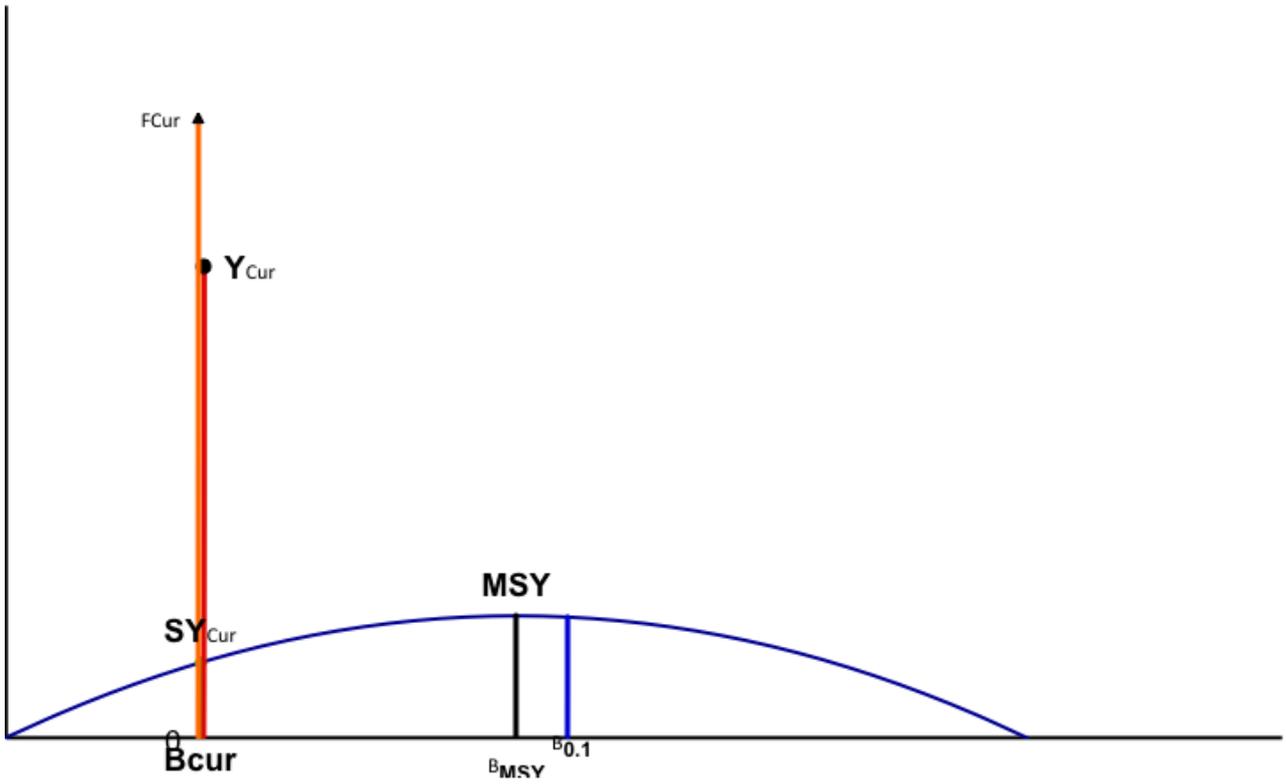


Fig. 6.12.4.1.3.4. Current situation of the anchovy stock in GSA 16.

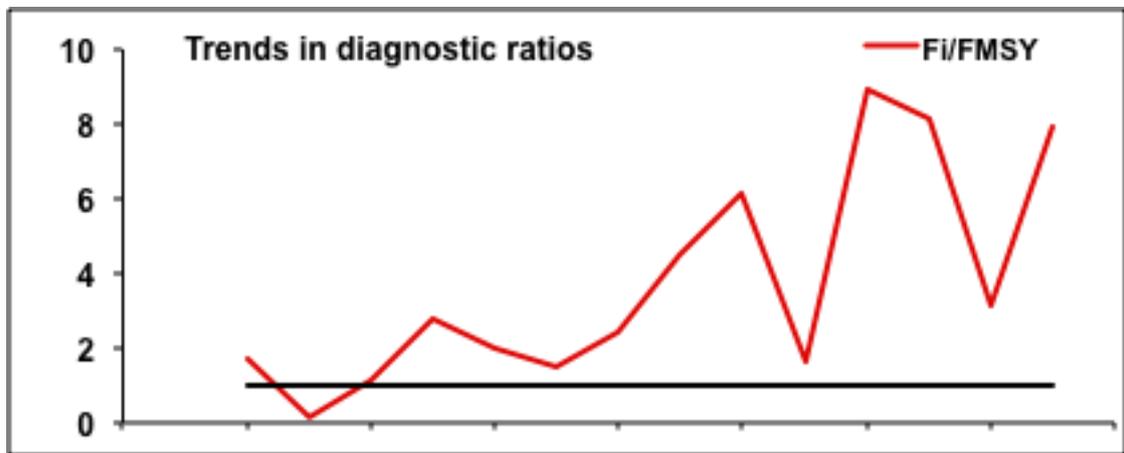


Fig. 6.12.4.1.3.5. Anchovy stock in GSA 16. Trends in F_i/F_{MSY} over the period 1998-2011.

Model diagnostics

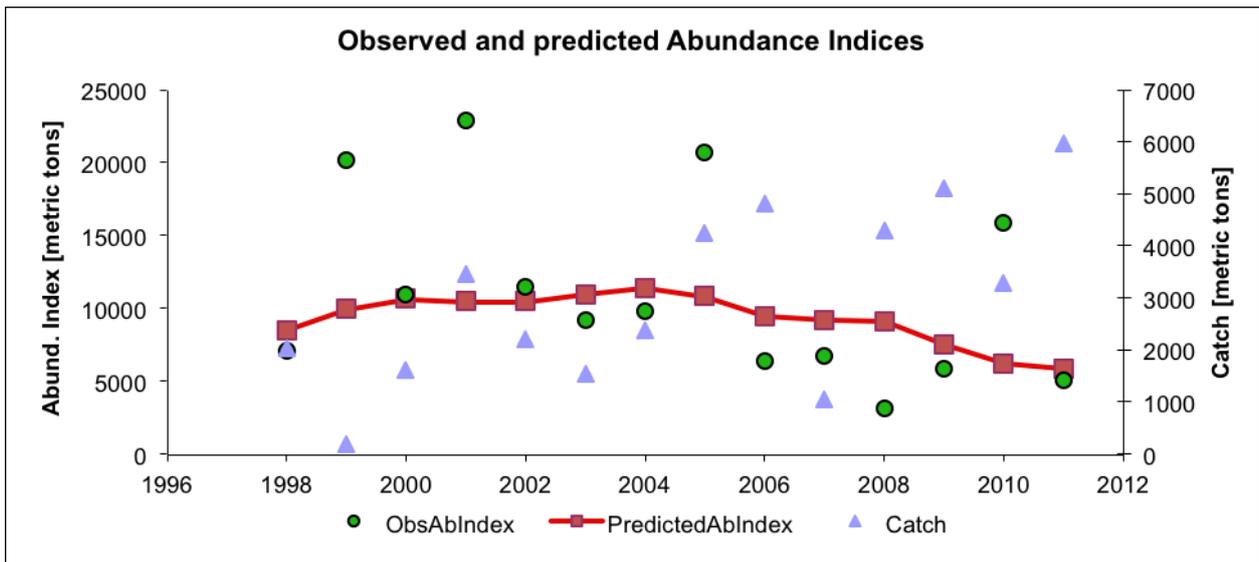


Fig. 6.12.4.1.3.6. Anchovy stock in GSA 16. Best fit obtained without incorporating the environmental.

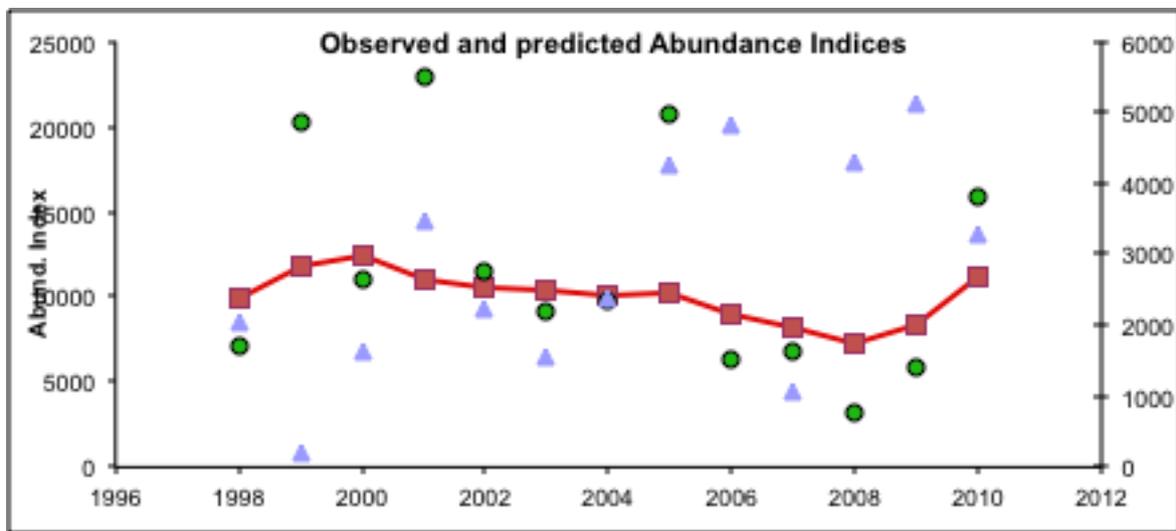


Fig. 6.12.4.1.3.7. Anchovy stock in GSA 16. Results of the retrospective analysis run, obtained using data from 1998 to 2010. Best fit with a flexible intrinsic growth rate “r”, modulated by chl-a concentration at sea.

Table 6.12.4.1.3.1. Anchovy stock in GSA 16. Reference points for the retrospective analysis run and for the best fit obtained including updated data (2011).

Year	MSY	B _{MSY}	F _{MSY}	B _{Cur} /B _{MSY}	F _{Cur} /F _{MSY}	F _{Cur} /F _{MSY}
2010	2198	17584	0.13	85%	153%	176%
2011	1546	20546	0.08	38%	628%	1017%

Results of retrospective analysis, based on the comparison between the model run using data from 1998 to 2010 (see Figure 6.12.4.1.3.7) with model run using updated data (1998-2011; Figure 6.12.4.1.3.2) show that reference points did change significantly (Table 6.12.4.1.3.1). This, together with the low level of total

variance explained by the model, raises doubts about the accuracy of model results. For this reason, no short term predictions were produced using the present surplus production method model results.

6.12.4.2. Method 2: XSA

6.12.4.2.1. Justification

Anchovy was previously assessed with a surplus production modeling approach (for the first time during STECF-EWG 11-12). This is the first attempt to also use an analytical approach for this stock in GSA 16. In particular, an XSA assessment was carried out using the catch data collected under DCF from 2004 to 2011 and calibrated with echosurveys data.

6.12.4.2.2. Input parameters

DCF data contained information anchovy landings and the respective size structure for 2004-2011. The annual size distributions of the catch as well as of echosurveys were converted in numbers at ages classes 1-6+ using a standard slicing approach, using the same growth parameters adopted to estimate natural mortality. Biological parameters are listed in Table 6.12.4.2.2.1 and data used are reported in Table 6.12.4.2.2.2. A natural mortality vector computed by Gislason (2010) formulation was used. The 0+ age class was not considered in the analysis and the LFD were splitted up to the age class 4+. Analysis was performed by sex combined.

Table 6.12.4.2.2.1. Input parameters for the XSA of anchovy in GSA 16.

	Growth (GSA16)	Length-weight relationship	Natural mortality vector (Gislason)	Proportion of matures
F+M	$L_{\infty} = 19.83$ $k = 0.31$ $T_0 = -1.83$	$a = 0.0089$ $b = 2.98$	0.97 (age 0) 0.68 (age 1) 0.54 (age 2) 0.47 (age 3) 0.43 (Age 4+)	0.091 (age 0) 0.911 (age 1) 0.996 (age 2) 0.999 (age 3) 1 (Age 4+)

The XSA settings are given below:

Fse: 0.5, 1.0, 2.0, 3.0

Rage: 1

Qage: 2

shk.yrs: 3

shk.ages: 3

Table 6.12.4.2.2.2. *Engraulis encrasicolus* in GSAs 16. XSA input data (i.e. catch at age, weight at age, maturity at age and natural mortality at age)

Catch-at-age (thousands)								
Age	2004	2005	2006	2007	2008	2009	2010	2011

class								
1	71557	97268	114226	49430	74404	150648	200509	59579
2	63636	54834	62392	79810	105172	78632	230791	122473
3	14499	13821	24874	13989	6958	51453	7800	28689
4+	2014	1728	6139	341	265	5909	918	1316
Weight-at-age								
Age class	2004	2005	2006	2007	2008	2009	2010	2011
1	0.0138	0.0145	0.0148	0.0177	0.0158	0.0147	0.0139	0.0126
2	0.0207	0.0204	0.0219	0.0204	0.0208	0.0211	0.0051	0.0197
3	0.0269	0.0256	0.0279	0.0271	0.0274	0.0269	0.0247	0.0241
4+	0.0329	0.0296	0.0333	0.0898	0.0341	0.3128	0.0308	0.0274
Maturity-at-age								
Age class	2004	2005	2006	2007	2008	2009	2010	2011
1	0.911	0.911	0.911	0.911	0.911	0.911	0.911	0.911
2	0.996	0.996	0.996	0.996	0.996	0.996	0.996	0.996
3	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999
4+	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Mortality-at-age								
Age class	2004	2005	2006	2007	2008	2009	2010	2011
1	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
2	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
3	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
4+	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43

6.12.4.2.3. Results including sensitivity analyses

XSA was run setting shrinkage at 0.5, 1.0, 2.0, 3.0. As showed by Figure 6.12.4.2.3.1 the three different settings produced quite similar estimates of recruitment and SSB except for the 2010 and 2011 when model with shrinkage 0.5 diverged from models with 1.0 and 2.0 shrinkage. The XSA model with 2.0 shrinkage produced significant lower estimates of F_{bar} .

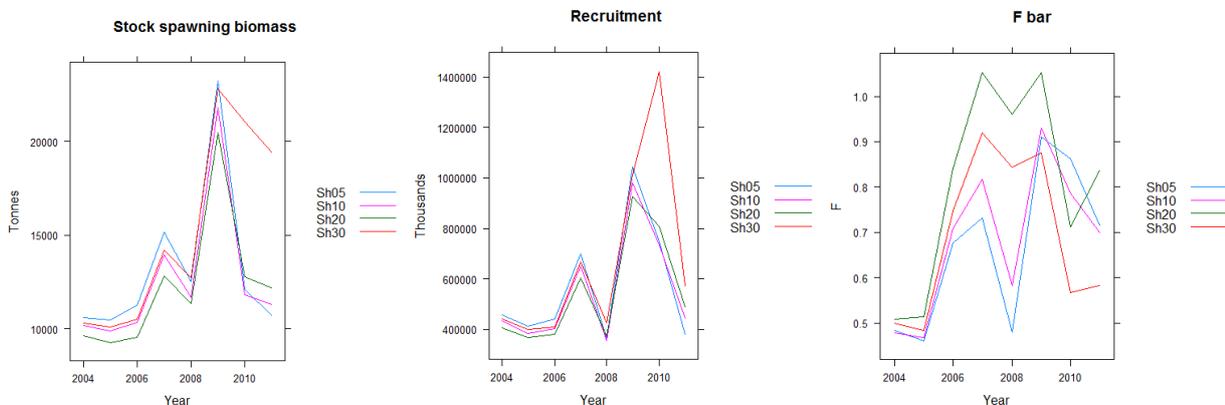


Fig. 6.12.4.2.3.1. Anchovy stock in GSA 16. Estimates of recruitment, SSB and Fbar using different values of shrinkage.

Model with 1.0 shrinkage was adopted as final model since it produced relatively small residuals, with no clear trend in their distribution (Figure 6.12.4.2.3.2) and a more consistent pattern as also showed by the retrospective analysis (Figure 6.12.4.2.3.3).

Shrinkage=0.5 Shrinkage=1.0 Shrinkage=2.0

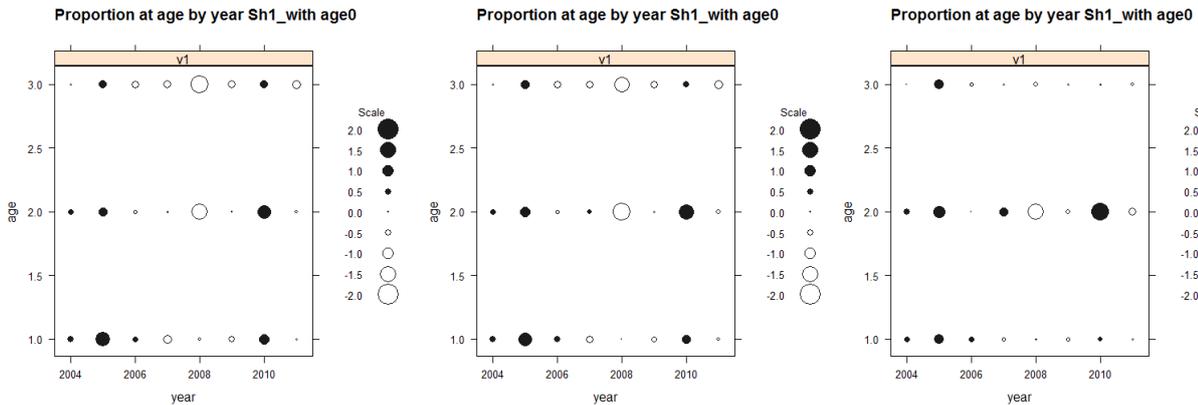
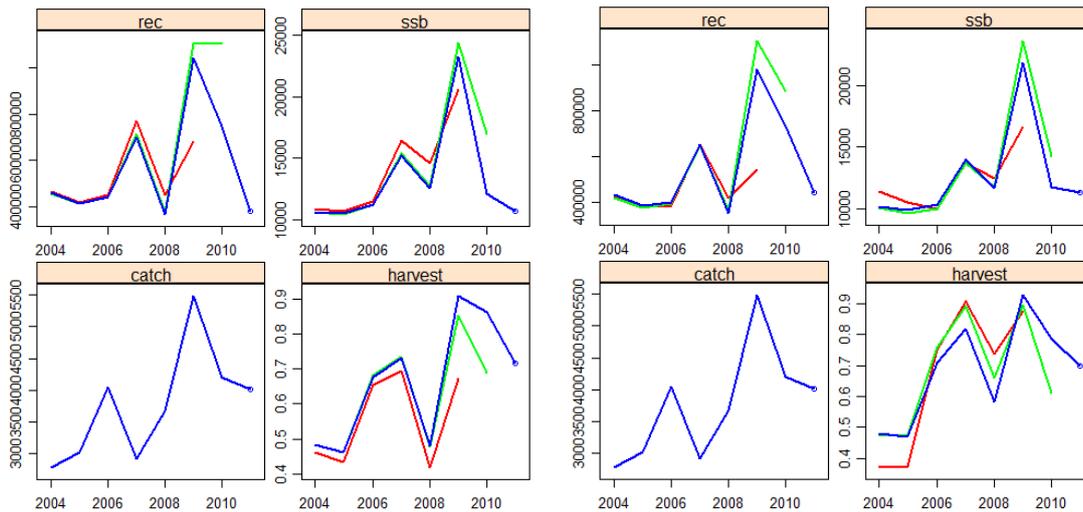


Fig. 6.12.4.2.3.2. Anchovy stock in GSA 16. Residuals at age obtained with shrinkage set at 0.5, 1.0, 2.0.

Shrinkage=0.5 Shrinkage=1.0



Shrinkage=2.0

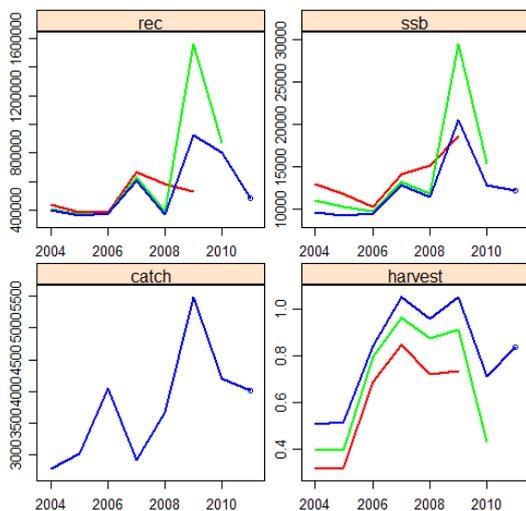


Fig. 6.12.4.2.3.3. Anchovy stock in GSA 16. Retrospective analysis for model with shrinkage set at 0.5, 1.0, 2.0

In 2004-2011 the SSB increased from 10610 t to 12089 t in 2010 and 10734 t in 2011. The recruitment also showed a decreasing from 457 millions in 2004 to 379 millions in 2011. The total biomass was increasing up to 2009, and declined in 2010-2011 to 2004 level. (Table 6.12.4.2.3.1). XSA estimates of $F_{bar_{1-4}}$ showed an increasing trend since 2006 as expected by the observed increase in the annual catches (Table 6.12.4.2.3.2) with the highest values in 2009. Figure 6.12.4.2.3.4 shows the summary of the stock parameters (recruitment, SSB, Catch and landing, F mean for ages 1-4) as estimated by XSA.

Table 6.12.4.2.3.1. Spawning stock biomass (SSB), total biomass (TB) and recruitment estimates by XSA for anchovy in GSA 16 from 2004 to 2011.

	2004	2005	2006	2007	2008	2009	2010	2011
SSB (tons)	10610	10482	11263	15161	12511	23242	12089	10734
TB (tons)	11186	11030	11857	16274	13054	24619	13021	11180
Recruitment at age 1 (millions)	457	412	441	700	366	1044	747	379

Table 6.12.4.2.3.2. Anchovy stock in GSA 16. Fishing mortality and numbers at age at age as estimated by XSA.

F-at-age

age	2004	2005	2006	2007	2008	2009	2010	2011
1	0.25	0.40	0.45	0.10	0.34	0.23	0.47	0.25
2	0.71	0.51	0.88	1.33	0.56	1.51	1.26	1.14
3	0.49	0.46	0.69	0.75	0.51	0.95	0.86	0.74
4+	0.49	0.46	0.69	0.75	0.51	0.95	0.86	0.74
Fbar₁₋₄	0.48	0.46	0.68	0.73	0.48	0.91	0.86	0.72

Numbers-at-age (thousands)

age	2004	2005	2006	2007	2008	2009	2010	2011
1	456957	411959	441382	699907	365827	1043903	747361	378796
2	164036	180570	139473	142309	319402	132375	421632	235909
3	47367	47013	63368	33649	22005	105845	17115	69524
4+	6397	5720	15093	790	814	11615	1932	3072

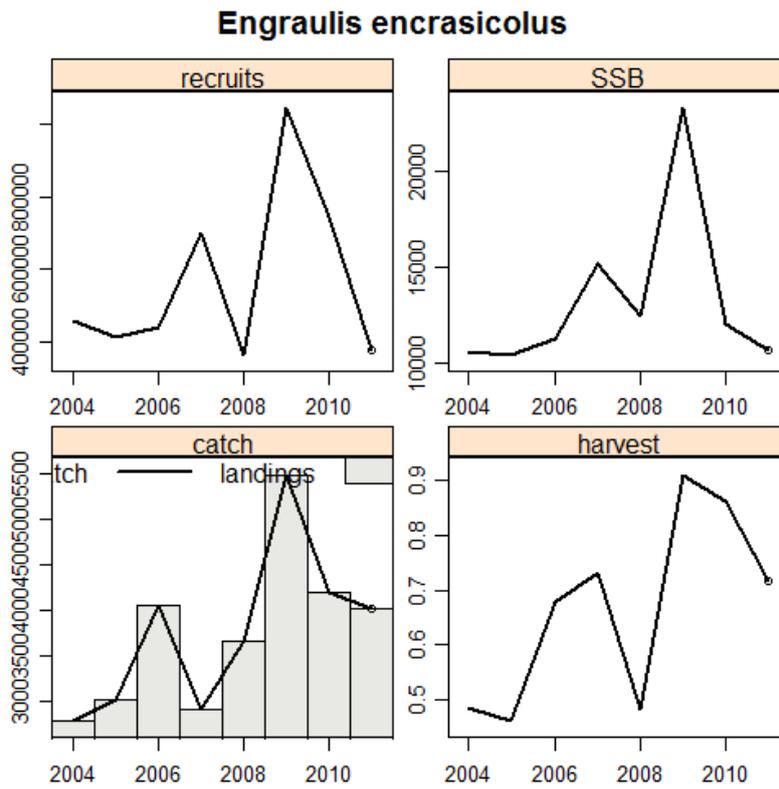


Fig. 6.12.4.2.3.4. Summary of anchovy stock parameters (recruitment, SSB, Catch and landing, F mean for ages 1-5) in GSA 16 as estimated by XSA (shrinkage=0.5).

Exploitation rate ($M=0.53$, the average over ages 1-4, is assumed)

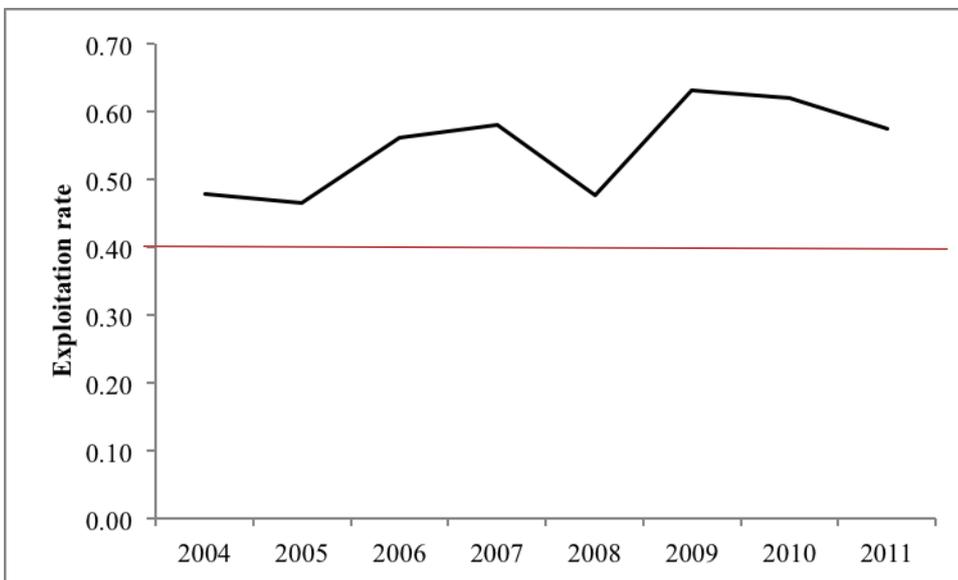


Fig. 6.12.4.2.3.5. Trend in estimated Exploitation rate. $M=0.53$, the average value estimated over ages 1-4, is assumed. Reference point $E=0.4$; fishing mortality corresponding to $E=0.4$; $F=0.35$.

Figure 6.12.4.2.3.5 shows that exploitation rate over the considered period (2004-2011) is increasing and above the agreed reference point.

6.12.5. Long term prediction

Not applicable. No forecast analyses were conducted.

6.12.6. Scientific advice

6.12.6.1. Short term considerations

6.12.6.1.1.State of the spawning stock size

Biomass estimates of total population obtained by hydro-acoustic surveys for anchovy in GSA 16 show a decreasing trend over the last decade, despite the occurrence of quite large inter-annual fluctuations, from a maximum of about 22,900 t in 2001 to a minimum of 3,100 t in 2008. Biomass estimates over the period 2006-2009 surveys were the lowest of the series (their average representing less than one-quarter of the maximum recorded value), and despite the anchovy stock biomass experienced a significant increase in 2010, current estimate is very low (about 5,000 t).

6.12.6.1.2.State of recruitment

Not evaluated.

6.12.6.1.3.State of exploitation

The first approach used herewith for the evaluation of stock status is based on the analysis of the harvest rates experienced in the available time series over the last years and on the related estimate of the current exploitation rate.

SGMED recommends $E=0.4$ as limit management reference point consistent with high long term yields. The high and increasing yearly harvest rates, as estimated by the ratio between total landings and stock sizes, indicate high fishing mortality levels. Actually, as long as this estimate of harvest rate can be considered as a proxy of F estimate obtained from the fitting of standard stock assessment models (assuming survey biomass estimate as a proxy of mean stock size), this index can be used to assess the corresponding exploitation rate $E=F/Z$, provided that an estimate of natural mortality is given.

The current (year 2011) harvest rate is 79.3% (DCF data were used for landings). The estimated average value over the years 2008-2011 is again 79.3%.

The exploitation rate corresponding to $F=0.79$ is $E=0.55$, if $M=0.66$, estimated with Pauly (1980) empirical equation, is assumed, and $E=0.59$ if $M=0.56$, estimated with Beverton & Holt's Invariants method (Jensen,

1996), is used instead. Consequently, considering as reference point for the exploitation rate the 0.4 value suggested by Patterson (1992), this stock should be considered as exploited unsustainably.

The results of the first formal assessment approach, based on the implementation of a logistic surplus production model, are consistent with the previous considerations. The fluctuations in stock biomass cannot be explained solely by the observed fishing pattern. This was an expected result, as pelagic stocks are known to be significantly affected by environmental variability. The incorporation of an environmental index in the model significantly improved the fitting of the model, allowing the stock to grow more or less than average depending on the state of the environment in each year. In the current formulation satellite-based data on chlorophyll concentration showed to have a positive effect on the yearly population intrinsic growth rate.

Current fishing mortality is far above the sustainable fishing mortality at current biomass levels (Table 6.12.6.1.3.1). Fishing mortality experienced very high values during the considered period, frequently well above the reference limit (Fig. 6.12.4.1.3.5). In addition B/B_{MSY} values was below 100% over the entire time series decade, again indicating the stock being exploited unsustainably.

Table 6.12.6.1.3.1. Reference points. Current estimates refer to year 2011.

MSY	B_{MSY}	F_{MSY}	B_{Cur}/B_{MSY}	$F_{Cur}/F_{SY_{Cur}}$	F_{Cur}/F_{MSY}
1546	20546	0.08	38%	628%	1017%

Actually, given the high sensitivity of this species to changes in environmental conditions, and the instability of the environment on the continental shelf of GSA16 (the habitat for the stock), characterized by coastal wind-induced upwelling and high short term mesoscale variability, it is expected that the anchovy stock may experience periods of very different production potential.

The results of the second analytical assessment approach (XSA) are consistent with the results obtained with the alternative methodology, confirming steadily increasing and high exploitation rates for the anchovy stock in GSA 16, above the reference limit for the entire considered period (2004-2011).

6.12.6.2. Management recommendations

Results of the surplus production modelling approach suggest that the environmental factors can be very important in explaining the variability in yearly biomass levels (mostly based on recruitment success). The stock level is currently well below the B_{MSY} during the considered period. In addition fishing levels are higher than those required for extracting the MSY of the resource, as also confirmed by XSA analysis.

Given that the stock is overfished and currently also overexploited, fishing effort and/or catches should be reduced by means of a multi-annual management plan until there is evidence for stock recovery. Consistent catch reductions along with effort reductions should be determined. However, the mixed fisheries effects, mainly the interaction with sardine, need to be taken into account when managing the anchovy fishery. As

the small pelagic fishery is generally multispecies, any management of fishing effort targeting the anchovy stock would also have effects on sardine. Local small pelagic fishery appears to be able to adapt at resource availability and market constraints, targeting the fishing effort mainly on anchovy. But due to the low biomass levels experienced by the anchovy stock over the last years, measures should be taken to prevent a possible further shift of effort back from anchovy to sardine.

6.13. Stock assessment of Sardine in GSA 16

6.13.1. Stock identification and biological features

6.13.1.1. Stock Identification

The main distribution area of the sardine stock in GSA 16 is the narrow continental shelf area between Mazara del Vallo and the southernmost tip of Sicily, Cape Passero (Patti *et al.*, 2004; Tugores *et al.*, 2011).

6.13.1.2. Growth

Growth parameters were only used for the estimation of natural mortality with the approaches suggested by Pauly (1980) and the Beverton & Holt's Invariants method (Jensen, 1996). Von-Bertalanffy growth parameters were estimated by FISAT using DCF data collected in GSA16 over the period 2007-2008. The applied growth parameters are given below in the following table:

L_{∞}	k	t_0
21.41	0.40	-1.83

For BHI method, the equation $M = \beta * k$ was applied, with β set to 1.8.

6.13.1.3. Maturity

Maturity data were not used for this assessment.

6.13.2. Fisheries

6.13.2.1. General description of fisheries

In Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA 16), accounting for about 2/3 of total landings in GSA 16, two operational units (OU) are presently active, purse seiners and pelagic pair trawlers. The fleet in GSA 16 is composed by about 50 units (17 purse seiners and 30 pelagic pair trawlers were counted up in a census carried out in December 2006). In both OUs, anchovy represents the main target species due to the higher market price.

6.13.2.2. Management regulations applicable in 2010 and 2011

Fisheries practices are affected by EU regulations through the Common Fisheries Policy (CFP), based on the following principles: protection of resources; adjustment of (structure) facilities to the available resources; market organization and definition of relationships with other countries.

The main technical measures regulating fishing concern minimum landing size (9 cm for anchovy, 11 cm for sardine), mesh regulations (20 mm for pelagic pair trawlers, 14 mm for purse seiners) and restrictions on the use of fishing gear. Towed fishing gears are not allowed in the coastal area in less than 50 m depth, or within a distance of 3 nautical miles from the coastline. A seasonal closure for trawling, generally during summer-autumn, has been established since 1993. In GSA 16, the two operational units fishing for small pelagic are present, mainly based in Sciacca port: purse seiners (lampara vessels, locally known as "Ciancioli") and midwaters pair trawlers ("Volanti a coppia"). Midwaters trawlers are based in Sciacca port only, and receive

a special permission from Sicilian Authorities on an annual basis. Another fleet fishing on small pelagic fish species, based in some northern Sicilian ports, was used to target on juvenile stages (mainly sardines). However this fishery, which in the past was allowed for a limited period (usually one or two months in the winter season) by a special Regional law renewed year by year, was no more authorized starting from 2010 and it is presently stopped.

6.13.2.3. Catches

6.13.2.6.1. Landings

Landings data were obtained within the framework of DCF and from the census data collection carried out by IAMC-CNR (Mazara del Vallo) in Sciacca port since 1998. Information collected in the framework of CA.SFO study project (Patti *et al.*, 2007) showed that landings in Sciacca port account for about 2/3 of the total landings in GSA 16. Average sardine landings in Sciacca port over the period 1998-2011 were about 1,400 metric tons, with a general decreasing trend. The production dramatically decreased in 2010 (-70% over 2009), but increased again (+372%) in 2011.

It is worth noting that, though trend in biomass is clearly decreasing over the last years (Figure 6.13.2.4.3.1), landings levels over the same period were relatively high, indicating an increased vulnerability of the resource (Figure 6.13.2.6.1.1).

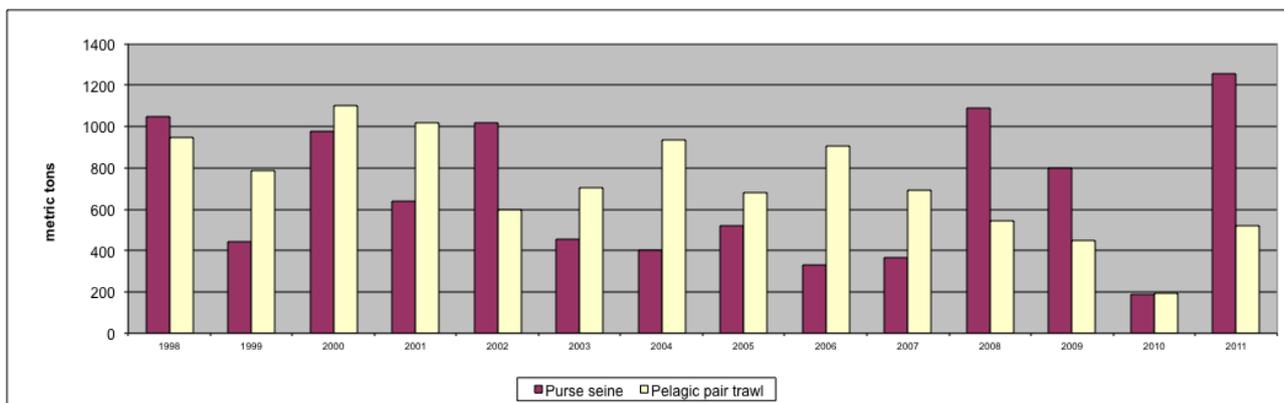


Fig. 6.13.2.6.1.1. Landings data regarding the purse seine and pelagic pair trawl fleets in Sciacca port (GSA 16), 1998-2011.

6.13.2.6.2. Discards

No discards data for sardine were used for this assessment. However, discards are estimated to be less than 5% of total catch for both the pelagic pair trawl and the purse seine fisheries (Kallianiotis & Mazzola, 2002).

6.13.2.7. Fishing effort

Fishing effort data refer to census data collected in Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA 16), accounting for about 2/3 of total landings in GSA 16.

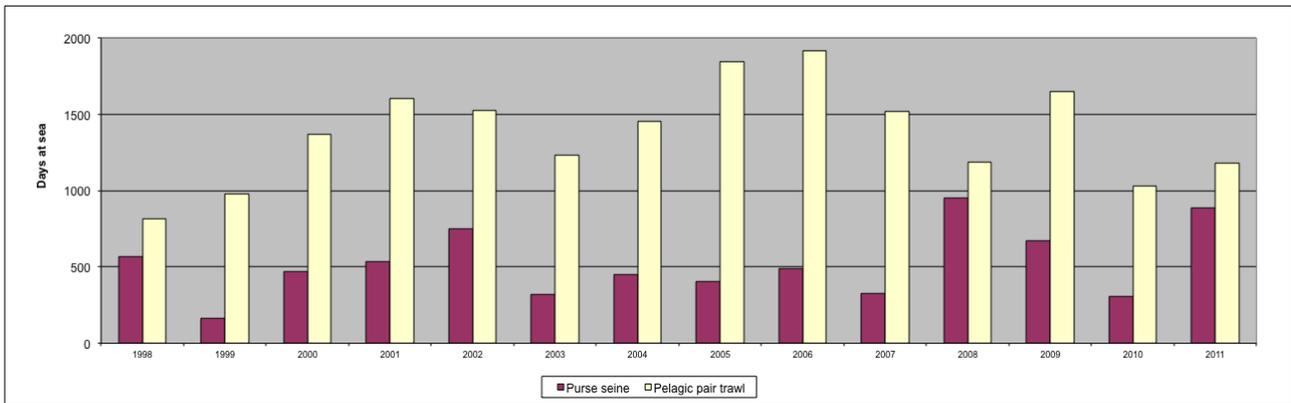


Fig. 6.13.2.7.1. Effort data regarding the purse seine and pelagic pair trawl fleets in Sciacca port (GSA 16), 1998-2011.

Fishing effort officially reported in 2011 through the DCF is also given below.

Table 6.13.2.7.1. Fishing effort (kW*days) as officially reported in 2011 through the DCF.

AREA	COUNTRY	GEAR	2004	2005	2006	2007	2008	2009	2010
SA 16	ITA	-1	510755	166307	326382	322280	244200	19958	162725
SA 16	ITA	FPO		3315	4134	24573		32546	19769
SA 16	ITA	GNS	72911					23354	6919
SA 16	ITA	GTR	2856282	2740397	2061147	2238474	1817880	2332119	1895364
SA 16	ITA	LLD	2445223	1126930	1190370	1986039	968632	1022321	1032262
SA 16	ITA	LLS	791587	788804	701737	729876	469933	592043	430656
SA 16	ITA	LTL		1188	3132				
SA 16	ITA	OTB	22019100	24560236	23812187	23046380	19534052	20447594	20412436
SA 16	ITA	OTM	71350	153833	309326		411995	421505	356224
SA 16	ITA	PS	1069415	848533	1290163	1394781	1533138	883222	616488
SA 16	ITA	PTB		264153	756502	887812	528969	485308	334649

6.13.3. Scientific surveys

6.13.3.1. Acoustics

6.13.3.1.1. Methods

Acoustic surveys methodology

Steps for biomass estimation

- Collection of acoustic and biological data during surveys at sea;
- Extraction of $NASC_{Fish}$ (Fishes Nautical Area Scattering Coefficient [$m^2/n.mi^2$]) by means of Echoview (Sonar Data) post-processing software;
- Link of $NASC$ values to control catches;
- Calculation of Fish density (ρ) from $NASC_{Fish}$ values and biological data;
- Production of ρ distribution maps for different fish species and size classes;

- Integration of density areas for biomass estimation.

Collection of acoustic and biological data

Since 1998 the IAMC-CNR has been collecting acoustic data for evaluating abundance and distribution pattern of small pelagic fish species (mainly anchovy and sardine) in the Strait of Sicily (GSA 16). The scientific echosounder Kongsberg Simrad EK500 was used for acquiring acoustic data until summer 2005; for the echosurvey in the period 2006-2010 the EK60 echosounder was used. In both cases the echosounder was equipped with three split beam transducers pulsing at 38, 120 and 200 kHz. During the period 1998-2008 acoustic data were collected continuously during day and night time; since the 2009 echosurvey acoustic data are collected during daytime, according to the MEDIAS protocol.

Before or after acoustic data collection a standard procedure for calibrating the three transducers was carried out by adopting the standard sphere method (Johannesson & Mitson, 1983).

Biological data were collected by a pelagic trawl net with the following characteristics: total length 78 m, horizontal mouth opening 13-15 m, vertical mouth opening 6-8 m, mesh size in the cod-end 10 mm. The net was equipped with two doors with weight 340 kg. During each trawl the monitoring system SIMRAD ITI equipped with trawl-eye and temp-depth sensors was adopted.

Extraction of $NASC_{Fish}$ by means of Echoview (Sonar Data) post-processing software

The evaluation of the $NASC_{Fish}$ (Fishes Nautical Area Scattering Coefficient [$m^2/n.mi^2$]) and the total NASC for each nautical mile of the survey track was performed by means of the SonarData Echoview software v3.50, taking into account the day and night collection periods.

Link of NASC values to control catches

For the echo trace classification the nearest haul method was applied, taking into account only representative fishing stations along transects.

Calculation of Fish density (ρ) from $NASC_{Fish}$ values and biological data

For each trawl haul the frequency distribution of the j -th species (v_j) and for the k -th length class (f_{jk}) are estimated as

$$v_j = \frac{n_j}{N} \quad \text{and} \quad f_{jk} = \frac{n_{jk}}{n_j}$$

where n_j is the total number of specimens of the j -th species, n_{jk} is the total number of specimens of the k -th length class in the j -th species, and N is the total number of specimens in the sample.

For each nautical mile the densities for each size class and for each fish species are estimated as

$$\rho_{jk} = \frac{NASC_{FISH} * n_{jk}}{\sum_{j=1}^n \sum_{k=1}^m n_{jk} * \sigma_{jk}} \quad (\text{number of fishes} / n.mi^2)$$

$$\rho_{jk} = \frac{NASC_{FISH} * W_{jk} * 10^{-6}}{\sum_{j=1}^n \sum_{k=1}^m n_{jk} * \sigma_{jk}} \quad (\text{t} / \text{n.mi}^2)$$

where W_{jk} is the total weight of the k -th length class in the j -th species, and σ_{jk} is the scattering cross section of the k -th length class in the j -th species. σ_{jk} is given by

$$\sigma_{spjk} = 4\pi * 10^{\frac{TS_k}{10}}$$

where the target strength (TS) is

$$TS_{jk} = a_j \text{Log}_{10} \left(L_k \right) + b_j$$

L_k is the length of the k -th length class while the a_j and b_j coefficient are linked to the fish species.

For anchovy, sardine and trachurus we adopted respectively the following relationships:

$$TS = 20 \log L_k - 76.1 \text{ [dB]}$$

$$TS = 20 \log L_k - 70.51 \text{ [dB]}$$

$$TS = 20 \log L_k - 72 \text{ [dB]}$$

Integration of density areas for biomass estimation

The abundance of each species was estimated by integrating the density surfaces for each species.

6.13.3.1.2. Geographical distribution patterns

No analyses were conducted during EWG MED 11-12.

6.13.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the sardine stock in GSA 16 was derived from the acoustics. Figure 6.13.3.1.3.1 displays the estimated trend in sardine total biomass (estimated by acoustics) for GSA 16.

Values of the last five years are below the average value over the period 1998-2011 (about 16,000 t).

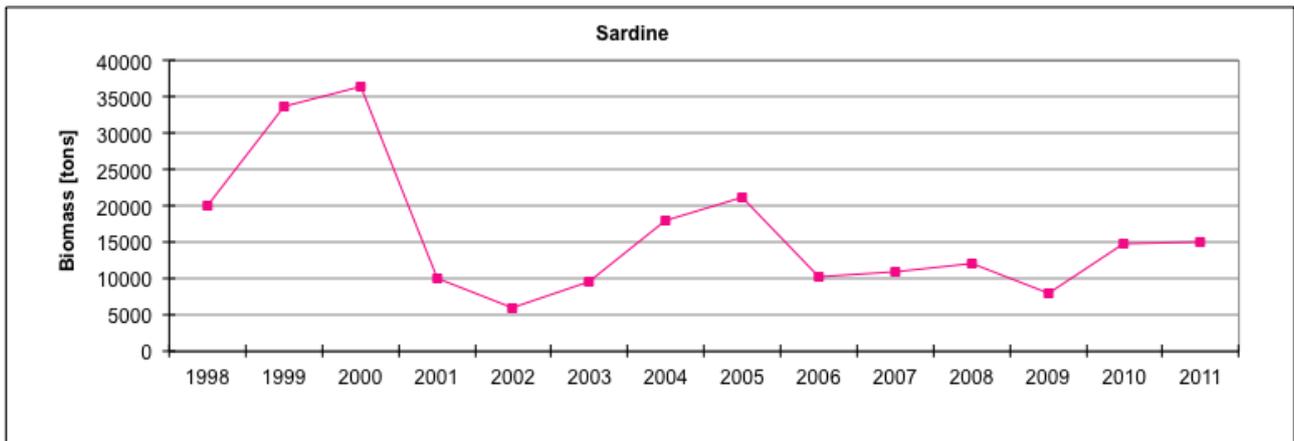


Fig. 6.13.3.1.3.1. Estimated sardine biomass indices for GSA 16, years 1998-2011.

6.13.3.1.4. Trends in abundance by length or age

No analyses were conducted during EWG12-10 meeting.

6.13.3.1.5. Trends in growth

No analyses were conducted during EWG12-10 meeting.

6.13.3.1.6. Trends in maturity

No analyses were conducted during EWG12-10 meeting.

6.13.4. Assessment of historic stock parameters

For the analysis of data, the medium-term aim is to apply age-based analytical assessment methods to the stock, such as VPA-based methods like ICA, XSA, or others. However, to use such methods catch statistics have to be age-disaggregated, in order to follow the different year-classes age by age and year by year through the time series of catch data. Age-disaggregated data for sardine stock in GSA16 are available, but have not been yet properly arranged to be used as input data for any specific age-based assessment method. Therefore, a surplus production modelling approach, not requiring age-disaggregated catch data, has been adopted for the present assessment.

6.13.4.1. Method: Surplus production modeling

6.13.4.1.1. Justification

The sardine stock in the area was assessed using a non-equilibrium surplus production model based on the Schaefer (logistic) population growth model.

The model was implemented in an MS Excel spreadsheet, modified from the spreadsheets distributed by FAO under the BioDyn package (P. Barros, pers. comm.). Details about the implementation of the applied logistic modelling approach can be found in a FAO report on the Assessment of Small Pelagic Fish off Northwest Africa (FAO, 2004).

The report is available at the web site <http://www.fao.org/docrep/007/y5823b/y5823b00.htm>.

The model uses four basic parameters: Carrying capacity (or Virgin Biomass) K , population intrinsic growth rate r , initial depletion B/K (starting biomass relative to K) and catchability q . Given the best parameter estimates, the model calculates the MSY , B_{MSY} and F_{MSY} reference points.

Derived reference points B_{Cur}/B_{MSY} (ratio indicating whether the estimated stock biomass, in any given year, is above or below the biomass producing the MSY), and F_{Cur}/FSY_{Cur} (the ratio between the fishing effort in the last year of the data series and the effort that would have produced the sustainable yield at the Biomass levels estimated in the same year, indicating whether the estimated fishing mortality coefficient, in any given year, is above or below the fishing mortality coefficient producing the sustainable yield in that year) were also evaluated. Values of F_{Cur}/FSY_{Cur} below 100% indicate that the catch currently taken is lower than the natural production of the stock, and thus that so stock biomass is expected to increase the following year, while values above 100% indicate a situation where fishing mortality exceeds the stock natural production, and thus where stock biomass will decline next year. For comparison purposes, also the series of F_{Cur}/F_{MSY} was evaluated and reported.

The fitting of the model was based on fitting the series of observed abundance indices. The model implementation adopted allows for the optional incorporation of environmental indices, so that the r and K parameters of each year can be considered to depend on the corresponding value of the applied index. The objective function, minimised with a non-linear algorithm implemented with the Solver add-in in MS Excel, was the sum of the squared residuals between the logarithms of the observed and predicted indices.

6.13.4.1.2. Input parameters

The input data used for the stock was total yearly catch estimates, and a series of abundance indices. Specifically, the time series of estimated total yearly sardine landings for GSA 16 between 1998 and 2011 was used as input data for the model, together with the abundance indices from the acoustic surveys from the same set of years. The scientific surveys, mainly carried during early summer of each year, were considered to represent the stock abundance the same year including part of the recruitment. In addition an environmental index, the satellite based estimate of yearly average chlorophyll-a concentration over the continental shelf off the southern sicilian coast, was used in the attempt of improving the performance of the model fitting, as expected because pelagic stocks are known to be significantly affected by environmental variability.

6.13.4.1.3. Results

Using the Excel spreadsheet, several model control settings have been tested. The first run was carried out without the incorporation of the selected environmental index. With this configuration, the best obtained fit was quite poor ($R^2=0.35$; see Figure 6.13.4.1.3.1). It appears that the evolution of the stock biomass cannot be explained solely by the dynamic of the catches or the average stock growth conditions, i.e. the model with constant parameters is not adequate to account for the high fluctuations in the time series. Current knowledge suggests that observed changes could be linked to strong environmental forcings (Patti et al., 2010). Therefore, a modification of the model was made to include environmental variability (average yearly chlorophyll concentration).

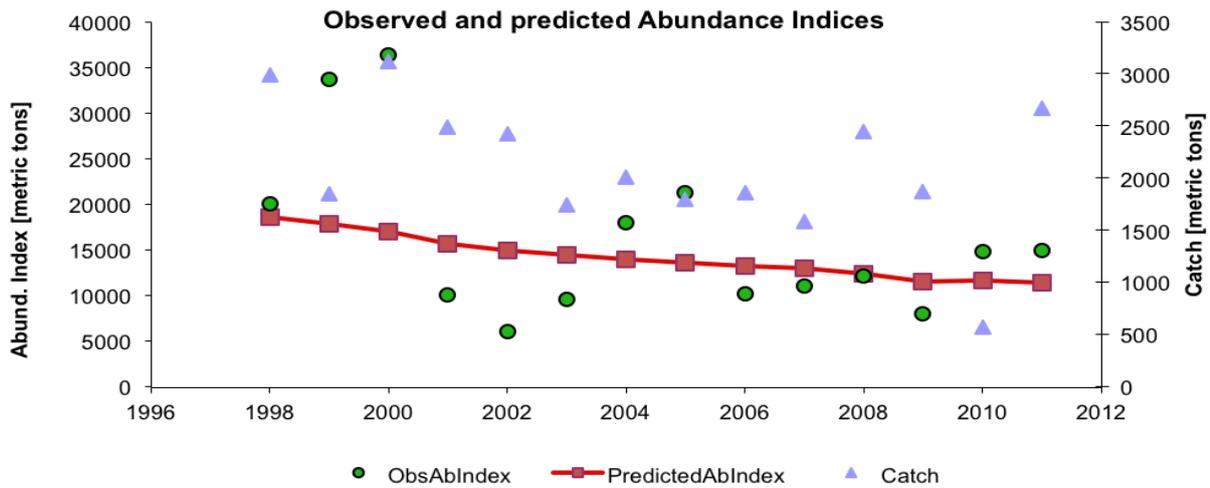


Fig. 6.13.4.1.3.1. Observed (green circles) and predicted sardine biomass in GSA 16, model with constant K and r parameters. Catches (purple triangles) are indicated on the right axis.

Figure 6.13.4.1.3.2 shows the trends in observed and predicted sardine biomass, model incorporating an environmental index. The best fit, obtained including an exponential environmental effect in the carrying capacity (K), explained the 76% of total variance.

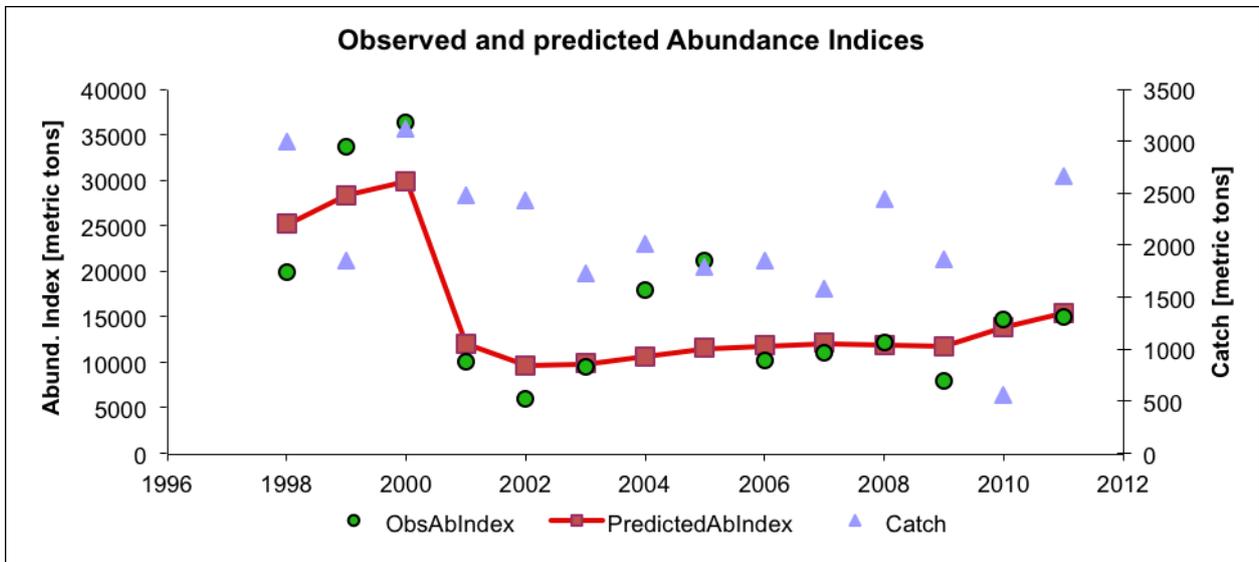


Fig. 6.13.4.1.3.2. Observed (green circles) and predicted sardine biomass in GSA 16, model with variable K and constant r . Catches (purple triangles) are indicated on the right axis.

Trends in B_{CUR}/B_{MSY} indicate that starting from 2002 stock biomass was below half of the biomass producing the maximum sustainable yield (Figure 6.13.4.1.3.3).

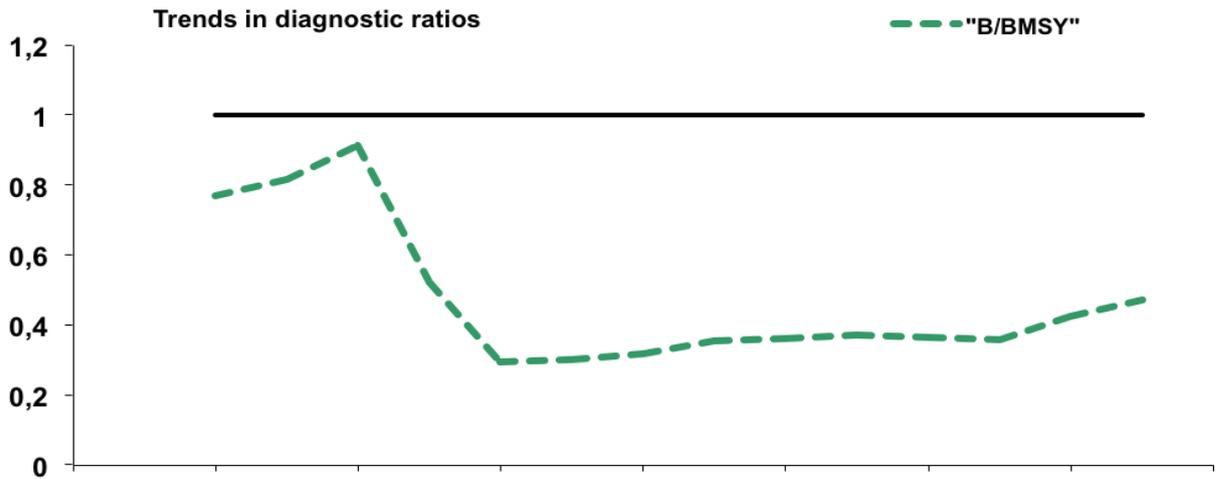


Fig. 6.13.4.1.3.3. Sardine stock in GSA 16. Trends in B_i/B_{MSY} over the period 1998-2011.

Current fishing mortality is far below the sustainable fishing mortality at current biomass levels (Figure 6.13.4.1.3.4), but fishing mortality experienced very high fluctuations during the considered period (Figure. 6.13.4.1.3.5, 6). Finally, current sustainable production is about the 73% of the MSY (Figure 6.13.4.1.3.4).

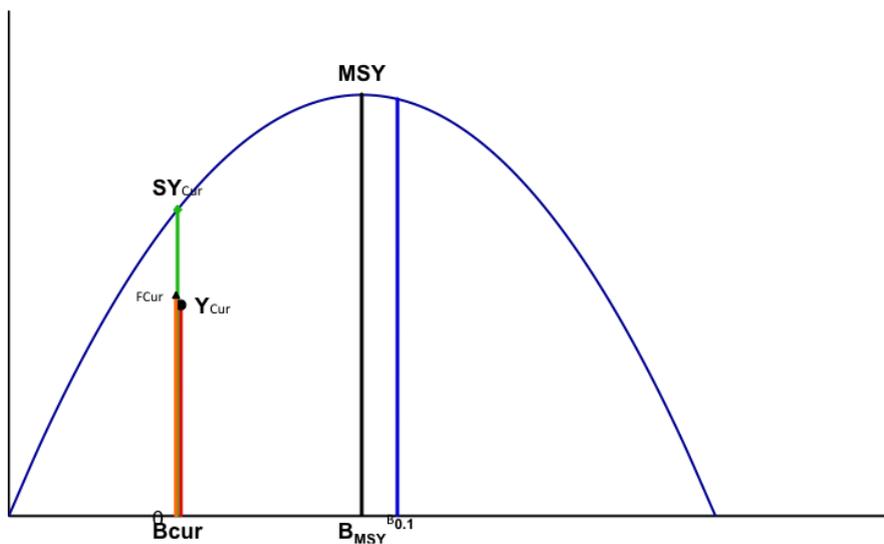


Fig. 6.13.4.1.3.4. Current situation of the sardine stock in GSA 16.

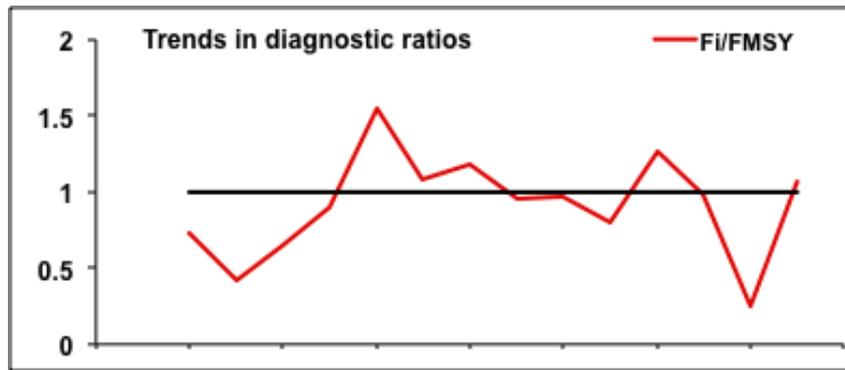


Fig. 6.13.4.1.3.5. Sardine stock in GSA 16. Trends in F_i/F_{MSY} over the period 1998-2011.

Model diagnostics

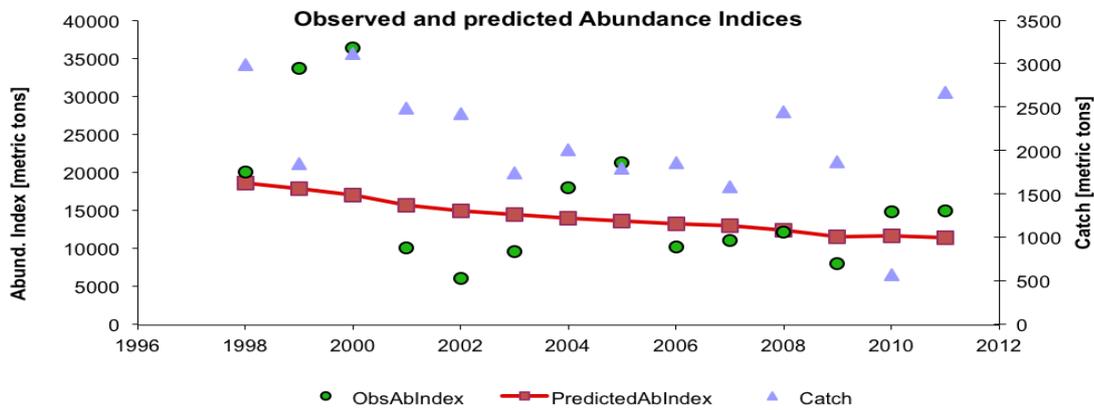


Fig. 6.13.4.1.3.6. Sardine stock in GSA 16. Best fit obtained without incorporating the environmental variability. Data 1998-2011.

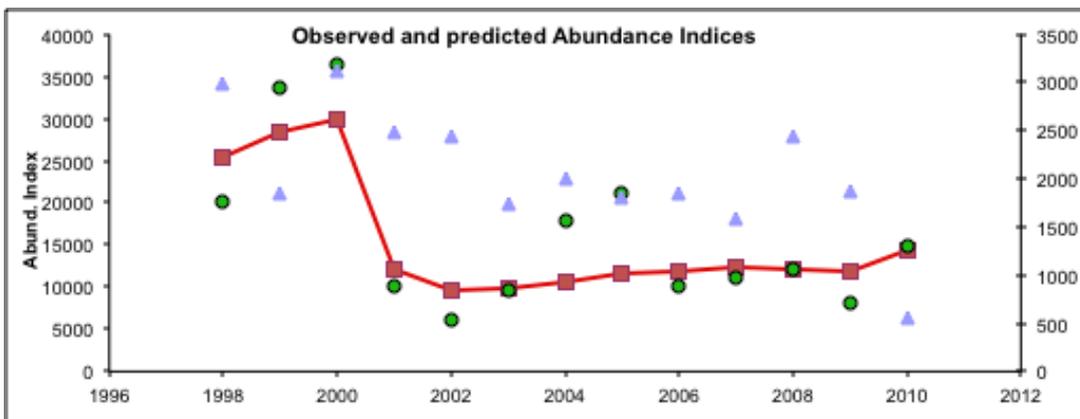


Fig. 6.13.4.1.3.7. Results of the retrospective analysis run, obtained using data from 1998 to 2010. Best fit with a flexible current capacity “K”, modulated by chl-a concentration at sea.

Table 6.13.4.1.3.1. Sardine stock in GSA 16. Reference points and stock status for the retrospective analysis run and for the best fit obtained including updated data (2011).

Year	MSY	B _{MSY}	F _{MSY}	B _{Cur} /B _{MSY}	F _{Cur} /F _{MSY}	F _{Cur} /F _{Cur}
2010	5430	32476	0.17	48%	14%	22%
2011	5307	32527	0.16	48%	69%	106%

Results of retrospective analysis, based on the comparison between the model run using data from 1998 to 2010 (see Figure 6.13.4.1.3.6) with model run using updated data (1998-2011; Figure 6.13.4.1.3.2) show that reference points and stock status did not change significantly with the only exception of current (2011) F, which largely increased compared to 2010 level (Table 6.13.4.1.3.1).

6.13.5. Long term prediction

Not applicable. No long term forecast analyses were conducted.

6.13.6. Scientific advice

6.13.6.1. Short term considerations

6.13.6.1.1.State of the stock size

Biomass estimates of the total population obtained by hydro-acoustic surveys for sardine in GSA 16 show that the recent stock level has been below the average value over the period 1998-2011.

EWG 12-19 notes that no age-structured production model was used at this stage. An attempt to use an analytical approach (XSA) failed for possible problems in the input data. However, a logistic (Shaefer) non-equilibrium general production modeling approach was adopted for the evaluation of stock status (see section 6.13.4).

6.13.6.1.2.State of recruitment

No recruitment data were used for this assessment.

6.13.6.1.3.State of exploitation

The first approach used herewith for the evaluation of stock status is based on the analysis of the harvest rates experienced in the available time series over the last years and on the related estimate of the current exploitation rate. EWG 12-19 recommends the application of the proposed exploitation rate $E \leq 0.4$ as management target for stocks of anchovy and sardine in the Mediterranean Sea, though this value might be revised in the future when more information becomes available.

Annual harvest rates, as estimated by the ratio between total landings and stock sizes, indicated relatively low fishing mortality during the last decade. Actually, as long as this estimate of harvest rate can be considered as a proxy of F obtained from the fitting of standard stock assessment models (assuming survey biomass estimate as a proxy of mean stock size), this index can also be used to assess the corresponding exploitation rate $E=F/Z$, provided that an estimate of natural mortality is given. Sardine biomass estimates

are based on acoustic surveys carried out during the summer and, as in general they would include the effect of the annual recruitment of the population, they are possibly higher than the average annual stock sizes. This in turn could determine in an underestimation of the harvest rates and of the corresponding exploitation rates.

The current (year 2011) harvest rate is 11.9% (DCF data were used for landings). The estimated average value over the years 2008-2011 is 13.7%.

The exploitation rate corresponding to $F=0.137$ is $E=0.15$, if $M=0.77$, estimated with Pauly (1980) empirical equation, is assumed, and $E=0.16$ if $M=0.72$, estimated with Beverton & Holt's Invariants method (Jensen, 1996), is used instead.

In relation to the above considerations on the possible overestimation of mean stock size in harvest rate calculation, it is worth noting that, even if the harvest rates were twice the estimated values, the exploitation rates would continue to be lower than the reference point (0.4) suggested by Patterson (1992). Thus, using the exploitation rate as a target reference point, the stock of sardine in GSA 16 would be considered as being sustainably exploited.

The results of the second assessment approach, which is based on the implementation of a non-equilibrium logistic surplus production model, are consistent with the previous considerations. The fluctuations in stock biomass cannot be explained solely by the observed fishing pattern. This was an expected result, as pelagic stocks are known to be significantly affected by environmental variability. The incorporation of an environmental index in the model significantly improved the fitting of the model, allowing the stock to grow more or less than average depending on the state of the environment in each year.

In the current formulation satellite-based data on chlorophyll concentration showed to have a positive effect on the yearly carrying capacity.

The current (year 2011) fishing mortality is below the sustainable fishing mortality at current biomass levels ($F_{Cur}/FSY_{Cur}=0.69$) but slightly above F_{MSY} ($F_{MSY}=0.16$; $F_{Cur}/F_{MSY}=1.05$) (Table 6.13.6.1.3.1), and fishing mortality experienced high values during the considered period, sometimes above sustainability ($F_{Cur}/F_{MSY}>1$; Figure 6.13.4.1.3.5). In addition abundance was low over the last decade ($B/B_{MSY} < 50\%$; $B_{MSY} = 32527$; $B_{Cur}/B_{MSY} = 0.48$; Figure 6.13.4.1.3.3). However, the average production of the last three years (1400 tons) is well below the estimated MSY (5307 tons).

Table 6.13.6.1.3.1. Sardine stock in GSA 16. Reference points. Current estimates refer to year 2011.

MSY	B_{MSY}	F_{MSY}	B_{Cur}/B_{MSY}	F_{Cur}/FSY_{Cur}	F_{Cur}/F_{MSY}
5307	32527	0.16	48%	69%	105%

Actually, given the high sensitivity of this species to changes in environmental conditions, and the instability of the environment on the continental shelf of GSA16 (the habitat for the stock), characterized by coastal wind-induced upwelling and high short term mesoscale variability, it is expected that the sardine stock may experience periods of very different production potential.

6.13.6.2. Management recommendations

Results of the adopted modelling approach suggest that the environmental factors can be very important in explaining the variability in yearly biomass levels (mostly due to recruitment success) and indicate that the stock status was well below the B_{MSY} during the considered period. The stock only partially recovered from the high decrease in biomass occurred in 2006 (-52% from July 2005 to June 2006), and landings show a general decreasing trend over the last decade. However, current fishing mortality is moderate, around sustainable levels.

Given that the stock appears to be below the B_{MSY} level and considering the fishing mortality pattern observed during the last years, fishing effort and OT /catches should not be increased beyond the current levels and catches consistent with E_{MSY} should be determined. However, as the small pelagic fishery is generally multispecies, any management of fishing effort targeting the sardine stock would also have effects on anchovy. Local small pelagic fishery appears to be able to adapt at resource availability and market constraints, targeting the fishing effort mainly on anchovy. But due to the generally low biomass levels experienced by the anchovy stock over the last years (see related assessment in the present report), measures should be taken to prevent a possible further shift of effort back from anchovy to sardine.

6.14. Stock assessment of Hake in GSA 17

6.14.1. Stock identification and biological features

6.14.1.1. Stock Identification

The distribution of hake (*Merluccius merluccius*) in GSA 17 during spring-summer is shown in Figure 6.14.1.1.1 (Sabatella and Piccinetti 2004). The picture on the left provides details on the depth, increasing with darker colour (0-50, 50-100, 100-200, 200-800, > 800 m). The picture on the right displays the hake densities at sea from MEDITS trawl survey in the second half of the 1990s, expressed as number of

individuals per square kilometer (Figure 6.14.1.1.1). In the GSA 17, higher densities are observed in the southern part and at depths between 100 and 200 m.

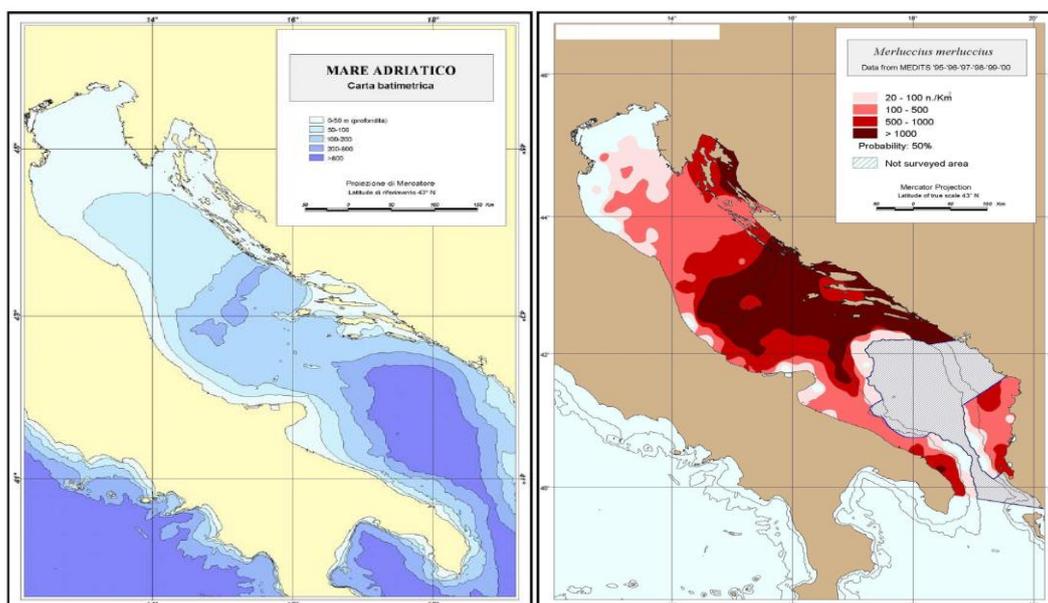


Fig. 6.14.1.1.1. Map of Adriatic sea (left) and spatial distribution of *M. merluccius* in Adriatic Sea (right).

In the subsequent three maps from Sabatella and Piccinetti (2004), densities at sea are plotted taking into account different length ranges (increasing in the maps from left to right). In particular, individuals with length lower than 12 cm are concentrated in the southern part of the GSA 17. The individuals with length between 12 and 20 cm display the same pattern but are more diffuse; the same pattern is observed also for the individuals with length larger than 20 cm, but they are more abundant on the eastern side of the Adriatic.

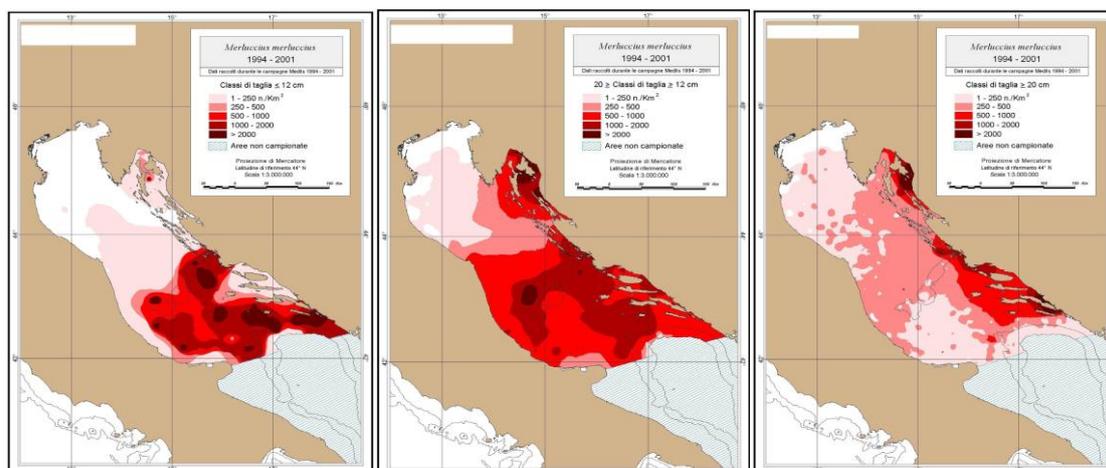


Fig. 6.14.1.1.2. Spatial distribution of *M. merluccius* in GSA 17

Spawning of hake occurs throughout the year with two peaks in winter and summer. Earliest spawning occurs in winter in deeper waters, up to 200 m, in the Pomo/Jabuka Pit (where the greatest depths in GSA 17 are observed; Figure 6.14.1.1.2). In the summer period, spawning occurs in shallower waters. Nursery areas are located close to the Pomo/Jabuka Pit (Vrgoc *et al.*, 2004).

6.14.1.2. Growth

According to Jardas (1996), European hake can grow to 130 cm of total length. However, its usual length in trawl catches is from 10 to 60 cm. This is a long-lived species, it can live more than 20 years. In the Adriatic, however, the exploited stock is mainly composed in number of 0+, 1+ and 2+ year-old individuals. On the basis of the vertebral counts of European hake from the northern and central Adriatic, Piccinetti and Piccinetti Manfrin (1971b) found that all specimens analysed belonged to the same population. Similarly, the Adriatic population has the same number of vertebrae as the European hake from the rest of the Mediterranean (Maurin, 1965).

Total Length (TL, cm) and age (year) data:

Author	Sex	Age (yr)							
		1	2	3	4	5	6	7	8
Ghirardelli, 1959b	M+F	18.8	23.0	28.8	38.0	-	-	-	-
Županović, 1968	M+F	9	19	28	35	40	44	49	57
Flamigni, 1983	M+F (May)	14.3	21.3	29.0	35.0	-	-	-	-
	M+F (Nov.)	19.0	26.2	33.3	39.0	-	-	-	-

Parameters of the Von Bertalanffy Growth Function (VBGF):

Author	Sex	L_{∞} (cm)	K (yr ⁻¹)	t_0 (yr)	Φ'
Flamigni, 1983	M+F	85	0.12	-	6.77
Alegria Hernandez and Jukić, 1990	M+F	92.83	0.097	-0.629	6.73
Bolje, 1992	M+F	75	0.12	-	6.52

Vrgoč, 1995 (“Hvar”)	M+F	83.27	0.125	-0.73	6.76
Ungaro <i>et al.</i> , 1993	M+F	75.68	0.153	0.14	6.78
	F	82.63	0.126	-0.312	6.76
Marano, 1996	M	57	0.17	-0.83	6.31
	F	67.5	0.159	-0.436	6.59
	M+F	67.5	0.144	-0.807	6.49
	M+F (Bhatt)	81	0.25	-	7.40
Marano <i>et al.</i> , 1998b Marano <i>et al.</i> , 1998c	M	72	0.15	0.005	6.66
	F	84	0.13	0.102	6.82
	M+F	84	0.12	-0.14	6.74
	M+F(Bhatt)	62.2	0.23	-	6.79
	M+F (Surf.)	68	0.25	-	7.05
Vrgoč, 2000	M+F	77.95	0.130	-	6.67
EC XIV/298/96-EN, Ionian and Southern Adriatic	M+F	68.19	0.157	-	6.59
EC XIV/298/96-EN, Adriatic Sea	M+F	85.0	0.12	-	6.77
Fast growth	M+F	104.0	0.2	-0.01	6.73

Females attain larger size than males, which grow more slowly after maturation at the age of three or four years. Consequently, the proportion of males in the population is higher in the lower length classes and proportion of females is higher for greater lengths. In the central and northern Adriatic, females already start dominating the population at lengths of about 30 to 33 cm. In trawl catches over 38 to 40 cm, almost all the specimens are females (Vrgoč, 2000).

6.14.1.3. Maturity

In the Adriatic, European hake spawn throughout the year, but with different intensities. The spawning peaks are in the summer and winter periods (Karlovac, 1965; Županović, 1968; Županović and Jardas, 1986, Županović and Jardas, 1989; Jukić and Piccinetti, 1981; Ungaro *et al.*, 1993). Hake is a partial spawner. Females spawn usually four or five times without ovarian rests. In females in the pre-spawning stage, fish 70 cm long can contain more than 400,000 oocytes (Sarano, 1986). The earliest spawning in the Pomo/Jabuka Pit occurs in winter in deeper water, (up to 200 m). As the season progresses into the spring-summer period, spawning occurs in more shallow water. The recruitment of young individuals into the breeding stock has two different maxima. The first one is in the spring and the second one in the autumn.

In the Pomo/Jabuka Pit, both of these maxima can be linked to hake's more intense summer and winter spawning period in the central Adriatic (Županović and Jardas, 1989). Recruitment does not seem to be

related to the parental stock size (Alegria Hernandez and Jukić, 1992). Nursery areas are located close to the Pomo/Jabuka Pit, between 150 and 200 m, on the upper part of the slope, and off the Gargano Cape (Županović, 1968; Jukić and Arneri, 1984; Županović and Jardas, 1986, Županović and Jardas, 1989; Frattini and Paolini, 1995; Frattini and Casali, 1998). Karlovac (1965) recorded young hake larvae from October to June, the highest numbers were recorded in January and February. Larvae and postlarvae were mainly distributed between 40 and 200 m; the highest number of individuals was caught mainly between 50 and 100 m.

Different data about the size at first sexual maturity of European hake in the Adriatic Sea, given by different authors, are shown in Table 6.14.1.3.1.

In the following analyses maturity at age for the sex combined from data available from GSA 18 were used.

Table 6.14.1.3.1. Total Length (L_m , cm) at the first sexual maturity:

Author	Sex	(L_m , cm)
Zei, 1949	M	22.30
Županović, 1968	M	20.28
	F	26-33
Županović and Jardas, 1986	M	20-28
	F	23-33
Ungaro <i>et al.</i> , 1993	M+F	25-30
Cetinić <i>et al.</i> , 1999	M+F (Velebit Channel)	24

6.14.2. Fisheries

6.14.2.1. General description of fisheries

The fisheries for hake are one of the most important in the GSA 17. Fishing grounds mostly correspond to the distribution of the stock (SEC (2002) 1374). In GSA 17 hake is a target species for the otter trawlers and Croatian long liners, but it is also caught in smaller quantity in the gill-net fisheries.

6.14.2.2. Management regulations applicable in 2010 and 2012

Italy and Slovenia:

Fishing closure for trawling: 30-60 days in summer.

Minimum landing sizes: EC regulation 1967/2006: 20 cm TL for hake.

Cod end mesh size of trawl nets: 40 mm (stretched, diamond meshes) till 30/05/2010. From 1/6/2010 the existing nets will be replaced with a cod end with 40 mm (stretched) square meshes or a cod end with 50 mm (stretched) diamond meshes.

Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.

Croatia:

Bottom trawl fishery in the Croatian territorial waters is mainly regulated by spatial and temporal fisheries regulation measures. Bottom trawl fisheries is closed one NM from the coast and island in inner sea, 2 NM around island on the open sea, and 3 NM about several island in the central Adriatic. Bottom trawl fishery is closed also in the majority of channel area and bays. About 1/3 of the territorial waters is closed for bottom trawl fisheries over whole year and additionally 10% is closed from 100-300 days per years. Minimum mesh size on the bottom trawl net is 20 mm (“knot to knot”) in the open sea, and 24 mm (“knot to knot”) in the inner sea. Minimum landing size for hake is 16 cm, and it will be increase to 20 cm from 1st July 2013.

6.14.2.3. Catches

6.14.2.3.1. Landings

On the basis of data collected for Italy through DCR from 2006 to 2011 (Table 6.14.2.3.1.1), landings are due mainly to bottom otter trawlers.

Table 6.14.2.3.1.1 Hake landings (tonnes) in GSA 17 by fishing technique, 2004-2008.

	Bottom trawls	Rapido trawls	Total
2006	3,979.6	236.8	4,216.5
2007	3,434.8		3,434.8
2008	3,036.6		3,036.6
2009	2,548.8		2,548.8
2010	1,862.9		1,862.9
2011	1,459.6	12.1	1,471.7

Moreover, according to the FAO statistics (www.fao.org/fishery/statistics/software/fishstatj/en), in the Adriatic Sea, the annual landings of hake (Figure 6.14.2.3.1.1) in the 1980s and 1990s were estimated at around 2,000-4,000 t, with some peaks over 5,000 tons. A decreasing trend occurred from 1993 to 2000, followed by a positive trend.

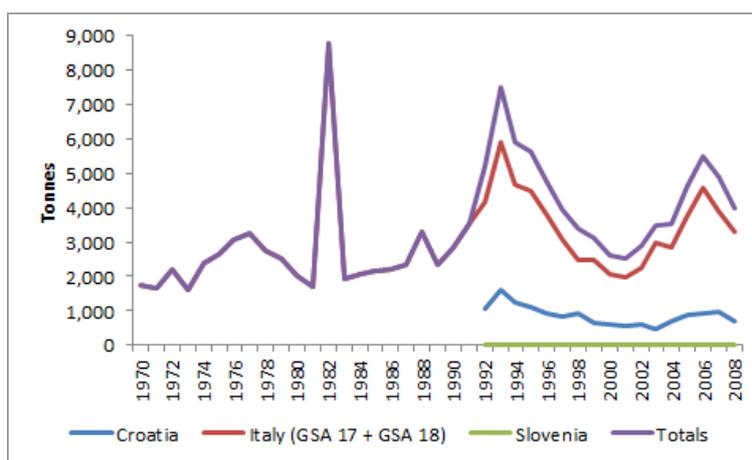


Fig. 6.14.2.3.1.1. FAO landing statistics 1970-2008.

Slovenian landings accounted on average only for 2 tons by year (DCR 2012 official data call), while Croatia showed higher catches (landings and discards) comprised between 700 and 900 tons (Croatian DemMon Project). Also in Croatia otter trawl represents the main gear in hake fishery, followed by long line and gill-nets activity.

Monitoring of demersal resources in Croatian territorial waters has been established through DemMon project starting from 2002/2003. Data has been collected on the board on fishing vessel and on the landing ports. Sampling methodology is similar to the DCF requirements. Starting from 2012/2013, data collection is adjusted to the DCF.

6.14.2.3.2. Discards

No information were documented during EWG 12-19 from Italian Data Collection Program except for 2006 and 2011. Also from Croatia no data from discard were available during EWG 12-19. Anyway discard data from Croatia were incorporated in the total catches.

6.14.2.4. Fishing effort

The Table 6.14.2.4.1 reveals an overall decreasing trend in effort of the major bottom otter trawl fleet.

Table 6.14.2.4.1. Annual effort (Nominal effort, GT*days, number of vessels) by gears in GSA 17 for Italy, 2004-2011.

Nominal effort (Italy)	2004	2005	2006	2007	2008	2009	2010	2011
DRB	6712171	5863557	6269118	6609979	5981163	4214396	4324692	5407947
FPO	1644292	987229	2255269	1882097	2000272	2031589	1842466	1601931
FYK	666287	806057	1262564	1465517	781602	989507	1232734	922333
GND		786						
GNS	3670219	5034324	4482659	2540061	2451730	3280887	3396375	4643321
GTR	1839843	1310715	1185365	1501656	893280	1079591	1261497	1508921
LLD	79060	132090	75655	179410	69897	68436	43012	
LLS			1123	1253				

OTB	24508972	24435356	20511450	19142133	20038778	18889991	18094570	16572093
OTM	480	18187	23022					
PS	417566	742574	1213073	1381548	752258	974144	454151	465035
PTM	4549858	4343407	4353095	3928692	5049383	5330574	5508572	3849990
TBB	4122458	4005521	5266768	6625945	4136346	4386154	3817491	2584717
Totals	56223249	53231476	50918218	47948715	44810446	44188556	42786674	40692273
GT x Days at sea (Italy)	2004	2005	2006	2007	2008	2009	2010	2011
DRB	758087	701117	769774	883332	797512	499579	511652	687273
FPO	59509	34111	88755	79239	65377	72872	63930	55708
FYK	24496	19862	48001	66152	41935	52442	63691	50721
GND		72						
GNS	181890	265903	225314	157327	135113	173403	190223	236375
GTR	131666	82814	81518	104491	56788	65074	66358	79984
LLD	5435	13087	7571	16925	5112	7147	3716	
LLS			42	62				
OTB	4267746	5220317	4185237	4018022	4082465	3830475	3837446	3482614
OTM	48	2302	3315					
PS	42524	73797	153615	233970	138210	210745	118095	131037
PTM	1106126	955710	1195560	1045902	1301638	1300357	1433482	1049204
TBB	988719	817931	1121657	1369571	843741	1045203	921158	665155
Totals	7944571	8399035	8030087	8073601	7548740	7351165	7308930	6543181
Number of vessels (Italy)	2004	2005	2006	2007	2008	2009	2010	2011
DRB	1679	1698	1829	1697	1757	1633	1699	1702
FPO	951	624	834	1214	1205	1438	1245	1058
FYK	655	576	724	972	599	828	914	787
GND		24						
GNS	2310	3470	3031	2565	2371	2909	2661	3025
GTR	764	753	717	824	610	757	740	808
LLD	146	140	28	138	49	22	10	
LLS			20	42				
OTB	3702	3571	2864	2533	2448	2215	1425	1550
OTM	2	76	85					
PS	165	177	162	265	119	126	85	57
PTM	233	276	296	242	317	351	418	303
TBB	365	302	386	468	321	348	314	237
Totals	16847	16859	15684	15984	14997	15179	14316	14501

6.14.3. Scientific surveys

6.14.3.1. MEDITS

6.14.3.1.1. Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 17 the following number of hauls was reported per depth stratum (Table 6.14.3.1.1.1).

Table 6.14.3.1.1.1. Number of hauls per year and depth stratum in GSA 17, 2002-2011.

	10-50 m	50 - 100 m	100-200 m	200-500 m	total
2002	54	59	53	11	177
2003	55	60	50	13	178
2004	56	69	41	12	178
2005	57	68	45	10	180
2006	58	67	43	11	179
2007	61	72	45	10	188
2008	60	66	44	10	180
2009	59	67	44	10	180
2010	58	64	49	9	180
2011	59	65	48	9	181

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Only valid Hauls were used, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Y_{st} = \sum (Y_i * A_i) / A$$

$$V(Y_{st}) = \sum (A_i^2 * s_i^2 / n_i) / A^2$$

Where:

A=total survey area

A_i=area of the i-th stratum

s_i=standard deviation of the i-th stratum

n_i=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Y_i=mean of the i-th stratum

Y_{st}=stratified mean abundance

V(Y_{st})=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Y_{st} ± t(student distribution) * V(Y_{st}) / n.

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution and/or quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien *et al.*, 2004).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance $\cdot 100$ (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.14.3.1.2. Geographical distribution patterns

See section 6.14.1.1.

6.14.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the hake in GSA 17 was derived from the international survey MEDITS. Figure 6.14.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 17.

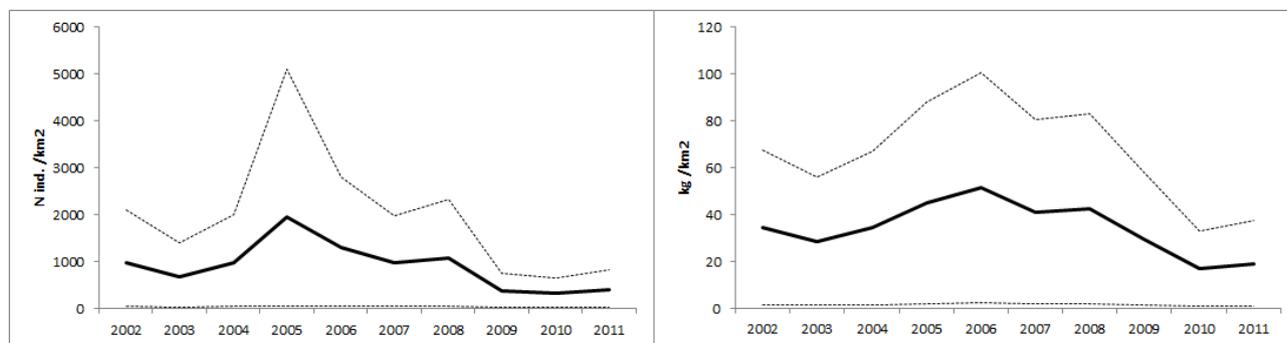
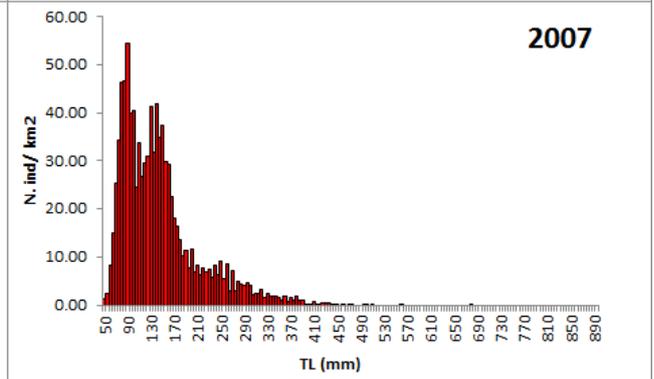
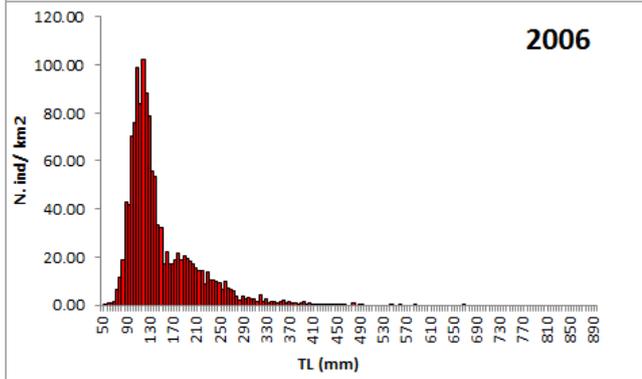
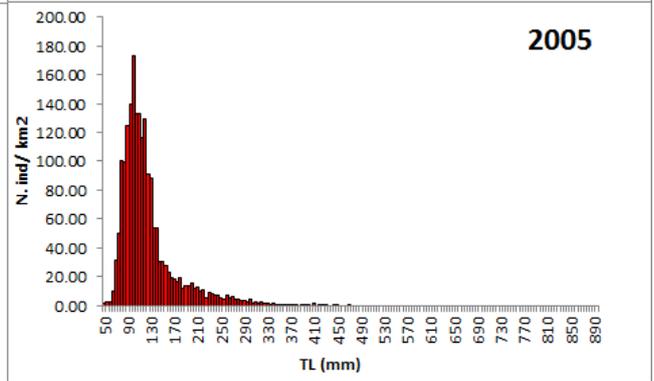
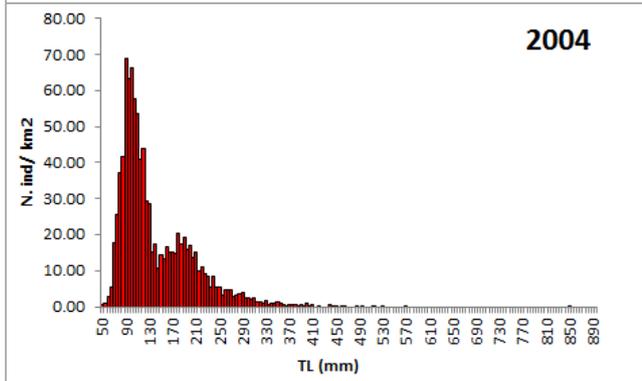
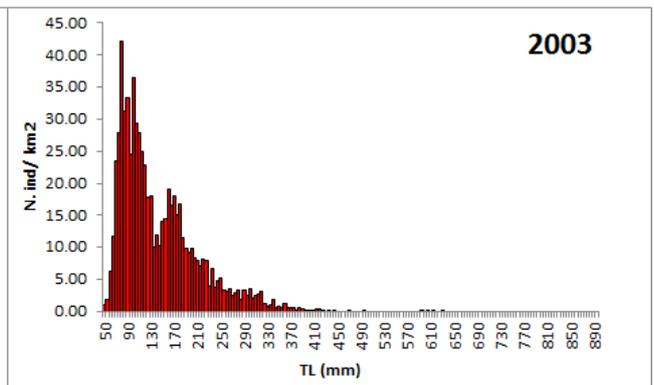
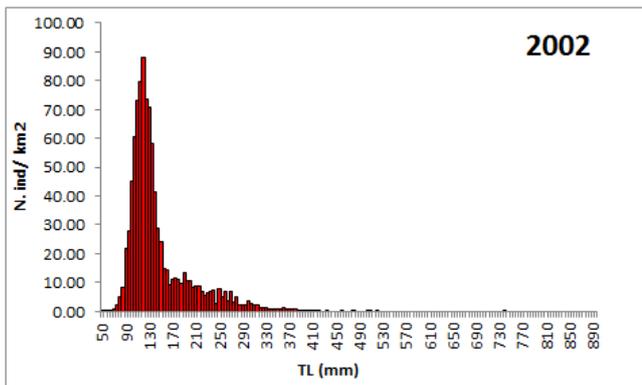


Fig. 6.14.3.1.3.1. Abundance and biomass indices of hake in GSA 17.

6.14.3.1.4. Trends in abundance by length or age

The following Figure 6.14.3.1.4.1 displays the stratified abundance indices of GSA 17 in 2002-2011.



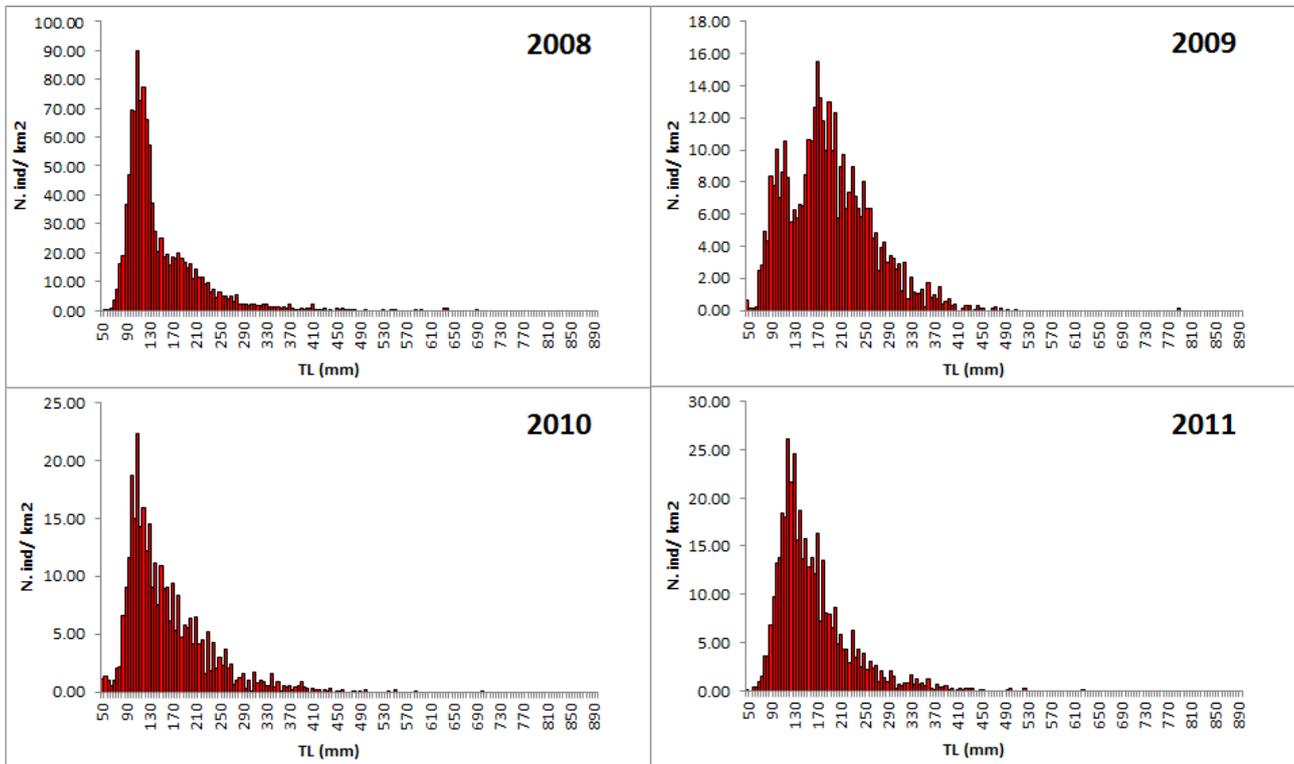


Fig. 6.14..3.1.4.1 Stratified abundance indices by size, 2002-2011.

6.14.3.1.5. Trends in growth

No analyses were conducted during EWG-12-19.

6.14.3.1.6. Trends in maturity

No analyses were conducted during EWG-12-19.

6.14.4. Assessment of historic stock parameters

Assessment based on fishery dependent data was carried out in SGMED-10-02, but results were rejected during SGMED-10-03, due discrepancies observed in catch at length data. A preliminary assessment using Length Cohort Analysis (LCA) can be found in the report of SGMED-08-04 working group.

6.14.4.1. Method 1: XSA

6.14.4.1.1. Justification

Considering the variability observed in the recruitment, the assessment is based on non-equilibrium method. FLR libraries were employed in order to carry out an XSA based assessment (Darby and Flatman 1994).

6.14.4.1.2. Input data and parameters

Catch at length data of the period 2007-2011 of GSA17 from Italy, Slovenia and Croatia has been employed in the analysis. Italian data of 2006 were not utilised due to the absence of catch statistics from the Croatian fleet for this year. Slovenian catches were assumed to present the same size frequency distribution of the Croatian catches and were included in the Croatian data set. Italian catch at age data were not employed due to the absence of discard data for the whole period. For the same reason also the catches of TBB were not included in the following analyses.

A comparison of Italian OTB catch at length data, observed in the framework of the 2012 official data collection, with the Croatian OTB data, observed in the framework of DemMon project, revealed completely different fishing patterns mainly due to the absence of discard data in the Italian official dataset (Figure 6.14.4.1.2.1).

The EWG 12-19 decided to reconstruct the Italian catch at length OTB data on the base of:

Italian OTB catches of the official 2012 data call for the period 2007-2011;

size frequencies distribution of Croatian data collected from otter trawlers operating in open sea area.

Also the long-line data from the Croatian observed in 2008 fleet were utilised in the analyses, assuming that the size composition was the same for all the period considered (2006-2011; Figure 6.14.4.1.2.1).

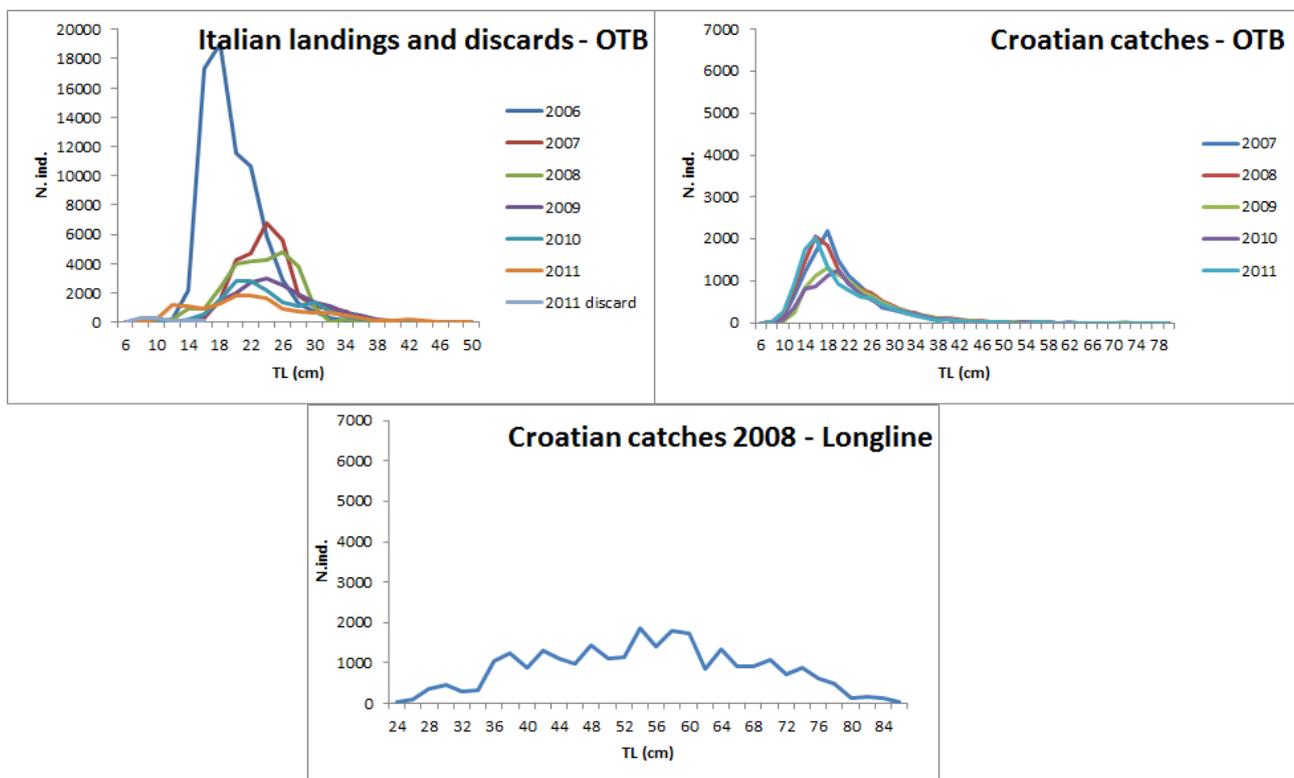


Fig. 6.14.4.1.2.1. Italian and Croatia catch at length data.

Length frequency distributions of Italian reconstructed OTB catches (Figure 6.14.4.1.2.2), Croatian OTB (Figure 6.14.4.1.2.3) and LLN (Figure 6.14.4.1.2.4) catches were divided in age classes by statistical slicing (assuming normal distribution of the cohorts) developed by Scott et al. (2012) during EWG 11-12 (Figures 6.14.4.1.2.5-7). LDF were divided up to the age class 5+. Analysis was performed by sex combined using the VBGF parameters assuming fast growth, as the EWG 12-19 suggested.

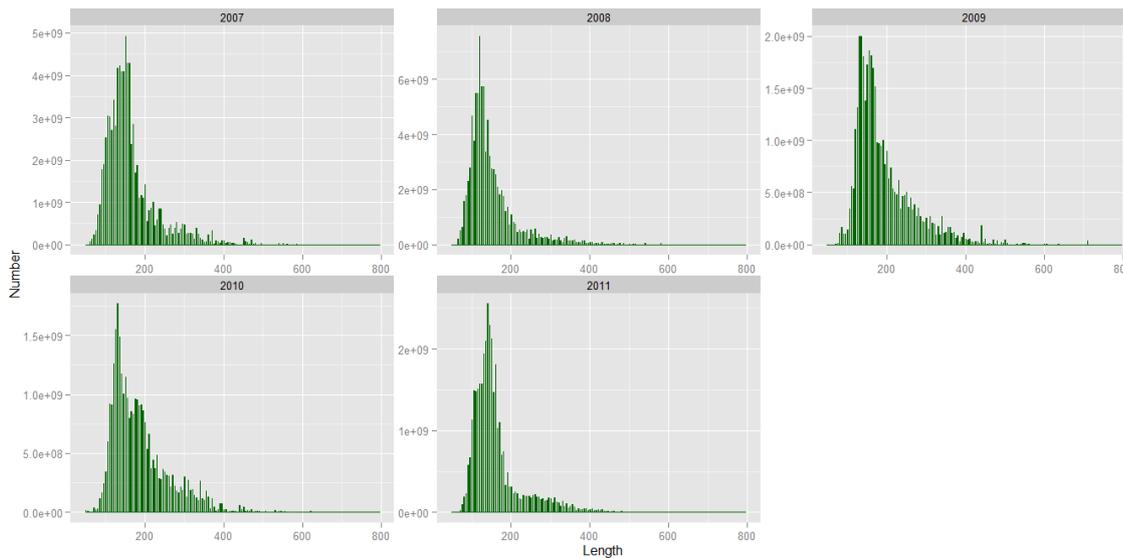


Fig. 6.14.4.1.2.2. Commercial length frequency distributions of *M. merluccius* of OTB Italian reconstructed catches (2007-2011).

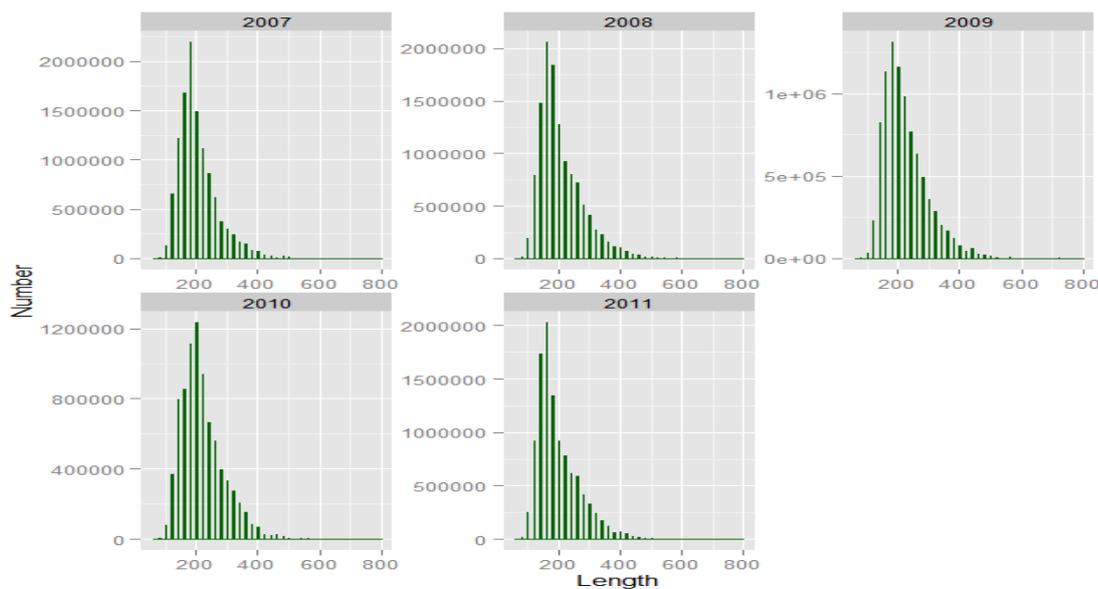


Fig. 6.14.4.1.2.3. Commercial length frequency distributions of *M. merluccius* of OTB Croatian catches (2007-2011).

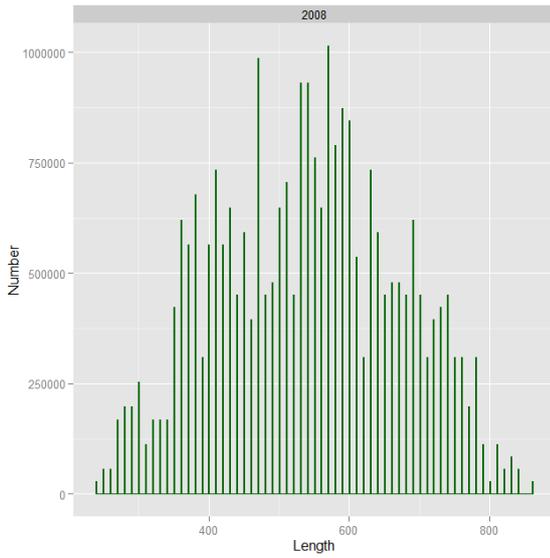


Fig. 6.14.4.1.2.4. Commercial length frequency distribution of *M. merluccius* of LLN Croatian catches (2008).

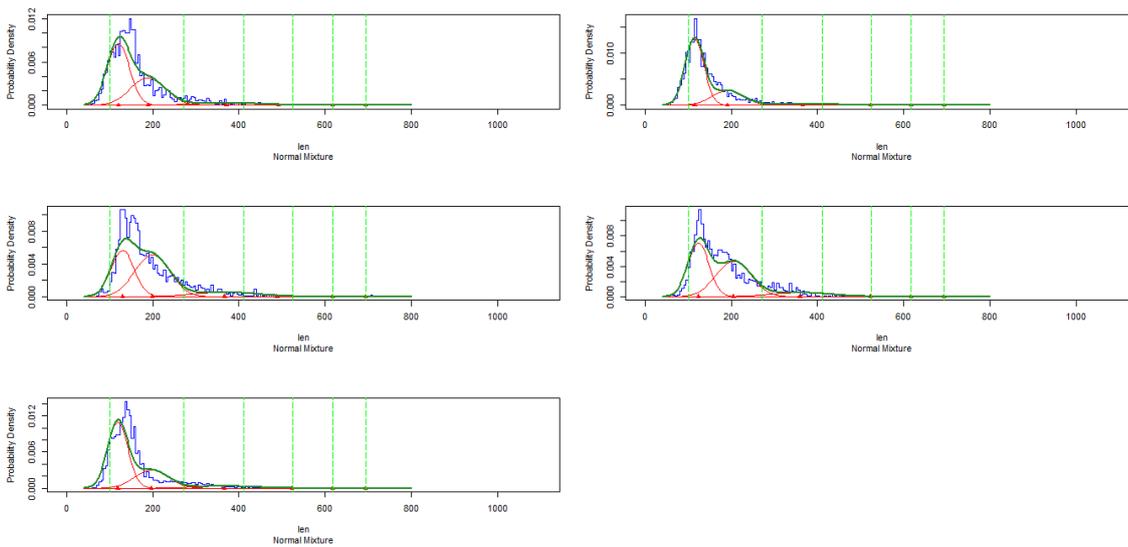


Fig. 6.14.4.1.2.5. Statistical age slicing of the commercial length frequency distribution of *M. merluccius* of OTB Italian reconstructed catches (2007-2011).

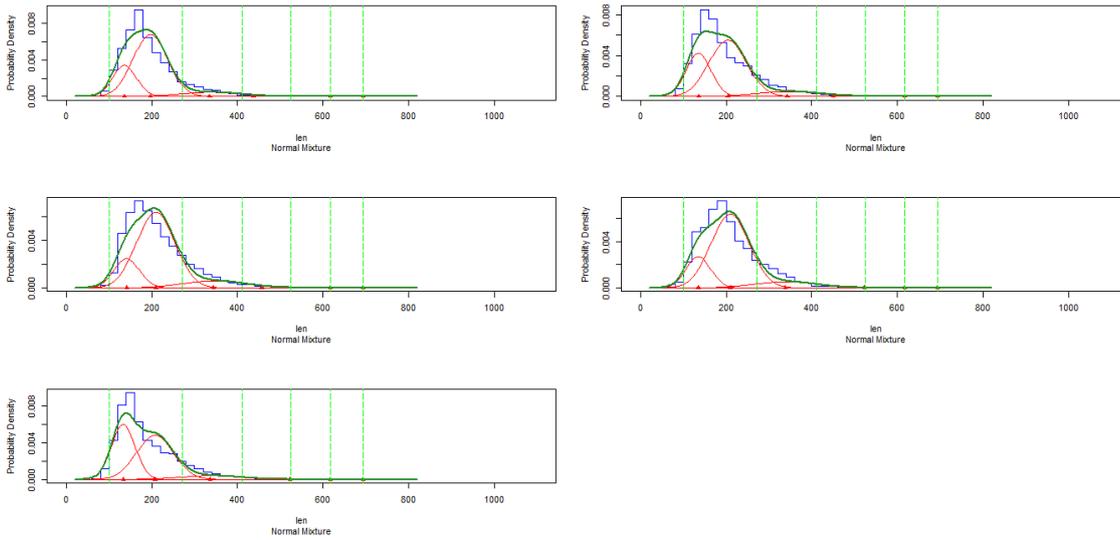


Fig. 6.14.4.1.2.6. Statistical age slicing of the commercial length frequency distribution of *M. merluccius* of OTB Croatian catches (2007-2011).

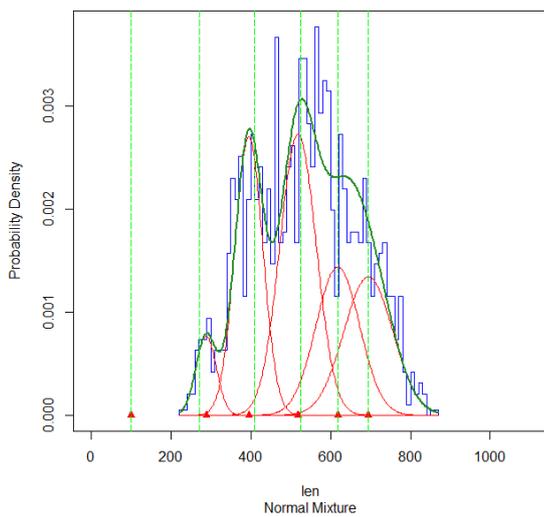


Fig. 6.14.4.1.2.7. Statistical age slicing of the commercial length frequency distribution of *M. merluccius* of LLN Croatian catches (2008).

The same procedure has been employed to transform in age the size frequency distributions of MEDITS survey (Figures 6.14.3.1.3.1 and 6.14.4.1.2.8).

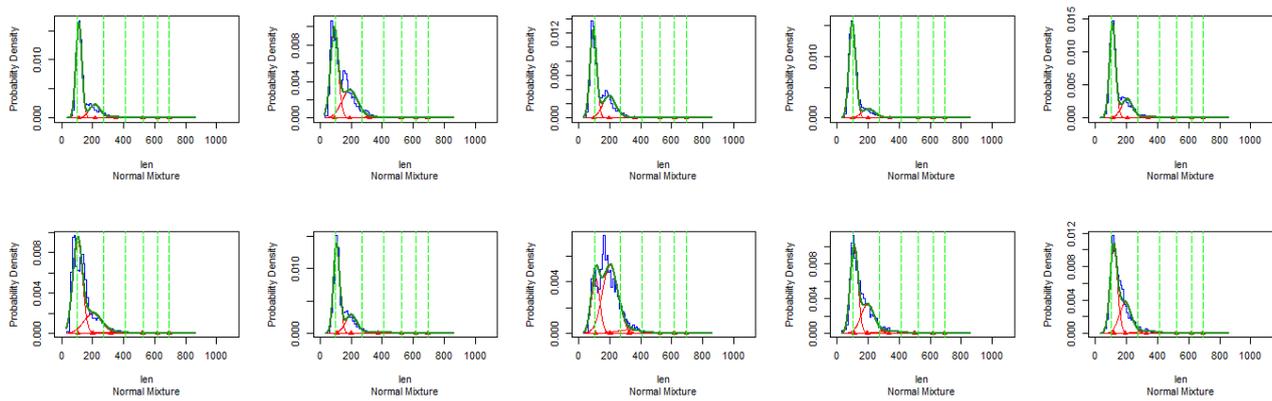


Fig. 6.14.4.1.2.8. Statistical age slicing of the survey length frequency distributions of *M. merluccius* of MEDITS survey (2002-2011).

Table 6.14.4.1.2.1. Input data parameters of the XSA.

Catch at age in numbers (x 1000)						
	0	1	2	3	4	5+
2007	59871.4	32012.6	1462.1	95.6	5.9	5.8
2008	74102.7	25309	3856.3	106.1	9.4	6.5
2009	19005	25860.2	1687.1	135.4	12	6.2
2010	18056.1	18520.6	2553.6	52.4	8.4	5.9
2011	35158.6	10198.3	848.3	40.4	8	6.9
Survey indexes (N. ind. km ⁻²)						
	0	1	2	3	4	5
2007	719	245	8.48	0.069	0.0025	0.0025
2008	784	265	23.99	0.883	0.8409	0.8409
2009	135	236	7.28	0.037	0.0001	0.0001
2010	208	109	7.76	0.193	0.0041	0.0031
2011	268	130	8.61	0.12	0.0054	0.0001
Mean stock weight (kg)						
	0	1	2	3	4	5+
PERIOD 2007-2011	0.05	0.3	0.78	1.47	2.28	3.13
Mean catch at age weight (kg)						
	0	1	2	3	4	5+
2007	0.045	0.068	0.111	0.181	0.213	0.399
2008	0.035	0.058	0.113	0.189	0.241	0.399
2009	0.069	0.089	0.138	0.232	0.331	0.399
2010	0.059	0.082	0.142	0.233	0.308	0.399

2011	0.052	0.075	0.142	0.237	0.304	0.399
Growth parameters						
Fast growth	L_{∞}	k	t_0			
PERIOD 2007-2011	104 cm	0.2 y^{-1}	-0.01 y			
Length-weight relationships						
		a	b			
PERIOD 2007-2011		0.004	3.17			
Maturity at Age						
GSA 18 data	0	1	2	3	4	5+
PERIOD 2007-2011	0	0.5	0.79	0.89	1	1
Natural mortality (M)						
Probiom (Abella et al., 1999)	0	1	2	3	4	5+
PERIOD 2007-2011	1.16	0.58	0.46	0.41	0.39	0.35

Sensitivity analyses were conducted to assess the effect of the main settings of the XSA.

The main settings have been chosen on the base of the best results in terms of residuals and XSA diagnostic.

The main XSA settings used are the following:

F_{bar} : 0-4.

Tuning ages: 0-2

Catchability analysis :

- Catchability independent of size for ages > 0
- Catchability independent of age for ages > 2
- Terminal population estimation: Survivor estimates shrunk towards the mean F of the final 4 years or the 2 oldest ages.
- S.E. of the mean to which the estimates are shrunk: 1
- Minimum standard error for population estimates derived from each fleet = 0.3

6.14.4.1.3.Results

XSA Diagnostics in the form of residuals by survey data and retrospective analyses are shown in the Figure 6.14.4.1.3.1.

Proportion at age by year Medits survey

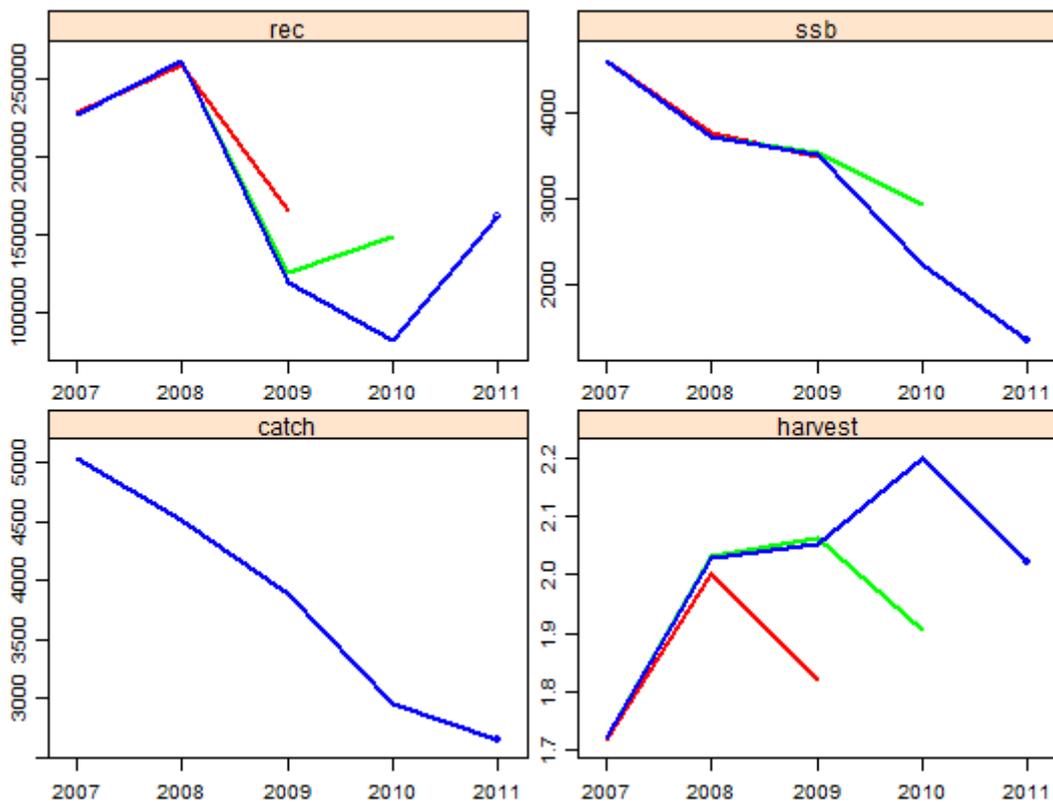
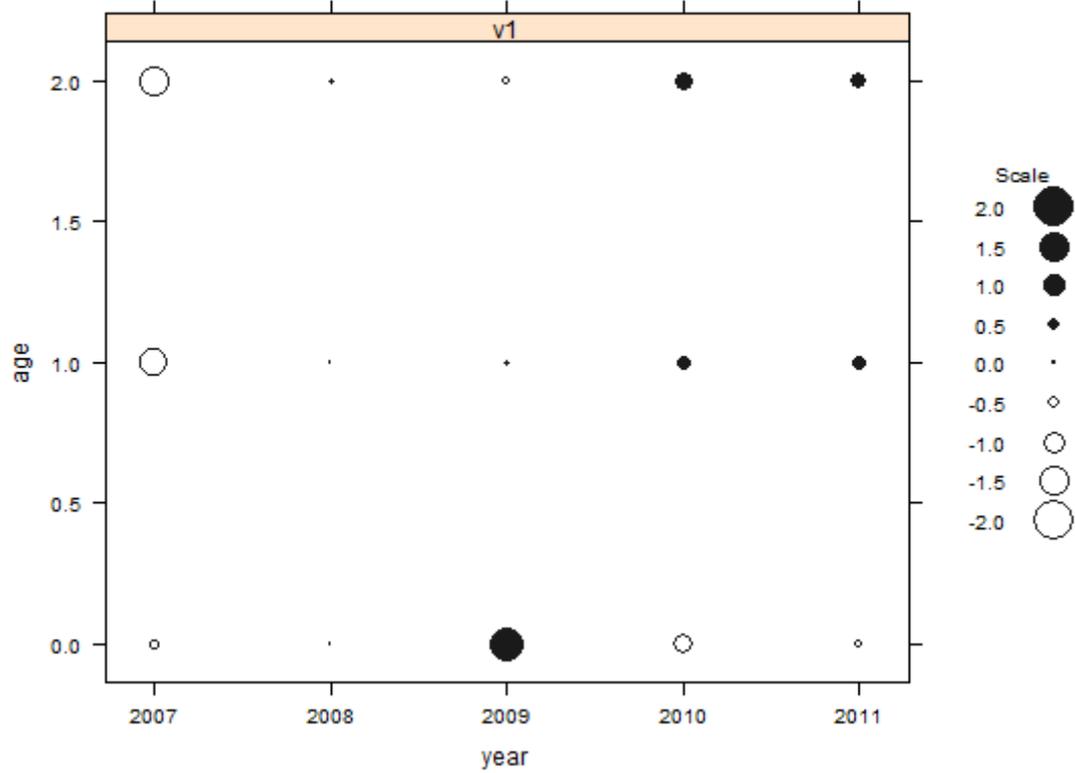


Fig. 6.14.4.1.3.1. Residuals by survey (graph above) and retrospective analysis (graphs below).

Residuals by survey do not show any particular trend or conflict as well as the retrospective analysis, although there is a tendency of the model to underestimate F.

The Figure 6.14.4.1.3.2 present the main results from the XSA: fishing mortality, relative F at age, total biomass, spawning stock biomass (SSB), recruitment.

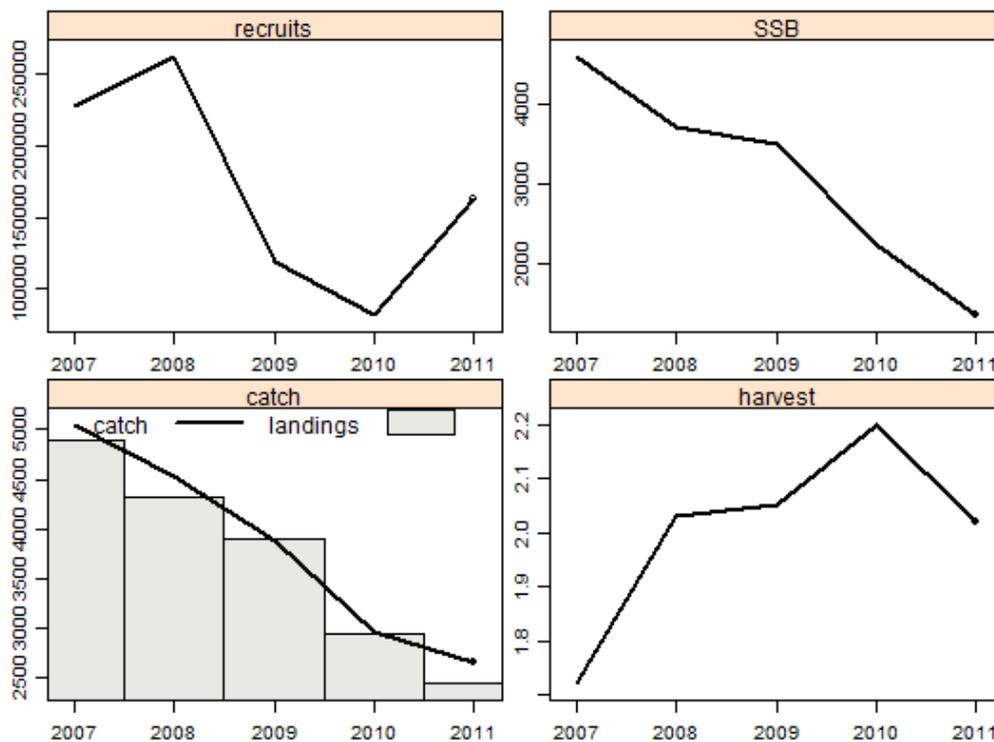


Fig. 6.14.4.1.3.2. Final assessment results of XSA.

State of exploitation: Exploitation increased from 2007 to 2010, and decreased in 2011. The most recent estimate of fishing mortality ($F_{0.4}$) is 2.02, the highest values of relative F are for ages 1 to 3.

State of the juveniles (recruits): Recruitment varied without any trend in the years 2007-2011, reaching a minimum in 2010.

State of the total biomass and adult biomass: The total biomass decreased from 2007 to 2011, when reached the minimum value of the period.

6.14.4.2. Method 2: SURBA

6.14.4.2.1. Justification

The MEDITS survey provided the longer standardized time-series data on abundance and population structure of *M. merluccius* in the GSA 17.

6.14.4.2.2. Input data and parameters

The survey-based stock assessment model SURBA (Needle, 2003) was used to reconstruct trend in the population size and fishing mortality. The data and parameters used are the same as for the XSA and are summarized in Table 6.14.4.2.2.1. LFD were splitted in age classes by statistical slicing (Scott et al., 2011). A sensitivity analysis has been carried out in order to select the more appropriate age ranges, age weightings and age catchabilities.

Table 6.14.4.2.2.1. Input data and parameters of SURBA model.

Age range: 0-3 (no plus group)				
Start and end period of survey: 0.50 - 0.75				
Index (N x km ⁻²)				
	Age 0	1	2	3
2002	753.8008	182.1400	15.7450	0.0738
2003	443.9056	230.6942	3.0708	0.0750
2004	642.8239	293.4106	8.8094	0.2064
2005	1659.1282	55.6447	8.4033	0.0012
2006	955.7428	318.3774	22.2287	0.5394
2007	719.6313	245.8237	8.4811	0.0690
2008	784.6771	265.3059	23.9932	0.8830
2009	135.8062	36.0236	7.2816	0.0376
2010	208.9736	109.1003	7.7660	0.1939
2011	268.8038	130.3119	8.6165	0.1206
Default age weightings				
0.9111				
Default catchabilities				
0.9110.75				
Natural mortality-at-age				

1.160.580.460.41
Proportion mature-at-age
00.30.510.79
Stock weights-at-age
0.050.300.781.47

6.14.4.2.3.Results

Fishing mortality estimated over age classes 0 to 3 showed a decreasing trend from 2002 to 2011. In the last two years (2009-2011) fishing mortality is consistent with the values estimated by XSA method. SSB in the last years is stable but at the lowest observed level in the time series, as also observed in the XSA outputs. The recruitment showed important oscillations with a general decreasing trend (Figure 6.14.4.2.3.1).

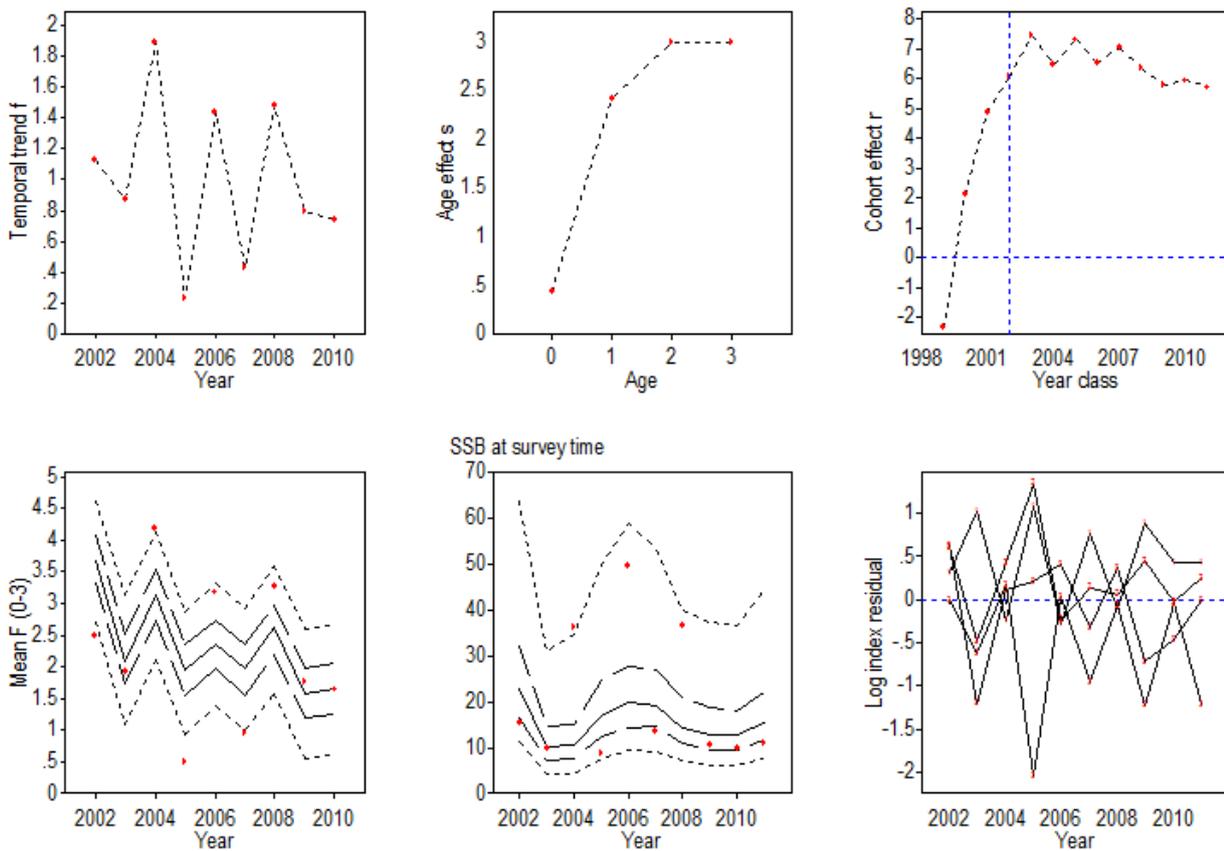


Fig. 6.14.4.2.3.1. SURBA outputs

Model diagnostics

The SURBA model for *M. merluccius* fits quite well on MEDITS survey data as showed in Figure 6.14.4.2.3.2. Also the retrospective analysis suggests a moderately good fit of the model (Figure 6.14.4.2.3.3).

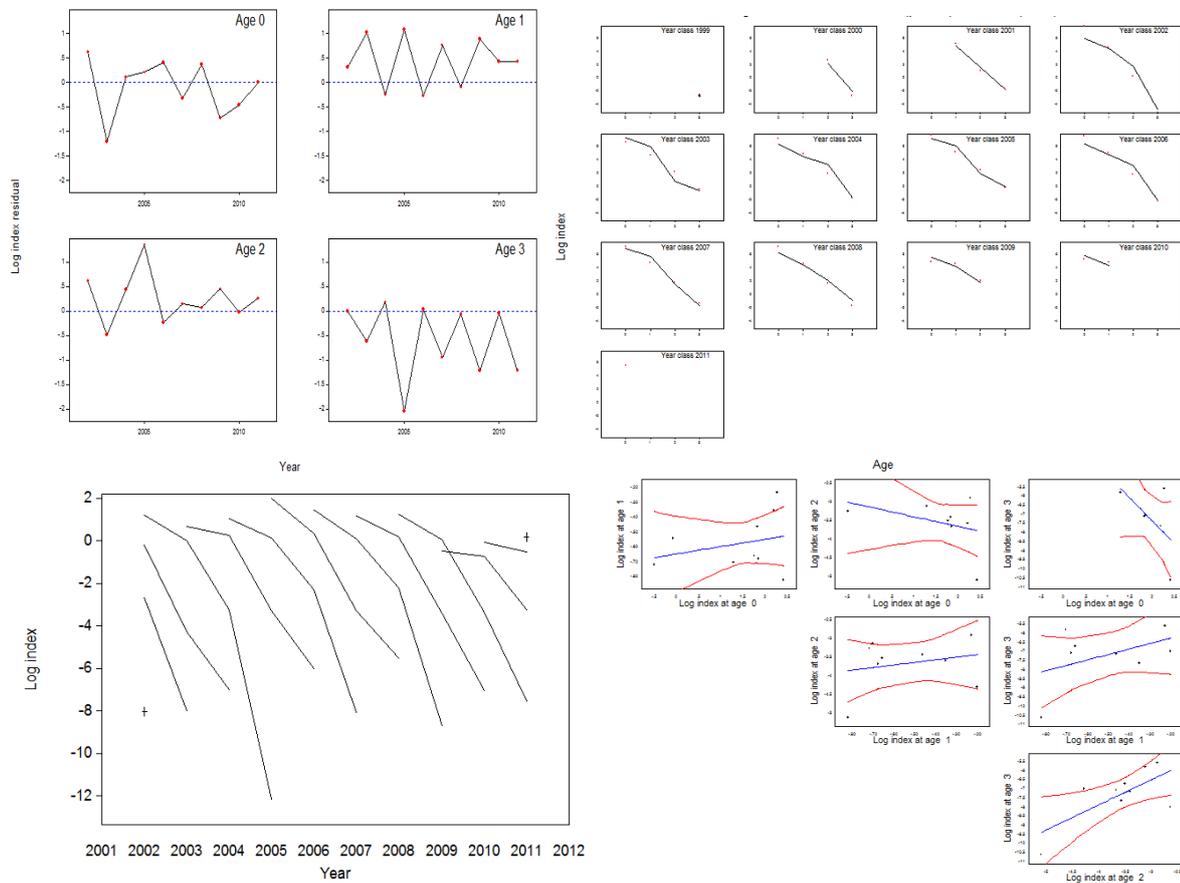


Fig. 6.14.4.2.3.2. SURBA diagnostics.

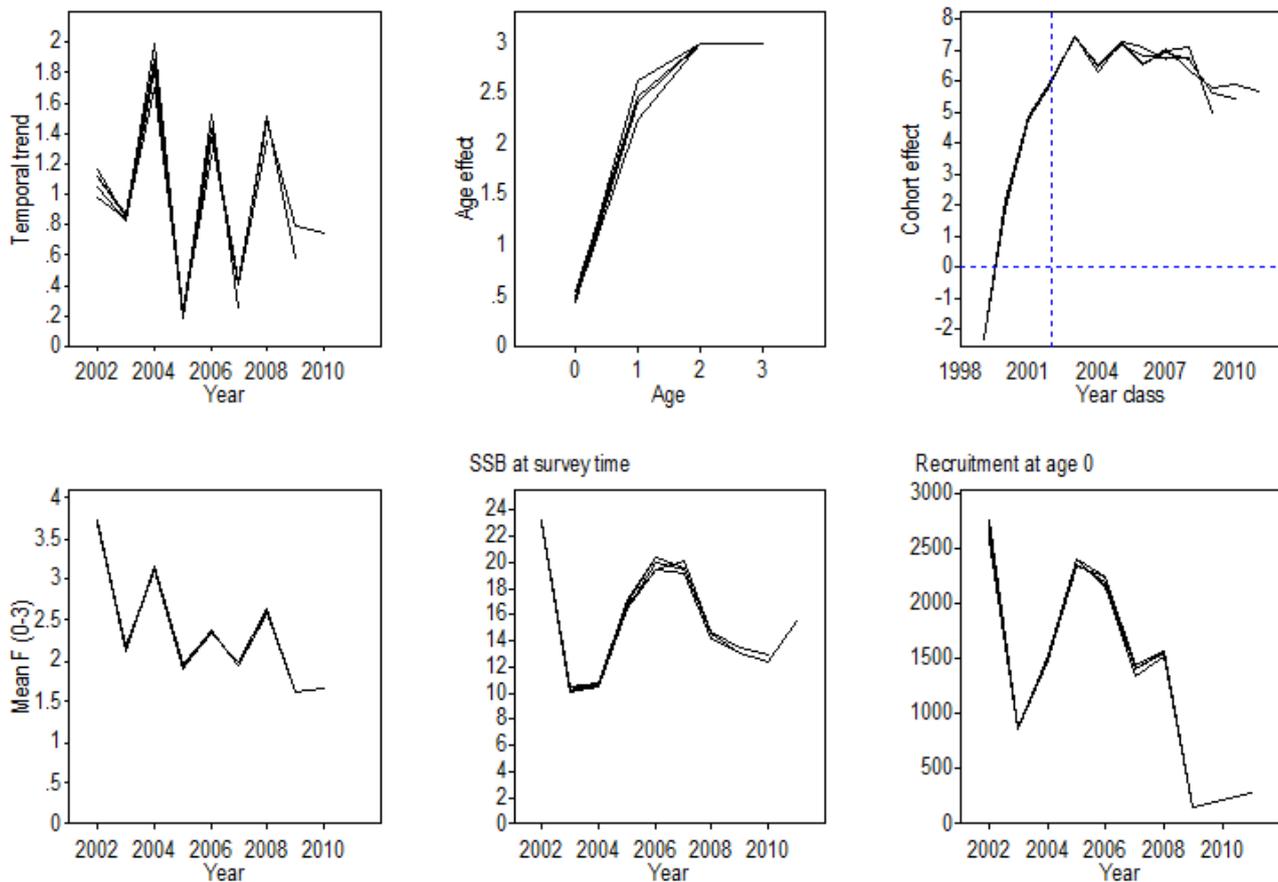


Fig. 6.14.4.2.3.3. SURBA retrospective analysis.

6.14.4.3. Method 3: Steady state VPA (VIT Model)

6.14.4.4.1. Justification

EWG 12-19 performed a steady state VPA on hake in GSA 17 using catch at age data of 2011. The software used to carry out the analyses was VIT (Leonart & Salat, 1992).

Data used in the analysis cover Italian and Croatian otter trawling (including discard) and Croatian longline.

6.14.4.4.2. Input data and parameters

The same catch at age data utilized in the previous XSA analysis has been employed also for the present analysis and are summarized in Table 6.14.4.4.2.1.

Table 6.14.4.4.2.1. Numbers at age (in thousands) of the total catches for 2011

Age	Italy OTB	Croatia OTB	Croatia LLN
0	28771.91	6386.74	0.01
1	6084.41	4112.48	1.38
2	602.64	239.54	6.13

3	25.61	5.67	9.10
4	3.55	0.01	4.48
5+	0.03	1.06	5.85

The set of parameters used were the same as reported in the previous analyses. The terminal F (0.35) has been assumed to be of the same of the M of the plus group.

6.14.4.4.3.Results

VIT results of catch and biomass at age, the initial number by age in the stock and the total fishing mortality are showed in Figure 6.14.4.4.3.1.

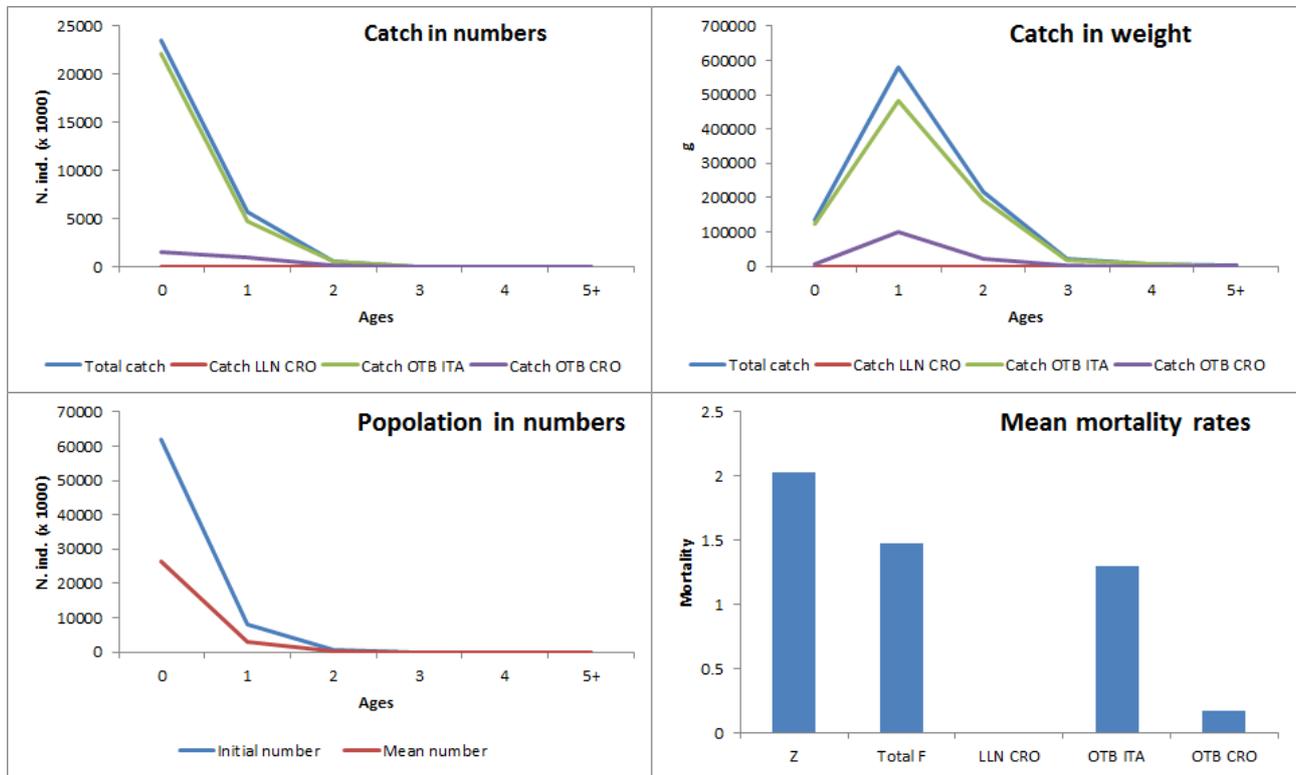


Fig. 6.14.4.4.3.1.VPA outputs: catch in number, biomass, initial and mean number and fishing mortality at age of *M. merluccius* in the GSA 17.

The total catch in number is almost composed by fish of the 0 and 1 age classes, while 1 and 2 age classes dominates in terms of biomass. Fishing mortality is mainly due to the Italian otter trawlers.

6.14.5. Long term prediction

6.14.5.1. Justification

Yield per recruit analyses (YPR) were conducted based on the exploitation pattern resulting from XSA and VIT model, using the same population parameters.

The YPR analyses allowed the estimate of $F_{0.1}$, which is considered as a proxy of F_{MSY} .

6.14.5.1.1. Input parameters

The input parameters were the same utilized in the XSA and in the VIT model.

6.14.5.1.2. Results

Figure 6.14.5.1.2.1 shows the results of the YPR analyses. Table 6.14.5.1.2.1 shows the reference fishing mortality, along with the reference points $F_{0.1}$ and the F_{max} both from XSA and VIT model.

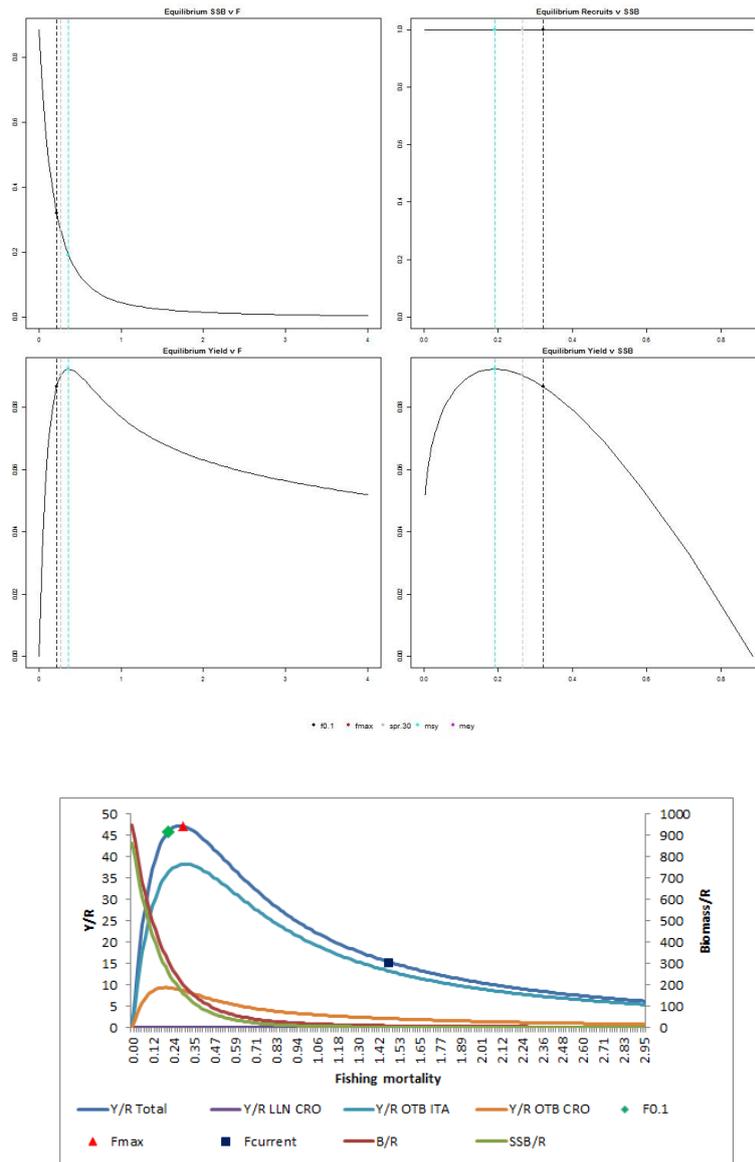


Fig. 6.14.5.1.2.1. Results summarising the yield per recruit analysis performed on 2011 data (XSA graph above - Vit model graph below)

Table 6.14.5.1.2.1. Reference points estimated with the YPR analyses.

	XSA		VIT Model	
	F _{ref}	Y/R	F _{ref}	Y/R
F _{0.1}	0.21	45.86	0.20	46.14
F _{max}	0.29	47.24	0.36	48.25
F _{current}	1.49	15.44	2.1	12.58

6.14.6. Data quality and data consistency of 2012 Italian data call

Total landings of hake are provided in GSA17 from the Italian National Data Collection for the period 2006-2011 only for OTB, while TBB data are available only in 2006 and 2011. The size structure of the landings have shown different distributions, 2006 showing a positively skewed distribution of the landings with the mode at 18 cm and a long tail to the right, while in the period 2007-2011 bell shaped distributions can be observed, with the main peaks comprised between at 20 and 26 cm. In the former case the percentage of specimens smaller than MLS was equal to 54%, instead in the latter ones smaller portions of undersized specimens were around 15%. It is quite difficult to understand if the reasons of such discrepancies are related to changes of the fishing grounds exploited by the fleet or in changes in the sampling design.

No data on discard quantity and size or age distribution were provided for hake in GSA17, although scientific papers reported the presence of discard for the species in the GSA 17 (e.g. Sánchez *et al.* 2007; Lucchetti, 2008).

6.14.7. Scientific advice

6.14.7.1. Short term consideration

6.14.7.1.1.State of the spawning stock size

The spawning stock biomass estimated by XSA and SURBA models shows a clear decrease trend in both analyses. Without any biomass reference proposed or agreed, EWG 12-19 is unable to fully evaluate the state of the stock size.

6.14.7.1.2.State of recruitment

The recruitment estimated by XSA and SURBA models shows a fluctuating pattern with a general decreasing trend. EWG 12-19 is unable to provide any scientific advice of the state of the recruitment given the preliminary state of the data and analyses and without any recruitment reference proposed or agreed.

6.14.7.1.3.State of exploitation

In the three methods used, the values of the most recent F_{bar} range from 1.48 to 2.02 and the values of $F_{0.1}$ is 0.2, thus the stock of hake in GSA17 can be considered exploited unsustainably.

6.15. Stock assessment of red mullet in GSA 17

6.15.1. Stock identification and biological features

6.15.1.1. Stock identification

Red mullet (*Mullus barbatus*) is uniformly distributed in the whole Adriatic and the isolation of the Adriatic population was assessed by molecular and Bayesian analysis (Maggio *et al.*, 2009). This study proved a limited gene flow attributable to really low adult migration and a reduced passive drift of pelagic larvae from and to the Adriatic Sea.

A previous study from Garoia *et al.* (2004) developed a set of dinucleotide microsatellite markers and revealed a significant overall heterogeneity within the red mullet Adriatic stock: this result indicate that this species may constitute local subpopulations that remain partly isolated from each other. However, the randomness of genetic differences among samples indicated that red mullet in the Adriatic likely belongs to a single population. Besides, no correlation between geographic distance and genetic differentiation has been detected.

The observed genetic fragmentation could be explained by a passive dispersion of larvae due to marine currents, from random changes in allele frequencies or from fishing pressure.

Although the red mullet is distributed in the entire Adriatic, the density of the population is not the same in space. For example, Arneri and Jukić (1986) found that the biomass index between Italian and Croatian waters is about 1:4.

The present stock assessment takes in consideration the population within the boundaries of the GSA 17 (Figure 6.15.1.1.1, darker area), including both Italian and Croatian data.

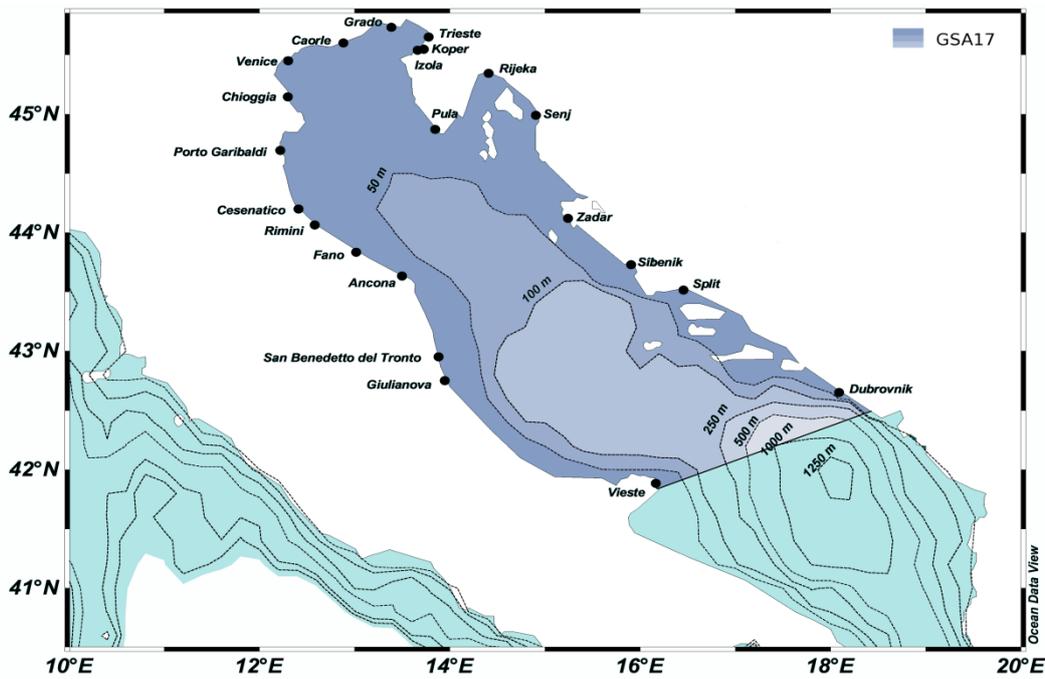


Fig. 6.15.1.1.1. GSA 17 boundaries in the Adriatic Sea.

6.15.1.2. Growth

According to Jardas (1996), red mullet grow up to 30 cm, with females growing faster and bigger than males.

The Von Bertalanffy Growth Function parameters available for this species are presented in Table 6.15.1.2.1.

Table 6.15.1.2.1. Summary of the Von Bertalanffy growth function parameters of *M. barbatus* in the Adriatic Sea (from Vrgoč *et al.*, 2004)

Author	Sex	L_{∞} (cm)	K (yr^{-1})	t_0 (yr)	Φ'
Scaccini (in Levi <i>et al.</i> , 1994)	M+F	27.49	0.5	-0.25	5.93
Jukić and Piccinetti, 1988	M+F	27.0	1.8		7.18
Marano, 1994; Ungaro <i>et al.</i> , 1994	M+F	19.70	0.360	-1.18	4.94
Vrgoč, 1995 ("Hvar")	M+F	27.75	0.274	-0.616	5.35
Marano, 1996; Marano <i>et al.</i> , 1998b, c	M	27	0.184	-1.92	4.90
	F	34.5	0.156	-1.53	5.22
	M+F	31.5	0.182	-1.45	5.19
	M+F (Bhatt)	26.3	0.45		5.74
Ardizzone, 1998	M+F	27.50	0.50		5.93
Marano, 1998b, c	M	22.5	0.24	-1.29	4.80
	F	26.2	0.23	-1.41	5.06
	M+F	22.5	0.38	-0.63	5.26
	M+F (Bhatt)	25.4	0.25		5.08
	M+F (Surf.)	23	0.52		5.62
Vrgoč, 2000	M+F	26.86	0.295		5.36
EC XIV/298/96-EN, Ionian and Southern Adriatic	M+F	21.72	0.31		4.99
EC XIV/298/96-EN, Adriatic Sea	M+F	27.5	0.50		5.94

6.15.1.3. Maturity

Red mullet reproduction in GSA 17 occurs in late spring and summer. Specimens reach sexual maturity during the first year of life, at length between 10 and 14 cm (Županović, 1963; Haidar, 1970; Jukić and Piccinetti, 1981; Marano *et al.*, 1998; Vrgoč, 2000).

6.15.2. Fisheries

6.15.2.1. General description of the fisheries

In the Adriatic, red mullet is mainly fished by bottom trawl nets. Smaller quantities are also caught with trammel-nets and gill nets.

6.15.2.2. Management regulations applicable in 2011 and 2012

Fishing closure for Italian trawlers: 45 days in late summer have been enforced in 2011-2012 for the Italian fleet. Before 2011 the closure period was 30 days in summer.

Minimum landing sizes: EC regulation 1967/2006 defined 11 cm TL as minimum legal landing size for red mullet.

Along Croatian coast bottom trawl fisheries is mainly regulated by spatial and temporal fisheries regulation measures, and about 1/3 of territorial sea is closed for bottom trawl fisheries over whole year. Also bottom trawl fishery is closed half year in the majority of the inner sea. Minimum landing size for red mullet is the same like in the EC regulation.

6.15.2.3. Catches

6.15.2.3.1. Landings

Mannini and Massa (2000) analyzed trends of the red mullet landings in the Adriatic from 1972 to 1997. In that period, the landings showed an overall increase. This positive trend was constant in the Western Adriatic, while in the Eastern Adriatic landings decreased during the second half of the 1990s.

Landings data for the Italian fleet were reported to STECF EWG 12-19 through the Data Collection Framework, while Croatian data comes from official statistics of Fisheries Department and data were collected through logbooks. The Italian catches remained above the 3000 t from 2006 to 2009 and then started to decrease, reaching the minimum in 2010 with less than 2000 t. In 2011 the landings increased again (see Table 6.15.2.3.1.1.). The Croatian catches remain lower than 1000 tons for all the time series except in 2011, in which the increase to a value around 1000 tons.

Table 6.15.2.3.1.1. Annual landings (t) by fishing gear as reported to STECF EWG 11-12 through the DCF data call for Italy, and official statistic data from Croatian Fisheries Department .

Species	Area	Country	Gear	2006	2007	2008	2009	2010	2011
MUT	17	ITA	OTB	3100.570	3298.478	3158.313	2433.403	1796.154	2618.797
MUT	17	ITA	GNS	n/a	n/a	n/a	n/a	n/a	31.225
MUT	17	ITA	TBB	n/a	n/a	n/a	n/a	n/a	43.588

MUT	17	CRO	OTB	805.000	950.000	767.351	818.017	763.562	1087.966
-----	----	-----	-----	---------	---------	---------	---------	---------	----------

Slovenian catches are low: the highest catches between 2006 and 2011 were 2 t reported in 2007.

6.15.2.3.2. Discards

Discard data for the Italian fleet are available for 2010 and 2011. The amount of discard for the Croatian bottom trawl fisheries is negligible due to the fact that the minimum size in the catches is bigger than the minimum landing size allowed (i.e. there are no juveniles in the catches).

Table 6.15.2.3.2.1. Discard data (t) by fishing gear as reported to STECF EWG 12-19 through the DCF data call.

Species	Area	Country	Gear	2010	2011
MUT	17	ITA	OTB	183	795.95
MUT	17	ITA	TBB	n/a	7.39

While in 2010 the discard represented about 9% of the total catches, in 2011 for the only otter trawl the discard amounted to 30% of the total catches. The TL of the discards in 2011 ranged between 4 and 16 cm.

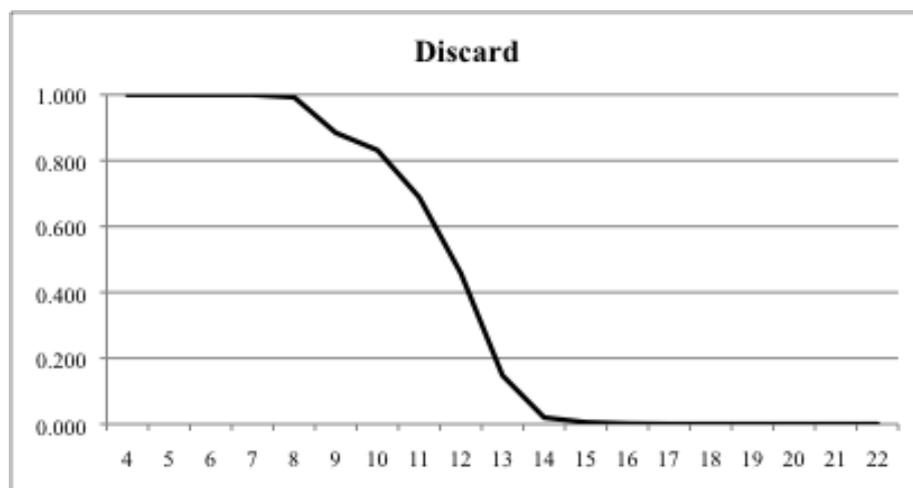


Fig. 6.15.2.3.2.1. Length of the discards of *M. barbatus* for Italian OTB in 2011, expressed as % of the total catch. The length at 50% discard is between 11-12 cm TL.

6.15.2.4. Fishing effort

The trend in fishing effort by year and major gear type for the Italian fleet is listed in Table 6.15.2.4.1. The total fishing effort in kWdays from 2006 to 2011 is decreasing (Figure 6.15.2.4.1.).

Table 6.15.2.4.1. Trend in nominal effort (kW*days) for GSA 17 by gear type, 2006-2011 as reported through the DCF official data call.

Area	Gear	Fishery	2006	2007	2008	2009	2010	2011	Total	
SA 17	DRB	MOL	6269118	6609979	5981163	4214396	4324692	5407947	45383023	
	FPO	DEMSP	2259253	1885243	2012117	2044266	1855252	1611908	14303755	
	FYK	CATSP			7253	11626	8903	2558	37123	
		DEMSP		1263716	1467137	774992	978492	1224764	921329	8096239
	GND	SPF	2090	1727	3538	2731	450	2711	42939	
	GNS	DEMSP		4973097	3101318	3551683	4469092	4965672	5859451	36165441
		SLPF		11055		5044	10672	1581	1061	31142
	GTR	DEMSP		1821930	2922357	2788971	3392336	3475548	4576602	22783912
	LHP	CEP				26	41	4483	4625	9175
		FINF			11	138	127	4903	8178	13392
	LLD	LPF		75655	179410	69897	68436	43012		647560
	LLS	DEMF		6660	1428	81	851	442	322	11454
	none	-1		4019057	2690424	2655737	2943287	2811114	3135985	31819320
		DEMF							12	12
	OTB	DEMSP		20224032	19641564	21684187	20691455	19812706	18097702	161006135
		DWSP				191741	101430	159412	131412	593230
MDDWSP			1239512	1100893	4910			6047	11162408	
OTM	MDPSP		23022		376	2694			44759	
PS	LPF					6190	287	4047	43658	
	SPF		1383666	1549344	890058	1198676	665404	653817	7608907	
PTM	SPF		4696448	4190687	5277496	5789325	5917072	4225935	39431223	
TBB	DEMSP		5266768	6625945	4136346	4386154	3817491	2584717	34945400	

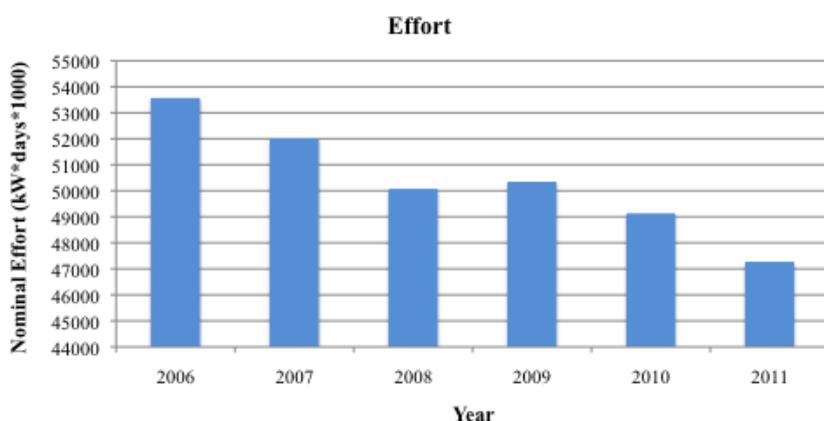


Fig. 6.15.2.4.1. Nominal effort in kW*days for the Italian fleet (GSA 17)

6.15.3. Scientific surveys

6.15.3.1. MEDITS

6.15.3.1.1. Methods

Based on the DCF data call, abundance and biomass indices were calculated. In GSA 17 (including Italian, Slovenian and Croatian parts of Adriatic Sea) the following number of hauls was reported per depth stratum (see Table 6.15.3.1.1.1.).

Table 6.15.3.1.1.1. Number of hauls per year and depth stratum in GSA 17 from 2006 to 2011.

Depth (m)	2006	2007	2008	2009	2010	2011
10-50	62	67	65	63	65	62
50-100	65	61	64	66	59	64
100-200	43	45	43	43	50	49
200-500	11	10	10	11	9	10

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Y_{st} = \sum (Y_i * A_i) / A$$

$$V(Y_{st}) = \sum (A_i^2 * s_i^2 / n_i) / A^2$$

Where:

A=total survey area

A_i=area of the i-th stratum

s_i=standard deviation of the i-th stratum

n_i=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Y_i=mean of the i-th stratum

Y_{st}=stratified mean abundance

V(Y_{st})=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval =

$$Y_{st} \pm t(\text{student distribution}) * V(Y_{st}) / n$$

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution and/or quasi-poisson. Indeed, data may be better modeled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length

frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.15.3.1.2. Geographical distribution patterns

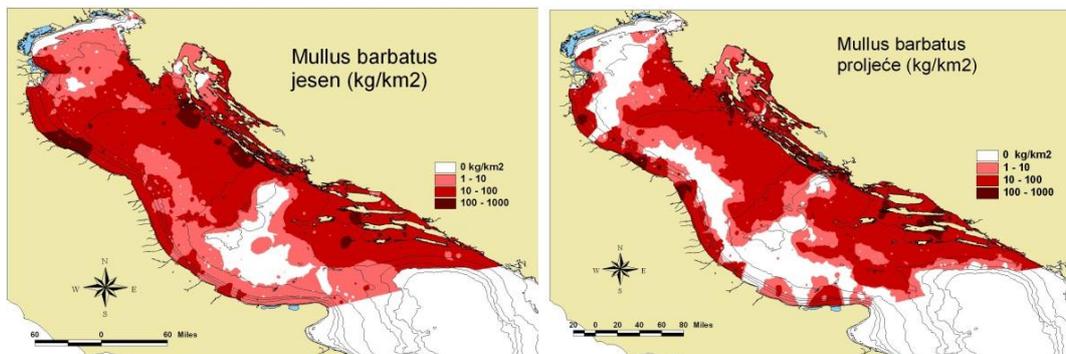


Fig. 6.15.3.1.2.1. Distribution of red mullet in the autumn –winter period (AdriaMed Trawl Survey + GRUND).

6.15.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 17 was derived from the international survey MEDITS. Figure 6.15.3.1.3.1 show the estimated trend in red mullet abundance and biomass in GSA 17. The stock seems stable with some fluctuations. The lowest values of the last 10 years were reached in 2007, but since then the indices are increasing.

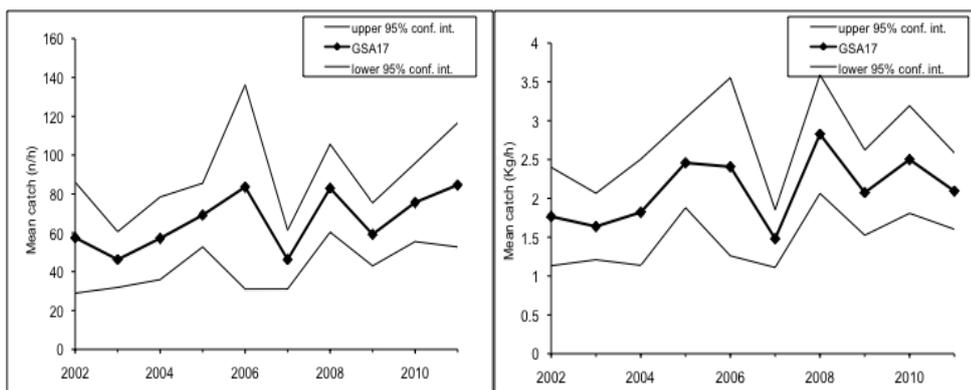


Fig. 6.15.3.1.3.1. Abundance and biomass indices of red mullet in GSA 17

6.15.3.1.4. Trends in abundance by length or age

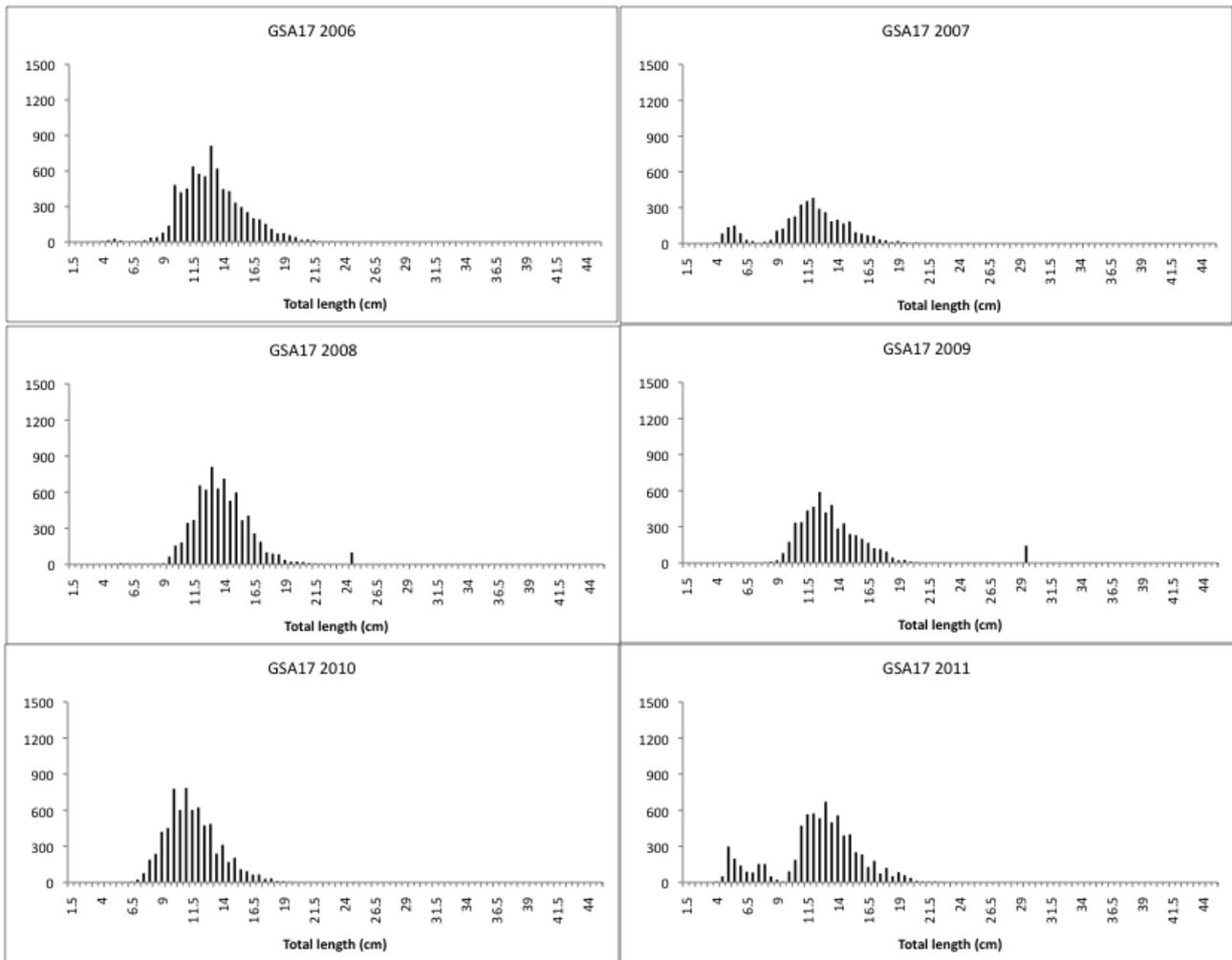


Fig. 6.15.3.1.4.1. Stratified abundance indices by size, 2006-2011

6.15.3.1.5. Trends in growth

No analyses were conducted during STECF EWG 12-19.

6.15.3.1.6. Trends in maturity

No analyses were conducted during STECF EWG 12-19.

6.15.4. Assessment of historic stock parameters

6.15.4.1. Method 1: Length cohort analysis (LCA)

6.15.4.1.1. Justification

An approach under steady state (i.e. pseudocohort) assumptions has been used for 2008 to 2011 age distributions for GSA 17 commercial catches (landings and discard). Cohort (VPA equation) and Yield per recruit (YPR) analysis as implemented in the package VIT4win were used (Leonart and Salat, 2000). Data were derived from the DCF data call and the Croatian Fisheries Department.

6.15.4.1.2. Input parameters

Italian catch at age data, obtained by the means of otolith reading, have been used. On the other hand, length frequency distributions from the Croatian fleet were converted into catch at age according to Italian ALKs. The growth parameters used were obtained independently for males and females (Vrgoc N., (coordinator), 2008: PHARE 2005 Project “ASSESSMENT OF DEMERSAL FISH AND SHELLFISH STOCKS COMMERCIALY EXPLOITED IN CROATIA”: *EuropeAid/123624/D/SER/HR*) (Table 6.15.4.1.2.1.).

The parameters of the length-weight relationship used for the present assessment are the ones suggested by Marano (1994) and Ungaro (1994) and reported in Table 6.15.4.1.2.1.

Table 6.15.4.1.2.1. *M. barbatus* growth parameter for GSA 17.

Time series: 2006-2011

Parameters	L_{∞}	K	t_0	a	b
	26.86 cm	0.295 y^{-1}	-1.1	0.009	3.076

The maturity vector by age is reported in Table 6.15.4.1.2.2.

Table 6.15.4.1.2.2. *M. barbatus* maturity vector for GSA 17.

Time series: 2006-2011

Age	0	1	2	3	4
Maturity	0.1	0.9	1	1	1

An M vector estimated using PRODBIOM (Abella *et al.*, 1997) was used (Table 6.15.4.1.2.3.).

Table 6.15.4.1.2.3. M vector from PRODBIOM for *M. barbatus* in GSA 17.

Time series: 2006-2011

Age	0	1	2	3	4
M	1.60	0.84	0.37	0.29	0.26

Terminal F was fixed at 0.5. Sensitivity analysis demonstrated that the results are not influenced by this choice.

Catch at age information for both Italian landings and discard was obtained within the framework of DCF for the years from 2008 to 2011 (Table 6.15.4.1.2.4.).

Table 6.15.4.1.2.4. Catch at age of for GSA 17

Age	2008		2009		2010		2011	
	Italy	Croatia	Italy	Croatia	Italy	Croatia	Italy	Croatia
0	52616906	870493	14965557	523536	12713163	125843	30935638	809229
1	63458499	7984760	65535928	7675901	31835203	3459483	49628641	5652968
2	6905832	5440588	16068508	6400837	19428807	7693286	23552991	7595335
3	860202	2504532	3261170	2763993	3161880	4426129	6615467	4946195
4	0	450592	282863	432643	659679	1748066	790063	2308831

6.15.4.1.3.Results

The contribution of each fleet to the catches in 2011 is shown in Figure 6.15.4.1.3.1: the Italian fleet exploit the youngest fraction of the population in much higher numbers, while the Croatian fleet tend to catch mainly the bigger and older specimen and contribute to the total catches on a much lower extent.

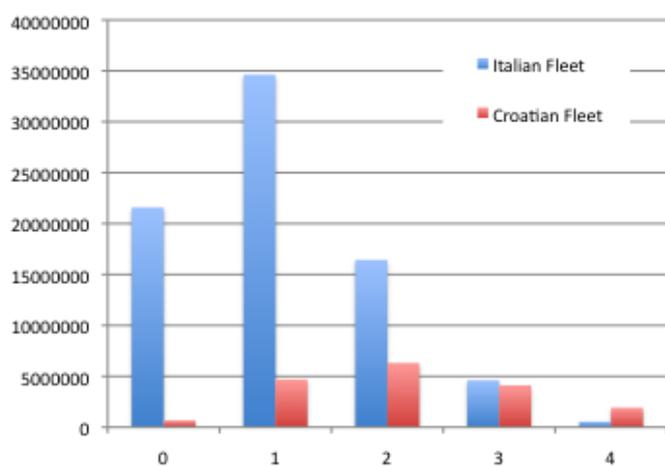


Fig. 6.15.4.1.3.1. Age distribution in the catches for the Italian fleet (blue bars) and the Croatian fleet (red bars).

The F estimated for 2011 clearly underline the different pattern of exploitation of the two fleets (fig xxx).

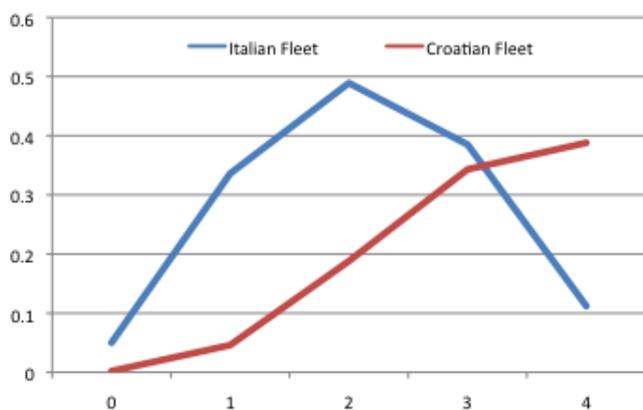


Fig. 6.15.4.1.3.2. F estimate by age resulting from LCA for *M. barbatus* in GSA 17 for both the Italian and the Croatian fleet.

The trends in both total biomass and SSB (mean biomass at sea) from 2008 to 2011 are increasing, reaching the maximum in 2011 with respectively 11513 tons and 7091 tons (Figure 6.15.4.1.3.3.).

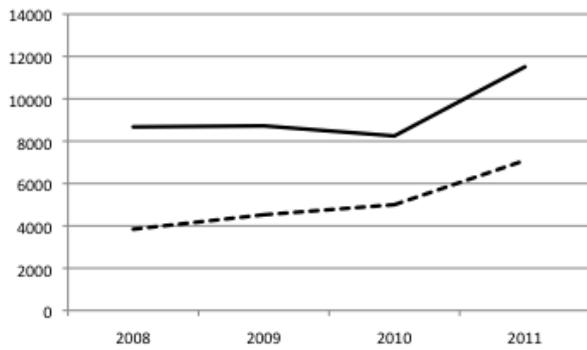


Fig. 6.15.4.1.3.3. Average biomass at sea (full line) and average SSB at sea (dashed line) estimated by LCA for *M. barbatus* from 2008 to 2011.

The trend in F for red mullet between 2008 and 2011 decrease from a value of about 0.9 to a value slightly lower of 0.5 (Figure 6.15.4.1.3.4.).

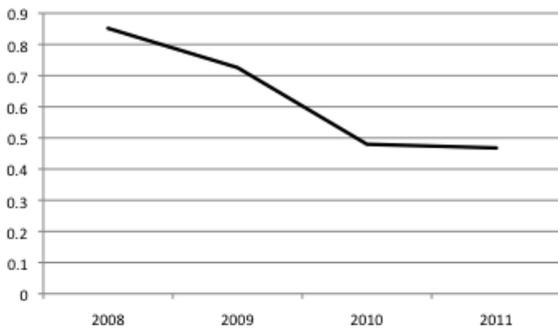


Fig. 6.15.4.1.3.4. F estimate by the means of LCA from 2008 to 2011 for *M. barbatus* in GSA 17.

6.15.5. Short term prediction

No short term prediction were performed by STECF EWG 12-19.

6.15.6. Long term prediction

6.15.6.1. Method 1: VIT

6.15.6.1.1. Justification

The YPR analysis provided by the VIT software has been applied. $F_{0.1}$ has been used as a proxy for F_{msy} .

6.15.6.1.2. Input parameters

The input parameters for the YPR analysis are those used in the LCA for 2011 data described above.

6.15.6.1.3.Results

The YPR results from the VIT analysis with the 2011 data are illustrated in Figure 6.15.6.1.3.1 and in Table 6.15.6.1.3.1.

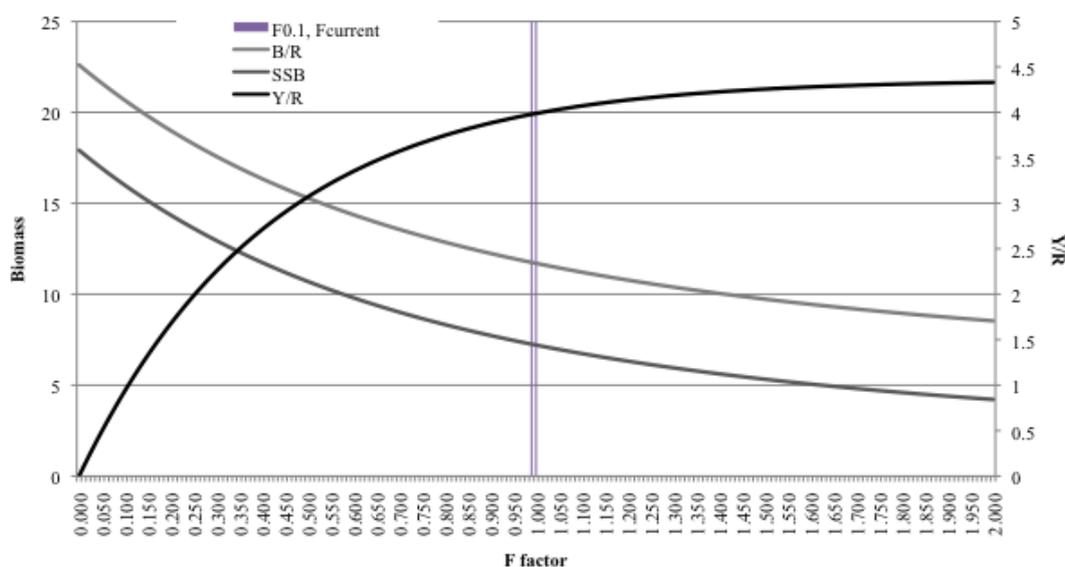


Fig. 6.15.6.1.3.1. Yield per recruit analysis for *M. barbatus* in GSA 17 for 2011.

Table 6.15.6.1.3.1. Reference points resulting from 2011 YPR for *M. barbatus* in GSA 17.

	F	YPR	SSB	TSB/R
F _{zero}	0.00	0.00	17.92	22.61
F _{0.1}	0.46	3.98	7.26	11.75

6.15.6.2. Method 2: Extended Survivor Analysis (XSA)

6.15.6.2.1. Justification

Data coming from DCF and Croatian Fisheries Department for the period 2006-2011 were used to perform an Extended Survivor Analysis (XSA) calibrated with fishery independent data (i.e. MEDITS abundance indices by age class for 2006-2011) and using FLR (www.r-project.org). Data included information on total landings and catch at age of *M. barbatus* in GSA 17 for both the Italian and Croatian fleet. Discard data from the Italian fleet (available for 2010 and 2011) were also included in the analyses.

6.15.6.2.2. Input parameters

Catch at age data were obtained from otolith reading carried out in the framework of DCF from 2006 to 2011. Annual amount and age structured data of discard were available for both 2010 and 2011.

XSA has been performed using commercial catch at age data derived from the DCF data call for GSA 17 and length frequency distribution from the Croatian Fisheries Department. No length frequency distribution were

available for the 2006-2007 Croatian data, so the average proportion at age from 2008 to 2011 has been applied to the total biomass.

MEDITS abundance indices have been used to tune the XSA. The numbers at age were obtained slicing the numbers at length in the survey with ALKs from Italian commercial samplings. (Figure 6.15.6.2.2.1 and Table 6.15.6.2.2.1). Since the ALK for 2006-2007 and 2008 showed a complete lack of age 4, the length distribution for those years was sliced using the ALK from 2009 samples (Figure 6.15.6.2.2.1).

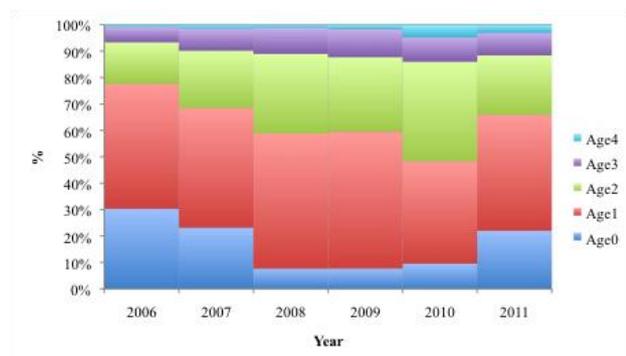


Fig. 6.15.6.2.2.1. Slicing of MEDITS abundance data using ALK from commercial data.

Table 6.15.6.2.2.1. MEDITS survey data disaggregated by age using ALK from commercial data.

	Age0	Age1	Age2	Age3	Age4
2006	279	468	169	62	9
2007	100	237	110	41	7
2008	74	473	277	88	11
2009	54	359	193	71	11
2010	107	359	304	66	31
2011	199	422	212	78	28

Discard data for 2010 and 2011 were used. The proportion of discard for each age class averaged between 2010 and 2011 has been applied to the previous years, to include a discard estimate in the catch at age matrix. Besides, the average between the percentage of discard on the overall catches in 2010 and 2011 has been added up to the total landings in the previous years, to include a complete time series of discards in the analysis (Table 6.15.6.2.2.1.). This procedure has been applied only to the Italian data since no relevant discard is reported for the Croatian fleet.

Table 6.15.6.2.2.2. Discard proportion applied to the overall Italian catches and to the Italian catch at age distribution from 2006 to 2009 for *M. barbatus* in GSA 17.

Overall Catch	Age0	Age1	Age2	Age3	Age4
0.20	0.62	0.32	0.02	0.00	0.00

In Table 6.15.6.2.2.3. and Table 6.15.6.2.2.4, the total catch numbers at age (Italian and Croatian landings + Italian discard) and the weight at age used in the analysis are presented.

Table 6.15.6.2.2.3. Catch numbers at age by year including discard proportion, used in the XSA analysis for *M. barbatus* in GSA 17.

	Age0	Age1	Age2	Age3	Age4
2006	45659	69231	16613	3845	328
2007	55299	81211	14554	3016	246
2008	53487	71443	12346	3365	451
2009	15489	73212	22469	6025	716
2010	13369	36008	27843	5795	2246
2011	31744	55282	31148	11561	3098

Table 6.15.6.2.2.4. Weight at age by year used in the XSA analysis for *M. barbatus* in GSA 17.

	Age0	Age1	Age2	Age3	Age4
2006	0.020	0.033	0.053	0.062	0.072
2007	0.020	0.033	0.053	0.062	0.072
2008	0.018	0.032	0.050	0.062	0.076
2009	0.018	0.029	0.047	0.063	0.078
2010	0.013	0.024	0.040	0.058	0.073
2011	0.011	0.021	0.037	0.058	0.073

The proportion of mature specimens and the M vector are the same used in the LCA analysis.

Trends in landings and in numbers at age by year are presented in Figure 6.15.6.2.2.2 and 6.15.6.2.2.3 respectively.

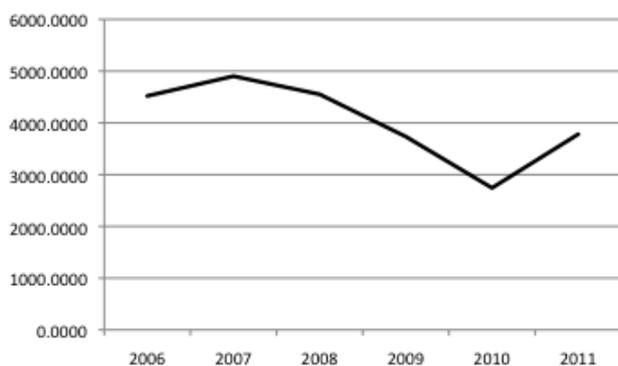


Fig. 6.15.6.2.2.2. Trend in total catch by year of *M. barbatus* in GSA 17.

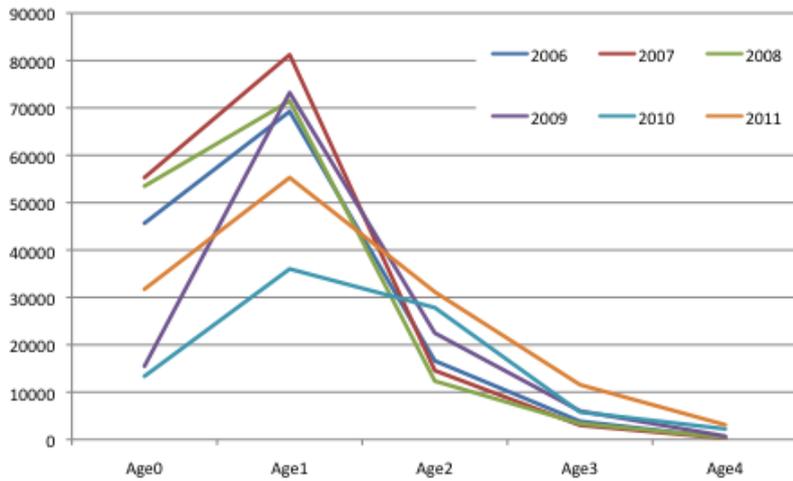


Fig. 6.15.6.2.2.3. Trend in numbers at age of the total catches of *M. barbatus* in GSA 17.

The XSA runs were made using the following settings:

- Catchability dependent on stock size for ages < -1
- Catchability independent of age for ages ≥ 3
- S.E. of the mean to which the estimates are shrunk = 2.50
- Minimum standard error for population estimates derived from each fleet = 0.300
- The number of ages used for the shrinkage mean: 2
- F_{bar} : 1-3

The first year of the MEDITS survey (2006) was not included in the analysis since it was producing really high residuals for the age 0 and an evident trend.

6.15.6.2.3.Results

XSA Diagnostics in the form of residuals by survey data are shown in Figure 6.15.6.2.3.1.

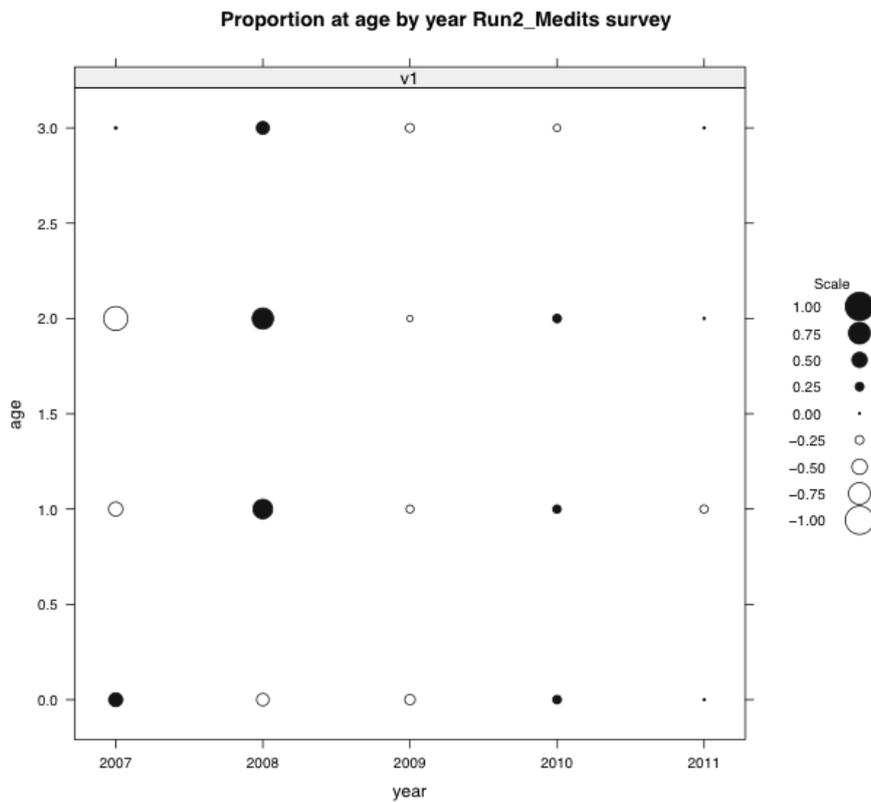


Fig. 6.15.6.2.3.1. Log transformed catchability residuals by age.

Table 6.15.6.2.3.1 shows the estimates for spawning stock biomass (SSB), total biomass (TB) and recruitment from 2006 to 2011 as derived from the XSA.

Table 6.15.6.2.3.1. Spawning stock biomass (SSB), total biomass (TB) and recruitment estimates for red mullet in GSA 17 from 2006 to 2011 derived by the XSA .

	2006	2007	2008	2009	2010	2011
SSB (tons)	4727	5434	6199	6265	5395	6211
TB (tons)	14072	15220	16275	13498	13010	19640
Recruitment (thousands)	1172544	1235133	1398465	959989	1416403	2981775

SSB is quite stable, the last year having about the same biomass of 2008 and 2009 (Table 6.15.6.2.3.1 and Figure 6.15.6.2.3.2). The total biomass instead steadily increase in the last year, due to a good recruitment level, growing from 13000 tons in 2010 up to 19600 tons in 2011 (Table 6.15.6.2.3.1).

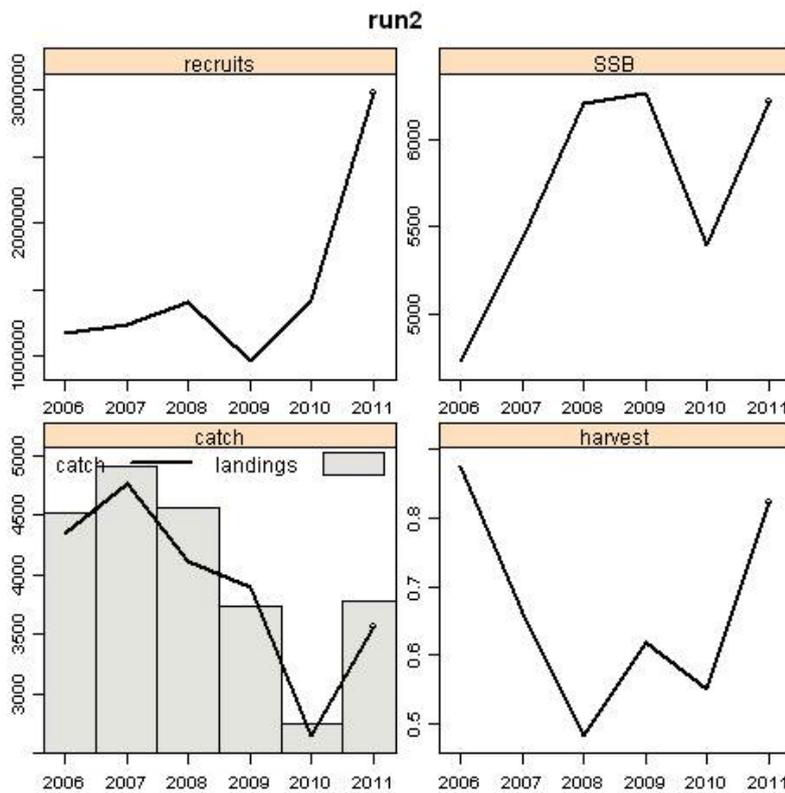


Fig. 6.15.6.2.3.2. Summary of stock parameters (recruitment, SSB, catch and landings, F mean for ages 1-3) as estimated by XSA.

XSA estimates of F_{bar} (estimates on ages 1 to 3) and F at age are shown in Table 6.15.6.2.3.2. F_{bar} shows a fluctuating pattern, with a minimum in 2010 ($F_{\text{bar}} = 0.463$), and a maximum in 2007 ($F_{\text{bar}} = 0.806$).

Table 6.15.6.2.3.2. Numbers at age (thousands) estimated by XSA for *M. barbatus* in GSA 17.

	2006	2007	2008	2009	2010	2011
Age0	1172544	1235133	1398465	959989	1416403	2981775
Age1	193189	216216	224521	258312	186859	279960
Age2	32560	37914	39984	49987	63412	57010
Age3	7573	8683	14092	17357	15853	20660
Age4	631	697	1866	2029	6043	5385

Table 6.15.6.2.3.3. Fishing mortality and F_{bar} (1-3) estimated by XSA for *M. barbatus* in GSA 17.

	2006	2007	2008	2009	2010	2011
Age0	0.091	0.105	0.089	0.037	0.021	0.024
Age1	0.788	0.848	0.662	0.565	0.347	0.357
Age2	0.952	0.620	0.464	0.778	0.751	1.071
Age3	0.884	0.513	0.323	0.513	0.549	1.041
Age4	0.884	0.513	0.323	0.513	0.549	1.041
F_{bar} (1-3)	0.875	0.660	0.483	0.619	0.549	0.823

6.15.7. Short term prediction

6.15.7.1. Method and justification

Short term predictions were implemented in R (www.r-project.org) using the FLR libraries and based on the results of Extended Survivorship Analysis (XSA) presented in the previous section.

6.15.7.1.1. Input parameters

The maturity and M vector input data for the short term predictions are the same used for the LCA and XSA analysis.

F vector

F	0	1	2	3	4
2011	0.024	0.357	1.071	1.041	1.041

The F_{bar} was calculated between ages 1 and 3.

Weight-at-age in the catch and in the stock

Mean weight in stock (2009-2011)	0	1	2	3	4
Kg	0.0150	0.0265	0.0435	0.0602	0.0750

6.15.7.1.2. Results

A short term projection (Table below), assuming an F_{stq} of 0.664 in 2012 and a recruitment of about 1786056 thousands individuals, shows that:

Fishing at the F_{stq} from 2012 to 2013 generates an increase in catch of 1.02 % and a decrease of the SSB between 2012 and 2013 of 15 %.

Fishing at F_{MSY} (0.358) for the same time frame (2012-2013) generates from 2013 to 2014 an increase in the catches of 1.07 % and an increase of spawning stock biomass of 11%.

STECF-EWG 12-19 considers the stock being overexploited, as F_{current} (0.664) is higher than F_{MSY} (0.358).

EWG 12-19 recommends that catches in 2013 should not exceed 3851 tons, corresponding to F_{MSY} .

Outlook until 2014

Short term forecast in different F scenarios computed for red mullet in GSA 17.

Basis: $R(2012) = GM(2009-2011) = 1.78$ (billions); $F_{bar}(2011) = 0.823$; $Catch(2011) = 3781$ t.

Rationale	F scenario	F factor	Catch 2013	Catch 2014	SSB 2014	Change SSB 2013-2014 (%)	Change Catch 2011-2013 (%)
Zero catch	0	0	0	0	16645	69	-100%
High long term yield (F_{MSY})	0.358	0.53	3851	3893	11080	11	8
Status quo	0.664	1.00	6244	5219	8188	-14	75
Different scenarios	0.133	0.20	1584	1879	14227	42	-55
	0.265	0.40	2976	3207	12250	22	-16
	0.398	0.60	4202	4137	10628	6	18
	0.531	0.80	5285	4780	9292	-5	48
	0.796	1.20	7097	5513	7271	-20	99
	0.929	1.40	7857	5707	6506	-25	121
	1.062	1.60	8537	5830	5865	-27	140
	1.195	1.80	9147	5906	5325	-29	157
1.327	2.00	9696	5951	4867	-30	172	

6.15.8. Data quality

Total landings and catch at age data for red mullet in GSA 17 from 2006 to 2011 were available at the EWG 12-19 from both the Italian and the Croatian fleet. Data concerning fishing activity and fishing effort for GSA 17 have been regularly submitted by the Italian Authorities. Discards data have been collected in the last two years, and for 2011 are available disaggregated by age as well. The biological parameters available from the Italian samplings are length frequencies distribution of the catches and ALK from otholit reading. On the other hand, the Croatian scientists provided data of length frequency distribution of the catches from 2008 to 2011. Since the Croatian fleet exploit the older part of the shared stock, information on the age structure in the catches would also provide an improvement to the quality of the data and therefore of the assessment.

6.15.9. Scientific advice

6.15.9.1. Short term considerations

6.15.9.1.1. State of spawning stock biomass

The analyses carried out on for the period 2006-2011 show that the SSB has been quite stable in the last 4 years, fluctuating around a value of 6000 tons. The spawning stock biomass value is similar between the LCA and the XSA analysis.

6.15.9.1.2.State of recruitment

The analyses carried out on for the period 2006-2011 show that recruitment has been stable until 2010, and in 2011 it grows much higher, reaching a value of 2981775.

6.15.9.1.3.State of exploitation

From a steady state perspective, the current F results equal of $F_{0.1}$, so the stock can be considered as sustainable exploited. Nevertheless, from the XSA analysis, the $F_{\text{bar}(1.3)}$ (0.823) resulted much higher than the $F_{0.1}$, estimated equal to 0.36, so the stock is considered exploited unsustainably..

In each case, from a management point of you, it worth taking into account the different exploitation rates carried out by the two fleets.

6.16. Stock assessment of Anchovy in GSA 17

6.16.1. Stock identification and biological features

6.16.1.1. Stock Identification

Anchovy (*Engraulis encrasicolus*) stock is shared among the countries belonging to GSA 17 (Italy, Croatia and Slovenia) and it constitutes a unique stock.

Many studies have been carried out regarding the presence of a unique stock or the presence of different sub populations living in the Adriatic Sea (GSA 17 and GSA 18). This has several implications for the management, i.e. differences in the growth features between subpopulations imply the necessity of *ad hoc* strategies in the management. The hypothesis of two distinct populations claims the evidence of morphometric differences between northern and southern Adriatic anchovy, such as color and length, and some variability in their genetic structure (Bembo et al., 1996). Nevertheless, many authors warn against the use of morphological data in studies on population structure (Tudela, 1999) and, a recent study from Magoulas et al. (2006), revealed the presence of two different clades in the Mediterranean, one of those is characterized by a high frequency in the Adriatic Sea (higher than 85%) with a low nucleotide diversity (around 1%).

6.16.1.2. Growth

The growth of anchovy in Adriatic Sea was assessed using the historical growth parameters (Sinovčić, 2000). Age- length and age-weight keys were produced using the otolith reading and actual length-weight parameters. The growth parameters used during the EWG 12-19 were:

Table 6.16.1.2.1. Von Bertalanffy growth parameters used in the assessment of anchovy in GSA 17.

Growth parameters	L_{inf}	k	t_0
Both sexes	19.4	0.57	-0.5

6.16.1.3. Maturity

Table 6.16.1.2.2. Proportion of mature specimens at age for anchovy in GSA 17.

PERIOD	Age	0	1	2	3	4	5
1975-2011	Prop. Matures	0.75	1.00	1.00	1.00	1.00	1.00

6.16.1.4. Natural mortality

Table 6.16.1.2.3. Natural mortality vector by age from Gislason et al. (2010) used in the assessment of anchovy in GSA 17.

PERIOD	Age	0	1	2	3	4	5
1975-2011	M	2.36	1.10	0.81	0.69	0.64	0.61

6.16.2. Fisheries

6.16.2.1. General description of the fisheries

Anchovy is commercially very important in Adriatic Sea. It is targeted by pelagic trawlers (Italy) and purse seiners (Croatia, Slovenia, Italy). The number of vessels targeting this species is around 300 units.

6.16.2.2. Management regulations applicable in 2010 and 2011

A closure period is observed from the Italian pelagic trawlers on August and from 15th December to 15th January from the Croatian purse seiners. In 2011 a closure period of 60 days (August and September) was endorsed by the Italian fleet.

6.16.2.3. Catches

6.16.2.3.1. Landings

In Figure 6.16.2.3.1.1 the trend in landings for Italy and Croatia are shown. From 1988 the trend is increasing with a maximum of 47055 tons in 2007. The Slovenian catches are included in the total landings but are not shown here since the quantities are really low (less than 150 tons in 2011):

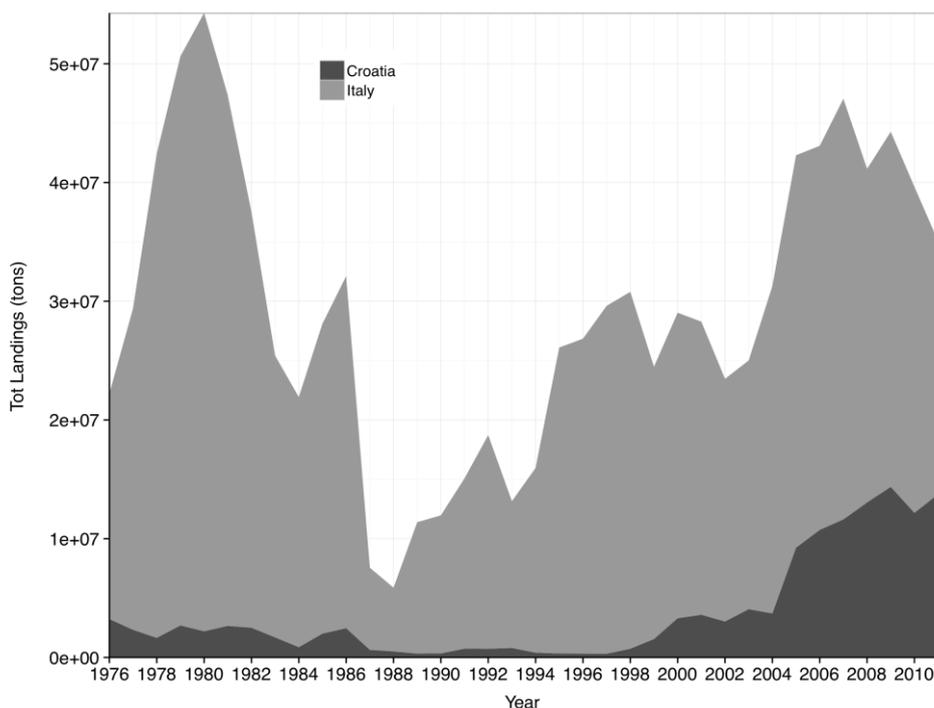


Fig. 6.16.2.3.1.1. Total landings (in tons) of anchovy by country for GSA 17 from 1975 to 2011.

The following table shows the annual landings (t) :

Table 6.16.2.3.1.1 Total landings (tons) of anchovy by year for the entire GSA 17.

Year	Catch	Year	Catch	Year	Catch	Year	Catch
1976	22215	1985	28113	1994	15960	2003	25016
1977	29400	1986	32110	1995	26103	2004	31280
1978	42422	1987	7558	1996	26844	2005	42296
1979	50633	1988	5875	1997	29611	2006	43090
1980	54279	1989	11390	1998	30792	2007	47055
1981	47346	1990	11967	1999	24484	2008	41151
1982	37525	1991	15088	2000	29036	2009	44280
1983	25418	1992	18726	2001	28280	2010	39639
1984	21930	1993	13160	2002	23467	2011	35058

The trend of the cohorts in the catches is shown in Figure 6.16.2.3.1.2. Each plot represents the number of fish of each age born in the same year. Age 1 can be identified as the first fully recruited age.

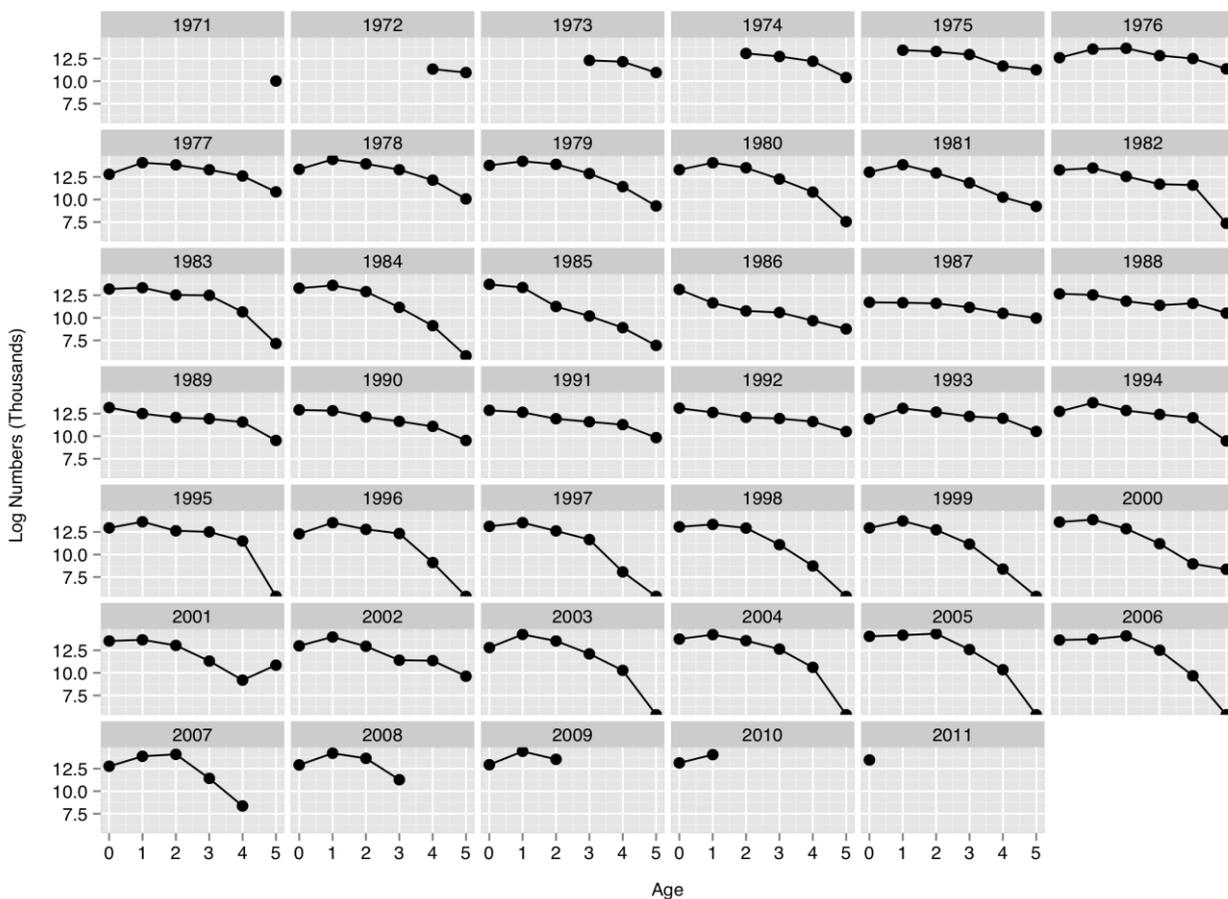


Fig. 6.16.2.3.1.2. Log numbers at age (thousands) of the catch at age used in the assessment of anchovy in GSA 17.

6.16.2.3.2. Discards

Discards were not included in the catches because landings were almost equal to catches as very few fishes are usually discarded.

6.16.3. *Scientific surveys*

6.16.3.1. MEDIAS

6.16.3.1.1. Methods

Echosurveys were carried out from 2004 to 2011 for the entire GSA 17. In the western part the acoustic survey was carried out since 1976 in the Northern Adriatic (2/3 of the area) and since 1987 also in the Mid Adriatic (1/3 of the area), and it is in the MEDIAS framework since 2009. The eastern part was covered by Croatian national pelagic monitoring program PELMON. The data from both the surveys have been combined to provide an overall estimate of numbers-at-age.

The survey methods for MEDIAS are given in the MEDIAS handbook (MEDIAS, March 2012).

Western Echosurvey:

Length frequencies distribution available from 2004 onward (no LFD for Mid Adriatic in 2004, so the biomass at length in 2004 was assumed equal to the proportion of biomass at length in the 2005 Mid Adriatic survey).

ALKs available for 2009-2010-2011;

Numbers at age for 2004 to 2008 were obtained applying the sum of the 2009-2010-2011 ALKs to the numbers at length.

Eastern Echosurvey:

Length frequencies distribution available from 2009.

No ALKs available.

Numbers at length from 2004 to 2008 were obtained applying the length frequency distribution from the 2009 survey to the total biomass.

Numbers at age were obtained applying commercial ALK from the eastern catches to the eastern echosurvey length distribution.

2011 survey covered only the Northern part of the area (about 52% of the total area), so the estimated biomass was raised to the total using an average percentage from previous years (2004-2010).

6.16.3.1.2. Geographical distribution patterns

Acoustic sampling transects and the total area covered is shown in Figure 6.16.3.1.2.1.

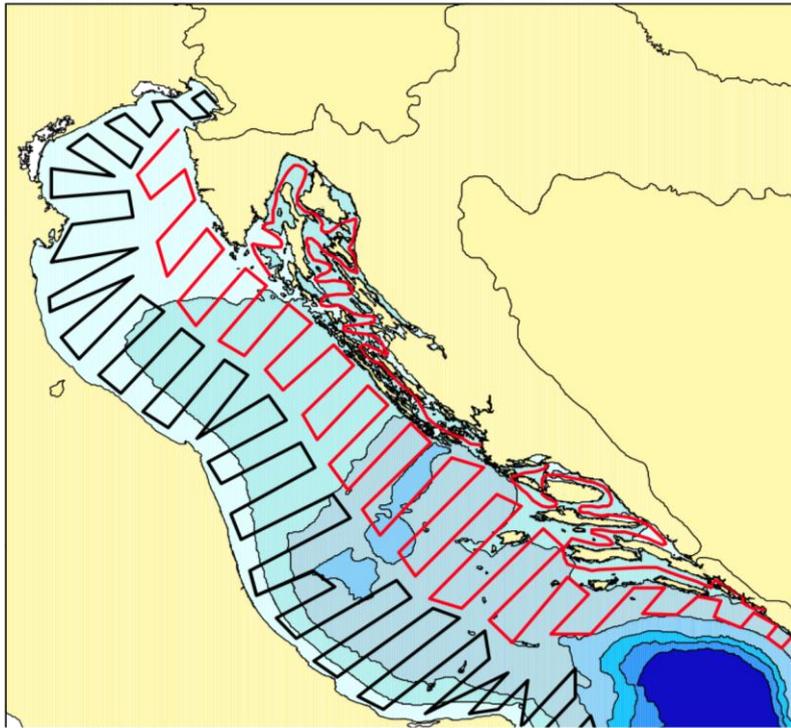


Fig. 6.16.3.1.2.1. Acoustic transects for the western echosurvey (on the left) .

6.16.3.1.3. Trends in abundance and biomass

Biomass estimates from the two surveys show a much higher occurrence of anchovy on the western side of the Adriatic. In 2008 the western survey contributed to more than 85% of the total estimated biomass.

Pooled total biomass in tons from eastern and western echosurvey (2004-2011) is given in table 6.16.3.1.3.1 and it is shown in figure 6.16.3.1.3.1.

Table 6.16.3.1.3.1. Total biomass (tons) estimated by the acoustic surveys in GSA 17.

	Tons
2004	302130
2005	335312
2006	627226
2007	533525
2008	858497
2009	486373
2010	642184
2011	474920

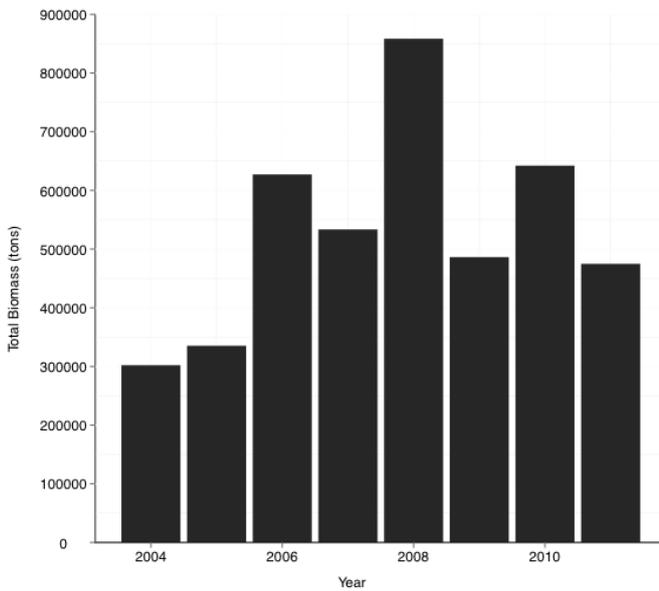


Fig. 6.16.3.1.3.1. Total biomass (tons) estimated from the eastern and western echosurvey

Figure 6.16.3.1.3.2. Proportion by year of each age class from the surveys. In 2008 a higher percentage of age 0 occurred. Age 3 and age 4 are scarcely represented in the population.

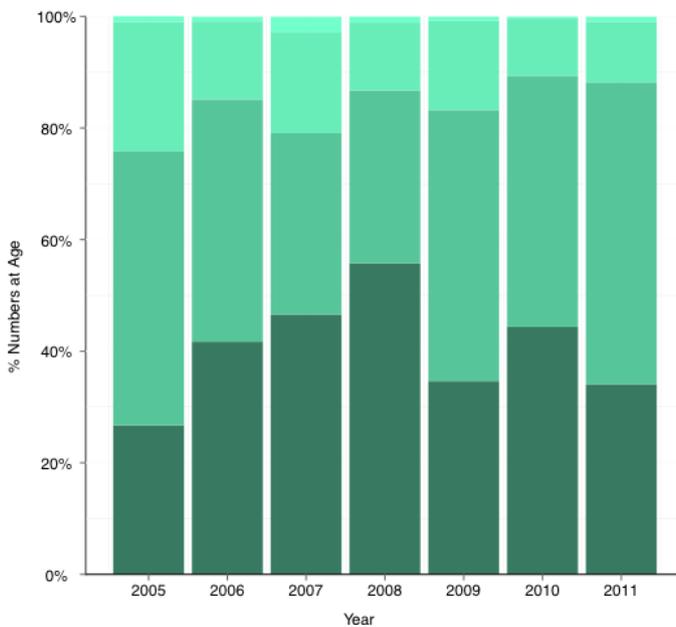


Fig. 6.16.3.1.3.2. Total proportion by age classes for the two surveys

In Figure 6.16.3.1.3.3. Trend of the cohorts in the acoustic survey is shown. Each plot represents the number of fish of each age born in the same year:

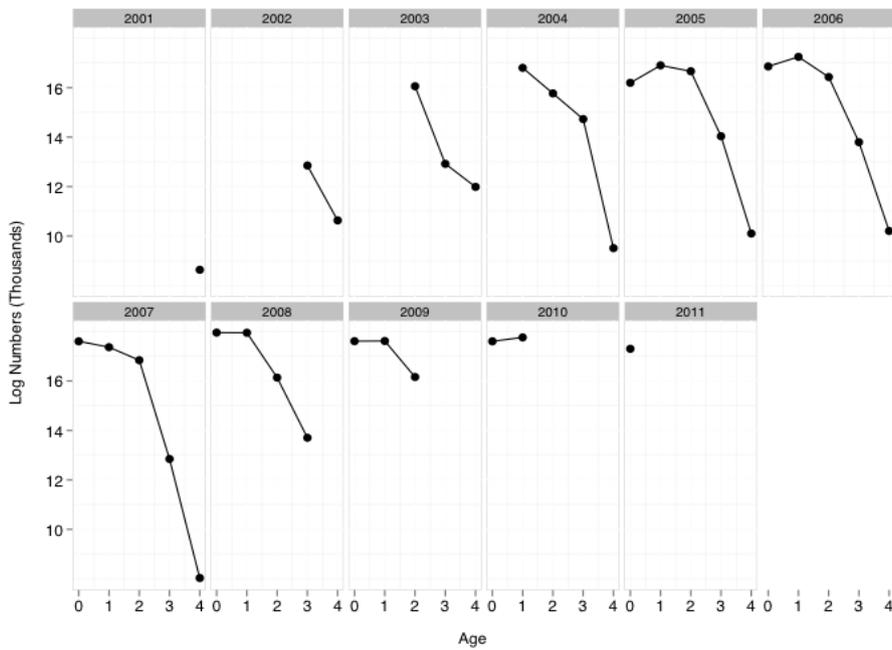


Fig. 6.16.3.1.3.3. Log numbers at age (thousands) of the echosurvey index used in the assessment of anchovy in GSA 17.

6.16.3.1.4. Trends in abundance by length or age

No analyses were conducted during EWG-12-19.

6.16.3.1.5. Trends in growth

No analyses were conducted during EWG-12-19.

6.16.3.1.6. Trends in maturity

No analyses were conducted during EWG-12-19.

6.16.4. Assessment of historic stock parameters

6.16.4.1. Method: ICA

6.16.4.1.1. Justification

Integrated Catch Analysis (ICA) has been performed from 1975 to 2011. Acoustic surveys were available for the assessment of anchovy in GSA 17. In the ICA, the last x years of the available catch-at-age matrix, are fitted by a separable model: in this approach the F is partitioned into a year effect and an age effect. Parameters for this separable model are estimated by minimizing the squared differences between observed and predicted catches. The earlier year in the dataset are modeled by a conventional VPA.

ICA was performed using the Patterson's software (ICA, version 4.2 – Patterson and Melvin, 1996).

6.16.4.1.2. Input parameters

The final assessment of anchovy was carried out by fitting the integrated catch-at age model (ICA) with a separable constraint over a ten-years period, tuned with the acoustic survey (2004-2010).

The model settings were the following:

10 years for separable constraint.

Reference age for separable constraint: 2.

Constant selection pattern model.

S to be fixed on last age: 1.2.

Fbar: 1-3.

Catchability model: Linear.

6.16.4.1.3. Results

The fishing mortality for age 2 (presented in Figure 6.16.4.1.3.1, top-right) remain at low levels (below 0.4) up to 2000, and after that shows a constant increase. The highest value of all the time series is 1.2 in 2010. In 2011 the $F_{\text{bar}(1-3)}$ is equal to 0.83.

The mid year spawning stock biomass (Figure 6.16.4.1.3.1, bottom-right) fluctuates from the highest values in the late 70th (about 600000tons) to a first drop in the 1985 with a biomass of 150000 tons. After that the stock recovered to about 400000 tons between 1989 and 1990 and then decreased again to a minimum of 100000 tons. A third phase saw a new recovery up to 350000 tons in 2005. In 2011 the estimated SSB is around 260000 tons. The recruitment (age 0 – Figure 6.16.4.1.3.1, bottom-left) fluctuates around a value of 100000000 thousands individuals.

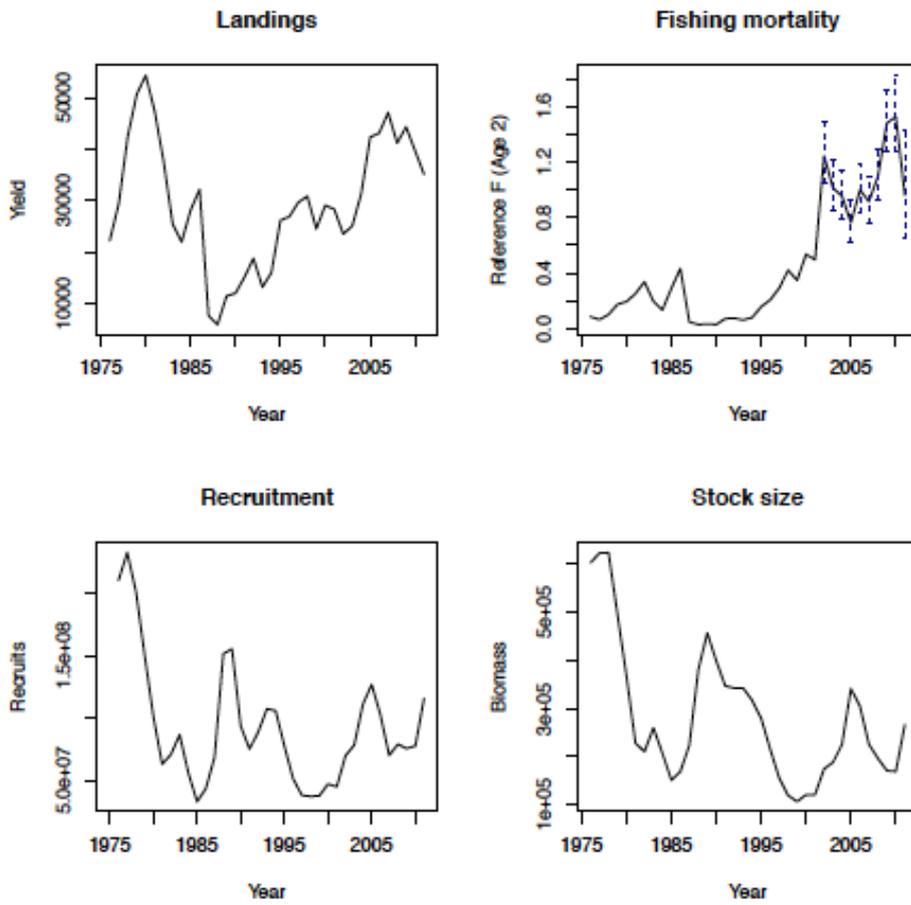


Fig. 6.16.4.1.3.1. Total landings in tons (top-left); reference F (F for age 2) with the confidence interval for the separability period (top-right); recruitment (as thousands individuals)(bottom-left); mid year stock biomass and SSB in tons (bottom-right).

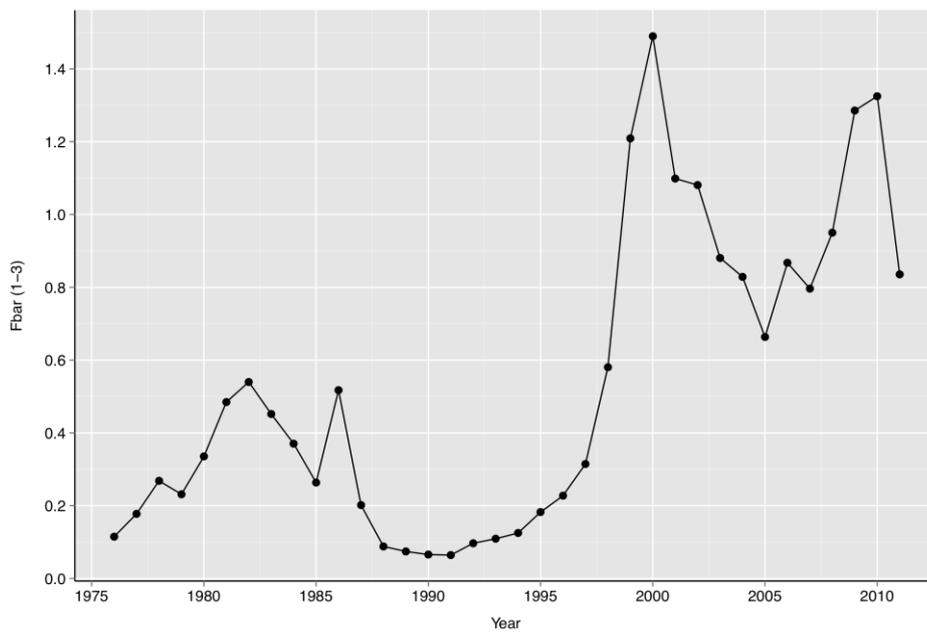


Fig. 6.16.4.1.3.2. $F_{bar}(1-3)$ resulting from the ICA model for anchovy in GSA 17.

Table 6.16.4.1.3.1 and 6.16.4.1.3.2 give respectively the stock numbers at age by year (in thousand) and the fishing mortality at age by year. In table the total biomass and the spawning stock biomass in tons are presented.

Table 6.16.4.1.3.1. Stock numbers at age by year (thousands)

	Age0	Age1	Age2	Age3	Age4	Age5
1976	210481678	13606244	5587440	2583531	600172	157873
1977	232749574	19800770	4155455	2176653	1143041	341261
1978	201331287	21887035	6171706	1472839	859322	239791
1979	150160244	18855164	6576646	2205726	455646	125175
1980	100749075	13941921	5266647	2271189	848535	239970
1981	63011456	9366847	3818480	1612426	736040	208818
1982	70652899	5836680	2422995	1013197	407715	110630
1983	86556026	6528613	1386030	617102	246354	62345
1984	55768935	8040611	1784950	357495	167545	35495
1985	32866922	5122286	2337032	612077	87689	5732
1986	43258201	2883957	1275504	861973	224549	20810
1987	68464063	3960153	622628	316535	253085	9281
1988	151430643	6434054	1255574	227386	110934	15260
1989	155453422	14220320	2077369	527866	95563	4192
1990	93431424	14548929	4580715	853476	237087	15010
1991	75141548	8722467	4695842	1946948	379506	65776
1992	88696239	7000103	2701074	1975927	915348	176135
1993	107343097	8254573	2160723	1083077	886947	309344
1994	105778288	10099150	2579614	863460	464472	96660
1995	77541407	9903817	3101150	1033171	358378	62320
1996	51158452	7217863	2813808	1176309	412078	68412
1997	37916108	4776873	1952801	1010336	454742	104653
1998	37029405	3457653	1188055	673989	340238	74030
1999	37520430	3380670	755781	302909	157453	20738
2000	46947421	3439359	794201	149838	12849	20137
2001	44808009	4234299	670463	103370	5026	2320
2002	69659903	4046712	857826	93310	10077	767
2003	78221946	6451021	928016	110046	9201	1289
2004	111045248	7269995	1585123	149895	14668	1646
2005	126859581	10330235	1818645	271804	21604	9089
2006	102504779	11836435	2735700	377154	50238	94014
2007	70017478	9529124	2921747	448673	51285	29017
2008	78861822	6517318	2410544	520014	67897	14260
2009	75500477	7320340	1563524	359452	62433	11731
2010	77525844	6966281	1564380	158496	26049	6661
2011	115679828	7148100	1468612	151547	10824	2786

Tab. 6.16.4.1.3.2. Fishing mortality at age by year

	Age0	Age1	Age2	Age3	Age4	Age5
--	------	------	------	------	------	------

1976	0.0037	0.0861	0.1327	0.1255	0.2064	0.2064
1977	0.0041	0.0657	0.2272	0.2394	0.2519	0.2519
1978	0.0082	0.1024	0.2189	0.4832	0.3720	0.3720
1979	0.0168	0.1754	0.2532	0.2653	0.4165	0.4165
1980	0.0155	0.1950	0.3737	0.4368	0.5434	0.5434
1981	0.0192	0.2522	0.5167	0.6849	0.7528	0.7528
1982	0.0216	0.3377	0.5577	0.7241	0.8953	0.8953
1983	0.0163	0.1968	0.5451	0.6138	0.6684	0.6684
1984	0.0276	0.1356	0.2603	0.7153	0.5039	0.5039
1985	0.0733	0.2903	0.1874	0.3128	0.5581	0.5581
1986	0.0309	0.4330	0.5837	0.5355	0.9752	0.9752
1987	0.0047	0.0487	0.1973	0.3585	0.2535	0.2535
1988	0.0055	0.0305	0.0565	0.1769	0.1174	0.1174
1989	0.0088	0.0328	0.0795	0.1104	0.1094	0.1094
1990	0.0113	0.0308	0.0456	0.1204	0.0962	0.0962
1991	0.0134	0.0723	0.0556	0.0647	0.1385	0.1385
1992	0.0145	0.0755	0.1038	0.1110	0.1762	0.1762
1993	0.0036	0.0631	0.1073	0.1567	0.1751	0.1751
1994	0.0084	0.0807	0.1050	0.1894	0.2076	0.2076
1995	0.0143	0.1584	0.1594	0.2292	0.3453	0.3453
1996	0.0111	0.2073	0.2143	0.2604	0.4421	0.4421
1997	0.0348	0.2915	0.2538	0.3984	0.6124	0.6124
1998	0.0336	0.4206	0.5566	0.7641	1.0178	1.0178
1999	0.0296	0.3485	0.8082	2.4701	1.5438	1.5438
2000	0.0458	0.5351	1.2290	2.7049	2.0330	2.0330
2001	0.0445	0.4966	1.1620	1.6381	1.6286	1.6286
2002	0.0194	0.3726	1.2435	1.6266	1.4922	1.4922
2003	0.0158	0.3036	1.0131	1.3252	1.2157	1.2157
2004	0.0149	0.2857	0.9533	1.2470	1.1440	1.1440
2005	0.0119	0.2287	0.7632	0.9983	0.9158	0.9158
2006	0.0156	0.2990	0.9978	1.3053	1.1974	1.1974
2007	0.0143	0.2745	0.9161	1.1983	1.0993	1.0993
2008	0.0170	0.3275	1.0930	1.4298	1.3116	1.3116
2009	0.0231	0.4432	1.4790	1.9346	1.7748	1.7748
2010	0.0238	0.4568	1.5243	1.9940	1.8292	1.8292
2011	0.0150	0.2880	0.9612	1.2573	1.1534	1.1534

Tab. 6.16.4.1.3.3. Start year Stock Biomass (SB) and Mid Year Spawning Stock Biomass (SSB) (tons)

	SB	Mid Year
1976	2177209	603761
1977	2199525	623525
1978	2182492	624589
1979	1687886	495411
1980	1203710	367278
1981	760972	228089
1982	768961	210282
1983	984445	259675
1984	704481	207014
1985	491082	151043
1986	622493	168419
1987	840409	223810

1988	1476821	380525
1989	1632112	457222
1990	1243572	399151
1991	1084324	346984
1992	1116225	342538
1993	1166025	342399
1994	1055548	316859
1995	909681	279760
1996	687829	215789
1997	508541	155557
1998	424877	119039
1999	404156	106204
2000	484495	120532
2001	471841	120587
2002	696245	174178
2003	719309	187859
2004	876867	225199
2005	1300939	341269
2006	1122847	304819
2007	801867	225623
2008	747500	196234
2009	647828	170686
2010	652189	168798
2011	1039911	266254

The diagnostic graph of the index SSQ against reference age F (age 2) from a separable VPA is plotted in Figure 6.16.4.1.3.3. The curves should be U-shaped, with minima fairly close to each other on *x*-axis (Needle, 2000).

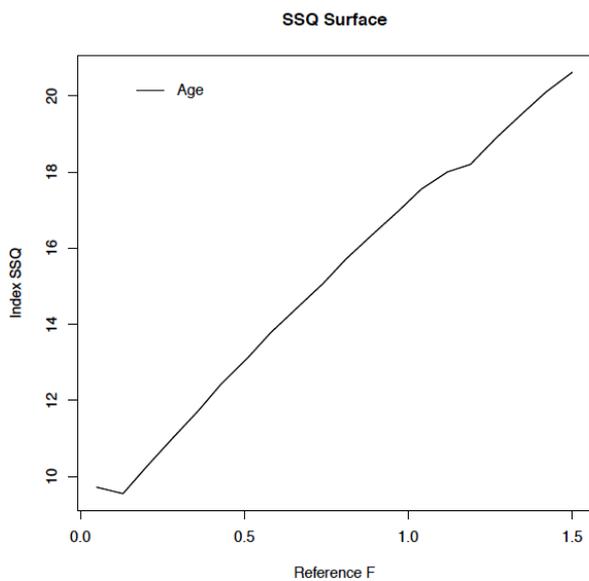


Fig. 6.16.4.1.3.3. SSQ surface plot.

The marginal totals of residuals between the catch and the separable model are overall small, as well as reasonably trend-free in the separable period (2000-2011) (see Figure 6.16.4.1.3.4).

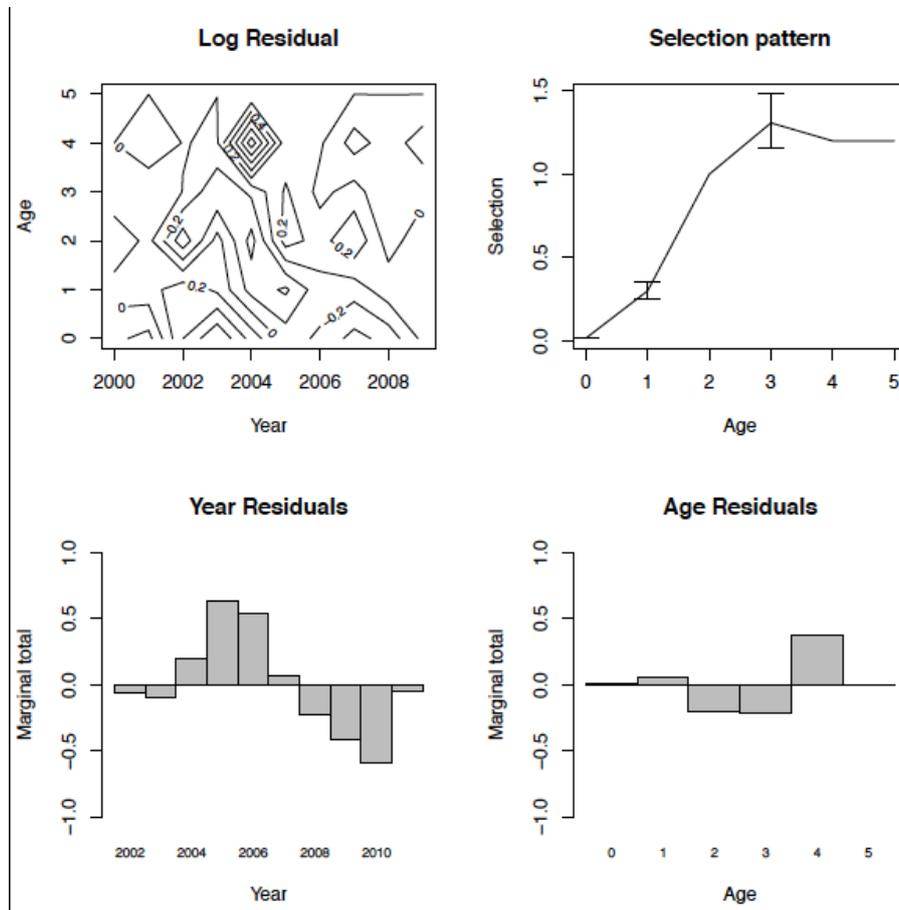


Fig. 6.16.4.1.3.4. Diagnostics: log-residual contour plot (top-left); fitted selection pattern (top-right); year residuals for the catches (bottom-left); age residuals for the catches (bottom-right).

In Figure 6.16.4.1.3.5 the fitting between the predicted and observed index numbers at age is presented. The fitting is good except for the younger ages, which in some degree is to be expected.

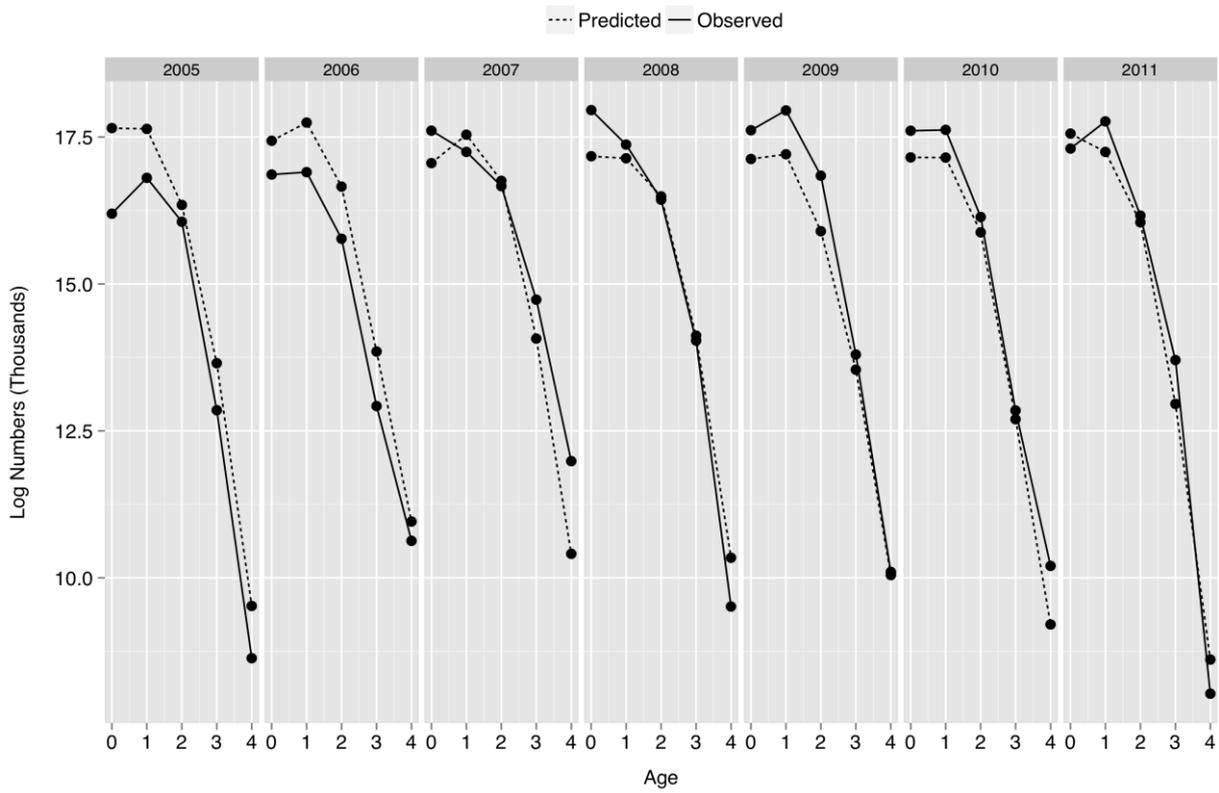


Fig. 6.16.4.1.3.5 Predicted VS observed echosurvey numbers at age for Anchovy in GSA 17.

Retrospective analysis was applied in the ICA model for the Adriatic anchovy 1975-2011 with four years backward analysis. Results are presented in Figure 6.16.4.1.3.6, showing a high retrospective bias in the reference F estimation, constantly underestimated throughout the years. On the other hand, SSB and recruitment are consistent except for 2008.

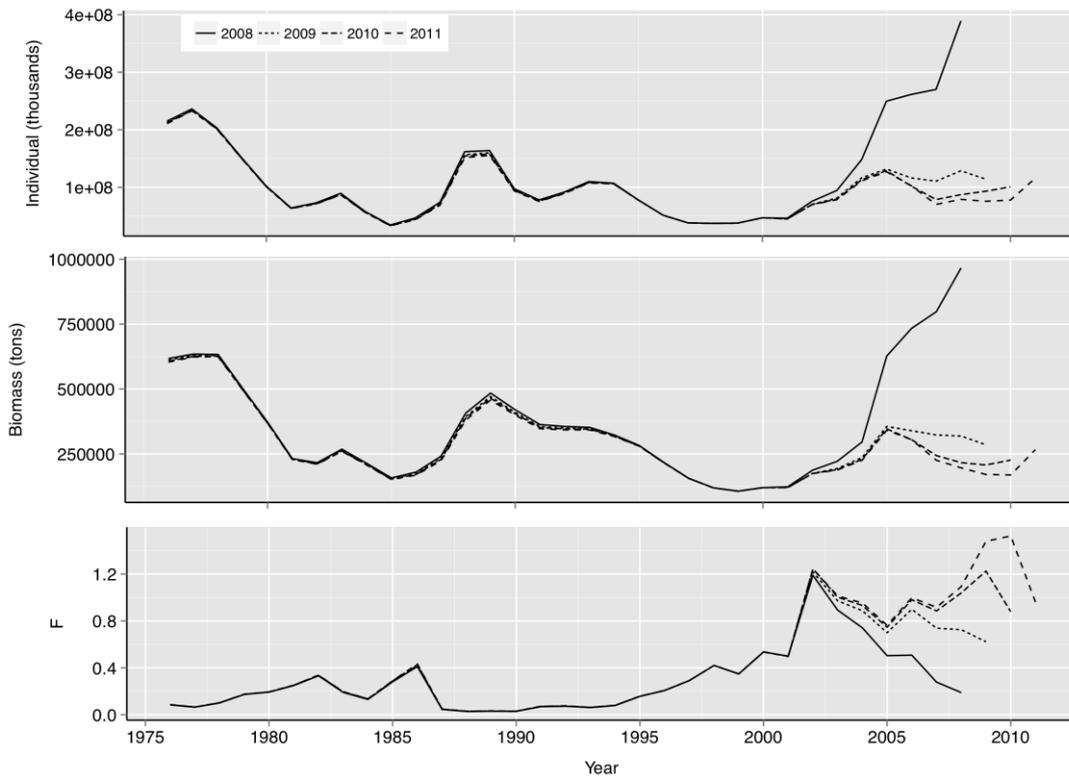


Fig. 6.16.4.1.3.6. The results of retrospective analysis of ICA model 1975-2011 for anchovy in GSA 17, concerning recruitment, SSB and reference F (age2).

The annual exploitation rate $E = F/(F+M)$ or F/Z was calculated and plotted over the years for the ages 1-3. The values obtained were compared with the threshold $F/Z = 0.4$ adopted as biological reference point for small pelagics (Patterson, 1992). The trends in values of F/Z were plotted in Figure 6.16.4.1.3.7.

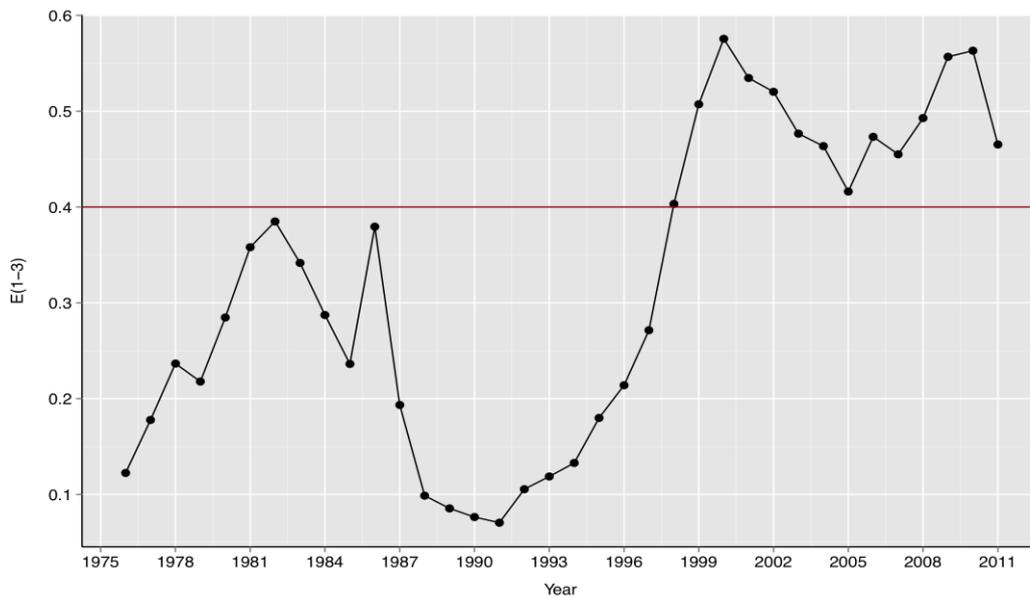


Fig. 6.16.4.1.3.7. Exploitation rate for the age 1-3 obtained by the ICA model for anchovy in GSA 17.

6.16.5. *Scientific advice*

6.16.5.1. Short term considerations

6.16.5.1.1.State of the spawning stock size

Estimates of fishery independent surveys for anchovy in GSA 17 indicated a slight increase from lower levels in 2004 to the most recent estimates in 2011. The highest value is registered in 2008 with about 850000 tons. Similarly, results of the Integrated Catch at Age analysis indicated an increasing trend starting in 1999 from the lowest biomass in the time series of 400000 tons (start year total biomass). Reference points were estimated for the first time during this WG as described in section 8.2.4. The level of anchovy SSB in 2011 is higher than both the estimated reference points for Blim and Bpa. (Blim = 187377 t, Bpa = 262327 t).

It should be considered that this assessment is based on a long time series of data and that the oldest years of catch data in the time series can be biased. Moreover, anchovy is a short lived species characterized by high fluctuations in abundance and recruitment strongly depends on environmental conditions.

6.16.5.1.2.State of recruitment

ICA model estimates had shown a rather fluctuating trend in the number of recruits since the beginning of the time series, around a value of about 92000000 thousands specimens.

6.16.5.1.3.State of exploitation

Based on ICA results, the F of the reference age 2 is strongly increasing since 1995. The F_{bar} (1-3) shows the same increasing trend with the highest value in 2000 equal to 1.4. : In 2011 the F_{bar} was 0.83, higher than the suggested F_{MSY} of 0.56. The exploitation rate since 1998 remained above the reference point of 0.4 while in 2011 gets lower to a value of 0.47.

Based on this assessment results the stock is currently considered to be exploited unsustainably. However, due to the fluctuating nature of recruitment, the anchovy stock should be monitored on an annual basis. Mixed fisheries implications, i.e. the interaction with sardine, need to be considered when managing this fishery.

6.17. Stock assessment of Sardine in GSA 17

6.17.1. Stock identification and biological features

6.17.1.1. Stock Identification

Sardine (*Sardine pilchardus*) stock is shared among the countries belonging to GSA 17 (Italy, Croatia and Slovenia) and constitutes a unique stock.

Although there is some evidence of differences on a series of morphometric, meristic, serological and ecological characteristics, the lack of genetic heterogeneity in the Adriatic stock has been demonstrated through allozymic and mitochondrial DNA (mtDNA) surveys (Carvalho et al. 1994) and through sequence variation analysis of a 307-bp cytochrome b gene (Tinti et al. 2002a,b). The results of the genetic analyses imply that the different trophic and environmental conditions found in the northern and central Adriatic, may cause differences in growth rates

6.17.1.2. Growth

The growth of sardine in the Adriatic Sea was assessed using historical growth parameters (Sinovčić, 1984). Age-length and age-weight keys were produced using otolith readings and actual length-weight parameters. The growth parameters used during the EWG 12-19 were:

Table 6.17.1.2.1. Von Bertalanffy growth parameters used in the assessment of sardine in GSA 17.

Growth parameters	L_{inf}	k	t_0
Both sexes	20.5	0.46	-0.5

6.17.1.3. Maturity

Table 6.17.1.3.1. Proportion of mature specimens at age for sardine in GSA 17.

PERIOD	Age	0	1	2	3	4	5
1975-2011	Prop. Matures	0.75	1.00	1.00	1.00	1.00	1.00

6.17.1.4. Natural mortality

Table 6.17.1.4.1. Natural mortality vector by age from Gislason et al. (2010) used in the assessment of sardine in GSA 17.

PERIOD	Age	0	1	2	3	4	5	6
1975-2011	M	2.51	1.10	0.76	0.62	0.56	0.52	0.50

6.17.2. Fisheries

6.17.2.1. General description of the fisheries

Sardine is commercially very important in the Adriatic Sea. It is targeted by pelagic trawlers (Italy) and purse seiners (Croatia, Slovenia, Italy). Number of vessels targeting this species is around 300.

6.17.2.2. Management regulations applicable in 2010 and 2011

A closure period is observed from the Italian pelagic trawlers on August and from 15th December to 15th January from the Croatian purse seiners. In 2011 a closure period of 60 days (August and September) was endorsed by the Italian fleet.

6.17.2.3. Catches

6.17.2.3.1. Landings

In Figure 6.17.2.3.1.1 the trend in landings for Italy and Croatia are shown. The trend started decreasing in the late eighties reaching a minimum in 2005 with 19000 tons. In the last 7 years the Croatian catches grew high, reaching the maximum of the entire time series in 2011 with about 46000 tons (almost 90% of the overall catches). The Slovenian catches are included in the total landings but are not shown here since the quantities are really low (less than 400 tons in 2011):

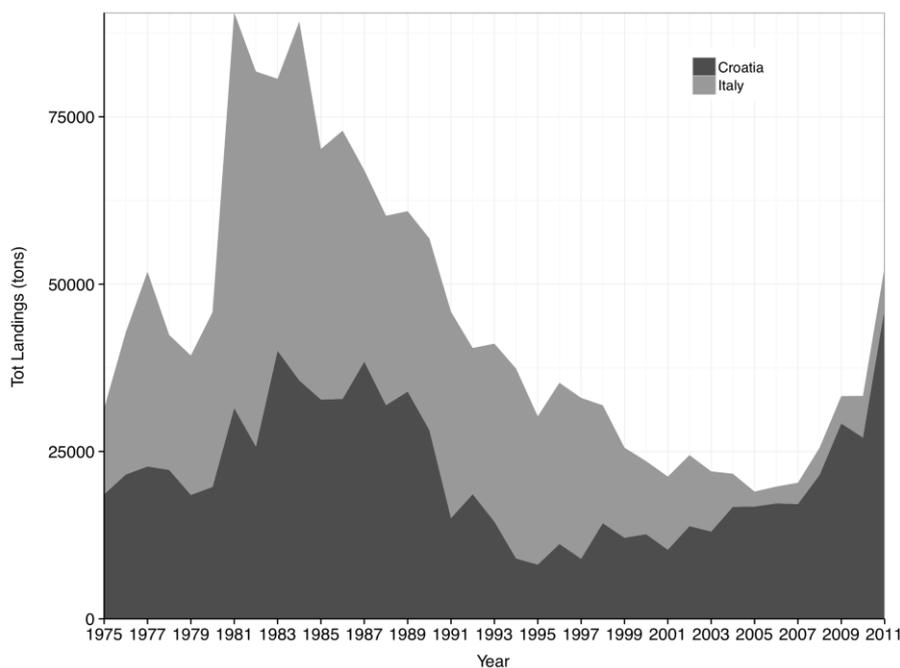


Fig. 6.17.2.3.1.1. Total landings (in tons) of sardine by country for GSA 17 from 1975 to 2011

The following table shows the annual landings (t):

Table 6.17.2.3.1.1. Total landings (tons) of sardine by year for the entire GSA 17.

Year	Catch	Year	Catch	Year	Catch	Year	Catch
1975	31455	1985	70192	1995	30244	2005	19008
1976	42825	1986	72932	1996	35272	2006	19759
1977	51852	1987	67017	1997	33012	2007	20329
1978	42417	1988	60217	1998	31895	2008	25566
1979	39337	1989	60900	1999	25574	2009	33279
1980	45822	1990	56824	2000	23558	2010	33301

1981	90563	1991	45869	2001	21242	2011	52546
1982	81771	1992	40457	2002	24459		
1983	80681	1993	41106	2003	22028		
1984	89213	1994	37393	2004	21671		

The trend of the cohorts in the catches is shown in Figure 6.17.2.3.1.2. Each plot represents the number of fish of each age born in the same year. Age 2 can be identified as the first fully recruited age in most of the years.

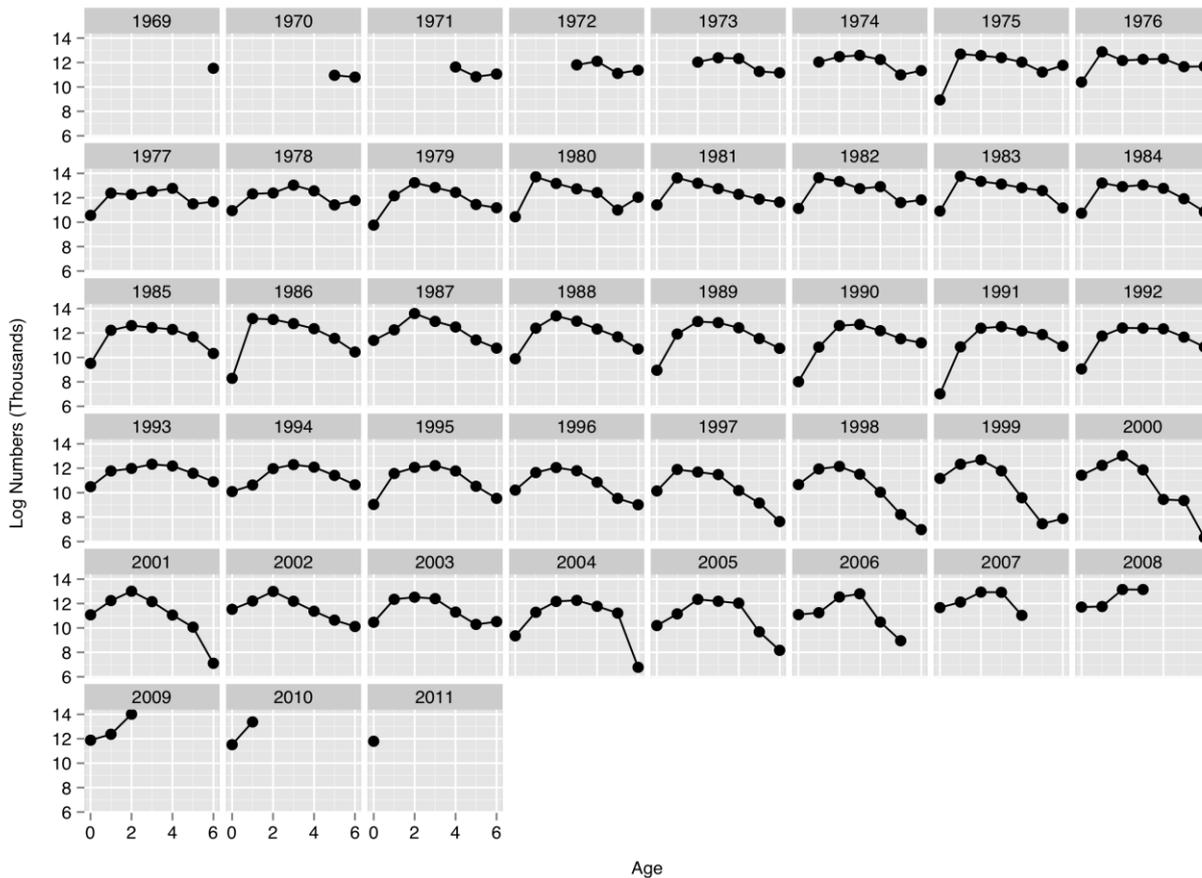


Fig. 6.17.2.3.1.2. Log numbers at age (thousands) of the catch at age used in the assessment of sardine in GSA 17.

6.17.2.3.2. Discards

Discards were not included in the catches because landings were almost equal to catches since very few fishes are discarded.

6.17.3. Scientific surveys

6.17.3.1. MEDIAS

6.17.3.1.1. Methods

Echosurveys were carried out from 2004 to 2011 for the entire GSA 17. In the western part the acoustic

survey was carried out since 1976 in the Northern Adriatic (2/3 of the area) and since 1987 also in the Mid Adriatic (1/3 of the area), and it is in the MEDIAS framework since 2009. The eastern part was covered by Croatian national pelagic monitoring program PELMON. The data from both the surveys have been combined to provide an overall estimate of numbers-at-age.

The survey methods for MEDIAS are given in the MEDIAS handbook (MEDIAS, March 2012).

Western Echosurvey:

- Length frequencies distribution available from 2004 onward (no LFD for Mid Adriatic in 2004, so the biomass at length in 2004 was assumed equal to the proportion of biomass at length in the 2005 Mid Adriatic survey).
- ALKs available for 2009-2010-2011;
- Numbers at age for 2004 to 2008 were obtained applying the sum of the 2009-2010-2011 ALKs to the numbers at length.

Eastern Echosurvey:

- Length frequencies distribution available from 2009.
- No ALKs available.
- Numbers at length from 2004 to 2008 were obtained applying the length frequency distribution from the 2009 survey to the total biomass.
- Numbers at age were obtained applying commercial ALK from the eastern catches to the eastern echosurvey length distribution.
- 2011 survey covered only the Northern part of the area (about 52% of the total area), so the estimated biomass was raised to the total using an average percentage from previous years (2004-2010).

6.17.3.1.2.Geographical distribution patterns

Acoustic sampling transects and the total area covered is shown in Figure 6.17.3.1.2.1.

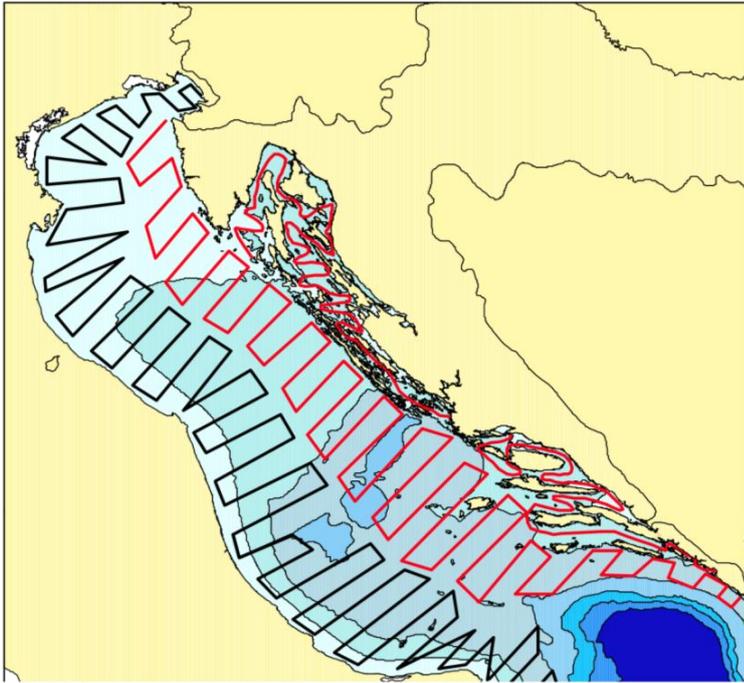


Fig. 6.17.3.1.2.1. Acoustic transects for the western echosurvey (black tracks).

6.17.3.1.3. Trends in abundance and biomass

Biomass estimates from the two surveys show a general higher occurrence of sardine on the eastern side of the Adriatic. Nevertheless, in 2011 the western survey contributed to about 83% of the total estimated biomass.

Pooled total biomass in tons from eastern and western echosurvey (2004-2011) is given in Table 6.17.3.1.3.1. and it is shown in figure 6.17.3.1.3.1.

Table 6.17.3.1.3.1. Total biomass (tons) estimated by the acoustic surveys in GSA 17.

	Tons
2004	287675
2005	140082
2006	312793
2007	217897
2008	272370
2009	365939
2010	258130
2011	483224

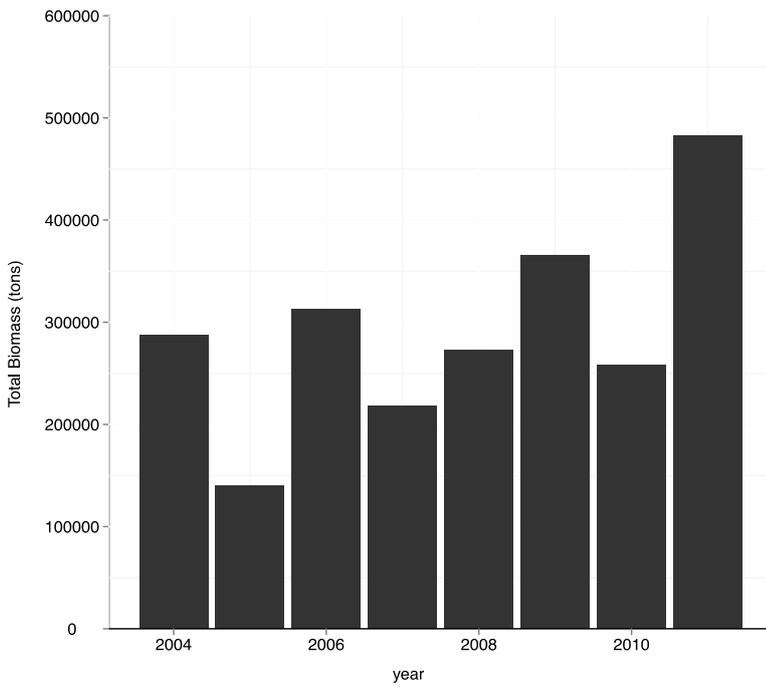


Fig. 6.17.3.1.3.1. Total biomass (tons) estimated from the eastern and western echosurvey.

Figure 6.17.3.1.3.2. Proportion by year of each age class from the surveys. In 2009 and 2011 a higher percentage of age 0 has occurred. Age 5 and age 6 are scarcely represented in the estimation.

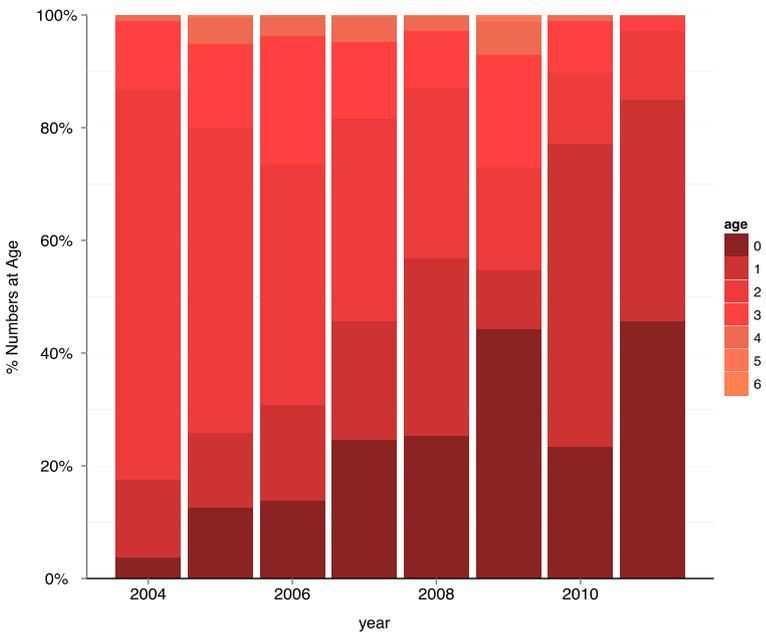


Fig. 6.17.3.1.3.2. Total proportion of age classes for the two surveys.

In Figure 6.17.3.1.3.3. the trend of the cohorts in the acoustic survey is shown. Each plot represents the number of fish of each age born in the same year:

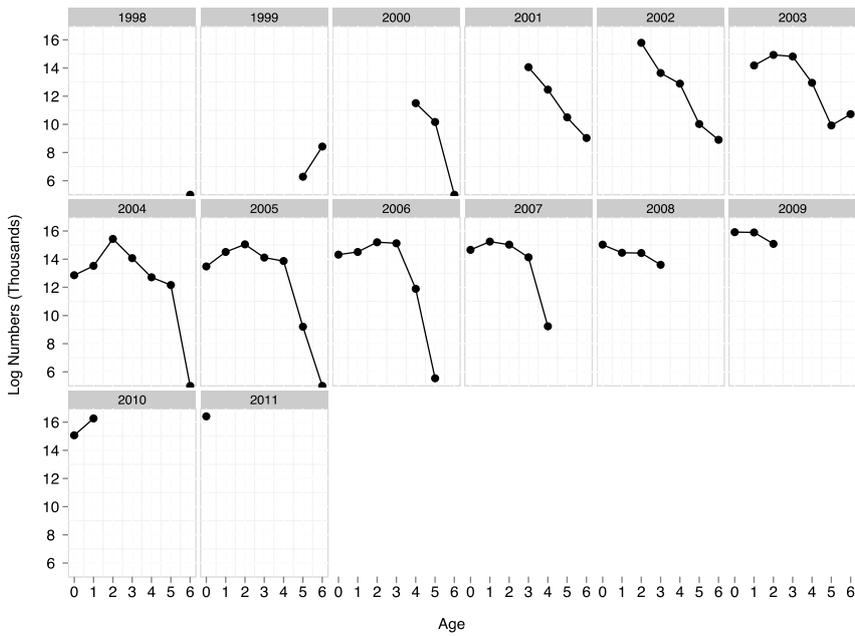


Fig. 6.17.3.1.3.3. Log numbers at age (thousands) of the echosurvey index used in the assessment of sardine in GSA 17.

6.17.3.1.4. Trends in abundance by length or age

No analyses were conducted during SGMED-12-19.

6.17.3.1.5. Trends in growth

No analyses were conducted during SGMED-12-19.

6.17.3.1.6. Trends in maturity

No analyses were conducted during SGMED-12-19.

6.17.4. Assessment of historic stock parameters

Integrated Catch Analysis (ICA) has been performed from 1975 to 2011. Acoustic survey was available for the assessment of sardine in GSA 17.

Age 0 was not included in the model. The high natural mortality of this particular age class, in fact, drives the biomass to really high and quite unrealistic values. Since age 0 is not largely represented in the catches, the WG decided not to include it in the assessment.

6.17.4.1. Method 1: ICA

6.17.4.1.1. Justification

Integrated Catch Analysis (ICA) has been performed from 1975 to 2011. Acoustic surveys were available for the assessment of sardine in GSA 17. In the ICA, the last x years of the available catch-at-age matrix, are fitted by a separable model: in this approach the F is partitioned into a year effect and an age effect. Parameters for this separable model are estimated by minimizing the squared differences between observed and predicted catches. The earlier year in the dataset are modeled by a conventional VPA.

ICA was performed using the Patterson's software (ICA, version 4.2 – Patterson and Melvin, 1996).

6.17.4.1.2. Input parameters

The final assessment of sardine was carried out by fitting the integrated catch-at age model (ICA) with a separable constraint over a seven-years period, tuned with the acoustic survey (2004-2011).

The model settings were the following:

7 years for separable constraint.

Reference age for separable constraint: 3.

Constant selection pattern model.

S to be fixed on last age: 1.1.

F_{bar} : 1-4.

Catchability model: Linear.

6.17.4.1.3. Results

The fishing mortality for age 3 (presented in Figure 6.17.4.1.3.1, top-right) shows a steep increase starting in 1996, a drop in 2003-2004-2005 to rise again thereafter up to highest value of the time series equal to 2.57. The $F_{bar}(1.4)$ in 2011 is equal to 1.6 (Figure 6.17.4.1.3.1).

The mid year spawning stock biomass (Figure 6.17.4.1.3.1, bottom-right) saw the highest values in the eighties (in 1984 have been estimated 1360000 tons); after that it start dropping down to the minimum in the time series reached in 1999 with around 65000 tons. Then the stock started to recovery. The estimate for 2011 is equal to 156000 tons.

The recruitment (age 1 – Figure 6.17.4.1.3.1, bottom-left) followed the trend in biomass, but in 2011 give a much more positive picture, with around 12069880 thousands of individuals.

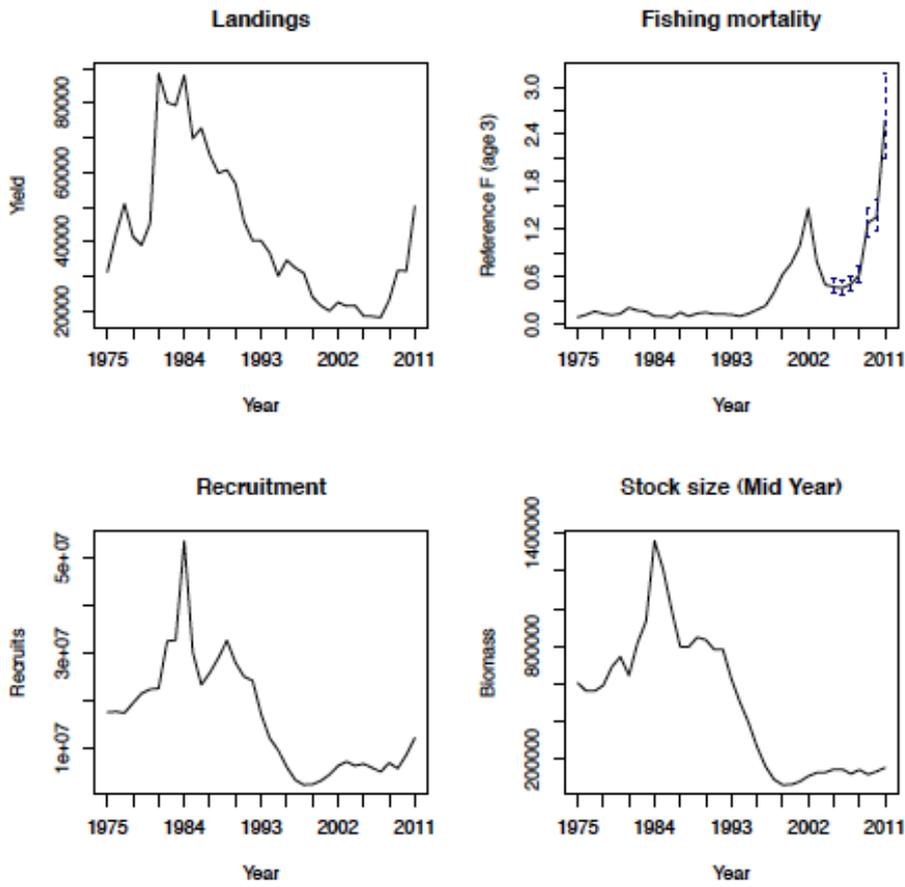


Fig. 6.17.4.1.3.1. Total landings in tons (top-left); reference F (F for age 2) with the confidence interval for the separability period (top-right); recruitment (as thousands individuals)(bottom-left); mid year stock biomass and SSB in tons (bottom-right).

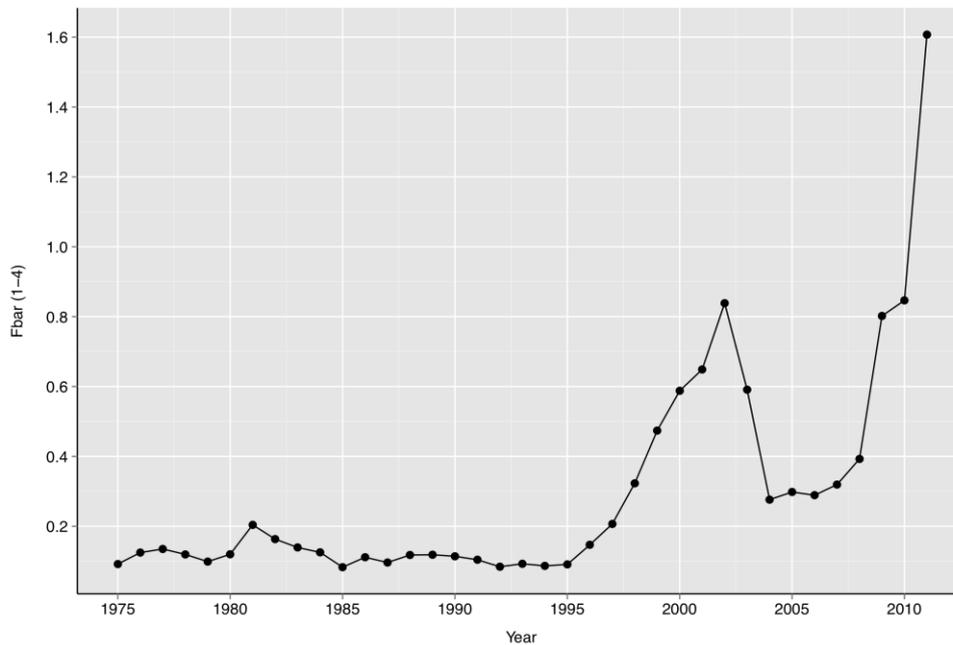


Fig. 6.17.4.1.3.2. Fbar (1-4) resulting from the ICA model for sardine in GSA 17.

Table 6.17.4.1.3.1 and 6.17.4.1.3.2 give respectively the stock numbers at age by year (in thousand) and the fishing mortality at age by year. In Table 6.17.4.1.3.3 the mid year stock biomass and the spawning stock biomass in tons are presented.

Table 6.17.4.1.3.1. Stock numbers at age by year (thousands) for sardine in GSA 17.

	Age1	Age2	Age3	Age4	Age5	Age6
1975	17446686	6017665	1967123	745494	527957	923251
1976	17595669	5714564	2701838	962209	343282	330197
1977	17307166	5678972	2497842	1281151	417783	393715
1978	19392917	5547264	2465627	1133676	565303	621151
1979	21385246	6325224	2466908	1153542	495525	584700
1980	22283795	6996132	2817640	1176271	534894	594332
1981	22467551	7312881	3112283	1318796	509569	564969
1982	32372913	6987744	3049734	1348898	495986	592372
1983	32575116	10321985	2921138	1371784	560127	719740
1984	53362861	10386278	4472415	1330124	597404	824061
1985	30055515	17245681	4445926	2160229	576662	686570
1986	23203166	9707528	7650925	2145391	1072711	1230298
1987	25749111	7612635	4272161	3758380	927231	956233
1988	28852904	8279422	3361424	1964669	1873593	873737
1989	32504906	9488336	3544737	1626001	861217	402591
1990	27855009	10687230	3903401	1654849	766661	332834
1991	24922001	9189967	4558860	1796952	774014	223378
1992	24107096	8267601	4019974	2145763	829919	306612
1993	17079111	7995917	3669619	1890624	1058555	414461
1994	12064918	5615441	3577825	1738954	895557	378555
1995	9491667	3945165	2461458	1729377	848877	382368

1996	6000990	3136938	1738371	1151224	844833	421064
1997	3270468	1939702	1362426	773687	489875	228459
1998	2233546	1026226	791884	576938	298474	143127
1999	2336357	663687	366257	282984	200094	117252
2000	3078941	694265	232106	104370	68641	76336
2001	4360675	901429	201946	57705	22461	22457
2002	6200497	1339063	213705	40231	14197	12209
2003	7124576	1951990	334735	26563	6871	3859
2004	6252030	2263292	623305	81157	4857	2971
2005	6642054	1955939	771781	202574	37089	7972
2006	5828236	2167116	772579	257436	68390	1718
2007	4965769	1902778	860513	261572	88349	3486
2008	6845410	1617880	742585	277417	85059	61260
2009	5668405	2219324	605712	212852	79268	58233
2010	8511818	1787914	658978	90099	29552	1356
2011	12069880	2676767	517670	91276	11565	4280

Table 6.17.4.1.3.2. Fishing mortality at age by year for sardine in GSA 17.

	Age1	Age2	Age3	Age4	Age5	Age6
1975	0.016	0.041	0.095	0.215	0.149	0.149
1976	0.031	0.068	0.126	0.274	0.208	0.208
1977	0.038	0.074	0.170	0.258	0.225	0.225
1978	0.020	0.050	0.140	0.268	0.193	0.193
1979	0.017	0.049	0.121	0.209	0.164	0.164
1980	0.014	0.050	0.139	0.277	0.195	0.195
1981	0.068	0.115	0.216	0.418	0.337	0.337
1982	0.043	0.112	0.179	0.319	0.288	0.288
1983	0.043	0.076	0.167	0.271	0.231	0.231
1984	0.030	0.088	0.108	0.276	0.223	0.223
1985	0.030	0.053	0.109	0.140	0.141	0.141
1986	0.014	0.061	0.091	0.279	0.189	0.189
1987	0.035	0.057	0.157	0.136	0.162	0.162
1988	0.012	0.088	0.106	0.265	0.219	0.219
1989	0.012	0.128	0.142	0.192	0.249	0.249
1990	0.009	0.092	0.156	0.200	0.219	0.219
1991	0.003	0.067	0.134	0.213	0.189	0.189
1992	0.004	0.052	0.134	0.147	0.152	0.152
1993	0.012	0.044	0.127	0.187	0.155	0.155
1994	0.018	0.065	0.107	0.157	0.159	0.159
1995	0.007	0.060	0.140	0.156	0.165	0.165
1996	0.029	0.074	0.190	0.294	0.244	0.244
1997	0.059	0.136	0.239	0.392	0.360	0.360
1998	0.114	0.270	0.409	0.499	0.597	0.597
1999	0.113	0.291	0.635	0.856	0.820	0.820
2000	0.128	0.475	0.772	0.976	1.101	1.101
2001	0.081	0.679	0.993	0.842	1.350	1.350
2002	0.056	0.626	1.465	1.207	1.589	1.589
2003	0.047	0.382	0.797	1.139	1.068	1.068
2004	0.062	0.316	0.504	0.223	0.587	0.587
2005	0.020	0.169	0.478	0.526	0.526	0.526

2006	0.019	0.164	0.463	0.509	0.509	0.509
2007	0.021	0.181	0.512	0.563	0.563	0.563
2008	0.026	0.222	0.630	0.693	0.692	0.692
2009	0.054	0.454	1.285	1.414	1.414	1.414
2010	0.057	0.479	1.357	1.493	1.492	1.492
2011	0.108	0.910	2.576	2.834	2.833	2.833

Table 6.17.4.1.3.3. Mid year Stock Biomass and Spawning Stock Biomass (tons). From age 1 all the specimens are mature, so the stock biomass coincide with the SSB.

	MidYear SB / SSB
1975	606951
1976	562947
1977	563158
1978	593477
1979	691198
1980	744921
1981	646165
1982	818055
1983	933058
1984	1360108
1985	1211078
1986	995766
1987	799258
1988	797290
1989	848497
1990	835601
1991	783010
1992	785333
1993	627325
1994	503895
1995	396989
1996	267162
1997	162800
1998	93220
1999	64708
2000	65990
2001	81952
2002	110649
2003	129293
2004	130885
2005	147448
2006	147152
2007	123173
2008	144745
2009	119925
2010	135512
2011	156071

The diagnostic graph of the index SSQ against reference age F (age 2) from a separable VPA is plotted in Figure 6.17.4.1.3.3. The curves should be U-shaped, with minima fairly close to each other on *x*-axis (Needle, 2000).

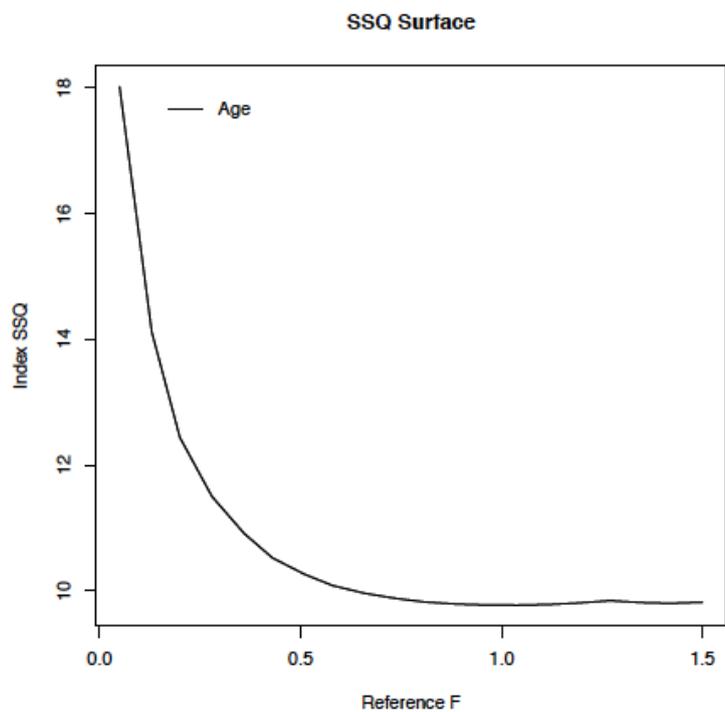


Fig. 6.17.4.1.3.3. SSQ surface plot.

The marginal totals of residuals between the catch and the separable model are overall small, as well as reasonably trend-free in the separable period (2000-2011) (see Figure 6.17.4.1.3.4).

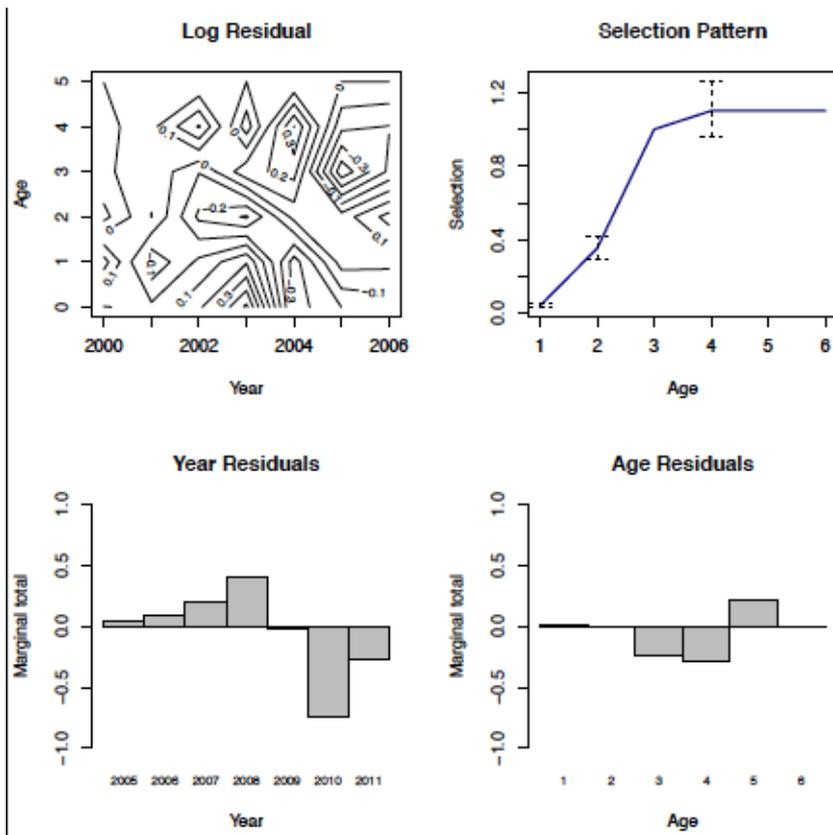


Fig. 6.17.4.1.3.4. Diagnostics: log-residual contour plot (top-left); fitted selection pattern (top-right); year residuals for the catches (bottom-left); age residuals for the catches (bottom-right).

In Figure 6.17.4.1.3.5 the fitting between the predicted and observed index numbers at age is presented. With the exception of 2009, on the overall the estimated data fit well to the observed ones.

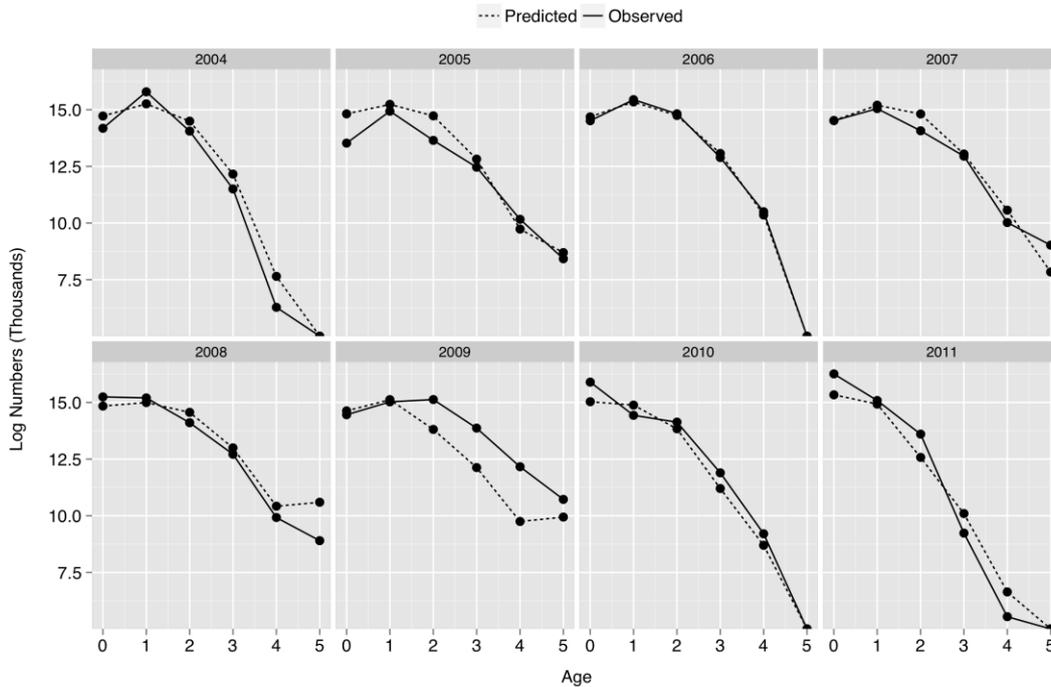


Fig. 6.17.4.1.3.5. Predicted VS observed echosurvey numbers at age for sardine in GSA 17.

Retrospective analysis was applied in the ICA model for the Adriatic sardine 1975-2011 with four years backward analysis. Results are presented in Figure 6.17.4.1.3.6, showing a high retrospective bias in the reference F estimation, constantly underestimated throughout the years. On the other hand, SSB and recruitment are consistent except for the 2009 estimation.

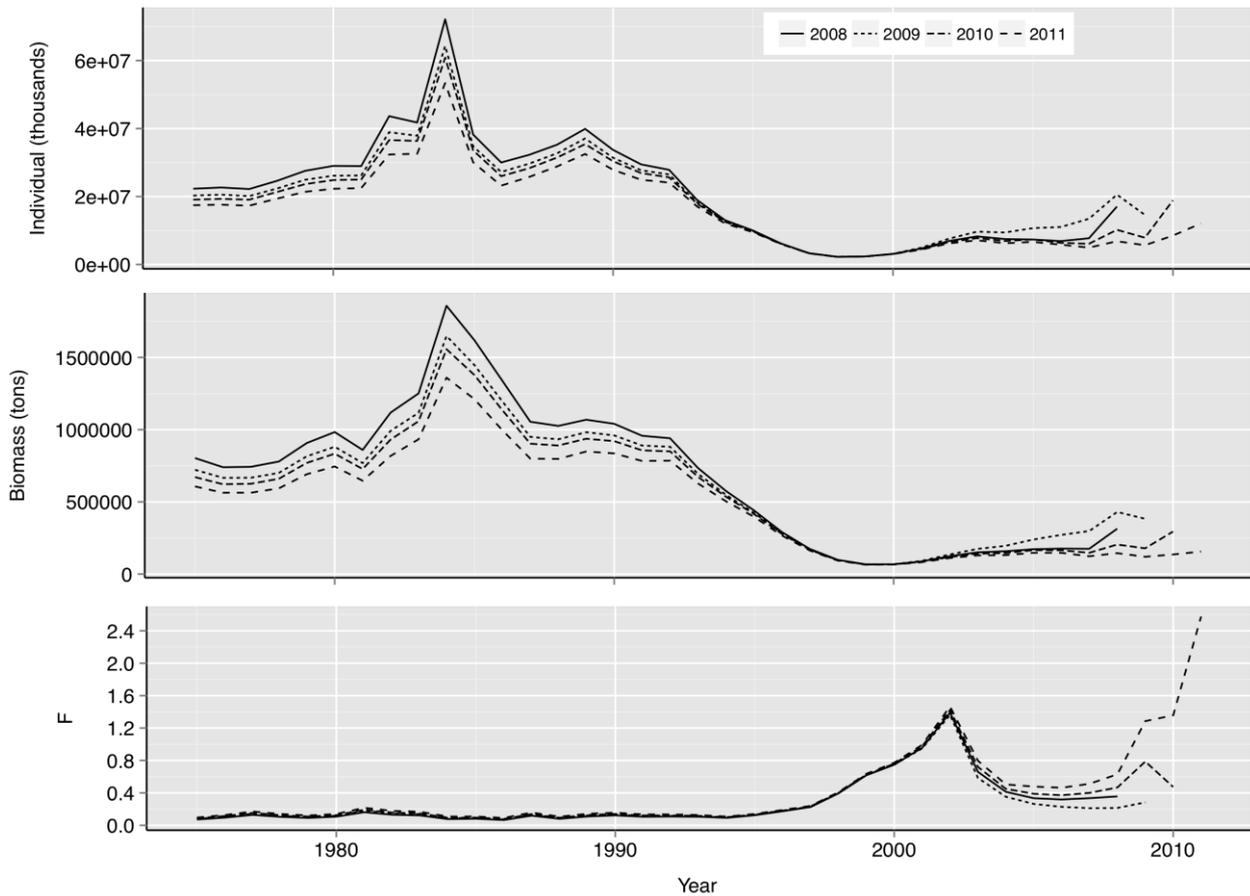


Fig. 6.17.4.1.3.6. The results of retrospective analysis of ICA model 1975-2011 for sardine in GSA 17, concerning recruitment, SSB and reference F (age3).

The annual exploitation rate $E = F/(F+M)$ or F/Z was calculated and plotted over the years for the ages 1-4 and it's equal to 0.57. The values obtained were compared with the threshold $F/Z = 0.4$ adopted as biological reference point for small pelagics (Patterson, 1992). The trends in values of F/Z were plotted in Figure 6.17.4.1.3.7.

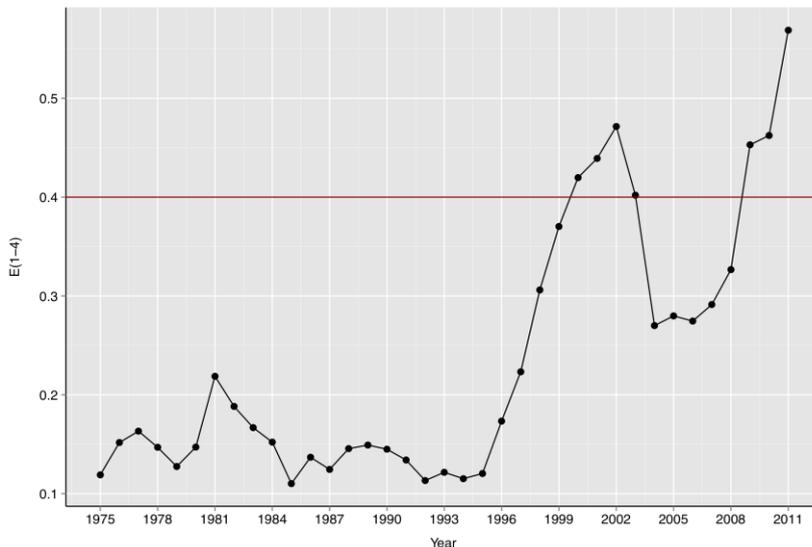


Fig. 6.17.4.1.3.7. Exploitation rate for the age 1-4 obtained by the ICA model for sardine in GSA 17.

6.17.5. Data quality

MEDIAS Eastern sampling coverage was incomplete in 2011 due to logistic problems so the observed biomass was raised to the total area using the average abundance percentage estimated in the previous years.

6.17.6. Scientific advice

6.17.6.1. Short term considerations

6.17.6.1.1.State of the spawning stock size

Estimates of fishery independent surveys for sardine in GSA 17 indicated a strong increase in biomass in the last year, reaching the value of about 500000 tons. Results of the Integrated Catch at Age analysis indicated a more or less stable biomass in the last 10 years, being the 2011 the highest, with 156000 tons. Reference points were estimated for the first time during this WG as described in section xxx. The level of sardine SSB in 2011 is much lower than both the estimated reference points for B_{lim} and B_{pa} ($B_{lim} = 408032$ t, $B_{pa} = 571245$ t).

It should be considered that this assessment is based on a long time series of data and that the oldest years of catch data in the time series can be biased. Moreover, sardine is a short lived species characterized by high fluctuations in abundance and recruitment strongly depends on environmental conditions.

6.17.6.1.2.State of recruitment

After the drop in recruitment occurred from 1985 to 1998, the recruitment level stabilized around an average value of 6144973 thousands specimens from 1999 to 2011. The last year estimates is the highest registered since 1994 and it's equal to 12069880 thousands individuals.

6.17.6.1.3.State of exploitation

Based on ICA results, the F of the reference age 3 is strongly increasing since 1995, with low values only between 2004 and 2008. The $F_{bar}(1-4)$ shows the same increasing trend with the highest value in 2011 ($F_{bar} =$

1.6), being much higher than the suggested F_{MSY} of 0.25. The exploitation rate in the last 3 years is above the reference point of 0.4, being equal in 2011 to 0.57.

Based on this assessment results the stock is considered to be exploited unsustainably. However, this has to be confirmed in following years and the sardine stock should be monitored on an annual basis. Mixed fisheries implications, i.e. the interaction with anchovy, need to be considered when managing this fishery.

6.18. Stock assessment of Giant red shrimp in GSA 18

6.18.1. Stock identification and biological features

6.18.1.1. Stock Identification

The stock of giant red shrimp *Aristaeomorpha foliacea* was assumed to be confined in the boundaries of the whole GSA18, lacking specific information on stock identity. In the past this species was considered rare in this GSA, though recently has become more frequent in the experimental catches of the trawl surveys and in the commercial catches as well.

6.18.1.2. Growth

The following estimates of von Bertalanffy growth parameters for each sex were used: females $CL_{\infty}=73$ mm, $K=0.438$, $t_0=-0.1$; males: $CL_{\infty}=50$ cm, $K=0.5$, $t_0=-0.1$.

6.18.1.3. Maturity

The maturity ogive used was $L_{m50\%} = 34.4 \text{ cm} \pm 0.25 \text{ mm}$ with maturity range of $3.35 \pm 0.16 \text{ mm}$.

6.18.2. Fisheries

6.18.2.1. General description of fisheries

The Giant red shrimp is only targeted by trawlers on fishing grounds located offshore 200 m depth, mainly in the northernmost and southernmost parts of the GSA between 400 and 700 m depth. Giant red shrimp occurs with *A. antennaus*, *P. longirostris* and *N. norvegicus*, depending on operative depth and area.

6.18.2.2. Management regulations applicable in 2010 and 2011

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 and the fishing capacity has been gradually reduced. Other measures on which the management regulations are based regards technical measures (mesh size) and seasonal fishing ban, that in southern Adriatic has been mandatory since the late eighties. In 2008 a management plan was adopted, that foresaw the reduction of fleet capacity associated with a reduction of the time at sea. Two biological conservation zone (ZTB) were permanently established in 2009 (Decree of Ministry of Agriculture, Food and Forestry Policy of 22.01.2009; GU n. 37 of 14.02.2009) along the mainland, offshore Bari (180 km², between about 100 and 180 m depth), and in the vicinity of Tremiti Islands (115 km² along the bathymetry of 100 m) on the northern border of the GSA, where a marine protected area (MPA) had been established in 1989. In the former only the professional small scale fishery using fixed nets and long-lines is allowed, from January 1st to June 30, while in the latter the trawling fishery is allowed from November 1st to March 31 and the small scale fishery all year round. Since June 2010 the rules implemented in the EU regulation (EC 1967/06) regarding the cod-end mesh size and the operative distance of fishing from the coasts are enforced.

6.18.2.3. Catches

6.18.2.3.1. Landings

Available landing data are from DCF regulations. EWG 12-19 received Italian landings data for GSA 18 by fisheries which are listed in Table 6.18.2.3.1.1 (in 2004-2008 the species was not a target for biological sampling in this GSA, thus the data of landings of these years were provided by the team in charge of DCF data collection in the western area).

Trawlers are the only fleet segment exploiting this resource. Higher landings were observed in 2006, 2007 and 2010 (Table 6.18.2.3.1.1).

Table 6.18.2.3.1.1. Annual landings (tons) by fishery (2004-2011).

YEAR	Level 4	Level 5	LANDINGS
2004	OTB	MDDWSP	89
2005	OTB	MDDWSP	72
2006	OTB	MDDWSP	166
2007	OTB	MDDWSP	115
2008	OTB	DWSP	59
2008	OTB	MDDWSP	37
2009	OTB	DWSP	30
2009	OTB	MDDWSP	58

2010	OTB	DWSP	48
2010	OTB	MDDWSP	79
2011	OTB	DWSP	21
2011	OTB	MDDWSP	54

6.18.2.3.2.Discards

Discards data were available, but the proportion of the discards of giant red shrimp in the GSA 18 was negligible.

6.18.2.4. Fishing effort

The trends in fishing effort by year and major gear type in terms of kW*days are listed in Table 6.18.2.4.1 and in Figure 6.18.2.4.1.

The fishing effort of trawlers that is the major component of fishing in the area is decreasing.

Table 6.18.2.4.1. Effort (kW*days) for GSA 18 by gear type, 2004-2011 as reported through the DCF official data call.

YEAR	GNS	GTR	LLS	OTB		
				DEMSP	DWSP	MDDWSP
2004	67828	29235	60741	147850		2388604
2005	94644	69435	80581	56423		2309466
2006	120055	32007	76098	598799		2054616
2007	70224	45292	74171	519085		1759397
2008	50376	83968	107911	1890398	29701	119323
2009	78139	80946	64941	2101567	18235	266753
2010	57056	79765	87474	1608697	21524	437823
2011	44943	79593	76512	1607442	10809	281989

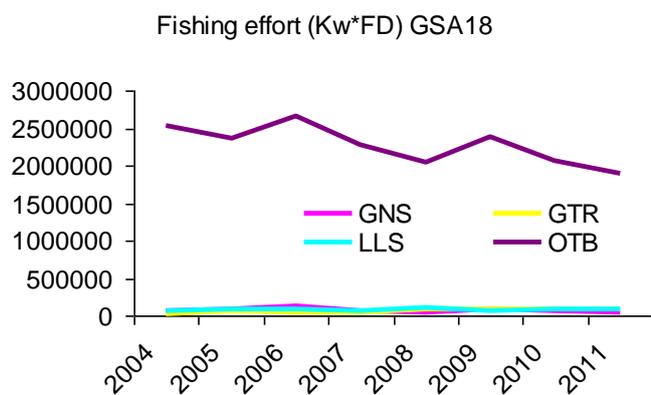


Fig. 6.18.2.4.1. Fishing effort of trawlers (KW*days).

The fishing effort of trawlers, which is the major component of fishing in the area, is decreasing.

6.18.3. Scientific surveys

6.18.3.1. MEDITS

6.18.3.1.1. Methods

According to the MEDITS protocol (Bertrand et al., 2002), trawl surveys were yearly (May-July) carried out, applying a random stratified sampling by depth (5 strata with depth limits at: 50, 100, 200, 500 and 800 m; each haul position randomly selected in small sub-areas and maintained fixed throughout the time). Haul allocation was proportional to the stratum area. The same gear (GOC 73, by P.Y. Dremière, IFREMER-Sète), with a 20 mm stretched mesh size in the cod-end, was employed throughout the years. Detailed data on the gear characteristics, operational parameters and performance are reported in Dremière and Fiorentini (1996). Considering the small mesh size a complete retention was assumed. All the abundance data (number of fish and weight per surface unit) were standardised to square kilometre, using the swept area method.

Based on the DCF data call, abundance and biomass indices were recalculated. In GSA 18 the following number of hauls was reported per depth stratum (Table 6.18.3.1.1.1).

Table 6.18.3.1.1.1. Number of hauls per year and depth stratum in GSA 18, 1994-2011.

Stratum	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
10-50 m	14	14	18	17	17	17	17	18	12	12	11	10	11	10	13	12	12	12
50-100 m	14	15	24	25	25	26	25	24	20	19	21	20	21	22	21	20	20	20
100-200 m	24	23	33	33	33	32	33	33	31	32	31	33	31	31	33	30	31	31
200-500 m	10	10	18	18	18	19	18	18	13	13	13	13	13	13	12	14	13	13
500-800 m	10	10	19	19	19	18	19	19	14	14	14	14	14	14	11	14	14	14
Total	72	72	112	112	112	112	112	112	90	90	90	90	90	90	90	90	90	90

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Y_{st} = \sum (Y_i * A_i) / A$$

$$V(Y_{st}) = \sum (A_i^2 * s_i^2 / n_i) / A^2$$

Where:

A=total survey area

A_i=area of the i-th stratum

s_i=standard deviation of the i-th stratum

n_i=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Y_i=mean of the i-th stratum

Y_{st}=stratified mean abundance

V(Y_{st})=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = $Y_{st} \pm t(\text{student distribution}) * V(Y_{st}) / n$

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution and/or quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.18.3.1.2. Geographical distribution patterns

The geographical distribution pattern of the nursery of the giant red shrimp has been studied in the area using MEDITS trawl-survey data. The abundance was higher in the southern part of the GSA in the vicinity of the Otranto Channel, though some nuclei with higher abundance of recruits were also identified in the northernmost part of the GSA (Figure 6.18.3.1.2.1).

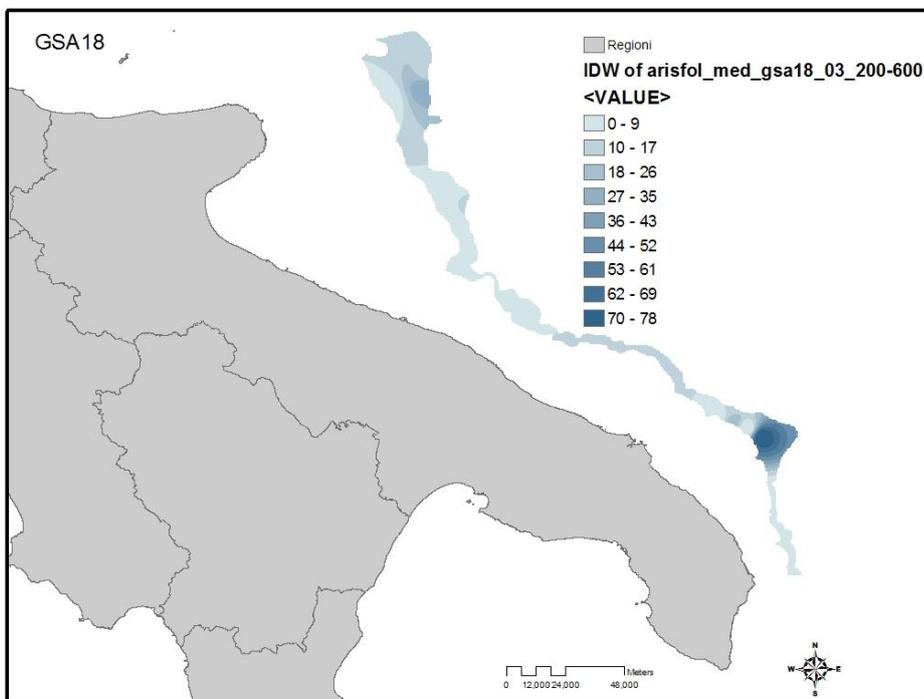


Fig. 6.18.3.1.2.1. Maps of the abundance of the giant red shrimp recruits in the western part of GSA 18 (from MEDITS survey in 2003).

6.18.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of giant red shrimp in the whole GSA18 was obtained from the international survey MEDITS.

Figure 6.18.3.1.3.1 displays the estimated trend of *A. foliacea* abundance and biomass standardized to the hour in the GSA18. The pattern is growing to 2003; then there is a slight decrease in 2004 followed by a remarkable increase in 2006. After this year the abundance indices are sharply decreasing in 2007 and then increasing to 2009. In 2010 and 2011 the values are again low (Figure 6.18.3.1.3.1).

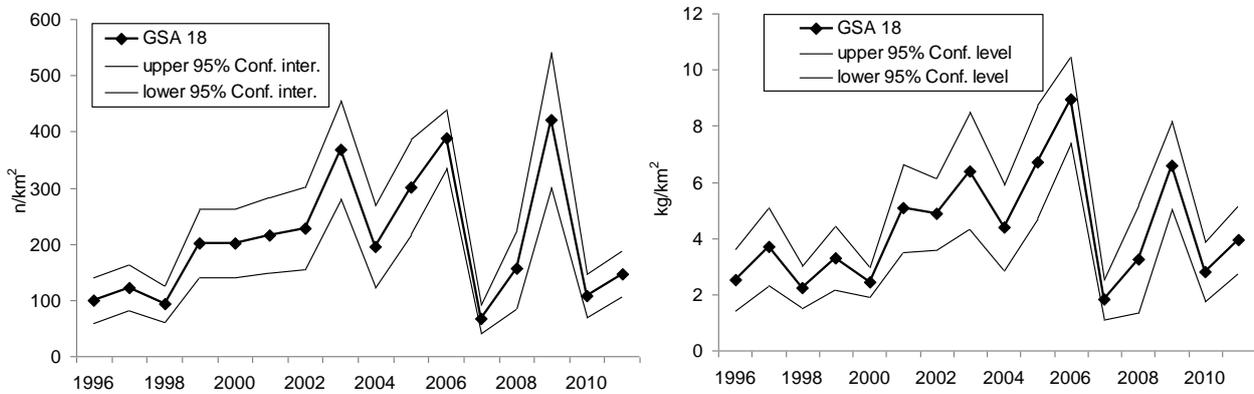
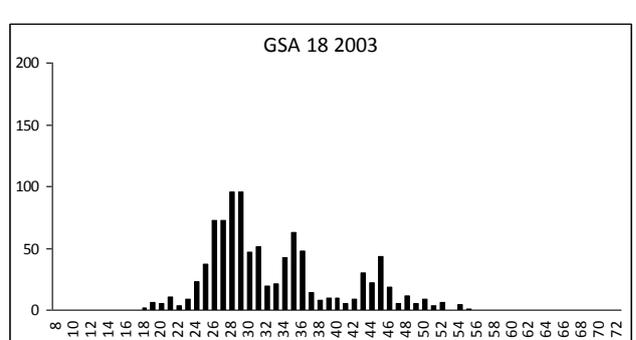
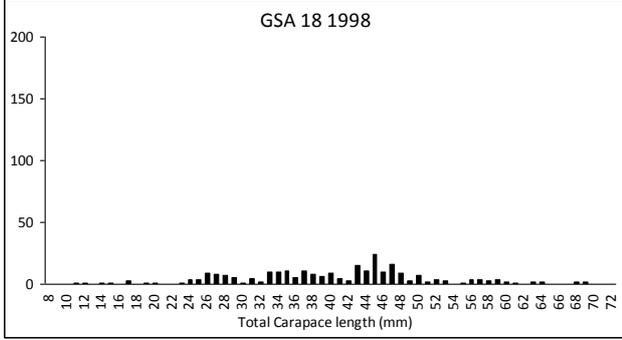
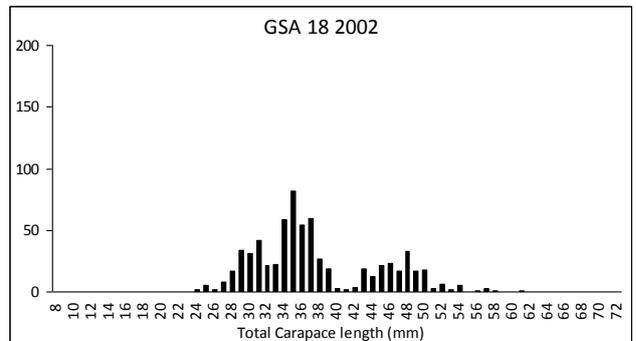
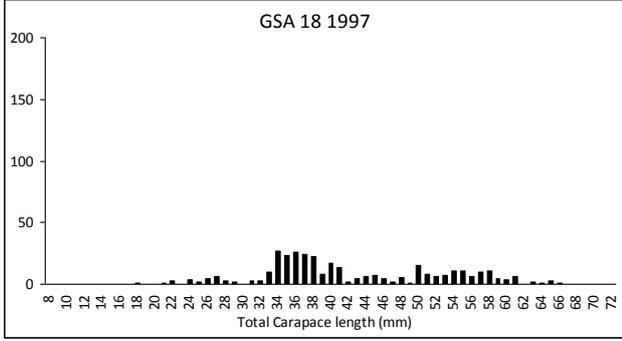
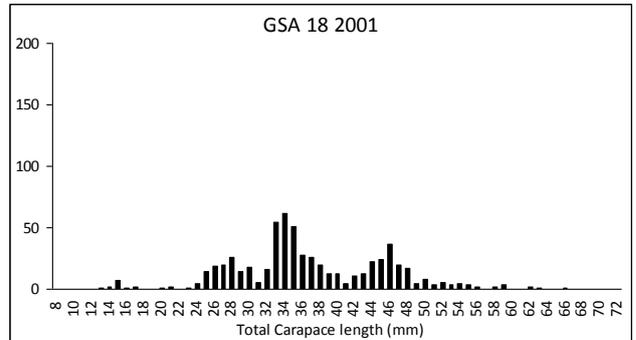
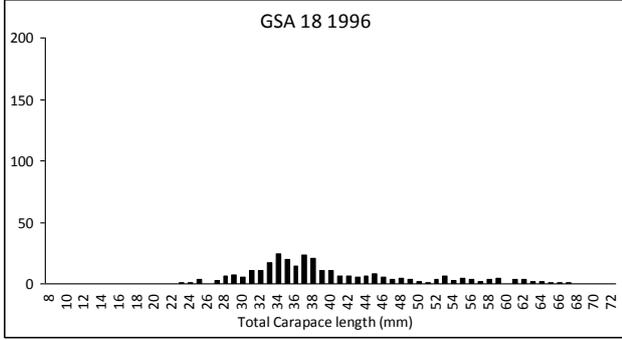
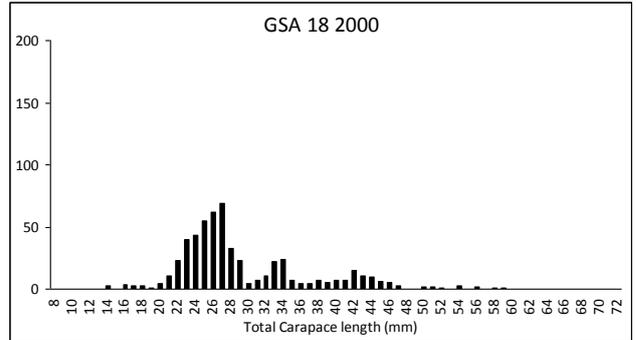
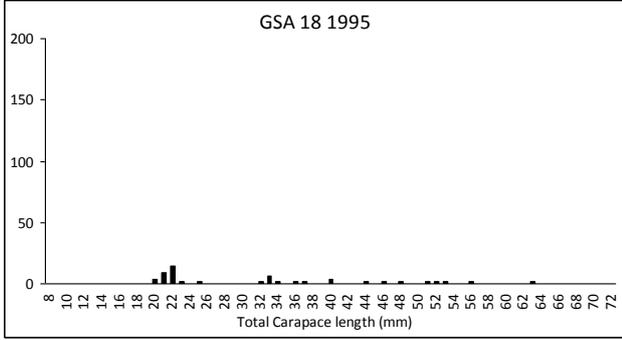
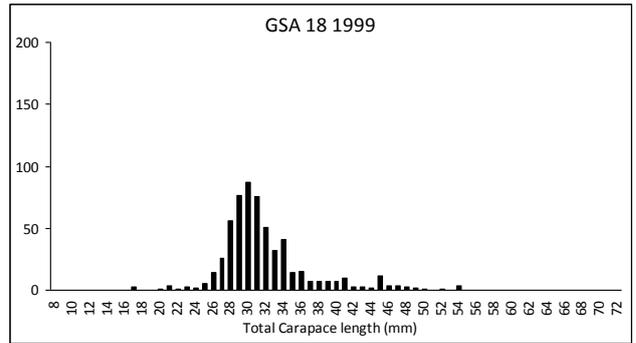
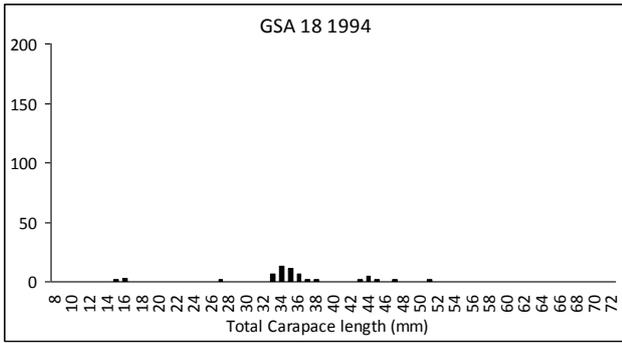


Fig. 6.18.3.1.3.1. Abundance and biomass indices of giant red shrimp in GSA 18.

6.18.3.1.4. Trends in abundance by length or age

No trend in the mean length was observed. The LFDs are rather varying throughout the MEDITS surveys. The species started to be more abundant since 1999.

The following Figure 6.18.3.1.4.1 displays the stratified abundance indices by length class in the GSA 18 in 1994-2011.



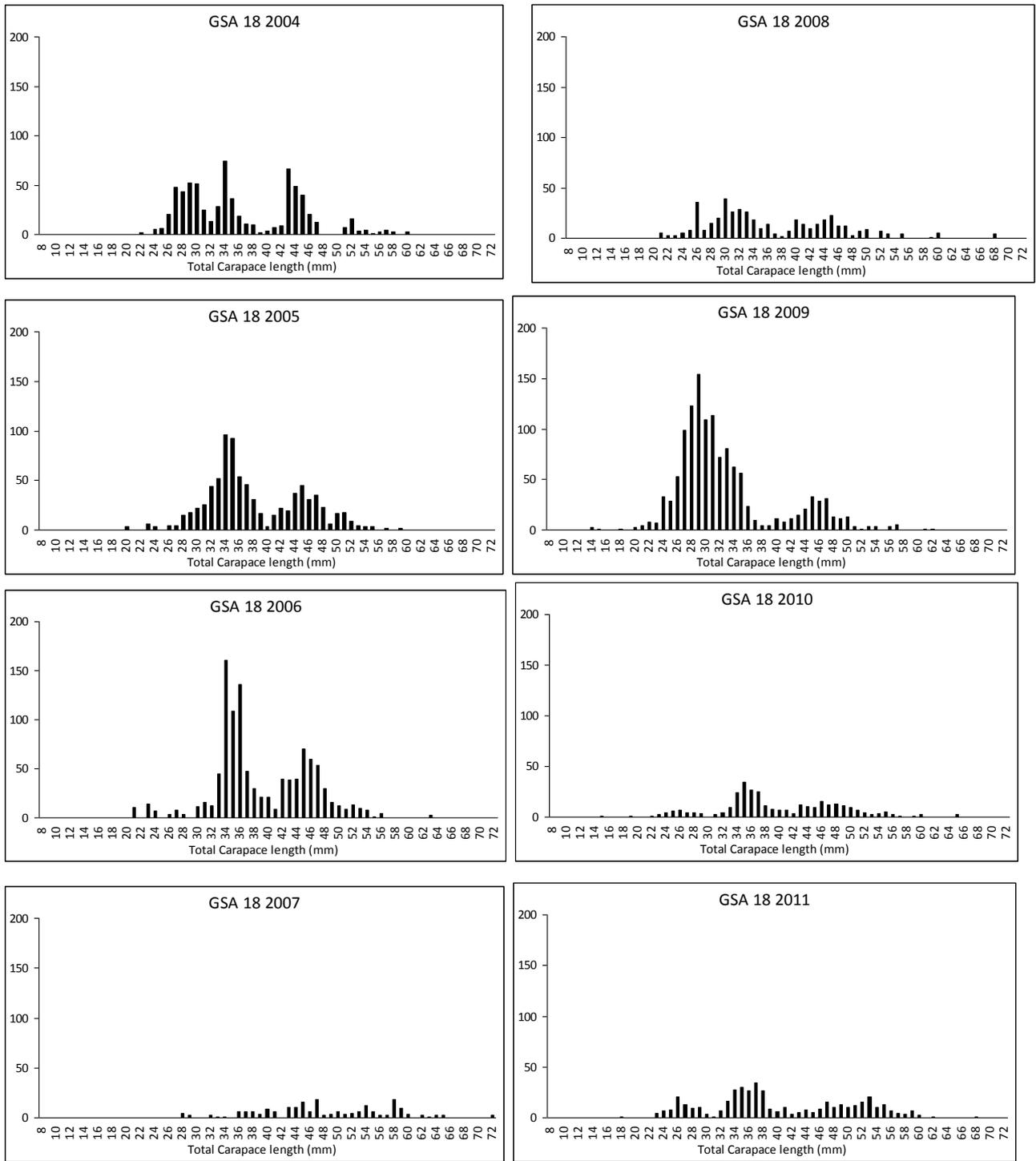


Fig. 6.18.3.1.4.1. Stratified abundance indices by size, 1994-2011.

6.18.3.1.5. Trends in growth abundance by length or age

No analyses were conducted during EWG-12-19.

6.18.3.1.6. Trends in maturity

No analyses were conducted during EWG-12-19.

6.18.4. Assessment of historic stock parameters

6.18.4.1. Method 1: VIT

6.18.4.1.1. Justification

VIT software was applied using the landing structures at age of 2009, 2010 and 2011 from DCF. Three separate analyses were performed (one for each year).

6.18.4.1.2. Input parameters

The set of parameters used in VIT were:

$CL_{\infty} = 7.3$ cm, $K = 0.438$, $t_0 = -0.1$; length-weight relationship: $a = 0.678$, $b = 2.51$.

Natural mortality at age was obtained using Prodbiom. A terminal fishing mortality $F_{term} = 0.5$ was used.

Age	0	1	2	3	4+
M	1.14	0.44	0.3	0.23	0.2
Proportion of mature	0	0.1	1	1	1

The number of individuals in landing at age used as input in VIT is showed below. In 2009 age 1 was more abundant in the catches, while in 2010 and 2011 age 2 was more abundant. The F current calculated in the age range 0-3 years.

Table 6.18.4.1.2.1. Landings in numbers at age in 2009, 2010 and 2011.

Age	2009	2010	2011
0	1347067	1469539	129367
1	3313990	2811438	795852
2	2307553	3104424	2319251
3	260061	468046	613956
4+	23572	44435	32458

* the last class is a plus group.

6.18.4.1.3. Results

Reconstructed catch in number and weight at age as estimated by the pseudocohort analysis using VIT and the estimates of total and fishing mortality at age for sex combined are plotted in the Figure 6.18.4.1.3.1. Z current was 1.7 in 2009, 1.57 in 2010 and 1.53 in 2011 (average over ages 0-3). The average fishing mortality acting on the age groups 0-3 was 1.17 in 2010, 1.05 in 2010 and 1.00 in 2011.

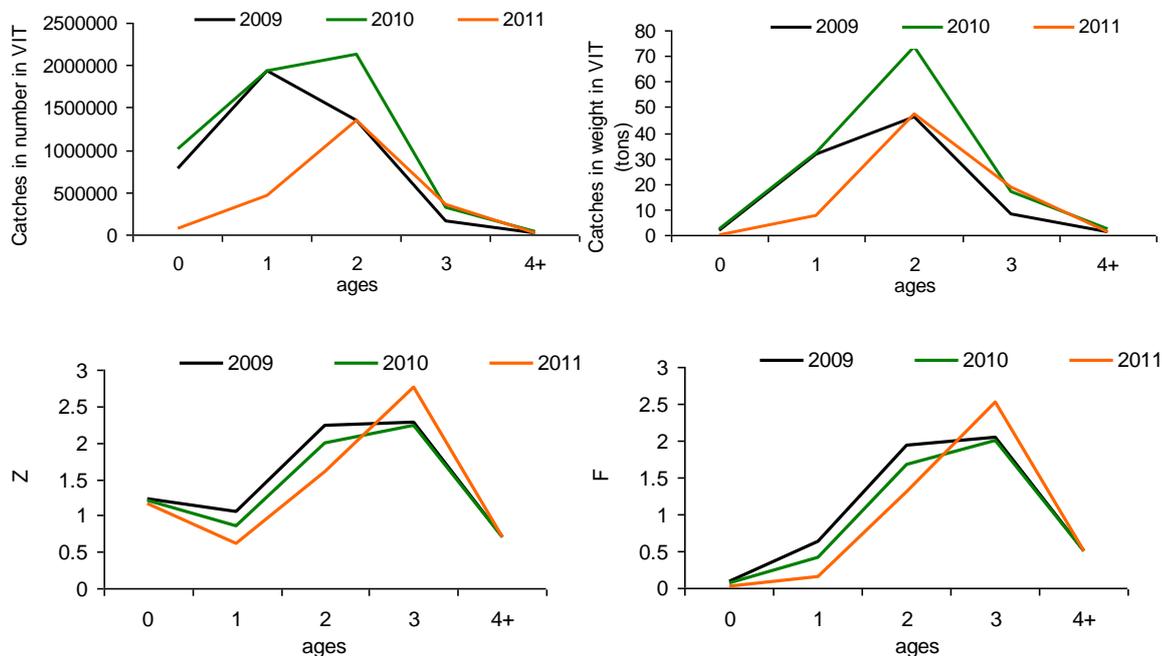


Fig. 6.18.4.1.3.1. Reconstructed catch in number and weight at age and total and fishing mortality at age as estimated by the pseudocohort analysis using VIT, by year (2009-2011).

6.18.5. Long term prediction

Y/R analysis has been applied for long term predictions using VIT software.

6.18.5.1. Method 1: VIT

6.18.5.1.1. Justification

The Y/R approach as implemented in the VIT software under equilibrium conditions was used to estimate limit and target reference points for the stock.

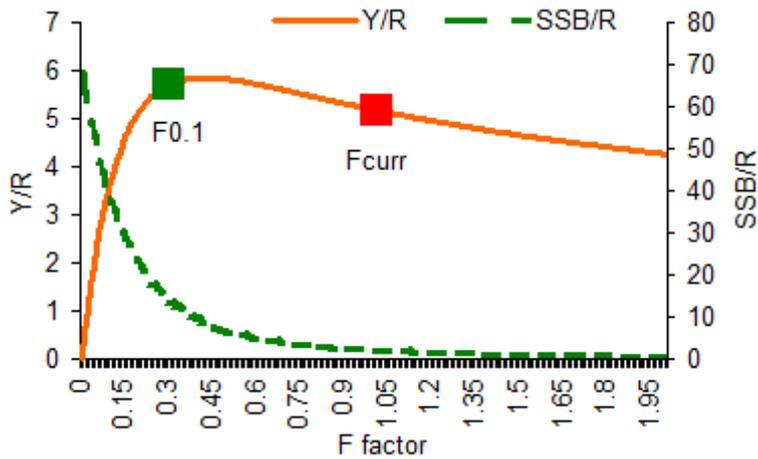
6.18.5.1.2. Input parameters

Input parameters are given in section 6.18.4.1.2 on the VIT assessment above.

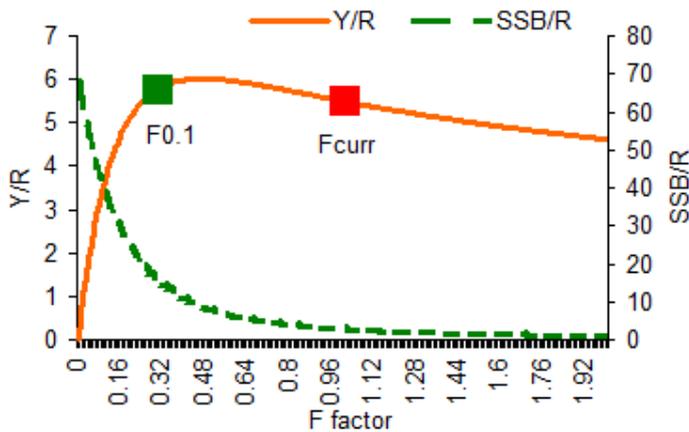
6.18.5.1.3. Results

Results of the YPR results from VIT are shown in the Figure 6.18.5.1.3.1. The Yield per Recruit analyses indicate that the reference point $F_{0.1}$ (proxy of F_{msy}) is 0.3 (last year).

2009	Ffactor	F	Y/R	B/R	SSB/R
F(0)	0	0	0.00	72.95	67.51
F(0.1)	0.25	0.29	5.52	22.45	17.43
Fmax	0.43	0.50	5.85	13.48	8.72
Fcurr	1.01	1.17	5.18	6.06	2.05
Fdouble	2	2.34	4.26	3.70	0.60



2010	Ffactor	F	Y/R	B/R	SSB/R
F(0)	0	0	0.00	72.95	67.51
F(0.1)	0.27	0.28	5.64	23.02	17.92
Fmax	0.48	0.50	6.01	13.70	8.83
Fcurr	1.01	1.05	5.50	7.11	2.79
Fdouble	2	2.09	4.61	4.46	0.94



2011	Ffactor	F	Y/R	B/R	SSB/R
F(0)	0	0	0.00	72.95	67.51
F(0.1)	0.3	0.30	6.08	22.85	17.54
Fmax	0.58	0.58	6.53	13.52	8.31
Fcurr	1.01	1.00	6.30	9.33	4.29
Fdouble	2	2.00	5.74	6.72	2.03

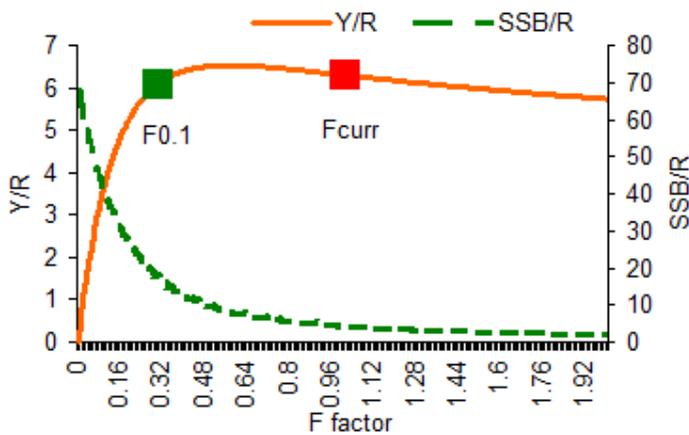


Fig. 6.18.5.1.3.1. Overall results and graphs of Y/R analysis using VIT software, years 2009-2011. Giant red shrimp, GSA18.

6.18.6. Data quality and availability

Data from DCF 2012 were used. A consistent sum of products compared to landings was observed (differences less than 10% for age data and lesser than 5% for length data).

Discards data of 2009, 2010 and 2011 were available. In 2009, 2010 and 2011 data were provided by year and level 4. Information on number of samples for landings, discards and catches, as well as the number of measurements by length for landings, discards and catches were also available.

6.18.7. Scientific advice

6.18.7.1. Short term considerations

6.18.7.1.1.State of the spawning stock size

In the absence of proposed and agreed precautionary management references, EWG 12-19 is unable to fully evaluate the status of SSB. Survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h). The pattern is growing to 2003; then there is a slight decrease in 2004 followed by a remarkable increase in 2006. After this year the abundance indices are sharply decreasing in 2007 and then increasing to 2009. In 2010 and 2011 the values are again low.

A scatter plot of the abundance indices of recruits (individuals smaller than ~31 mm carapace length) vs. abundance indices of spawners (individuals larger than ~36 mm carapace length) from MEDITS is reported in the Figure 6.18.7.1.1.1.

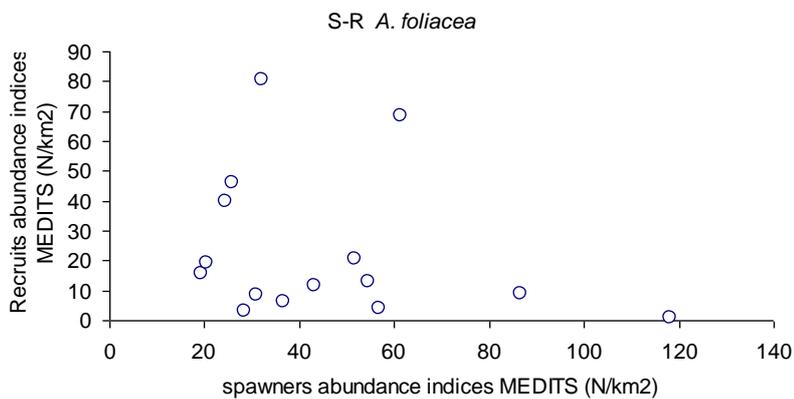


Fig. 6.18.7.1.1.1. Scatter plot of the abundance indices of recruits (<31 mm carapace length) vs. abundance indices of spawners (>36 mm carapace length) from MEDITS.

State of recruitment

Recruitment estimates from MEDITS surveys (individuals smaller than ~30 mm carapace length) in the GSA 18 are highly fluctuating and showed three peaks (Figure 6.18.7.1.1.2): in 1999-2000, in 2003 and in 2009; the values of 2010 and 2011 are among the lower of the time series.

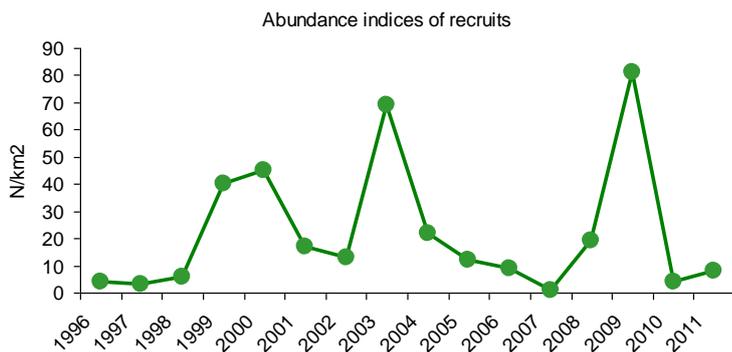


Fig. 6.18.7.1.1.2. Recruits (individuals smaller than ~30 mm carapace length) from MEDITS data.

6.18.7.1.2.State of exploitation

EWG 12-19 proposes $F_{0.1}$ (as a proxy of F_{msy}) ≤ 0.3 as limit management reference point of exploitation consistent with high long term yield. Given the results of the present analysis ($F_{current}$ (2011) = 1.00), the stock is considered exploited unsustainably during the period 2009-2011. EWG 12-19 recommends the relevant fleets' effort and/or catches to be reduced to reach the proposed F_{msy} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan.

6.19. Stock assessment of European Hake in GSA 19

6.19.1. Stock identification and biological features

6.19.1.1. Stock Identification

No information was documented during EWG 12-19

6.19.1.2. Growth

Growth parameters ($L_{inf}= 85.0$, $k= 0.172$; $t_0= -0.177$; data source: SGMED-10-01 report; growth parameters estimated for GSA05) were chosen taking into account the largest specimens that had been caught over 2006-2011 (82 cm TL). The length- weight relationship parameters used are $a=0.0048$ and $b=3.129$, submitted in the frame of the DCR for GSA19 in 2008.

6.19.1.3. Maturity

Maturity ogive was taken from García- Rodríguez and Esteban (1995).

age	0	1	2	3	4	5+
prop. mat.	0	0.15	0.82	0.98	1	1

Natural mortality

M	0	1	2	3	4	5+
	0.87	0.39	0.29	0.25	0.23	0.21

Natural mortality was estimated using PROBIOM (Abella *et al.*, 1997). M at the mid-point of the year was selected as M representative for that annual class.

6.19.2. Fisheries

6.19.2.1. General description of fisheries

STECF (stock review part II in 2007) noted that *Merluccius merluccius* is one of the most important species in GSA 19, considering both the amount of catch and the commercial value. It is fished with bottom trawl (OTB) and different small-scale gears (long-line (LLS), gillnet (GNS) and trammel net (GTR)). The main fisheries operating in GSA 19 are from Gallipoli, Taranto, Schiavonea and Crotona. The fishing pressure varies between fisheries and fishing grounds. No new documentation on the hake fishery in GSA 19 was submitted to EWG 12-19. During 2006-2011 annual landings ranged between 1648 t in 2006 and 820 t in 2011.

6.19.2.2. Management regulations applicable in 2010 and 2011

No information was documented.

6.19.2.3. Catches

Data on landings 2006-2011 were available by gear. Data on discards (weight and sizes) were available for OTB 2006, and 2009 to 2011.

6.19.2.3.1. Landings

Table 6.19.2.3.1.1. Hake catch (t) in GSA 19 by gear, 2006-2011 (Data source: DCF; OTB discards data included).

	2006	2007	2008	2009	2010	2011
OTB	1412.3	654.2	764.7	696.3	577.9	543.5
GNS	7.7	7.7	36.7	36.7	20.7	20.7
GTR	91.8	24.6	16.2	16.2	17.9	17.9
LLS	136.2	274.6	196.3	296.0	240.3	237.5
ALL GEARS	1648.0	961.2	1013.9	1045.2	856.8	819.6

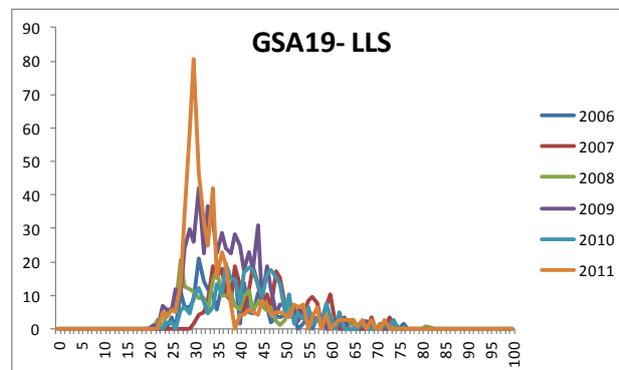
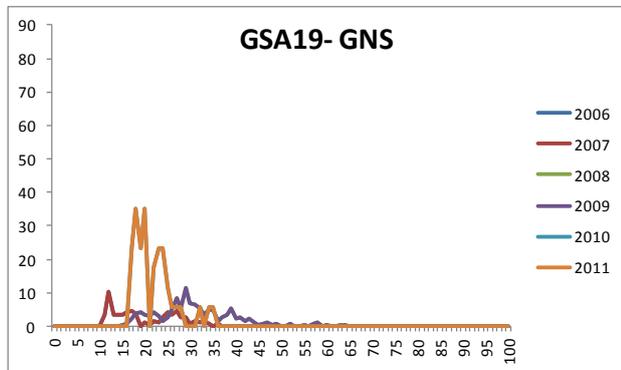
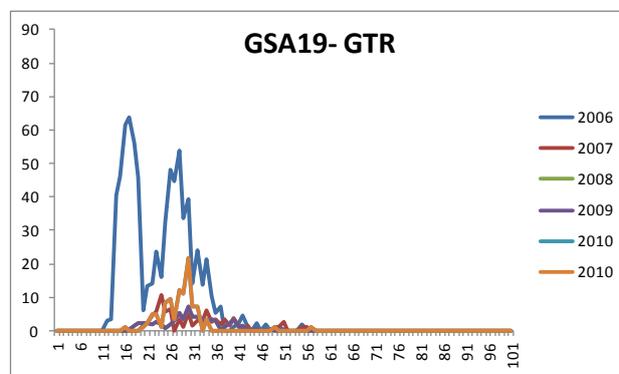
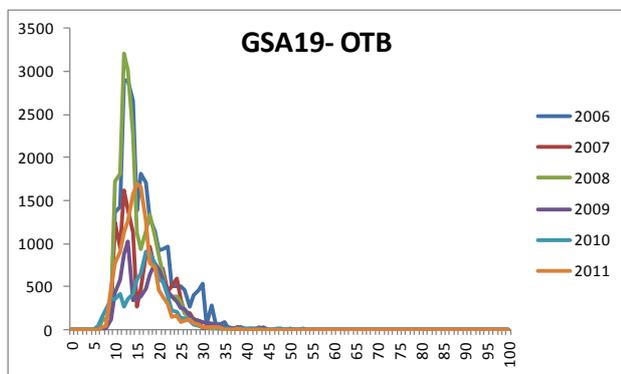


Fig. 6.19.2.3.1.1. Size frequency distributions (TL in cm), by gear, 2006-2011 (Data source: DCF; OTB discards data included).

By far, the highest catches in number were from the bottom otter trawls, most of them made up by immature individuals. The smallest caught size class was 5 cm TL (OTB discards) and the largest one was 82 cm TL (LLS landings).

6.19.2.3.2. Discards

Discards data (weight and size distributions) were available for OTB, 2006 and 2009 to 2011. Since according to the DCR, discards data were to be collected triannually, 2006 discards data were used in combination with the landings data to estimate 2007 and 2008 catches. In weight, discards ranged between 82 t in 2006 and 9.8 t in 2011.

6.19.2.4. Fishing effort

Table 6.19.2.4.1. Fishing effort in different units, by gear, deployed in GSA 19 over 2004- 2011 (Data source: DCF).

OTB	2004	2005	2006	2007	2008	2009	2010	2011
NOMINAL_EFFORT	6293262	4309873	6373213	5247464	5350926	6361017	6642497	6832229
GT_DAYS_AT_SEA	840177	450755	614647	484660	574366	711619	759137	805415
NO_VESSELS	308	116	248	202	252	294	303	285
GNS	2004	2005	2006	2007	2008	2009	2010	2011
NOMINAL_EFFORT	1028528	1234269	1428127	1456115	1275650	1441596	1813781	1705748
GT_DAYS_AT_SEA	96935	106626	125543	124382	98544	107494	134114	117849
NO_VESSELS	151	276	314	342	178	288	193	256
GTR	2004	2005	2006	2007	2008	2009	2010	2011
NOMINAL_EFFORT	2654268	2115507	1083556	937370	1131865	1653130	1896850	1777574
GT_DAYS_AT_SEA	226380	197023	102209	88720	102936	141967	149802	140997
NO_VESSELS	480	307	259	244	306	387	371	376
LLS	2004	2005	2006	2007	2008	2009	2010	2011
NOMINAL_EFFORT	1200947	748253	1066480	1147170	620865	679391	852696	1056634
GT_DAYS_AT_SEA	121476	63411	81333	95517	64130	68039	71070	101916
NO_VESSELS	304	146	55	168	138	114	61	124

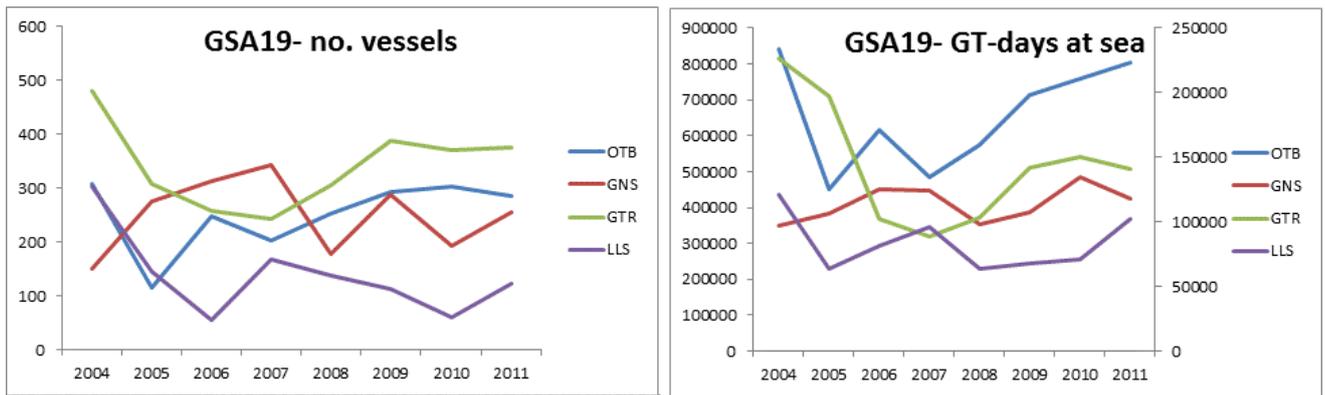


Fig. 6.19.2.4.1. Trend of fishing effort, by gear, expressed in number of vessels (left) and kW-days (OTB left axis; small-scale gears, right axis).

6.19.3. Scientific surveys

6.19.3.1. MEDITS

6.19.3.1.1. Methods

Based on the DCF data call, abundance and biomass indices were recalculated. In GSA 19 the following number of hauls was reported per depth stratum (Table 6.19.3.1.1.1).

Table 6.19.3.1.1.1. Number of hauls per year and depth stratum in GSA19, 1996-2011.

STRATUM	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
GSA19_010-050	9	9	9	9	9	9	9	9	9	9	9	8	9	9	9	9
GSA19_050-100	8	8	8	8	8	8	8	8	8	8	8	9	8	8	8	8
GSA19_100-200	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
GSA19_200-500	15	15	15	15	15	15	14	14	14	15	14	14	14	14	14	14
GSA19_500-800	32	32	32	32	32	32	29	29	29	28	29	29	29	29	29	29

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Y_{st} = \sum (Y_i * A_i) / A$$

$$V(Y_{st}) = \sum (A_i^2 * s_i^2 / n_i) / A^2$$

Where:

A=total survey area

A_i=area of the i-th stratum

s_i=standard deviation of the i-th stratum

n_i=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Y_i=mean of the i-th stratum

Yst= stratified mean abundance

V(Yst)= variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval:

Confidence interval = $Y_{st} \pm t(\text{student distribution}) * V(Y_{st}) / n$

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.19.3.1.2. Geographical distribution patterns

No information was documented during STECF EWG 12-19.

6.19.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of the European hake in GSA 19 was derived from the international survey MEDITS and was compiled during STECF EWG 12-19.

Figure 6.19.3.1.3.1 displays the estimated trend in European hake abundance and biomass in GSA 19. The estimated abundance indices as taken from the access database seem too low compared to abundance indices (see data quality at the end of the assessment).

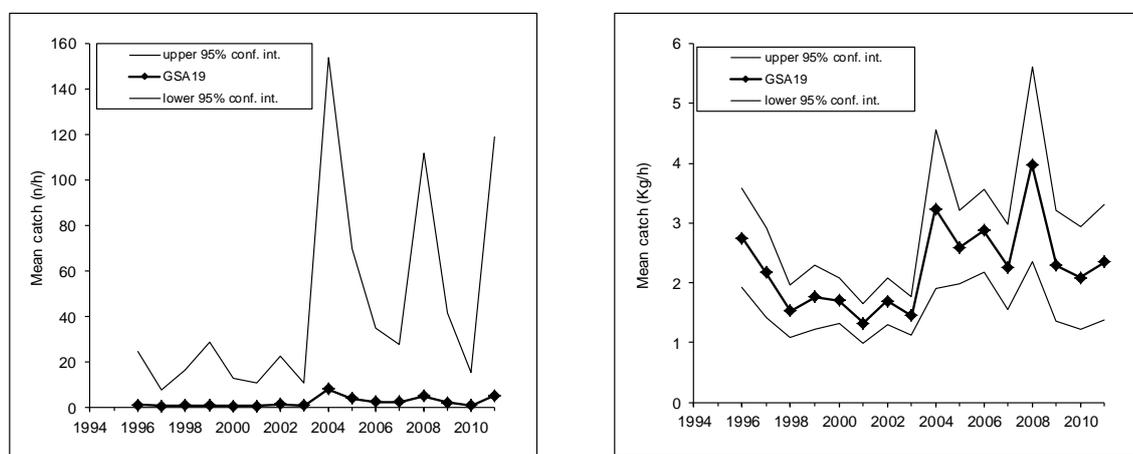


Fig. 6.19.3.1.3.1. Abundance and biomass indices of European hake in GSA 19.

6.19.3.1.4. Trends in abundance by length or age

The following figures show hake abundance by size in GSA 19 over 1996-2001, 2002-2009 and 2010-2011 respectively, and were compiled during STECF EWG 12-19.

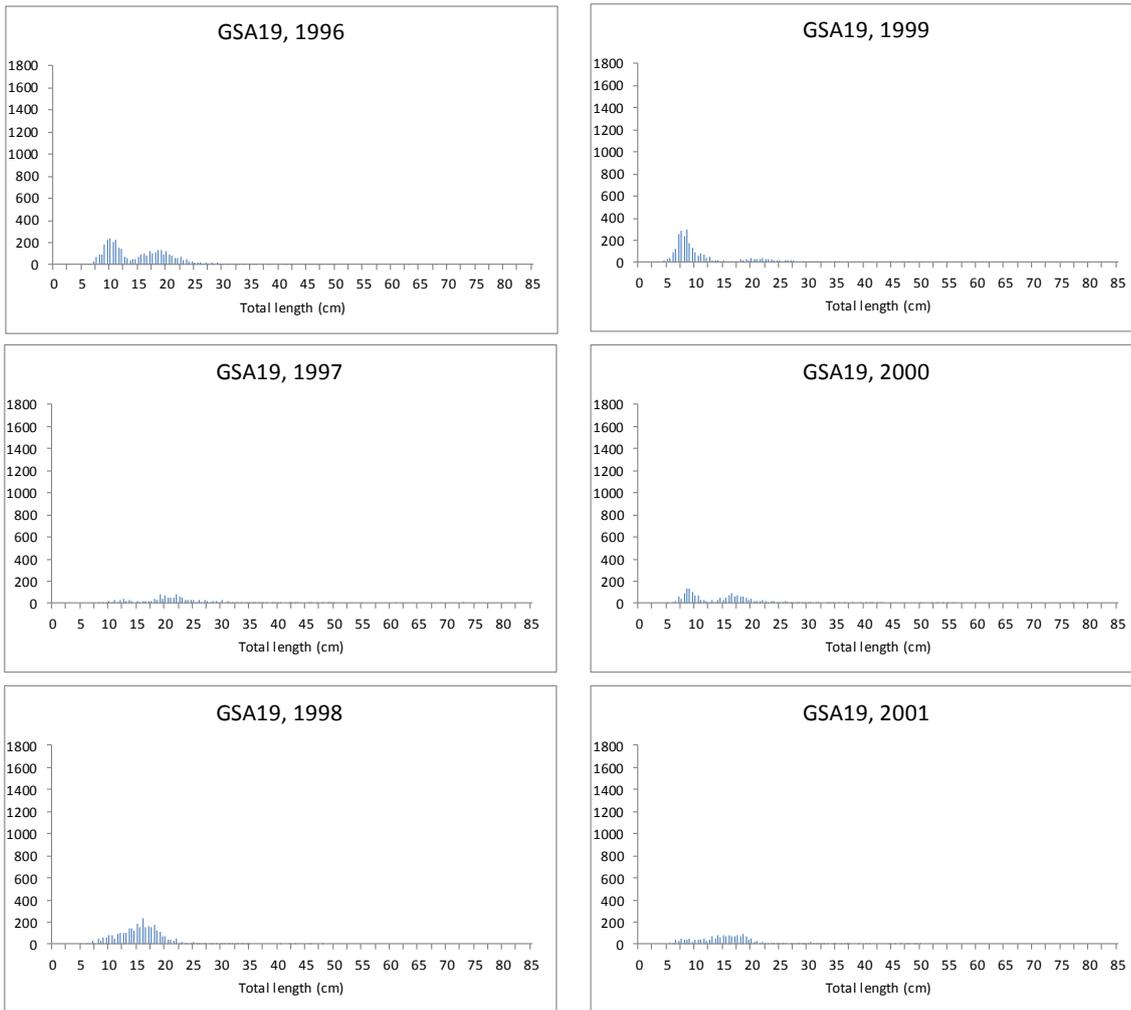


Fig. 6.19.3.1.4.1. Hake abundance indices by size, 1996-2001.

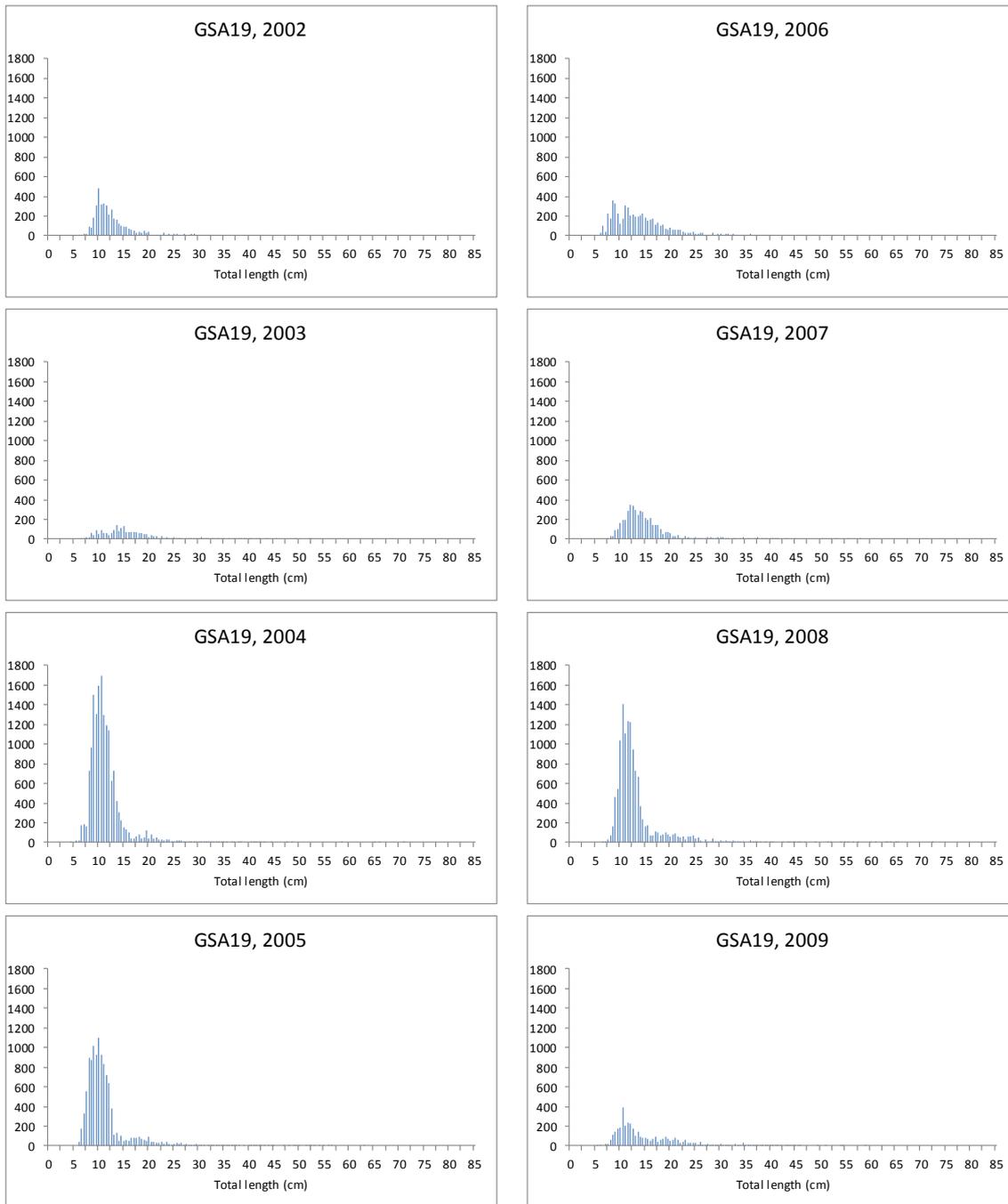


Fig. 6.19.3.1.4.2. Hake abundance indices by size, 2002-2009.

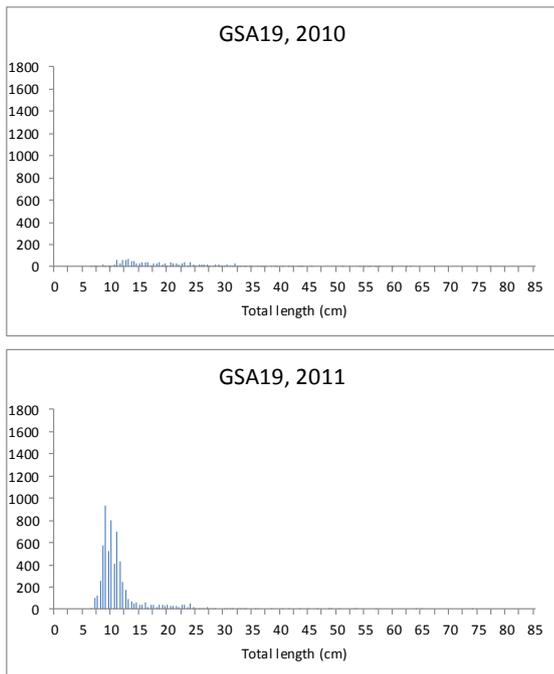


Fig. 6.19.3.1.4.3. Hake abundance indices by size, 2010-2011.

6.19.3.1.5. Trends in growth

No analyses were conducted during STECF EWG 12-19.

6.19.3.1.6. Trends in maturity

No analyses were conducted during STECF EWG 12-19.

6.19.4. Assessment of historic stock parameters

6.19.4.1. Method 1: XSA

6.19.4.1.1. Justification

This stock was assessed for the first time during in SGMED-09-02. LCA (VIT program (Leonart and Salat, 1992) was performed using as input data the mean pseudo-cohort for the period 2006-2008. Three years later XSA has been performed to assess hake in GSA 19 (this assessment).

6.19.4.1.2. Input Data

Catch numbers at age (Figure 6.19.4.1.2.2) were derived form the DCF annual size distributions (Figure 6.19.4.1.2.1) using the L2A program (i.e. knife edge slicing).

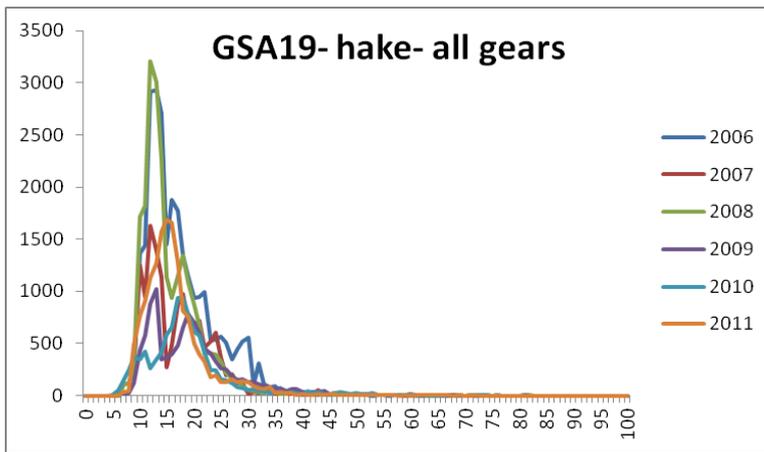


Fig. 6.19.4.1.2.1. Hake annual distributions by size, all gears combined, 2006- 2011.

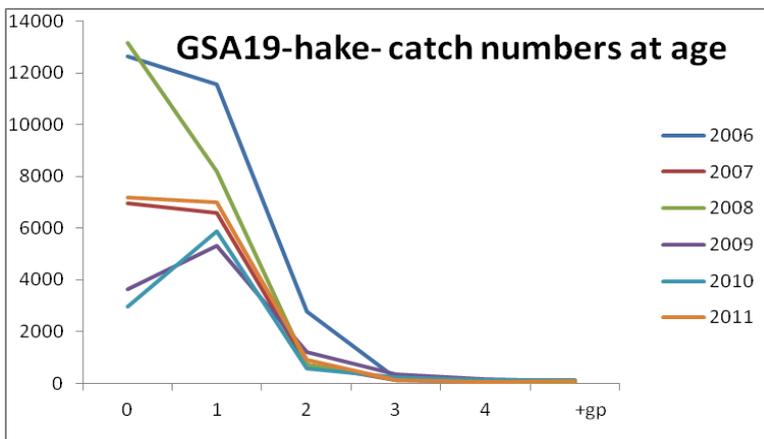


Fig. 6.19.4.1.2.2. Hake annual distributions by age, all gears combined, 2006- 2011.

Maturity at age and natural mortality M are those indicated at the beginning of the assessment, in sections 6.19.1.3.

Table 6.19.4.1.2.1. Input data used in the XSA assessment.

GSA 19 *Merluccius merluccius*

Catch numbers at age	Numbers*10** ⁻³					
	2006	2007	2008	2009	2010	2011
0	12647	6974	13158	3627	2951	7188
1	11542	6608	8195	5338	5890	7000
2	2766	735	736	1197	587	917
3	190	137	148	369	223	111
4	79	99	45	146	135	56
+gp	58	94	70	81	119	73
Catch weights at age (kg)						

AGE	2006	2007	2008	2009	2010	2011
0	0.015	0.013	0.014	0.014	0.012	0.015
1	0.059	0.065	0.057	0.065	0.057	0.048
2	0.203	0.195	0.194	0.212	0.204	0.211
3	0.442	0.494	0.473	0.467	0.486	0.448
4	0.741	0.8	0.775	0.771	0.823	0.799
+gp	1.697	1.644	1.694	1.525	1.413	1.673

Tuning parameters MEDITS (2006-2011)						
	0	1	2	3	4	5+
2006	3830.9	1639.5	216.2	49.7	27.9	4.4
2007	3123.6	1388.3	172.2	57.6	2.6	5.4
2008	10432.4	1551.8	211.9	43.8	18.5	16.5
2009	2452.4	1132.5	195.4	54.5	16.3	6.4
2010	535.8	597.6	199.7	28.9	5.8	20.3
2011	5626.3	678.1	103.2	10.3	10.4	9.3

Tuning converged after 17 iterations.

Hake XSA model diagnostics are shown in Table 6.19.4.1.2.2 and Figure 6.19.4.1.2.3.

Table 6.19.4.1.2.2. Hake XSA model diagnostics.

Regression weights						
	2006	2007	2008	2009	2010	2011
	0.954	0.976	0.99	0.997	1	1

Log catchability residuals.						
	2006		2008	2009	2010	2011
0	-0.14	-0.14	0.31	0.18	-0.34	0.13
1	0.1	0.15	0.11	0.39	-0.38	-0.36
2	-0.1	-0.09	-0.16	0.02	0.63	-0.3
3	0.13	0.84	-0.15	-0.12	-0.01	-0.66
4	1.2	-1.83	0.71	-0.18	-1.16	0.3

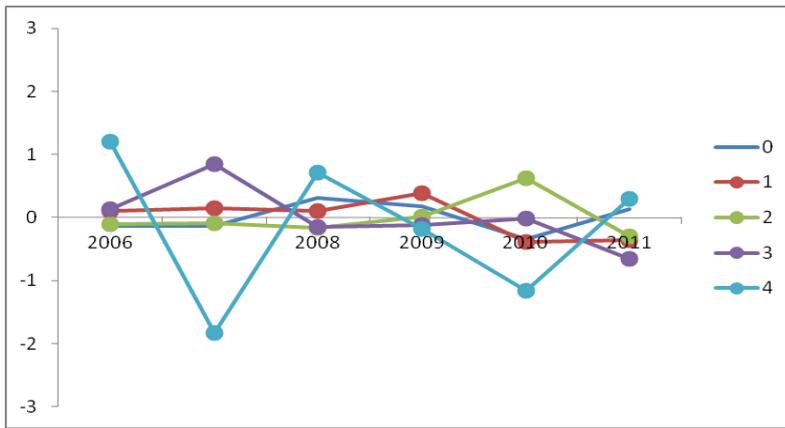


Fig. 6.19.4.1.2.3. Trends in log catchability residuals by age.

6.19.4.1.3.Results

Table 6.19.4.1.3.1. Results of the hake XSA assessment.

Fishing mortalities						
Age	2006	2007	2008	2009	2010	2011
0	0.568	0.303	0.729	0.226	0.166	0.352
1	1.994	1.389	1.521	1.701	1.487	1.626
2	2.255	0.838	0.637	1.323	1.179	1.384
3	0.638	0.802	0.425	0.878	1.111	0.818
4	1.349	0.897	0.725	1.082	1.065	1.049

Stock number at age (start of year)							
Numbers*10** ⁻³							
AGE	2006	2007	2008	2009	2010	2011	2012
0	45074	41196	39268	27675	29834	37412	0
1	16239	10698	12745	7935	9247	10589	11021
2	3572	1498	1806	1886	980	1415	1410
3	457	280	485	715	376	226	265
4	119	188	98	247	231	96	78
+gp	85	173	149	133	198	122	61
TOTAL	65547	54033	54551	38590	40867	49860	12835

	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 0-2	FBAR 0- 4
	Age 0						
2006	45074	2794	1169	1648	1.4103	1.6055	1.3607
2007	41196	2096	915	961	1.0511	0.8433	0.8458
2008	39268	2184	949	1014	1.0687	0.9623	0.8073
2009	27675	2030	1125	1045	0.929	1.0834	1.0421
2010	29834	1738	892	857	0.9601	0.9442	1.0017
2011	37412	1750	701	820	1.1698	1.1209	1.0459
Arith.							

Mean	36743	2098	958	1057	1.0982	1.0172	
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)			

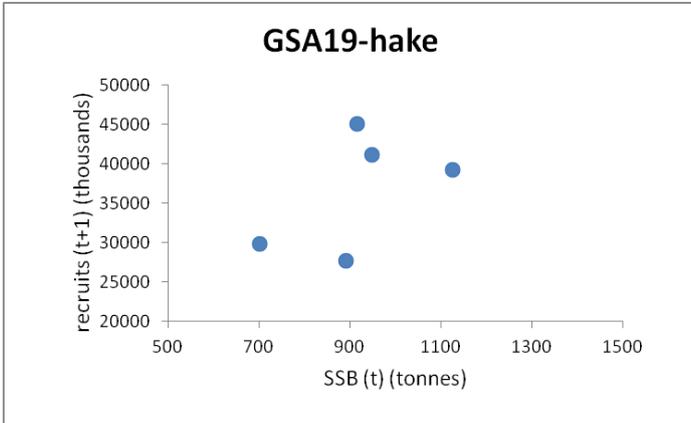


Fig. 6.19.4.1.3.1. SSB in year (t) and recruits in year (t+1) relationship as estimated by XSA.

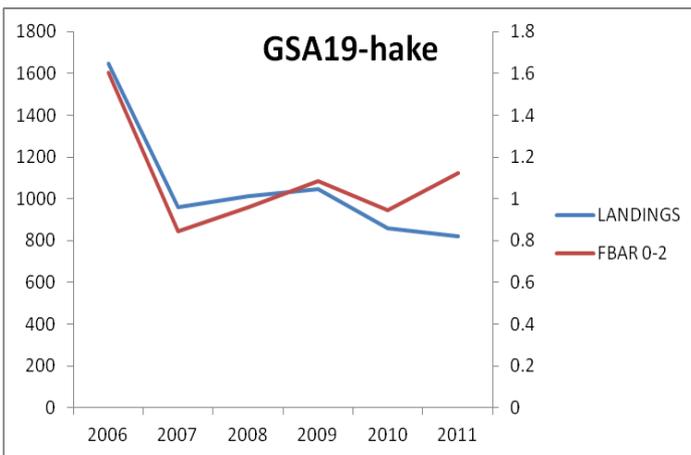


Fig. 6.19.4.1.3.2. Trends in catches and fishing mortality (F_{bar} ages 0-3) as estimated by XSA.

6.19.5. Long term prediction

6.19.5.1. Justification

Yield per recruit analysis (YPR) was performed based on the exploitation pattern resulting for the XSA analysis. YPR was used for the estimation of $F_{0.1}$ (i.e. proxy of F_{msy}) and F_{max} .

6.19.5.1.1. Input parameters

Table 6.19.5.1.1.1. Input parameters used in the YPR analysis.

age group	stock weight	catch weight	maturity	F(2011)	M
0	0,014	0,014	0,00	0,3522	0,870
1	0,059	0,059	0,15	1,6264	0,390
2	0,203	0,203	0,82	1,3841	0,290
3	0,468	0,468	0,98	0,818	0,250
4	0,785	0,785	1,00	1,0487	0,230
+gp	1,608	1,608	1,00	1,0487	0,210

YPR was performed using as $F_{ref} = F_{bar0-2(2006-2011)} = 1.09$

6.19.5.1.2.Results

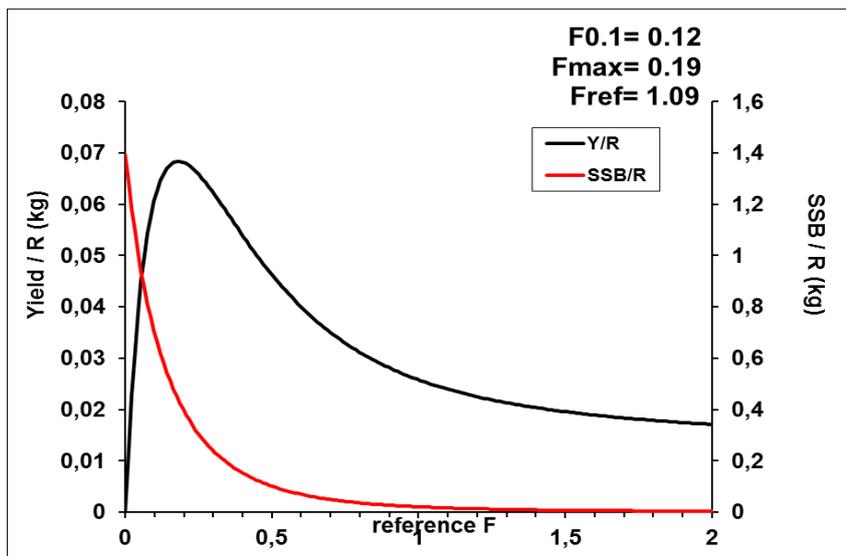


Fig. 6.19.5.1.2.1. Yield per recruit analysis, taking as $F_{ref} = F_{bar0-2}$ over 2006-2011.

By comparing $F_{current(2011)}$ against $F_{0.1}$ EWG 12-19 concludes that the stock is exploited unsustainably.

6.19.6. Scientific advice

6.19.6.1. Short term considerations

6.19.6.1.1.State of the spawning stock size

In the absence of proposed or agreed reference points, EWG 12-19 is unable to fully evaluate the state of the spawning stock in comparison to these.

Over 2006- 2011, SSB highest stock sizes corresponded to 2006 (1169 t) and 2009 (1125 t), while in the last two years of the analyzed period (2010 and 2011) SSB was at its lowest level (892 and 701 t). No baseline for comparison of the current values against historic SSB is available.

6.19.6.1.2.State of recruitment

In the absence of proposed or agreed reference points, EWG 12-19 is unable to fully evaluate the state of recruitment in comparison to these.

Recruitment decreased by 40% over 2006-2009, from around $45 \cdot 10^6$ to $27.7 \cdot 10^6$ recruits (age 0). In 2010, but also in 2011, the number of recruits was higher than in 2009, despite the observed relative small SSB size in 2010.

6.19.6.1.3.State of exploitation

No management reference points have been proposed for this stock.

Fishing mortality was highest in 2006, at the beginning of the analyzed period, and sharply decreased in 2007 and 2008. In the last three years $F_{\text{bar}0-4}$ and $F_{\text{bar}0-2}$ are around 1, well above $F_{0.1} = 0.12$ as estimated from YPR, therefore, the stock is considered as being exploited unsustainably.

6.19.7. Data quality

MEDITS data on abundance as taken from the access database during EWG 12-19 are suspiciously low for the reported biomass. For comparison, MEDITS data on abundance and biomass in this report are compared to the MEDITS data in SGMED 09-02 report (Figure 6.19.7.1). Values of abundances by size in this report are also lower than those in SGMED 09-02 report.

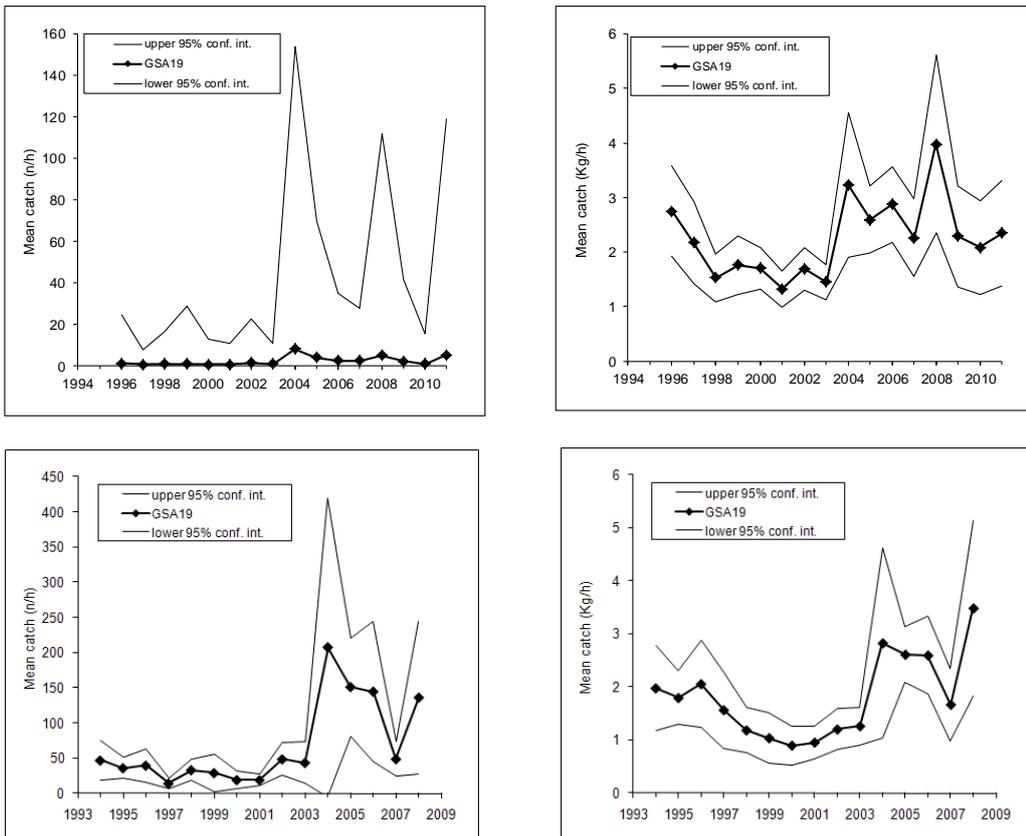


Fig. 6.19.7.1. MEDITS data on hake abundance in biomass in GSA19, as taken from the access database during STECF EWG 12-19, upper graphs, and taken from the SGMED-09-02 report (Villasimius, June 2009), lower graphs.

6.20. Stock assessment of Red mullet in GSA 19

6.20.1. Stock identification and biological features

6.20.1.1. Stock Identification

No information was documented during EWG 12-19.

6.20.1.2. Growth

Growth parameters ($L_{inf}= 30.0$, $k= 0.4$; $t_0= -0.3$) and length- weight relationship parameters ($a=0.0083$ and $b=3.1134$) were taken from STECF 12-10 (Sète, July 2012) report. These parameters were used for *M. barbatus* in GSA 18.

6.20.1.3. Maturity

Maturity ogive was taken STECF 12-10 (Sète, July 2012) report. These parameters were used for *M. barbatus* assessment in GSA 18.

age	0	1	2	3+
prop. mat.	0.16	0.92	1	1

Natural mortality

M	0	1	2	3+
	1.0	0.61	0.54	0.47

Natural mortality was estimated using PROBIOM (Abella *et al.*, 1997). M at the mid-point of the year was selected as M representative for that annual class.

6.20.2. Fisheries

6.20.2.1. General description of fisheries

STECF (stock review part II in 2007) noted that red mullet *Mullus barbatus* is among the species with high commercial value in GSA 19. Red mullet is targeted by otter bottom trawl (OTB) and small- scale fisheries (gillnet (GNS) and tammel net (GTR)). The highest trawl fishing pressure occurs along the Calabrian coast while the presence of rocky bottoms on the shelf along the Apulian coast prevents the fishing by trawling in this sector. No new documentation on the red mullet fishery in GSA 19 was submitted to EWG 12-19. During 2006-2011, annual catches ranged between 727 t in 2006 and 360 t in 2008.

6.20.2.2. Management regulations applicable in 2010 and 2011

No information was documented.

6.20.2.3. Catches

Data on landings 2006-2011 were available by gear. Data on discards (weight and sizes) were available for OTB, 2009 and 2011.

6.20.2.3.1.Landings

Table 6.20.2.3.1.1. Red mullet (t) catches in GSA 19 by gear, 2006-2011 (Data source: DCF; OTB discards data included).

	2006	2007	2008	2009	2010	2011
OTB	421.1	218.6	262.5	290.9	212.7	276.5
GNS	64.7	54.6	68.5	113.8	218.2	172.8
GTR	240.9	189.5	29.3	15.5	13.1	25.0
ALL GEARS	726.7	462.7	360.3	420.2	444.0	474.2

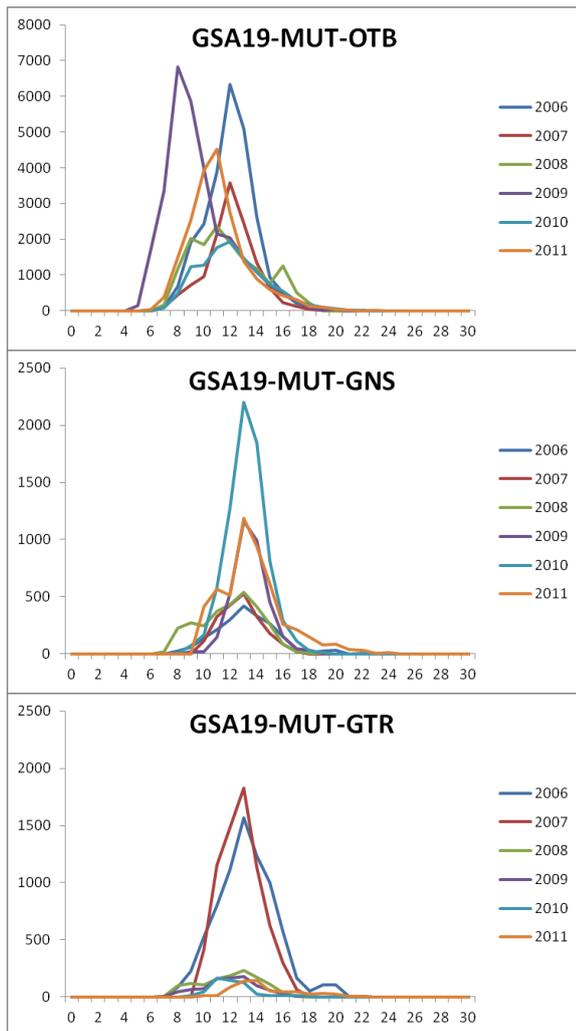


Fig. 6.20.2.3.1.1. Size frequency distributions (TL in cm), by gear, 2006-2011 (Data source: DCF; OTB discards data included).

6.20.2.3.2.Discards

Discards data (weight and size distributions) were available for OTB, 2009 and 2011. 2009 discards data were used in combination with the landings data to estimate 2006 to 2009 catches, and 2011 discards data were used to estimate 2010 catch.

6.20.2.4. Fishing effort

Table 6.20.2.4.1. Fishing effort in different units, by gear, deployed in GSA19 over 2004- 2011 (Data source: DCF).

OTB	2004	2005	2006	2007	2008	2009	2010	2011
NOMINAL_EFFORT	6293262	4309873	6373213	5247464	5350926	6361017	6642497	6832229
GT_DAYS_AT_SEA	840177	450755	614647	484660	574366	711619	759137	805415
NO_VESSELS	308	116	248	202	252	294	303	285
GNS	2004	2005	2006	2007	2008	2009	2010	2011
NOMINAL_EFFORT	1028528	1234269	1428127	1456115	1275650	1441596	1813781	1705748
GT_DAYS_AT_SEA	96935	106626	125543	124382	98544	107494	134114	117849
NO_VESSELS	151	276	314	342	178	288	193	256
GTR	2004	2005	2006	2007	2008	2009	2010	2011
NOMINAL_EFFORT	2654268	2115507	1083556	937370	1131865	1653130	1896850	1777574
GT_DAYS_AT_SEA	226380	197023	102209	88720	102936	141967	149802	140997
NO_VESSELS	480	307	259	244	306	387	371	376
LLS	2004	2005	2006	2007	2008	2009	2010	2011
NOMINAL_EFFORT	1200947	748253	1066480	1147170	620865	679391	852696	1056634
GT_DAYS_AT_SEA	121476	63411	81333	95517	64130	68039	71070	101916
NO_VESSELS	304	146	55	168	138	114	61	124

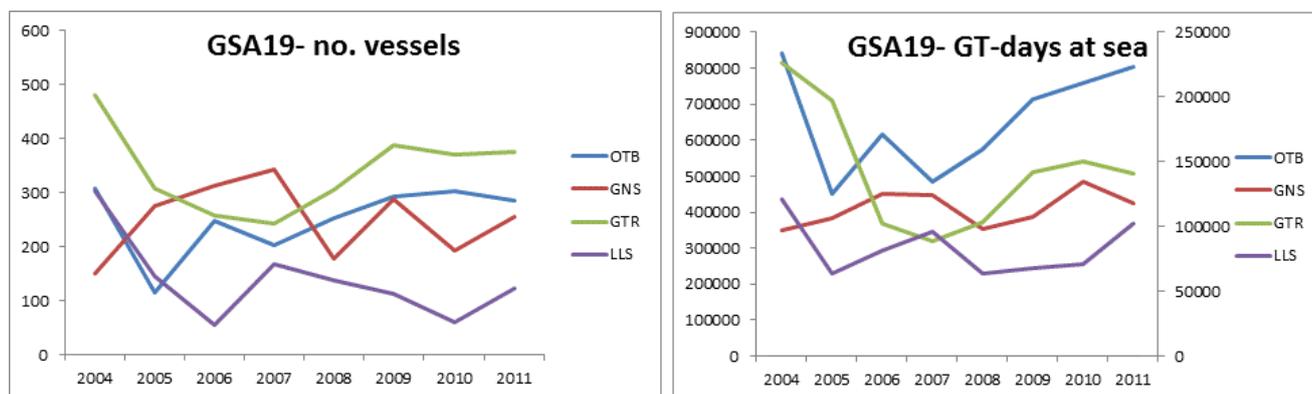


Fig. 6.20.2.4.1. Trend of fishing effort, by gear, expressed in number of vessels (left) and kW-days (OTB left axis; small-scale gears, right axis).

6.20.3. Scientific surveys

6.20.3.1. MEDITS

6.20.3.1.1. Methods

Based on the DCF data call, abundance and biomass indices were recalculated. In GSA 19 the following number of hauls was reported per depth stratum (Table 6.20.3.1.1.1).

Table 6.20.3.1.1.1. Number of hauls per year and depth stratum in GSA19, 1996-2011.

STRATUM	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
GSA19_010-050	9	9	9	9	9	9	9	9	9	9	9	8	9	9	9	9
GSA19_050-100	8	8	8	8	8	8	8	8	8	8	8	9	8	8	8	8
GSA19_100-200	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
GSA19_200-500	15	15	15	15	15	15	14	14	14	15	14	14	14	14	14	14
GSA19_500-800	32	32	32	32	32	32	29	29	29	28	29	29	29	29	29	29

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Y_{st} = \sum (Y_i * A_i) / A$$

$$V(Y_{st}) = \sum (A_i^2 * s_i^2 / n_i) / A^2$$

Where:

A=total survey area

A_i=area of the i-th stratum

s_i=standard deviation of the i-th stratum

n_i=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Y_i=mean of the i-th stratum

Y_{st}=stratified mean abundance

V(Y_{st})=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval:

$$\text{Confidence interval} = Y_{st} \pm t(\text{student distribution}) * V(Y_{st}) / n$$

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.20.3.1.2. Geographical distribution patterns

No information was documented during STECF EWG 12-19.

6.20.3.1.3. Trends in abundance and biomass

Fishery independent information regarding the state of red mullet in GSA 19 was derived from the international survey MEDITS and was compiled during STECF EWG 12-19. Fig. 6.20.3.1.3.1 displays the estimated trend in red mullet abundance and biomass in GSA 19.

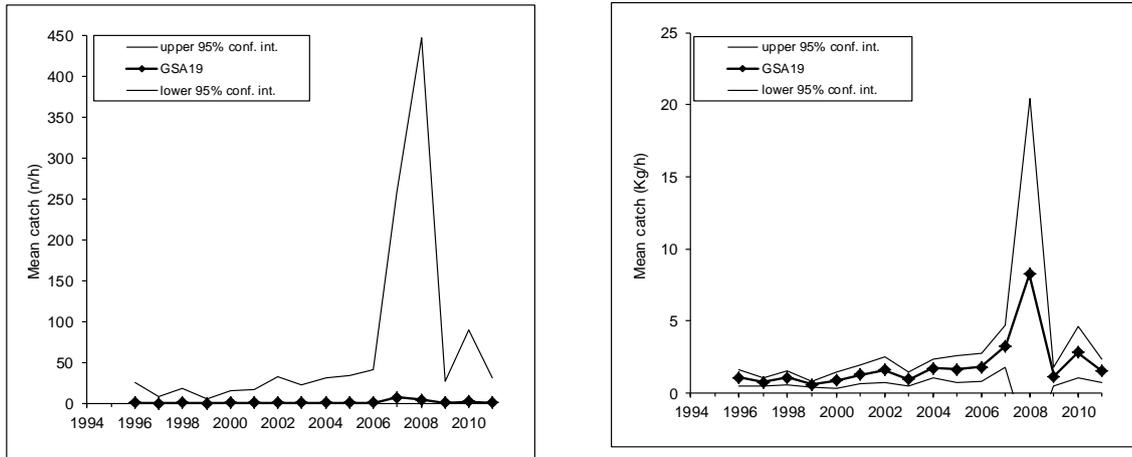


Fig. 6.20.3.1.3.1. Abundance and biomass indices of red mullet in GSA 19.

6.20.3.1.4. Trends in abundance by length or age

The following figures display red mullet abundance by size in GSA 19 over 1996-2001, 2002-2009 and 2010-2011 respectively, and were compiled during STECF EWG 12-19.



Fig. 6.20.3.1.4.1. Red mullet abundance indices by size, 1996-2001.

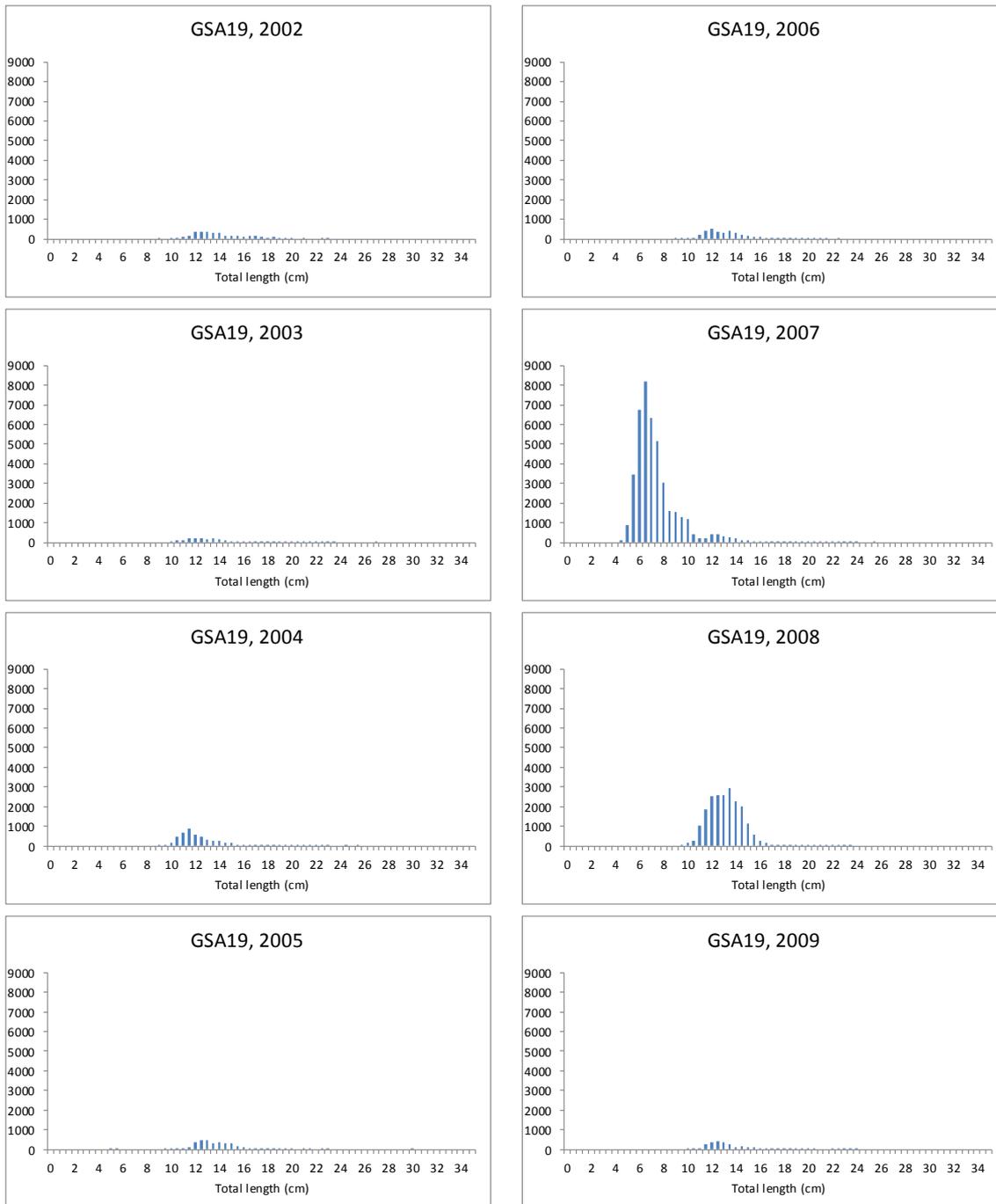


Fig. 6.20.3.1.4.2. Red mullet abundance indices by size, 2002-2009 in GSA 19.

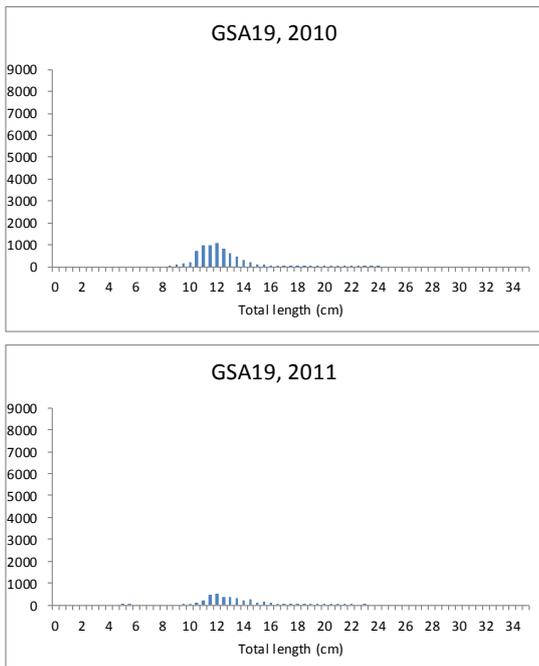


Fig. 6.20.3.1.4.3. Red mullet abundance indices by size, 2010-2011 in GSA 19.

6.20.3.1.5. Trends in growth

No analyses were conducted during STECF EWG 12-19.

6.20.3.1.6. Trends in maturity

No analyses were conducted during STECF EWG 12-19.

6.20.4. Assessment of historic stock parameters

6.20.4.1. Method 1: XSA

6.20.4.1.1. Justification

This stock was assessed for the first time during in SGMED-09-02. LCA (VIT program (Lleonart and Salat, 1992) was performed using as input data the mean pseudo-cohort for the period 2006-2008. Three years later XSA has been performed to assess red mullet in GSA 19 (this assessment).

6.20.4.1.2. Input Data

Catch numbers at age (Figure 6.20.4.1.2.1) were derived from the DCF annual size distributions (Figure 6.20.4.1.2.2) using the L2A program (i.e. knife edge slicing).

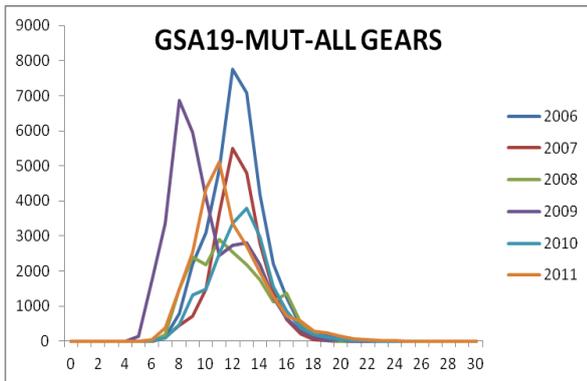


Fig. 6.20.4.1.2.1. Red mullet annual distributions by size, all gears combined, 2006- 2011.

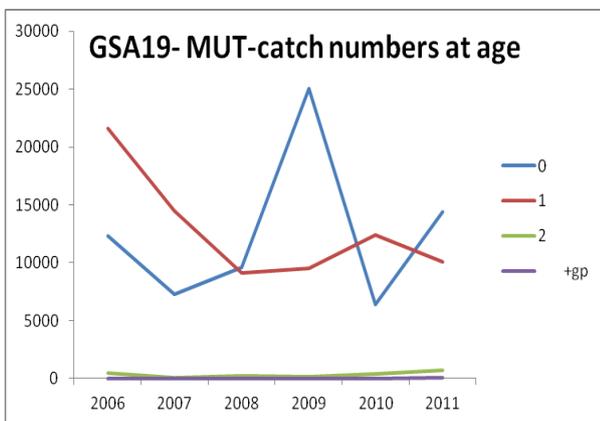


Fig. 6.20.4.1.2.2. Red mullet annual distributions by age, all gears combined, 2006- 2011.

Maturity at age and natural mortality M are those indicated at the beginning of the assessment, in sections 6.20.1.3.

Table 6.20.4.1.2.1. Input data used in the XSA assessment.

GSA19 *Mullus barbatus*

Catch numbers at age		Numbers*10** ⁻³				
	2006	2007	2008	2009	2010	2011
0	12339	7285	9598	25011	6424	14427
1	21624	14463	9102	9478	12383	10087
2	491	55	222	184	377	696
+gp	4	0	11	5	22	65
Catch weights at age (kg)						
AGE	2006	2007	2008	2009	2010	2011
0	0.014	0.015	0.012	0.009	0.014	0.013
1	0.031	0.03	0.035	0.032	0.032	0.033
2	0.088	0.078	0.077	0.081	0.084	0.087
+gp	0.133	0	0.159	0.135	0.14	0.147
Tuning parameters MEDITS (2006- 2011)						
	0	1	2	3+		
2006	865.3	2561.4	196.5	15.5		
2007	40609.1	2033.4	289.4	43.5		
2008	4172.5	16281	186.4	35.6		
2009	518.5	1972.1	121.4	23		
2010	3572.2	3718.6	149.8	20.4		
2011	1002.1	2482.2	232.5	10.8		

Tuning converged after 11 iterations.

Red mullet XSA model diagnostics are shown in Table 6.20.4.1.2.2 and Figure 6.20.4.1.2.3.

Table 6.20.4.1.2.2. Red mullet XSA model diagnostics.

Regression weights

	2006	2007	2008	2009	2010	2011
	0.954	0.976	0.99	0.997	1	1

Log catchability residuals.

Age	2006	2007	2008	2009	2010	2011
0	0.04	-0.26	0.06	-0.08	0.2	0.04
1	0.05	-0.6	1.79	-0.73	-0.45	-0.05
2	0.17	2.19	0.31	-0.09	-0.78	-0.49

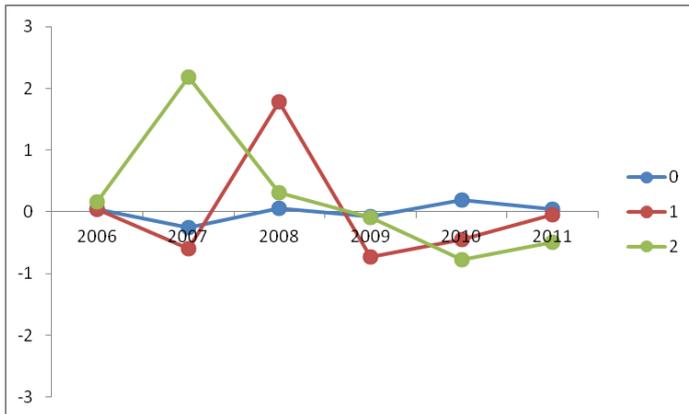


Fig. 6.20.4.1.2.3. Trends in log catchability residuals by age.

6.20.4.1.3.Results

Table 6.20.4.1.3.1. Results of the red mullet XSA assessment.

Fishing mortality (F) at age							
AGE	2006	2007	2008	2009	2010	2011	
0	0.3144	0.2944	0.3458	0.5931	0.2434	0.3928	
1	5.2374	3.4566	3.1414	2.4355	2.2689	3.4429	
2	2.8869	1.9015	1.8068	1.5776	1.3331	2.0096	
+gp	2.8869	1.9015	1.8068	1.5776	1.3331	2.0096	
FBAR 0- 2	2.8129	1.8842	1.7647	1.5354	1.2818	1.9484	
YEAR Stock number at age (start of year)				Numbers*10**-3			
AGE	2006	2007	2008	2009	2010	2011	2012
0	75413	47093	54128	92169	49017	73221	0
1	29492	20259	12906	14091	18737	14136	18186
2	681	85	347	303	670	1053	246
+gp	5	0	15	7	36	88	89
TOTAL	105592	67438	67397	106570	68460	88498	18521
RECRUITS							
YEAR	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 0- 2		
2006	75413	2031	1125	727	0.6457	2.8129	
2007	47093	1321	715	463	0.6469	1.8842	
2008	54128	1130	576	360	0.6257	1.7647	
2009	92169	1306	600	420	0.7002	1.5354	
2010	49017	1347	759	444	0.5852	1.2818	
2011	73221	1523	714	474	0.6641	1.9484	
Arith.							
Mean	65174	1443	748	481	0.6446	1.8712	
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)			

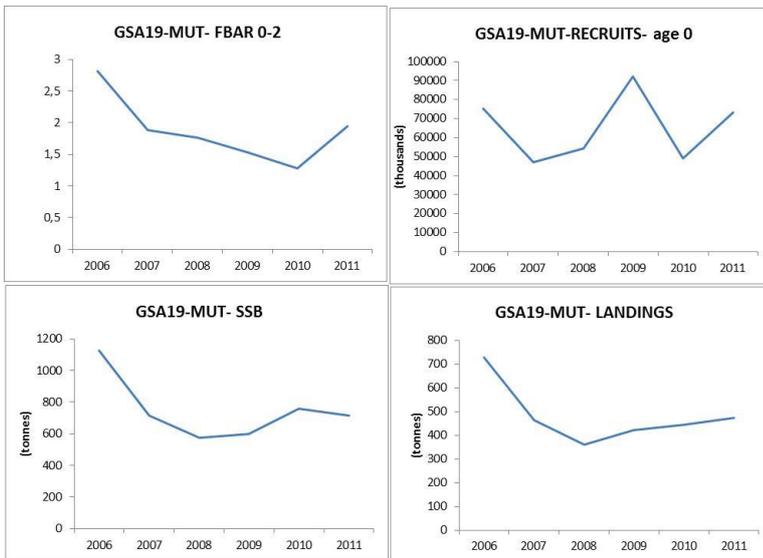


Fig. 6.20.4.1.3.1. XSA results for red mullet in GSA19.

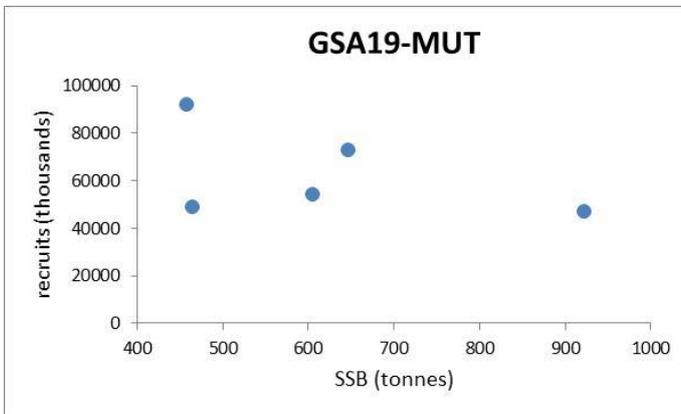


Fig. 6.20.4.1.3.2. SSB in year (t) and recruits in year (t+1) relationship as estimated by XSA.

6.20.4.2. Method 2: LCA

6.20.4.2.1. Justification

Three pseudo-cohort analyses, for 2009, 2010 and 2011 separately, were performed, using VIT software (Leonart and Salat 1992).

6.20.4.2.2. Input Data

The biological parameters (growth, length-weight relationship, natural mortality M and maturity ogive) and age frequencies were the same as those used in the XSA.

The main components of the catches were age classes 0 and 1. Highest catches corresponded to age 0 in 2009 and 2011, and age 1 in 2010 (Table 6.20.4.2.2.1 and Figure 6.20.4.2.2.1). In 2010 the mode was around 12-13 cm TL (Figure 6.20.4.2.2.2).

Table 6.20.4.2.2.1. Input data for LCA. Catch at age 2009-2011.

Age	2009	2010	2011
0	25010.5	6424	14426.8
1	9477.5	12383.2	10086.7
2	183.6	376.8	696.1
3+	4.5	21.8	64.8

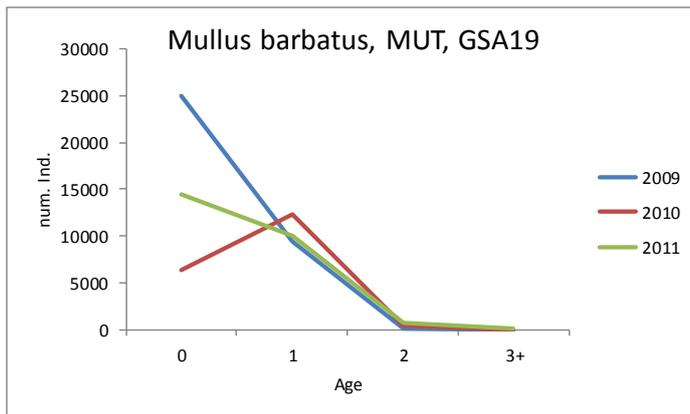


Fig. 6.20.4.2.2.1. Input data for LCA- Red mullet age frequencies, 2009- 2011.

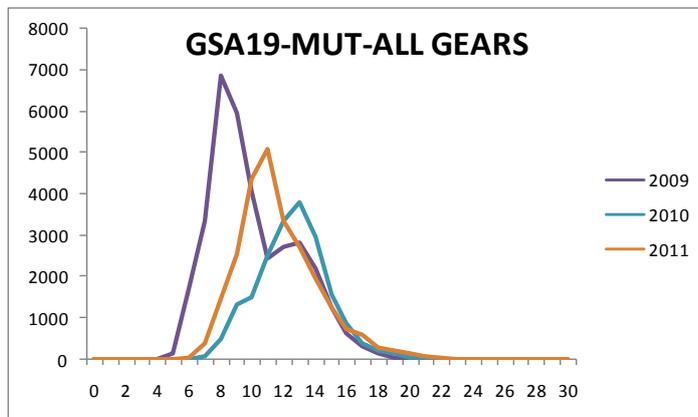


Fig. 6.20.4.2.2.2. Red mullet annual distributions by size, all gears combined, 2009- 2011.

6.20.4.2.3. Results

Results summary from the pseudo-cohort analysis in 2009, 2010 and 2011 are shown in Table 6.20.4.2.3.1. Ages and lengths of the catches and the stock in 2010 and 2011 were quite similar, while in 2009 were lower, reflecting the effect of the high amount of catches of age 0 observed in the landings. Biomass increased between 2009 and 2011, while recruitment ranged between $69.3 \cdot 10^6$ recruits in 2009 and $51.5 \cdot 10^6$

recruits in 2010. Stock initial numbers, by age, are shown in Figure 6.20.4.2.3.1. For age classes 2 and 3+, stock numbers were very low.

Table 6.20.4.2.3.1. LCA summary results.

	2009	2010	2011
Catch mean age	0.608	0.994	0.81
Catch mean length	8.766	11.741	10.239
Mean F	1.6	1.3	2
Total catch (Tons)	420.2127	443.9968	474.249
Catch/D%	67.06	63.81	62.94
Catch/B%	173.47	142.73	132.32
Current Stock Mean Age	0.434	0.519	0.525
Current Stock Critical Age	1	1	1
Virgin Stock Critical Age	2	2	2
Current Stock Mean Length	7.404	8.099	8.103
Current Stock Critical Length	12.164	12.164	12.164
Virgin Stock Critical Length	18.044	18.044	18.044
Number of recruits, R	69301142	51512047	60410441
Mean Biomass, Bmean (Tons)	242.2351	311.0653	358.4102
Spawning Stock Biomass, SSB (Tons)	108.2757	163.9835	208.9138
Biomass Balance, D (Tons)	626.5884	695.7989	753.5167
Bmax/Bmean	95.06	97.72	78.01
Turnover, D/Bmean	258.67	223.68	210.24

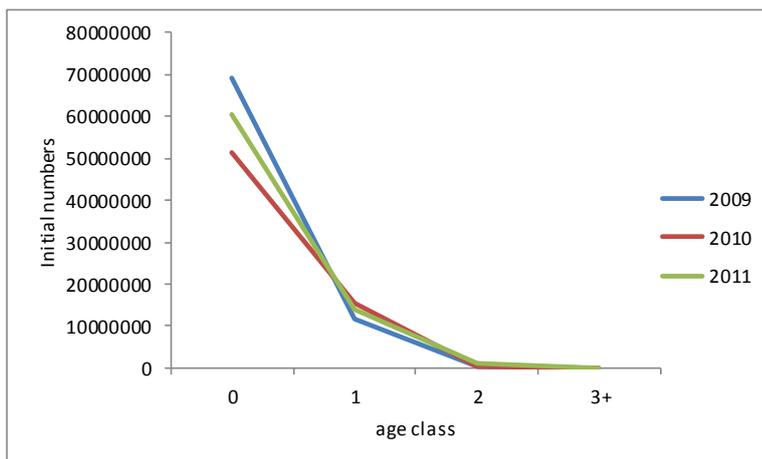


Fig. 6.20.4.2.3.1. LCA results. Stock initial numbers, by age.

Fishing mortality vectors in 2009 and 2010 displayed the same trend, and the highest F corresponded to age class 1. In 2011, F was quite similar for classes 1, 2 and 3+.

$F_{\text{bar}}(0-2)$, which included the majority of the catch (Figure 6.20.4.2.3.3; 2.4 in 2009, 1.8 in 2010 and 1.5 in 2011), decreased in the period 2009-2011.

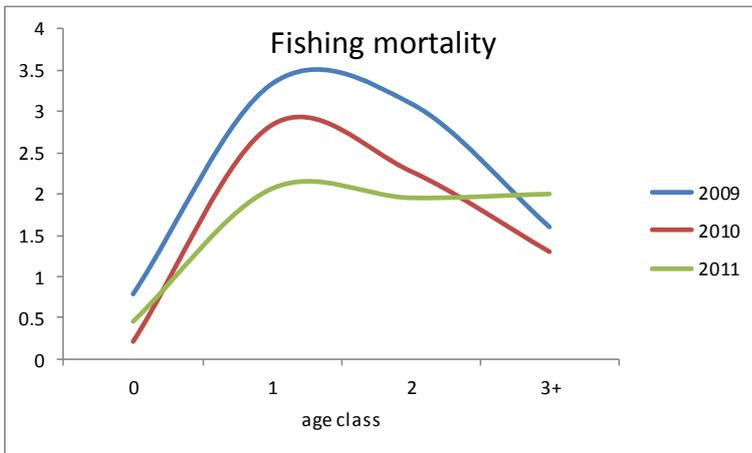


Fig. 6.20.4.2.3.2. LCA results. Fishing mortality by age of *M. barbatus* in GSA19.

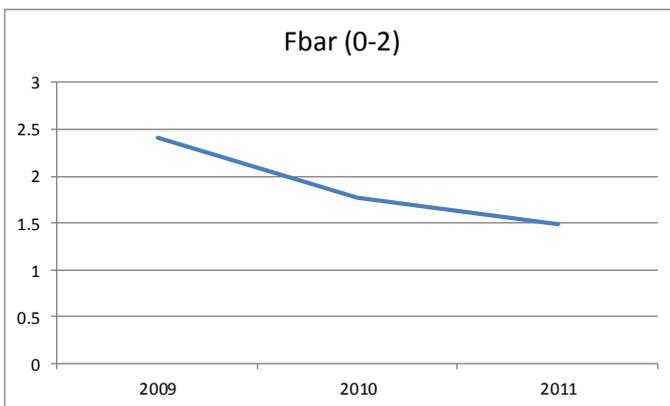


Fig. 6.20.4.2.3.3. LCA output. $F_{\text{bar}}(0-2)$ over 2009-2011.

6.20.5. Long term prediction

6.20.5.1. Justification

Yield per recruit analysis (YPR) was performed based on the exploitation pattern resulting for the XSA analysis and also based on the LCA results. YPR was used for the estimation of $F_{0.1}$ (i.e. proxy of F_{MSY}) and F_{max} .

6.20.5.1.1. Input parameters

Table 6.20.5.1.1.1. Input parameters used in the YPR analysis (taken from XSA).

age group	stock	catch	maturity	F(2011)	M
-----------	-------	-------	----------	---------	---

	weight	weight			
0	0,013	0,013	0,16	0,3928	1,000
1	0,032	0,032	0,92	3,4429	0,610
2	0,083	0,083	1,00	2,0096	0,540
3+	0,119	0,119	1,00	2,0096	0,470

YPR was performed using as $F_{ref} = F_{bar0-2(2006-2011)} = 1.86$

Table 6.20.5.1.1.2. Input parameters used in the YPR analysis, separately for 2009, 2010 and 2011, based on LCA.

2009	age group	stock weight (g)	catch weight (g)	maturity	F	M
	0	4.686	4.686	0.16	0.787	1
	1	29.635	29.635	0.92	3.334	0.61
	2	81.861	81.861	1	3.098	0.54
	3+	152.255	152.255	1	1.6	0.47

2010	age group	stock weight (g)	catch weight (g)	maturity	F	M
	0	5.444	5.444	0.16	0.212	1
	1	30.696	30.696	0.92	2.835	0.61
	2	84.363	84.363	1	2.276	0.54
	3+	155.937	155.937	1	1.3	0.47

2011	age group	stock weight (g)	catch weight (g)	maturity	F	M
	0	5.112	5.112	0.16	0.455	1
	1	32.651	32.651	0.92	2.064	0.61
	2	85.487	85.487	1	1.953	0.54
	3+	148.643	148.643	1	2	0.47

6.20.5.1.2.Results

Due to the flat-topped shape of the yield curve resulting from using as input XSA results, these YPR reference points should be treated with caution.

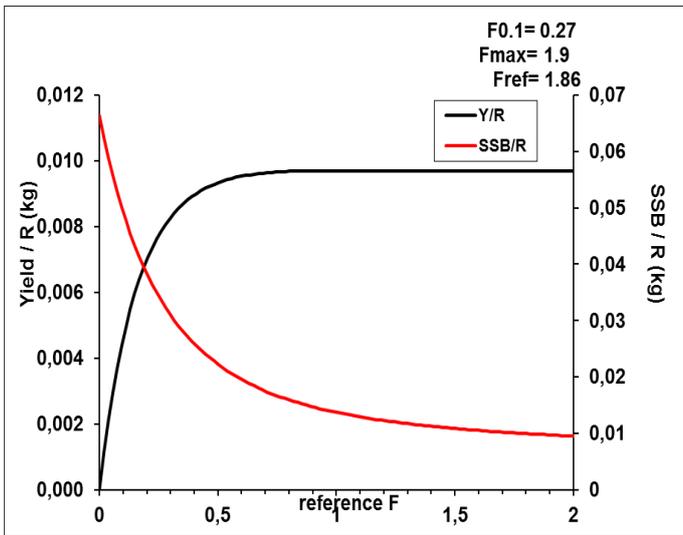


Fig. 6.20.5.1.2.1. Yield per recruit analysis results, using as input XSA results, and taking as $F_{ref} F_{bar0-2}$ over 2006-2011.

Table 6.20.5.1.2.1 lists the results from the YPR analysis performed separately for 2009, 2010 and 2011, based on LCA results (VIT), and Figure 6.20.5.1.2.2 shows the YPR curve. Yield per recruit at Factor=1 was between 8 and 11 g/recruit.

Table 6.20.5.1.2.1. Results of the YPR analysis, based on the LCA results.

2009	Factor	Y/R	B/R	SSB
F(0)	0	0	80.605	76.679
F(0.1) factor	0.15	10.065	29.23	25.697
Fmax	0.25	10.669	18.005	14.683
Fcurrent	1.01	7.886	4.421	2.04

2010	Factor	Y/R	B/R	SSB
F(0)	0	0	80.605	76.679
F(0.1) factor	0.21	10.868	28.549	24.905
Fmax	0.4	11.673	15.69	12.237
Fcurrent	1.01	10.881	7.013	3.951

2011	Factor	Y/R	B/R	SSB
F(0)	0	0	80.605	76.679
F(0.1) factor	0.19	11.081	31.776	28.156
Fmax	0.31	11.657	21.336	17.879
Fcurrent	1.01	9.345	6.921	4.12

$F_{0.1}$ calculated from $F_{0.1}$ factor, and $F_{bar(0-2)}$ were the following:

	2009	2010	2011

Fbar 0-2	2.41	1.77	1.49
F(0.1)factor	0.15	0.21	0.19
F0.1	0.36	0.37	0.28

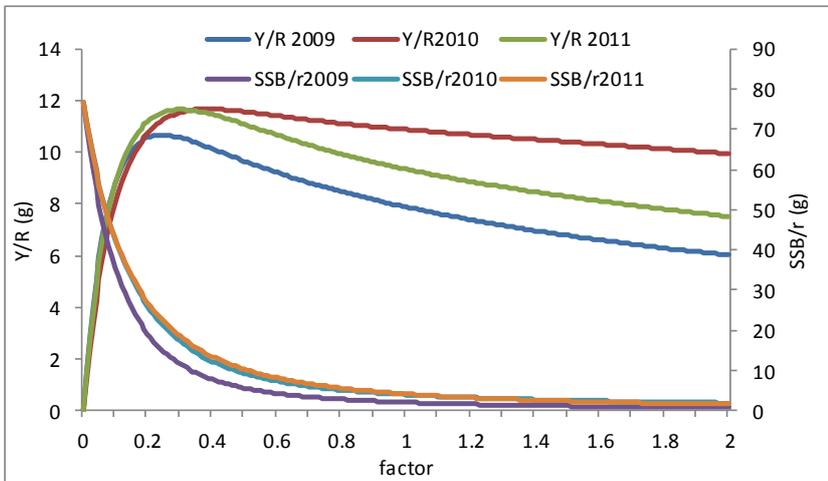


Fig. 6.20.5.1.2.2. YPR outputs. Yield per recruit and SSB per recruit curves for red mullet in GSA 19, in 2009, 2010 and 2011.

By comparing $F_{\text{bar}(0.2)}$ against $F_{0.1}$ EWG 12-19 concludes that the stock is exploited unsustainably and proposes $F_{0.1} \text{mean}(2009-2011) = 0.3$ as proxy of F_{MSY} and as the exploitation reference point consistent with high long term yields.

6.20.6. Scientific advice

6.20.6.1. Short term considerations

6.20.6.1.1.State of the spawning stock size

In the absence of proposed or agreed reference points, EWG 12-19 is unable to fully evaluate the state of the spawning stock in comparison to these.

According to XSA results, over 2006- 2011, SSB highest stock size was observed in 2006 (1125 t), which sharply decreased to 715 t in 2007, a stock size similar to that estimated in 2011. No baseline for comparison of the current values against historic SSB is available.

6.20.6.1.2.State of recruitment

In the absence of proposed or agreed reference points, EWG 12-19 is unable to fully evaluate the state of the recruitment in comparison to these.

Over 2006- 2011, recruitment did not show neither decreasing nor increasing trend, although it did display marked inter-annual variations, ranging from $92.1 \cdot 10^6$ recruits (class 0) in 2009 and $47.0 \cdot 10^6$ recruits in 2007.

6.20.6.1.3.State of exploitation

No management reference points have been proposed for this stock.

By comparing $F_{\text{bar}(0-2)}$ against $F_{0.1}$ EWG 12-19 concludes that the stock is exploited unsustainably and proposes $F_{0.1 \text{ mean}(2009-2011)} = 0.3$ as proxy of F_{MSY} as the exploitation reference point consistent with high long term yields.

7. TOR F SHORT TERM, MEDIUM TERM AND LONG TERM FORECASTS OF STOCK SIZE AND YIELD

7.1. Short term predictions for *Nephrops norvegicus* in GSA01 (2012-2013)

7.1.1. Short term prediction 2012-2013

A deterministic short term prediction for 2012 to 2013 was performed using the EXCEL workbook provided by JRC (H.-J. Raetz) which takes into account the catch and landings in numbers and weight and the discards, and based on the results of annual LCA stock assessments performed during EWG12-19 for the years 2009, 2010, 2011.

7.1.1.1. Input parameters

The following data have been used to derive the input data for the short term prediction of the Norway lobster stock in GSA 01 (average values for the 2009-2011 period):

Maturity and M vectors

PERIOD	age class	1	2	3	4	5	6	7	8	9	10	11	12	13+
--------	-----------	---	---	---	---	---	---	---	---	---	----	----	----	-----

2009-2011	proportion mature	0.05	0.14	0.32	0.58	0.8	0.92	0.97	0.99	1	1	1	1	1
	M	0.47	0.37	0.29	0.26	0.24	0.23	0.22	0.21	0.21	0.21	0.21	0.21	0.21

F vector

PERIOD	age class	1	2	3	4	5	6	7	8	9	10	11	12	13+
2009-2011	F	0.001	0.006	0.112	0.398	0.445	0.399	0.271	0.244	0.201	0.22	0.298	0.159	0.25

In the period 2009-2011 the bulk of the catch was comprised of Norway lobster of ages 3-7, the reference F selected was the average F_{bar} for ages 3-7 ($F_{\text{bar}}=0.325$).

Weight-at-age in the stock

PERIOD	age class	1	2	3	4	5	6	7	8	9	10	11	12	13+
2009-2011	weight (kg)	0.0025	0.0094	0.0212	0.0367	0.0552	0.0752	0.0957	0.1156	0.1345	0.1519	0.1677	0.1821	0.2106

Weight-at-age in the catch

PERIOD	age class	1	2	3	4	5	6	7	8	9	10	11	12	13+
2009-2011	weight (kg)	0.0025	0.0094	0.0212	0.0367	0.0552	0.0752	0.0957	0.1156	0.1345	0.1519	0.1677	0.1821	0.2106

Number at age in the catch

PERIOD	age class	1	2	3	4	5	6	7	8	9	10	11	12	13+
2009-2011	Nb in the catch 000s	4.4	21.9	269.1	571.7	327.3	151.5	58.5	32.8	4.4	21.9	269.1	571.7	327.3

Number at age in the stock

PERIOD	age class	1	2	3	4	5	6	7	8	9	10	11	12	13+
2009-2011	Nb in the stock 000s	6833.1	4267.2	2929.4	1960.6	1015.4	511.7	272.9	167.0	6833.1	4267.2	2929.4	1960.6	1015.4

Stock recruitment

Recruitment (class 1) has been estimated as the geometric mean from 2009 to 2010 (7439 thousand individuals).

7.1.1.2. Results

Short-term implications

A short term projection table (Table 7.1.1.2.1). assuming a *status-quo* F (F_{stq}) of =0.325 in 2011 and a recruitment of 7439 thousand individuals shows that:

- Fishing at F_{stq} from 2011 to 2012 would generate a small decrease in the catches (less than 1%), with no noticeable effect on SSB between 2012 and 2013.
- Fishing at $F_{0.1}$ (0.20) from 2011 to 2012 would generate a decrease of 38.4% of the catches and an increase of 11.5% in SSB.
- STECF EWG 12-19 recommends that catch in 2013 does not exceed 55 t. corresponding to $F_{0.1}=0.20$.

Outlook until 2013

Table 7.1.1.2.1. Short term forecast for different F scenarios computed for *Nephrops norvegicus* in GSA 1

Basis: $F(2011) = 0.321$ mean (F_{bar} 3-7); $R(2012-2013) : GM (2009-2011) = 7439$ (thousands); $F(2011)=0.325$; $SSB(2011)= 186$ t; $landings(2011)= 74.6$ t. Weights in tons.

Rationale	F scenario	F factor	Catch 2012	Catch 2013	SSB 2013	Change SSB 2012-2013 (%)	Change catch 2011-2012 (%)
------------------	-------------------	-----------------	-------------------	-------------------	-----------------	---------------------------------	-----------------------------------

zero catch	0	0	0	0	312	32.8	-100.0
High long-term yield (F0.1)	0.20	0.61	46	55	262	11.5	-38.4
Status quo	0.3250	1	74	74	235	0.0	-0.8
Different scenarios	0.0325	0.1	7	11	302	28.5	-90.6
	0.0650	0.2	16	22	295	25.5	-78.6
	0.0975	0.3	25	30	285	21.3	-66.5
	0.1300	0.4	31	37	278	18.3	-58.5
	0.1625	0.5	38	44	270	14.9	-49.1
	0.1950	0.6	46	54	263	11.9	-38.4
	0.2275	0.7	53	61	253	7.7	-29.0
	0.2600	0.8	62	65	247	5.1	-16.9
	0.2925	0.9	67	69	242	3.0	-10.2
	0.3575	1.1	79	78	229	-2.6	5.9
	0.3900	1.2	85	81	222	-5.5	13.9
	0.4225	1.3	90	83	217	-7.7	20.6
	0.4550	1.4	95	87	213	-9.4	27.3
	0.4875	1.5	102	91	207	-11.9	36.7

7.2. Short term predictions for Black-bellied anglerfish in GSA 5

7.2.1. Short term prediction 2012-2014

7.2.1.1. Method and justification

Short term predictions were implemented in R (www.r-project.org) using the FLR libraries and based on the results of the Extended Survivor Analyses (XSA, Darby and Flatman, 1994) presented at the EWG -19-10 (Ancona).

7.2.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of the black-bellied anglerfish in GSA 5:

Maturity and M vectors

Maturity oogive								
Age	0	1	2	3	4	5	6	7+
Prop. Matures	0.09	0.14	0.21	0.30	0.41	0.54	0.66	0.91

M								
Age	0	1	2	3	4	5	6	7+
Prop. Matures	0.960	0.477	0.375	0.293	0.260	0.241	0.230	0.222

F vector

F	0	1	2	3	4	5	6	7+
2009-2011	0.01	0.11	0.79	1.62	1.25	1.49	0.47	1.41

Weight-at-age in the stock

Mean weight in the stock (kg)							
0	1	2	3	4	5	6	7+
0.036	0.222	0.494	0.986	1.681	2.475	3.306	4.589

Weight-at-age in the catch

Mean weight in the catch (kg)							
0	1	2	3	4	5	6	7+
0.036	0.222	0.494	0.986	1.681	2.475	3.306	4.589

Number at age in the catch

Catch at age in numbers (thousands)	0	1	2	3	4	5	6	7+
2011	0	1.2	21.5	9.4	9	0.2	0.0	0.0

Number at age in the stock

Stock at age in numbers (thousands)	0	1	2	3	4	5	6	7+
2012	156.72*	57.31	34.13	7.30	1.28	0.22	0.03	0.09

* arithmetic mean 2009-2011

Different scenarios of constant harvest strategy with F_{bar} calculated as the average of ages 1 to 5 (F_{bar} ages 1-5) and F status quo ($F_{\text{stq}} = 1.13$) were performed.

Stock recruitment

Recruitment (class 0) has been estimated from the population results from the mean of the last three years 2009-2011 estimated with FLR.

Different trials: mean 2009-2011, mean 2002-2011, geometric mean 2009-2011, geometric mean 2002-2011. Survey is not able to estimate recruitment, as for many years catches for age 0 during the survey are 0.

	Recruitment (thousands)
Mean 2009-2011	156.72
Mean 2001-2011	157.19
Geometric mean 2009-2011	156.31
Geometric mean 2001-2011	155.06

7.2.1.3. Results

A short term projection (Table 7.2.1.3.1), assuming an F_{stq} of 1.13 in 2011 and a recruitment of 157 (thousands) individuals, shows that:

- Fishing at the F_{stq} (1.13) generates a decrease of the catch of 21% from 2011 to 2013 along with an increase of the spawning stock biomass of 1% from 2013 to 2014.

- Fishing at $F_{0.1}$ (0.18) generates a decrease of the catch of 81% from 2011 to 2013 and an increase of the spawning stock biomass of 72% from 2013 to 2014.

Outlook until 2014

Table 7.2.1.3.1. Short term forecast in different F scenarios computed for black-bellied anglerfish in GSA 5.

Basis: $F(2012) = \text{mean}(F_{\text{bar}1-5} \text{ 2009-2011}) = 1.13$; $R(2012) = \text{mean of the recruitment of the last 3 years}$; $R = 157$ (thousands); $SSB(2011) = 11.6$ t, $\text{Catch}(2011) = 21.8$ t.

Rationale	Ffactor	fbar	Catch 2013	Catch 2014	SSB 2014	Change SSB 2013-2014 (%)	Change Catch 2011-2013 (%)
zero catch	0.00	0.00	0.000	0.000	19	95	-100
High long-term yield (F0.1)		0.18	4.215	7.727	17	72	-81
Status quo	1.00	1.13	17.715	17.922	10	1	-21
Different scenarios	0.1	0.11	2.792	5.381	18	79	-88
	0.2	0.23	5.273	9.301	17	66	-76
	0.3	0.34	7.482	12.132	15	54	-67
	0.4	0.45	9.454	14.152	14	43	-58
	0.5	0.56	11.218	15.570	13	34	-50
	0.6	0.68	12.801	16.541	13	26	-43
	0.7	0.79	14.224	17.185	12	19	-37
	0.8	0.90	15.506	17.589	11	12	-31
	0.9	1.02	16.665	17.818	11	6	-26
	1	1.13	17.715	17.922	10	1	-21
	1.1	1.24	18.668	17.937	10	-3	-17
	1.2	1.35	19.536	17.889	9	-7	-13
	1.3	1.47	20.328	17.799	9	-11	-9
	1.4	1.58	21.052	17.681	9	-15	-6
	1.5	1.69	21.716	17.545	8	-18	-3
	1.6	1.81	22.327	17.399	8	-20	0
	1.7	1.92	22.889	17.249	8	-23	2
	1.8	2.03	23.409	17.099	7	-25	4
	1.9	2.14	23.890	16.950	7	-27	7
	2	2.26	24.336	16.804	7	-29	9

Data consistency

No particular issue was identified with data quality and data consistency.

7.2.2. Medium term prediction

7.2.2.1. Method and justification

Following the agreement reached during the discussions of the EWG 12-19, since no stock-recruitment relationship could be reliably fitted to the dataset (Figure 7.2.2.1.1), no medium term predictions were made.

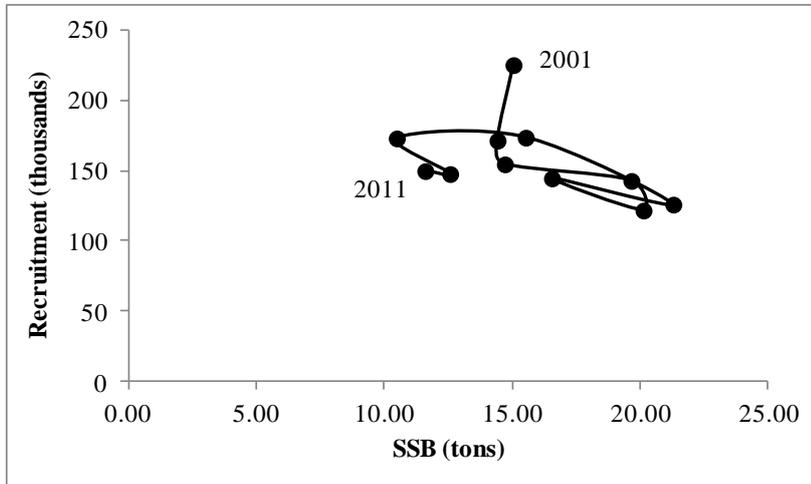


Fig. 7.2.2.1.1. SSB and recruitment relationship for Norway lobster in GSA05.

7.3. Short term forecast for Common octopus in GSA 5

7.3.1. Short term prediction 2012-2014

7.3.1.1. Method and justification

The ASPIC projection tool was used to perform the short term prediction outputs for the years 2012-2014. Given that ASPIC is a surplus production model that do not consider the age structure of the stock analysed, no inferences are possible concerning the spawning stock biomass.

7.3.1.2. Input parameters

The input parameters were the outputs of the ASPIC model developed using yields and fishing effort from GSA 5 between 1977 and 2011. For the short term projection, the following scenarios were simulated for the time series 2012-2014: 1) fishing at current F; and 2) fishing at F_{MSY} (0.320). Current F, or F status quo, was set as the arithmetic mean of the last three years ($F_{stq}=0.449$).

7.3.1.3. Results

Short-term implications

A short term projection (Table 7.3.1.3.1), assuming an F_{stq} of 0.449 in 2012, shows that:

- Fishing at the F_{stq} (0.449) generates an increase of the stock biomass (SB) of 2.4% from 2013 to 2014 along with a decrease of the catch of 1.4% from 2011 to 2013.
- Fishing at F_{MSY} (0.320) for the same time frame (2012-2014) generates a decrease of the catch of 16.6% from 2011 to 2013 and a stock biomass increase of 12.9% from 2013 to 2014.

The estimated catch of common octopus in GSA 5 for 2013 amounts 122.6 tons. Consequently, SGMED recommends that the catch level of 122.6 t not to be exceeded.

Outlook until 2013

Table 7.3.1.3.1. Short term forecast in different F scenarios computed for red mullet in GSA 5.

Rationale	F scenario	Catch 2012	Catch 2013	Catch 2014	SB 2014	Change SB 2013-2014 (%)	Change Catch 2011-2013 (%)
Zero catch	0.00	0.0	0.0	0.0	674.8	40.47	-100.00
High long-term yield (F_{MSY})	0.320	107.3	122.6	136.7	405.5	12.86	-16.60
Status quo	0.449	141.4	145.0	148.2	326.9	2.38	-1.36

Weights are in tons.

7.3.2. *Medium term prediction*

7.3.2.1. Method and justification

Medium term projections for the next 9 years were also run using the ASPIC projection tool. Four different scenarios were used in those projections:

- 1) constant $F=F_{MSY}$;
- 2) 10% reduction in F per year;
- 3) linear decrease from F_{stq} to F_{MSY} by 2015, then constant F_{MSY} ;
- 4) linear decrease from F_{stq} to F_{MSY} by 2020.

7.3.2.2. Input parameters

As in the short term projections, the input parameters were the outputs of the ASPIC model developed using yields and fishing effort from GSA 5 between 1977 and 2011.

7.3.2.3. Results

Only the annual 10% reduction in F (scenario 2) let the stock biomass to reach the B_{MSY} , which takes place in the 7th year of projection (Figure 7.3.2.3.1). The relative biomass (B/B_{MSY}) increased gradually through the projected 9 years in all other scenarios, but without reaching the B_{MSY} during such a period of time. Although scenario 4 (linear decrease in F to F_{MSY} by 2020) increased with non-asymptotic growth, scenarios 1 (constant $F=F_{MSY}$) and 3 (linear decrease from F_{stq} to F_{MSY} by 2015) displayed asymptotic growth.

The projected yields (in tons) for each scenario during the medium term simulations are in Figure 7.3.2.3.2. Yields in scenario 1 remained rather constant close to 130 tons during the 9 projected years. The highest increase was reached with scenario 2, which increased from 107 tons in 2012 to 185 tons in 2020. Scenario 3 showed two periods with different trends, a decrease of yields from 135 tons in 2012 to 128 tons in 2015, followed by a marked increase up to 178 tons in 2020. Yields increased almost linearly from 138 to 160 tons during the 9 projected years in scenario 4.

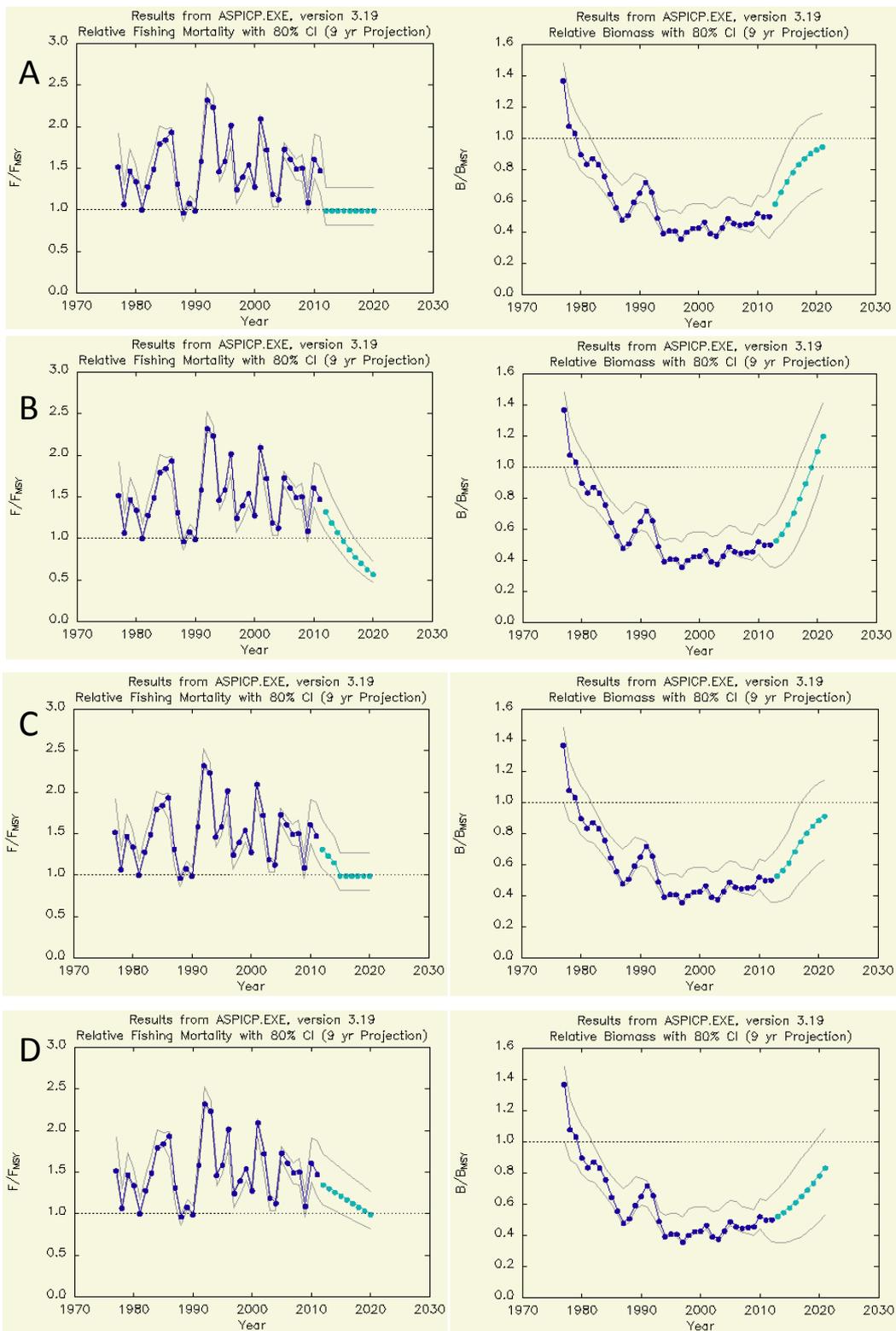


Fig. 7.3.2.3.1. Relative fishing mortality (F/F_{MSY}) and relative biomass (B/B_{MSY}) of the four medium term forecasts computed for the common octopus in GSA 5 under different scenarios: A) constant $F=F_{MSY}$; B) 10% reduction in F per year; C) linear decrease from F_{stq} to F_{MSY} by 2015, then constant F_{MSY} ; and D) linear decrease from F_{stq} to F_{MSY} by 2020.

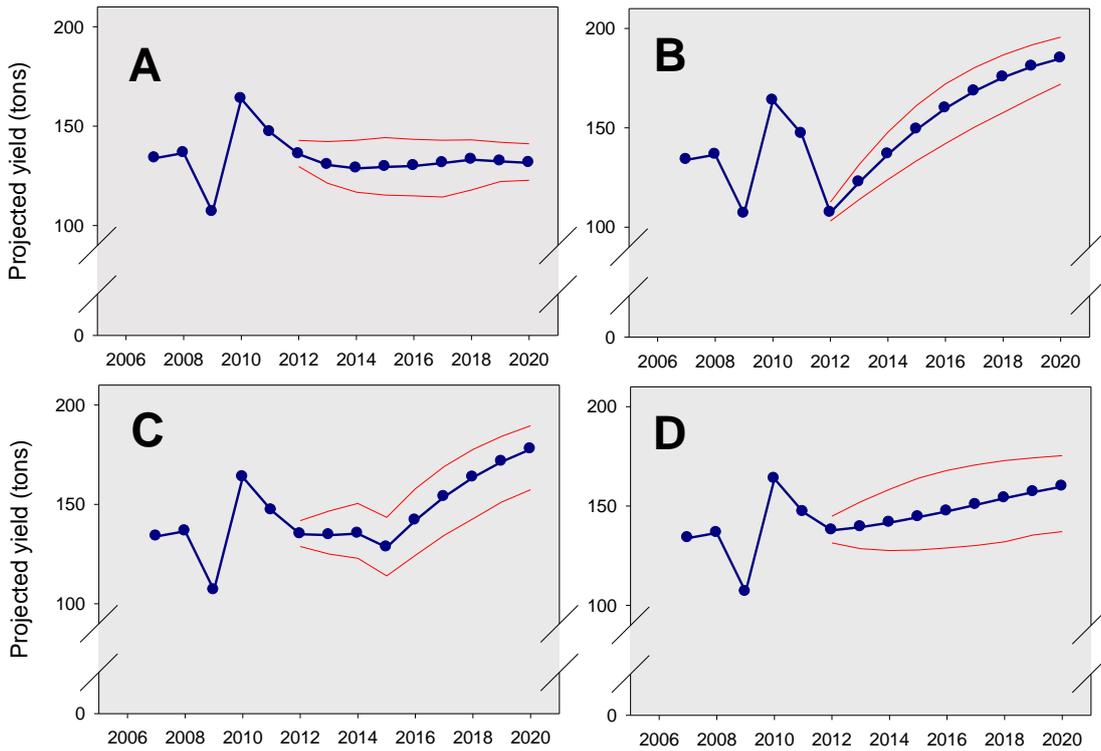


Fig. 7.3.2.3.2. Mean (blue) and 80% confidence intervals (red) of ASPIC projected yields (in tons) of the medium term forecasts (2012-2020) computed for the common octopus in GSA 5 under four different scenarios: A) constant $F=F_{MSY}$; B) 10% reduction in F per year; C) linear decrease from F_{stq} to F_{MSY} by 2015, then constant F_{MSY} ; and D) linear decrease from F_{stq} to F_{MSY} by 2020. For comparative purposes, landings from the previous five years (2007-2011) are also shown.

7.4. Short term prediction for Norway lobster in GSA 5

7.4.1. Short term prediction 2012-2014

7.4.1.1. Method and justification

Short term predictions were implemented in R (www.r-project.org) using the FLR libraries and based on the results of the Extended Survivor Analyses (XSA, Darby and Flatman, 1994) presented at the EWG 12-10 (Sète).

7.4.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of the Norway lobster in GSA 5:

Maturity and M vectors

Maturity oogive										
Age	0	1	2	3	4	5	6	7	8	9+
Prop. Matures	0.02	0.05	0.14	0.32	0.58	0.80	0.92	0.97	0.99	1.00

M										
Age	0	1	2	3	4	5	6	7	8	9+
Mortality	0.95	0.47	0.37	0.29	0.26	0.24	0.23	0.22	0.21	0.21

F vector

F	0	1	2	3	4	5	6	7	8	9+
2009-2011	0.000	0.002	0.093	0.477	0.615	0.503	0.511	0.616	0.589	0.589

Weight-at-age in the stock

Mean weight in the stock (kg)										
0	1	2	3	4	5	6	7	8	9+	
0.001	0.004	0.012	0.022	0.037	0.054	0.075	0.094	0.117	0.162	

Weight-at-age in the catch

Mean weight in the catch (kg)										
0	1	2	3	4	5	6	7	8	9+	
0.001	0.004	0.012	0.022	0.037	0.054	0.075	0.094	0.117	0.162	

Number at age in the catch

Catch at age in	0	1	2	3	4	5	6	7	8	9+

numbers (thousands)										
2011	5454.7	2075.2	1220.5	1045.1	450.7	235.1	100.7	42.7	16.5	24.5

Number at age in the stock

Stock at age in numbers (thousands)	0	1	2	3	4	5	7	8	9+	7
2012	5300.28*	2121.31	1292.10	739.86	423.81	153.04	106.36	45.13	16.86	14.49

* arithmetic mean 2009-2011

Different scenarios of constant harvest strategy with F_{bar} calculated as the average of ages 3 to 8 (F_{bar} ages 3-8) and F status quo ($F_{\text{stq}} = 0.55$) were performed.

Stock recruitment

Catches on age 0 from the bottom trawl surveys are absent for most of the year, so recruitment (class 0) has been estimated from the population results from the mean of the last three years 2009-2011 estimated with XSA.

Different trials: mean 2009-2011, mean 2002-2011, geometric mean 2009-2011, geometric mean 2002-2011.

	Recruitment (thousands)
Mean 2009-2011	5295.26
Mean 2002-2011	5560.80
Geometric mean 2009-2011	5292.60
Geometric mean 2002-2011	5517.82

7.4.1.3. Results

A short term projection (Table 7.4.1.3.1), assuming an F_{stq} of 0.55 in 2011 and a recruitment of 5295 (thousands) individuals, shows that:

- Fishing at the F_{stq} (0.55) generates a decrease of the catch of 36% from 2011 to 2013 along with a decrease of the spawning stock biomass of 3% from 2013 to 2014.
- Fishing at $F_{0.1}$ (0.42) generates a decrease of the catch of 48% from 2011 to 2013 and an increase of the spawning stock biomass of 8% from 2013 to 2014.

Outlook until 2014

Table 7.4.1.3.1. Short term forecast in different F scenarios computed for Norway lobster in GSA 5.

Basis: $F(2012) = \text{mean}(F_{\text{bar}3-8} \text{ 2009-2011}) = 0.55$; $R(2012) = \text{mean of the recruitment of the last 3 years}$; $R = 5295$ (thousands); $SSB(2011) = 46.3$ t, $\text{Catch}(2011) = 32.3$ t.

Rationale	Ffactor	fbar	Catch 2013	Catch 2014	SSB 2014	Change SSB 2013-2014 (%)	Change Catch 2011-2013 (%)
zero catch	0.00	0.00	0.00	0.00	57.07	53	-100
High long-term yield (F0.1)		0.42	17.42	18.84	40.18	8	-48
Status quo	1.00	0.55	21.57	21.30	36.25	-3	-36
Different scenarios	0.00	0.00	0.00	0.00	57.07	53	-100
	0.10	0.06	2.67	3.80	54.45	46	-92
	0.20	0.11	5.21	7.10	51.96	39	-85
	0.30	0.17	7.63	9.97	49.61	33	-77
	0.40	0.22	9.93	12.44	47.38	27	-71
	0.50	0.28	12.12	14.57	45.27	21	-64
	0.60	0.33	14.20	16.39	43.27	16	-58
	0.70	0.39	16.18	17.95	41.37	11	-52
	0.80	0.44	18.06	19.27	39.57	6	-46
	0.90	0.50	19.86	20.37	37.87	1	-41
	1.00	0.55	21.57	21.30	36.25	-3	-36
	1.10	0.61	23.20	22.06	34.72	-7	-31
	1.20	0.66	24.75	22.68	33.26	-11	-27
	1.30	0.72	26.23	23.18	31.88	-15	-22
	1.40	0.77	27.64	23.57	30.58	-18	-18
	1.50	0.83	28.99	23.87	29.34	-21	-14
	1.60	0.88	30.27	24.08	28.16	-25	-10
	1.70	0.94	31.49	24.22	27.04	-28	-7
	1.80	0.99	32.66	24.30	25.99	-30	-3
	1.90	1.05	33.77	24.33	24.98	-33	0

Data consistency

No particular issue was identified with data quality and data consistency.

7.4.2. Medium term prediction

7.4.2.1. Method and justification

Following the agreement reached during the discussions of the EWG 12-19, since no stock-recruitment relationship could be reliably fitted to the dataset (Fig. 7.4.2.1.1), no medium term predictions were made.

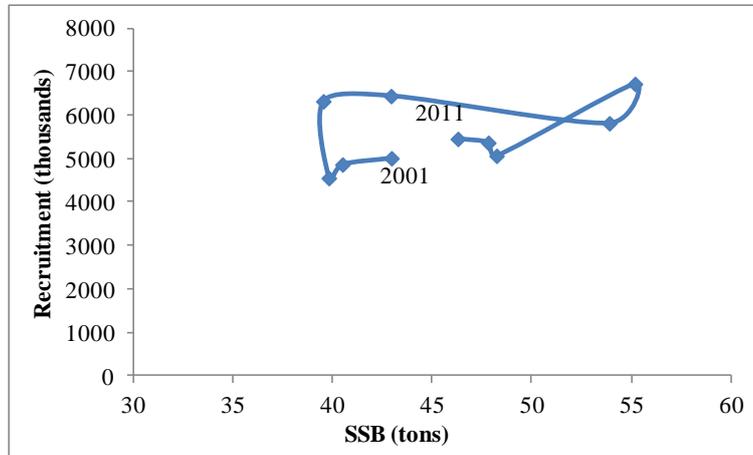


Fig. 7.4.2.1.1. SSB and recruitment relationship for Norway lobster in GSA05.

7.5. Short and medium term predictions for Blackbellied Anglerfish in GSA 06

7.5.1. Short term prediction 2012-2013

A deterministic short term prediction for 2012 to 2013 was performed using the EXCEL workbook provided by JRC (H.-J. Ratz) which takes into account the catch and landings in numbers and weight and the discards, and based on the results of annual LCA stock assessments performed during EWG12-10 for the years 2009, 2010, 2011.

7.5.1.1. Input parameters

The following data have been used to derive the input data for the short term prediction of the anglerfish stock in GSA 06 (average values for the 2009-2011 period):

Maturity and M vectors

PERIOD	Age	0	1	2	3	4	5	6	gp+
2009-2011	M	0.767	0.428	0.298	0.244	0.215	0.196	0.182	0.174
	Prop. mature	0.101	0.228	0.322	0.386	0.445	0.502	0.551	0.586

F vector

PERIOD	Age	0	1	2	3	4	5	6	gp+
2009-2011	F	0.015	0.247	1.336	0.828	0.479	0.698	1.005	0.500

In the period 2009-2011 the bulk of the catch was comprised of anglerfish of ages 1-3, the reference F selected was the average F_{bar} for ages 1-3 ($F_{\text{bar}}=0.80$).

Weight-at-age in the stock

PERIOD	Age	0	1	2	3	4	5	6	gp+
2009-2011	weight (kg)	0.011	0.133	0.415	0.927	1.589	2.319	3.095	4.775

Weight-at-age in the catch

PERIOD	Age	0	1	2	3	4	5	6	gp+
2009-2011	weight (kg)	0.011	0.133	0.415	0.927	1.589	2.319	3.095	4.775

Number at age in the catch

PERIOD	Age	0	1	2	3	4	5	6	gp+
2009-2011	Nb in the catch. 000s	98	774	1444	218	51	34	18	3

Number at age in the stock

PERIOD	Age	0	1	2	3	4	5	6	gp+
2009-2011	Nb in the stock. 000s	9424.7	4311.7	2194.7	428.4	146.7	73.3	30.0	9.1

Stock recruitment

Recruitment (class 0+) has been estimated as the geometric mean from 2009 to 2011 (7177 thousand individuals).

7.5.1.2. Results

Short-term implications

A short term projection table (Table 7.5.1.2.1). assuming a *statu-quo* F of $F_{stq}=0.80$ in 2011 and a recruitment of 7177 thousand individuals shows that:

- Fishing at F_{stq} from 2011 to 2012 would generate no significant change in the catches (less than 0.1% variation). with a moderate reduction in SSB of -3.4% between 2012 and 2013.
- Fishing at $F_{0.1}$ (0.16) from 2011 to 2012 would generate a decrease of 75.8% of the catches and an increase of 66.5% in SSB.
- STECF EWG 12-19 recommends that catch in 2013 does not exceed 447 t. corresponding to $F_{0.1}=0.16$.

Outlook until 2013

Table 7.5.1.2.1. Short term forecast for different F scenarios computed for anglerfish (*Lophius budegassa*) in GSA 6

Basis: $F(2011) = 0.8037$ mean (F_{bar} 1-3); $R(2012-2013) : GM (2009-2011) = 7\ 177$ (thousands); $F(2011)=0.8037$; $SSB(2011)= 854$ t; $landings(2011)= 1136$ t. Weights in tons.

Rationale	F scenario	F factor	Catch 2012	Catch 2013	SSB 2013	Change SSB 2012-2013 (%)	Change catch 2011-2012 (%)
zero catch	0	0	0	0	0	90.2	-100.0
High long-term yield (F0.1)	0.16	0.17	275	447	1424	66.5	-75.8
Status quo	0.8037	1	1136	1113	826	-3.4	0.0
Different scenarios	0.0804	0.1	166	284	1503	75.8	-85.4
	0.1607	0.2	323	506	1393	62.9	-71.6
	0.2411	0.3	460	678	1301	52.2	-59.5
	0.3215	0.4	588	810	1207	41.2	-48.2
	0.4018	0.5	699	905	1127	31.8	-38.5
	0.4822	0.6	804	982	1053	23.2	-29.2
	0.5626	0.7	897	1034	989	15.7	-21.0
	0.6429	0.8	983	1071	929	8.7	-13.5
	0.7233	0.9	1066	1098	880	2.9	-6.2
	0.884	1.1	1204	1114	779	-8.9	6.0
	0.9644	1.2	1264	1116	737	-13.8	11.3
	1.0448	1.3	1318	1108	702	-17.9	16.0
	1.1251	1.4	1368	1104	675	-21.1	20.4
	1.2055	1.5	1420	1090	642	-24.9	25.0

7.5.2. *Medium term prediction*

7.5.2.1. Method and justification

Medium term predictions from 2012 to 2020 were implemented in R (www.r-project.org). Four scenarios of F reduction were considered. As in the short-term prediction, constant recruitment was assumed (geometric mean recruitment over 2009-2011), with a random stochastic component following a uniform distribution function between 80% of the minimum recruitment estimated and 120% of the maximum recruitment estimated in the 3 year series. Runs were made with 500 simulations per run.

The scenarios were the following:

- 1: Constant $F = F_{0.1}$
- 2: 10% reduction in F per annum
- 3: Linear decrease to hit $F=F_{0.1}$ by 2015, then fix at $F=F_{0.1}$ until 2020
- 4: Linear decrease in F to reach $F = F_{0.1}$ in 2020

7.5.2.2. Input parameters

Input parameters (maturity ogive, M, weight-at-age for the stock and for the catch) were the same as in the short- term prediction. Catches over 2002-2011 were taken from DCF data set.

7.5.2.3. Results

SSB responds quickly to the simulated reductions in F, because of the very high current exploitation rate ($F_{curr} / F_{0.1} = 5$). In Scenario 1, yield would recover to historical values by 2015 and remain stable thereafter. Scenario 2 shows a slight decrease in yield from the maximum observed in 2011, but yield would remain at historical high levels for the entire simulation horizon. Scenario 3 shows a 3 year decline in yield, to levels similar to the minimum observed in the catch series, but yield would recover towards the end of the simulation scenario at historical medium to high levels. In Scenario 4, yield would decrease continuously with decreasing F, but always at levels similar to the medium-high catches observed.

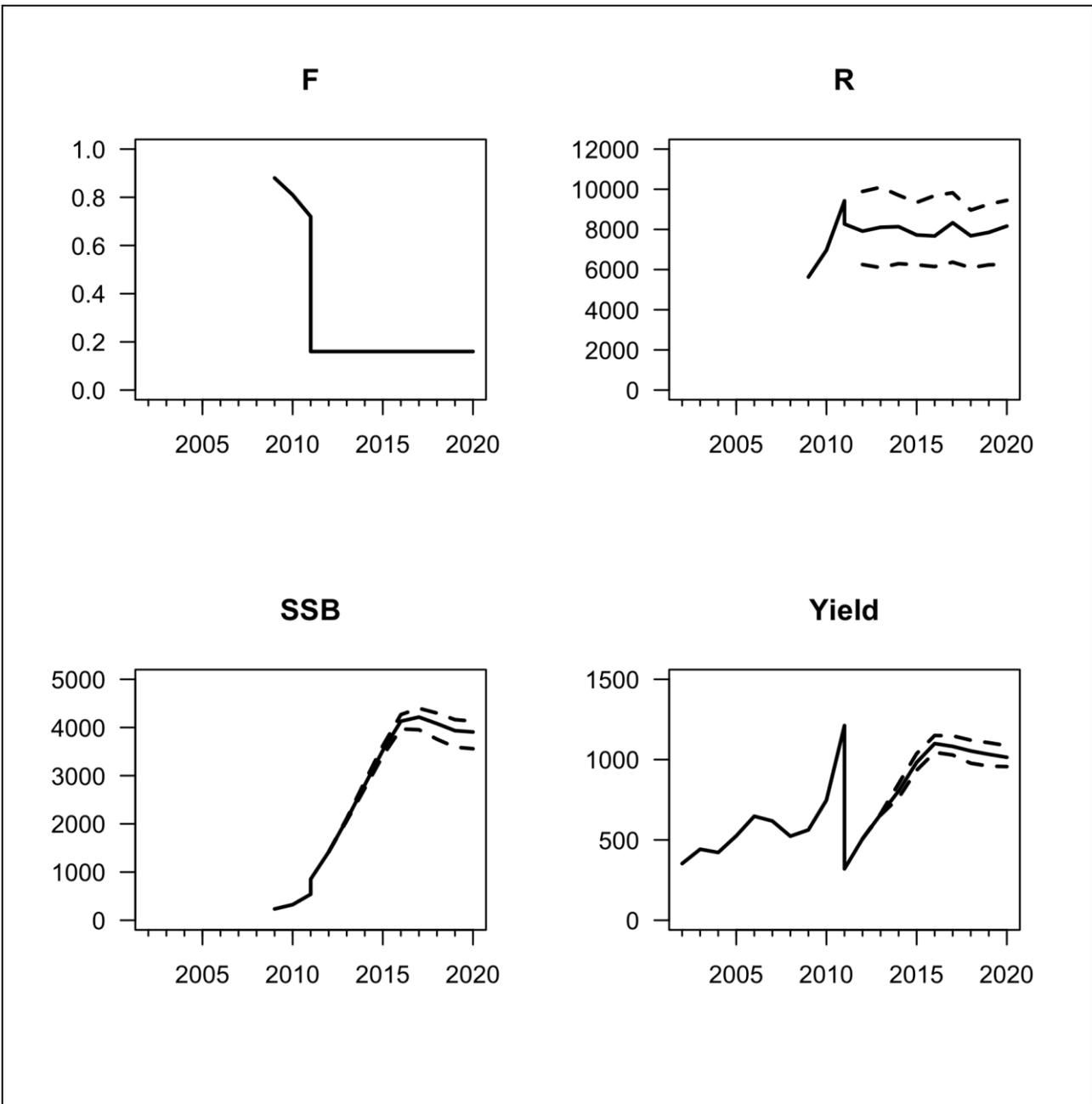


Fig. 7.5.2.3.1. Medium term projections. Scenario 1: constant $F = F_{0.1}$. Lines from 2012 onwards are 25%, 50% and 75% quantiles. R: recruitment in thousand individuals; SSB and Yield in tons

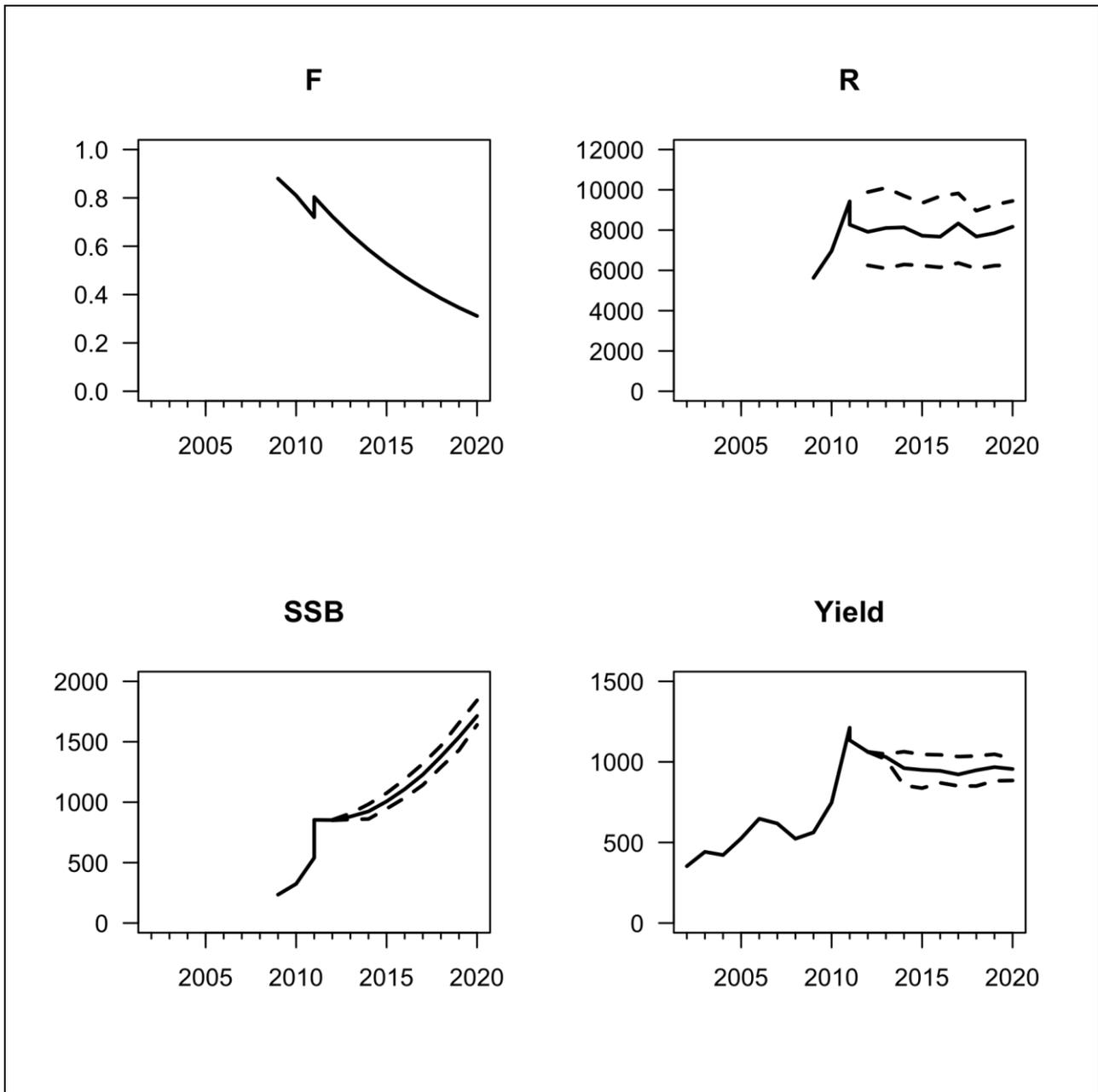


Fig. 7.5.2.3.2. Medium term projections. Scenario 2: 10% reduction in F per annum. Lines from 2012 onwards are 25%, 50% and 75% quantiles. R: recruitment in thousand individuals; SSB and Yield in tons

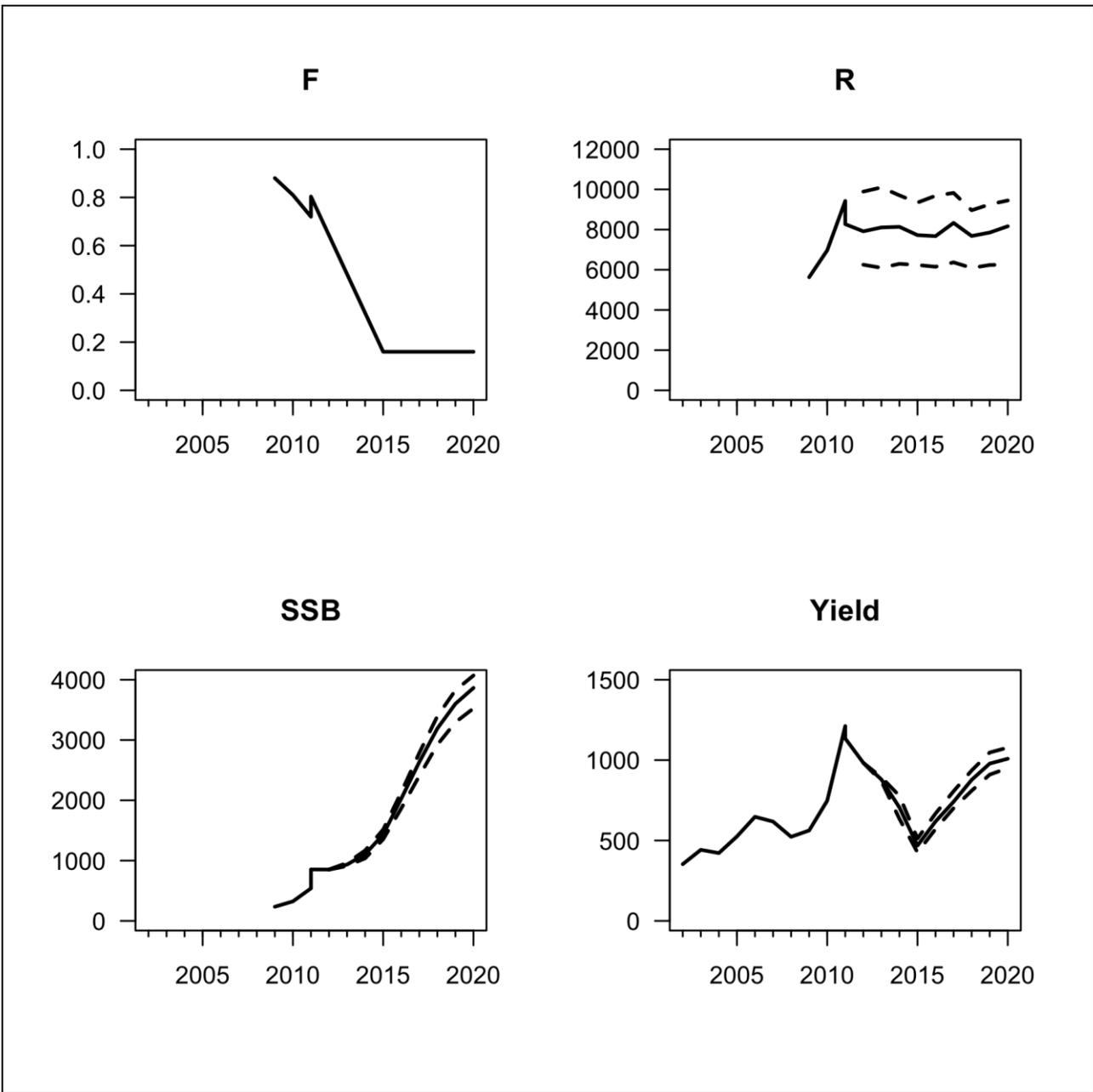


Fig. 7.5.2.3.3. Medium term projections. Scenario 3: Linear decrease to hit $F=F_{0.1}$ by 2015, then fix at $F=F_{0.1}$ until 2020. Lines from 2012 onwards are 25%, 50% and 75% quantiles. R: recruitment in thousand individuals; SSB and Yield in tons

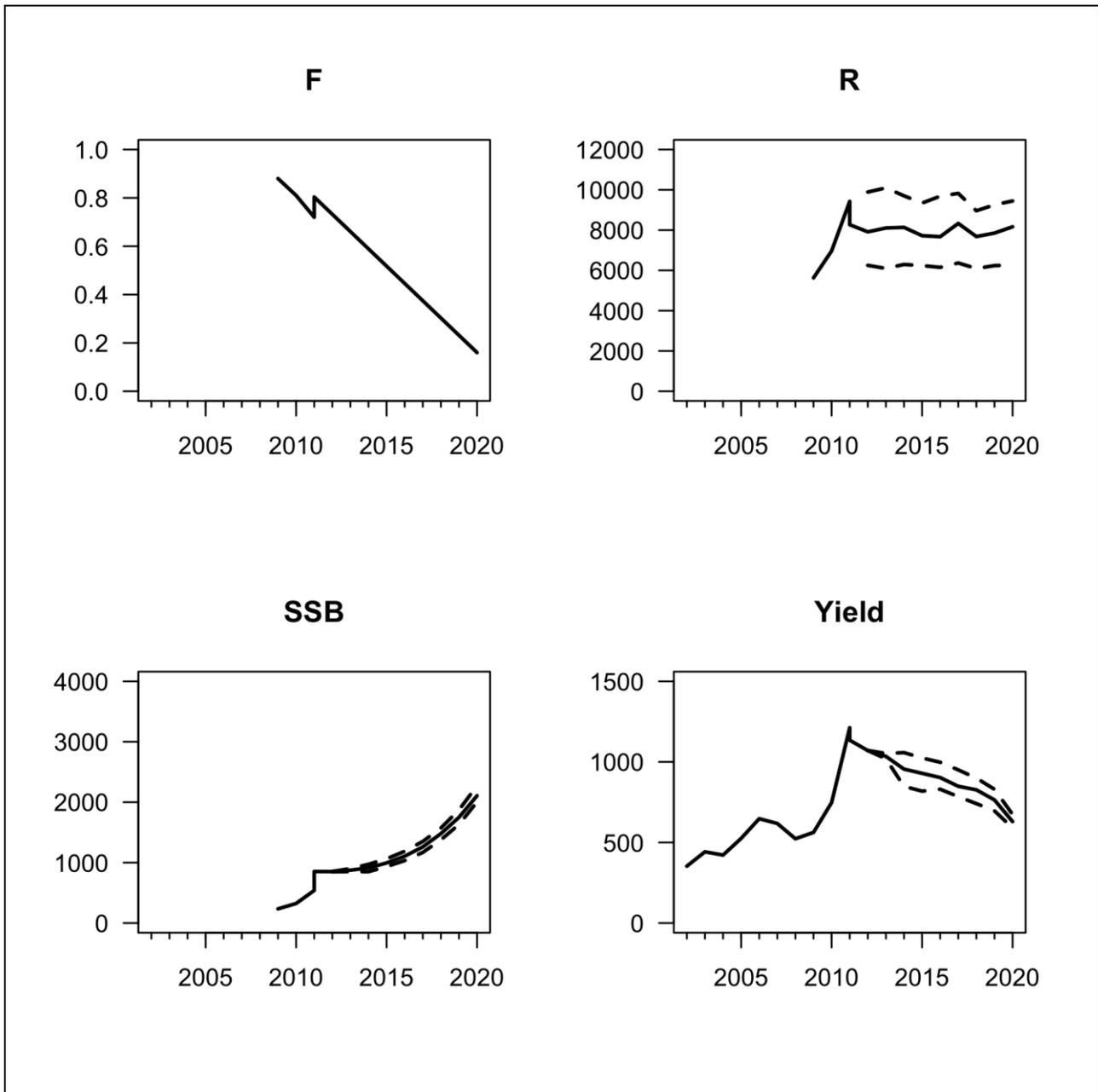


Fig. 7.5.2.3.4. Medium term projections. Scenario 4: Linear decrease in F to reach $F = F_{0.1}$ in 2020. Lines from 2012 onwards are 25%, 50% and 75% quantiles. R: recruitment in thousand individuals; SSB and Yield in tons

7.6. Short term predictions for Blue and red shrimp in GSA 06

7.6.1. Short term prediction 2012-2014

7.6.1.1. Method and justification

A deterministic short term prediction for 2012 to 2014 was performed using the EXCEL workbook provided by JRC IPSC (H.-J. Rätz) which takes into account the catch and landings in numbers and weight and the discards, and based on the results of the Extended Survivor Analyses (XSA, Darby and Flatman, 1994) stock assessment performed during EWG12-10.

7.6.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of the Blue and red shrimp stock in GSA 6:

Maturity and M vectors

PERIOD	Age	0	1	2	3	gp+
2011	Prop. Matures	0.08	0.8	0.9	1	1

PERIOD	Age	0	1	2	3	gp+
2011	M	0.46	0.46	0.46	0.46	0.46

F vector

F	0	1	2	3	gp+
2011	0.2714	1.6037	1.128	1.147	1.147
2011rescaled	0.2374	1.5457	1.281	1.086	1.086

Since F was oscillating during 2009-2011, F in 2011 was rescaled and these values were taken as input for the short-term prediction. F_{stq} (F_{bar} ages 0-3) was calculated from the rescaled values ($F_{stq}=1.04$).

Weight-at-age in the stock

Mean weight in stock (kg)	0	1	2	3	gp+
2011	0.006	0.015	0.034	0.054	0.071

Weight-at-age in the catch

Mean weight in catch (kg)	0	1	2	3	gp+
2011	0.006	0.015	0.034	0.054	0.071

Number at age in the catch

Catch at age in numbers (thousands)	0	1	2	3	gp+
2011	13107	44583	6879	588	41

Number at age in the stock

Numbers at age in the stock (thousands)	0	1	2	3	gp+
2012	94824*	33399	8920	2616	232

Stock recruitment

*Recruitment (class 0+) has been estimated as the geometric mean from 2009 to 2011 as 94824 thousand individuals (from XSA done in SGMED-12-10).

7.6.1.3. Results

Short-term implications

A short term projection (Table 7.6.1.3.1), assuming an F_{stq} of 1.04 in 2012 and a recruitment of 94824 (thousand) individuals, shows that:

- Fishing at the F_{stq} (1.0) from 2011 to 2013 would generate an increase of the catches of 27%, and if we consider the period 2013-2014, there is a decrease of spawning stock biomass of 9%.
- Fishing at $F_{0.1}$ (0.33) from 2011 to 2013 generates a decrease of the catches of 40% and a spawning stock biomass increase by 58% from 2013 to 2014.
- EWG 12-19 recommends that catch in 2013 should not exceed 399 tons, corresponding to $F_{0.1} = 0.33$.

Outlook until 2014

Table 7.6.1.3.1. Short term forecast for different F scenarios computed for blue and red shrimp in GSA 06.

Basis: $F(2011) = 1.04$ mean (F_{bar} 0-3, rescaled 2009-2011); $R(2012) = GM(2009-2011) = 94824$ (thousands); $F(2012) = 1.04$; $SSB(2012) = 844$ t; $landings(2011) = 670$ t. Weights in t.

Rationale	F scenario	F factor	Catch 2013	Catch 2014	SSB 2014	Change SSB 2013-2014 (%)	Change catch 2011-2013 (%)
zero catch	0	0	0	0	2194	122.1	-100.0
High long-term yield ($F_{0.1}$)	0.34	0.33	399	563	1561	58.0	-40.4
Status quo	1.04	1.0	850	753	899	-9.0	27.0
Different scenarios	0.10	0.1	140	240	1970	99.4	-79.1
	0.21	0.20	261	411	1775	79.7	-61.0
	0.31	0.30	370	534	1607	62.7	-44.7

0.42	0.40	465	618	1459	47.7	-30.5
0.52	0.50	549	676	1332	34.8	-18.0
0.63	0.60	624	713	1221	23.6	-6.8
0.73	0.70	690	737	1123	13.7	3.1
0.83	0.80	749	748	1038	5.1	11.9
0.94	0.90	802	753	965	-2.3	19.8
1.15	1.10	891	749	841	-14.9	33.1
1.25	1.20	931	744	788	-20.2	39.1
1.36	1.30	965	737	745	-24.6	44.1
1.46	1.40	997	728	703	-28.8	48.9
1.56	1.50	1026	720	668	-32.4	53.2

Comparison between the short- term forecast delivered previously

Short- term prediction was performed for *Aristeus antennatus* in GSA 06 by SGMED09-03 (December 2009) considering an F_{bar} (1-4), $F_{\text{sq}}=1.61$ and $R=88322$ thousands individuals. Projections for 2011 were: Catch $stq = 470$ t, SSB $stq = 504$ t. In 2011 *Aristeus antennatus* landings amounted to 670 t and SSB was estimated to be 1332 t, higher than expected by projections.

7.6.2. Medium term prediction

7.6.2.1. Method and justification

Medium term predictions from 2012 to 2020 were implemented in R (www.r-project.org). Four scenarios of F reduction were considered. Runs were made with 500 simulations per run. Since SSB and recruitment relationship seemed to follow Beverton and Holt's model, data were first fitted to this model. SSB and recruitment input data were taken from the XSA results, performed during STECF EWG 12-10 (Sète, July 2012). One-year lag was considered between SSB and R.

Table 7.6.2.1.1. SSB (2002-2010) and recruitment (2003-2011) data used to fit Beverton and Holt's model, taken from the XSA results.

	SSB	RECRUITS	
year(t)	(tonnes)	(thousands)	year(t+1)
2002	143	49044	2003
2003	204	48567	2004
2004	412	63809	2005
2005	292	79203	2006

2006	438	74764	2007
2007	609	96721	2008
2008	589	96551	2009
2009	630	127242	2010
2010	831	69402	2011

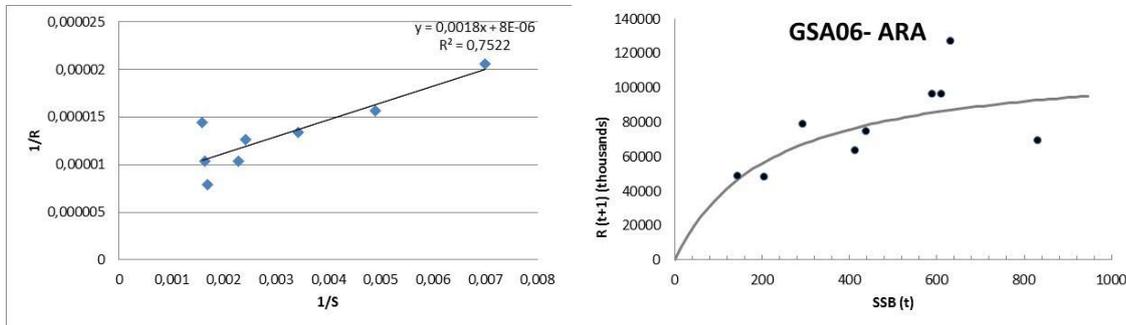


Fig. 7.6.2.1.1. Results of the fitting of SSB and R data to Beverton and Holt's model (B&H parameters: $\alpha=8.53753E-06$, $\beta=0.001864622$, $\sigma=0.401943846$).

The scenarios were the following:

- 1: Constant $F = F_{0.1}$
- 2: 10% reduction in F per annum
- 3: Hit $F = F_{0.1}$ by 2015, then fix at $F = F_{0.1}$
- 4: Linear decrease in F to hit $F = F_{0.1}$ in 2020

7.6.2.2. Input parameters

Input parameters (maturity ogive, M , weight-at-age for the stock and for the catch) were the same as in the short-term prediction. Stock numbers at-age and F at-age in 2011 were taken from the XSA results.

7.6.2.3. Results

In all 4 scenarios SSB responds very quickly to the decrease in F , which is to be expected since the blue and red shrimp fishery in GA06 is highly dependent on recruitment and the age of maturity is one year (77% mature at 1 year). Also in the four scenarios considered, R stabilizes at around 100000 thousands, which corresponds to R in the flat part of the B&H curve. In scenarios 1 and 3, those which highest F reduction, SSB would reach 3000 tonnes in 2020, but this level would be reached sooner in scenario 1 than in scenario 3. In this regard, it is worth mentioning, that after a sharp decrease in yield, more marked in scenario 1, yield would recover quickly, with F much lower than that before 2011. Scenario 2, 10% decrease of F per annum, would result in high yield, and increasing SSB, although with smaller SSB size than in scenarios 1 and 3. Predictions for scenario 4 are very similar to those of scenario 2, although by the end of the period yield would slightly decrease.

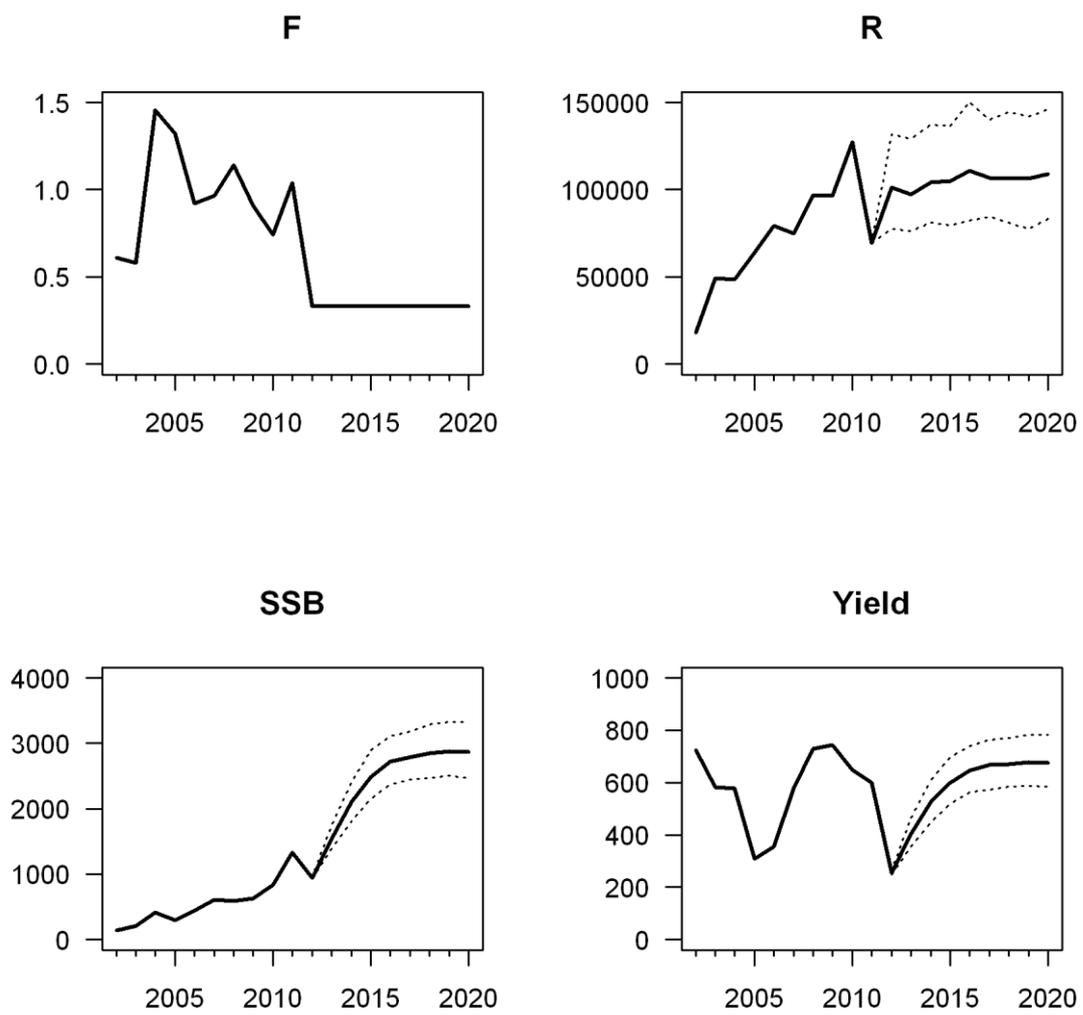


Fig. 7.6.2.3.1. Medium term predictions. Scenario 1: constant $F = F_{0.1}$

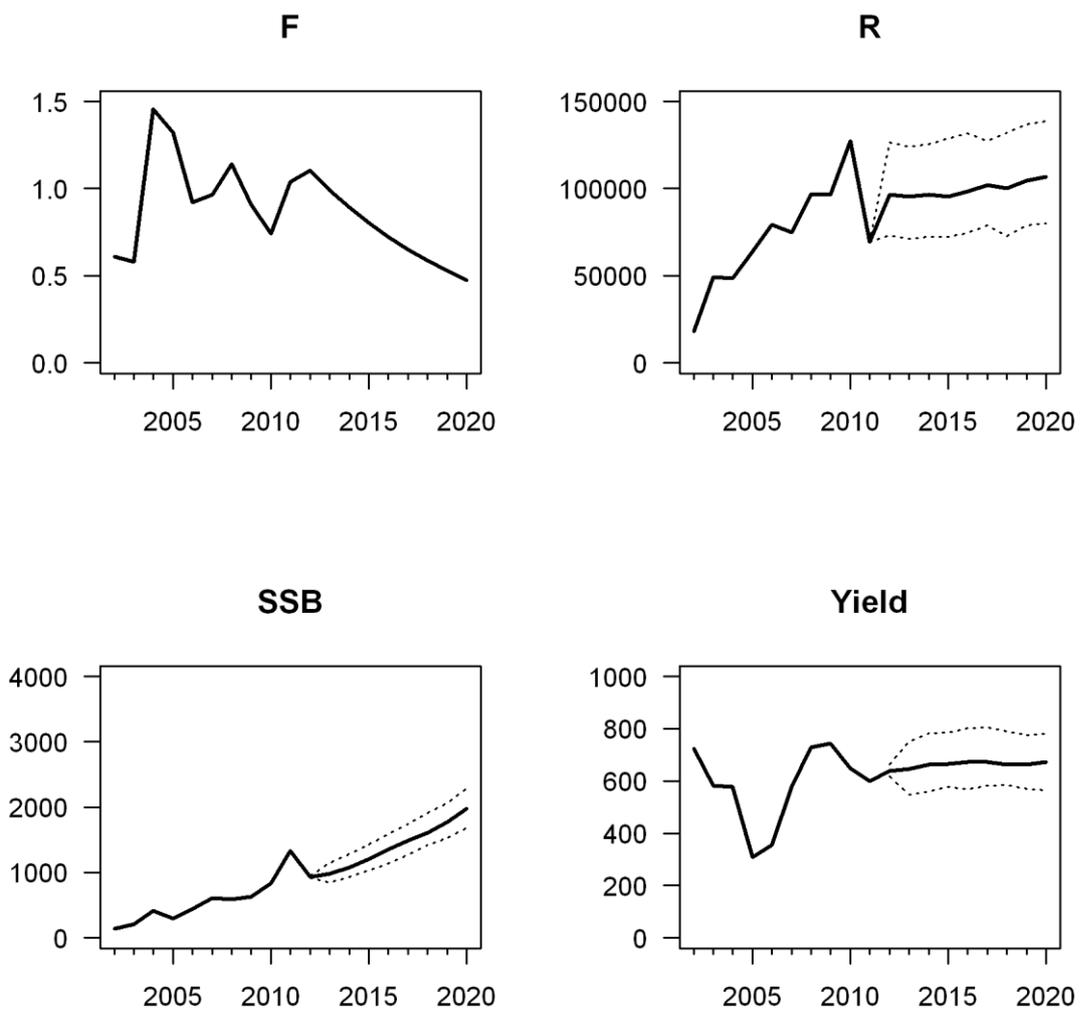


Fig. 7.6.2.3.2. Medium term predictions. Scenario 2: 10% reduction in F per annum.

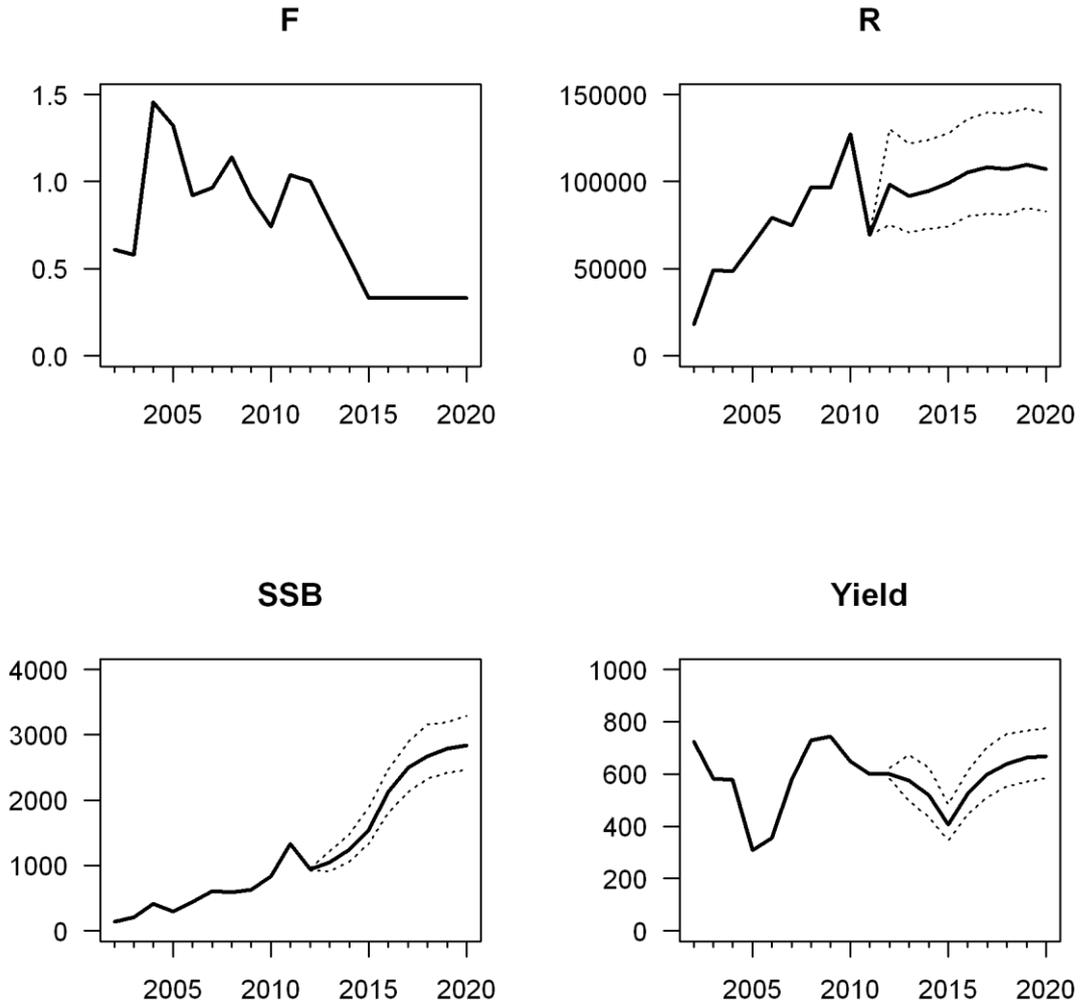


Fig. 7.6.2.3.3. Medium term predictions. Scenario 3: Hit $F = F_{0.1}$ by 2015, then fix at $F = F_{0.1}$.

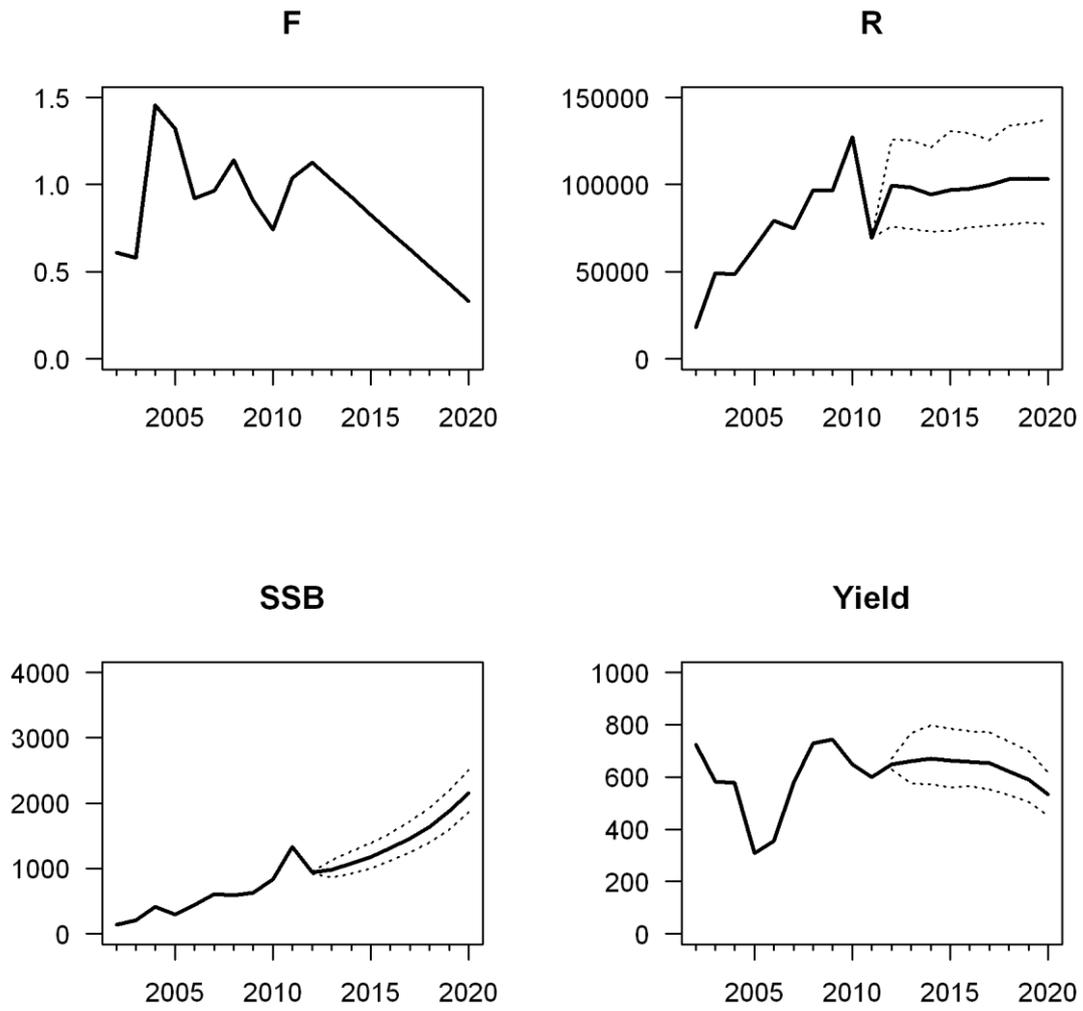


Fig. 7.6.2.3.4. Medium term predictions. Scenario 4: Linear decrease in F to hit $F = F_{0.1}$ in 2020.

7.7. Short term predictions for Nephrops Norvegicus GSA06 (2012-2013)

7.7.1. Short term prediction 2012-2013

A deterministic short term prediction for 2012 to 2013 was performed using the EXCEL workbook provided by JRC (H.-J. Ratz) which takes into account the catch and landings in numbers and weight and the discards, and based on the results of annual LCA stock assessments performed during EWG12-19 for the years 2009, 2010, 2011.

7.7.1.1. Input parameters

The following data have been used to derive the input data for the short term prediction of the Norway lobster stock in GSA 06 (average values for the 2009-2011 period):

Maturity and M vectors

PERIOD	age class	1	2	3	4	5	6	7	8	9+
2009-2011	proportion mature	0.05	0.14	0.32	0.58	0.8	0.92	0.97	0.99	1
	M	0.47	0.37	0.29	0.26	0.24	0.23	0.22	0.21	0.21

F vector

PERIOD	age class	1	2	3	4	5	6	7	8	9+
2009-2011	F	0.008	0.246	0.791	0.742	0.439	0.368	0.367	0.210	0.750

In the period 2009-2011 the bulk of the catch was comprised of Norway lobster of ages 3-7, the reference F selected was the average F_{bar} for ages 3-7 ($F_{\text{bar}}=0.63$).

Weight-at-age in the stock

PERIOD	age class	1	2	3	4	5	6	7	8	9+
2009-2011	weight (kg)	0.0024	0.0091	0.0203	0.0359	0.0547	0.0746	0.0948	0.1148	0.144

Weight-at-age in the catch

PERIOD	age class	1	2	3	4	5	6	7	8	9+
2009-2011	weight (kg)	0.0024	0.0091	0.0203	0.0359	0.0547	0.0746	0.0948	0.1148	0.144

Number at age in the catch

PERIOD	age class	1	2	3	4	5	6	7	8	9+
2009-2011	Nb in the catch. 000s	366.4	6784.6	9666.4	3178.1	793.9	349.5	192.4	66.1	198.2

Number at age in the stock

PERIOD	Age	1	2	3	4	5	6	7	8	9+
--------	-----	---	---	---	---	---	---	---	---	----

2009-2011	Nb in the stock. 000s	59653	36996	19990	6780	2489	1261	693	386	254
-----------	-----------------------	-------	-------	-------	------	------	------	-----	-----	-----

Stock recruitment

Recruitment (class 1) has been estimated as the geometric mean from 2009 to 2010 (50648 thousand individuals).

7.7.1.2. Results

Short-term implications

A short term projection table (Table 7.7.1.2.1). assuming a *status-quo* F (F_{stq})=0.6299 in 2011 and a recruitment of 50648 thousand individuals shows that:

- Fishing at F_{stq} from 2011 to 2012 would generate a 4% increase in the catches, with a reduction of SSB of 5% between 2012 and 2013.
- Fishing at $F_{0.1}$ (0.15) from 2011 to 2012 would generate a decrease of 73.5% of the catches and an increase of 48.9% in SSB.
- STECF EWG 12-19 recommends that catch in 2013 does not exceed 129 t. corresponding to $F_{0.1}$ =0.15.

Outlook until 2013

Table 7.7.1.2.1. Short term forecast for different F scenarios computed for *Nephrops norvegicus* in GSA 6

Basis: $F(2011) = 0.693$ mean (F_{bar} 3-7); $R(2012-2013) : GM(2009-2011) = 50648$ (thousands); $F(2011)=0.541$; $SSB(2011)=476$ t; $landings(2011)=486$ t. Weights in tons.

Rationale	F scenario	F factor	Catch 2012	Catch 2013	SSB 2013	Change SSB 2012-2013 (%)	Change catch 2011-2012 (%)
zero catch	0	0	0	0	0	67.5	-100.0
High long-term yield (F0.1)	0.15	0.2	129	182	926	48.9	-73.5
Status quo	0.6299	1	506	483	590	-5.1	4.1
Different scenarios	0.0630	0.1	66	99	982	57.9	-86.4
	0.1260	0.2	129	182	926	48.9	-73.5
	0.1890	0.3	186	249	874	40.5	-61.7
	0.2520	0.4	239	306	825	32.6	-50.8
	0.3150	0.5	291	354	780	25.4	-40.1
	0.3780	0.6	341	391	736	18.3	-29.8
	0.4410	0.7	387	425	695	11.7	-20.4
	0.5039	0.8	428	447	658	5.8	-11.9
	0.5669	0.9	469	468	624	0.3	-3.5
	0.6929	1.1	542	492	560	-10.0	11.5
	0.7559	1.2	574	501	531	-14.6	18.1
	0.8189	1.3	604	506	503	-19.1	24.3
	0.8819	1.4	636	509	478	-23.2	30.9

	0.9449	1.5	664	510	455	-26.8	36.6
--	--------	-----	-----	-----	-----	-------	------

7.8. Short term predictions for Red mullet in GSA 07

7.8.1. Short term prediction 2009-2011

7.8.1.1. Method and justification

Short term predictions were implemented in R (www.r-project.org) using the FLR libraries and based on the results of the Extended Survivor Analyses (XSA, Darby and Flatman, 1994) presented at the EWG -12-10 (Sète).

7.8.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of the red mullet stock in GSA 7:

Maturity and M vectors

PERIOD	Age	0	1	2	3	4	5+
2004-2011	Prop. Matures	0	1	1	1	1	1

PERIOD	Age	0	1	2	3	4	5+
2004-2011	M	1.3	0.79	0.62	0.54	0.54	0.54

F vector

F	0	1	2	3	4	5+
2009-2011	0.37	1.59	2.00	1.08	1.49	1.49

Weight-at-age in the stock

Mean weight in stock (kg)	0	1	2	3	4	5+
2009-2011	0.016	0.054	0.121	0.187	0.225	0.259

Weight-at-age in the catch

Mean weight in catch (kg)	0	1	2	3	4	5+
2009-2011	0.016	0.054	0.121	0.187	0.225	0.259

Number at age in the catch

Catch at age in numbers (thousands)	0	1	2	3	4	5+
2011	4077	2983	205	15	5	2

Number at age in the stock

Stock at age in numbers (thousands)	0	1	2	3	4	5+
2012	26369*	3615	816	15	3	1

* average of the recruitment estimated over the 2009-2011 period

Different scenarios of constant harvest strategy with F_{bar} calculated as the average of ages 0 to 3 (F_{bar} ages 0-3) and F status quo ($F_{\text{stq}} = 1.26$) were performed.

Stock recruitment

Recruitment (class 0) has been estimated from the population results from the mean of the last three years 2009-2011 estimated with FLR.

7.8.1.3. Results

A short term projection (Table 7.8.1.3.1), assuming an F_{stq} of 1.26 in 2011 and a recruitment of 26369 (thousands) individuals, shows that:

Fishing at the F_{stq} (1.26) generates an increase in the catch of 6% from 2011 to 2013 along with an increase in the spawning stock biomass of 3% from 2013 to 2014.

Fishing at $F_{0.1}$ (0.41) generates a decrease in the catch of 53% from 2011 to 2013 and an increase in the spawning stock biomass of 66% from 2013 to 2014.

Outlook until 2014

Table 7.8.1.3.1. Short term forecast in different F scenarios computed for red mullet in GSA 07.

Basis: $F(2012) = \text{mean}(F_{\text{bar}0-3} \text{ 2009-2011})$; $R(2012) = \text{mean recruitment of the last 3 years}$; $R = 26369$ (thousands); $F(2012) = 1.26$; $\text{SSB}(2012) = 298 \text{ t}$, $\text{Catch}(2011) = 256 \text{ t}$

Rationale	Ffactor	fbar	Catch 2013	Catch 2014	SSB 2014	Change SSB 2013-2014 (%)	Change Catch 2011-2013 (%)
zero catch	0,00	0,00	0	0	703	119	-100
High long-term yield ($F_{0.1}$)	0.33	0,41	121	192	531	66	-53
Status quo	1,00	1,26	272	280	331	3	6
Different scenarios	0,00	0,00	0	0	703	119	-100
	0,10	0,13	42	82	642	100	-83
	0,20	0,25	80	141	588	84	-69
	0,30	0,38	114	183	541	69	-56
	0,40	0,50	144	214	500	56	-44
	0,50	0,63	171	236	463	44	-33
	0,60	0,76	195	252	431	34	-24
	0,70	0,88	217	263	401	25	-15
	0,80	1,01	237	271	375	17	-7
	0,90	1,13	255	277	352	10	0

	1,00	1,26	272	280	331	3	6
	1,10	1,39	287	283	312	-3	12
	1,20	1,51	301	285	295	-8	18
	1,30	1,64	315	286	279	-13	23
	1,40	1,77	327	287	265	-17	28
	1,50	1,89	338	287	251	-22	32
	1,60	2,02	348	287	239	-25	36
	1,70	2,14	358	287	228	-29	40
	1,80	2,27	368	287	217	-32	44
	1,90	2,40	376	287	207	-35	47

Data consistency

No particular issue was identified with data quality and data consistency.

7.8.2. *Medium term prediction*

7.8.2.1. Method and justification

Following the agreement reached during the discussions of the working group, since no stock-recruitment relationship could be reliably fitted to the dataset (Figure 7.8.2.1.1), no medium term predictions were made.

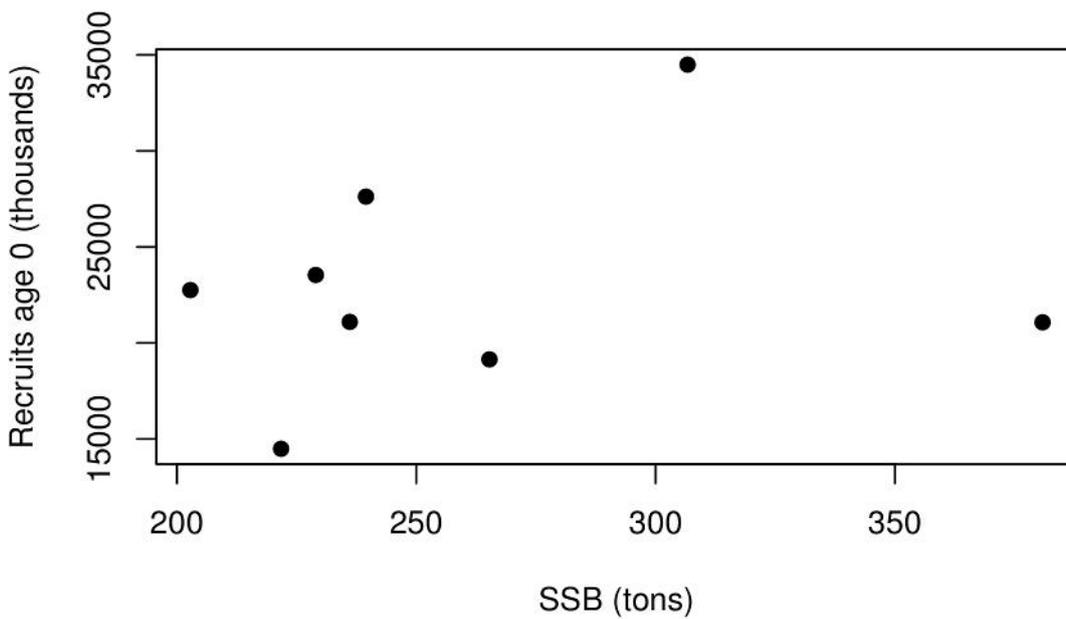


Fig. 7.8.2.1.1. Recruitment versus spawning stock biomass.

7.9. Short term prediction for European Hake in GSA 7

7.9.1. Short term prediction 2012-2013

7.9.1.1. Method and justification

Short term predictions were implemented in R (www.r-project.org) using the FLR libraries and based on the results of the Extended Survivor Analyses (XSA. Darby and Flatman, 1994) presented at the EWG-12-10 (Sète).

7.9.1.2. Input parameters

The following data have been used for the short term projection of the hake stock in GSA 7:

Maturity and M vectors

PERIOD	Age	0	1	2	3	4	5	6+
1998-2011	Prop. Matures	0	0.11	0.63	0.91	0.98	0.99	1

PERIOD	Age	0	1	2	3	4	5	6+
1998-2011	M	0.88	0.43	0.33	0.25	0.22	0.20	0.19

F vector

F	0	1	2	3	4	5	6+
2011	0.24	1.43	1.88	2.54	2.19	2.43	2.43

Several scenarios with different harvest strategy were run with F_{stq} (F_{bar} ages 0-3, mean of the last 3 years)

Weight-at-age in the stock

Mean weight in stock (kg)	0	1	2	3	4	5	6+
1998-2011	0.03	0.12	0.40	0.86	1.40	1.97	2.57

Weight-at-age in the catch

Mean weight in catch (kg)	0	1	2	3	4	5	6+
1998-2011	0.03	0.12	0.40	0.86	1.40	1.97	2.57

Number at age in the catch

Catch at age in numbers (thousands)	0	1	2	3	4	5	6+
2011	2471	6242	1582	136	6.2	1	0.2

Number at age in the stock

Stock at age in numbers (thousands)	0	1	2	3	4	5	6+
2012	18061*						
	32157**						
	42864***	5900	1593	243	10	1	0

Recruitment

* Recruitment (last year 2011, 18061 thousands)

** Recruitment has been estimated by the mean of the last 3 years (32157 thousands)

*** Recruitment (class 0) has been estimated with the regression between MEDITS indices 2012 (n/h) and XSA results (numbers of age 0): estimated value was 42864 (thousands) individuals described in the Table 7.9.1.2.1. Recruitment versus spawning stock biomass.

and Figure 7.9.1.2.1 below.

Table 7.9.1.2.1. Prediction of Recruitment (Age 0+) based on the relationship between the MEDITS survey index and the results of XSA (Age 0+)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
MEDITS abundance index (n/h)	25927	13199	25559	28426	63246	4472	23177	9418	9365	11995	87422	27946	20268	10401	11071
XSA - Age 0 (n*1000)	71290	44884	52464	75809	75492	34140	35698	31664	31737	71103	50431	43159	35250	18061	42864 ***

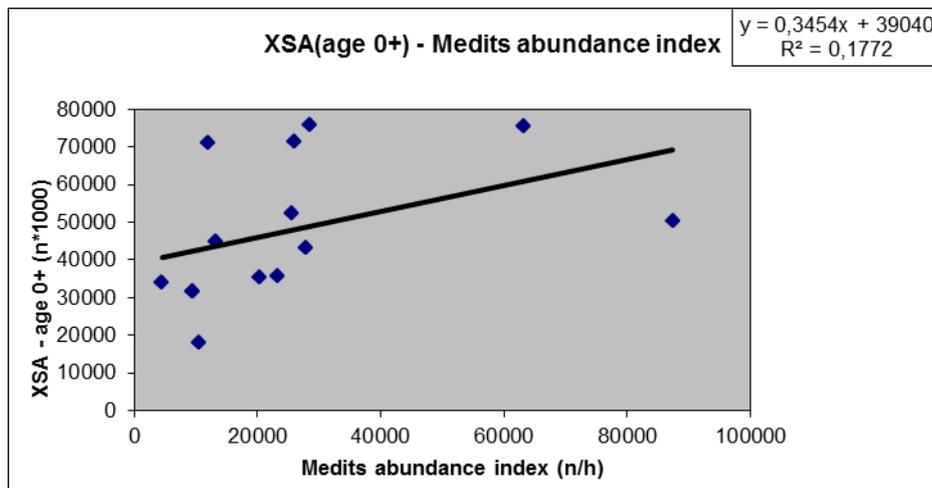


Fig. 7.9.1.2.1. Prediction of recruitment (Age 0+) based on the relationship between the MEDITS index and the results of XSA (Age 0+).

7.9.1.3. Results

Short-term implications

Considering short term forecasts, three different scenarios were conducted using three different recruitment calculations as explained in the input parameters. The final recruitment value selected is the last year recruitment, which is more precautionary.

A short term projection (Table 7.9.1.3.1), assuming an F_{stq} of 1.68 in 2011 (mean 0-3 ages) and a recruitment of 18061 (thousand) individuals shows that:

- Fishing at the F_{stq} (1.68) generates a decrease of the catch of 40 % from 2011 to 2013 along with a decrease of the spawning stock biomass of 11 % from 2013 to 2014.
- Fishing at $F_{0.1}$ (0.10) generates a decrease of the catch of 93 % from 2011 to 2013 and a spawning stock biomass increase by 262 % from 2013 to 2014.

Outlook until 2014 all fleets combined (Spanish and French bottom trawl. Spanish longline. French gillnet).

Table 7.9.1.3.1. Short term forecast in different F scenarios computed for hake in GSA 07, (All fleets combined: Spanish and French bottom trawl. Spanish longline French gillnet).

Basis: $F(2011) = \text{mean}(F_{\text{bar}} 0-3, 2009-2011)$; $R(2011) = 18061$ (thousands); $F(2011) = 1.68$; $SSB(2012) = 384$ t; $\text{Catch}(2011) = 1623$ t. Weights in t.

Rationale	Ffactor	fbar	Catch 2013	Catch 2014	SSB 2014	Change SSB 2013-2014 (%)	Change Catch 2011-2013 (%)
zero catch	0.00	0.00	0	0	1724	301	-100
High long-term yield ($F_{0.1}$)	Na	0.10	112	304	1556	262	-93
Status quo	1.00	1.68	967	924	384	-11	-40
Different scenarios	0.10	0.17	179	458	1457	239	-89
	0.20	0.34	330	728	1236	188	-80
	0.30	0.50	458	881	1053	145	-72
	0.40	0.67	567	960	900	110	-65
	0.50	0.84	660	994	773	80	-59
	0.60	1.01	740	1001	666	55	-54
	0.70	1.17	809	991	577	34	-50
	0.80	1.34	869	972	502	17	-46
	0.90	1.51	921	949	438	2	-43
	1.00	1.68	967	924	384	-11	-40
	1.10	1.84	1008	898	338	-21	-38
	1.20	2.01	1044	873	299	-30	-36
	1.30	2.18	1076	849	266	-38	-34
	1.40	2.35	1105	827	237	-45	-32
	1.50	2.52	1131	806	213	-50	-30
	1.60	2.68	1154	787	191	-55	-29
	1.70	2.85	1175	770	173	-60	-28
	1.80	3.02	1195	753	157	-63	-26
	1.90	3.19	1213	738	143	-67	-25
	2.00	3.35	1229	724	131	-69	-24

Data consistency

No particular issue was identified with data quality and data consistency.

7.9.2. *Medium term prediction*

7.9.2.1. Method and justification

Following the agreement reached during the discussions of the working group, since no stock-recruitment relationship could be reliably fitted to the dataset (Figure 7.9.2.1.1), no medium term predictions were conducted.

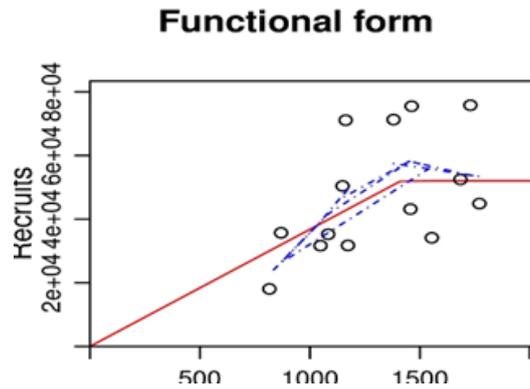


Fig. 7.9.2.1.1. Scatter plot of the SSB/Recruitment, and fit of Hockey stick relationship

7.10. Short and medium term predictions for Spottail mantis in GSA10

A deterministic short term prediction for 2012 to 2013 was performed using the EXCEL workbook provided by JRC (H.-J. Ratz) which takes into account the catch and landings in numbers and weight and the discards, and based on the results of annual LCA stock assessment performed during EWG12-10 for the year 2011.

7.10.1. Input parameters

The following data have been used to derive the input data for the short term prediction of the spot tail mantis shrimp stock in GSA 10:

Maturity and M vectors

PERIOD	Age	0	1	2	3
2011	M	1.42	0.63	0.479	0.497
	Prop. mature	0.04	0.9	1	1

F vector

PERIOD	Age	0	1	2	3
2011	F	0.069	1.25	1.355	0.5

In the 2011, the bulk of the catch was comprised of mantis shrimp of ages 1-2, the reference F selected was the average F_{bar} for ages 1-2 ($F_{\text{bar}}=1.30$).

Weight-at-age in the stock

PERIOD	Age	0	1	2	3
2011	weight (kg)	0.001374	0.01491	0.040226	0.076114

Weight-at-age in the catch

PERIOD	Age	0	1	2	3
2011	weight (kg)	0.001374	0.01491	0.040226	0.076114

Number at age in the catch

PERIOD	Age	0	1	2	3
2011	Nb in the catch. 000s	4357.0	15439.0	2594.0	211.0

Number at age in the stock

PERIOD	Age	0	1	2	3
2011	Nb in the stock. 000s	121425.1	27400.6	4179.2	667.0

Stock recruitment

Recruitment (class 0+) was assumed constant and corresponding to the number of individuals of age 0 in 2011 (121 425 thousand individuals).

7.10.2. Results

Short-term implications

A short term projection table (Table 7.10.1.2.1). assuming a *status-quo* F (F_{stq})=1.3025 in 2011 and a recruitment of 121425 thousand individuals shows that:

- Fishing at F_{stq} from 2011 to 2012 would generate no significant change in the catches nor in SSB.
- Fishing at $F_{0.1}$ (0.41) from 2011 to 2012 would generate a decrease of 49.2% of the catches and an increase of 47.1% in SSB.
- STECF EWG 12-19 recommends that catch in 2013 does not exceed 260 t. corresponding to $F_{0.1}$ =0.41.

Outlook until 2013

Table 7.10.1.2.1. Short term forecast for different F scenarios computed for anglerfish (*Squilla mantis*) in GSA 10.

Basis: $F(2011) = 1.3025$ mean (F_{bar} 1-2); $R(2012-2013) : R(2011) = 121\ 426$ (thousands); $F(2011)=1.3025$; $SSB(2011)= 594$ t; $landings(2011)= 356$ t. Weights in tons.

Rationale	F scenario	F factor	Catch 2012	Catch 2013	SSB 2013	Change SSB 2012-2013 (%)	Change catch 2011-2012 (%)
zero catch	0	0	0	0	1185	99.5	-100.0
High long-term yield (F0.1)	0.41	0.38	181	260	874	47.1	-49.2
Status quo	1.3025	1	356	356	594	0.0	0.0
Different scenarios	0.1303	0.1	56	98	1088	83.2	-84.3
	0.2605	0.1	105	171	1002	68.7	-70.5
	0.3908	0.1	150	227	927	56.1	-57.9
	0.521	0.1	188	268	861	44.9	-47.2
	0.6513	0.1	225	298	802	35.0	-36.8
	0.7815	0.1	258	320	749	26.1	-27.5
	0.9118	0.1	286	335	703	18.4	-19.7
	1.042	0.1	311	345	663	11.6	-12.6
	1.1723	0.1	336	352	626	5.4	-5.6
	1.4328	1.1	376	360	564	-5.1	5.6
	1.563	1.2	392	360	540	-9.1	10.1
	1.6933	1.3	409	360	517	-13.0	14.9
	1.8235	1.4	424	359	497	-16.3	19.1
	1.9538	1.5	437	358	478	-19.5	22.8

7.11. Short and Medium term predictions for Red mullet in GSA 11

7.11.1. Short term prediction for 2012 and 2014

7.11.1.1. Justification.

Short term predictions were implemented in R (www.r-project.org) using the FLR libraries and based on the results of the Extended Survivor Analyses (XSA, Darby and Flatman, 1994) presented in the previous paragraph.

7.11.1.2. Input parameters

The same input parameters utilized for the XSA were used for the short term prediction of the red mullet stock in GSA 11. The F_{stq} (F_{bar} ages 1-3) has been considered as the mean of the last 3 years F_{bar} , as well as the catch weight at age used in the analysis. Recruitment has been estimated as the geometric mean of the last 3 years.

7.11.1.3. Results

A short term projection (Table 7.11.1.3.1), assuming an F_{stq} of 2.91 in 2011 and a recruitment of 34,549 (thousand) individuals shows that:

- Fishing at the F_{stq} (2.9) generates an increase of the catch of 60% from 2011 to 2013 as well as an increase of SSB of 18% from 2013 to 2014.
- Fishing at $F_{0.1}$ (0.29) generates a decrease of the catch of 86% from 2011 to 2013 along with the SSB increase by 166% from 2013 to 2014.

EWG 12-19 recommends that catch in 2013 should not exceed 45 tons corresponding to $F_{0.1} = 0.29$.

Outlook until 2014

Table 7.11.1.3.1 - Short term forecast in different F scenarios computed for *M. barbatus* in GSA 11

Rationale	Ffactor	fbar	Catch 2013	Catch 2014	SSB 2014	Change SSB 2013-2014 (%)	Change Catch 2011-2013 (%)
zero catch	0.0	0.00	0.0	0.0	602.0	188	-100
High long-term yield ($F_{0.1}$)	0.1	0.29	27.5	56.9	547.5	166	-86
Status quo	1.0	2.91	191.64	278.72	191.64	50	-3
Different scenarios	0.2	0.58	52.5	104.0	498.9	146	-73
	0.3	0.87	75.4	142.9	455.5	128	-62
	0.4	1.17	96.4	175.1	416.6	112	-51
	0.5	1.46	115.6	201.6	381.7	99	-41
	0.6	1.75	133.4	223.5	350.4	86	-32
	0.7	2.04	149.7	241.6	322.2	76	-24

	0.8	2.33	164.7	256.4	296.8	66	-16
	0.9	2.62	178.7	268.7	273.8	58	-9
	1.0	2.91	191.6	278.7	253.0	50	-3
	1.1	3.21	203.7	287.0	234.1	44	3
	1.2	3.50	214.9	293.7	217.0	38	9
	1.3	3.79	225.4	299.2	201.4	32	14
	1.4	4.08	235.2	303.7	187.2	28	19
	1.5	4.37	244.4	307.3	174.2	24	24
	1.6	4.66	253.1	310.3	162.2	20	28
	1.7	4.95	261.3	312.6	151.3	17	33
	1.8	5.25	269.0	314.5	141.3	14	36
	1.9	5.54	276.3	316.0	132.1	11	40
	2.0	5.83	283.3	317.2	123.5	9	44

Weights in t. Basis: F_{stq} (2011) = mean (F_{bar} 1-3, 2009-2011); R (geometric mean 2009-2011) = 34,549 (thousands); F_{stq} (2011) = 2.91; SSB (2012) = 248 t; Catch (2011) = 192 t.

7.11.2. Medium term prediction

7.11.2.1. Justification

As shown below a bad fit of stock-recruitment relationship do not allow EWG 12-19 to run the medium term projection.

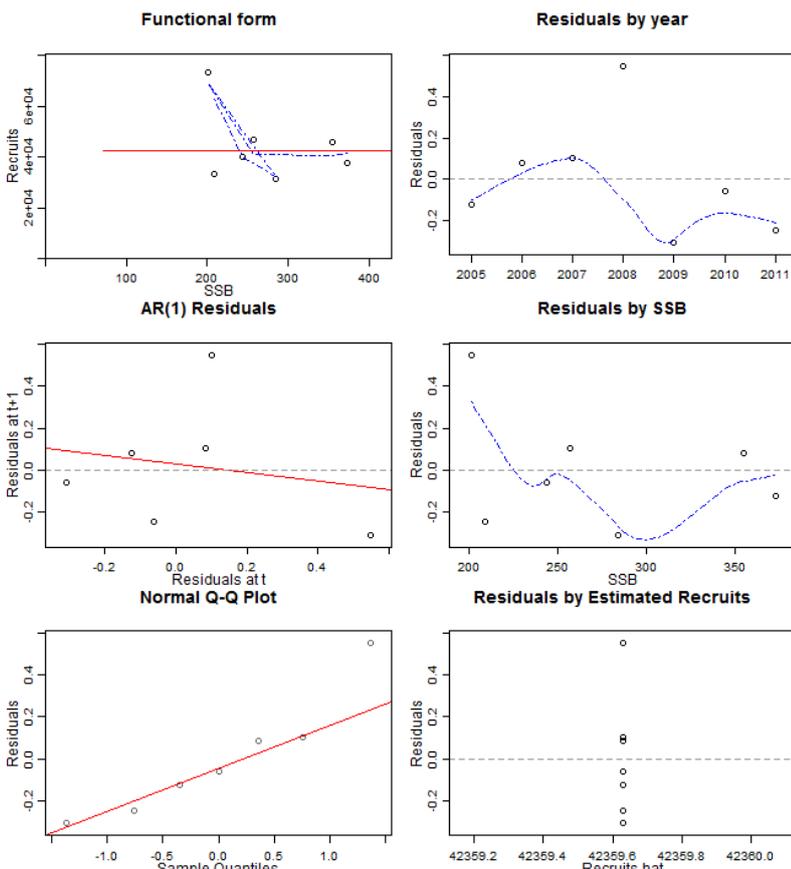


Fig. 7.11.2.1.1. Results of SSB fitting.

7.12. Short and Medium term predictions for European Hake in GSA 11

7.12.1. Short term prediction for 2012 and 2014

7.12.1.1. Justification.

Short term predictions were implemented in R (www.r-project.org) using the FLR libraries and based on the results of the Extended Survivor Analyses (XSA, Darby and Flatman, 1994) presented in the previous paragraph.

7.12.1.2. Input parameters

The same input parameters utilized for the XSA were used for the short term prediction. Further the F_{stq} was considered as the mean of last 3 years F_{bar} (0-3) obtained from the XSA assessment. It was also assumed a constant future recruitment that was estimated as the mean of last 3 years (2009-2011).

Several scenarios with different harvest strategy were run.

7.12.1.3. Results

A short term projection (Table 7.12.1.3.1), assuming an F_{stq} of 2.5 in 2011 (mean 0-3 ages) and a recruitment of 12,448 (thousand) individuals shows that:

- Fishing at the F_{stq} (2.5) generates an increase of the catch of 12% from 2011 to 2013 as well as an increase of SSB of 14% from 2013 to 2014.
- Fishing at $F_{0.1}$ (0.25) generates a decrease of the catch of 73% from 2011 to 2013 along with the SSB increase by 577% from 2013 to 2014.

EWG 12-19 recommends that catch in 2013 should not exceed 106 tons corresponding to $F_{0.1} = 0.25$.

Outlook until 2014

Table 7.12.1.3.1. Short term forecast in different F scenarios computed for *M. merluccius* in GSA 11

Rationale	Ffactor	fbar	Catch 2013	Catch 2014	SSB 2014	Change SSB 2013-2014 (%)	Change Catch 2011-2013 (%)
zero catch	0.0	0.0	0.0	0.0	1257.6	787	-100
High long-term yield (F0.1)	0.1	0.25	106.5	410.3	960.8	577	-73
Status quo	1.0	2.54	438.02	478.87	438.02	17	12
Different scenarios	0.2	0.51	182.7	572.2	746.6	426	-53
	0.3	0.76	239.9	621.9	587.7	316	-39
	0.4	1.02	284.6	622.4	467.2	233	-27
	0.5	1.27	321.0	602.8	374.3	170	-18
	0.6	1.53	351.4	576.3	301.8	122	-10

	0.7	1.78	377.4	548.8	244.6	85	-3
	0.8	2.03	400.1	522.9	199.2	57	2
	0.9	2.29	420.1	499.5	163.0	35	8
	1.0	2.54	438.0	478.9	134.0	17	12
	1.1	2.80	454.1	460.8	110.7	4	16
	1.2	3.05	468.8	445.2	91.9	-6	20
	1.3	3.31	482.1	431.7	76.7	-13	23
	1.4	3.56	494.4	420.0	64.5	-19	27
	1.5	3.82	505.8	410.1	54.5	-23	30
	1.6	4.07	516.3	401.6	46.5	-26	32
	1.7	4.32	526.1	394.3	39.9	-28	35
	1.8	4.58	535.3	388.0	34.5	-30	37
	1.9	4.83	543.9	382.7	30.1	-30	39
	2.0	5.09	549.3	379.7	27.6	-30	41

Weights in t. Basis: $F_{stq}(2011) = \text{mean}(F_{bar} 0-3, 2009-2011)$; $R(\text{mean } 2009-2011) = 12448$; $F_{stq}(2011) = 2.5$; $SSB(2012) = 190$ t; $\text{Catch}(2011) = 390.5$ t.

7.12.2. Medium term prediction

Taking in to account the poor fit of the stock-recruitment relationship (Figure 7.12.2.1) EGW was unable to run the medium term projection.

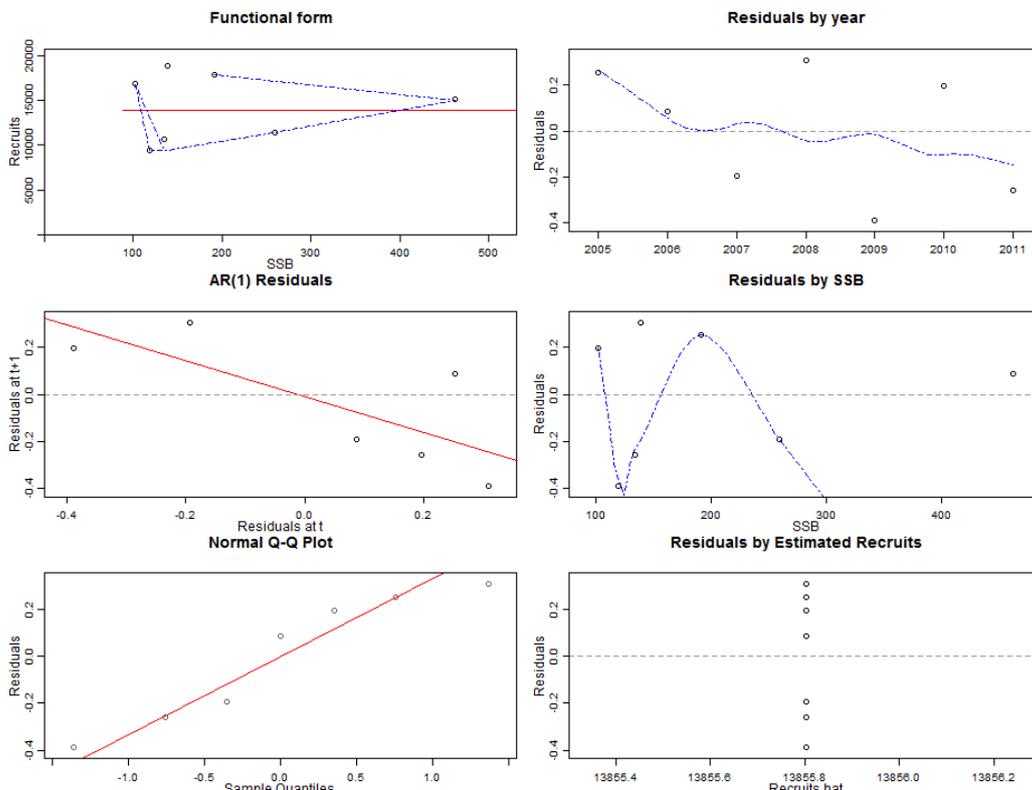


Fig. 7.12.2.1. Stock recruitment relationship of *M. merluccius* in GSA 11.

7.13. Short term predictions of Giant Red Shrimp in GSAs 12-16

7.13.1. Short term prediction 2012-2014

7.13.1.1. Method and justification

Short term predictions for 2013 and 2014 were implemented in R (www.r-project.org) using the FLR libraries and based on the results of Extended Survivors Analysis (XSA) carried out on 2006-2011 of catch data collected under DCF.

7.13.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of giant red shrimp stock in GSA 15-16:

Maturity and M vectors

PERIOD	Age	1	2	3	4	5+
2011	Prop. Matures	0.8	1	1	1	1
	M	0.728	0.4649	0.3771	0.3333	0.3069

F vector

PERIOD	2	3	4	5+
2011	0.83	2.52	1.67	1.67

Fstq was computed as the current F(age2-5) of 2011, (Fstq = 1.67).

Weight-at-age in the stock – from input file

PERIOD	Age	1	2	3	4	5+
2011	Mean weight in stock (kg)	0.00916	0.02327	0.03394	0.0573	0.0638

Weight-at-age in the catch – from input file

PERIOD	Age	1	2	3	4	5+
2011	Mean weight in stock (kg)	0.00916	0.02327	0.03394	0.0573	0.0638

Number at age in the catch – from input file

Age	1	2	3	4	5+
2006	1362	26248	10550	576	62
2007	10429	22057	19532	196	10
2008	7048	38413	6303	1204	472
2009	7941	37276	16120	1033	283
2010	8755	41038	17380	865	156
2011	5251	37666	18503	620	100

Number at age in the stock - result

Age	2006	2007	2008	2009	2010	2011	2012
2	74858	43424	82240	82530	90469	84416	84851
3	13192	26221	9797	21218	22301	24306	23176
4	796	310	1808	1499	1202	902	1347
5	81	15	677	391	205	139	140

Stock recruitment

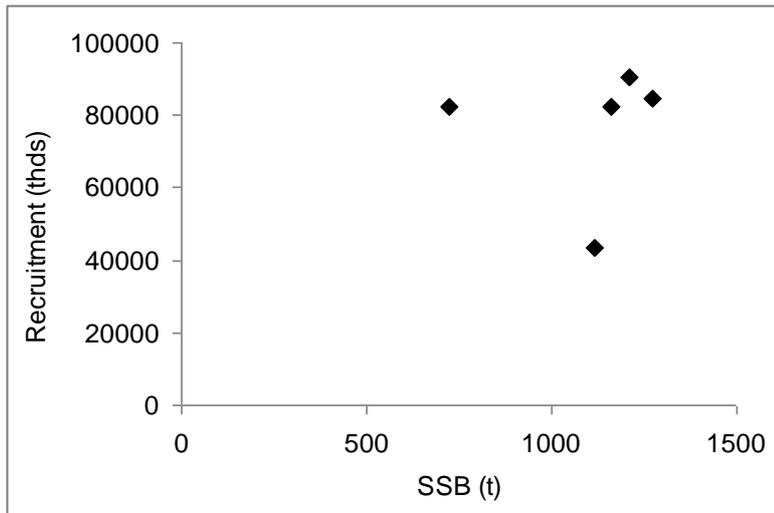


Fig. 7.13.1.2.1. Giant red shrimp stock – recruitment (age 1) relationship in 2006-2011.

For the short term projection a guess estimation of recruitment (76.3 millions) was computed as the arithmetic mean in 2006-2011.

7.13.1.3. Results

A short term projection (Table 7.13.1.3.1), assuming an F_{stq} of 1.67 and a recruitment of 76 million individuals, shows that:

Fishing at the F_{stq} from 2013 to 2014 generates a minor increase of 0.05 % both in SSB and an increase of catch of about 5.25 % in 2011 to 2013.

Fishing at $F_{0.1}$ (0.37) for the same time frame gives an increase of about 39.5% in the spawning stock biomass and a decrease of about 62.5% in catches from 2011 to 2013

The analysis shows that in order to reach $F_{0.1}$, a decrease of F_{stq} by 77% is needed.

EWG 12-19 recommends that fishing mortality in 2012 should not exceed $F_{0.1} = 0.37$, corresponding to catches of about 579.45 t.

Outlook until 2014

Table 7.13.1.3.1. Short term forecast in different F scenarios computed for giant red shrimp in GSAs 12-16
 Basis: $F_{stq(2011)} = 1.67$; R (arithmetic mean 2006-2011) = 76 (millions); SSB (2011) = 1254.7t; Catch (2011) = 1546.4 t.

Rationale	F scenario	F factor	Catch 2013 (t)	SSB 2014 (t)	Change SSB 2014 -2013 (%)	Change Catch 2013 -2011 (%)
Zero catch	0.00	0.00	0.00	3910.01	69.68	-100.00
High long term yield (F at F=0.1)	0.37	0.23	579.45	2779.64	39.45	-62.53
Status quo	1.67	1.00	1627.53	1265.13	0.05	5.25
Different scenarios	0.33	0.20	528.05	2871.98	41.96	-65.85
	0.67	0.40	917.74	2213.06	23.92	-40.65
	1.00	0.60	1213.51	1778.44	12.23	-21.53
	1.34	0.80	1443.90	1479.63	4.75	-6.63
	2.00	1.20	1776.80	1104.44	-2.80	14.90
	2.34	1.40	1900.14	979.10	-4.43	22.88
	2.67	1.60	2003.41	877.78	-5.25	29.55
	3.01	1.80	2090.82	793.31	-5.55	35.21
	3.34	2.00	2165.45	721.14	-5.53	40.03

7.13.2. Medium term prediction

No medium term predictions were performed at STECF EWG 12-19.

7.13.3. Long term prediction

No long term predictions were performed at STECF EWG 12-19.

7.14. Short term prediction of Red mullet in GSA 15-16

7.14.1. Short term prediction 2012-2014

Short term predictions for 2013 and 2014 were implemented in R (www.r-project.org) using the FLR libraries and based on the results of Extended Survivors Analysis (XSA) carried out on 2006-2011 of catch data of red mullet collected under DCF in the GSA 15 - 16.

7.14.1.1. Input parameters

The following data have been used to derive the input data for the short term projection of red mullet stock in GSA 15-16:

Maturity and M vectors

PERIOD	Age	0	1	2	3	4	5
2011	Prop. Matures	0.1	0.9	1.0	1.0	1.0	1.0
	M	1.0	0.60	0.42	0.36	0.33	0.31

F vector

PERIOD	Age	0	1	2	3	4	5+
2011		0.06	0.4	2.3	2.6	1.6	1.6

Fstq was computed as $F_{0.4}$ of 2011 (Fstq = 1.3).

Weight-at-age in the stock

PERIOD	Age	0	1	2	3	4	5+
2011	Mean weight in stock (kg)	0.005	0.041	0.058	0.085	0.106	0.117

Weight-at-age in the catch

PERIOD	Age	0	1	2	3	4	5+
2011	Mean weight in catch (kg)	0.005	0.041	0.058	0.085	0.106	0.117

Number at age in the catch

PERIOD	Age	0	1	2	3	4	5+
2009	Catch at age in numbers (thousands)	5038	12214.2	7186.5	506.52	30.43	0.04
2010		2259.7	4095.7	4849.1	379.2	33.35	0.02
2011		1694.7	5262.4	4656.3	285.98	15.46	0.01

Number at age in the stock

PERIOD	Age	0	1	2	3	4	5+
--------	-----	---	---	---	---	---	----

2009	Stock numbers at age (thousands)	51944.0	26592.0	8822.0	632.0	40.0	0.06
2010		58061.0	16216.0	6052.0	452.0	45.0	0.02
2011		68931.0	20051.0	5969.0	358.0	22.0	0.02

Stock recruitment

For the short term projection a guess estimation of recruitment (87 millions) was computed as the arithmetic mean from 2009-2011.

In fig. x is showed the stock-recruitment relationships of red mullet in 2006-2011 calculated using the outputs of the XSA. In Fig. z a stock-recruitment was obtained using survey abundance indices (n/km^2) of recruits in autumn (GRUND survey) and spawners in spring (MEDITS survey) of red mullet in GSAs 16.

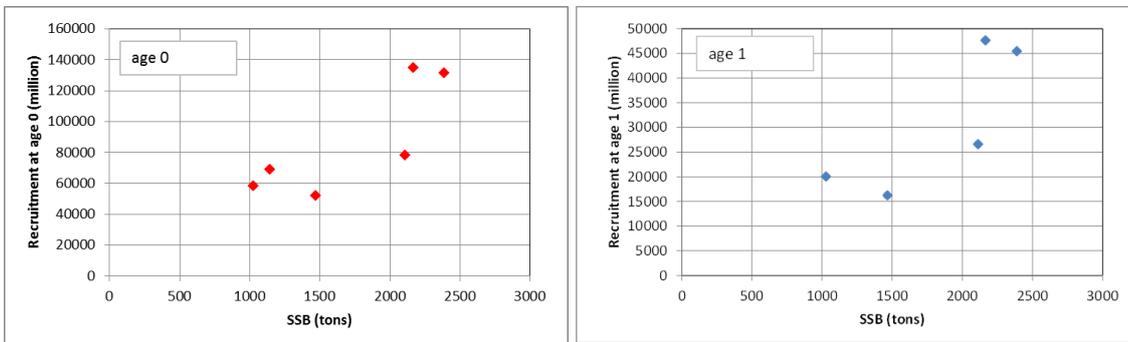


Fig. 7.14.1.1.1. Stock- recruitment relationship at age 0 (left) and age 1 (right) of red mullet in GSAs 15-16

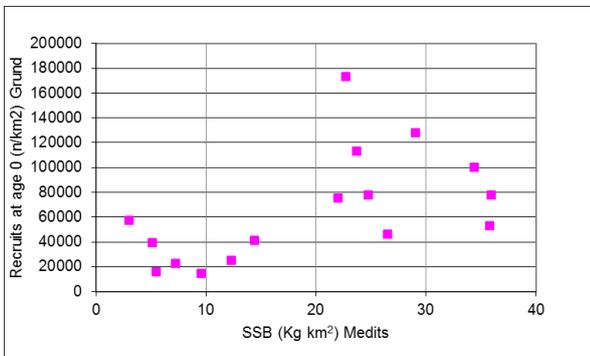


Fig. 7.14.1.1.2. Stock- recruitment relationship of red mullet obtained using survey abundance indices (n/km^2) of recruits in autumn (GRUND) and spawners in spring (MEDITS) of red mullet in GSAs 15-16

7.14.1.2. Results

A short term projection (Table 7.14.1.2.1), assuming an F_{stq} of 1.30 and a recruitment of 87 million individuals, shows that:

Fishing at the F_{stq} from 2013 to 2014 generates a minor increase of 1 % in SSB and an increase of catch of about 17.2 % in 2011 to 2013.

Fishing at $F_{0.1}$ (0.29) for the same time frame gives an increase of about 36.3% in the spawning stock biomass and a decrease of about 59% in catches from 2011 to 2013

The analysis shows that in order to reach $F_{0.1}$, a decrease of F_{stq} by 77% is needed.

EWG 12-19 recommends that fishing mortality in 2013 should not exceed $F_{0.1} = 0.29$, corresponding to catches of about 245 t.

Outlook until 2014

Table 7.14.1.2.1. Short term forecast in different F scenarios computed for red mullet in GSAs 15-16

Basis: $F_{stq} = F(2011)$, $R(2011) = \text{average}(2009-2011) = 87$ (millions); $F(2011) = 1.30$; $SSB(2011) = 1147$ t; $Catch(2011) = 618.7$ t

Rationale	F	F	Catch	SSB	Change SSB	Change Catch
	scenario	factor	2013	2014	2014 -2013	2013 -2011
			(t)	(t)	(%)	(%)
Zero catch	0.0	0.0	0.0	2227.8	69.6	-100.0
High long term yield ($F_{0.1}$)	0.3	0.2	254.5	1947.7	36.3	-58.9
Status quo	1.3	1.0	725.1	1442.3	0.9	17.2
Different scenarios	0.3	0.2	229.4	1975.1	38.2	-62.9
	0.5	0.4	401.0	1788.7	25.1	-35.2
	0.8	0.6	533.4	1646.4	15.2	-13.8
	1.0	0.8	638.8	1534.0	7.3	3.2
	1.3	1.0	725.1	1442.3	0.9	17.2
	1.6	1.2	797.5	1365.5	-4.5	28.9
	1.8	1.4	859.6	1299.4	-9.1	38.9
	2.1	1.6	913.8	1241.5	-13.1	47.7
	2.3	1.8	961.8	1189.9	-16.7	55.4
	2.6	2.0	1004.7	1143.5	-20.0	62.4

7.15. Short term predictions of Common Pandora in GSA 15 - 16

7.15.1. Short term prediction 2012-2014

7.15.1.1. Method and justification

Short term predictions for 2013 and 2014 were implemented in R (www.r-project.org) using the FLR libraries and based on the results of Extended Survivors Analysis (XSA) carried out on 2006-2011 of catch data collected under DCF.

7.15.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of the common Pandora stock in GSA 15-16:

Maturity at Age

Age	0	1	2	3	4	5	6	7+
Maturity	0	0	1	1	1	1	1	1

Mortality at Age

Age	0	1	2	3	4	5	6	7+
Mortality	0.59	0.22	0.14	0.11	0.09	0.08	0.07	0.07

F vector

F ₂₋₇					
2006	2007	2008	2009	2010	2011
0.92	1.18	0.65	0.63	0.78	0.72

Fstq was computed as the arithmetic mean F (age 2-7) of the last 3 years (2009-2011).

Weight at Age in the Catch / Stock

Age	0	1	2	3	4	5	6	7+
Weight (g)	0.012	0.040	0.083	0.136	0.194	0.253	0.310	0.433

Catch at Age

	2006	2007	2008	2009	2010	2011
0	212.92	128.23	100.14	63.63	56.02	69.72
1	1763.94	1064.16	828.54	525.72	1112.49	74.28
2	1590.28	2805.44	1209.30	843.11	1194.23	339.90

3	3924.79	3644.71	1855.23	923.44	1030.80	711.24
4	1834.67	1818.17	686.55	530.07	640.98	646.03
5	535.22	525.47	168.66	161.96	178.29	206.19
6	239.93	138.02	68.05	118.05	114.80	97.79
7+	142.65	40.22	58.51	75.41	26.93	60.67

Numbers at Age in the Stock (thousands)

	2006	2007	2008	2009	2010	2011
1	10973	9763	8647	7547	1108	4847
2	9981	5924	5317	4719	4136	572
3	7538	6430	3801	3524	3316	2323
4	6723	5071	2974	2177	2278	1769
5	2722	2308	1093	909	1077	1065
6	746	733	371	342	324	371
7	322	175	173	180	160	128

Stock recruitment

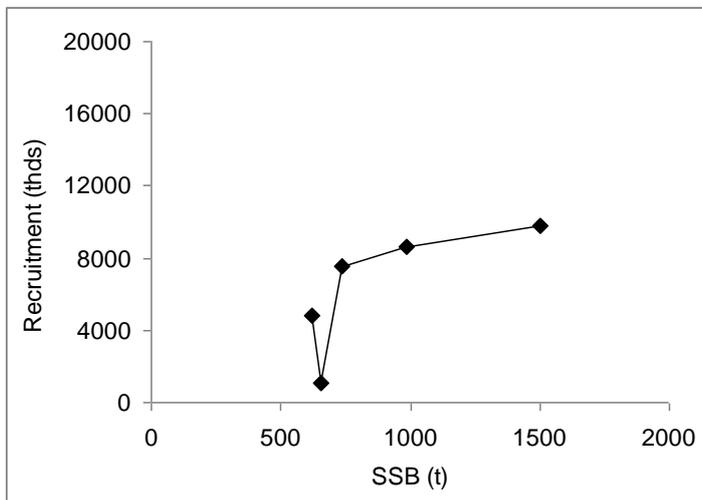


Fig. 7.15.1.2.1. Common Pandora stock – recruitment (age 1) relationship in 2006-2011.

For the short term projection a constant recruitment of 4.5 millions was computed based on the arithmetic mean of recruitment in last three years (2009-2011).

7.15.1.3. Results

A short term projection (Table 7.15.1.3.1), assuming an F_{stq} of 0.71 and a recruitment of 4.5 million individuals, shows that:

- Fishing at the F_{stq} from 2013 to 2014 generates a minor decrease of 0.62 % in SSB and a decrease in the relative catch of 29 % in 2011 to 2013;

- Fishing at $F_{0.1}$ (0.3) for the same time frame gives an increase of about 20% in the spawning stock biomass and a decrease of about 62.9% in catches from 2011 to 2013;
- The analysis shows that in order to reach $F_{0.1}$, a decrease of F_{stq} by 42% is needed.

EWG 12-19 recommends that fishing mortality in 2013 should not exceed $F_{0.1} = 0.3$, corresponding to catches of about 134.75 t.

Outlook until 2014

Table 7.15.1.3.1. Short term forecast in different F scenarios computed for common Pandora in GSAs 15-16; Basis: $F_{stq} = 0.71$, $R = 4.5$ (millions); $SSB(2012) = 548.59$ t; $Catch(2011) = 362.87$ t.

Rationale	F scenario	F factor	Catch 2013 (t)	SSB 2014 (t)	Change SSB 2014 -2013 (%)	Change Catch 2013 -2011 (%)
Zero catch	0.00	0.00	0.00	750.33	53.16	-100.00
High long term yield (F at F=0.1)	0.30	0.42	134.75	501.52	20.34	-62.86
Status quo	0.71	1.00	257.46	311.63	-0.62	-29.05
Different scenarios	0.14	0.20	69.95	616.01	34.92	-80.72
	0.28	0.40	128.85	511.55	21.57	-64.49
	0.43	0.60	178.71	429.42	11.79	-50.75
	0.57	0.80	221.14	364.12	4.62	-39.06
	0.85	1.20	288.72	268.98	-4.44	-20.43
	1.00	1.40	315.78	233.93	-7.20	-12.98
	1.14	1.60	339.33	204.85	-9.18	-6.49
	1.28	1.80	359.95	180.47	-10.57	-0.80
	1.42	2.00	378.11	159.84	-11.53	4.20

7.15.2. Medium term prediction

No medium term predictions were performed at STECF EWG 12-19.

7.15.3. Long term prediction

No long term predictions were performed at STECF EWG 12-19.

7.16. Short and medium term predicitions for Common sole in GSA 17

During the EWG 12-19 meeting the stock assessments of common sole in GSA 17 carried out at GFCM-SAC SCSEA Working group on demersal meeting (Split, 5th -9th of November 2012) was presented.

At the GFCM SCSEA meeting XSA, SURBA, Statistical catch at age using SS3 model and steady state VPA using the VIT model were carried out using data sets provided both in the framework of the official Italian and Slovenian data collection programs and in other project (Croatia Primo Project, SoleMon project).

The detailed assessment is presented in GFCM webpage (http://151.1.154.86/GfcmWebSite/SAC/SCSEA/WGDemersal_Species/2012/SAFs/2012_SOL_GSA17_CNR_ISMAR_ISPRA_IZOR_FRIS.pdf), while section 5.15 provides the stock summary sheet and section 7.16.1 provides the deterministic short term prediction of catch and biomass along with specific scientific advice.

7.16.1. Short term prediction 2012-2014

7.16.1.1. Method and justification

Short term predictions for 2012 and 2014 were implemented in R (www.r-project.org) using the FLR libraries and based on the results of the XSA that was applied for sole stock in GSA 17 in the framework of the FAO-GFCM-WG on demersal of 2012 (www.gfcm.org).

7.16.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of the sole stock in GSA 17:

Maturity and M vectors

PERIOD	Age	0	1	2	3	4	5+
2006-2011	Prop. Matures	0	0.16	0.76	0.96	0.99	1

PERIOD	Age	0	1	2	3	4	5+	Mean 0-4
2006-2011	M	0.7	0.35	0.28	0.25	0.23	0.22	0.40

F vector

F	0	1	2	3	4	5+
2006	0.15	1.46	1.37	1.84	1.55	1.55
2007	0.01	1.58	1.87	2.14	1.90	1.90
2008	0.05	1.20	1.05	0.97	0.96	0.96
2009	0.24	2.06	1.13	2.35	1.92	1.92

2010	0.26	1.01	1.73	3.36	2.13	2.13
2011	0.25	1.38	1.41	2.19	1.67	1.67

Weight-at-age in the stock

Mean weight in stock (kg)	0	1	2	3	4	5+
Period 2006-2011	0.024	0.104	0.207	0.304	0.38	0.522

Weight-at-age in the catch

Mean weight in catch (kg)	0	1	2	3	4	5+
2006	0.066	0.125	0.186	0.356	0.453	0.522
2007	0.066	0.125	0.186	0.356	0.453	0.522
2008	0.077	0.133	0.211	0.356	0.453	0.522
2009	0.077	0.137	0.224	0.356	0.453	0.522
2010	0.079	0.156	0.254	0.356	0.453	0.522
2011	0.065	0.116	0.200	0.356	0.453	0.522

Number at age in the catch

Catch at age in numbers (thousands)	0	1	2	3	4	5+
2006	2858	10617	2154	371	46	18
2007	208	8574	1974	496	47	19
2008	799	8681	1058	171	32	12
2009	5180	8051	1840	395	70	28
2010	5614	7124	706	655	29	10
2011	5649	8364	2243	103	15	30

Number at age in the stock

Stock at age in numbers (thousands)	0	1	2	3	4	5+
2006	29975	16457	3312	500	65	25
2007	30073	12871	2685	631	62	11
2008	23261	14787	1873	313	53	7
2009	34214	10988	3133	496	93	14
2010	33196	13340	985	768	37	11
2011	35498	12528	3420	130	20	4
2012	34290*	13647	1807	635	11	3

* geometric mean 2009-2011

Weight-at-age in the catch were estimated as the mean of the last 3 years. Different scenarios of constant harvest strategy with variation of the mean F (F_{bar} ages 0-4), calculated as the average of the last 3 years, were tested.

The recruitment used for the short term projection was estimated as the geometric mean from 2009-2011. The 2012 SoleMon survey data were not available during the meeting because the survey has been conducted at the end of November 2012.

7.16.1.3. Results

A short term projection (Table 7.16.1.3.1), assuming an F_{stq} of 1.54 in 2012 and a recruitment of 34,290 (thousand) individuals, shows that:

- Fishing at the F_{stq} (1.54) generates an increase of the catch of 16% from 2011 to 2013 along with a decrease of the spawning stock biomass of 2% from 2013 to 2014.
- Fishing at $F_{0.1}$ (0.26) generates a decrease of the catch of 69% from 2011 to 2013 and a spawning stock biomass increase by 170% from 2013 to 2014.

EWG 12-19 recommends that catch in 2013 should not exceed 570 tons corresponding to $F_{0.1} = 0.26$.

Outlook until 2014

Table 7.16.1.3.1. Short term forecast in different F scenarios computed for sole in GSA 17.

Rationale	F_{factor}	F_{bar}	Catch 2013	Catch 2014	SSB 2014	Change SSB 2013-2014 (%)	Change Catch 2011-2013 (%)
Zero catch	0	0.00	0.0	0.0	2098.0	241.8	-100.0
High long-term yield ($F_{0.1}$)	0.17	0.26	570.6	994.3	1442.2	170.4	-69.1
Status quo	1	1.54	2154.7	2134.9	265.9	-2.4	16.8
Different scenarios	0.1	0.15	353.1	656.9	1678.5	197.2	-80.9
	0.2	0.31	662.6	1122.2	1347.5	159.2	-64.1
	0.3	0.46	934.7	1451.0	1085.5	126.7	-49.3
	0.4	0.62	1174.8	1682.3	877.6	98.9	-36.3
	0.5	0.77	1387.5	1843.9	712.1	75.1	-24.8
	0.6	0.92	1576.5	1955.6	580.1	54.6	-14.6
	0.7	1.08	1745.2	2031.7	474.4	37.1	-5.4
	0.8	1.23	1896.3	2082.4	389.5	21.9	2.8
	0.9	1.39	2032.1	2115.0	321.1	8.9	10.1
	1	1.54	2154.7	2134.9	265.9	-2.4	16.8
	1.1	1.69	2265.8	2145.8	221.1	-12.2	22.8
	1.2	1.85	2366.9	2150.5	184.7	-20.6	28.3
	1.3	2.00	2459.2	2151.0	154.9	-28.0	33.3
	1.4	2.16	2543.8	2148.6	130.6	-34.4	37.9
	1.5	2.31	2621.6	2144.5	110.5	-40.0	42.1

	1.6	2.46	2693.6	2139.4	93.9	-44.9	46.0
	1.7	2.62	2760.3	2133.6	80.2	-49.1	49.6
	1.8	2.77	2822.3	2127.7	68.8	-52.9	53.0
	1.9	2.92	2880.3	2121.8	59.2	-56.2	56.1

Weights in t. Basis: $F_{stq}(2011) = \text{mean}(F_{bar} 0-4, 2009-2011)$; R (geometric mean 2009-2011) = 34,290 (thousands); $F_{stq}(2011) = 1.54$; $SSB(2012) = 350$ t; $\text{Catch}(2011) = 1,845$ t.

The actual landings recorded in 2011 (1,574 t for the Italian, Slovenian and Croatian fleet combined) are lower compared to the landings projected for 2011 by EWG 11-20 (2,219). Such discrepancy, is probably related to the decrease of the Italian nominal effort of TBB and GNS from 2010 to 2011.

7.16.2. Medium term prediction

Considering the poor fit of stock-recruitment relationship (Figure 7.16.2.1) was not possible to perform medium term projection.

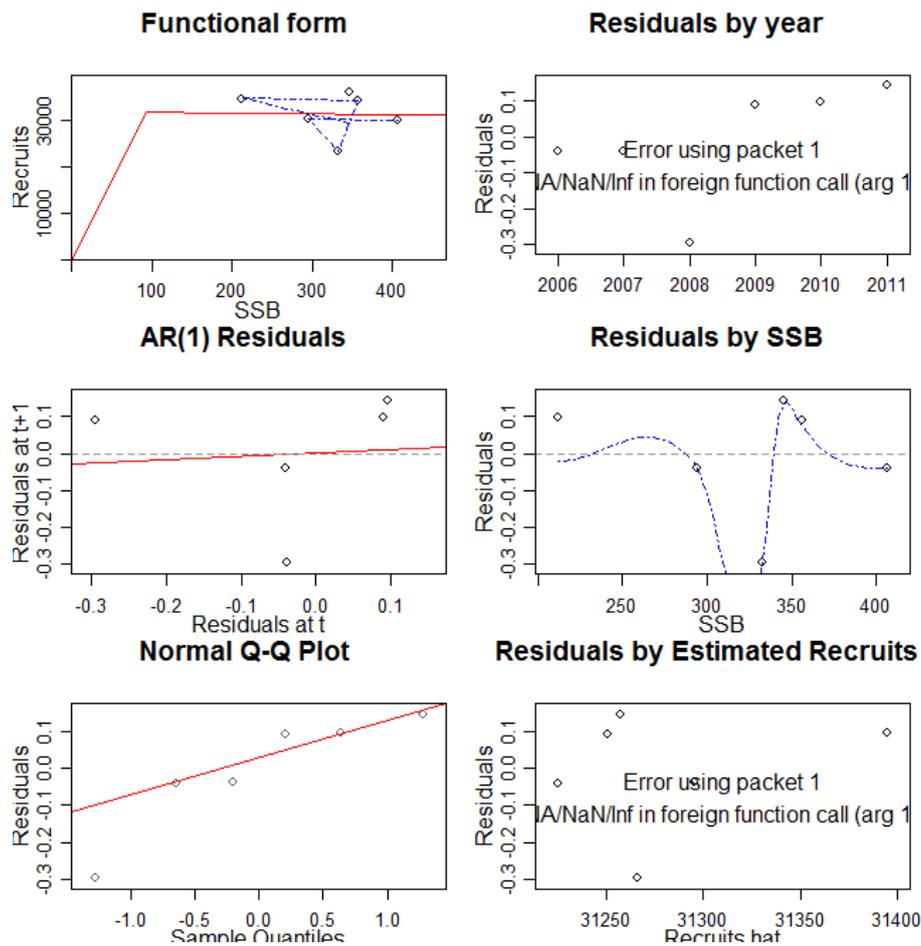


Fig. 7.16.2.1. Stock recruitment relationship of *S. solea* in GSA 17.

7.17. Short term predictions for Anchovy in GSA 16

7.17.1. Short term prediction 2013-2014

7.17.1.1. Method and justification

Short term predictions for 2013 and 2014 were implemented in R (www.r-project.org) using the FLR libraries and based on the results of Extended Survivors Analysis (XSA) carried out on 2006-2011 of catch data collected under DCF.

7.17.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of anchovy stock in GSA 16:

Maturity and M vectors

PERIOD	Age	1	2	3	4+
2011	Prop. Matures	0.91	0.99	0.99	1.0
	M	0.68	0.54	0.47	0.43

F vector

PERIOD	Age	1	2	3	4+
2011		0.25	1.14	0.74	0.74

Fstq was computed as the average of the last 3 years, but rescaled to the F(2-8) of 2010 (Fstq = 0.64).

Weight-at-age in the stock

PERIOD	Age	1	2	3	4+
2011	Mean weight in stock (kg)	0.0138	0.0207	0.0269	0.0329

Weight-at-age in the catch

PERIOD	Age	1	2	3	4+
2010	Mean weight in catch (kg)	0.0138	0.0207	0.0269	0.0329

Number at age in the catch

PERIOD	Age	1	2	3	4+
2009	Catch at age in numbers (thousands)	1043903	132375	105845	11615
2010		747360	421632	17115	1931
2011		378796	235909	69524	3071

Number at age in the stock

PERIOD	Age	1	2	3	4+
2009	Stock numbers at age (thousands)	150648	78632	51453	5909
2010		200509	230791	7800	918
2011		59579	122473	28689	1316

Stock recruitment

For the short term projection a guess estimation of recruitment at age 1 of (594 millions) was computed as the arithmetic mean from 2006-2011.

7.17.1.3. Results

A short term projection (Table 7.17.1.3.1), assuming an F_{stq} of 0.71 (2011 current value) and a recruitment of 594 millions individuals at age 1, shows that:

Fishing at the F_{stq} from 2013 to 2014 generates a decrease of about -2.1% in SSB and from 2011 to 2013 an increases of 25.4 % in catch;

Fishing at F corresponding to $E=0.4$ ($F_{ref}=0.35$) for the same time frame gives an increase of about 19% in the spawning stock biomass and a decrease of about 28% in catches;

The analysis shows that in order to reach F_{ref} , a decrease of F_{stq} by 51% is needed. This would produce an increase in SSB of about 19%, and a reduction in catch of about 28%.

Outlook until 2014

Table 7.17.1.3.1. Short term forecast in different F scenarios computed for abchovy in GSA 16.

Basis: $F_{stq} = F(2011)$ $R(2011) = GM(2006-2011) = 594$ (millions); $F(2011) = 0.71$; $SSB(2011) = 10734$ t; $Catch(2011) = 4018$ t

Rationale	F	F	Catch	SSB	Change SSB	Change Catch
	scenario	factor	2013 (t)	2014 (t)	2014 -2013 (%)	2013 -2011 (%)
Zero catch	0.0	0.0	0.0	19665	48.5	-100.0
High long term yield (F at E=0.4)	0.35	0.49	3603.15	16463	18.7	-27.7
Status quo	0.71	1.00	6254.298	14217	-2.1	25.4
Different scenarios	0.14	0.2	1634.991	18196	34.9	-67.2
	0.28	0.4	3042.23	16952	23.3	-39.0
	0.43	0.6	4260.918	15894	13.4	-14.5
	0.57	0.8	5322.945	14991	5.0	6.8
	0.85	1.2	7076.197	13549	-8.4	41.9
	0.99	1.4	7806.001	12972	-13.8	56.6
	1.14	1.6	8457.948	12470	-18.5	69.6
	1.28	1.8	9043.74	12031	-22.5	81.4
	1.42	2	9573.026	11647	-26.1	92.0

Fishing at the current F: catch increases by 25% (2013); SSB decreases by 2%.

7.18. Short and medium term prediction for European Hake in GSA 17

7.18.1. Short term prediction for 2012 and 2014

7.18.1.1. Justification.

Short term predictions were implemented in R (www.r-project.org) using the FLR libraries and based on the results of the Extended Survivor Analyses (XSA. Darby and Flatman, 1994) presented in the previous paragraph.

7.18.1.2. Input parameters

The following data have been used to drive input data for the short term projection of the hake stock in GSA 17:

Maturity and M vectors

PERIOD	Age	0	1	2	3	4	5+
2007-2011	Prop. Matures	0	0.5	0.79	0.89	1	1

PERIOD	Age	0	1	2	3	4	5
1998-2011	M	1.16	0.58	0.46	0.41	0.39	0.35

F vector

F	0	1	2	3	4	5+
2011	0.56	2.15	2.95	2.03	2.56	2.56

Weight-at-age in the stock

Mean weight in stock (kg)	0	1	2	3	4	5+
2007-2011	0.05	0.3	0.78	1.47	2.28	3.13

Weight-at-age in the catch

Mean weight in catch (kg)	0	1	2	3	4	5+
Mean 2009-2011	0.06	0.08	0.14	0.23	0.31	0.40

Number at age in the catch

Catch at age in numbers (thousands)	0	1	2	3	4	5+
2011	35158.6	10198.3	848.3	40.4	8	6.9

Number at age in the stock

Stock at age in numbers (thousands)	0	1	2	3	4	5+
2012	112,522	15,426	1,126.6	57.106	10.536	8.3891

Several scenarios with different harvest strategy were run.

The F_{stq} (F_{bar} ages 0-4) has been considered as the mean of last 3 years F_{bar} , as well as the catch weight at age used in the analysis. Recruitment has been estimated by the geometric mean of the last 3 years (112,522 thousands of individuals).

7.18.1.3. Results

A short term projection (Table 7.18.1.3.1), assuming an F_{stq} of 2.1 in 2011 (mean 0-4 ages) and a recruitment of 112,522 (thousand) individuals shows that:

- Fishing at the F_{stq} (2.1) generates an increase of the catch of 20% from 2011 to 2013 along with a decrease of the spawning stock biomass of 2% from 2013 to 2014.
- Fishing at $F_{0.1}$ (0.20) generates a decrease of the catch of 81% from 2011 to 2013 and a spawning stock biomass increase by 185% from 2013 to 2014.

EWG 12-19 recommends that catch in 2013 should not exceed 498.4 tons corresponding to $F_{0.1} = 0.20$.

Outlook until 2014

Table 7.18.1.3.1. Short term forecast in different F scenarios computed for hake in GSA 17, (All fleets combined: Italian, Croatian and Slovenian bottom trawl. Croatian long line).

Rationale	Ffactor	fbar	Catch 2013	Catch 2014	SSB 2014	Change SSB 2013-2014 (%)	Change Catch 2011-2013 (%)
zero catch	0	0.00	0.0	0.0	12629.0	235.3	-100.0
High long-term yield ($F_{0.1}$)	0.1	0.20	498.4	923.9	10020.3	185.1	-81.2
Status quo	1	2.10	3168.8	3146.1	1793.8	-1.9	19.2
Different scenarios	0.2	0.42	972.3	1595.3	7859.1	141.3	-63.4
	0.3	0.63	1365.5	2026.5	6304.3	108.2	-48.6
	0.4	0.84	1711.8	2329.8	5114.0	81.5	-35.6
	0.5	1.05	2019.4	2551.8	4194.1	60.0	-24.0
	0.6	1.26	2294.9	2721.0	3475.8	42.6	-13.7

	0.7	1.47	2543.7	2855.6	2909.0	28.2	-4.3
	0.8	1.68	2770.1	2966.8	2456.6	16.4	4.2
	0.9	1.89	2977.5	3062.1	2091.6	6.5	12.0
	1	2.10	3168.8	3146.1	1793.8	-1.9	19.2
	1.1	2.31	3346.2	3221.9	1548.3	-9.1	25.9
	1.2	2.52	3511.5	3291.5	1343.7	-15.2	32.1
	1.3	2.73	3666.4	3356.5	1171.8	-20.6	37.9
	1.4	2.94	3812.0	3417.6	1026.0	-25.4	43.4
	1.5	3.15	3949.4	3475.7	901.3	-29.6	48.6
	1.6	3.36	4079.4	3531.1	794.1	-33.4	53.5
	1.7	3.57	4202.9	3584.3	701.3	-36.9	58.1
	1.8	3.78	4320.5	3635.5	620.6	-40.0	62.5
	1.9	3.99	4432.5	3685.0	550.1	-42.9	66.8
	2	4.20	4539.6	3732.8	488.2	-45.7	70.8

Weights in t. Basis: F_{stq} (2011) = mean (F_{bar} 0-4, 2009-2011); R (geometric mean 2009-2011) = 112,522 (thousands); F_{stq} (2011) = 2.1; SSB (2012) = 1,828 t; Catch (2011)= 2,658 t.

7.18.2. Medium term prediction

Considering the poor fit of stock-recruitment relationship (Figure 7.18.2.1) was not possible to perform medium term projection.

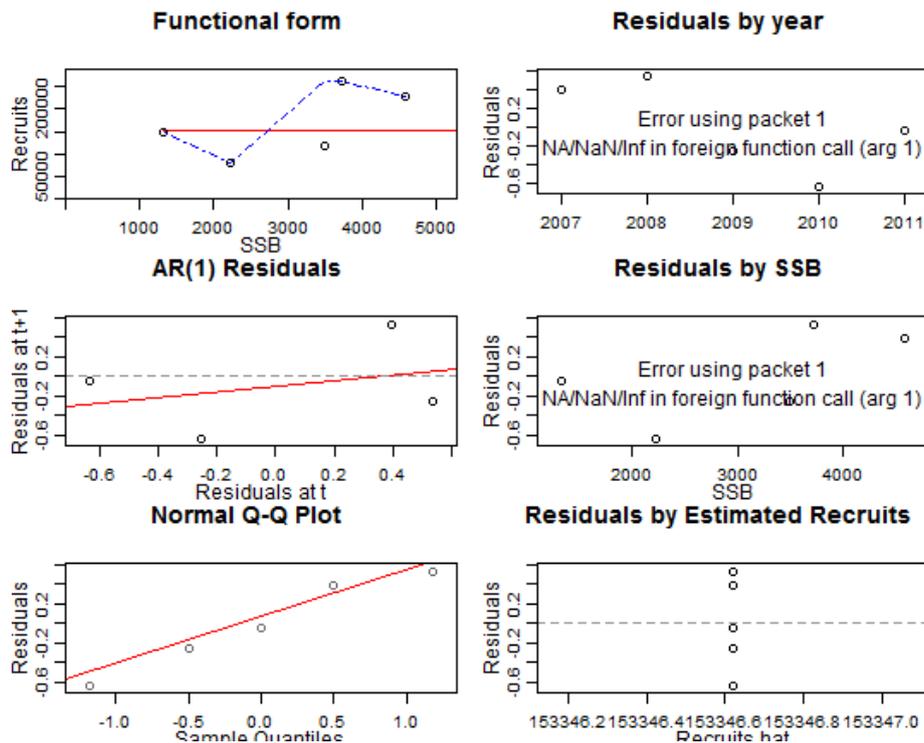


Fig. 7.18.2.1. Stock recruitment relationship of *M. merluccius* in GSA 17.

7.19. Short term prediction for Red mullet in GSA 18

7.19.1. Short term prediction 2012-2014

7.19.1.1. Method and justification

Short term prediction for 2012 -2014 was implemented in R (www.r-project.org) using the FLR libraries and based on the results of the stock assessment performed using VIT (Leonart and Salat, 1997), which was conducted in the framework of the EWG 12-19 using the VPA Lowestoft routines.

7.19.1.2. Input parameters

The input parameters were derived using XSA method for the time series 2007-2011. A sex combined analysis was carried out. The data used in the XSA analyses were from trawl surveys (time series of MEDITS survey from 1996 to 2011) and from commercial catches. The analysis was carried out for the western side of the GSA 18, given the availability of fishery data only for this side.

The following data have been used to derive the input data for the short term projection of the red mullet in the GSA 18:

Maturity and M vectors

PERIOD	Age	0	1	2	3+
2008-2010	Prop. Matures	0.16	0.92	1	1

PERIOD	Age	0	1	2	3+	Mean 0-2
2008-2010	M	1.03	0.71	0.65	0.62	0.8

F vector

F	0	1	2	3+
2007	0.44	3.41	1.98	1.98

2008	0.18	2.38	1.11	1.11
2009	0.43	3.16	1.81	1.81
2010	0.51	1.66	0.92	0.92
2011	0.12	2.74	1.58	1.58

Several scenarios with different harvest strategy were run, with F_{stq} (F_{bar} ages 0-2) equal to the F of the last year ($F_{stq} = 1.48$).

Weight-at-age in the stock

Weight at age (kg)	0	1	2	3+
2007	0.011	0.034	0.075	0.143
2008	0.013	0.032	0.075	0.186
2009	0.014	0.034	0.079	0.154
2010	0.012	0.030	0.082	0.162
2011	0.013	0.033	0.079	0.161

Weight-at-age in the catch

Mean weight in catch (kg)	0	1	2	3+
2007	0.011	0.034	0.075	0.143
2008	0.013	0.032	0.075	0.186
2009	0.014	0.034	0.079	0.154
2010	0.012	0.030	0.082	0.162
2011	0.013	0.033	0.079	0.161

Number at age in the catch

Catch numbers (thousands)	age 0	age 1	age 2	age 3+
2007	32139	33643	1321	51
2008	9232	22085	393	30
2009	18901	19173	951	21
2010	16208	11962	260	25
2011	7664	9621	1135	25

Number at age in the stock

Stock numbers (thousands)	0	1	2	3+
2007	150989	49629	2121	72
2008	95451	34701	810	57
2009	90702	28561	1575	31
2010	68208	21088	598	54
2011	113221	14666	1980	40
2012	88810	35850	466	217

Stock recruitment

The recruitment in 2011 estimated by XSA is greater than the values from 2008; however, the survey abundance indices confirm this increasing signal in 2011. Thus, the recruitment used for the short term projection was estimated as the geometric mean from 2009-2011.

7.19.1.3. Results

A short term projection (Table 7.19.1.3.1), assuming an F_{stq} of 1.48 in 2012 and a recruitment of 88,810 (thousands) individuals, shows that:

- Fishing at the F_{stq} (1.48) from 2012 to 2013 generates an increase of the catch for 68 % and a decrease of the spawning stock biomass of the 1 % from 2013 to 2014.
- Fishing at $F_{0.1}$ (0.5) for the same time (2012-2013) generates a decrease of the catch of 5% and an increase of the spawning stock biomass of the 40% from 2013 to 2014.
- A 30% reduction of the F_{stq} ($F=1.04$) generates an increase of catch for 45% and an increase of spawning stock biomass of about 11% from 2013 to 2014, indicating that this level of reduction could generate a significant increase of catches but a small increase of the spawning stock biomass.

EWG 12-19 recommends that fishing mortality in 2013 should not exceed $F_{0.1}= 0.5$, corresponding to catches of 483 t.

Outlook until 2014

Table 7.19.1.3.1. Basis: F (2012) = F (2011) ($F_{bar\ 0-2}$)=1.48; R (2012) = GM (2009–2011) = 88,816 (thousands); SSB (2013) = 1140 t; Catch (2012) = 1038 t

Rationale	F scenario	F factor	Catch 2013	Catch 2014	SSB 2014	Change SSB 2013-2014 (%)	Change Catch 2011-2013 (%)
Zero catch	0.00	0.00	0	0	2341	105.33	-100.00
High long-term yield ($F_{0.1}$)	0.50	0.34	483	641	1602	40.45	-5.35
Status quo	1.48	1.00	860	854	1130	-0.91	68.44
Different scenarios	0.15	0.10	181	288	2053	80.06	-64.47
	0.30	0.20	327	479	1830	60.49	-35.96
	0.44	0.30	445	605	1657	45.29	-12.90
	0.59	0.40	541	689	1521	33.42	5.88
	0.74	0.50	620	746	1415	24.09	21.32
	0.89	0.60	685	784	1331	16.72	34.13
	1.04	0.70	740	811	1264	10.84	44.86
	1.18	0.80	786	830	1210	6.11	53.94
	1.33	0.90	826	844	1166	2.26	61.71

1.63	1.10	890	862	1100	-3.55	74.32
1.78	1.20	917	868	1074	-5.79	79.51
1.92	1.30	941	873	1052	-7.71	84.15
2.07	1.40	962	877	1033	-9.39	88.34
2.22	1.50	982	880	1016	-10.88	92.15
2.37	1.60	999	883	1001	-12.22	95.65
2.52	1.70	1016	886	987	-13.44	98.88
2.66	1.80	1031	888	974	-14.57	101.90
2.81	1.90	1046	890	962	-15.62	104.73
2.96	2.00	1059	891	951	-16.62	107.40

Weights in tons

7.19.2. Medium term prediction

No medium term forecast has been performed, because of lacking of stock-recruitment relationship.

7.20. Short term prediction for European Hake in GSA 18

7.20.1. Short term prediction 2011-2013

7.20.1.1. Method and justification

Short term prediction for 2012 -2013 was implemented in R (www.r-project.org) using the FLR libraries and based on the results of the stock assessment performed using VIT (Lleonart and Salat, 1997) that was conducted in the framework of the EWG 12-19 using the VPA Lowestoft routines.

7.20.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of hake in the GSA 18.

Maturity and M vectors

PERIOD	Age	0	1	2	3	4+
2007-2011	Prop. Matures	0.01	0.12	0.92	1.00	1.00

PERIOD	Age	0	1	2	3	4+	Mean 0-4
2007-2011	M	1.16	0.52	0.40	0.34	0.31	0.55

F vector

F	0	1	2	3	4+
2008	0.252	2.655	0.657	0.617	0.320
2009	0.301	2.437	0.995	0.450	0.320
2010	0.343	2.116	0.821	0.507	0.320
2011	0.249	2.151	0.861	0.422	0.320
2012*	0.266	2.177	0.776	0.464	0.298

* geometric mean of the last three years rescaled to 2012

Several scenarios with different harvest strategy were run, with F_{stq} (F_{bar} ages 0-3) calculated as the mean of the last 3 years, but rescaled to the F of 2011 ($F_{stq}=0.921$).

Weight-at-age in the stock

Mean weight in stock	0	1	2	3	4+
kg	0.008	0.105	0.487	1.109	2.866

Weight-at-age in the catch

Mean weight in catch	0	1	2	3	4+
kg	0.008	0.105	0.487	1.109	2.866

Number at age in the catch

Catch at age in numbers (thousands)	0	1	2	3	4+
2011	19575	26870	1213	207	167

Number at age in the stock

Stock at age in numbers (thousands)	0	1	2	3	4+

2011	146400	35845	2479	702	328
2012	162212	35231	2416	765	493

Stock recruitment

The recruitment used for the short term projection was estimated as the geometric mean from 2009-2011.

7.20.1.3. Results

A short term projection (Table 7.20.1.3.1), assuming an F_{stq} of 0.921 in 2011 and a recruitment of 162,212 (thousands) individuals, shows that:

- Fishing at the F_{stq} (0.921) from 2012 to 2013 generates an increase of the catch for 4.1% from 2011 to 2013 and an increasing of the spawning stock biomass of 6.3%. from 2012 to 2013
- Fishing at $F_{0.1}$ (0.21) for the same time generates a decrease of the catch of 61% from 2011 to 2013 and a spawning stock biomass increase of 165% from 2012 to 2013.
- A 30% reduction of the F_{stq} ($F=0.64$) generates a decrease of catch for 14% and an increase of spawning stock biomass of about 44% from 2012 to 2013, indicating that this level of reduction could generate a decrease of catches but a significant increase of the spawning stock biomass.

EWG 12-19 recommends that fishing mortality in 2013 should not exceed $F_{0.1}= 0.21$, corresponding to catches of 1,641 t.

Outlook until 2014

Table 7.20.1.3.1. Basis: $F(2012) = F(2011)$ rescaled ($F_{bar} 0-3$); $R(2011) = GM(2009-2011) = 162,212$ (thousands); $F(2012) = 0.921$; $SSB(2013) = 4149$; $Catch(2012) = 4072$ t

Rationale	F scenario	F factor	Catch 2013	Catch 2014	SSB 2014	Change SSB 2013-2014 (%)	Change Catch 2011-2013 (%)
Zero catch	0.00	0.00	0	0	15663	278	-100.00
High long-term yield (F_{MSY})	0.21	0.23	1641	2803	11018	165.53	-61.45
Status quo	0.92	1.00	4431	4518	4149	6.27	4.07
Different scenarios	0.09	0.1	795	1510	13366	222.14	-81.32
	0.18	0.2	1470	2569	11483	176.75	-65.46
	0.28	0.3	2046	3301	9934	139.43	-51.94
	0.37	0.4	2541	3798	8657	108.65	-40.32

0.46	0.5	2968	4126	7600	83.16	-30.29
0.55	0.6	3339	4333	6721	61.97	-21.57
0.64	0.7	3664	4454	5987	44.28	-13.94
0.74	0.8	3950	4514	5370	29.43	-7.22
0.83	0.9	4204	4531	4851	16.91	-1.26
1.01	1.1	4634	4485	4033	-2.81	8.85
1.10	1.2	4818	4437	3709	-10.61	13.17
1.20	1.3	4985	4380	3429	-17.36	17.10
1.29	1.4	5138	4317	3185	-23.24	20.69
1.38	1.5	5279	4250	2971	-28.40	23.99
1.47	1.6	5409	4181	2782	-32.96	27.04
1.57	1.7	5529	4110	2613	-37.02	29.87
1.66	1.8	5642	4039	2463	-40.65	32.51
1.75	1.9	5747	3968	2327	-43.92	34.98
1.84	2	5845	3898	2204	-46.89	37.30

Weights in tons

Respect to the previous short term forecasts (EWG 11-20, in 2011 the foreseen catch were 4202) the observed production for 2011 was 4258 tons. The difference between the 2 values is about 1.3%.

7.21. Short term predicitions for Pink shrimp in GSA 18

7.21.1. Short term prediction for 2012 and 2013

7.21.1.1. Method and justification

Short term prediction for 2012 and 2013 was implemented in R (www.r-project.org) using the FLR libraries and based on the results of the stock assessment performed using VIT (Lleonart and Salat, 1997) that was conducted in the framework of the EWG 12-19 using the VPA Lowestoft routines.

7.21.1.2. Input parameters

The following data have been used to derive the input data for the short term projection of pink shrimp in the GSA 18.

Maturity and M vectors

PERIOD	Age	0	1	2	3+
2008-2011	Prop. Matures	0.47	0.98	1	1

PERIOD	Age	0	1	2	3+	Mean 0-3+
2008-2011	M	1.41	0.81	0.7	0.65	0.89

F vector

F	0	1	2	3+
2008	0.211	2.198	2.550	1
2009	0.220	2.362	2.620	1
2010	0.139	2.117	2.328	1
2011	0.115	2.157	2.086	1
2012*	0.156	2.015	2.187	0.913

*mean of 2008-2011 rescaled to 2011

Several scenarios with different harvest strategy were run, with F_{stq} (F_{bar} ages 0-2) calculated as the average of the time series, but rescaled to the F of 2011 ($F_{stq} = 1.45$).

Weight-at-age in the stock

Mean weight in stock	0	1	2	3+
g	2.14	9.93	19.34	27.39

Weight-at-age in the catch

Mean weight in catch	0	1	2	3+
g	2.14	9.93	19.34	27.39

Number at age in the catch

Catch at age in numbers (thousands)	0	1	2	3+
2011	40266	102636	5382	286

Number at age in the stock

Stock at age in numbers (thousands)	0	1	2	3+
2011	683795	148842	7661	472
2012	717648	142788	8825	526

Stock recruitment

The recruitment used for the short term projection was estimated as the geometric mean from 2009-2011.

7.21.1.3. Results

A short term projection (Table 7.21.1.3.1), assuming an F_{stq} of 1.45 in 2012 and a recruitment of 717,648 (thousands) individuals, shows that:

- Fishing at the F_{stq} (1.45) generates an increase of the catch of 2.24 % from 2011 to 2013 and an increase of the spawning stock biomass of 0.34% from 2013 to 2014.
- Fishing at $F_{0.1}$ (0.68) from 2011 to 2013 generates a decrease of the catch of 33.9 % and an increase of the spawning stock biomass of 21.0% from 2013 to 2014.
- A 30% reduction of the F_{stq} ($F=1.02$) generates a decrease of catch of 14.9% in 2013 and an increase of spawning stock biomass of about 9.9 % from 2013 to 2014, indicating that this level of reduction could generate a decrease of catches but an almost equal increase of the spawning stock biomass.

EWG recommends that fishing mortality in 2012 should not exceed $F_{0.1} = 0.68$, corresponding to catches of 1202 t.

Outlook until 2014

Table 7.21.1.3.1. Basis: F (2012) = F (2011) rescaled ($F_{\text{bar}} 0-2$); R (2012) = GM (2009–2011) = 717,648 (thousands); F (2012) = 1.45; SSB (2013) = 2352; Catch (2012) = 1202 t

Rationale	F scenario	F factor	Catch 2013	Catch 2014	SSB 2014	Change SSB 2013-2014 (%)	Change Catch 2011-2013 (%)
zero catch	0	0	0	0	3828	62.8	-100.0
High long-term yield ($F_{0.1}$)	0.68	0.47	805	1035	2846	21.0	-33.9
Status quo	1.45	1	1244	1250	2360	0.34	2.24
Different scenarios	0.15	0.1	226	387	3544	50.7	-81.4
	0.29	0.2	418	654	3307	40.6	-65.7
	0.44	0.3	581	840	3109	32.2	-52.3
	0.58	0.4	721	970	2944	25.1	-40.8
	0.73	0.5	841	1061	2804	19.2	-30.9
	0.87	0.6	945	1126	2686	14.2	-22.4
	1.02	0.7	1035	1173	2585	9.9	-14.9
	1.16	0.8	1114	1207	2499	6.3	-8.5
	1.31	0.9	1183	1232	2425	3.1	-2.8
	1.60	1.1	1245	1250	2360	0.3	2.2
	1.74	1.2	1299	1264	2303	-2.1	6.7
	1.89	1.3	1348	1275	2253	-4.2	10.7
	2.03	1.4	1391	1283	2209	-6.1	14.3
	2.18	1.5	1431	1289	2169	-7.8	17.6
	2.32	1.6	1467	1293	2132	-9.4	20.5
	2.47	1.7	1500	1297	2099	-10.8	23.2
2.61	1.8	1531	1299	2068	-12.1	25.7	
2.76	1.9	1559	1301	2039	-13.3	28.1	
2.91	2	1585	1302	2013	-14.4	30.2	

(weights in tons)

8. TORE

8.1. Time series of anchovy and sardine total biomass in the Adriatic Sea

In order to evaluate the possibility to use the historical series of catch at age and biological data of anchovy and sardine to estimate stock biomass with VPA and ICA methodology, the historical trends of biomass derived from ICA were plotted against the time series from the acoustic survey.

Some assumptions were made for what concerns echo-survey due to the lack of complete coverage in the past years. In particular, acoustic surveys were conducted only in the western side of the Adriatic Sea from 1976 to 2003. Moreover the Italian acoustic survey did not cover the complete western side of GSA 17 in the years 1976-1985 and also in 1990, 1991, 1996, 2000. In 1979, 1984, 1986, 2002 and 2003, either the survey was not conducted, either it covered only a small part of the total area.

The study area covered from 1976 to 1985 and in 1990, 1991, 1996, 2000 and 2004 is given in Figure 8.1.1 (up, left), where is reported also the full western side area covered starting from 1987 for the majority of the years (up, right) and the full coverage of GSA 17 performed since 2005 (down). The offshore limit is the Mid-Line that divides the Adriatic Sea in two equal parts due to political agreements among the countries sharing the coastlines of the Adriatic Sea. This limit is changed with the 200 m bathymetry in the case where this isobath is nearer to the coast respect to the Mid-Line.

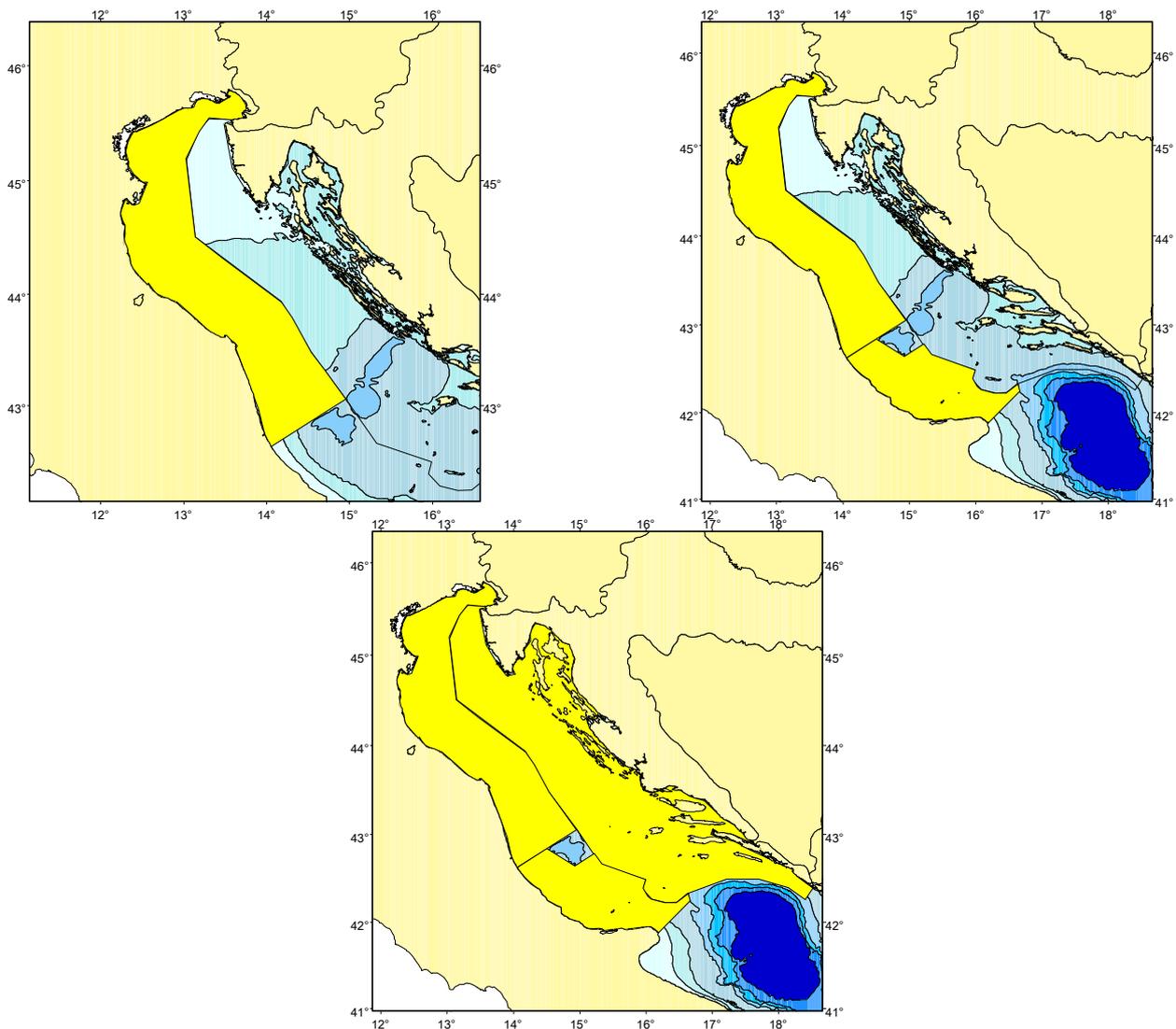


Fig. 8.1.1. Study area in western GSA 17 during the first acoustic surveys in 1976-1985 and also in 1990, 1991, 1996, 2000 and 2004 (up, left). Study area covering all western GSA 17 since 1987 for most of the annual surveys (up, right). Full coverage of GSA 17 since 2005 (down)

Assumptions to build the graphs below concerning the historical series for acoustic survey:

For the years in which only the northern part of western GSA 17 was covered (about 2/3 of the area) the estimates of the missing part, the western central Adriatic Sea, were derived using the difference in average estimates between northern part of western GSA 17 and western central Adriatic Sea all over the time series. For the years in which the survey in Croatian side was not conducted (1976-2003), the missing information was filled in this way: the two average values (Italian and Croatian) were calculated for the years 2004- 2011 and on the base of the reciprocal ratio between these two averages the supposed complete estimate was calculated.

Together with the trend of acoustic survey biomass estimates per each species, the two trends of anchovy and sardine from VPA estimations of mid-year biomass (for which only half fishing

mortality is supposed to have occurred) and total biomass (begin of the year, no fishing mortality had occurred yet) are reported in Figure 8.1.2.

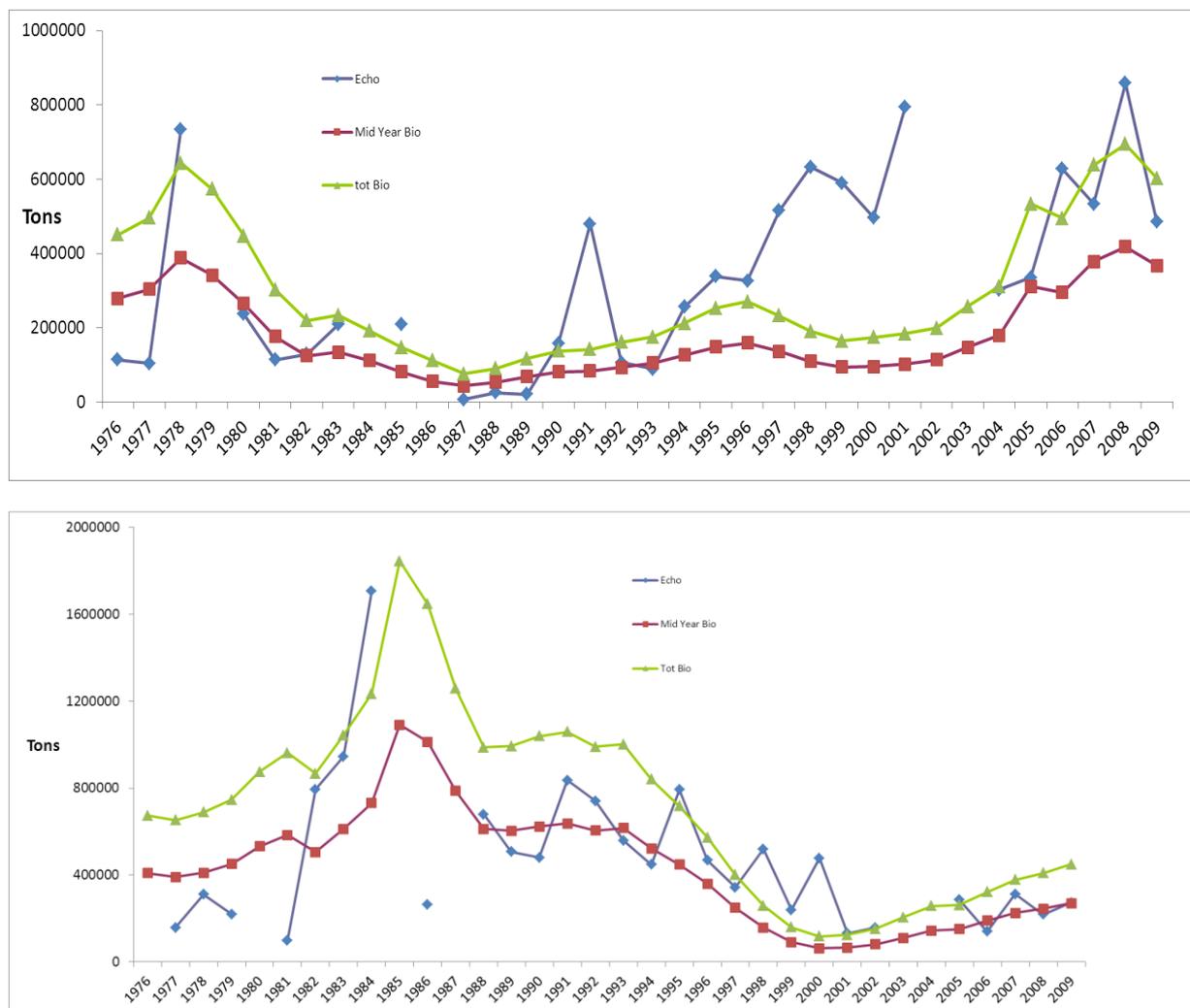


Fig. 8.1.2. Trend of total and mid-year biomass in GSA 17 from VPA together with biomass estimate from acoustic survey raised to the whole area for anchovy (above) and sardine (below)

Comparison with acoustic results has to consider mid-year estimate from VPA for anchovy due to the survey period of the survey, while comparison for sardine should take into account the total biomass from VPA with the result of survey from the previous year also due to the time frame of the echosurvey.

Giving the fact that acoustic estimates extrapolated for all the GSA 17 did not result in a systematic bias compared to the corresponding VPA estimates, there is no firm evidence to discard the first part of the historical time series. The majority of the scientists composing the EWG 12-19 working group agrees with this statement.

8.2. Estimation of reference points for Sardine and Anchovy in GSA 17

8.2.1. Introduction

Reference points (biomass and exploitation rates) were estimated for two stocks: the stock assessment of Anchovy and Sardine in GSA 17 are included respectively in section 6.16 and 6.17.

Estimation of reference points was done based on the methodology described in Simmonds et al., (2011) which originated as a working document to the 2010 WKFRAME meeting (Anon., 2010). The framework uses computer intensive methods to estimate MSY (Maximum Sustainable Yield) reference points and calculates for a given value of B_{lim} corresponding F_{lim} reference points. These reference points have a probabilistic interpretation, for example two of the F_{lim} reference points calculated are the F that gives a 5% probability of SSB (spawning stock biomass) falling below B_{lim} (denoted F_{lim5}) and the F that gives a 10% probability of SSB falling below B_{lim} . Other F reference points are F_{msy} : the median of the F s that give the maximum sustainable yield, $F_{msy\ catch}$: the F that gives the maximum average yield, F_{crash5} : the F that has a 5% chance of crashing the stock, and $F_{crash50}$: the F that has a 50% chance of crashing the stock. The method also attempts to estimate a B_{lim} by using the location of the breakpoint in a fit of the hockey-stick stock recruitment (SR) function.

8.2.2. Methodology

The methodology follows that in Simmonds et al. (2011), there were some refinements of the model averaging methodology largely of a technical nature.

The approach follows that of a typical medium term projection but it includes the uncertainty in the choice of the stock recruitment model. Three models were investigated: the Ricker, the Beverton and Holt and the Hockey-stick models. Bayesian model averaging was used to combine the models giving appropriate weight to the best fitting models. The result is an algorithm which simulates recruitment given an SSB estimate while incorporating error not just in the fit of the individual model parameters (parameter uncertainty) but also incorporating error in the choice of model (model uncertainty). The method in Simmonds et al. (2011) uses an estimate of the posterior model probability from Gammerman 1997, then samples independently from the parameter distribution in each model, selecting which model to sample based on the estimate of the posterior model probability. This was changed and the approach taken here is to sample from the joint distribution of models and parameters (as in Madigan and York, 1995 and discussed in Hoeting et al., 1999), which is more appropriate.

The inputs to the medium term projection were mean weight at age in the catch, mean weight at age in the stock, selectivity at age, maturity and natural mortality. For each year in the projection, sets of these values

from 2009 to 2011 were chosen at random by selecting a year and using the same compliment of selectivity and weights at age and other parameters to maintain any within year correlation while also adding some noise that reflects current variations in these quantities. The simulations were initiated with a recruitment equal to the mean geometric mean of the series, and other inputs such as proportion of F before spawning and proportion of M before spawning were fixed based on a three year average (though these quantities do not change).

The projection was run for 200 years and reference point calculations were based on the last 50 years (i.e. it is assumed that equilibrium is reached before 150 years). A range of Fbar values (40 in total) were simulated between 0 and 1 and for each Fbar value 5000 simulations were conducted. Bpa was defined as $1.4 \times B_{lim}$.

8.2.3. *Results*

8.2.3.1. Sardine in GSA 17

8.2.3.1.1. The data

The stock recruitment data are plotted in Figure 1. It shows an approximately linear relationship between SSB and recruitment. The data presented on this plot are from the final SGMED assessment (see section 6.17).

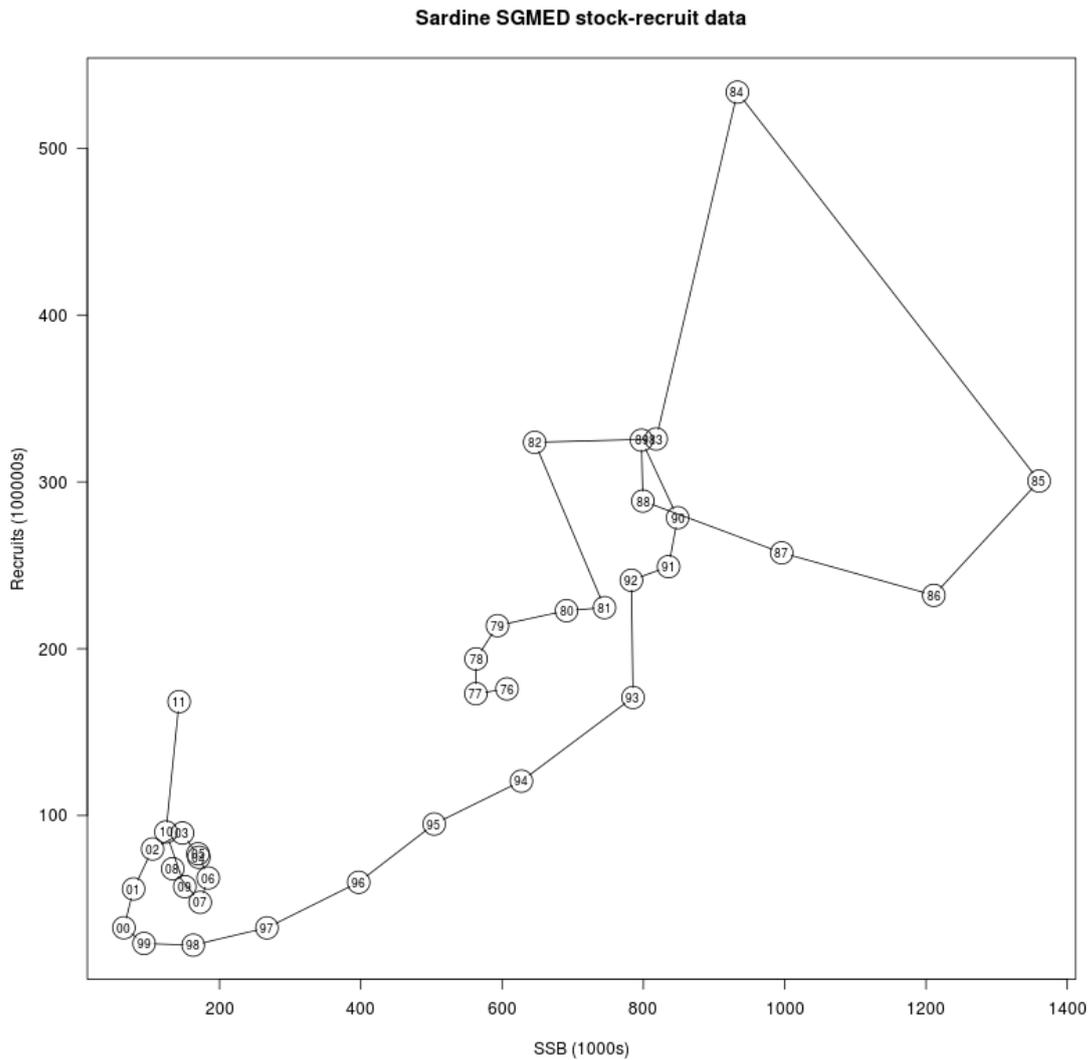


Fig. 8.2.3.1.1.1. Stock and recruitment data for sardine in GSA 17. Consecutive years are joined by lines. The year in which the recruitment takes place is given inside the point (years run from 1975 to 2011).

8.2.3.1.2.Scenario 1: SGMED assessment stock-recruit data

The data used in these simulations is shown in Figure 8.2.3.1.1.1. The fits of the individual stock recruitment models are shown in Figure 8.2.3.1.2.1 along with a figure showing 500,000 simulations of recruitment after accounting for model and parameter uncertainty. Looking at Figure 8.2.3.1.2.2 and 8.2.3.1.2.2d) in particular it can be seen that, although the 1984 recruitment is high, it is not as much of an outlier as the low 1997 recruitment. This is a consequence of the constant CV assumption and is not obvious prior to looking at Figure 8.2.3.1.2.1. The overall fits look good, apart from the period of lower than expected recruitments between 1993 and 1998.

The results of the simulations are given in Figures 8.2.3.1.2.1 and 8.2.3.1.2.2 and the reference points estimated are shown in table 8.2.3.1.2.1. It was not possible to use the estimate of B_{lim} from the hockey stick recruitment model break point since it was not well defined. A pragmatic alternative is to use 30% of the

maximum predicted historical SSB taking this to be a proxy for 30% of virgin biomass and this is the value used to estimate F_{lim} and B_{pa} .

Table 8.2.3.1.2.1. Estimated reference points. F_{lim5} , F_{lim10} and F_{lim50} are the F values that give a 5%, 10% and 50% probability of SSB falling below B_{lim} . F_{MSY} is the median F that gives maximum sustainable yield and $F_{max\ catch}$ maximises average catch. F_{crash5} and $F_{crash50}$ are the F values that give 5% and 50% probability of crashing the stock. B_{lim} was defined as 30% of maximum observed SSB

B_{lim}	B_{pa}	F_{lim5}	F_{lim10}	F_{lim50}	F_{MSY}	$F_{max\ Catch}$	F_{crash5}	$F_{crash50}$
408,032	571,245	0.15	0.21	0.45	0.46	0.28	0.41	0.97

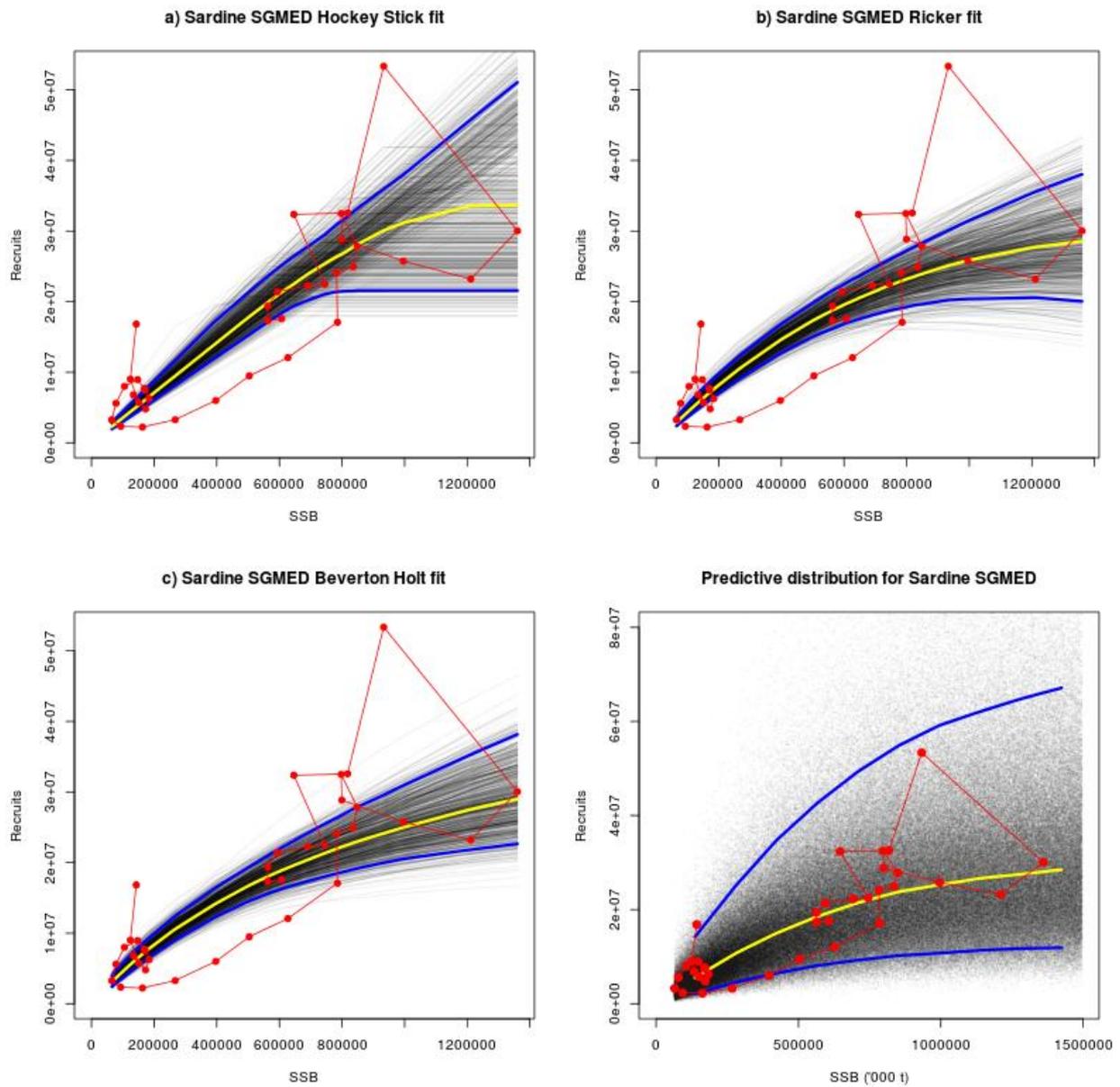


Fig. 8.2.3.1.2.1. Stock-recruitment model fits showing the data (red), the median (yellow) and the 5th and 95th percentiles. Panels a) – c) show SR model fits (Hockey-stick, Ricker and Beverton and Holt) along with 5000 simulated recruitment relationships showing the parameter uncertainty. Panel d) shows predicted recruitments at different level of SSB accounting for both parameter and model uncertainty.

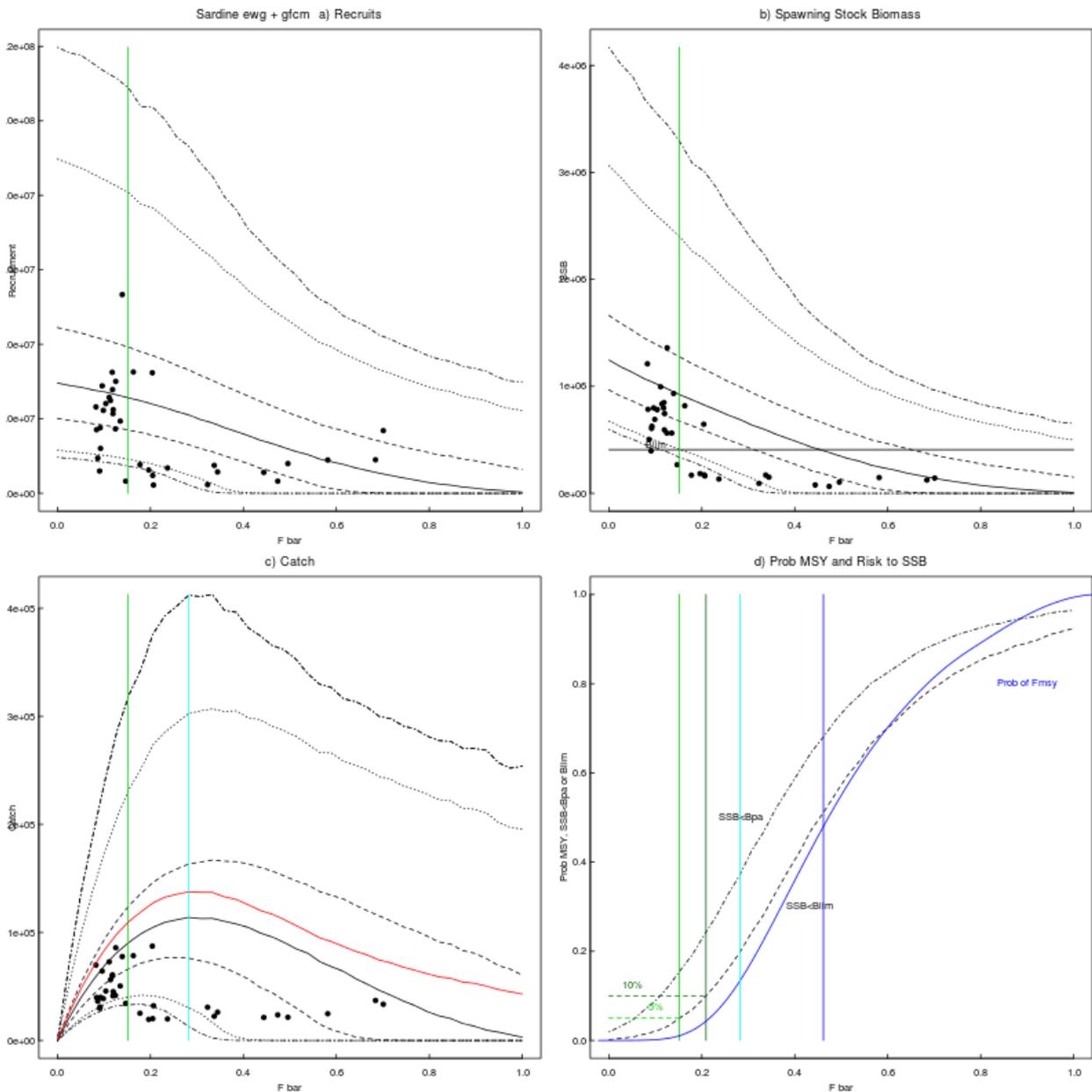


Fig. 8.2.3.1.2.2. A summary of the state of the equilibrium stock under different fishing mortalities. The points show the recent state of the stock. Panel a) shows the distribution of recruitment against F_{bar} , the solid line is the median, with the remaining dotted lines showing the 25th and 75th, 5th and 95th, and 2.5th and 97.5th quantiles. The vertical green bar shows the position of F_{lim5} . Panel b) show the same for SSB against F with a solid horizontal line representing B_{lim} highlighting the definition of F_{lim5} . Panel c) shows catch against F_{bar} , here a red line shows average equilibrium catch, which is maximised at $F_{max catch}$ indicated by a vertical light blue line. In the final panel (d) three distributions are shown: the probability of achieving MSY in blue and the probability of SSB falling below B_{lim} and B_{pa} . F_{MSY} (blue), $F_{max catch}$ (light blue), F_{lim5} (green) and F_{lim10} (dark green) are shown as vertical lines.

8.2.3.1.3.Scenario 2: SGMED assessment stock-recruit data with high recruitment removed

The results of the simulations are given in Figures 8.2.3.1.3.1 and 8.2.3.1.3.2 and the reference points estimated are shown in Table 8.2.3.1.3.1. It was not possible to use the estimate of B_{lim} from the hockey stick break point since it was not well defined. A pragmatic alternative is to use 30% of the maximum predicted historical SSB taking this to be a proxy for 30% of virgin biomass and this is the value used to estimate F_{lim} and B_{pa} .

Table 8.2.3.1.3.1. Estimated reference points. F_{lim5} , F_{lim10} and F_{lim50} are the F values that give a 5%, 10% and 50% probability of SSB falling below B_{lim} . F_{MSY} is the median F that gives maximum sustainable yield and $F_{max\ catch}$ maximises average catch. F_{crash5} and $F_{crash50}$ are the F values that give 5% and 50% probability of crashing the stock. B_{lim} was defined as 30% of maximum observed SSB.

B_{lim}	B_{pa}	F_{lim5}	F_{lim10}	F_{lim50}	F_{MSY}	$F_{max\ Catch}$	F_{crash5}	$F_{crash50}$
408,032	571,245	0.14	0.19	0.43	0.46	0.23	0.41	1.00

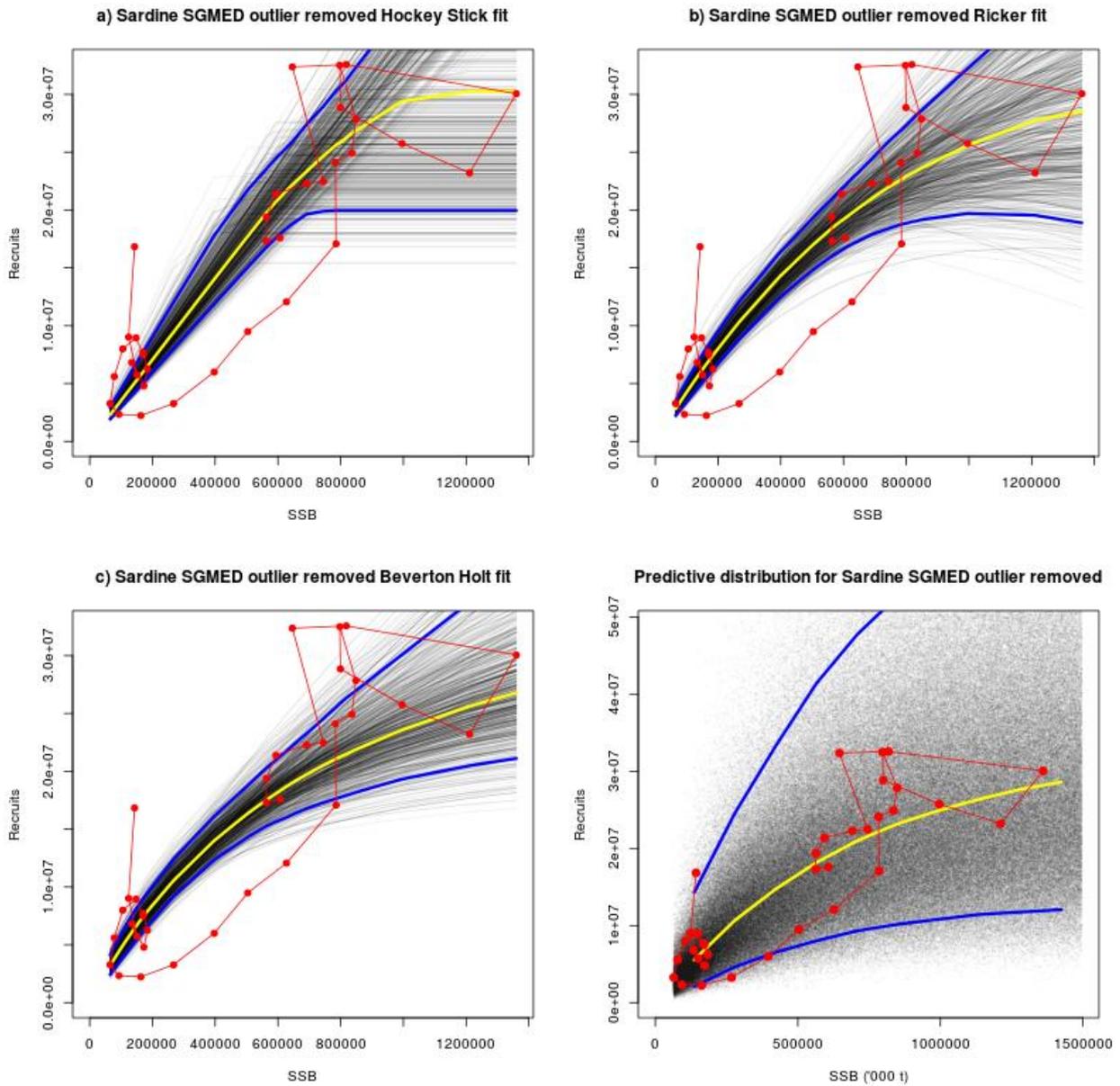


Fig. 8.2.3.1.3.1. Stock-recruitment model fits showing the data (red), the median (yellow) and the 5th and 95th percentiles. Panels a) – c) show model fits (Hockey-stick, Ricker and Beverton and Holt) along with 5000 simulated recruitment relationships showing the parameter uncertainty. Panel d) shows predicted recruitments given different values of SSB accounting for both parameter and model uncertainty.

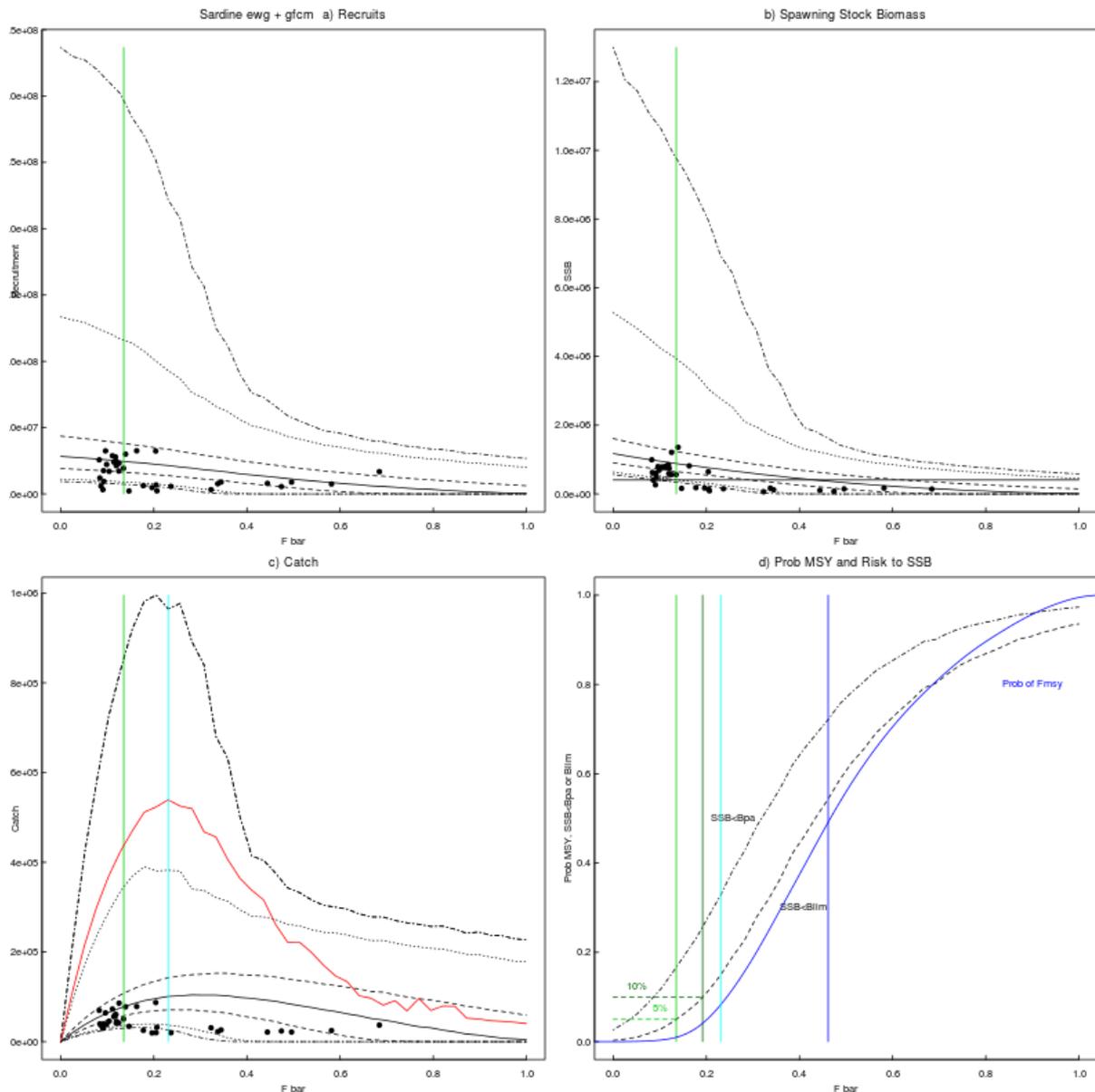


Fig. 8.2.3.1.3.2. A summary of the state of the equilibrium stock under different fishing mortalities. The points show the recent state of the stock. Panel a) shows the distribution of recruitment against F_{bar} , the solid line is the median, with the remaining dotted lines showing the 25th and 75th, 5th and 95th, and 2.5th and 97.5th quantiles. The vertical green bar shows the position of F_{lim5} . Panel b) show the same for SSB against F with a solid horizontal line representing B_{lim} highlighting the definition of F_{lim5} . Panel c) shows catch against F_{bar} , here a red line shows average equilibrium catch, which is maximised at $F_{max catch}$ indicated by a vertical light blue line. In the final panel (d) three distributions are shown: the probability of achieving MSY in blue and the probability of SSB falling below B_{lim} and B_{pa} . F_{MSY} (blue), $F_{max catch}$ (light blue), F_{lim5} (green) and F_{lim10} (dark green) are shown as vertical lines.

8.2.3.1.4.Scenario 3: stock-recruit data from ICA fit to the full series using 2010 settings

The results of the simulations are given in Figures 8.2.3.1.4.1 and 8.2.3.1.4.2 and the reference points estimated are shown in Table 8.2.3.1.4.1. It was not possible to use the estimate of B_{lim} from the hockey stick break point since it was not well defined. A pragmatic alternative is to use 30% of the maximum

predicted historical SSB taking this to be a proxy for 30% of virgin biomass and this is the value used to estimate F_{lim} and B_{pa} .

Table 8.2.3.1.4.1. Estimated reference points. F_{lim5} , F_{lim10} and F_{lim50} are the F values that give a 5%, 10% and 50% probability of SSB falling below B_{lim} . F_{MSY} is the median F that gives maximum sustainable yield and $F_{max\ catch}$ maximises average catch. F_{crash5} and $F_{crash50}$ are the F values that give 5% and 50% probability of crashing the stock. B_{lim} was defined as 30% of maximum observed SSB.

B_{lim}	B_{pa}	F_{lim5}	F_{lim10}	F_{lim50}	F_{MSY}	$F_{max\ Catch}$	F_{crash5}	$F_{crash50}$
408,032	571,245	0.16	0.22	0.53	0.54	0.28	0.49	>1*

* $F_{crash50}$ is beyond the range of investigated F values

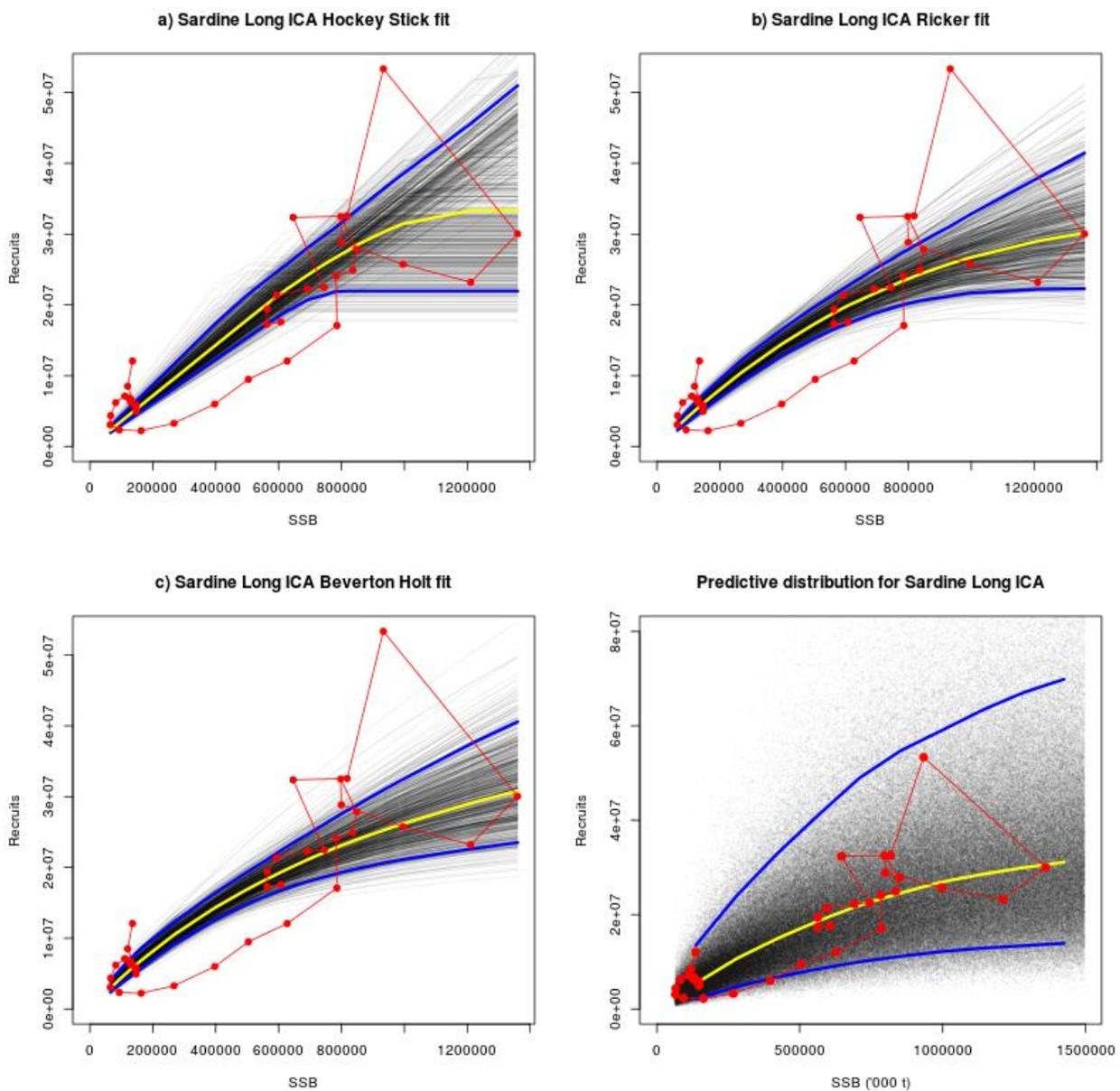


Fig. 8.2.3.1.4.1. Stock-recruit model fits showing the data (red), the median (yellow) and the 5th and 95th percentiles. Panels a) – c) show model fits (Hockey-stick, Ricker and Beverton and Holt) along with 5000 simulated recruitment relationships showing the parameter uncertainty. Panel d) shows predicted recruitments given different values of SSB accounting for both parameter and model uncertainty.

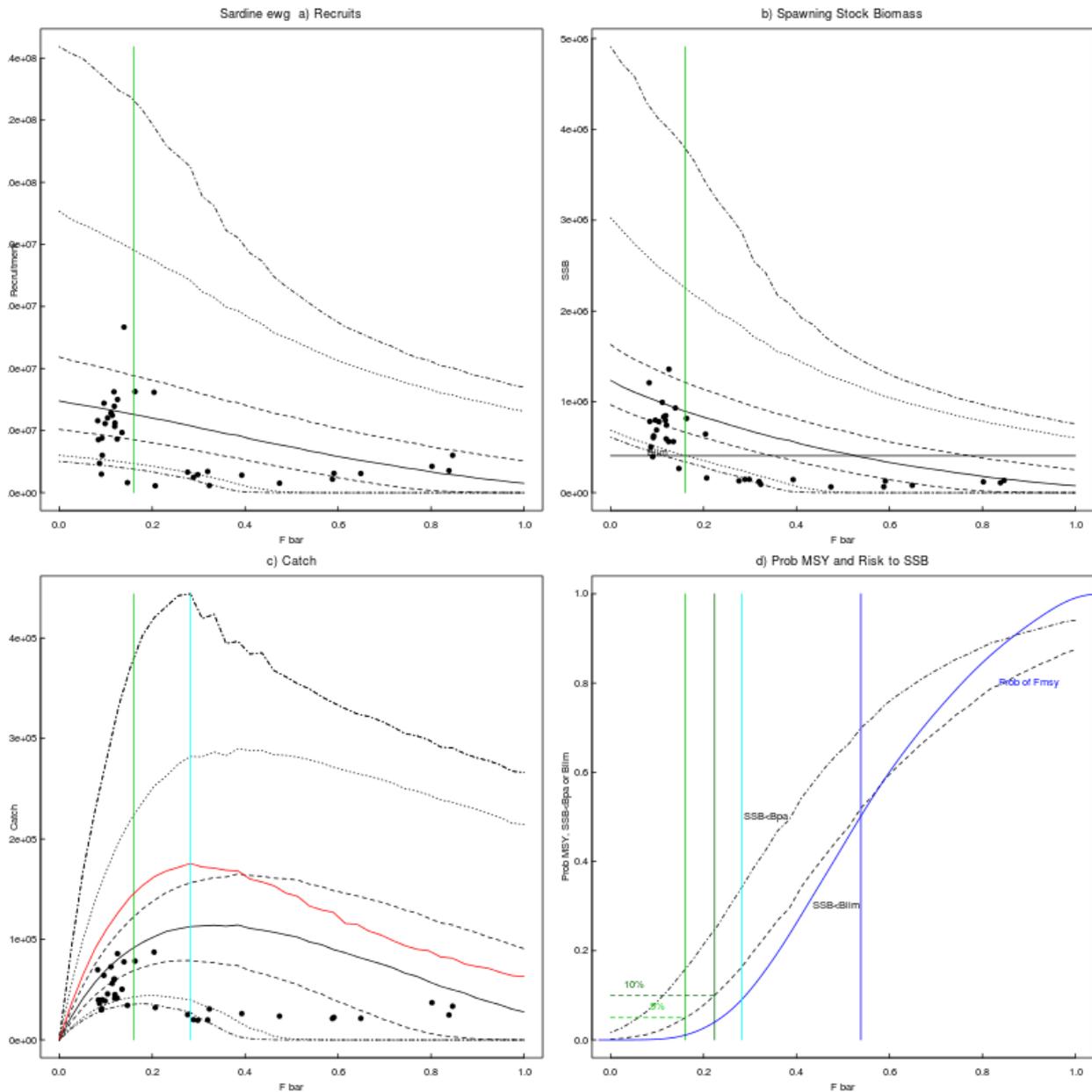


Fig. 8.2.3.1.4.2. A summary of the state of the equilibrium stock under different fishing mortalities. The points show the recent state of the stock. Panel a) shows the distribution of recruitment against F_{bar} , the solid line is the median, with the remaining dotted lines showing the 25th and 75th, 5th and 95th, and 2.5th and 97.5th quantiles. The vertical green bar shows the position of F_{lim5} . Panel b) show the same for SSB against F with a solid horizontal line representing B_{lim} highlighting the definition of F_{lim5} . Panel c) shows catch against F_{bar} , here a red line shows average equilibrium catch, which is maximised at $F_{max\ catch}$ indicated by a vertical light blue line. In the final panel (d) three distributions are shown: the probability of achieving MSY in blue and

the probability of SSB falling below B_{lim} and B_{pa} . F_{MSY} (blue), $F_{max\ catch}$ (light blue), F_{lim5} (green) and F_{lim10} (dark green) are shown as vertical lines.

8.2.3.1.5.Scenario 4: GFCM 2011 assessment stock-recruit data

The results of the simulations are given in Figures 8.2.3.1.5.1 and 8.2.3.1.5.2 and the reference points estimated are shown in Table 8.2.3.1.5.1. It was not possible to use the estimate of B_{lim} from the hockey stick break point since it was not well defined. A pragmatic alternative is to use 30% of the maximum predicted historical SSB taking this to be a proxy for 30% of virgin biomass and this is the value used to estimate F_{lim} and B_{pa} .

Table 8.2.3.1.5.1. Estimated reference points. F_{lim5} , F_{lim10} and F_{lim50} are the F values that give a 5%, 10% and 50% probability of SSB falling below B_{lim} . F_{MSY} is the median F that gives maximum sustainable yield and $F_{max\ catch}$ maximises average catch. F_{crash5} and $F_{crash50}$ are the F values that give 5% and 50% probability of crashing the stock. B_{lim} was defined as 30% of maximum observed SSB.

B_{lim}	B_{pa}	F_{lim5}	F_{lim10}	F_{lim50}	F_{MSY}	$F_{max\ Catch}$	F_{crash5}	$F_{crash50}$
55,217	77,304	-	-	-	-	-	-	-

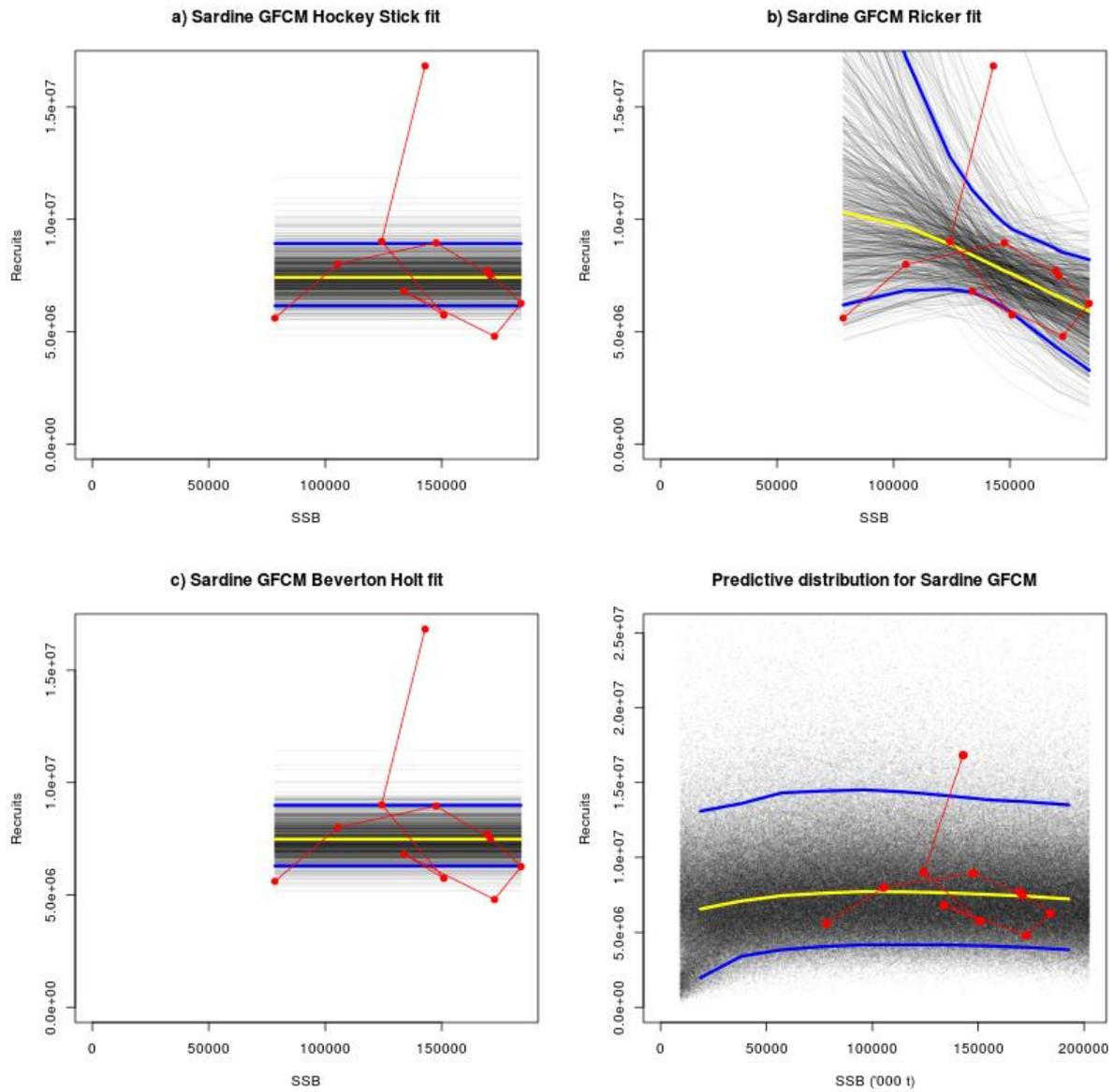


Fig. 8.2.3.1.5.1. Stock-recruit model fits showing the data (red), the median (yellow) and the 5th and 95th percentiles. Panels a) – c) show model fits (Hockey-stick, Ricker and Beverton and Holt) along with 5000 simulated recruitment relationships showing the parameter uncertainty. Panel d) shows predicted recruitments at different values of SSB accounting for both parameter and model uncertainty.

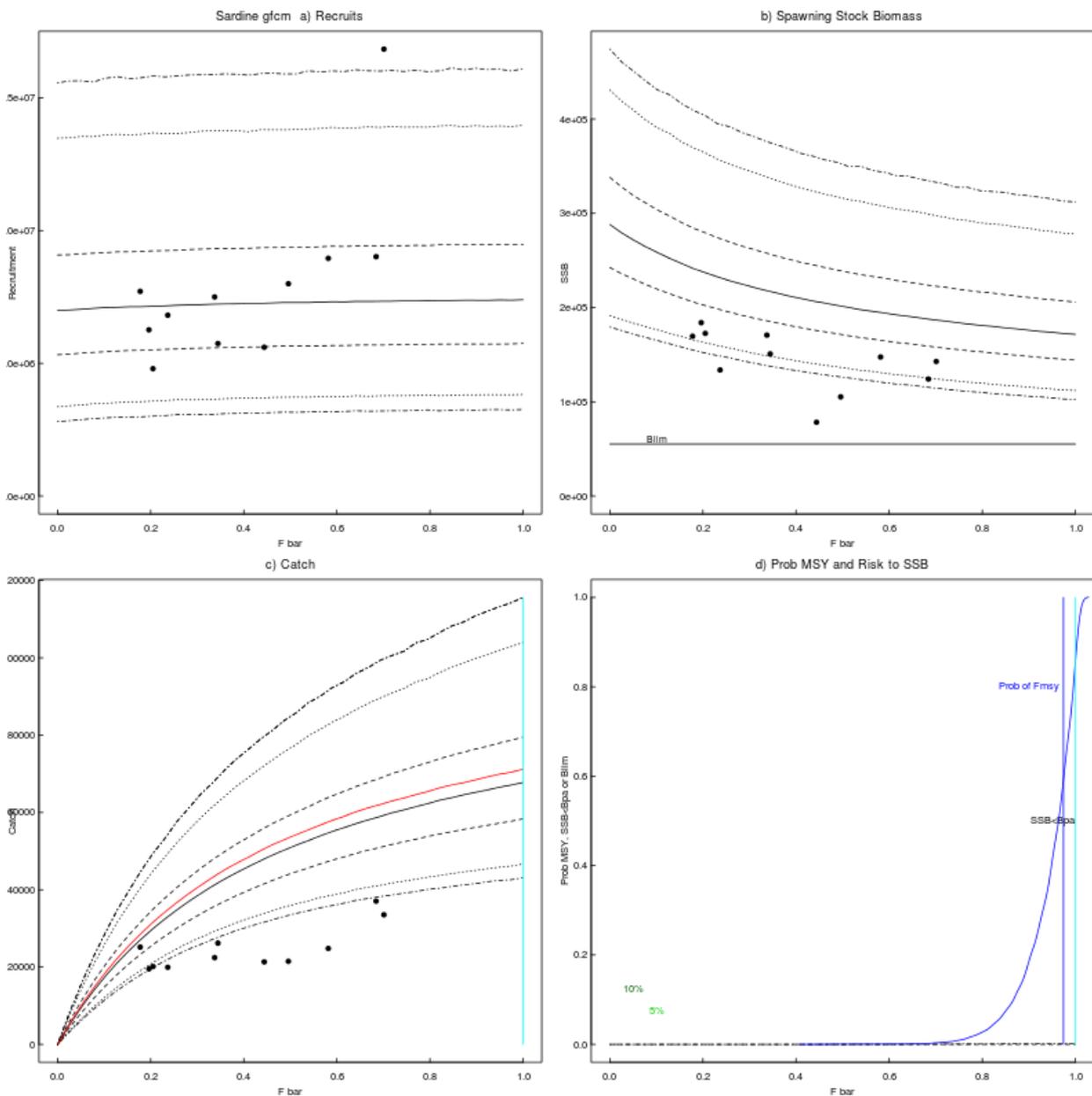


Fig. 8.2.3.1.5.2. A summary of the state of the equilibrium stock under different fishing mortalities. The points show the recent state of the stock. Panel a) shows the distribution of recruitment against F_{bar} , the solid line is the median, with the remaining dotted lines showing the 25th and 75th, 5th and 95th, and 2.5th and 97.5th quantiles. The vertical green bar shows the position of F_{lim5} . Panel b) show the same for SSB against F with a solid horizontal line representing B_{lim} highlighting the definition of F_{lim5} . Panel c) shows catch against F_{bar} , here a red line shows average equilibrium catch, which is maximised at $F_{max\ catch}$ indicated by a vertical light blue line. In the final panel (d) three distributions are shown: the probability of achieving MSY in blue and the probability of SSB falling below B_{lim} and B_{pa} . F_{MSY} (blue), $F_{max\ catch}$ (light blue), F_{lim5} (green) and F_{lim10} (dark green) are shown as vertical lines.

8.2.3.2. Summary and recommendations

There was a suitable stock-recruitment relation in long time series scenarios to estimate reference points. The short time series (scenario 4) did not have sufficient contrast to estimate anything but a straight line (i.e. recruitment independent of stock size).

A summary of estimated reference points is shown in Table 8.2.3.2.1. Scenarios 1 to 3 vary a little in the estimates of F reference point estimates but we may be seeing some error due to the simulations themselves (so called monte-carlo error). F_{MSY} is estimated to be around 0.5, however the F that gives a 1/20 chance of crashing the stock is lower than this (0.38 – 0.44). The F that maximises average catch is estimated to be around 0.25 which may give a very low chance of crashing the stock. Setting B_{lim} at 30% of the maximum observed SSB results in F_{lim} values that pose a small risk to crashing the stock.

Thus, EWG 12-19 suggest to adopt $B_{lim} = 408,032$ (i.e. 30% of SSB_{max}) and $F_{msy} = 0.26$ (i.e. $F_{max\ Catch}$).

Table 8.2.3.2.1. Summary of reference point estimates from all four scenarios.

Scenario	B_{lim}	B_{pa}	F_{lim5}	F_{lim10}	F_{lim50}	F_{MSY}	$F_{max\ Catch}$	F_{crash5}	$F_{crash50}$
1	408,032	571,245	0.15	0.21	0.45	0.46	0.28	0.41	0.97
2	408,032	571,245	0.14	0.19	0.43	0.46	0.23	0.41	1.00
3	408,032	571,245	0.16	0.22	0.53	0.54	0.28	0.49	>1
4	55,217	77,304	-	-	-	-	-	-	-

8.2.4. Anchovy in GSA 17

8.2.4.1. The data

The stock recruitment data are plotted in Figure 8.2.4.1.1. It shows an approximately linear relationship between SSB and recruitment. The data presented on this plot are from the final STECF assessment (see section 6.16).

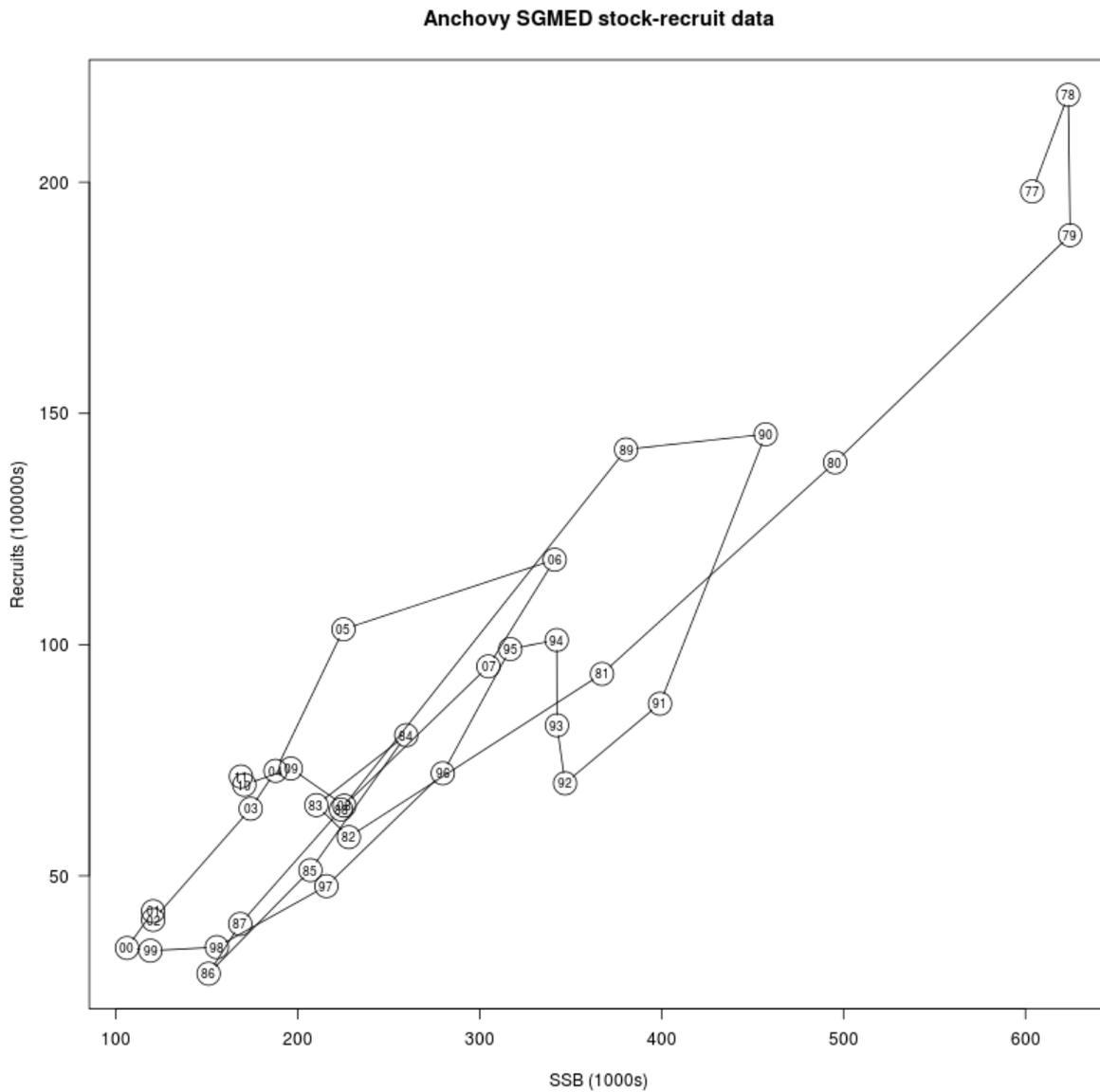


Fig. 8.2.4.1.1. Stock and recruitment data for anchovy in GSA 17. Consecutive years are joined by lines and the year. The year in which the recruitment takes place is given inside the point (years run from 1977 to 2011).

8.2.4.1.1.Scenario 1: SGMED assessment stock-recruit data

The results of the simulations are given in Figures 8.2.4.1.1.1. and 8.2.4.1.1.2. and the reference points estimated are shown in Table 8.2.4.1.1.1. It was not possible to use the estimate of B_{lim} from the hockey stick break point since it was not well defined. A pragmatic alternative is to use 30% of the maximum predicted historical SSB taking this to be a proxy for 30% of virgin biomass and this is the value used to estimate F_{lim} and B_{pa} .

Table 8.2.4.1.1.1. Estimated reference points. F_{lim5} , F_{lim10} and F_{lim50} are the F values that give a 5%, 10% and 50% probability of SSB falling below B_{lim} . F_{MSY} is the median F that gives maximum sustainable yield and $F_{max\ catch}$ maximises average catch. F_{crash5} and $F_{crash50}$ are the F values that give 5% and 50% probability of crashing the stock. B_{lim} was defined as 30% of maximum observed SSB.

B_{lim}	B_{pa}	F_{lim5}	F_{lim10}	F_{lim50}	F_{MSY}	$F_{max\ Catch}$	F_{crash5}	$F_{crash50}$
187,377	262,327	-	-	-	-	-	-	-

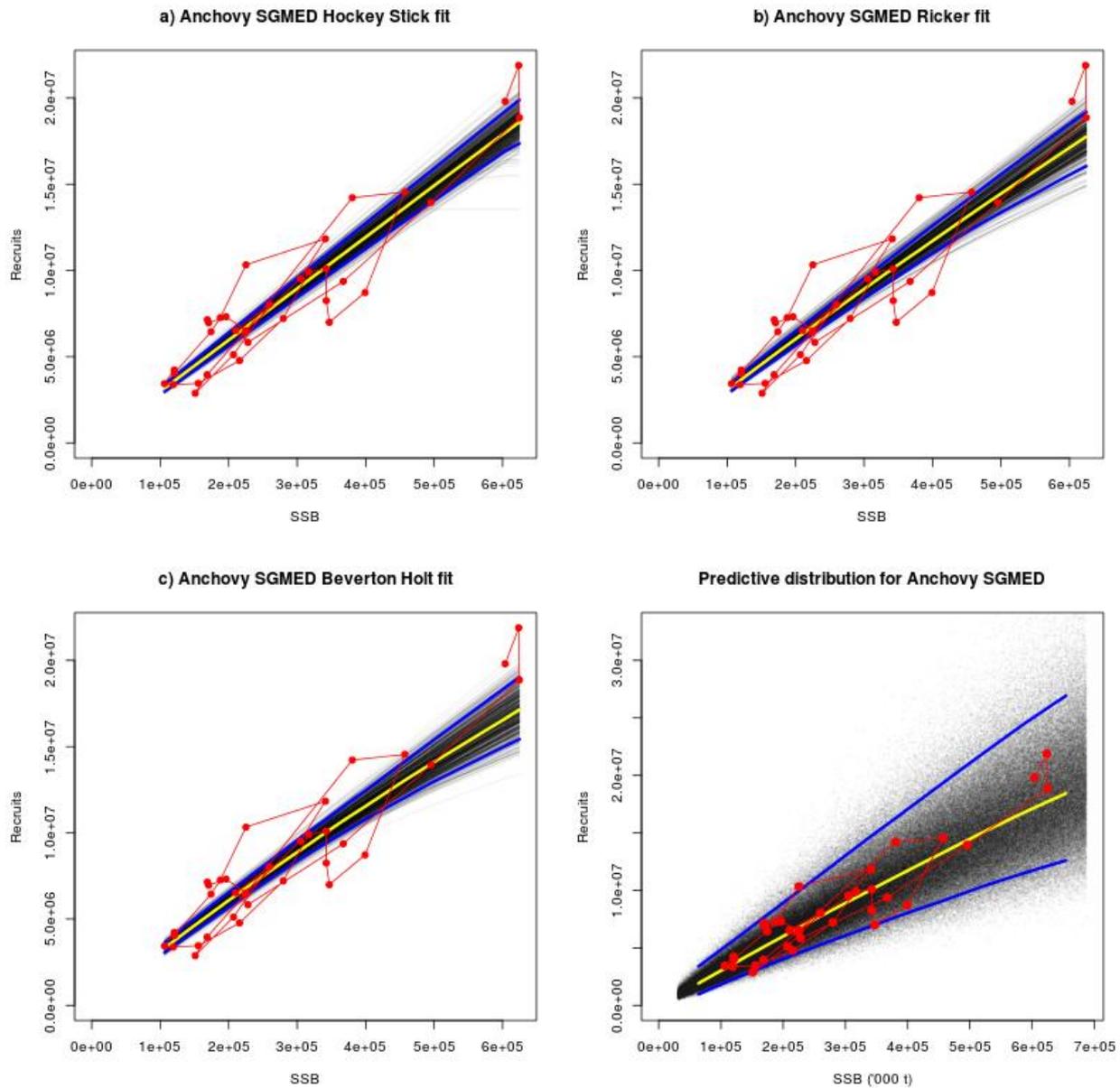


Fig. 8.2.4.1.1.1. Stock-recruit model fits showing the data (red), the median (yellow) and the 5th and 95th percentiles. Panels a) – c) show model fits (Hockey-stick, Ricker and Beverton and Holt) along with 5000 simulated recruitment relationships showing the parameter uncertainty. Panel d) shows predicted recruitments at different values of SSB accounting for both parameter and model uncertainty.

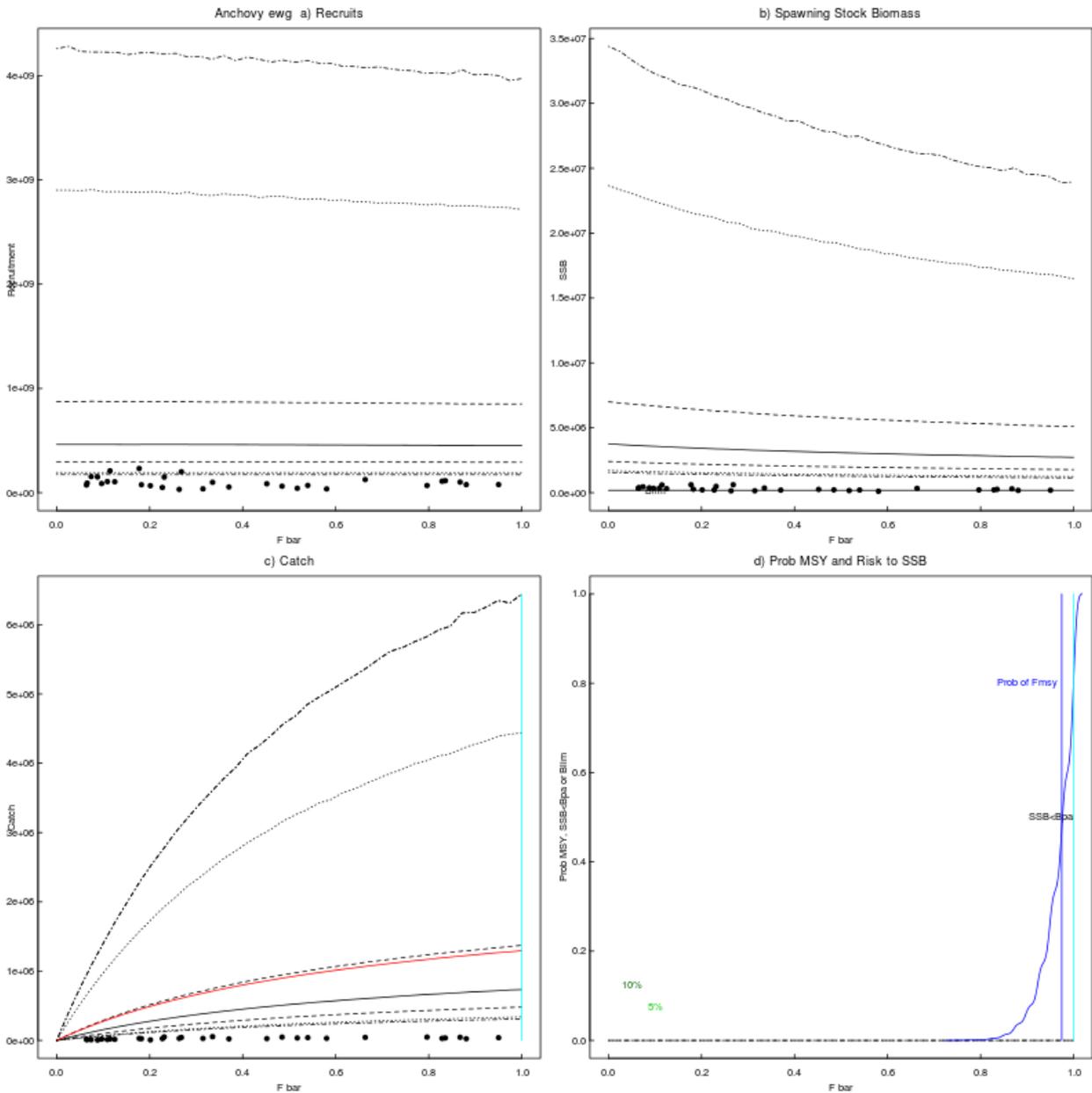


Fig. 8.2.4.1.1.2. A summary of the state of the equilibrium stock under different fishing mortalities. The points show the recent state of the stock. Panel a) shows the distribution of recruitment against F_{bar} , the solid line is the median, with the remaining dotted lines showing the 25th and 75th, 5th and 95th, and 2.5th and 97.5th quantiles. The vertical green bar shows the position of F_{lim5} . Panel b) show the same for SSB against F with a solid horizontal line representing B_{lim} highlighting the definition of F_{lim5} . Panel c) shows catch against F_{bar} , here a red line shows average equilibrium catch, which is maximised at $F_{max catch}$ indicated by a vertical light blue line. In the final panel (d) three distributions are shown: the probability of achieving MSY in blue and the probability of SSB falling below B_{lim} and B_{pa} . F_{MSY} (blue), $F_{max catch}$ (light blue), F_{lim5} (green) and F_{lim10} (dark green) are shown as vertical lines.

8.2.4.1.2.Scenario 2: SGMED assessment stock-recruit data with high SSBs removed

The results of the simulations are given in Figures 8.2.4.1.2.1 and 8.2.4.1.2.2 and the reference points estimated are shown in Table 8.2.4.1.2.1. It was not possible to use the estimate of B_{lim} from the hockey stick break point since it was not well defined. A pragmatic alternative is to use 30% of the maximum predicted historical SSB taking this to be a proxy for 30% of virgin biomass and this is the value used to estimate F_{lim} and B_{pa} .

Table 8.2.4.1.2.1. Estimated reference points. F_{lim5} , F_{lim10} and F_{lim50} are the F values that give a 5%, 10% and 50% probability of SSB falling below B_{lim} . F_{MSY} is the median F that gives maximum sustainable yield and $F_{max\ catch}$ maximises average catch. F_{crash5} and $F_{crash50}$ are the F values that give 5% and 50% probability of crashing the stock. B_{lim} was defined as 30% of maximum observed SSB.

B_{lim}	B_{pa}	F_{lim5}	F_{lim10}	F_{lim50}	F_{MSY}	$F_{max\ Catch}$	F_{crash5}	$F_{crash50}$
148,623	208,073	-	-	-	-	-	-	-

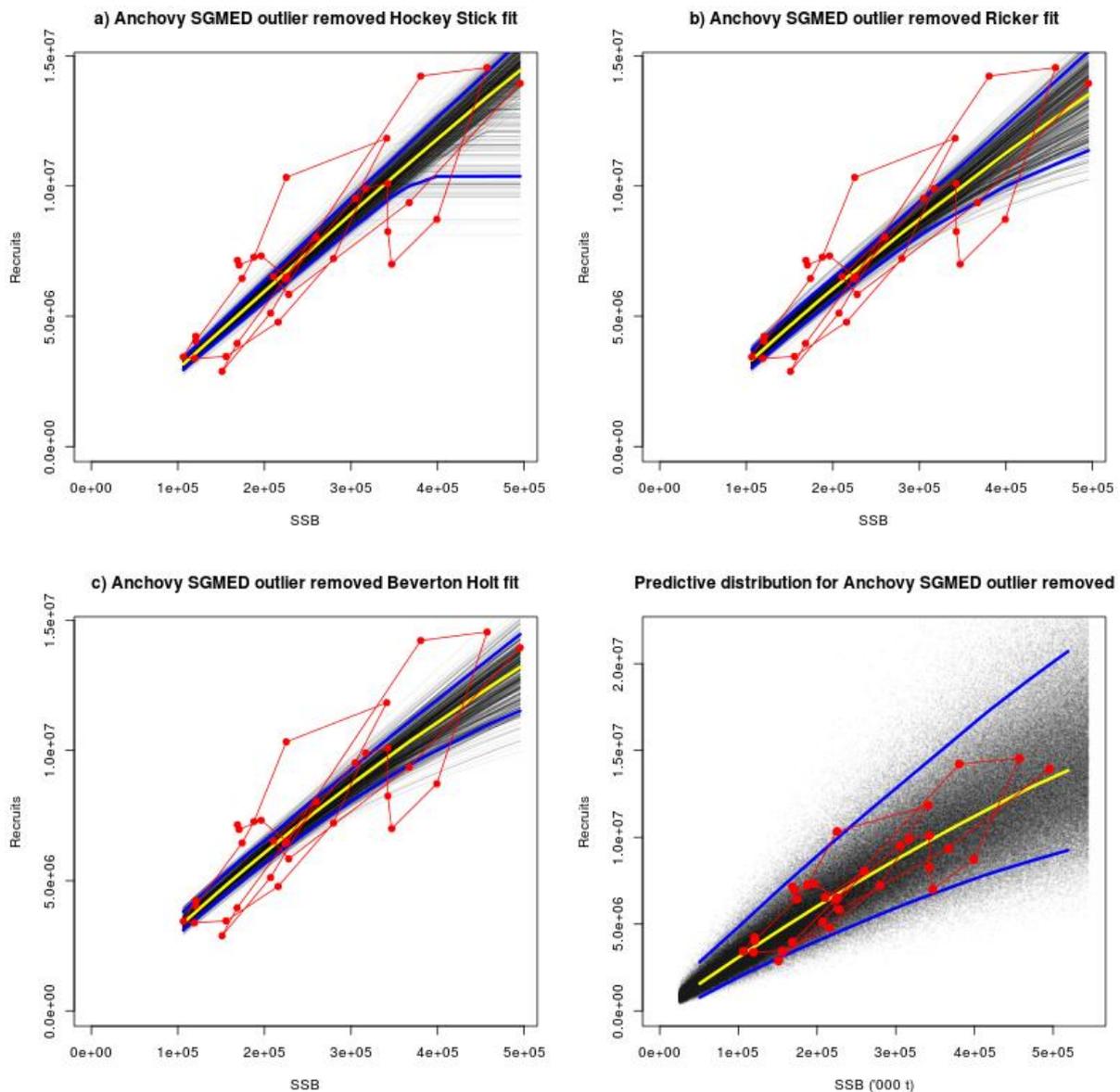


Fig. 8.2.4.1.2.1. Stock-recruit model fits showing the data (red), the median (yellow) and the 5th and 95th percentiles. Panels a) – c) show model fits (Hockey-stick, Ricker and Beverton and Holt) along with 5000 simulated recruitment relationships showing the parameter uncertainty. Panel d) shows predicted recruitments given SSB accounting for both parameter and model uncertainty.

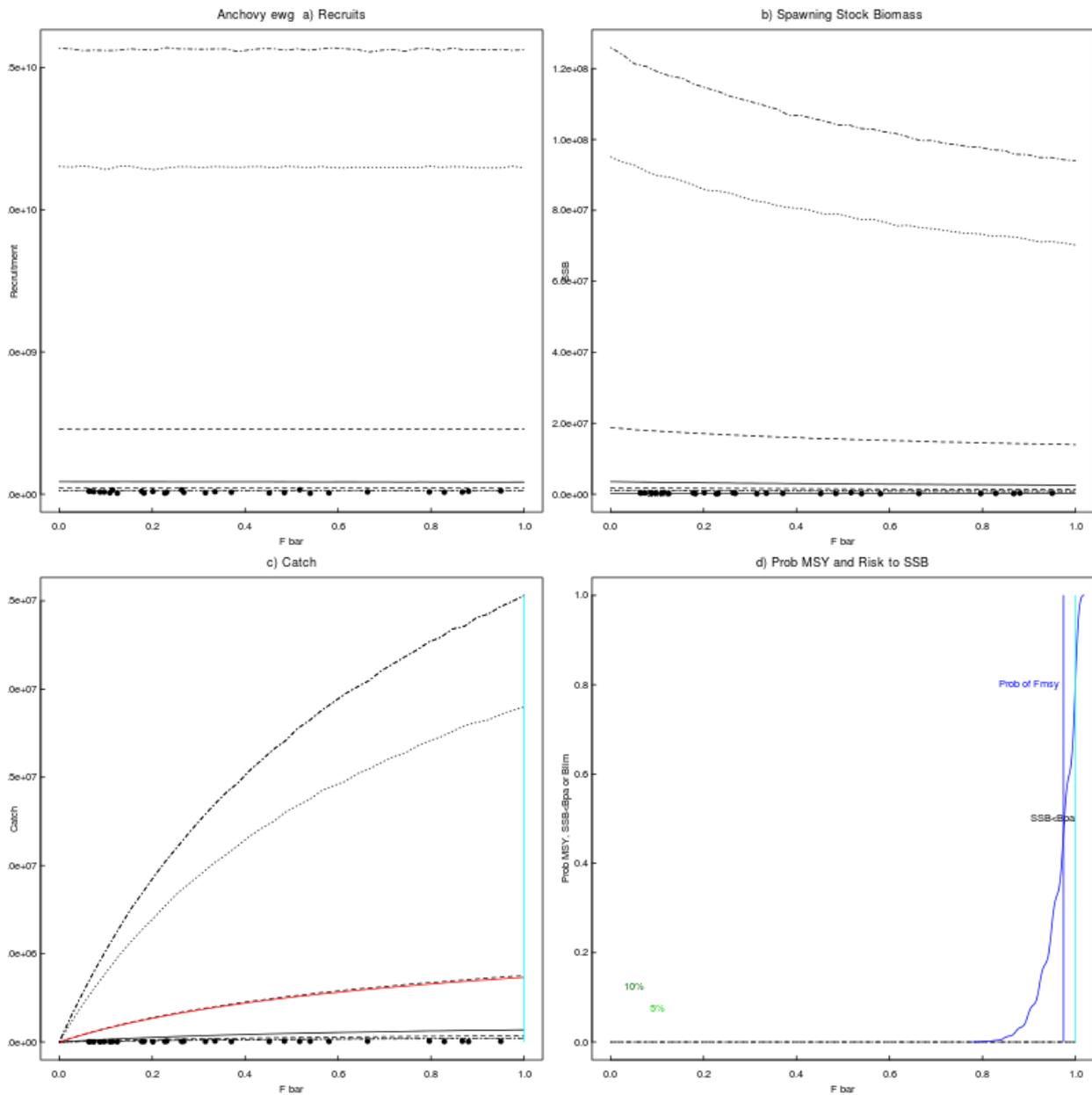


Fig. 8.2.4.1.2.2. A summary of the state of the equilibrium stock under different fishing mortalities. The points show the recent state of the stock. Panel a) shows the distribution of recruitment against F_{bar} , the solid line is the median, with the remaining dotted lines showing the 25th and 75th, 5th and 95th, and 2.5th and 97.5th quantiles. The vertical green bar shows the position of F_{lim5} . Panel b) show the same for SSB against F with a solid horizontal line representing B_{lim} highlighting the definition of F_{lim5} . Panel c) shows catch against F_{bar} , here a red line shows average equilibrium catch, which is maximised at $F_{max\ catch}$ indicated by a vertical light blue line. In the final panel (d) three distributions are shown: the probability of achieving MSY in blue and

the probability of SSB falling below B_{lim} and B_{pa} . F_{MSY} (blue), $F_{max\ catch}$ (light blue), F_{lim5} (green) and F_{lim10} (dark green) are shown as vertical lines.

8.2.4.1.3.Scenario 3: SGMED assessment stock-recruit data with age zero removed

Note age zero was also removed from the SSB calculation.

The results of the simulations are given in Figures 8.2.4.1.3.1 and 8.2.4.1.3.2 and the reference points estimated are shown in Table 8.2.4.1.3.1. It was not possible to use the estimate of B_{lim} from the hockey stick break point since it was not well defined. A pragmatic alternative is to use 30% of the maximum predicted historical SSB taking this to be a proxy for 30% of virgin biomass and this is the value used to estimate F_{lim} and B_{pa} .

Table 8.2.4.1.3.1. Estimated reference points. F_{lim5} , F_{lim10} and F_{lim50} are the F values that give a 5%, 10% and 50% probability of SSB falling below B_{lim} . F_{MSY} is the median F that gives maximum sustainable yield and $F_{max\ catch}$ maximises average catch. F_{crash5} and $F_{crash50}$ are the F values that give 5% and 50% probability of crashing the stock. B_{lim} was defined as 30% of maximum observed SSB.

B_{lim}	B_{pa}	F_{lim5}	F_{lim10}	F_{lim50}	F_{MSY}	$F_{max\ Catch}$	F_{crash5}	$F_{crash50}$
62611	87655	0.47	0.56	0.93	0.72	0.56	1.03	1.69

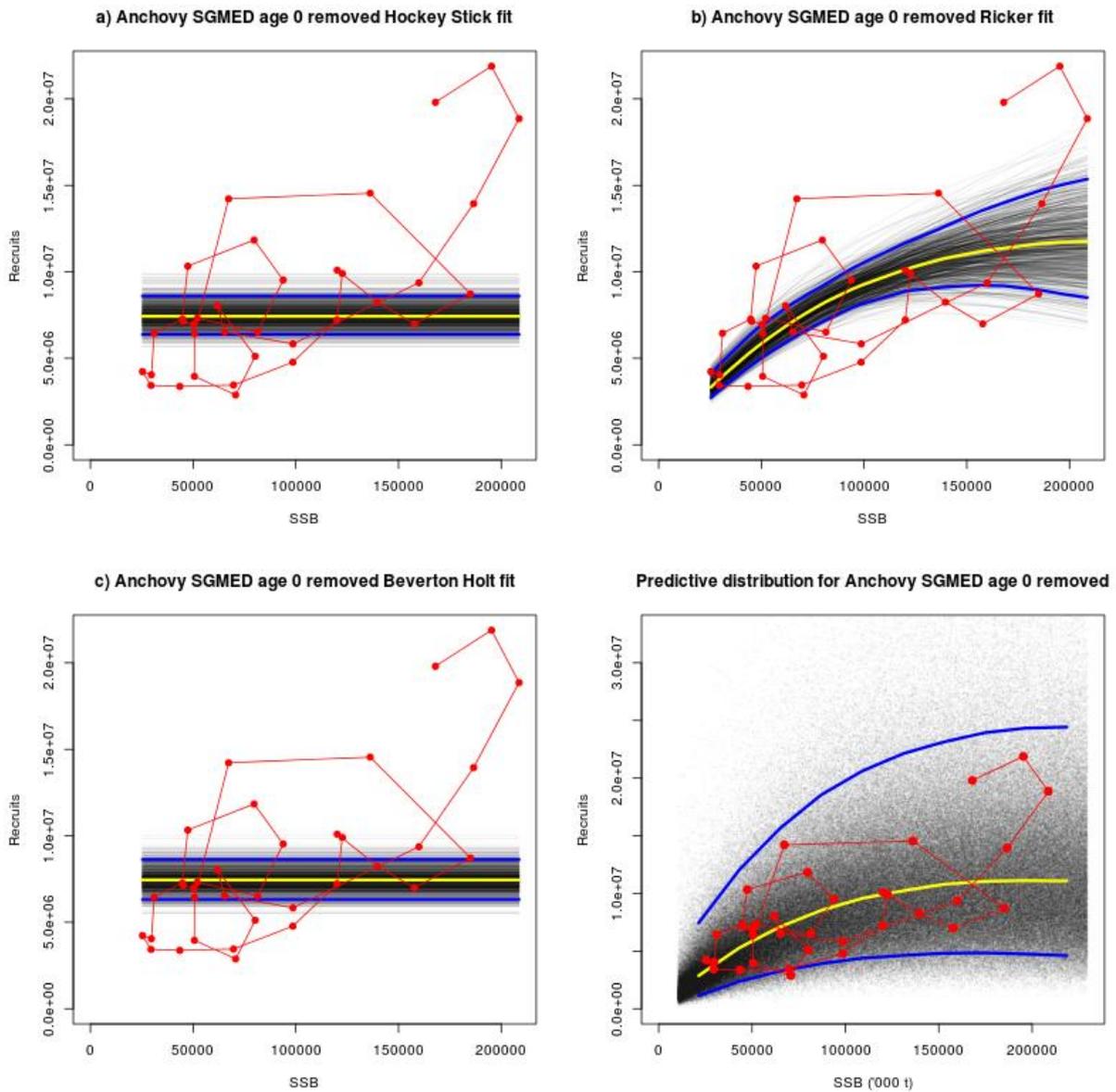


Fig. 8.2.4.1.3.1. Stock-recruit model fits showing the data (red), the median (yellow) and the 5th and 95th percentiles. Panels a) – c) show model fits (Hockey-stick, Ricker and Beverton and Holt) along with 5000 simulated recruitment relationships showing the parameter uncertainty. Panel d) shows predicted recruitments given SSB accounting for both parameter and model uncertainty.

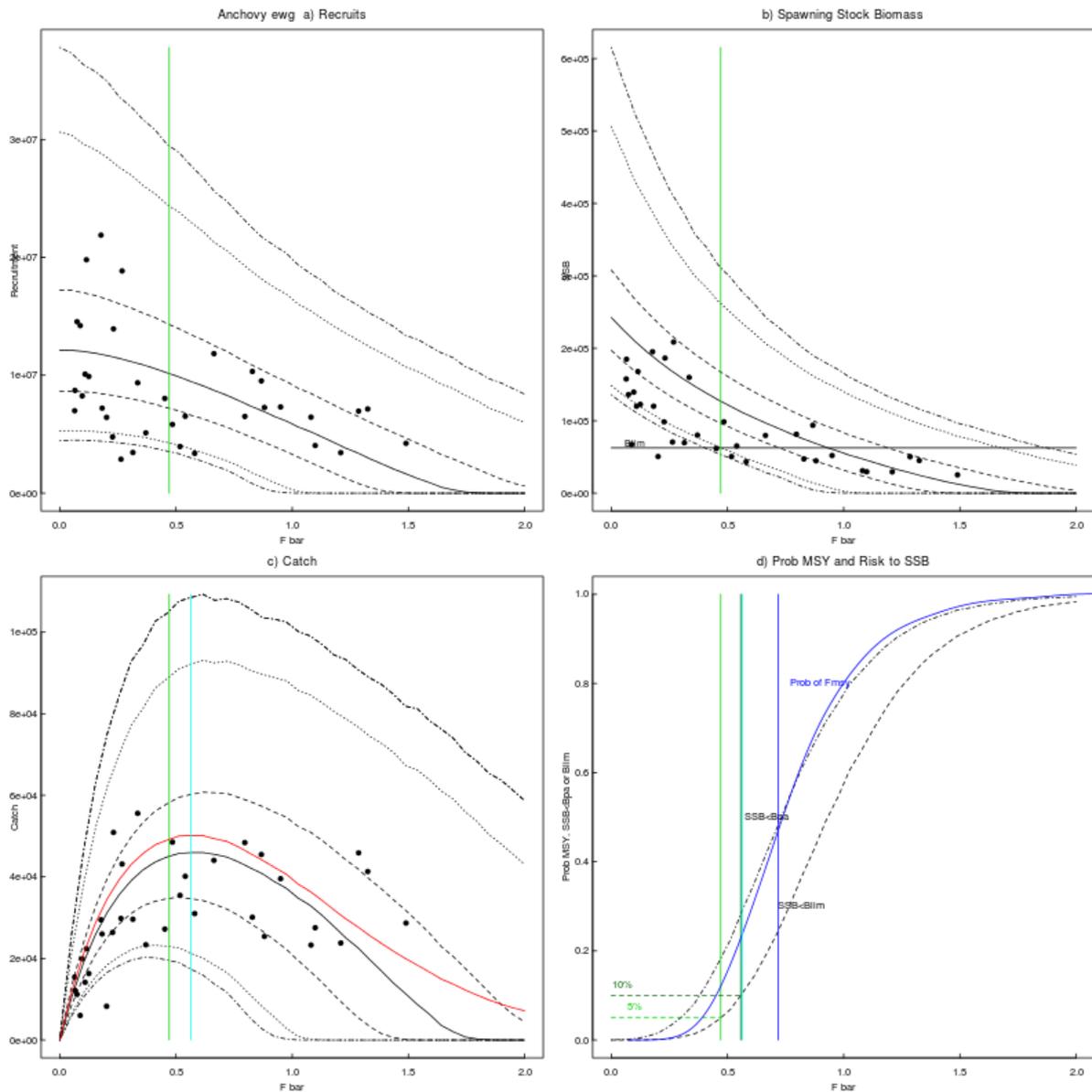


Fig. 8.2.4.1.3.2. A summary of the state of the equilibrium stock under different fishing mortalities. The points show the recent state of the stock. Panel a) shows the distribution of recruitment against F_{bar} , the solid line is the median, with the remaining dotted lines showing the 25th and 75th, 5th and 95th, and 2.5th and 97.5th quantiles. The vertical green bar shows the position of F_{lim5} . Panel b) show the same for SSB against F with a solid horizontal line representing B_{lim} highlighting the definition of F_{lim5} . Panel c) shows catch against F_{bar} , here a red line shows average equilibrium catch, which is maximised at $F_{max catch}$ indicated by a vertical light blue line. In the final panel (d) three distributions are shown: the probability of achieving MSY in blue and the probability of SSB falling below B_{lim} and B_{pa} . F_{MSY} (blue), $F_{max catch}$ (light blue), F_{lim5} (green) and F_{lim10} (dark green) are shown as vertical lines.

8.2.4.2. Summary and recommendations

Due to the strong linearity and lack of curvature in the stock-recruitment relationship in anchovy none of the simulations using age zero were able to estimate reference points. However when recruitment was modelled

as age 1 (age zero having been removed completely from the analysis) then equilibrium reference points were estimable. F_{msy} was high (0.7). However, since the equilibrium yield curve is quite flat, $F_{max\ catch}$ (0.56) gives a similar equilibrium yield to F_{msy} but with a lower probability (10% chance) of going below B_{lim} . F_{lim5} was 0.47.

Thus, SGMED suggest to adopt $B_{lim} = 148,623$ (i.e. 30% of SSB_{max} in scenario 2) and $F_{msy} = 0.56$ (i.e. $F_{max\ catch}$).

Table 8.2.4.2.1. Summary of reference point estimates from all three scenarios. Estimated reference points. F_{lim5} , F_{lim10} and F_{lim50} are the F values that give a 5%, 10% and 50% probability of SSB falling below B_{lim} . F_{MSY} is the median F that gives maximum sustainable yield and $F_{max\ catch}$ maximises average catch. F_{crash5} and $F_{crash50}$ are the F values that give 5% and 50% probability of crashing the stock. B_{lim} was defined as 30% of maximum observed SSB.

Scenario	B_{lim}	B_{pa}	F_{lim5}	F_{lim10}	F_{lim50}	F_{MSY}	$F_{max\ Catch}$	F_{crash5}	$F_{crash50}$
1	187,377	262,327	-	-	-	-	-	-	-
2	148,623	208,073	-	-	-	-	-	-	-
3	62611	87655	0.47	0.56	0.93	0.72	0.56	1.03	1.69

9. TOR F MIXED FISHERIES

The EWG 12-19 was requested to review and evaluate the mixed fisheries frameworks and computer programs to deliver mixed fisheries management advice. The great majority of Mediterranean stocks are exploited by multi-species (mixed) fisheries, particularly the near bottom and bottom dwelling species due to their coexistence in diverse communities and the poor selectivity of many gears used. The variety of exploited stocks in mixed fisheries still requires specific conservation needs as defined by the Marine Strategy Framework Directive (EU 2008, EU COM 2011).

The EWG continuously note that the selection of the various mixed fisheries involved in the exploitation of certain stocks potentially varies with the areas, gears and the fishing strategies. It is argued that the mixed fisheries are best managed by fishing effort, if they deploy trawled (active) gears. This can be done by settings of maximum allowable effort (TAE) in units of days at sea or the product of kilo Watt times days at sea to account for boat specific fishing power. The applicability of such effort measures or alternative ones regarding passive demersal gears has still to be proven. Fishing grounds with high stratification, e.g. along narrow continental shelves, may force certain stocks or parts of them to occur highly aggregated and thus make pure effort measures ineffective to control fishing mortality, like in the example of pelagic fisheries or particular demersal species with an aggregation behaviour during part of the life cycle. However, catch figures estimated and set consistently with effort constraints (TAE) will help to communicate foreseen constraints in fishing possibilities to the involved stakeholders.

EWG 12-19 updated the discussion on evaluation of different approaches to analyse and provide management advice regarding mixed fisheries under various scenarios. The group emphasized the relevance of tools with different potential methodologies that have been developed in recent years to guide management and to design multiannual management plans towards sustainable fisheries.

In 2006, the 'Fleet and Fisheries Forecast method' (F3 or Fcube) approach was presented and tested by ICES assessment working groups. This Fcube framework (Ulrich *et al.* 2011) focuses on fisheries and fleets rather than stocks, thus providing a bridge between the traditional single-species advice and the ecosystem approach to fishery management. The software is designed for short term forecasts (for the running and one future year) and not age specific. As such, medium term and selection effects cannot be simulated and short term advice might be biased in cases of recruitment events.

The EWG 12-19 reviewed another mixed fisheries assessment approach, published by Abella *et al.* (2011), based on non-equilibrium simulations of stock size, exploitation and yield. The study regards the group of vessels, operating near the coast that targets a multispecific groundfish assemblage. The analysis is based on a biomass dynamic model and is aimed at the definition of the Maximum Sustainable Yield and FMSY. The analyses were performed using the ASPIC software (Prager, 1994, 2005). This latter implements a non-equilibrium, continuous-time, observation-error estimator for the production model (Schnute, 1977; Prager,

1994). The approach allows specific short and medium term advice. The population estimates calculated by the surplus production model were used to project the population forward in time for a period of 10 years at different levels of F to evaluate changes in biomass and potential harvest levels.

The EWG proposed in previous meetings (EWG 11-05 and EWG 11-12), the design of a multi-annual management plan for demersal fisheries in GSA 9, in addition to a significant reduction in the effort of relevant fisheries, that consider the option of a disproportional and fisheries specific approach to optimize catch options consistent with conservation requirements and fishing effort deployed. The stochastic medium term forecast model for mixed fisheries (maximum 10 stocks, 10 fisheries) provided quantitative conclusions on future catch and biomass trends under various management scenarios over medium term (10 years). The model is age specific and thus was capable to consider fisheries specific exploitation patterns and temporal changes of them. It is formulated in VISUAL BASIC using EXCEL spreadsheets as in- and output. A simulation of the mixed fisheries on GSA 09 was conducted using data of four fisheries being jointly involved in exploitation of seven stocks.

STECF EWG 12-19 further advises that the potential use of existing tools to improve the selectivity of mixed fisheries shall be evaluated and promoted in order to simplify overly complex fisheries strategies through reduction of by catch and number of species exploited by the same gear. The mixed fisheries framework is considered very essential issue and relevant investigations shall be continued during the forthcoming meetings. Because of the complexity of the subject and the overload work during the current meeting, the group advises to establish a dedicated working framework to thoroughly tackle the subject.

10. TOR G QUALITY CHECKS

The request for TOR g was to review the quality and completeness of all data resulting from the official Mediterranean DCF data call issued on April 2012 requesting MEDITS trawl survey data updated to year 2012. STECF is requested to summarize and concisely describe in detail all data quality deficiencies of relevance for the assessment of stocks and fisheries. Such review and description are to be based the data format of the official DCF data calls for the Mediterranean and Black Sea issued on April 2012. Particular attentions should be devoted to assessing the quality of MEDITS survey for which several inconsistencies had emerged during the EWG 11-12 and EWG 12-10 meeting.

Test and validate some of the error patterns emerging from MEDITS quality checks, developed in SQL by JRC, exploring inconsistencies across tables (TA, TB, TC) and for hauls parameter. Such routines share a similar philosophy to the ROME script but a different implementation and functionality.

10.1. Checks on MEDITS data

The Medits trawl survey data submitted in response to the data call is considered to be one of the most important and structured fisheries independent information collected from Member States.

Given the importance of this dataset, the JRC data collection team developed a new library of quality checks in PostgreSQL (the Medits database stored at JRC) in order to discover hidden inconsistencies/erroneous entries in the submitted data with respect to the Medits instruction manual (Version 5 for current checks but will be updated to Version 6 for checks from 2012 onward). The checks reveal different types of inconsistencies in relations within and between TA, TB and TC data tables. This has never been performed before on Medits data submitted by all countries, years and areas of interest. Using this tool at a post processing level and before being examined by the relevant STECF EWG, JRC team could perform an automated and analytical check on the Medits data, discover any important quality issues and communicate these findings back to the Member States requesting clarification or data resubmission. Following this approach, the data provided to STECF working group and the JRC PostgreSQL database will be of higher quality which consequently, will improve the quality and reliability of the scientific advice provided.

In total, 26 checks have been designed (following the philosophy of the ROME routine developed by Spedicato and Bitetto) and applied to the Medits dataset submitted in response to the 2012 data call. Total run time of the checks is approximately 7 min for all countries, years, GSAs with no optimization of the queries. There was a significant number of inconsistencies detected at a different level of importance. The trends in error patterns show more errors in earlier years and to specific areas.

The library of the Medits quality checks is still under testing and some routines are still under validation and the preliminary results were presented during the EWG 12-19 meeting. The problematic data identified by the checks was communicated back to the experts that requested it in order to be examined and hence to

validate the methodology. The feedback from the experts is expected to improve the library and make it fully functional for the 2013 data call.

This library contributes to the JRC data collection team efforts in performing thorough quality checks on the data submitted via the data calls, give the necessary feedback to MS regarding the quality of the data.

10.1.1. Summary of the JRC SQL quality checks on MEDITS data

MEDITS data before and upon submission are quality checked against duplication, identical records and field values via the JRC DV Tool. A brief description of the check is followed by a percentage of erroneous records returned. The percentage when referring to errors emerging from TA table (haul information) will indicate the percentage of erroneous hauls while if emerging from tables TB and TC will refer to the percentage of erroneous entries.

Checks Performed

1 (Identical Records in TA, TB, TC, TD, TT)

No erroneous records found. The check was already performed by the DV Tool and upload facility.

2 (Check in case of valid records if vertical opening is zero OR wing opening is zero OR warp diameter is zero)

Percentage of returned Errors: 18% of the Records

3 (Check if the value of bridles length is consistent according to the mean depth (see Instruction Manual 5))

Percentage of returned Errors : 24%

4 (Check consistency of the hauls coordinates with the distance as calculate with the haversine method (adjusted to 100% difference))

Percentage of returned Errors : 0.4%

5 (Check consistency between weight of the fraction in TC and total weight in haul in TB)

Percentage of returned Errors : 2.8%

6 (Check consistency between not null weight and not null total number in TB)

Percentage of returned Errors : 0.1%

7 (Check if the difference between start depth and end depth is not greater than 20%)

Percentage of returned Errors : 1.5%

8 (Check consistency among duration, start time and end time of the haul in TA)

Percentage of returned Errors : 0.1%

9 (Check between duration of the haul and distance (tolerance of 15%))

Percentage of returned Errors : 8.9%

10 (Check if all the hauls in TB are in TA Hauls from TB not in TA)

Percentage of returned Errors : 3.5%

11 (Check if all the hauls in TA are in TB (percent error 3.3%))

Check if all the hauls in TA are in TC (percent error 3.5%)

Check if all the hauls in TB are in TC (percent error 0.2%)

Check if all the hauls in TC are in TA (percent error 3.5%)

Check if all the hauls in TC are in TB (percent error 0%)

12 (Check if the number per sex is equal to the sum of number per length per sex)

Percentage of returned Errors : 0.6%

13 (Check if the start depth and end depth of each haul are in the same stratum)

Percentage of returned Errors : 3.6%

14 (Check if the haul start in the same quadrant)

Percentage of returned Errors : 0.04%

15 (Check if all the species in TC are in TB)

Percentage of returned Errors : TB 0.1%

16 (Check if the total number in the haul is equal to the sum of females, males and undetermined in the haul)

Percentage of returned Errors : 13.9%, but most have just 1 number difference, can be due to conversion problems.

17 (Among hauls with the same code only one must be valid (no errors reported))

18 (Identical records at the aggregation level for TA, TB, TC, TD, TT (no errors reported))

19 (Check if, in case of sub-sampling in TC, the number per sex in TB is raised correctly)

20 (Check consistency between weight of the fraction in TC and total weight in haul in TB is under validation since returned exceedingly high error rates)

10.1.2. Conclusions

JRC is moving to higher level quality checks to give feedback to MS, produce Data Coverage Reports for 2013 data calls and overall contribute to improve the quality of MEDITS database and the quality of scientific advice deriving from the analysis of MEDITS data.

Overall significant numbers of errors emerged from almost every check with apparent trends in error patterns:

- Older Years have more errors
- Some GSAs have more errors

There is a different relevance of the errors:

- “fatal” errors->break the time-series of the data and undermine the use of MEDITS data. For example errors in wing spread specification in Check 1, values of the distance covered by a tow in Checks 8-9 and erroneous subsampling of the hauls Check 20, fall under this category and need thorough checking and correction.
- Protocol violation: this type of errors might not break the series but nevertheless can introduce systematic bias across years and between GSA’s which can impair joining of data from different sampling units and full standardization of the survey.

From the 26 preliminary checks performed by JRC there appear both fatal errors and protocol violations that need to be seriously scrutinized.

EWG 12-19 recommends a revision of the records emerging from each of the quality checks and correction of erroneous entries. EWG 12-19 recommends the use of quality check routines such as the JRC one (although not currently distributed) and the ROME library.

10.2. Evaluation of fisheries and effort data quality by EWG Experts

The following tables summarises the evaluation performed by the EWG 12-19 to assess the coverage and quality of data. The checks covered data from only GSA 1, 6, 9, 15 and 17.

Table 10.2.1.1 displays the species (rows) in the DCR/DCF lists and the fishing gear/metier combination responsible for the bulk of catches (columns) in GSA01. This table shows that bottom otter trawl (OTB) catches the largest variety of species (almost all listed are observed in the catches of OTB). On the other hand, almost all species appear in the catches of 2 or more fishing gears. In particular, demersal species such as *Merluccius merluccius*, *Lophius* sp., *Sepia officinalis*, *Loligo vulgaris* and most sparids (*Pagellus* sp., *Sparus aurata*) are caught simultaneously by bottom trawl and set gears (gillnets, trammel nets and longlines) resulting in technical interactions that may complicate assessing the stock status of these species. The most important fishing techniques, in terms of catch volume, are selected for sampling. For some species, the length frequency distributions are representative of the whole landings (100%), while for other species the coverage is low or incomplete one or more métiers were not sampled for demography (particularly species caught by set nets in DCR 2002-2008). Length frequency sampling cover now (DCF 2009-2011) the most significant fishing gear /metier combinations in GSA01.

10.2.1. Data coverage in GSA 1

Table 10.2.1.1. Landings information by gear (DCR: 2002-2008) or métier (DCF: 2009-2011) for GSA 1 (Alboran). Y (yes) mean occurrence of data while while empty cells mean no landings.

	DCR (2002-2008)								DCF (2009-2011)									
	F P O	G N S	G T R	L A	L D	L S	O T B	P S	F P O	G N S	G T R	L A	L D	L S	OTB_ DEMS P	OTB_ DWSP	OTB_M DDWSP	P S
<i>Engraulis encrasicolus</i>							Y	Y							Y			Y
<i>Lophius budegassa</i>		Y	Y			Y	Y			Y	Y			Y	Y	Y		
<i>Aristeus antennatus</i>							Y									Y	Y	
<i>Aristaeomorpha foliacea</i>																		
<i>Boops boops</i>			Y				Y	Y		Y	Y				Y		Y	Y
<i>Spicara maena</i>							Y	Y							Y		Y	

<i>Helicolenus dactylopterus</i>		Y	Y			Y	Y			Y	Y		Y	Y		
<i>Dicentrarchus labrax</i>			Y			Y	Y	Y		Y	Y		Y	Y		Y
<i>Citharus linguatula</i>		Y	Y			Y				Y	Y		Y		Y	
<i>Sepia officinalis</i>	Y	Y	Y			Y	Y			Y	Y		Y		Y	
<i>Chelidonichthys lastoviza</i>																
<i>Squalus acanthias</i>																
<i>Coryphaena hippurus</i>			Y		Y			Y		Y	Y		Y			Y
<i>Parapenaeus longirostris</i>						Y							Y		Y	
<i>Eledone moschata</i>																
<i>Eledone cirrosa</i>			Y			Y							Y		Y	
<i>Phycis blennoides</i>		Y	Y			Y	Y			Y	Y		Y	Y	Y	Y
<i>Eutrigla gurnardus</i>																
<i>Aspitrigla cuculus</i>																
<i>Chelidonichthys lucerna</i>																
<i>Merluccius merluccius</i>		Y				Y	Y			Y	Y		Y	Y	Y	Y
<i>Trachurus mediterraneus</i>		Y	Y			Y	Y			Y	Y		Y	Y	Y	Y
<i>Trachurus trachurus</i>		Y	Y			Y	Y			Y	Y		Y	Y	Y	Y
<i>Zeus faber</i>						Y	Y			Y			Y		Y	
<i>Lepidorhombus boscii</i>		Y	Y			Y							Y		Y	
<i>Scomber spp</i>		Y	Y			Y	Y			Y	Y		Y			Y
<i>Lophius piscatorius</i>		Y	Y			Y	Y			Y	Y		Y	Y	Y	Y
<i>Squilla mantis</i>										Y			Y			
<i>Mugilidae</i>		Y	Y			Y	Y			Y	Y		Y			Y
<i>Mullus surmuletus</i>			Y			Y				Y			Y		Y	Y
<i>Mullus barbatus</i>			Y			Y				Y			Y		Y	Y
<i>Nephrops norvegicus</i>						Y							Y	Y	Y	
<i>Octopus vulgaris</i>	Y	Y	Y			Y	Y		Y	Y	Y		Y	Y	Y	
<i>Pagellus erythrinus</i>		Y	Y			Y	Y	Y		Y	Y		Y	Y	Y	Y
<i>Sardina pilchardus</i>						Y	Y			Y	Y		Y			Y
<i>Trisopterus minutus</i>						Y							Y		Y	
<i>Raja clavata</i>																
<i>Rapana venosa</i>																
<i>Pagellus acarne</i>		Y	Y			Y	Y	Y		Y	Y		Y	Y	Y	Y
<i>Sparus aurata</i>		Y	Y			Y	Y			Y	Y		Y			Y

<i>Pagellus bogaraveo</i>		Y	Y			Y	Y	Y		Y	Y			Y	Y		Y	Y
<i>Galeus melastomus</i>							Y							Y	Y	Y	Y	
<i>Solea solea</i>			Y				Y			Y				Y				
<i>Spicara smaris</i>			Y				Y	Y										
<i>Sprattus sprattus</i>																		
<i>Loligo spp</i>			Y				Y	Y		Y	Y				Y			Y
<i>Illex coindetii</i>																		
<i>Diplodus spp</i>		Y	Y			Y	Y	Y		Y	Y			Y	Y		Y	Y
<i>Scyliorhinus canicula</i>		Y					Y				Y				Y	Y	Y	
<i>Penaeus kerathurus</i>																		
<i>Psetta maxima</i>			Y				Y				Y				Y			
<i>Micromesistius poutassou</i>							Y	Y							Y	Y	Y	
<i>Merlangius merlangus</i>																		
Is the métier selected for sampling?	Y	N	Y	N	N	N	Y	Y	Y	N	Y	N	N	N	Y	Y	N	Y

The Table 10.2.1.2 reports the coverage of the size frequency distributions with respect to the total landings (first three columns). Most stocks for which sufficient length frequency data exists have been assessed at least once in the past 3 years (2010-2012), green rows. There remain some species for which length frequency data and survey data exists but have not been assessed so far, but these are species of minor commercial importance in GSA01. Nevertheless, *Lophius budegassa*, *Parapenaeus longirostris*, *Mullus surmuletus*, *Pagellus erythrinus* and the cephalopods *Octopus vulgaris*, *Loligo vulgaris* and *Sepia officinalis* deserve attention in upcoming assessments. Biological data (maturity ogive, growth parameters) are in general very scarce and has already been used for stocks assessed in the past three years.

Table 10.2.1.2 Summary of data coverage for GSA 1 (Alborán). Y (yes) indicate data availability whereas N (No) means absence. Y(ESP) signify Biological data available through Spanish National Plan.

	Lengths from commercial fleet			Bottom trawl surveys		Maturity ogive, length-weight	Growth parameters (otolith reading or others)
	DCR	DCF	Other Projects	MEDITS (2007-2012)	Other surveys		
<i>Engraulis encrasicolus</i>	Assessed 2010 STECF SGMED 10-02						
<i>Lophius budegassa</i>		Y				Y (ESP)	Y (ESP)
<i>Aristeus antennatus</i>	Assessed 2011 STECF SGMED 11-08						
<i>Aristaeomorpha foliacea</i>				Y		N	N
<i>Boops boops</i>						N	N
<i>Spicara maena</i>						N	N
<i>Helicolenus dactylopterus</i>				Y		N	N
<i>Dicentrarchus labrax</i>						N	N
<i>Citharus linguatula</i>		Y		Y		N	N
<i>Sepia officinalis</i>		Y				N	N
<i>Chelidonichthys lastoviza</i>				Y		N	N
<i>Squalus acanthias</i>						N	N
<i>Coryphaena hippurus</i>						N	N
<i>Parapenaeus longirostris</i>	Y	Y				Y (ESP)	Y (ESP)
<i>Eledone moschata</i>						N	N
<i>Eledone cirrosa</i>				Y		Y	Y
<i>Phycis blennoides</i>		Y				N	N
<i>Eutrigla gurnardus</i>						N	N
<i>Aspitrigla cuculus</i>				Y		N	N
<i>Chelidonichthys lucerna</i>						N	N
<i>Merluccius merluccius</i>	Assessed 2011 STECF SGMED 11-08; 2011 SGMED 11-14						
<i>Trachurus mediterraneus</i>		Y		Y		N	N
<i>Trachurus trachurus</i>	Y	Y		Y		N	N
<i>Zeus faber</i>						N	N
<i>Lepidorhombus boscii</i>						N	N
<i>Scomber spp</i>		Y				N	N
<i>Lophius piscatorius</i>				Y		N	N
<i>Squilla mantis</i>						N	N
<i>Mugilidae</i>				Y		N	N
<i>Mullus surmuletus</i>	Y	Y		Y		Y (ESP)	Y (ESP)
<i>Mullus barbatus</i>	Assessed 2011 STECF SGMED 11-08; 2011 SGMED 11-14						
<i>Nephrops norvegicus</i>	Assessed 2012 STECF EWG 12-19						

<i>Octopus vulgaris</i>	Y	Y		Y		Y (ESP)	N
<i>Pagellus erythrinus</i>		Y		Y		N	N
<i>Sardina pilchardus</i>	Assessed 2010 STECF SGMED 10-02						
<i>Trisopterus minutus</i>						N	N
<i>Raja clavata</i>						N	N
<i>Rapana venosa</i>						N	N
<i>Pagellus acarne</i>		Y		Y		N	N
<i>Sparus aurata</i>						N	N
<i>Pagellus bogaraveo</i>				Y		N	N
<i>Galeus melastomus</i>		Y		Y		N	N
<i>Solea solea</i>		Y				N	N
<i>Spicara smaris</i>				Y		N	N
<i>Sprattus sprattus</i>						N	N
<i>Loligo spp</i>		Y				Y	N
<i>Illex coindetii</i>				Y		N	N
<i>Diplodus spp</i>		Y				N	N
<i>Scyliorhinus canicula</i>		Y		Y		N	N
<i>Penaeus kerathurus</i>						N	N
<i>Psetta maxima</i>						N	N
<i>Micromesistius poutassou</i>		Y		Y		Y (ESP)	Y (ESP)
<i>Merlangius merlangus</i>						N	N

10.2.2. Data coverage in GSA 5

Table 10.2.2.1 shows the available information on landings for GSA 5 (Balearic Islands) considering the two different periods of the Data Collection: DCR (2002-2008) and DCF (2009-2011). This table explains the availability of landings for each species and gear or métier. Empty cells mean that there are no landings for that species in the corresponding gear/métier. During the DCR, length sampling was based in stocks, while in the DCF, length sampling is based in the métier (concurrent sampling). In this sense, the last row of the table marks if each métier has been selected by the ranking system to be sampled during DCF. According to this, for all the species that has a Y in the previous rows for a selected métiers to be sampled should have length-frequency distributions available. However, as the sampled is based in the species, if the number of individuals caught during the samples was too low, the length frequency distribution cannot be considered as reliable.

Table 10.2.2.2 shows the summary of data available for GSA 5 by species, taking into account not only the length sampling obtained from the commercial fleet, but also information from surveys and biological information obtained in the stock-related sampling (maturity ogive, length-weight relationship and growth parameters). For each variable, a code of colors has been used: green if there is available information, yellow if there is some kind of information but it is not enough and red if there is no any information. The colors for the species column have the following meaning: white if the stock have been already assessed (in STECF-EWG or GFCM WG), green if there is enough data to perform a full assessment, yellow if there is some data that would potentially allow some kind of stock assessment to be performed and red if data cannot considered enough to perform an assessment.

In the case of the Balearic Islands (GSA 5), from the 20 species mentioned in the ToRs of this meeting, 6 have been already assessed, 8 do not have enough data to be assessed and 6 could be potentially assessed, with some limitations (one of this species, *L. budegassa* was assessed during this meeting).

Table 10.2.2.1 Landings information by gear (DCR: 2002-2008) or métier (DCF: 2009-2011) for GSA 5 (Balearic Islands).

Species	DCR (2002-2008)					DCF (2009-2011)						
	GNS	GTR	LA	OTB	PS	GNS	GTR	LA	OTB_DEMSP	OTB_DWSP	OTB_MDDWSP	PS
<i>S. pilchardus</i>				Y	Y				Y			Y
<i>E. encrasicolus</i>				Y	Y				Y			Y
<i>M. merluccius</i>				Y					Y	Y	Y	
<i>S. solea</i>		Y		Y		Y	Y		Y		Y	
<i>M. barbatus</i>		Y		Y			Y		Y		Y	
<i>P. longirostris</i>				Y					Y		Y	
<i>A. antennatus</i>				Y						Y	Y	
<i>A. foliacea</i>									Y	Y	Y	
<i>N. norvegicus</i>				Y					Y	Y	Y	
<i>L. budegassa</i>				Y					Y	Y	Y	
<i>L. picatorius</i>				Y					Y	Y	Y	
<i>P. erythrinus</i>		Y		Y		Y	Y		Y		Y	
<i>T. lucerna</i>												
<i>Trachurus</i> spp.				Y	Y				Y		Y	Y
<i>E. gurnardus</i>												
<i>M. poutassou</i>				Y	Y				Y	Y	Y	
<i>T. minutus</i>				Y					Y		Y	
<i>M. surmuletus</i>		Y		Y			Y		Y		Y	
<i>Spicara</i> spp		Y		Y	Y	Y			Y		Y	Y
<i>B. boops</i>		Y		Y	Y		Y		Y			Y
Is the métier selected for sampling?						N	Y	N	Y	Y	Y	N

Table 10.2.2.2 Summary data available for GSA 5 (Balearic Islands). Note: MEDIAS survey is not carried out in GSA 5.

Species	Lengths from commercial fleet			Bottom trawl surveys		Maturity ogive, length-weight	Growth parameters (otolith reading or others)
	DCR (2002-2008)	DCF (2009-2011)	Other projects	MEDITS (2007-2012)	Other surveys (BALAR, 2001-2006)		
<i>S. pilchardus</i>	No	No	No	Yes (pelagic)	Yes (pelagic)	No	No
<i>E. encrasicolus</i>	No	No	No	Yes (pelagic)	Yes (pelagic)	No	No
<i>M. merluccius</i>	Already assessed (STECF-EWG 2011, GFCM 2012)						
<i>S. solea</i>	No	No	No	5 individuals (2001-2011)		No	No
<i>M. barbatus</i>	Already assessed (STECF-EWG 2010, GFCM 2010)						
<i>P. longirostris</i>	Already assessed (STECF-EWG 2010, GFCM 2010)						
<i>A. antennatus</i>	Already assessed (GFCM 2012)						
<i>A. foliacea</i>	No	Only 2011	No	58 individuals (2001-2011)		No	No
<i>N. norvegicus</i>	Already assessed (STECF-EWG 2012, GFCM 2012)						
<i>L. budegassa</i>	Yes	Yes	No	Yes	Yes	Yes (ESP)	Yes (ESP)
<i>L. picatorius</i>	Yes	Yes	No	Yes	Yes	No	No
<i>P. erythrinus</i>	No	Yes	No	Yes	Yes	No	No
<i>T. lucerna</i>	No	No	No	9 individuals (2001-2011)		No	No
<i>Trachurus spp.</i>	No	Only OTB (36%)	Maybe (only OTB)	Yes (pelagic)	Yes (pelagic)	Maybe	Maybe
<i>E. gurnardus</i>	No	No	No	16 individuals (2001-2011)		No	No
<i>M. poutassou</i>	No	Yes	Maybe (2002-2008)	Yes	Yes	Yes (ESP)	Yes (ESP)
<i>T. minutus</i>	No	Yes	Maybe (2002-2008)	Yes	Yes	No	No
<i>M. surmuletus</i>	Already assessed (STECF-EWG 2010, GFCM 2012)						
<i>Spicara spp</i>	No	Only OTB (85%)	Maybe (2002-2008)	Yes	Yes	No	No
<i>B. boops</i>	No	No	No	Yes (pelagic)	Yes (pelagic)	No	No

10.2.3. Data coverage in GSA 6

The following table 10.2.3.1 displays the species (rows) in the DCR/DCF lists and the fishing gear / metier combination responsible for the bulk of catches (columns) in GSA06. This table shows that bottom otter trawl (OTB) catches the largest variety of species (almost all listed are observed in the catches of OTB). On the other hand, almost all species appear in the catches of 2 or more fishing gears. In particular, demersal species such as *Merluccius merluccius*, *Lophius* sp., *Sepia officinalis*, *Loligo vulgaris* and most sparids (*Pagellus* sp., *Sparus aurata*) are caught simultaneously by bottom trawl and set gears (gillnets, trammel nets and longlines) resulting in technical interactions that may complicate assessing the stock status of these species. The most important fishing techniques, in terms of catch volume, are selected for sampling. For some species, the length frequency distributions are representative of the whole landings (100%), while for other species the coverage is low or incomplete one or more métiers were not sampled for demography (particularly species caught by set nets in DCR 2002-2008). Length frequency sampling cover now (DCF 2009-2011) the most significant fishing gear /metier combinations in GSA06.

Table 10.2.3.1 Landings information by gear (DCR: 2002-2008) or métier (DCF: 2009-2011) for GSA 6 (Northern Spain). Y indicates data availability whereas N means absence. Empty cells mean no landings information.

	DCR (2002-2008)								DCF (2009-2011)								
	FP O	G N S	G T R	L A	L L D	L L S	O T B	P S	F P O	G N S	G T R	L A	L L D	L L S	OTB_ DEMS P	OTB_ DWS P	OTB_M DDWS P
<i>Engraulis encrasicolus</i>							Y	Y		Y				Y		Y	Y
<i>Lophius budegassa</i>		Y	Y				Y		Y	Y	Y		Y	Y	Y	Y	
<i>Aristeus antennatus</i>							Y								Y	Y	
<i>Aristaeomorpha foliacea</i>																	
<i>Boops boops</i>			Y				Y	Y	Y	Y			Y	Y		Y	Y
<i>Spicara maena</i>							Y							Y			
<i>Helicolenus dactylopterus</i>			Y			Y	Y		Y	Y			Y	Y	Y	Y	
<i>Dicentrarchus labrax</i>		Y	Y			Y	Y	Y	Y	Y			Y	Y		Y	Y
<i>Citharus linguatula</i>		Y	Y				Y		Y	Y	Y		Y	Y	Y	Y	
<i>Sepia officinalis</i>	Y	Y	Y				Y		Y	Y	Y		Y	Y		Y	
<i>Chelidonichthys lastoviza</i>																	

<i>Squalus acanthias</i>																		
<i>Coryphaena hippurus</i>			Y		Y	Y	Y	Y		Y	Y		Y	Y	Y			Y
<i>Parapenaeus longirostris</i>							Y							Y			Y	
<i>Eledone moschata</i>																		
<i>Eledone cirrosa</i>							Y		Y	Y	Y			Y	Y	Y		
<i>Phycis blennoides</i>							Y		Y	Y	Y		Y	Y	Y	Y		
<i>Eutrigla gurnardus</i>							Y			Y				Y	Y	Y		
<i>Aspitrigla cuculus</i>										Y			Y	Y			Y	
<i>Chelidonichthys lucerna</i>			Y			Y	Y		Y	Y	Y		Y	Y			Y	
<i>Merluccius merluccius</i>		Y				Y	Y			Y	Y		Y	Y	Y	Y		
<i>Trachurus mediterraneus</i>							Y	Y	Y	Y	Y		Y	Y			Y	Y
<i>Trachurus trachurus</i>		Y	Y				Y	Y	Y	Y	Y		Y	Y			Y	Y
<i>Zeus faber</i>		Y	Y			Y	Y			Y	Y		Y	Y	Y	Y		
<i>Lepidorhombus boscii</i>							Y							Y	Y	Y		
<i>Scomber spp</i>		Y	Y				Y	Y		Y	Y		Y	Y			Y	Y
<i>Lophius piscatorius</i>							Y							Y	Y	Y		
<i>Squilla mantis</i>	Y		Y				Y		Y	Y	Y			Y			Y	
<i>Mugilidae</i>		Y	Y				Y	Y	Y	Y	Y		Y	Y				Y
<i>Mullus surmuletus</i>			Y				Y		Y	Y	Y		Y	Y			Y	
<i>Mullus barbatus</i>			Y				Y		Y	Y	Y		Y	Y			Y	
<i>Nephrops norvegicus</i>							Y							Y	Y	Y		
<i>Octopus vulgaris</i>	Y	Y	Y			Y	Y		Y	Y	Y		Y	Y			Y	
<i>Pagellus erythrinus</i>		Y	Y			Y	Y	Y		Y	Y		Y	Y			Y	Y
<i>Sardina pilchardus</i>							Y	Y		Y				Y			Y	Y
<i>Trisopterus minutus</i>							Y			Y	Y			Y	Y	Y		
<i>Raja clavata</i>			Y			Y	Y				Y			Y				
<i>Rapana venosa</i>																		
<i>Pagellus acarne</i>		Y	Y			Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y
<i>Sparus aurata</i>		Y	Y			Y	Y	Y	Y	Y	Y		Y	Y			Y	Y

<i>Pagellus bogaraveo</i>		Y	Y			Y	Y	Y		Y	Y			Y	Y	Y	Y	
<i>Galeus melastomus</i>							Y			Y	Y			Y	Y	Y	Y	
<i>Solea solea</i>		Y	Y				Y		Y	Y	Y			Y	Y			
<i>Spicara smaris</i>							Y			Y					Y			
<i>Sprattus sprattus</i>																		
<i>Loligo spp</i>			Y			Y	Y	Y	Y	Y	Y			Y	Y	Y	Y	Y
<i>Illex coindetii</i>							Y								Y	Y	Y	
<i>Diplodus spp</i>		Y	Y			Y	Y	Y	Y	Y	Y			Y	Y	Y	Y	Y
<i>Scyliorhinus canicula</i>							Y			Y	Y			Y	Y	Y	Y	
<i>Penaeus kerathurus</i>	Y		Y				Y		Y		Y				Y			
<i>Psetta maxima</i>			Y				Y			Y	Y			Y	Y			
<i>Micromesistius poutassou</i>							Y	Y							Y	Y	Y	
<i>Merlangius merlangus</i>																		
Is the métier selected for sampling?	Y	N	Y	N	N	N	Y	Y	N	Y	Y	N	N	Y	Y	Y	Y	Y

The table 10.2.3.2 reports the coverage of the size frequency distributions with respect to the total landings (first three columns). Most stocks for which sufficient length frequency data exists have been assessed at least once in the past 3 years (2010-2012), green rows. There remain some species for which length frequency data and survey data exists but have not been assessed so far, but these are species of minor commercial importance in GSA 06. Nevertheless, *Mullus surmuletus*, *Pagellus erythrinus* and the cephalopods *Octopus vulgaris*, *Loligo vulgaris* and *Sepia officinalis* deserve attention in upcoming assessments. Biological data (maturity ogive, growth parameters) are in general very scarce and has already been used for stocks assessed in the past three years.

Table 10.2.3.2. Summary data availability for GSA 6 (Northern Spain). Y (yes) indicate data availability whereas N (No) means absence. Y(ESP) signify Biological data available through Spanish National Plan.

	Lengths from commercial fleet			Bottom surveys		Maturity ogive, length-weight	Growth parameters (otolith reading or others)
	DCR	DCF	Other Projects	MEDITS (2007-2012)	Other surveys		
<i>Engraulis encrasicolus</i>	Assessed 2010 STECF SGMED 10-02						
<i>Lophius budegassa</i>	Assessed 2012 STECF EWG 12- 10						
<i>Aristeus antennatus</i>	Assessed 2010 STECF SGMED 10-02; 2012 STECF EWG 12- 10						
<i>Aristaeomorpha foliacea</i>						N	N
<i>Boops boops</i>				Y		N	N
<i>Spicara maena</i>						N	N
<i>Helicolenus dactylopterus</i>		Y		Y		N	N
<i>Dicentrarchus labrax</i>						N	N
<i>Citharus linguatula</i>				Y		N	N
<i>Sepia officinalis</i>						N	N
<i>Chelidonichthys lastoviza</i>				Y		N	N
<i>Squalus acanthias</i>						N	N
<i>Coryphaena hippurus</i>						N	N
<i>Parapenaeus longirostris</i>	Assessed 2010 STECF SGMED 10-02; 2011 EWG 11-12						
<i>Eledone moschata</i>						N	N
<i>Eledone cirrosa</i>	Y	Y		Y		Y	Y
<i>Phycis blennoides</i>		Y		Y		N	N
<i>Eutrigla gurnardus</i>		Y		Y		N	N
<i>Aspitrigla cuculus</i>				Y		N	N
<i>Chelidonichthys lucerna</i>				Y		N	N
<i>Merluccius merluccius</i>	Assessed 2010 STECF SGMED 10-02; 2011 EWG 11-12						
<i>Trachurus mediterraneus</i>		Y		Y		N	N
<i>Trachurus trachurus</i>		Y		Y		N	N
<i>Zeus faber</i>						N	N
<i>Lepidorhombus boscii</i>		Y		Y		N	N
<i>Scomber spp</i>		Y				N	N
<i>Lophius piscatorius</i>		Y		Y		N	N
<i>Squilla mantis</i>						N	N
<i>Mugilidae</i>						N	N
<i>Mullus surmuletus</i>	Y	Y		Y		Y (ESP)	Y (ESP)
<i>Mullus barbatus</i>	Assessed 2010 STECF SGMED 10-02; 2011 EWG 11-12						
<i>Nephrops norvegicus</i>	Assessed 2012 STECF EWG 12- 19						

<i>Octopus vulgaris</i>				Y		Y (ESP)	N
<i>Pagellus erythrinus</i>		Y		Y		N	N
<i>Sardina pilchardus</i>	Assessed 2010 STECF SGMED 10-02						
<i>Trisopterus minutus</i>		Y		Y		N	N
<i>Raja clavata</i>						N	N
<i>Rapana venosa</i>						N	N
<i>Pagellus acarne</i>				Y		N	N
<i>Sparus aurata</i>						N	N
<i>Pagellus bogaraveo</i>				Y		N	N
<i>Galeus melastomus</i>				Y		N	N
<i>Solea solea</i>						N	N
<i>Spicara smaris</i>		Y		Y		N	N
<i>Sprattus sprattus</i>						N	N
<i>Loligo spp</i>				Y		Y	N
<i>Illex coindetii</i>		Y		Y		N	N
<i>Diplodus spp</i>						N	N
<i>Scyliorhinus canicula</i>				Y		N	N
<i>Penaeus kerathurus</i>						N	N
<i>Psetta maxima</i>						N	N
<i>Micromesistius poutassou</i>	Assessed in 2012 STECF EWG 12-10						
<i>Merlangius merlangus</i>						N	N

10.2.4. Data coverage in GSA 7

Table 10.2.4.1 shows the available information on landings by gear (DCR: 2002-2008) or métier (DCF: 2009-2011) for GSA 7 (Gulf of Lions).

This table provides the availability of landings for each species and gear or métier. Empty cells mean that there are no landings for that species in the corresponding gear/métier. During the DCR, length sampling was based on stocks, whereas in the DCF, length sampling is based on the métier (concurrent sampling). In this sense, the last line of the table marks if each métier has been selected by the ranking system to be sampled during DCF. According to this, for all the species that has a Y in the previous rows for a selected métiers to be sampled should have length-frequency distributions available. However, as the sampled is based on the species, if the number of individuals caught during the samples was too low, the length frequency distribution cannot be considered as reliable.

The Table 10.2.4.2 shows the summary of data available for GSA 7 by species, taking into account not only the length sampling obtained from the commercial fleet, but also information from surveys and biological information obtained in the stock-related sampling (maturity ogive, length-weight relationship and growth parameters). For each variable, a code of colors has been used: green if there is available information, yellow if there is some kind of information but it is not enough and red if there is no information. The colors for the species column have the following meaning: white if the stock have been already assessed (in STECF-EWG or GFCM WG), green if there is enough data to perform a full assessment, yellow if there is some data that would potentially allow some kind of stock assessment to be performed and red if data cannot considered enough to perform an assessment.

Table 10.2.4.3 shows that, in the case of the Gulf of Lions (GSA 7), out of the 22 species mentioned in the ToRs of this meeting, 5 have already been assessed, 16 do not have enough data to be assessed and 3 (*S. aurata*, *D. labrax*, *M. surmuletus*) could be potentially assessed in 2 years, with some limitations mentioned in the comments row.

Table 10.2.4.1 Landings information by gear (DCR: 2002-2008) or métier (DCF: 2009-2011) for GSA 7 (Gulf of Lions)

Species	DCR (2002-2008)					DCF (2009-2011)							
	GNS	GTR	OTM	OTB	PS	GNS_DEF _0_0_0	GTR_DEF >=16_0_0	LLS_DEF _0_0_0	OTB_DES _>=40_0_0	OTM_SPF _>=20_0_0	DRB_MO L_0_0_0	PS_SPF_> =14_0_0	FYK_CAT _0_0_0
<i>S. pilchardus</i>			Y							Y		Y	
<i>E. encrasicolus</i>			Y							Y			
<i>M. merluccius</i>	Y		Y	Y		Y	Y		Y	Y			
<i>S. solea</i>				Y		Y (2010-2011)			Y		Y(2011)		Y
<i>M. barbatus</i>				Y		Y(2011)			Y				
<i>P. longirostris</i>				Y					Y				
<i>A. antennatus</i>				Y					Y				
<i>A. foliacea</i>				Y					Y				
<i>N. norvegicus</i>				Y					Y				
<i>L. budegassa</i>				Y					Y				
<i>L. picatorius</i>				Y					Y				
<i>Pagellus spp.</i>				Y		Y (2010-2011)			Y				
<i>Triglidae</i>				Y		Y (2010-2011)			Y				
<i>Trachurus spp.</i>				Y		Y (2010-2011)		Y	Y			Y	
<i>M. poutassou</i>				Y					Y				
<i>T. minutus</i>				Y					Y				
<i>M. surmuletus</i>				Y		Y(2011)			Y				
<i>Spicara spp</i>				Y					Y				
<i>B. boops</i>				Y					Y				
Is the métier selected for sampling?						Y	Y	Y	Y	Y	Y	Y	Y

Table 10.2.4.2 Summary of data availability in GSA 7.

GSA7	MS	Lengths from commercial fleet		Bottom trawl surveys	Maturity ogive, length-weight	Growth parameters (otolith reading or others)
Species		DCR (2002-2008)	DCF (2009-2011)	MEDITS (1994-2012) <u>Carried out by FR</u>		
<i>S. pilchardus</i>	FR	Already assessed based on Echosurvey (GFCM 2012)				
	SP	No	Yes (2009-2010), OTB		No	No
<i>E. encrasicolus</i>	FR	Already assessed based on Echosurvey (GFCM 2012)				
	SP	No	Yes, OTB		No	No
<i>M. merluccius</i>		Already assessed (STECF-EWG 2012, GFCM 2012)				
<i>S. solea</i>	FR	No	OTB: 2009-2011 GNS, GTR: 2011 Dredges: 2011	Not useful	No	No
	SP	No	Yes (OTB)		No	No
<i>M. barbatus</i>		Already assessed (STECF-EWG 2012, GFCM 2012)				
<i>P. longirostris</i>	FR	No	No	Yes (scarce)	No	No
	SP	No	Yes (OTB < 1 t)		No	No
<i>A. antennatus</i>	FR	No	No	Yes (scarce)	No	No
	SP	No	Yes		No	No
<i>A. foliacea</i>	FR	No	No	Yes (scarce)	No	No
	SP	No	No		No	No
<i>N. norvegicus</i>	FR	No	No	Yes	No	No
	SP	No	Yes		No	No
<i>L. budegassa</i>	FR	Already assessed (STECF-EWG 2012, GFCM 2012) , BUT growth and maturity parameters borrowed from GSA6				
	SP					
<i>L. piscatorius</i>	FR	Yes (2005-2011)	Yes	Yes (identification problems for juveniles, confusion with <i>L.budegassa</i> over 1994-2008)	No	No
	SP	Yes	Yes		No	No
<i>P. erythrinus</i>	FR	No	No	Yes	No	No

	SP	No	Yes (1-6 t/year)		No	No
<i>T. lucerna</i>	FR	No	No	Yes (scarce)	No	No
	SP	No	Yes (OTB, LLS 5-8 t/years)		No	No
<i>Trachurus spp.</i>	FR	No	No	Yes (pelagic)	No	No
	SP	No	Yes (OTB)		No	No
<i>E. gurnardus</i>	FR	No	No	Yes	No	No
	SP	No	No		No	No
<i>M. poutassou</i>	FR	No	No	Yes	No	No
	SP	No	Yes (OTB)		No	No
<i>T. minutus</i>	FR	No	No	Yes	No	No
	SP	No	Yes		No	No
<i>M. surmuletus</i>	FR	Yes (OTB) GNS 2011	Yes (OTB) GNS 2011	Yes	Yes (2006-2008)	Yes (2006-2008)
	SP	Yes (OTB) No small-scale	Yes (OTB) No small-scale		No	No
<i>Spicara spp</i>	FR	No	No	Yes	No	No
	SP	No	No		No	No
<i>B. boops</i>	FR	No	No	Yes	No	No
	SP	No	No		No	No
<i>S. aurata</i>	FR	OTB: 2002-2008	OTB: 2009-2011 GNS, GTR: 2010-2011 LLS, FYK: 2011	Yes (scarce)	Yes (2006-2011)	Yes (2006-2011)
	SP	No	No		No	No
<i>D. labrax</i>	FR	OTB: 2002-2008	OTB: 2009-2011 GNS, GTR, LLS: 2010-2011 FYK: 2011	Yes (scarce)	Yes (only 2 years 2006-2007)	Yes (only 2 years, 2006-2007)
	SP	No	No		No	No

Table 10.2.4.3 Summary of stocks' assessment status in GSA 7.

Species order for future assessments	Length-weight	Maturity ogive	Growth parameters	Comments
<i>S.aurata</i>	Yes (FR), but only OTB(2002-2008), very FEW small scale fisheries (2010-2011)	Yes (FR) only 2006-2011	Yes (FR) only 2006-2011	Very few small scale fisheries data (length and catches, 2 years), no data on recreational fishing. No SP data
<i>D. Labrax</i>	Yes (FR), but only OTB(2002-2008), few Small scale fisheries (2010-2011)	Yes (FR) only 2 years 2006-2007	Yes (FR) only 2 years 2006-2007	Very few small scale fisheries data (length and catches, 2 years). Only 2 years for growth and maturity parameters. No SP data
<i>M. surmuletus</i>	Yes (FR) but only OTB, (2002-2008) few Small scale fisheries (2011)	Yes (FR) only 2 years 2006-2008	Yes (FR) only 2 years 2006-2008	Very few small scale fisheries data (length and catches). 3 years for growth and maturity parameters. No SP data
<i>L. piscatorius</i>	Yes OTB (FR +SP) 2005-2011	No	No	Ok for lengths of OTB, but No other parameters. No SP data
<i>S. solea</i>	Yes (FR+SP) but only OTB (2009-2011) few Small scale fisheries (2011)	No	No	Only 3 years for OTB, few data of small scale fisheries (2011). No other parameters. No SP data

10.2.5. Data coverage in GSA 9

Landings information by métier for GSA 9 (Ligurian and North Tyrrhenian Sea)

In table 10.2.5.1 is reported the list of the DCR/DCF target species (rows) and the different métiers selected in the GSA 9 for biological sampling (columns). The green cells indicate the presence of the landing of that species and the percentage represents the contribution to the total biomass landed by each métier. For some species, indicated in red cells, landing data are not available because the species are landed in mixed boxes and not detected in the national sampling.

Table 10.2.5.1 - Percentage of contribution to the total landing of the selected métiers in the GSA 9. Empty cells mean no landings.

Species	DCR (2006-2008)						DCF (2009-2011)					
	GNS	GTR	OTB_DEM	OTB_DW	OTB_MDDW	PS	GNS	GTR	OTB_DEM	OTB_DW	OTB_MDDW	PS
<i>A. antennatus</i>				15%	85%					51%	49%	
<i>A. foliacea</i>				7%	93%					22%	78%	
<i>A. cuculus</i> G3												
<i>B. boops</i>	24%	3%	22%		29%	22%	24%	6%	31%		5%	33%
<i>C. linguatula</i> G3												
<i>abrax</i>	42%	22%	17%		18%		15%	43%	38%		4%	
<i>Diplodus</i> spp.	51%	27%	8%		14%		48%	27%	23%		1%	1%
<i>L. cirrhosa</i>			56%		44%				87%		13%	
<i>E. encrasicolus</i>			1%		2%	96%			3%			97%
<i>E. gurnardus</i>	42%	1%	29%		28%				99%		1%	
<i>L. moschata</i>			58%		41%				87%		13%	
<i>H. dactylopterus</i> G3												
Ommastrephidae	5%		43%		48%	4%	3%		79%		17%	
<i>L. boscii</i> G3												
<i>L. budegassa</i>	1%		42%		56%				85%		14%	
<i>L. piscatorius</i>	5%	1%	51%		42%		5%	3%	63%	3%	27%	
<i>L. vulgaris</i>	17%		52%		30%		8%		80%		11%	
<i>M. barbatus</i>		1%	52%		46%		1%	5%	86%		8%	
<i>M. merluccius</i>	29%	11%	29%		31%		36%	4%	50%		10%	
<i>M. poutassou</i>	5%		26%		69%				61%	2%	37%	
<i>M. surmuletus</i>	45%	34%	12%		9%		32%	47%	20%		1%	

Mugilidae	43%	26%	10%		11%	10%	38%	18%	32%		2%	11%
<i>N. norvegicus</i>			28%		72%				55%	1%	44%	
<i>O. vulgaris</i>	19%	20%	38%		23%		22%	22%	49%		6%	
<i>P. acarne</i> G3												
<i>P. blennoides</i>	8%	18%	16%	1%	57%		6%	15%	36%	5%	38%	
<i>P. bogaraveo</i> G3												
<i>P. erythrinus</i>	36%	18%	22%		24%		16%	21%	55%		8%	
<i>P. longirostris</i>			36%		64%				72%	1%	27%	
<i>P. kerathurus</i>	5%	10%	61%		23%		1%	2%	89%		9%	
<i>R. clavata</i>	20%	4%	38%		38%		31%	7%	50%		11%	
<i>S. aurata</i>	34%	29%	15%		16%	6%	38%	25%	27%		3%	7%
<i>S. canicula</i>			45%		54%		3%	4%	64%	5%	24%	
<i>Scomber</i> spp.	12%	4%	12%		6%	66%	16%	4%	19%		4%	57%
<i>S. flexuosa</i> G3												
<i>S. mantis</i>	13%	3%	54%		29%		3%	1%	86%		10%	
<i>S. officinalis</i>	19%	40%	29%		13%		10%	41%	44%		5%	
<i>S. pilchardus</i>			1%			99%			1%			99%
<i>S. smaris</i>	98%				2%		83%	1%	11%		2%	3%
<i>S. solea</i>	33%	28%	22%		17%		26%	31%	40%		3%	
<i>T. lastoviza</i> G3												
<i>T. lucerna</i>	20%	3%	42%		35%		10%	3%	77%		11%	
<i>T. mediterraneus</i>	22%	7%	24%		26%	21%	5%	18%	41%	1%	15%	20%
<i>T. minutus</i>	2%		51%		47%				91%		9%	

<i>T. trachurus</i>	24%	4%	29%		25%	17%	14%	5%	47%		10%	24%
<i>Z. faber</i>	3%	16%	45%		36%		3%	1%	87%		10%	
Is the métier selected for sampling?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

The Table 10.2.5.2 displays the percentage of coverage of the size frequency distributions with respect to the total landing. Biological data useful for stock assessments are available since 2006. For some species, the length frequency distributions are representative of the whole landing (100%). For other species the coverage is lower because one or more métiers were not sampled for demography. For other species demographic structure is not available due to the low number of specimens measured.

Table 10.2.5.2. Percentage of coverage of the size frequency distributions with respect to the total landings.

	0-39% of coverage		40-69% of coverage		70-100% of coverage
--	-------------------	--	--------------------	--	---------------------

Species	2006	2007	2008	2009	2010	2011
<i>A. antennatus</i>	100%	100%	51%	100%	100%	100%
<i>A. foliacea</i>	100%	100%	72%	100%	100%	74%
<i>A. melanostomus</i>	0%	0%	0%	0%	0%	0%
<i>B. boops</i>	20%	0%	0%	29%	32%	48%
<i>C. Linguatula</i>	0%	0%	0%	0%	0%	0%
<i>D. labrax</i>	0%	0%	0%	0%	0%	0%
<i>Diplodus</i> spp.	0%	0%	0%	0%	0%	0%
<i>E. cirrhosa</i>	44%	99%	100%	100%	100%	100%
<i>E. encrasicolus</i>	97%	96%	92%	95%	98%	98%
<i>E. gurnardus</i>	0%	0%	0%	0%	0%	0%
<i>E. moschata</i>	33%	46%	0%	91%	99%	0%
<i>G. melastomus</i>	0%	0%	0%	0%	100%	100%
<i>H. dactylopterus</i>	0%	0%	0%	0%	0%	0%
Ommastrephidae	22%	41%	0%	97%	93%	86%
<i>L. boschii</i>	0%	0%	0%	0%	0%	0%
<i>L. budegassa</i>	0%	0%	0%	0%	0%	0%
<i>L. piscatorius</i>	0%	0%	0%	0%	0%	0%
<i>L. vulgaris</i>	33%	45%	82%	100%	92%	75%
<i>M. barbatus</i>	35%	100%	88%	92%	88%	93%
<i>M. merluccius</i>	100%	100%	91%	100%	100%	95%
<i>M. poutassou</i>	0%	0%	0%	0%	97%	97%
<i>M. surmuletus</i>	48%	9%	99%	99%	100%	56%
Mugilidae	0%	0%	0%	0%	0%	0%
<i>N. norvegicus</i>	100%	100%	100%	100%	98%	98%
<i>O. vulgaris</i>	29%	51%	0%	0%	81%	47%
<i>P. acarne</i>	0%	0%	0%	0%	0%	0%
<i>P. blennoides</i>	0%	0%	0%	0%	82%	76%
<i>P. bogaraveo</i>	0%	0%	0%	0%	0%	0%
<i>P. erythrinus</i>	68%	100%	96%	97%	83%	84%
<i>P. longirostris</i>	100%	99%	100%	100%	98%	98%

<i>P. kerathurus</i>	95%	0%	0%	98%	98%	0%
<i>R. clavata</i>	0%	0%	0%	0%	0%	0%
<i>S. aurata</i>	0%	0%	0%	0%	0%	0%
<i>S. canicula</i>	0%	0%	0%	0%	0%	0%
<i>Scomber</i> spp.	0%	0%	0%	0%	32%	0%
<i>S. flexuosa</i>	0%	0%	0%	0%	0%	0%
<i>S. mantis</i>	0%	34%	84%	94%	100%	88%
<i>S. officinalis</i>	63%	67%	80%	96%	100%	87%
<i>S. pilchardus</i>	99%	99%	98%	99%	99%	99%
<i>S. smaris</i>	0%	0%	0%	0%	11%	5%
<i>S. solea</i>	40%	42%	0%	99%	94%	24%
<i>T. lastoviza</i>	0%	0%	0%	0%	0%	0%
<i>T. lucerna</i>	26%	0%	0%	98%	76%	75%
<i>T. mediterraneus</i>	14%	0%	0%	66%	59%	42%
<i>T. minutus</i>	11%	0%	0%	0%	79%	95%
<i>T. trachurus</i>	18%	25%	85%	71%	84%	67%
<i>Z. faber</i>	0%	0%	0%	0%	0%	0%

In the following Table 10.2.5.3 is reported the list of the species already assessed in GSA 9 during the SGMED/EWGs. Information on the data sets used for the fishing mortality estimation is also reported. A total of 15 species have been assessed, 2 small pelagic fishes, 5 crustaceans, 7 bony fishes and 1 cartilaginous fish.

Table 10.2.5.3 - Species already assessed in GSA9

Species	Group	Assessment (last revision)	Data set used for F estimation	
<i>A. antennatus</i>	G1	STECF-EWG 11-12	Commercial catches	
<i>A. foliacea</i>	G1	STECF-EWG 11-12	Commercial catches	
<i>E. encrasicolus</i>	G1	STECF-EWG 11-12	Commercial catches	
<i>G. melastomus</i>	G1	STECF-EWG 11-12	Commercial catches	
<i>M. barbatus</i>	G1	STECF-EWG 11-12	Commercial catches	
<i>M. merluccius</i>	G1	STECF-EWG 11-12	Commercial catches	Meditis
<i>M. poutassou</i>	G2	STECF-EWG 12-10	Commercial catches	Meditis
<i>M. surmuletus</i>	G1	STECF-EWG 11-12	Commercial catches	
<i>N. norvegicus</i>	G1	STECF-EWG 11-12	Commercial catches	Meditis
<i>P. blennoides</i>	G3	STECF-EWG 12-19	Commercial catches	Meditis
<i>P. erythrinus</i>	G2	STECF-EWG 11-12	Commercial catches	
<i>P. longirostris</i>	G1	STECF-EWG 11-12	Commercial catches	Meditis
<i>S. mantis</i>	G2	STECF-EWG 11-12	Commercial catches	
<i>S. pilchardus</i>	G1	STECF-EWG 12-10	Commercial catches	
<i>T. minutus</i>	G3	STECF-EWG 12-10	Commercial catches	Meditis

In Table 10.2.3.4 is reported the list of species for which it will possible to perform new stock assessments in the future. The species are represented by 4 cephalopods (Ommastrephidae is mainly *Illex coindetii*) and 2 bony fishes.

Table 10.2.5.4 - Species available for assessment in GSA9

Species	ip	Data set available	
<i>E. cirrhosa</i>		Commercial catches	Medit
Ommastrephidae		Commercial catches	Medit
<i>L. vulgaris</i>		Commercial catches	Medit
<i>S. officinalis</i>		Commercial catches	Medit
<i>T. lucerna</i>		Commercial catches	Medit
<i>T. trachurus</i>		Commercial catches	Medit

10.2.6. Data coverage in GSA 15

Table 10.2.6.1 gives an overview of landings data by species and applicable gears sampled under the DCR in 2005-2008, and subsequently applicable metiers sampled under the DCF in 2009-2011. Although national statistics do contain some landings data prior to Malta's accession to the EU in 2005, the format of the data is different and information is thus only of limited use. Since the introduction of the DCF metiers are selected for sampling based on the annual ranking system; the metiers pots and traps (FPO) and trammel nets (GTR) were for the first time selected in 2011.

Table 10.2.6.1 Landings information by gear (DCR: 2005-2008) or métier (DCF: 2009-2011) for GSA 15 (Malta). Empty cells mean no landings.

Species	DCR (2005-2008)							DCF (2009-2011)								
	FPO	GNS	GTR	LA	LLS	OTB	PS	FPO	GNS	GTR	LA	LLS	PS	OTB_DEMSP	OTB_DWSP	OTB_MDDWSP
<i>A. antennatus</i>															Y	Y
<i>A. foliacea</i>						Y									Y	Y
<i>B. boops</i>	Y	Y	Y			Y	Y	Y	Y	Y			Y	Y		Y
<i>E. encrasicolus</i>						Y	Y						Y			
<i>E. gurnardus</i>																Y
<i>L. budegassa</i>						Y								Y	Y	Y
<i>L. picatorius</i>						Y								Y	Y	Y
<i>M. barbatus</i>			Y			Y								Y		Y
<i>M. merluccius</i>		Y	Y		Y	Y			Y	Y		Y		Y	Y	Y
<i>M. poutassou</i>						Y						Y		Y	Y	Y
<i>M. surmuletus</i>		Y	Y			Y			Y	Y				Y		Y
<i>N. norvegicus</i>						Y								Y	Y	Y
<i>P. erythrinus</i>			Y		Y	Y				Y		Y		Y		Y
<i>P. longirostris</i>						Y								Y	Y	Y
<i>S. pilchardus</i>						Y	Y						Y			
<i>S. solea</i>																
<i>Spicara spp</i>	Y		Y			Y		Y		Y				Y		Y
Triglidae					Y	Y						Y				
<i>Trachurus spp.</i>		Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y		
Is metier selected for sampling?								Since 2011	N	Since 2011	Y	Y	N	Y	Y	Y

The Table 10.2.6.2 gives a summary of data availability for stock assessments in terms of (1) commercial length frequency distributions, (2) trawl survey data and (3) biological stock related parameters. Under the Data Collection Regulation (Regulations (EC) 1639/2001; (EC) 1543/2000) Malta collected biological data for three species, namely, bluefin tuna, swordfish and dolphinfish. When the currently applicable Data Collection Framework (Regulations (EC) 199/2008; (EC) 665/2008 and (EC) 93/2010) came into force, the concept of the métier-based approach was introduced and thus length sampling began for more species. For the gears selected via the annual ranking system, length samples are available for Group 1 species since 2009 and Group 2 / 3 species since 2011.

It is noted that the data may not be sufficient for stock assessment purposes for several reasons:

- For some species, the length frequency distributions are representative of the total landings, whilst for other species the coverage is lower because one or more métiers fishing the same species were not sampled for selected by the DCF ranking.
- Biological stock related variables are only available for a limited number of species since annual landings for the vast majority of species targeted by Maltese fishers constitute less than 200 tonnes and / or less than 10% of the total Community landings from the Mediterranean Sea.
- The total number of individuals sampled for both demographic structure and biological stock related variables depends on the frequency of occurrence of the species in catches.

Finally in addition to the short and patchy nature of the data available for GSA 15, it is not possible to analyse Maltese data by itself for the species listed. Instead GSA 15 data availability needs to be cross-checked with GSA 12-14 and GSA 16 data availability depending on the species being considered.

Stock assessments have already been carried out for most of the species for which sufficient data is available: giant red shrimp (STECF EWG 11-12, 12-19), black bellied anglerfish (STECF EWG 12-10), red mullet (STECF EWG 12-10), hake (in collaboration with Tunisian scientists under the auspices of the FAO regional project MedSudMed / at the GFCM demersal working groups in 2011 and 2012), common Pandora (STECF 12-10) and pink shrimp (in collaboration with Tunisian scientists under the auspices of the FAO regional project MedSudMed / at GFCM demersal working groups in 2010-2012). Species for which GSA 15 data is available but which have not yet been assessed are: striped red mullet, Norway lobster and red shrimp. However all three stocks are exploited by Sicilian fishermen and thus can not be assessed for GSA 15 in isolation.

Table 10.2.6.2 Summary of data availability in GSA 15. NB: Listed species are shared stocks.

Species	Lengths from commercial fleet		MEDITS	Maturity oogive, length-weight	Growth parameters
	DCR (2005-2008)	DCF (2009-2011)			
<i>A. antennatus</i>	No	Few samples	Few samples	Few samples	No
<i>A. foliacea</i>	Already assessed (STECF EWG 11-12, 12-19)				
<i>B. boops</i>	No	FPO, GTR since 2011	Yes (pelagic)	FPO, GTR since 2011	No
<i>E. encrasicolus</i>	No	No	Yes (pelagic)	No	No
<i>E. gurnardus</i>	No	Few samples	Yes	No	No
<i>L. budegassa</i>	Already assessed (STECF EWG 12-10)				
<i>L. picatorius</i>	No	Few samples	Yes	No	No
<i>M. barbatus</i>	Already assessed (STECF EWG 12-10)				
<i>M. merluccius</i>	Already assessed (MedSudMed / GFCM 2011, 2012)				
<i>M. poutassou</i>	No	Few samples	Yes	No	No
<i>M. surmuletus</i>	No	Yes	Yes	Yes	No
<i>N. norvegicus</i>	No	Yes	Yes	Yes	No
<i>P. erythrinus</i>	Already assessed (STECF EWG 12-10)				
<i>P. longirostris</i>	Already assessed (MedSudMed / GFCM 2011, 2012)				
<i>S. pilchardus</i>	No	No	Yes (pelagic)	No	No
<i>S. solea</i>	No	No	Yes	No	No
<i>Spicara spp.</i>	No	FPO, GTR since 2011	Yes	FPO, GTR since 2011	No
Triglidae	No	Few samples	Yes	No	No
<i>Trachurus spp.</i>	No	Few samples	Yes (pelagic)	No	No

10.2.7. Data coverage in GSA 17

Table 10.2.7.1. Landings information by gear (DCR: 2002-2008) or métier (DCF: 2009-2011) for GSA 17 (Northern-central Adriatic Sea, Italian waters). Empty cells mean no landings.

Species	DCR (2005-2008)						DCF (2009-2011)							
	GNS	GTR	PTM	OTB	TBB	PS	GNS	GTR	PTM	OTB_DEMSP	OTB_DWSP	OTB_MDDWSP	TBB_DEMSP	PS
<i>S. pilchardus</i>			Y			Y			Y					Y
<i>E. encrasicolus</i>			Y			Y			Y					Y
<i>M. merluccius</i>				Y	Y					Y			Y	
<i>S. solea</i>	Y			Y	Y		Y			Y			Y	
<i>M. surmuletus</i>							Y			Y				
<i>M. barbatus</i>				Y			Y			Y			Y	
<i>L. budegassa</i>				Y										
<i>Scomber Spp.</i>				Y										
<i>T. trachurus</i>			Y	Y										
Is the métier selected for sampling?														

Table 10.2.7.2 Landings information by gear (DCR: 2002-2008) or métier (DCF: 2009-2011) for GSA 17 (Northern-central Adriatic Sea, Croatian waters).

Species	National Data Collection Programme (2002-2011)							PS
	GNS	GTR	PTM	OTB_DEMSP	OTB_DWSP	OTB_MDDWSP	TBB_DEMSP	
<i>S. pilchardus</i>								Y
<i>E. encrasicolus</i>								Y
<i>M. merluccius</i>				Y				
<i>S. solea</i>				Y				
<i>N. norvegicus</i>				Y				
<i>M. barbatus</i>				Y				
Is the métier selected for sampling?								

Table 10 2.7.3. Summary data available for GSA 17 (Northern-Central Adriatic Sea). (*) Species being subject of present or past assessments.

Species	Samplings from commercial fleet			Surveys at sea			Maturity ogive, length-weight	Growth parameters (otolith reading or others)
	DCR (2002-2008)	DCF (2009-2011)	Croatian National Programme	MEDITS (1994-2011)	MEDIAS (2009-2011)	SOLEMON (2005-2011)		
<i>S. pilchardus</i> *	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
<i>E. encrasicolus</i> *	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
<i>M. merluccius</i> *	Yes	Yes	Yes	Yes	Too few individuals	Yes	Yes	Yes
<i>S. solea</i> *	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
<i>M. barbatus</i> *	Yes	Yes	Yes	Yes	Too few individuals	No	Yes	Yes
<i>P. longirostris</i>	No	No	No	Yes	No	No	No	No
<i>A. antennatus</i>	No	No	No	Rare in catches	No	No	No	No
<i>A. foliacea</i>	No	No	No	No	No	No	No	No
<i>N. norvegicus</i> *	Yes	Yes	Yes	Yes	No	No	Yes	No
<i>L. budegassa</i>	Yes	Yes	No	Yes	No	No	Yes	Yes
<i>L. piscatorius</i>	Yes	Yes	No	Yes	No	No	Yes	Yes
<i>P. erythrinus</i>	Yes	Yes	No	Yes	Too few individuals	No	Yes	Yes
<i>P. acarne</i>	Yes	Yes	No	Yes	Too few individuals	No	Yes	Yes
<i>S. aurata</i>	Yes	Yes	No	Yes	Too few individuals	No	Yes	Yes
<i>T. lucerna</i>	Yes	Yes	No	Yes	Too few individuals	Yes	Yes	Yes
<i>T. trachurus</i>	Yes	Yes	No	Yes	Only biological data from trawl hauls	No	Yes	Yes
<i>T. mediterraneus</i>	Yes	Yes	No	Yes	Only biological data from trawl hauls	No	Yes	Yes
<i>E. gurnardus</i>	Yes	Yes	No	Yes	Too few individuals	No	Yes	Yes
<i>S. scombrus</i>	Yes	Yes	No	Yes	Only biological data from trawl hauls	No	No	No
<i>S. japonicus</i>	Yes	Yes	No	Yes	Only biological data from trawl hauls	No	No	No
<i>M. poutassou</i>	Yes	Yes	No	Yes	Too few individuals	No	Yes	Yes

<i>T. minutus</i>	Yes	Yes	No	Yes	Too few individuals	No	Yes	Yes
<i>M. surmuletus</i>	Yes	Yes	No	Yes	Too few individuals	No	Yes	Yes
<i>Spicara spp.</i>	Yes	Yes	No	Yes	Only biological data from trawl hauls	No	Yes	Yes
<i>B. boops</i>	Yes	Yes	No	Yes	Only biological data from trawl hauls	No	Yes	Yes
<i>M. cephalus</i>	No	No	No	Rare in catches	Only biological data from trawl hauls	No	No	No
<i>L. aurata</i>	No	No	No	Yes	Only biological data from trawl hauls	No	No	No
<i>S. sprattus</i>	No	No	No	Yes	Yes	No	No	No
<i>S. mantis</i> *	Yes	Yes	No	Yes	No	Yes	Yes	No
<i>R. clavata</i>	Yes	Yes	No	Yes	No	Yes	No	No
<i>R. asterias</i>	Yes	Yes	No	Yes	No	Yes	No	No
<i>P. jacobus</i>	No	No	No	Yes	No	Yes	No	No
<i>A. opercularis</i>	No	No	No	Rare in catch	No	Yes	No	No
<i>P. maxima</i>	No	No	No	Yes	No	Yes	No	No
<i>S. officinalis</i>	Yes	Yes	No	Yes	Too few individuals	Yes	Yes	No
<i>Z. faber</i>	No	No	No	Yes	No	No	Yes	Yes
<i>O. vulgaris</i>	Yes	Yes	No	Yes	No	No	Yes	No
<i>L. vulgaris</i>	Yes	Yes	No	Yes	Too few individuals	No	Yes	No
<i>M. kerathurus</i>	Yes	Yes	No	Yes	Too few individuals	Yes	Yes	No
<i>C. gallina</i> *	Yes	Yes	No	No	No	No	No	No

11. TOR H REVISION AND SUGGESTIONS FOR DCF DATA CALL

The DCF data call for Mediterranean data issued by DG MARE in April 2012 was fundamentally the same of the 2011 at the exception of the withdrawal of the two economic tables. During data submission by Member States, JRC data collection team noted minor issues in terms of data format and reported this to the EWG.

To tackle this data format deficiency, the EWG 12-19 recommends the following little but necessary amendments:

- Fisheries tables

In B Landings data it is impossible to accommodate fish of lengths above 100 cm (LENGTHCLASS100). The suggestion is to add a LENGTHCLASS100_PLUS (cm or mm) which will be the sum of all the individuals of length classes above 100 cm and will be equivalent to an Age+ group.

For consistency, in Table A should be added a column for AgeClass20_PLUS to accommodate larger Age classes.

Since 2009 biological parameters of Mediterranean stocks have not been called in recent Data calls. Experts faced the lack of biological parameters to perform age slicing and use in the assessments. Thus, since according to DCF regulation biological parameters and age length keys are collected every year or every three, in the 2013 DCF data call these should be requested and made available to expert working groups.

- MEDITS tables

In 2012 new procedures were introduced in the MEDITS trawl survey definition of the file format. According to MEDITS manual Version 6 a new TA file will incorporate temperature and stratum and part of the cod-end (PART OF THE CODEND, BOTTOM TEMPERATURE BEGINNING, BOTTOM TEMPERATURE END, MEASURING SYSTEM 2A, NUMBER OF THE STRATUM). Additionally former TT and TD files were dropped and some fields were added to TB and TC (MONTH, DAY, AREA AND FAUNISTIC CATEGORY). A file containing biological parameters at individual level (TE) was designed.

These generate new data tables and modification of current TA table with the addition of Temperature and Strata information from tables TT and TD.

The EWG 12-19 recommends to call the MEDITS data from 2012 onwards according to the new MEDITS manual Version 6 for tables (TA, TB, TC). Since the new table TE will contain few data and will unlikely be used for STECF working groups, TE should not be requested in 2013.

12. TOR I IDENTIFICATION OF STOCK PRIORITY LIST

Taking into account the catch composition of the different fisheries/metier, the biological characteristics and the current level of overfishing identify the major stocks of the different species whose scientific assessment has to be carried annually, biennially or over a longer timeframe starting from 2013. This should facilitate the STECF systematic approach in monitoring and following recovery of major stocks and fisheries in the Mediterranean based on a prioritized schedule of stock assessments. Such exercise is to be based on pragmatic expertise on data coverage by GFCM GSA resulting from Mediterranean DCF data calls.

The STECF EWG 12-19 was requested to propose a prioritized schedule for assessments including 30 major stocks where the EWG's advice and assessment's revision will be undertaken annually or/and biennially or over a longer timeframe. The suggested framework would enable a regular monitoring of recovery of major stocks in the Mediterranean.

It is likely that an assessment for each stock every year will not be necessary, but changes in the frequency of such stock assessment could affect the ability to provide advice to fisheries management. The impact of assessment frequency and scientific advice provided to managers may change in specific conditions, considering they are influenced by several factors as quality of data, current stock status, stock evolution, and the assumptions made about resilience and stock responses in productivity derived from management implementation of advice. Thus, in order to decide the assessment frequency it is necessary to consider which is the expected impact on the advice that can be provided, and which elements would be needed to perform a new assessment. The changes in assessment frequency should not negatively impact accuracy and precision of the population estimates.

A systematic selection of fish stocks on the basis of a set of criteria was performed to identify major stocks to be assessed during the next EWGs' schedule. The criteria are the following:

- To represent a major catch contribution and thus stocks are selected by their prominence in landings. The species that are involved in the main fisheries could be prioritized. The selection is limited for each GSA to the first ranked species that cover most (around 80%) of total landings.
- To have an important commercial value. This criterion enables to prioritize the commercially important species by area. This is particularly critical for small pelagics that were assessed only in a very limited number of GSAs, despite of their high commercial importance.
- To be a significant species that induces concern regarding their conservation status including threatened species from the point of view of science or conservation (in red lists, elasmobranchs action plans, etc.).

Despite of the agreed perception of a need of assessments for certain stocks, such assessments are conditioned by the availability of fisheries data (e.g. catches, landings,) and essential information that enables to run "proper" assessment (e.g. age structure, biological features, etc...). Hence, the species that have never been assessed will have a higher priority to be included, when data availability allows.

The EWG also noted that the selection should also take in consideration the importance of the fisheries targeting the stock. Coastal assemblages include stocks involved in several important fisheries (Indicator species which are representative of a stock assemblage).

Selected stocks are then classified according to their life span in two categories short and long living species. Small pelagics species (e.g. anchovy and sardine) together with cephalopods (e.g. *Sepia officinalis*) should be in the first category (short living), and the remaining stock species in the second class (long living). This categorization helps to specify the frequency of assessment and revisions of stocks.

The performance of frequent assessments is also requested when specific management strategies are defined for some stocks (i.e. adaptive management).

Applying these screenings, the EWG 12-19 then noted that the prioritization of particular stocks should also be based on the stock status. Stocks with critical exploitation status require frequent (annual) evaluation. Furthermore, the EWG advise to evaluate the possibility of using alternative ways (e.g. stock indicators) that could be used to monitor the stock status during the intervening time until a revision of the stock assessment in the case of biannual evaluation.

The results of fish stock selection and ranking was summarized in the Table 12.1 presenting major stocks in each GSA, together with the corresponding data collected under the DCF data calls and available in the JRC database. The EWG 12-19 advised to enhance the quality of data collection to gather better and complete catch at age data for all the metiers within which stocks considered of great importance are involved, as well as on specific effort, discard rates, etc.

Table 12.1 Proposed priority list for which stock assessment should be performed in each calendar year.

GSA	CODE	Common name	Species	YEAR		
				2013	2014	2015
1	PIL	Sardine	<i>Sardina pilchardus</i>	1		
1	ARA	Blue and red shrimp	<i>Aristeus antennatus</i>			1
1	HKE	Hake	<i>Merluccius merluccius</i>	1		1
1	DPS	Pink shrimp	<i>Parapenaeus longirostris</i>	1		
1	MUT	Red mullet	<i>Mullus barbatus</i>		1	
5	ARA	Blue and red shrimp	<i>Aristeus antennatus</i>		1	
5	MUR	Striped red mullet	<i>Mullus surmuletus</i>	1		
5	HKE	Hake	<i>Merluccius merluccius</i>		1	
5	NEP	Norway lobster	<i>Nephrops norvegicus</i>		1	
5	DPS	Pink shrimp	<i>Parapenaeus longirostris</i>	1		
5	MUT	Red mullet	<i>Mullus barbatus</i>	1		
6	PIL	Sardine	<i>Sardina pilchardus</i>		1	
6	HKE	Hake	<i>Merluccius merluccius</i>			
6	ANK	Black-bellied angler	<i>Lophius budegassa</i>		1	

6	DPS	Pink shrimp	<i>Parapenaeus longirostris</i>	1		
6	MUT	Red mullet	<i>Mullus barbatus</i>	1		
6	ARA	Blue and red shrimp	<i>Aristeus antennatus</i>		1	
7	PIL	Sardine	<i>Sardina pilchardus</i>	1		
7	ANE	Anchovy	<i>Engraulis encrasicolus</i>		1	
7	HKE	Hake	<i>Merluccius merluccius</i>		1	
7	ANK	Black-bellied angler	<i>Lophius budegassa</i>		1	
7	MUT	Red mullet	<i>Mullus barbatus</i>		1	
9	PIL	Sardine	<i>Sardina pilchardus</i>	1	1	
9	HKE	Hake	<i>Merluccius merluccius</i>			
9	MUT	Red mullet	<i>Mullus barbatus</i>		1	
9	DPS	Pink shrimp	<i>Parapenaeus longirostris</i>		1	
9	NEP	Norway lobster	<i>Nephrops norvegicus</i>		1	
9	ARS	Giant red shrimp	<i>Aristaeomorpha foliacea</i>	1		
10	HKE	Hake	<i>Merluccius merluccius</i>	1		
10	DPS	Pink shrimp	<i>Parapenaeus longirostris</i>	1		
10	MTS	Spottail mantis	<i>Squilla mantis</i>		1	
10	MUT	Red mullet	<i>Mullus barbatus</i>		1	
11	HKE	Hake	<i>Merluccius merluccius</i>	1		
11	MUR	Striped red mullet	<i>Mullus surmuletus</i>	1		
11	MUT	Red mullet	<i>Mullus barbatus</i>	1		
11	ARS	Giant red shrimp	<i>Aristaeomorpha foliacea</i>		1	
11	DPS	Pink shrimp	<i>Parapenaeus longirostris</i>		1	
15+16	ANE	Anchovy	<i>Engraulis encrasicolus</i>		1	
15+16	PIL	Sardine	<i>Sardina pilchardus</i>		1	
12-16	ARS	Giant red shrimp	<i>Aristaeomorpha foliacea</i>			
12-16	DPS	Pink shrimp	<i>Parapenaeus longirostris</i>			
12-16	NEP	Norway lobster	<i>Nephrops norvegicus</i>	1		
15+16	ARA	Blue and red shrimp	<i>Aristeus antennatus</i>	1		
15+16	PAC	Common Pandora	<i>Pagellus erythrinus</i>			
12-16	HKE	Hake	<i>Merluccius merluccius</i>			
15+16	MUT	Red mullet	<i>Mullus barbatus</i>			
15+16	MUR	Striped red mullet	<i>Mullus surmuletus</i>	1		
15+16	OCC	Common octopus	<i>Octopus vulgaris</i>		1	
4,5,11-16	DOL	Common dolphinfish	<i>Coryphaena hippurus</i>	1		
17	ANE	Anchovy	<i>Engraulis encrasicolus</i>	1		
17	PIL	Sardine	<i>Sardina pilchardus</i>	1		

17	HKE	Hake	<i>Merluccius merluccius</i>		1	
17	MUT	Red mullet	<i>Mullus barbatus</i>		1	
17	MTS	Spottail mantis	<i>Squilla mantis</i>		1	
17	SOL	Common sole	<i>Solea solea</i>	1		
18	ANE	Anchovy	<i>Engraulis encrasicolus</i>	1		
18	HKE	Hake	<i>Merluccius merluccius</i>	1		
18	MUT	Red mullet	<i>Mullus barbatus</i>		1	
18	MTS	Spottail mantis	<i>Squilla mantis</i>		1	
18	DPS	Pink shrimp	<i>Parapenaeus longirostris</i>		1	
19	DPS	Pink shrimp	<i>Parapenaeus longirostris</i>	1		
19	ANE	Anchovy	<i>Engraulis encrasicolus</i>	1		
19	HKE	Hake	<i>Merluccius merluccius</i>	1		
22+23	ANE	Anchovy	<i>Engraulis encrasicolus</i>	1		
22+23	PIL	Sardine	<i>Sardina pilchardus</i>		1	
22+23	HKE	Hake	<i>Merluccius merluccius</i>	1		
22+23	MUT	Red mullet	<i>Mullus barbatus</i>		1	
25	MUR	Striped red mullet	<i>Mullus surmuletus</i>		1	
25	MUT	Red mullet	<i>Mullus barbatus</i>		1	
TOTAL STOCK NUMBER				31	32	

13. TOR J OTHER BUSINESS:

Cephalopods represent relevant species for some fisheries/métier and play important ecological roles in the marine food webs; there is increasing need to identify the best appropriate scientific approaches, proportionate to the consistency and value of the catches, to evaluate their status and calibrate their exploitation with a low risk of poor recruitment in the subsequent fishing season. Identify the most likely scientific procedure(s) making use, as required, of scientific surveys and/or commercial data. Evaluate whether the data collected through the DCF are adequate to that regard in the different GSA and where necessary propose solutions to fill the gaps.

There is a specific ICES Working Group dealing with cephalopods: the Working Group on Cephalopod Fisheries and Life History ([WGCEPH](#)). Since most of the issues raised in point j) have already been discussed in the annual reports of this WG, the relevant information have been summarized in the following paragraphs. Assessments of cephalopod species in the scientific literature have also been reviewed.

Assessments of cephalopods are important because, besides sustaining commercial fisheries of high economic value (e.g. *Sepia officinalis* and *Octopus vulgaris*) and supporting commercial fisheries with high socio-economic importance (e.g. *Loligo vulgaris*), cephalopods play an important trophic dynamics role in the ecosystem (ICES, 2010).

The need of cephalopod assessments

The life-history characteristics of cephalopods pose particular problems for fishery assessment and management (Pierce & Guerra, 1994). Most of the commercially important species of cephalopods have a short life cycle (1 to 2 years), grow rapidly to maturity, spawn once at the end of their life, are ecological opportunists and have labile populations consisting of only one or two generations of animals (ICES, 2009). Cephalopods are highly affected by environmental conditions on early life phases that have major effects on recruitment and, later, on the biomass that can be harvested. This implies that it may be possible to forecast cephalopod abundance based on environmental conditions (ICES, 2009).

In general, no analytical assessment or fishery forecasting is being carried out on a regular basis for the species/stocks of cephalopods in the ICES area. There are no formal reference points against which to assess stock status, which is therefore usually inferred from trends in landings time-series (ICES, 2009). The idea is that when no other data than just fisheries statistics is available, cephalopod stock status could be provided looking at trends (ICES, 2011).

Historical time-series of data must be established, to allow trends in the abundance/status of different species be monitored and to underpin any future assessment and management. Precise data needs for assessment cannot be defined at present, because several different assessment methods could be used, but minimum requirements can be specified (ICES, 2009):

- a) Landings, by métier, by species, by area, by month.
- b) Fishing effort and discard data are also required to generate CPUE.

- c) Length-frequency or weight-frequency data are important, collected by market or on-board sampling.
- d) Both bottom trawl and artisanal fisheries should be monitored.
- e) Sex and maturity data are useful, collected with a frequency appropriate to the life cycle biology (e.g. monthly).

Most appropriate methods for cephalopod assessment

Existing standard models have been used to assess cephalopods from the 1980s, although several authors have tried to improve them during the last years (ICES, 2010). The use of **length frequency analyses (LFA)** should be avoided since the validity of this approach depends on the existence of a stable age-length relationship. However, cephalopod growth rates are known to be highly variable and, in many species, growth does not fit a Von Bertalanffy growth model (Pierce & Guerra, 1994). There is compelling evidence that LFA should be abandoned since growth parameters inferred from progression and statolith analyses showed to be markedly different (Jackson et al., 1997, 2000).

Biomass dynamic models (BDMs) have been applied to octopus and cuttlefish from the Saharan Bank (Sato and Hatanaka, 1983; Bravo de Laguna, 1989) and cuttlefish from the Arabian Sea (Sato and Hatanaka, 1983). Roel & Butterworth (2000) used modified BDMs in the South African fishery of *Loligo vulgaris*. Chedia et al. (2010) explored the effect of environment on Tunisian octopus CPUE through correlation analyses and the incorporation into BDMs of SST and rainfall data. Jurado-Molina (2010) used a Bayesian approach to BDMs to assess octopus populations from the Yucatan Peninsula. Although most currently available BDMs (e.g. ASPIC) use the assumption of non-equilibrium, equilibrium-based models are of doubtful value for the highly variable populations of cephalopods (Pierce & Guerra, 1994).

According to Young et al. (2004), **depletion models (DMs)** are likely to be the most appropriate models for cephalopod assessment (e.g. Pierce et al., 1996; Dunn, 1999; Royer et al., 2002). At present, DMs are successfully applied for the management of squid fisheries around the Falkland Islands (Rosenberg et al., 1990; Beddington et al., 1990; Agnew et al., 1998). DMs have also been used in the squid fishery from northern Scottish waters (Young et al., 2004). More recently, Robert et al. (2010) and Sauer et al. (2011) used DMs to analyse octopus populations from Moroccan waters and western Indian Ocean, respectively.

There also exist examples of **other procedures** applied to cephalopods. The Gómez-Muñoz model, which utilizes interview data obtained from fishermen, have been used to analyse squid small-scale fisheries (Simón et al., 1996; Young et al., 2006). Furthermore, time series analyses techniques have been applied to forecast interannual variations in squid populations (Brodziak & Hendrickson, 1999; Pierce & Boyle, 2003; Georgakarakos et al., 2006).

In the case of survey data collected under DCF, relative biomass indices can be used, but swept area biomass estimates (using bottom trawl gear) are preferable (ICES, 2010).

Adequacy of the Data Collection Framework (DCF) for cephalopod assessment

The WGCEPH (ICES, 2010) expressed concern that the frequency of sampling defined in the DCF for cephalopods is too low to permit the use of the data for assessment purposes, even if the “simplest” assessment methods (in relation to data requirements) could be chosen (e.g. Depletion and Production models).

This concern is related to the life history of cephalopod species. Given the short life cycles of most of these species (1 or 2 years), it is necessary to monitor biological variables regularly, ideally every week or month. Quarterly sampling is insufficient for cephalopod assessment and management. Even length composition sampling should be carried out on a more regular time basis in those métiers in which cephalopods are considered as G2 species. Sampling should be based on the seasonality of the landings and discards with a concentration of sampling during times when cephalopod catches are highest (ICES, 2010). In general, monthly sampling is necessary although samplings every 2-3 months would provide some useful data. For some purposes (e.g. assessment by depletion methods), weekly sampling is needed, taking into consideration the seasonal availability of some commercial species (*Sepia officinalis*, *Loligo vulgaris*) targeted by specific gears in coastal fishing grounds (ICES, 2009).

Species identification (i.e. unsorted landings) is a drawback still existing both in the official statistics and the National Sampling Programs, despite the fact that the Regulation is clear in relation to carrying out additional biological sampling programs to estimate the share of various species (ICES, 2010).

There is a need to develop integrated population models that take into account both life cycle parameters and environmental drivers, potentially allowing both a better understanding of the mechanisms linking life history and environment, and a way to evaluate the relative importance of different drivers, e.g. global change vs. overfishing. Such models would be facilitated by the availability of accurate estimates of age and mortality. It is also necessary to find ways to introduce environmental information into cephalopod stock assessment and to fishery management (ICES, 2009).

Depletion models inputs and outputs

To show the data needs and output results of depletion models, the work of Young et al. (2004) on the assessment of squid in Scottish waters is reproduced here.

These authors used the Catch and Effort Data Analysis (CEDA) software package, developed by the Marine Resources Assessment Group (MRAG) at Imperial College, University of London. This package, which includes the implementation of depletion methods, produces estimates of current stock size, catchability and other population dynamics parameters. As with most stock assessment models, depletion models require values for input parameters that cannot readily be measured, such as natural mortality.

Model input

Application of depletion methods requires data for a series of consecutive time periods during which abundance declines due to fishing, as follows:

- (a) Total catches (weight landed plus an estimate of discards if available).
- (b) An abundance index. This may be provided by CPUE data for a particular “métier”.
- (c) A method for converting catches in weight to catches in numbers. This can be derived from market sample length–frequency data and length–weight relationships.
- (d) If recruitment continues during the period of the fishery, an index of recruitment.
- (e) If natural mortality cannot be assumed to be zero, an estimate of natural mortality.
- (f) A closed population is assumed and immigration and emigration are ignored.

Model output

The model provides estimates of the following variables:

- (a) Initial population sizes in terms of number of animals and numbers for each month (N_t) in the depletion period.
- (b) Expected catches and CPUE for each month in the depletion period.
- (c) Catchability coefficient.
- (d) Goodness of fit measure (R^2). Further information on goodness of fit was obtained from visual examination of plots of residuals against both the expected value and time. A judgment was made as to whether the distribution of residuals was “good” (even scatter of points), “reasonable” (a slight trend might be apparent) or “poor” (a clear trend in the plot). Since the present application typically involved data series of no more than 10 months, only large departures from a random scatter of residuals are likely to be detectable.
- (e) Constant of proportionality between the recruitment index and actual recruitment.
- (f) Bootstrapped 95% confidence intervals for M_1 , q and l . Repeated re-sampling from differences between observed and expected values in the original data set generates the bootstrap data sets. The resampling is done by replacement (after a data point is chosen, it is replaced and is available again when the next choice is made), 1000 simulated data sets are generated and confidence intervals calculated.

14. REFERENCES

- AA.VV. 2000 – Mediterranean Landings Pilot Project (MEDLAND). E.U. project n°97/0066. (1998-2000). Final Report.
- AA.VV. 2002. Stock Assessment in the Mediterranean-SAMED. Final Report EU Project n° 99/047.
- AA.VV. (2008). Status of deep-sea Red Shrimps in the Central and Eastern Mediterranean Sea, Final Report. *Project Ref FISH/2004/03-32*.
- Abella, A., Caddy, J.F., 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. Liv. Res.* 10: 257–269.
- Abella A., Belluscio A., Bertrand J., Carbonara P., Giordano D., Sbrana M., Zamboni A. (1999). Use of trawl surveys and commercial fleet data for the assessment of some Mediterranean demersal resources. *Aquat. Living Res.* 12: 155-166.
- Abella A., Carpentieri P., Mannini A., Sartor P., Viva C., Voliani A.. (2004). Selection of possible indicators of sustainable yield from total mortality rates for red mullet *Mullus barbatus* (Linnaeus, 1758) in the GFCM Geographic Sub-Area 9 (Eastern Ligurian-Central Tyrrhenian Sea). *Biologia Marina Mediterranea*.
- Abella A, Ria M and Mancusi C. 2010 – Assesment of the status of the coastal groundfish assemblage exploited by the Viareggio fleet (Southern Ligurian Sea). *Scientia Marina*, 74(4), 12pp.
- Abelló P., Abella A., Adamidou A., Jukic-Peladic S., Spedicato M.T., Tursi A. (2002) - Global population characteristics of two decapod crustaceans of commercial interest (*Nephrops norvegicus* and *Parapenaeus longirostris*) along the European Mediterranean coasts. *Scientia Marina*, 66 (Suppl. 2): 125-141.
- Andaloro F. 1981 – Contribution on the knowledge of the age and growth of the Mediterranean red mullet, *Mullet surmuletus* (L. 1758). ICES report 27: 111-113.
- Andaloro F. 1982 – Resume des paramètres biologiques sur *Mullus surmuletus* de la mer Tyrrhenienne meridionale et la mer Ionienne septentrionale. FAO Fish Rep. 266: 87-88.
- Andaloro F and Prestipino S.G. 1985 – Contribution to the knowledge of the age and growth of striped mullet, *Mullus barbatus* (L., 1758) and red mullet *Mullus surmuletus* (L., 1758) in the Sicilian Channel. FAO Fish. Rep. 336:89-92.
- Andaloro F. 1996 – Recupero dello scarto nella pesca a strascico e dei residui di lavorazione dell' industria di trasformazione dei prodotti ittici. Regione siciliana (L. 28/96), 1-25 pp.
- Anon., 2010. Report of the Workshop on Implementing the ICES FMSY framework. *ICES CM 2010/ACOM:54*
- Agnew, D.J., Baranowski, R., Beddington, J.R., des Clers, S., Nolan, C.P., 1998. Approaches to assessing stocks of *Loligo gahi* around the Falkland Islands. *Fish. Res.* 35, 155-169.
- Ardizzone G.D, Agnesi S., Corsi F., Atlante delle Risorse Ittiche Demersali Italiane triennio 1994-1996 CD-ROM.
- Atkinson, R.J.A., Froglija, C, Arneri, E., Antolini, B. 1997. Observations on the burrows and burrowing behaviour of *Squilla mantis* (L.) (Crustacea : Stomatopoda). *Marine Ecology – PSZN*: 18(4): 337-359
- Au D.W and Smith S.E. 1997 – A demographic method with population density compensation for estimating productivity and yield per recruit of the leopard shark (*Triakis semifasciata*). *Canadian Journal of Fisheries and Aquatic Sciences*, 54: 415–420.
- Bauchot M., Hureau J.C. (1986). Sparidae. In: Whitehead P.J.P., Bauchot M.L., Hureau J.C., Nielsen J., Tortonese E. (eds.), *Fishes of the north-eastern Atlantic and the Mediterranean*. P. 883-907. Paris: UNESCO.
- Bauchot M.L. 1987 – Mullidae. In: Fisher W. Bauchot M.L., Schneider (eds) *Fishes FAP d'identification des especes pour les besoins de la peche* 37 (2). Vertebres. FAO, Rome, 1195-1200.
- Basilone, G., Guisande, C., Patti, B., Mazzola, S., Cuttitta, A., Bonanno, A., Vergara, A.R., Maneiro, I. (2006). Effect of habitat conditions on reproduction of the European anchovy (*Engraulis encrasicolus*) in the Strait of Sicily. *Fisheries Oceanography*, 15 (4), pp. 271-280.

- Basilone, G., Guisande, C., Patti, B., Mazzola, S., Cuttitta, A., Bonanno, A., Kallianiotis, A. (2004). Linking habitat conditions and growth in the European anchovy (*Engraulis encrasicolus*). *Fisheries Research*, 68 (1-3), pp. 9-19.
- Beddington, J.R., Rosenberg, A.A., Crombie, J.A., Kirkwood, G.P., 1990. Stock assessment and the provision of management advice for the short fin squid fishery in Falkland Islands waters. *Fish. Res.* 8, 351-365.
- Bellonci, G., 1878. Morfologia del sistema nervoso centrale della *Squilla mantis*. *Annali Museo civico di Storia naturale*, Genova, 12: 518-545, pls. 4-10.
- Berkes F, Mahon R, McConney P, Pollnac R and Pomeroy R. 2001 – Managing small-scale fisheries: alternative directions and methods. International Development Research Centre, Ottawa, 309 pp.
- Bertrand J, Leonori I, Dremière PY, Cosmi G. 2002 - Depth trajectory and performance of a trawl used for an international bottom trawl survey in the Mediterranean. *Scientia Marina* Vol 66, suppl.2, p169-182.
- Bertrand J.A., Gil de Sola L., Papaconstantinou C., Relini G., Souplet A. 2002. The general specifications of the Medits surveys. *Scientia marina* 66 (suppl. 2): 9-17.
- Beverton R.J.H. and Holt S.J. 1957 – On the dynamics of exploited fish populations. *Fishery Investigations*. London Series II, Vol. XIX, HMSO, Ser. 2 (19), ISBN 0412 54960 3, 541 pp.
- Bini G. (1968-70). *Atlante dei pesci delle coste italiane*. 1-10. Mondo Sommerso Roma.
- Biagi F., De Ranieri S., Viva C. 1990 – Contributo alla conoscenza del merluzzo cappellano, *Trisopterus minutus capellanus* (Lacepede, 1800), nell'Arcipelago Toscano meridionale. *Oebalia*, suppl., 15 (1): 225-233.
- Biagi F., De Ranieri S., Viva C. 1992 – Recruitment, length at first maturity and feeding of poor-cod, *Trisopterus minutus capellanus*, in the northern Tyrrhenian Sea. *Boll. Zool.*, 59: 87-93.
- Biagi F., Farnocchia I. (1994). Reclutamento ed accrescimento di *Phycis blennoides* (Brünnich, 1768) nel Mar Tirreno settentrionale. *Biol. Mar. Mediterr.*, 1 (1): 295-296.
- Biagi F., De Ranieri S., Rocca V. 1996 – Relazione taglia-profondità di specie ittiche nell'Arcipelago Toscano meridionale. *Biol. Mar. Mediterr.*, 3 (1): 527-528.
- Biagi F., Sartor P., Ardizzone G.D., Belcari P., Belluscio A., Serena F. 2002 – Analysis of demersal assemblages off the Tuscany and Latium coasts (north-western Mediterranean). *Sci. Mar.*, 66 (Suppl. 2): 233-242.
- Branch T.A., Kirkwood G.P., Nicholson S.A., Lawlor B., Zara S.J. 2000 – Yield version 1.0, MRAG Ltd, London, U.K.
- Brian A. 1931 – La biologia del fondo a "scampi" del Mare Ligure: *Aristaeomorpha*, *Aristeus* ed altri macruri natanti. *Bollettino del Museo di Zoologia e Anatomia Comparata dell'Università di Genova* 11(45) : 1 :6.
- Bravo de Laguna, J. 1989. Managing an international multispecies fishery: the Saharan trawl fishery for cephalopods. In: J.F. Caddy (Ed.), *Marine Invertebrate Fisheries: Their Assessment and Management*. John Wiley, New York, pp. 591-612.
- Brodziak, J., Hendrickson, L., 1999. An analysis of environmental effects on survey catches of squids *Loligo pealei* and *Illex illecebrosus* in the northwest Atlantic. *Fish. Bull.* 97, 9-24.
- Burnham KP and Anderson DR. 2002 – Model Selection and Multimodel Inference: A Practical Information-Theoretic Approach, 2nd edn. New York, Springer-Verlag.
- Carlucci R., Lembo G., P. Maiorano, F. Capezzuto, A.M.C. Marano, L. Sion, M.T. Spedicato, N. Ungaro, A. Tursi, G. D'Onghia. 2009. Nursery areas of red mullet (*Mullus barbatus*), hake (*Merluccius merluccius*) and deep-water rose shrimp (*Parapenaeus longirostris*) in the Eastern-Central Mediterranean Sea. *Estuarine, Coastal and Shelf Science*, doi: 10.1016/j.ecss.2009.04.034.
- Camilleri M, Dimech M, Drago A, Fiorentino F, Fortibuoni T, Garofalo G, Gristina M, Schembri P.J, Massa F, Coppola S, Bahri T and Giacalone V. 2008 – Spatial distribution of demersal fishery resources, environmental factors and fishing activities in GSA 15 (Malta Island). GCP/RER/010/ITA/MSM-TD-13. *MedSudMed Technical Documents*, 13: 97 pp.
- Cannizzaro, L., Garofalo, G. and Scalisi M. (1994). Nasello, Luvaro e Scorfano di fondale nel Canale di Sicilia - Distribuzione spazio-temporale. *NTR-ITPP* 44, 4 pp.
- Cannizzaro L, Rizzo P, Levi D, Garofalo G and Gancitano S. 1995 – *Raja clavata* (Linneo, 1758) nel Canale di Sicilia: crescita, distribuzione e abbondanza. *Biol. Mar. Medit.*, 2(2): 257-262.
- Cardinale M, Hagberg J, Svedäng H, Bartolino V, Gedamke T, Hjelm J, Börjesson P and Norén F. 2009 – Fishing through time: population dynamics of plaice (*Pleuronectes platessa*) in the Kattegat-Skagerrak over a century. *Pop. Ecol.* DOI 10.1007/s10144-009-0177-x.

- Carlucci R., Lembo G., P. Maiorano, F. Capezzuto, A.M.C. Marano, L. Sion, M.T. Spedicato, N. Ungaro, A. Tursi, G. D'Onghia. 2009 Nursery areas of red mullet (*Mullus barbatus*), hake (*Merluccius merluccius*) and deep-water rose shrimp (*Parapenaeus longirostris*) in the Eastern-Central Mediterranean Sea. *Estuarine, Coastal and Shelf Science*, doi: 10.1016/j.ecss.2009.04.034.
- Cartes J.E and Sardà F, 1989 – Feeding ecology of the deep-water aristeid crustacean *Aristeus antennatus*. *Marine Ecology Progress Series* 54 : 229-238.
- Chedia, J., Widien, K., Amina, B., 2010. Role of sea surface temperature and rainfall in determining the stock and fishery of the common octopus (*Octopus vulgaris*, Mollusca, Cephalopoda) in Tunisia. *Mar Ecol-Evol Persp* 31, 431-438.
- Chiericoni V., De Ranieri S., Sartor P. 1996 – Periodo di deposizione di *Micromesistius poutassou* (Risso, 1826) (Osteichthyes, Gadiformes) nel Tirreno Settentrionale. *Biol. Mar. Mediterr*, 3 (1): 540-541.
- Clark, W. G. (1991). Groundfish exploitation rates based on life history parameters. *Can. J. Fish. Aquat. Sci.* 48:734-750.
- Cochran W. G. (1953) - Sampling techniques. New York, John Wiley and Sons, 143 p.
- Coelho R., Bentes L., Correia C., Gonclaves J.M.S., Lino P.G., Menteiro P., Ribeiro J., Erzini K. (2010). Life history of the Common Pandora *Pagellus erythrinus* (Linnaeus, 1758) (Actinopterygii: Sparidae) from southern Portugal. *Brazilian Journal of Oceanography* 58(3): 233-245.
- Cohen D.M., Inada T., Iwamoto T. , Scialabba N. (1990). Gadiform fishes of the world (Order Gadiformes). An annotated and illustrated catalogue of codsw, hakes, grenadiers and other gadiform fishes known to date. *FAO Fisheries synopsis* 125, 10, 442 pp.
- Colloca F, Gentiloni P, Agnesi S, Schintu P, Cardinale M, Belluscio A and Ardizzone G.D. 1998 – Biologia e dinamica di popolazione di *Aristeus antennatus* (Decapoda : Aristeidae) nel Tirreno Centrale. *Biologia Marina Mediterranea* 5 (2) : 218-231.
- Colloca F, Carpentieri P, Balestri E and Ardizzone G.D. 2004 – A critical habitat for Mediterranean fish resources: shelf-break areas with *Leptometra phalangium* (Echinodermata: *Crinoidea*). *Marine Biology* 145(6): 1129-1142.
- Coppola SR. 2003 – Inventory of Artisanal Fishery Communities in the Western-Central Mediterranean. *FAO-COPEMED technical report*. 81 pp. See <http://www.faocopemed.org/reports/>.
- Cowx I.G. 2002 – Recreational fishing. In: Hart, P., Reynolds, J.D. (Eds.), *Handbook of Fish Biology and Fisheries*, vol. II. Blackwell Science, Oxford: 367–390 pp.
- Dunn, M.R., 1999. Aspects of the stock dynamics and exploitation of cuttlefish, *Sepia officinalis* (Linnaeus, 1758), in the English Channel. *Fish. Res.* 40, 277–293.
- EC XIV/298/96-EN – 1996. Report of the Group of independent Experts to Advise the European Commission on the Fourth Generation of Multi-annual Guidance Programmes.
- EU 2008 – Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of environmental policy (Marine Strategy Framework Directive), 22 pp.
- European Commission. 2004 – Fishing in Europe Magazine No 21. Mediterranean: guaranteeing sustainable fisheries. See <http://europa.eu.int/comm/fisheries/>
- European commission 2011 – Commission Decision of 1 September 2010 on criteria and methodological standards on good environmental status of marine waters (notified under document C(2010) 5956), 11 pp.
- FAO. Report of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa. Saly, Senegal, 17-27 March 2004. *FAO Fisheries Report*. No762. Rome, FAO. 2004. 135p.
- Fanciulli G., Relini Orsi L. (1979). Biologia di *Phycis blennioides* (Osteichthyes, Gadidae). II - Rapporto sessi e osservazioni sulla maturità sessuale. *Atti Soc. Tosc. Sc. Nat.*, Mam. ser. B, 86, suppl.: 383-387
- Fanciulli G., Relini Orsi L. (1980). Biologia di *Phycis blennioides* (Brunn.). 3. L'accrescimento. *Mem. Biol. Marina e Oceanogr.*, suppl. X: 391-392.
- Ferrero, E.A., and Burgni, P., 1989. Stomatopod nervous system. Recent contribution to its functional interpretation. – In: E.A. Ferrero (Ed/) – *Biology of Stomatopods*. E.Z.I. Selected Symposia and Monographs, 3: 71-86.
- Ferrero, E.A., Marzari, R., Mosco, A., and Riggio, D., 1988. Dynamics of morphometric and biochemical parameters of the reproductive condition of *Squilla mantis* fished by creels in the Gulf of Trieste. Use of VTGs as biochemical markers. *Bollettino della societa' adriatica di Scienze*, 70: 47-59.

- Fiorentino F, Orsi Relini L, Zamboni A and Relini G. 1998 – Remarks about the optimal harvest strategy for red shrimps (*Aristeus antennatus*, Risso 1816) on the basis of the Ligurian experience. *Cahiers Options Méditerranéennes*, 35: 323-333.
- Fiorentini, L., G. Cosimi, A. Sala, I. Leonori, and V. Palumbo. 1999 – Efficiency of the bottom trawl used for Mediterranean international trawl survey (MEDITS). *Aquatic Living Resources* 12(3): 187-205.
- Fiorentino F, Bono G, Garofalo G, Gristina M, Ragonese S, Gancitano S, Giusto G.B, Rizzo P and Sinacori G. 2003 – A further contribution on stock's status and fisheries of main demersal resources in the Strait of Sicily: ED/TN/FF-GB-GG-MG-SR-SG-GBG-PR-GS/4/0303/DRAFT.
- Fiorentino F., Mazzola S., Garofalo G., Patti B., Gristina M., Bonanno A., Massi D., Basilone G., Cuttitta A., Giusto G.B., Gancitano S., Sinacori G., Rizzo P., Levi D., Ragonese S. (2005) - Lo stato delle risorse demersali e dei piccoli pelagici e le prospettive di pesca "sostenibile" nello Stretto di Sicilia. Convenzione con Assessorato Regione Siciliana Cooperazione, Commercio, Artigianato e Pesca, Mazara del Vallo, Italia., 136 pp.
- Frogliia, C., Gramitto, M. E. (1981) Summary of biological parameters on the Norway lobster, *Nephrops norvegicus* (L.), in the Adriatic. *FAO Fish. Rep.*, (253): 165 – 178.
- Frogliia, C. (1982) Contribution to the knowledge of the biology of *Parapenaeus longirostris* (Lucas) (Decapoda, Penaeoidea). *Quad. Lab. Tecnol. Pesca.*, 3(2-5): 163-168.
- Frogliia, C., and Gramitto, M.E. 1986 – Diurnal changes in fishery resources catchability by bottom trawl in the Adriatic Sea. *FAO Fish. Rep.*, 345: 11 1-1 18.
- Frogliia, C. and M.E. Gramitto. 1987 – An estimate of growth and mortality parameters for Norway lobster (*Nephrops norvegicus*) in the central Adriatic Sea. *FAO Fish.Rep.*, 394: 189-204.
- Frogliia, C., and Giannini, S. 1989 – Field observations on diel rhythms in catchability and feeding of *Squilla mantis* (L.) (Crustacea, Stomatopoda) in the Adriatic Sea. In: E.A. FERRER (Ed.), *Biology of Stomatopods. Selected Symposia and Monographs U.Z.I.*, Mucchi Editore, Modena, 3 221-228.
- Frogliia, C., Atkinson, R.J.A., Gramitto, M.E., Arneri, E., Antolini, B., Congolani, L. 1996 – Growth and behaviour of *Squilla mantis* (mantis shrimp) in the Adriatic Sea. IRPEM – CNR. Study contract XIV/MED/93/016. Final Report. 55 p.
- Gabriel W. Mace P. (1999). A Review of Biological Reference Points in the Context of the Precautionary Approach Proceedings, 5th NMFS NSAW. 1999. NOAA Tech. Memo. NMFS-F/SPO-40:34-45
- Gaertner J C, Mazouni N, Sabatier R and Millet B. 1999 – Spatial structure and habitat associations of demersal assemblages in the Gulf of Lions: a multicompartamental approach . *Marine Biology* 135(1): 199-208.
- Galarza J.A, Turner G.F, Macpherson E, Carreras-Carbonell J and Rico C. 2007 – Cross-amplification of 10 new isolated polymorphic microsatellite loci for red mullet (*Mullus barbatus*) in striped red mullet (*Mullus surmuletus*). *Molecular Ecology Notes* 7: 230-232.
- Galarza J.A, Turner G.F, Macpherson E and Rico C. 2009 – Patterns of genetic differentiation between two co-occurring demersal species: the red mullet (*Mullus barbatus*) and the striped red mullet (*Mullus surmuletus*). *Canadian Journal of Fisheries and Aquatic Sciences* 66 (9): 1478-1490.
- Gamerman, D. 1997. *Markov Chain Monte Carlo: Stochastic simulation for Bayesian Inference*. Chapman and Hall, London.
- Gancitano V., Badalucco C., Rizzo P., Gancitano S., Sieli G., Cusumano S., Fiorentino F. (2010b). Age cohort analysis of common Pandora (*Pagellus erythrinus* L., 1758; Pisces: Sparidae) in the Strait of Sicily. 41st Congresso della Società Italiana di Biologia Marina, Rapallo (Genova), 7-11 June 2010.
- García- Rodríguez M. 2003 – La gamba roja *Aristeus antennatus* (Risso, 1816) (Crustacea, Decapoda): Distribución, demografía, crecimiento, reproducción y explotación en el Golfo de Alicante, Canal de Ibiza y Golfo de Vera. Universidad Complutense de Madrid. Tesis Doctoral, 303 pp.
- Garoia F., Guarniero, I., Piccinetti, C. & Tinti, F. (2004) First Microsatellite Loci of Red Mullet (*Mullus barbatus*) and their Application to Genetic Structure Analysis of Adriatic Shared Stock. *Marine Biotechnology*, 6 (5):446-452.
- Gavaris, S. (1988). An adaptive framework for the estimation of population size. *CAFSAC Res. Doc.* 88/29.
- Gayanilo F.C. ,Jr., P. Sparre, D. Pauly. 2005 – Food And Agriculture Organization Of The United Nations – Fisat II (version 1.2.2) Roma, 2005.

- Gedamke T, Hoenig JM. 2006 – Estimation of mortality from mean length data in non-equilibrium situations, with application to monkfish (*Lophius americanus*). *Trans Amer Fish Soc* 135:476-487.
- Georgakarakos, S., Koutsoubas, D., Valavanis, V., 2006. Time series analysis and forecasting techniques applied on loliginid and ommastrephid landings in Greek waters. *Fish. Res.* 78, 55-71.
- Giannoulaki M, Machias A, Somarakis S, Tsimenides N. 2004 – The spatial distribution of anchovy and sardine in the northern Aegean Sea in relation to hydrographic regimes. *Belgian Journal of Zoology*, 134: 43-48.
- Giannoulaki M, Valavanis V.D, Palialexis A, Tsagarakis K, Machias A., Somarakis, S., Papaconstantinou C. 2008 – Modelling the presence of anchovy *Engraulis encrasicolus* in the Aegean Sea during early summer, based on satellite environmental data. *Hydrobiologia*, 612: 225-240.
- Giesbrecht, W., 1910 – Stomatopoden. *Fauna and Flora der Gulf von Neapel*, 33: VII + 1 - 239 p.
- Gislason H., Daan N., Rice J. C., and Pope J. G. (2010). Size, growth, temperature and the natural mortality of marine fish. *Fish and Fisheries*, 11(2):149–158.
- Gonzales Pajuelo J.M and Lorenzo Nespereira J.M. 1993 – Spawning period and sexual maturity of red mullet, *Mullus surmuletus* (Linnaeus, 1758), off the Canary Islands (in Spanish). *Boletín del Instituto Español de Oceanografía*, 9 (2): 361-366.
- Goodyear C.P. 1995 – Red snapper stocks in U.S. waters of the Gulf of Mexico. *National Marine*.
- 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 Journal of Marine Science*, 63: 52-67.
- Gulland, J.A. Borema L.K.. (1973). Scientific advice on catch levels. *Fishery Bulletin* 71(2):325-335.
- Haidar, Z. (1970) L'océologie du rouget (*Mullus barbatus* L.) en Adriatique orientale. *Acta Adriat.*, 14 (1): 1-94.
- Hashem, M. T., Gassim, A. S. 1981. Some aspects of the fishery biology of *Pagellus erythrinus* (L) in the Libyan waters. *Bull. Inst. Oceanogr. & Fish., ARE*, 7(3), 429-441.
- Heldt J.H. 1955 – Contribution a l'étude de la biologie des crevettes peneides *Aristaeomorpha foliacea* (Risso) et *Aristeus antennatus* (Risso) (formes larvaires). *Bulletin Société Sciences Naturelles de Tunisie* (1954-1955), 8 (1,2): 9-33, Tav. 1-17.
- Hilborn, R. & Walters, C.J., 1992. Biomass Dynamic models. In: Hilborn, R. & Walters, C.J., *Quantitative fisheries stock assessment*. Chapman & Hall, New York, p 297-329.
- Hoeting, J.A., Madigan, D., Raferty, A.E., and Volinsky, C.T. 1999. Bayesian model averaging: a tutorial. *Statistical Science*, 14(4): 382-417.
- Holden M.J. 1975 – The fecundity of *Raja clavata* in British waters. *J. Cons. Int. Explor. Mer.*, 36 (2):110-118.
- Hossucu B., Cakir D.T. (2003). Some parameters about the population biology of the common Pandora (*Pagellus erythrinus* L., 1758) (Sparidae) in the Edremit Bay (Turkey). *EU Journal of Fisheries and Aquaculture Sciences* 20 (3-4): 329-336.
- Hureau J-C. 1986 – Mullidae. p. 877-882. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) *Fishes of the north-eastern Atlantic and the Mediterranean*. UNESCO, Paris. Vol. 2.
- ICES. 2006 – Report of the Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine and Anchovy (WGMHSA), 6-15 September 2005, Vigo, Spain. *ICES CM 2006/ACFM*: 08.
- ICES (2008) – Report of Workshop on Maturity Ogive Estimation for Stock Assessment (WKMOG). 3-6 June 2008 Lisbon, Portugal: 68 pp.
- ICES. 2009 - Report of the Working Group on Cephalopod Life History and Fisheries (WGCEPH), 27–30 April 2009, Vigo, Spain. *ICES CM 2009/LRC:06*. 157 pp.
- ICES. 2010 - Report of the Working Group on Cephalopod Fisheries and Life History (WGCEPH), 9–11 March 2010, Sukarrieta, Spain. *ICES CM 2010/SSGEF:09*. 95 pp.
- ICES. 2011 - Report of the Working Group on Cephalopod Fisheries and Life History (WGCEPH), 28 February–03 March 2011, Lisbon, Portugal. *ICES CM 2011/SSGEF:03*. 118 pp.
- Ifremer. 2002 – La pêche aux petits métiers en Languedoc-Roussillon en 2000-2001. Report IFREMER Sète.
- Ifremer. 2007 – Small-Scale Coastal Fisheries in Europe, Final report of the EU contract No FISH/2005/10, 447 p.
- Jackson, G.D., Alford, R.A., Choat, J.H., 2000. Can length frequency analysis be used to determine squid

growth? An assessment of ELEFAN. ICES J. Mar. Sci. 57, 948-954.

Jackson, G.D., Forsythe, J.F., Hixon, Hanlon, R.T., 1997. Age, growth and maturation of *Lolliguncula brevis* (Cephalopoda: Loliginidae) in the Northwestern Gulf of Mexico with a comparison of length-frequency vs statolith age analysis. Can. J. Fish. Aquat. Sci. 54, 2920-2929.

Jensen, A.L. (1996). Beverton and Holt life history invariants result from optimal trade-off of reproduction and survival. Can. J. Fish. Aquat. Sci., 53: 820-822.

Johannesson, K.A., & Mitson, R.B. (1983). Fisheries Acoustics - FAO Fisheries Technical Paper N.240:249pp.

Jones R. 1981 – The use of length composition data in fish stock assessment (with notes on VPA and Cohort Analysis) *FAO Fisheries Circular* 734, 46pp.

Jukić, S. 1971 – Studies on the population and catchability of Norway lobster in the central Adriatic. *FAO Stud. Rev.*, 48: 27-52.

Jurado-Molina, J., 2010. A Bayesian framework with implementation error to improve the management of the red octopus (*Octopus maya*) fishery off the Yucatan Peninsula. *Ciencias Marinas* 36, 1-14.

Kallianiotis, A., & Mazzola, S. (2002). Final report of EC-DG XIV study project “Study on purse seine activity in Eastern and Central Mediterranean” (MED 99-035).

Karlovac O. 1949 – *Le Parapenaeus longirostris* (H. Lucas) de la haute Adriatique. *Acta Adriat.*, 3(12): 407-418.

Karlovac, O. 1953 – An ecological study of *Nephrops norvegicus* (L) of the high Adriatic. *Izv. rep. Rib.biol. Eksp. Hvar* 1948-49, 5(2C): 1-50.

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

Klaoudatos S.D., Iakovopoulos G. (2004). *Pagellus erythrinus* (common Pandora): a promising candidate species for enlarging the diversity of aquaculture production. *Aquaculture International*, v. 12, n. 3, p. 299-320.

Lagardere J.P. 1972 – Recherches sur l'alimentation des crevettes de la pente continentale marocaine. *Tethys* 3(3) : 655-675.

Leonart J and Salat J. 1992 – VIT. Programa de analisis de pesquerias. *Inf. Tec. Sci. Mar.* 168-169 : 116.

Leonart J., Salat J., 2000. Vit4winVersion 1.1. www.faocopemed.org/es/activ/infodif.htm

Leonart J., Salat J., 1997. VIT: Software for fishery analysis. User's manual. FAO Computerised Information Series. Fisheries, 11: 107 p.

Lloret J, Zaragoza N, Caballero D and Riera V. 2008 – Biological and socioeconomic implications of recreational boat fishing for the management of fishery resources in the marine reserve of Cap de Creus (NW Mediterranean). *Fisheries Research* 91:252–259.

Lo Bianco S. (1909). Notizie biologiche riguardanti specialmente il periodo di maturità sessuale degli animali del Golfo di Napoli. *Mitth. Zool. Stat. Neapel*, 19: 513 p.

Lo Bianco S. (1931-33). Fauna e flora del Golfo di Napoli: Uova, larve e stadi giovanili di Teleostei. Eggs, larvae and juvenile stages of Teleostei. Jerusalem, Israel. Program for Scientific Translations, IPST No 1515: 417 pp. *Trnsl. of Monogr. Stn. Zool. Napoli* (38) Pts 1-2 (1931-33).

Lucchetti A., 2008. Comparison of diamond- and square-mesh codends in the hake (*Merluccius merluccius* L. 1758) trawl fishery of the Adriatic Sea (central Mediterranean). *Scientia Marina* 72(3): 451-460.

Machias A, Somarakis S and Tsimenides N. 1998 – Bathymetric distribution and movements of red mullet *Mullus surmuletus*. *Marine Ecology Progress Series*, 166(0): 247-257.

MacLennan D.N. and Simmonds E.J. 1992 – Fisheries Acoustics. Chapman and Hall, London.

MacLennan, D.N., Fernandes, P.G., and Dalen, J. (1996). A consistent approach to definitions and symbols in fisheries acoustics. - *ICES Journal of Marine Science*, 59:365-369.

Mace P., Sissenwine M. P. (1993). How much Spawning per Recruit is Enough?. In: Smith S.J., Hunt J.J. and Rivard D. (eds) Risk evaluation and biological reference points for fisheries management. *Can Spec. Publ. Fish. Aquat. Sci.* 120:101-118

Madigan, D. and York, J. 1995. Bayesian graphical models for discrete data. *International Statistical Review*, 93(2): 215-232.

- Mamuris Z, Apostolidis A.P and Triantaphyllidis C. 1998 – Genetic protein variation in red mullet (*Mullus barbatus*) and striped red mullet (*M. surmuletus*) populations from the Mediterranean Sea. *Mar. Biol.* 130(3): 353-360.
- Mamuris Z, Stamatis C, Moutou K.A, Apostolidis A.P and Triantaphyllidis C. 2001 – RFLP Analysis of mitochondrial DNA to evaluate genetic variation in striped red mullet (*Mullus surmuletus* L.) and red mullet (*Mullus barbatus* L.) populations. *Marine Biotechnology* 3: 264-274.
- Manning, R.B., 1977 – A monograph of the West African Stomatopod Crustacea. *Atlantide Report*, 12: 1-181.
- Mannini, P., Massa F. and Milone, N. 2004 – Adriatic fisheries: outline of some main facts. In *AdriaMed Seminar on Fishing Capacity: Definition, Measurement and Assessment*. GCP/RER/010/ITA/TD-13, FAO-AdriaMed.
- Mannini A, 2010 – Approfondimenti conoscitivi sulla pesca a strascico ligure (la pesca di scarpata). Relazione finale: 38 pp.
- MATTIANGELI V., RYAN A. W., GALVIN P., MORK J., CROSS T. F. 2003 - Eastern and Western poor cod (*Trisopterus minutus capelanus*) populations in the Mediterranean Sea: evidence from allozyme and minisatellite loci. *PSZN Marine Ecology*, 24 (3):1-12.
- Marano, G., Ungaro, N., Marano, C.A., Marsan, R. (1998) La ricerca sulle risorse demersali del bacino Adriatico sud-occidentale (anni 1985-97): sintesi dei risultati. *Biol. Mar. Medit.*, 5 (3): 109-119.
- Metin G., Ilkyaz A.T., Soykan O., Kinacigil H.T. 2011 – Biological characteristics of the common Pandora, *Pagellus erythrinus* (Linnaeus, 1758), in the central Aegean Sea. *Turkish Journal of Zoology* 35 (3): 307-315.
- Murenu M, M Muntoni and Cau A. 2010 – Spatial characterization of fishing areas and fleet dynamics in the Central Mediterranean: GIS application to test VMS usefulness. In: Nishida T, Kailola PJ and Caton AE (eds) *The Fourth Symposium on GIS/Spatial analysis in fishery and aquatic sciences*, Vol 4: 381-398.
- Mytilinéou, C., 1989. Données biologiques sur le pageot, *Pagellus erythrinus*, des côtes orientales de la Grèce centrale. *FAO Fish. Rep.*, 412, Rome, 77-82.
- National Research Council. 1999 – *Sustaining Marine Fisheries*. National Academy Press, Washington, DC.
- National Research Council. 2006 – *Review of Recreational Fisheries Survey Methods*. National Academy Press, Washington, DC.
- Needle C.L. 2003 – Survey based assessment with SURBA. Working document to the ICES WGMFSA, Copenhagen, 29 January to 5 February 2003.
- O'Brien C.M, Pilling G.M, Brown C. 2004 – Development of an estimation system for U.S. longline discard estimates. In Payne, A., O'Brien, C. and Rogers, S. (Eds). *Management of shared fish stocks*. Blackwell Publishing, Oxford. 384pp.
- Ordines F., E. Massutí, B. Guijarro and R. Mas. Diamond vs. square mesh codend in a multi-species trawl fishery of the western Mediterranean: effects on catch composition, yield, size selectivity and discards. 2006. *Aquatic Living Resources*, 19: 329-338.
- Orsi Relini L and Relini G. 1979 – Pesca e riproduzione del gambero rosso *Aristeus antennatus* (Decapoda Penaeidae) nel Mar Ligure. *Quaderni della Civica Stazione Idrobiologica di Milano* 7: 39-62.
- Orsi Relini L and Pestarino M. 1981 – Riproduzione e distribuzione di *Aristeus antennatus* (Risso, 1816) sui fondi batiali liguri. Nota preliminare. *Quaderni Laboratorio Tecnologia della Pesca* 3(1): 123-133.
- Orsi Relini L and Semeria M. 1983 – Oogenesis and fecundity in bathyal penaeid prawns, *Aristeus antennatus* and *Aristaeomorpha foliacea*. *Rapport Commission Internationale Mer Méditerranée* 28(3): 281-284.
- Orsi Relini L., Peirano A. 1983 – A length-age key for *Micromesistius poutassou* (Risso), Osteichthyes, Gadidae, of the Ligurian Sea. *Rapp. Comm. Int. Mer. Medit.*, 28 (5): 49-52.
- Orsi Relini L., Peirano A. 1985 – Biological notes on the blue whiting, *Micromesistius poutassou* Risso, of the Ligurian Sea. *FAO Fish. Rep.*, 336: 113-117.
- Orsi Relini L., Romeo G. (1985). Vertical distribution, age, growth and mortality of *Pagellus erythrinus* on trawled areas of Ligurian Sea. *Rapp. Comm. Int. Mer Médit.*, 29 (8): 103-106.
- Orsi Relini L and Relini G. 1998 – An uncommon recruitment of *A. antennatus* (Risso) (Crustacea Decapoda Aristeidae) in the Gulf of Genoa. *Rapport Commission Internationale Mer Méditerranée*, 31:10.
- Orsi Relini L and Relini G. 1998 – Long term observations of *Aristeus antennatus*: size-structures of the fished stock and growth parameters, with some remarks about the "recruitment". *Cahiers Options Méditerranéennes*, 35: 311-322.
- Orsi Relini L., Relini G. (1998). Seventeen instars of adult life in female *Aristeus antennatus* (Crustacea: Decapoda: Aristeidae). A new interpretation of life span and growth. *Journal of Natural History*, 32: 1719-1734.

- Orsi Relini, L., Zamboni, A., Fiorentino, F., Massi, D. 1998 – Reproductive patterns in Norway lobster *Nephrops norvegicus* (L.) of different Mediterranean areas. *Scientia Marina*, 62 (Suppl.1), 25-41.
- Orsi Relini, L., Mannini, A. and Relini, G. (2012), Updating knowledge on growth, population dynamics, and ecology of the blue and red shrimp, *Aristeus antennatus* (Risso, 1816), on the basis of the study of its instars. *Marine Ecology*. doi: 10.1111/j.1439-0485.2012.00528.x
- Pajuelo J.G, Lorenzo J.M, Ramos A.G and Mendez-Villamil M. 1997 – Biology of the red mullet *Mullus surmuletus* (Mullidae) off the Canary Islands, Central-East Atlantic. *South African Journal of Marine Science* 18 (1): 265-272.
- Pajulero J. G., Lorenzo J.M. 1998 – Population biology of the common Pandora *Pagellus erythrinus* (Pisces: Sparidae) off the Canary Islands. *Fish. Res.*, v. 36, n. 2-3, p. 75-86, 1998.
- Pauly D. 2006 – Major trends in small-scale marine fisheries, with emphasis on developing countries, and some implications for the social sciences. *Maritime Studies* 4:7–22.
- Pastorelli A.M., Vaccarella, R., Marano, G., Ungaro, N. (1996) I crostacei dei fondi strascicabili del basso Adriatico. *Nova Thalassia*, 12: 27-35..
- Patterson, K. (1992). Fisheries for small pelagic species: an empirical approach to management targets. *Review of Fish Biology and Fisheries*, 2: 321-338.
- Patti, B., Bonanno, A., Basilone, G., Goncharov, S., Mazzola, S., Buscaino, G., Cuttitta, A., García Lafuente, J., García, A., Palombo, V. and Cosimi, G. (2004). Interannual fluctuations in acoustic biomass estimates and in landings of small pelagic fish populations in relation to hydrology in the Strait of Sicily. *Chemistry and Ecology*, 20(5), 365-375.
- Patti, B., Venezia, S., Piazza, I., Basilone, G., Patti, C., Caruana, L. and Mazzola, S. (2007). Final Report of Project CAS.FO. "Cattura e sforzo di piccoli pelagici nel Canale di Sicilia per la gestione delle risorse pescabili". In Italian. Regolamento C.E.E. n. 1263/99 – SFOP – Misura n 4.17 – Sottomisura B.
- Patti, B., Guisande, C., Bonanno, A., Basilone, G., Cuttitta, A., Mazzola, S. (2010). Role of physical forcings and nutrient availability on the control of satellite-based chlorophyll a concentration in the coastal upwelling area of the Sicilian Channel. *Scientia Marina*, 74(3), 577-588.
- Pauly, D. (1980). On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. *J. Cons. Int. Explor. Mer*, 39 (3): 175-192.
- Piccinetti, C., and Piccinetti Manfrin, G., 1970 – Osservazioni su alcuni aspetti della biologia di *Squilla mantis* L. Pubblicazioni della Stazione Zoologica, Napoli; 38 suppl/: 119-124.
- Piccinetti, C., and Piccinetti Manfrin, G., 1971 – Osservazioni sulla pesca biologia di *Squilla mantis* L. Note del Laboratorio di Biologia marina e Pesca Fano; 4: 27-38.
- Pierce, G.J., Bailey, N., Robin, J.-P., 1996. Stock assessment for *Loligo* spp. in the Northeast Atlantic. International Council for the Exploration of the Sea CM 1996/K:23.
- Pierce, G.J., Boyle, P.R., 2003. Empirical modelling of interannual trends in abundance of squid (*Loligo forbesi*) in Scottish waters. *Fish. Res.* 59, 305-326.
- Pierce, G.J., Guerra, A., 1994. Stock assessment methods used for cephalopod fisheries. *Fish. Res.* 21, 255-285.
- Piet G.J. Abella A.J, Aro E, Farrugio H, Lleonart J, Lordan C, Mesnil B, Petrakis G, Pusch C, Radu G and Rätz H-J. 2010 – Marine Strategy Framework Directive, Task Group 3 Report. Commercially exploited fish and shellfish. JRC Scientific and Technical Reports, joint JRC and ICES report, editors H. Dörner and R. Scott. Luxembourg (Luxembourg): OPOCE; 2010. ISSN 1018-5593, 82 pp.
- Police, G., 1908 – Sul sistema nervoso viscerale della *Squilla mantis*. *Mittheilungen aus den Zoologische Station zu Neapel*, 19: 144-148, pl. 8.
- Pope J. and Shepherd J.G. 1985 – A comparison of the performance of various methods for tuning VPA's using effort data. *Journal du Conseil International pour l'Exploration de la Mer*, 42: 129-151.
- Prager M. H. 1994 – A suite of extensions to a non-equilibrium surplus-production model. *Fishery Bulletin*, Vol 92: 374-389.
- Quetglas A., B. Guijarro, F. Ordines and E. Massutí. Stock boundaries for fisheries assessment and management in the Mediterranean: the Balearic Islands as a case study. 2012. *Scientia Marina*, 76(1): 17-28.
- Ragonese S., Bianchini M. L. 1998 – Growth, mortality and yield-per-recruit of the poor cod, *Trisopterus minutus capelanus*, from the Strait of Sicily. *NAGA, The ICLARM Quarterly*, 21 (1): 61-70.
- Ragonese S., Andreoli M.G., Bono G., Giusto G.B., Rizzo P., Sinacori G. (2004). Overview of the available

- biological information on demersal resources of the Strait of Sicily. In MedSudMed. 2004. Report of the Expert Consultation on the Spatial Distribution of Demersal Resources in the Straits of Sicily and the Influence of Environmental Factors and Fishery Characteristics. GCP/RER/010/ITA/MSM-TD-02. *MedSudMed Technical Documents*, 2: 102 pp.
- Ragonese S., Abella A., Fiorentino F., Spedicato M.T. 2006 – Metodi per la stima del tasso istantaneo di mortalità naturale (M) nella scienza alieutica con particolare riferimento alla realtà mediterranea. *Biol. Mar. Medit.*, 13 (3): 151 pp.
- Rätz H-J, Bethke E, Dörner H, Beare D and Gröger J. 2007 – Sustainable management of mixed demersal fisheries in the North Sea through fleet-based management-a proposal from a biological perspective. *ICES Journal of Marine Science*, 64: 652-660.
- Rätz, H-J., & Cheilari, A. (2009). Coincidence between trends in MEDITS biomass indices and landings of selected demersal Mediterranean stocks and its potential use for data validation and short term predictions. STECF SGMED 09-03 Working paper.
- Relini G., Orsi Relini L. (1987) - The decline of red shrimps stocks in the Gulf of Genoa. *Inv. Pesq.*, 51 (Supl.1): 245-260.
- Relini, G., Bertrand, J., Zamboni, A. (eds.) (1999) Synthesis of the knowledge on bottom fishery resources in Central Mediterranean (Italy and Corsica). *Biol. Mar. Medit.*, 6 (suppl. 1).
- Relini M, Maiorano P, D'Onghia G, Orsi Relini L, Tursi A and Panza M. 2000 – A pilot experiment of tagging the deep shrimp *Aristeus antennatus* (Risso, 1816). *Scientia Marina*, 64: 357-361.
- Relini M, Maiorano P, D'Onghia G, Orsi Relini L, Tursi A and Panza M. 2004 – Recapture of tagged deep-sea shrimp *Aristeus antennatus* (Risso, 1816) in the Mediterranean Sea. *Rapport Commission Internationale Mer Méditerranée*, 37: 424.
- Renones O, Massuti E. and Morales Nin B. 1995 – Life history of the red mullet *Mullus surmuletus* from the bottom-trawl fishery off the Island of Majorca (north-west Mediterranean). *Marine Biology*, 123 (3): 411-419.
- Repetto N., Rebora F., Costa M., Minetti D., Cavassa M. (1991). Distribuzione di *Phycis blennoides* Brünnich (Osteichthyes, Gadidae), *Mullus barbatus* L. (Osteichthyes, Mullidae) ed *Helicolenus dactylopterus* Delaroché (Osteichthyes, Scorpaenidae) in Mar Ligure occidentale. *Ricerche Biologia Selvaggina*, 14 (suppl.): 113-117.
- Ricker W. 1975 – Computation and Interpretation of biological statistics of fish populations. *Bull. Fish. Res. Bd. Canada* 191, 382 pp.
- Righini P, Abella A. 1994 – Life cycle of *Aristeus antennatus* and *Aristaeomorpha foliacea* in the Northern Tyrrhenian Sea. *N.T.R.-I.T.P.P. Special Publication*, 3: 29-30.
- Robert, M., Faraj, A., McAllister, M.K., Rivot, E., 2010. Bayesian state-space modelling of the De Lury depletion model: strengths and limitations of the method, and application to the Moroccan octopus fishery. *ICES J. Mar. Sci.* 67, 1272-1290.
- Rochet M.J., Trenkel V.M., 2003. Which community indicators can measure the impact of fishing? A review and proposals. *Canadian Journal of Fisheries and Aquatic Science*, 60: 86-99.
- Roel, B.A., Butterworth, D.S., 2000. Assessment of the South African chokka squid *Loligo vulgaris reynaudii*: Is disturbance of aggregations by the recent jig fishery having a negative impact on recruitment? *Fish. Res.* 48, 213-228.
- Rosenberg, A.A., Kirkwood, G.P., Crombie, J.A., Beddington, J.R., 1990. The assessment of stocks of annual squid species. *Fish. Res.* 8, 335-350.
- Royer, J., Peries, P., Robin, J.P., 2002. Stock assessments of English Channel loliginid squids: updated depletion methods and new analytical methods. *ICES J. Mar. Sci.* 59, 445–457.
- Sabates A. 1990 – Changes in the heterogeneity of mesoscale distribution patterns of larval fish associated with a shallow coastal haline front. *Estuarine Coastal and Shelf Science* 30 (2): 131-140.
- Sabatella E., Piccinetti C., 2004. Example of capacity assessment of a Mediterranean fishery and relevant bio-economic indicators. In *AdriaMed Seminar of Fishing Capacity: definition, measurement and assessment*, *AdriaMed Technical Documents*, 13: 27 pp.
- Sardà F., D'Onghia G., Politou C.-Y., Company J.B., Maiorano P., Kapiris K. (2004). Maximum deep-sea distribution and ecological aspects of *Aristeus antennatus* in the western and central Mediterranean Sea. *Sci. Mar.*, 68 (3): 117-127.
- Scaccini, A. (1947) L'accrescimento e la proporzione dei sessi nella popolazione adriatica di *Mullus barbatus* Rond. . *Note Lab. Biol. Mar. Fano*, 1(3):17-24

- SAMED, 2002 – Stock Assessment in the MEDiterranean. European Commission – DG XIV, Project 99/047 – Final Report.
- Santos, M.N., Monteiro, C.C., Erzini, K. (1995). Aspects of the biology and gillnet selectivity of the axillary seabream (*Pagellus acarne*, Risso) and common Pandora (*Pagellus erythrinus*, Linnaeus) from the Algarve (south Portugal). *Fisheries Research* 23, 223-236.
- Sánchez P., Sartor P., Recasens L., Ligas A., Martin J., De Ranieri S., Demestre M, 2007. Trawl catch composition during different fishing intensity periods in two Mediterranean demersal fishing grounds. *Scientia Marina*, 71(4): 765-773.
- Sardà F., D'Onghia G., Politou Ch.Y., Company J.B., Maiorano P., Kapiris K. 2004 – Deep-sea distribution, biological and ecological aspects of *Aristeus antennatus* (Risso, 1816) in the western and central Mediterranean Sea. *Sci. Mar.* 68 (Suppl. 3): 117- 127.
- Sartor P., Sbrana M., Viva C. (1990). Gadiformes (Pisces, Osteichthyes) dell' Arcipelago Toscano meridionale: distribuzione e abbondanza. *Atti VI Convegno Nazionale Associazione "Alessandro Ghigi" per la biologia dei Vertebrati*: 145-147.
- Sartor P., Biagi F. (1992). Feeding of *Phycis blennoides* (Brünnich, 1768) in the northern Tyrrhenian Sea: a preliminary note. *Rapp. Comm. Int. Mer Médit*, 33: 310.
- Sartor P. 1993 – Alimentazione e reti trofiche di pesci demersali di platea e scarpata continentale nel mar Tirreno settentrionale. Tesi Dottorale, Univ. Pisa, 239 pp.
- Sartor P. (1995). Regime alimentare di osteitti gadiformi nel Mar Tirreno Settentrionale. *Att. Soc. Tosc. Sc. Nat. Serie B*, 102: 59-67.
- Sato, T., Hatanaka, H., 1983. A review of assessment of Japanese distant-water fisheries for cephalopods. In: J.F. Caddy (Ed.), *Advances in Assessment of World Cephalopod Resources*. Fish. Tech. Pap. 231, FAO, Rome, pp. 145-203.
- Sauer, W., Potts, W., Raberinary, D., Anderson, J., Perrine, M., 2011. Assessment of current data for the octopus resource in Rodrigues, western Indian Ocean. *Afr J Mar Sci* 33, 181-187.
- Saville A. 1977 - Survey methods of appraising fisheries resources. *FAO Fish.Tech.Pap.*, (171): 76 pp.
- Scott F., Osio C., Cardinale M. (2011). Comparison of age slicing methods. Working document in support to the STECF Expert Working Group 11-12 Assessment of the Mediterranean Sea stocks – part II. JRC Technical Notes, 26pp.
- Schaefer, M.B. 1954. Some aspects of the dynamics of populations important to the management of commercial marine fisheries. *Bull Inter-Amer Trop Tuna Commission* 1:27-56.
- Serena F and Abella A. 1999a – *Raja clavata*. In Relini G., J. A. Bertrand and A. Zamboni (eds), *Synthesis of Knowledge on Bottom Fishery Resources in Central Mediterranean (Italy and Corsica)*. *Biol. Mar. Medit.* 6 (1): 87-93.
- Serena F. 2005 – Field identification guide to the sharks and rays of the Mediterranean and Black Sea. *Fao Species Identification Guide for Fishery Purpose*. Rome, FAO. 95p. 11 colour plates+egg capsules.
- Seridji R. 1971 – Contribution a l'étude des larves crustaces decapods en baie d'Alger. *Pelagos*, 3 (2) : 1-105.
- Shepherd J.G. 1999 – Extended survivors analysis: An improved method for the analysis of catch-at-age data and abundance indices. *ICES J. Mar. Sci* 56: 584–591.
- Simón, F., Rocha, F., Guerra, A., 1996. The small-scale squid hand-jig fishery off the northwestern Iberian Peninsula: application of a model based on a short survey of fishery statistics. *Fish. Res.* 25, 253-263.
- Simmonds, E.J., Campbell, A., Skagen, D., Roel, B.A., and Kelly, C. 2011. Development of a stock-recruit model for simulating stock dynamics for uncertain situations: the example of Northeast Atlantic mackerel (*Scomber scombrus*). *ICES Journal of Marine Science*, **68**: 848-859
- Simpfendorfer C. A. 1999 – Demographic analysis of the dusky shark fishery in southwestern Australia, p. 149-160. In: *Life in the slow lane. Ecology and conservation of long-lived marine animals*. J. A. Musick (ed.). American Fisheries Society Symposium 23, Bethesda, Maryland.
- Sinovčić G. 1984 – Summary of biological parameters of sardine (*Sardina pilchardus* WALB.) From the Central Adriatic. *FAO Fish.Rep.*, 290: 147-148.
- Somarakis S. 2005 – Marked interannual differences in reproductive parameters and daily egg production of anchovy in the northern Aegean Sea. *Belgian Journal of Zoology*, 134: 123–132.
- Somarakis S, Palomera I, Garcia A, Quintanilla L, Koutsikopoulos C, Uriarte A and Motos L. 2004 – Daily egg production of anchovy in European waters. *ICES Journal of Marine Science* 61: 944-958.
- Somarakis S and Nikolioudakis N. 2007 – Oceanographic habitat, growth and mortality of larval anchovy (*Engraulis encrasicolus*) in the northern Aegean Sea (eastern Mediterranean). *Mar. Biol.* 152: 1143–1158

- Somarakis S. 1999 – Ichthyoplankton of the Northeastern Aegean Sea with emphasis on anchovy *Engraulis encrasicolus* (Linnaeus, 1758) (June 1993, 1994, 1995, 1996). PhD Thesis, University of Crete (in Greek with English Abstract).
- Spedicato M.T., Lembo G., Carbonara P., Silecchia T. (1994) - A first attempt to estimate biological parameters and dynamics of *Aristaeomorpha foliacea* in the Southern Tyrrhenian Sea. In "Life cycles and fisheries of deep water red shrimps *Aristaeomorpha foliacea* and *Aristeus antennatus*". Proceedings of the International Workshop held in the Istituto di Tecnologia della Pesca e del Pescato (ITPP - CNR), Mazara del Vallo (Italy), 28-30 Aprile 1994. *N.T.R. - I.T.P.P. Special Publication, n. 3*: 35-36.
- Spedicato M.T., Greco S., Lembo G., Perdichizzi F., Carbonara P. (1995) - Prime valutazioni sulla struttura dello stock di *Aristeus antennatus* (Risso, 1816) nel Tirreno Centro-Meridionale. *Biol. Mar. Medit.*, **2** (2): 239-244.
- Spedicato M.T., Lembo G., Silecchia T., Carbonara P. (1998) - Contributo alla valutazione dello stato di sfruttamento del gambero rosso (*Aristaeomorpha foliacea*, Risso, 1827) nel Tirreno Centro-Meridionale. *Biol. Mar. Medit.*, **5** (2): 252-261.
- Spedicato M.T., Silecchia T., Carbonara P. (1999) – *Aristeus antennatus*. In: *Sintesi delle conoscenze sue risorse da pesca dei fondi del Mediterraneo Centrale (Italia e Corsica)*. Relini G., Bertrand J., Zamboni A (eds.). *Biol. Mar. Medit.*, **6** (suppl. 1): 517-530.
- Spedicato M.T, Greco S, Sophronidis K, Lembo G, Giordano D, Argyri A. 2002 – Geographical distribution, abundance and some population characteristics of the species of the genus *Pagellus* (Osteichthyes: Perciformes) in different areas of the Mediterranean. *Scientia Marina*, Vol 66 (2): 65-82.
- Sumner NR and Williamson P. 1999 – A 12-month survey of coastal recreational boat fishing between Augusta and Kalbarri on the west coast of Western Australia during 1996-97. FISHERIES RESEARCH REPORT NO. 117. Report Fisheries Western Australia.
- Tahvonon, O., 2008. Harvesting an age structured population as biomass: does it work? *Natural Resource Modeling*, 21(4): 525-550.
- Tsagarakis K, Somarakis S, Machias A, Giannoulaki M, Valavanis V, Palialexis A and Papaconstantinou C. 2007 – Preliminary analysis of the habitat characteristics of anchovy and sardine in the Aegean Sea in relation to fish size. Proceedings of the 38th CIESM Congress, Istanbul (Turkey), April 2007, 621 pp.
- Tsagarakis K, Somarakis S, Machias A, Giannoulaki M, Valavanis D.V and Palialexis A. 2008 – Habitat discrimination of juvenile sardines in the Aegean Sea using remotely sensed environmental data. *Hydrobiologia*, 612: 215-223.
- Tserpes, G. 2008. Estimates of the Mediterranean swordfish stock by means of a non-equilibrium surplus production model approach. *Collect Vol Sci Pap ICCAT* 61: 1084-1087.
- Tugores, M.P., Giannoulaki, M., Iglesias, M., Bonanno, A., Tičina, V., Leonori, I., Machias, A., Tsagarakis, K., Díaz, N., Giráldez, A., Patti, B., De Felice, A., Basilone, G., Valavanis, V. (2011) Habitat suitability modeling for sardine (*Sardina pilchardus*) in a highly diverse ecosystem: the Mediterranean Sea. *Marine Ecology Progress Series*, 443: 181–205.
- Ulrich C, Reeves S A, Vermard Y, Holmes S J, and Vanhee W. 2011 – Reconciling single-species TACs in the North Sea demersal fisheries using the Fcube mixed-fisheries advice framework. *ICES Journal of Marine Science*; doi:10.1093/icesjms/fsr060, 13 pp.
- Ungaro, N., Marano, G., Marsan, R., Pastorelli, A.M., (1999) On the reproduction of *Nephrops norvegicus* (L.) in the Southern Adriatic Sea (Mediterranean Sea): sex ratio, maturity length and potential fecundity. *Crustacean Issues*, 12: 553-561.
- Ungaro, N., Gramolini, R., 2006. Possible effect of bottom temperature on distribution of *Parapenaeus longirostris* (Lucas, 1846) in the Southern Adriatic (Mediterranean Sea). *Turkish Journal of Fisheries Aquatic Sciences* 6, 109-115.
- Ünsal, N., 1984. Determination of the sparids (Sparidae) of the Sea of Marmara and researchs on the biology of two dominant species, common Pandora (*Pagellus erythrinus*) and annular bream (*Diplodus annularis*). *Ist. Univ. Fen. Fak. Mec.Seri B*, 49, 99-118.
- Vrgoc N., Arneri E., Jukic-Peladic S., Krstulovic Sifner S., Mannini P., Marceta B., Osmani K., Piccinetti C., Ungaro N., 2004. Review of current knowledge on shared demersal stocks of the Adriatic Sea. *AdriaMed Technical Documents*, 12: 91pp

- Voliani A., Abella A. (1998). Stime di selettività su *Mullus barbatus* con differenti metodologie e alcune considerazioni sulla loro validità. *Biol. Mar. Medit.* 5 (2): 457-464
- Voliani A., Abella A., Auteri A., (1998). Some considerations on the growth performance of *Mullus barbatus*. *Cahiers Options Médit.* 35:93-106
- Wheeler A. 1969 – The fishes of the British Isles and north-west Europe. Macmillan, London. 613 pp.
- Young, I.A.G., Pierce, G.J., Daly, H.I., Santos, M.B., Key, L.N., Bailey, N., Robin, J.P., Bishop, A.J., Stowasser, G., Nyegaard, M., Cho, S.K., Rasero, M., Pereira, J.M.F., 2004. Application of depletion methods to estimate stock size in the squid *Loligo forbesi* in Scottish waters (UK). *Fish. Res.* 69, 211-227.
- Young, I.A.G., Pierce, G.J., Murphy, J., Daly, H.I., Bailey, N., 2006. Application of the Gómez-Muñoz model to estimate catch and effort in squid fisheries in Scotland. *Fish. Res.* 78, 26-38.

ANNEX I LIST OF PARTICIPANTS TO STECF EWG 12-19

¹ - Information on STECF members and invited experts' affiliations is displayed for information only. In some instances the details given below for STECF members may differ from that provided in Commission COMMISSION DECISION of 27 October 2010 on the appointment of members of the STECF (2010/C 292/04) as some members' employment details may have changed or have been subject to organisational changes in their main place of employment. In any case, as outlined in Article 13 of the Commission Decision (2005/629/EU and 2010/74/EU) on STECF, Members of the STECF, invited experts, and JRC experts shall act independently of Member States or stakeholders. In the context of the STECF work, the committee members and other experts do not represent the institutions/bodies they are affiliated to in their daily jobs. STECF members and invited experts make declarations of commitment (yearly for STECF members) to act independently in the public interest of the European Union. STECF members and experts also declare at each meeting of the STECF and of its Expert Working Groups any specific interest which might be considered prejudicial to their independence in relation to specific items on the agenda. These declarations are displayed on the public meeting's website if experts explicitly authorized the JRC to do so in accordance with EU legislation on the protection of personnel data. For more information: <http://stecf.jrc.ec.europa.eu/adm-declarations>

Name	Address ¹	Telephone no.	Email
STECF members			
Abella, Alvaro	Agenzia Regionale Protezione Ambiente della Toscana Via Marradi 114 57126 Livorno, Italy	Tel.+390586263456 Fax+390586263477	alvarojuan.abella@arpat.toscana.it
Cardinale, Massimiliano	IMR Föreningsgatan 28 45 330 Lysekil, Sweden	Tel.+46730342209 Fax	massimiliano.cardinale@slu.se
Martin, Paloma	CSIC Instituto de Ciencias del Mar Passeig Maritim 37-49 08003 Barcelona, Spain	Tel. +3493 2309552 Fax+3493 2309555	paloma@icm.csic.es
Scarcella, Giuseppe	National Research Council (CNR) L.go Fiera della Pesca 60100 Ancona, Italy	Tel.+390712078846 Fax +3907155313	g.scarcella@ismar.cnr.it
Invited experts			
Bitetto, Isabella	COISPA Tecnologia & Ricerca Via dei trulli 18 70126 Bari, Italy	Tel.+390805433596 Fax+390805433586	bitetto@coispa.it
Carpi, Piera	National Research Council (CNR) ISMAR Largo Fiera della Pesca 60100 Ancona, Italy	Tel. +39071207881 Fax +39071207881	piera.carpi@an.ismar.cnr.it
ČIKEŠ KEČ, Vanja	Institute of oceanography and fisheries Set. I. Mestrovica 63 21000 Split Croatia	Tel. +38521408005	cikes@izor.hr
Colloca, Francesco	University of Rome "laSapienza2 V.le dell'Università, 32 185, Rome, Italy	Tel.+390649914763 Fax +39064958259	francesco.colloca@uniroma1.it
Fiorentino, Fabio	CNR_IAMC Via L. Vaccara 61 91026 Mazara del Vallo Italy	Tel.+390923948966 Fax+390923906634	fabio.fiorentino@irma.pa.cnr.it

Guijarro, Beatriz	Spanish Institute of oceanography Apt. 291 7015 Palma de Mallorca Spain	Tel. +34971133739 Fax +34971404945	beatriz@ba.ieo.es
Jadaud, Angélique	IFREMER 1, rue Jean Monnet 34200 Sète, France	Tel. +33499573243 Fax +33499573295	ajadaud@ifremer.fr
Knittweis, Leyla	Malta Centre for Fisheries Science Fort San Lucjan BBG 1283 Marsaxlokk Malta	Tel. +35622293312 Fax +35621659380	leyla.knittweis@gov.mt
De Felice, Andrea	CNR-ISMAR Largo Fiera della Pesca 60125 Ancona, Italy	Tel.+39 071 207881 Fax +39 071 55313	a.defelice@ismar.cnr.it
Mannini, Alessandro	Università di Genova DIP.TE.RIS., Viale Benedetto XV, 3 16132 Genova, Italy	Tel.+390103533015 Fax +39010357888	biolmar@unige.it
Maynou, Francesc	Institut de Ciències del Mar CSIC Psg Marítim de la Barceloneta 37-49, 8003, Barcelona Spain	Tel.+ 34932309500 Fax +34932309555	maynouf@icm.csic.es
Murenu, Matteo	University of Cagliari (DBAE) Viale Poetto,1 09126 Cagliari, Italy	Tel.+390706758017 Fax +390706758022	mmurenu@unica.it
Quetglas, Antoni	Spanish Institute of oceanography Apt. 291 7015 Palma de Mallorca Spain	Tel. +34971401561 Fax +34971404945	toni.quetglas@ba.ieo.es
Recasens, Laura	Institut Ciències Mar Barcelona (ICM-CSIC) Passeig Marítim 37-49 8191 Barcelona Spain	Tel. +3493 2309563 Fax+3493 2309555	laura@icm.csic.es
Rouyer, Tristan	IFREMER 1, rue Jean Monnet 34200 Sète, France	Tel. +33499573237 Fax +33499573295	tristan.Rouyer@ifremer.fr
Sbrana, Mario	Centro Intruniversitario di Biologia Marina Viale Nazario Sauro 4 57128 Livorno, Italy	Tel.+390586260723 Fax+390586260723	msbrana@cibm.it
Spedicato, Maria Teresa	COISPA Via Dei Trulli 18 70126, Bari, Italy	Tel.+390805433596 Fax+390805433586	spedicato@coispa.it
Vrgoc, Nedo	Institute of oceanography and fisheries Set. I. Mestrovica 63 21000 Split Croatia	Tel.+38521408005 Fax	vrgoc@izor.hr
JRC Experts			
Charef, Aymen	Joint Research Centre (IPSC) Maritime Affairs Unit Via E. Fermi, 2749 21027 Ispra (Varese), Italy	Tel.+390332786719 Fax+390332789658	aymen.charef@jrc.ec.europa.eu
Osio, Giacomo Chato	Joint Research Centre (IPSC) Maritime Affairs Unit Via E. Fermi, 2749 21027 Ispra (Varese), Italy	Tel.+390332785948 Fax+390332789658	giacomo-chato.osio@jrc.ec.europa.eu

Millar, Colin	Joint Research Centre (IPSC) Maritime Affairs Unit Via E. Fermi, 2749 21027 Ispra (Varese), Italy	Tel.+390332785208 Fax+390332789658	colin.millar@jrc.ec.europa.eu
European Commission - STECF Secretariat			
Charef, Aymen	Joint Research Centre (IPSC)	Tel.+390332786719 Fax+390332789658	aymen.charef@jrc.ec.europa.eu
Osio, Giacomo Chato	Joint Research Centre (IPSC)	Tel.+390332785948 Fax+390332789658	giacomo-chato.osio@jrc.ec.europa.eu
Millar, Colin	Joint Research Centre (IPSC)	Tel.+390332785208 Fax+390332789658	colin.millar@jrc.ec.europa.eu

– ANNEX II STOCK SUMMARY TABLE

Common name	GSA	Method	Short term	Medium term	Stock status (F_{msy}) in 2011
Norway lobster	1	VIT	Yes		Exploited unsustainably
Blue whiting	1	VIT			Exploited unsustainably
Norway lobster	5	XSA	Yes		Exploited unsustainably
Octopus	5	ASPIC	Yes	Yes	Exploited unsustainably
Black bellied Anglerfish	5	XSA	Yes		Exploited unsustainably
Red shirmp	6	XSA	Yes	Yes	Exploited unsustainably
Anglerfish	6	XSA	Yes		Exploited unsustainably
Norway lobster	6	VIT	Yes		Exploited unsustainably
Red mullet	7	XSA	Yes		Exploited unsustainably
Hake	7	XSA	Yes		Exploited unsustainably
Red mullet	9	ASPIC	Yes	Yes	Exploited unsustainably
Great forkbeard	9	VIT,SURBA			Exploited unsustainably
Squilla mantis	10	VIT	Yes		Exploited unsustainably
Blue and red shrimp	10	SURBA,VIT			Exploited unsustainably
Giant red shrimp	10	SURBA,XSA			Exploited unsustainably
Hake	11	SURBA,XSA			Exploited unsustainably
Red mullet	11	SURBA,XSA	Yes		Exploited unsustainably
Sardine	16	BioDyn	Yes	Yes	Exploited sustainably
Anchovy	16	XSA, BioDyn	Yes		Exploited unsustainably
Hake	17	SURBA,VIT,XSA			Exploited unsustainably
Sardine	17	ICA			Exploited unsustainably
Red mullet	17	VIT,XSA	Yes		Exploited unsustainably
Anchovy	17	ICA			Exploited unsustainably
Sole	17	XSA	Yes		Exploited unsustainably
Hake	18	SURBA, VIT	Yes		Exploited unsustainably
Pink shrimp	18	VIT	Yes		Exploited unsustainably
Red mullet	18	XSA	Yes		Exploited unsustainably
Giant red shrimp	18	VIT			Exploited unsustainably
Giant red shrimp	12-16	SURBA,XSA	Yes		Exploited unsustainably
Common pandora	15&16	XSA	Yes		Exploited unsustainably
Red mullet	15&16	XSA	Yes		Exploited unsustainably
Red mullet	19	XSA,VIT			Exploited unsustainably
Hake	19	XSA			Exploited unsustainably

– LIST OF BACKGROUND DOCUMENTS

Background documents are published on the EWG 12-19 meeting's web page on:

<http://stecf.jrc.ec.europa.eu/web/stecf/ewg19>

European Commission

EUR 25971 EN – Joint Research Centre – Institute for the Protection and Security of the Citizen

Title: REPORT OF THE SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF). 2012 Assessment of Mediterranean Sea stocks part 2 (STECF-13-05).

Author(s):

STECF EWG 12-19 members: Abella, A., Cardinale, M., Martin, P., Scarcella, G., Bitetto, I., Carpi, P., Cikes, K., Colloca, F., De Felice, A., Fiorentino, F., Guijarro, B., Jadaud, A., Knittweis, L., Mannini, A., Maynou, F., Murenu, M., Quetglas, A., Recasens, L., Rouyer, T., Sbrana, M., Spedicato, M. T., Vrgoc, N., Charef, A. Osio, C. G & Millar, C.

STECF members: Casey, J., Abella, J. A., Andersen, J., Bailey, N., Bertignac, M., Cardinale, M., Curtis, H., Daskalov, G., Delaney, A., Döring, R., Garcia Rodriguez, M., Gascuel, D., Graham, N., Gustavsson, T., Jennings, S., Kenny, A., Kirkegaard, E., Kraak, S., Kuikka, S., Malvarosa, L., Martin, P., Motova, A., Murua, H., Nord, J., Nowakowski, P., Prellezo, R., Sala, A., Scarcella, G., Somarakis, S., Stransky, C., Theret, F., Ulrich, C., Vanhee, W. & Van Oostenbrugge, H.

Luxembourg: Publications Office of the European Union

2013 – 618 pp. – 21 x 29.7 cm

EUR – Scientific and Technical Research series – ISSN 1831-9424 (online), ISSN 1018-5593 (print)

ISBN 978-92-79-29905-6

doi:10.2788/89997

Abstract

The Expert Working Group meeting of the Scientific, Technical and Economic Committee for Fisheries EWG 12-19 was held from 10 – 14 December 2012 in Ancona, Italy to assess the status of demersal and small pelagic stocks in the Mediterranean Sea against the proposed FMSY reference point. The report was reviewed and adopted by the STECF during its Spring plenary held from 8 to 12 April 2013 in Brussels (Belgium).

How to obtain EU publications

Our priced publications are available from EU Bookshop (<http://bookshop.europa.eu>), where you can place an order with the sales agent of your choice.

The Publications Office has a worldwide network of sales agents. You can obtain their contact details by sending a fax to (352) 29 29-42758.

As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new standards, methods and tools, and sharing and transferring its know-how to the Member States and international community.

Key policy areas include: environment and climate change; energy and transport; agriculture and food security; health and consumer protection; information society and digital agenda; safety and security including nuclear; all supported through a cross-cutting and multi-disciplinary approach.

The Scientific, Technical and Economic Committee for Fisheries (STECF) has been established by the European Commission. The STECF is being consulted at regular intervals on matters pertaining to the conservation and management of living aquatic resources, including biological, economic, environmental, social and technical considerations.

