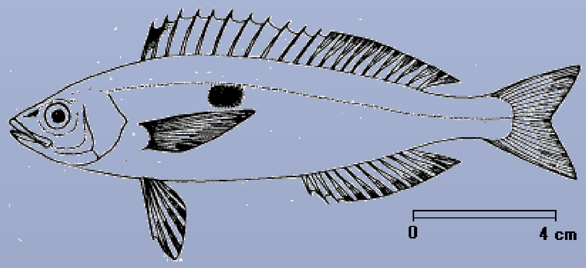

Stock Assessment Form

Demersal species

Reference year: 2012

Reporting year: 2014

Stock assessment of picarel (Spicara smaris) from GSA 25 has been carried out applying tuned VPA (Extended Survivor Analysis - XSA) on the cohorts present during 2005-2012. The results showed fishing mortality fluctuating with an increase from 2006 to 2009 and a rapid decrease from 2009 to 2012. The most recent estimate of fishing mortality (F0-4) is 0.09.Recruitment varied with a decreasing trend during the study period reaching a minimum in 2010, while the spawning stock biomass showed a maximum value in 2007 and a minimum in 2009. Reference points from Yield per Recruit analysis have values of 0.14 and 0.25 for F0.1 and Fmax, respectively. According to the results, the stock is in fully exploitation.

Stock Assessment Form version 1.0 (January 2014)

Uploader: *Marios Josephides*

Stock assessment form

1 Basic Identification Data

Scientific name:	Common name:	ISCAAP Group:
Spicara smaris	Picarel	[ISCAAP Group]
1st Geographical sub-area:	**2nd Geographical sub-area:**	**3rd Geographical sub-area:**
GSA_25	[GSA_2]	[GSA_3]
4th Geographical sub-area:	**5th Geographical sub-area:**	**6th Geographical sub-area:**
[GSA_4]		
1st Country	**2nd Country**	**3rd Country**
Cyprus	[Country_2]	[Country_3]
4thCountry	**5thCountry**	**6thCountry**
Stock assessment method: (direct, indirect, combined, none)		
Indirect		
Authors:		
Marios Josephides[1], Giuseppe Scarcella[2], Constantina Riga[3]		
Affiliation:		
[1] Department of Fisheries and Marine Research, [2] Institute Research Council, [3] FAO- -EastMed		

The ISSCAAP code is assigned according to the FAO 'International Standard Statistical Classification for Aquatic Animals and Plants' (ISSCAAP) which divides commercial species into 50 groups on the basis of their taxonomic, ecological and economic characteristics. This can be provided by the GFCM secretariat if needed. A list of groups can be found here:

http://www.fao.org/fishery/collection/asfis/en

Direct methods (you can choose more than one):

- Acousticssurvey
- Eggproductionsurvey
- Trawlsurvey
- SURBA
- Other (pleasespecify)

Indirect method (you can choose more than one):

- ICA

- VPA
- LCA
- AMCI
- XSA
- Biomassmodels
- Lengthbasedmodels
- Other (pleasespecify)

Combined method: you can choose both a direct and an indirect method and the name of the combined method (please specify)

2 Stock identification and biological information

The stock of picarel is considered as a single stock in GSA 25, though this has not been evidenced by studies on population structure.

2.1 Stock unit

2.2 Growth and maturity

Table 2.2-1: Maximum size, size at first maturity and size at recruitment.

Somatic magnitude measured (LT, LC, etc)			**LT**	**Units**	**cm**
Sex	**Fem**	**Mal**	**Combined**	**Reproduction season**	February-May
Maximum size observed			20	**Recruitment season**	Autumn
Size at first maturity			9.1	**Spawning area**	Shelf
Recruitment size to the fishery				**Nursery area**	Shelf

Table 2-2.2: M vector and proportion of matures by size or age (Males)

Size/Age	Natural mortality	Proportion of matures
3	0.08	0.96
4	0.08	0.99
5	0.2	1.00

Table 2-2.3: M vector and proportion of matures by size or age (Females)

Size/Age	Natural mortality	Proportion of matures
0	0.38	0.80
1	0.12	0.86
2	0.08	0.90

Table 2-3: Growth and length weight model parameters

			Sex			
		Units	female	male	Combined	Years
Growth model	L_∞	cm			19.62	
	K	years-1			0.27	
	t_0	years			-2.01	
	Data source					
Length weight relationship	a				0.007	
	b				3.1	

M (scalar)				
sex ratio (% females/total)				

3 Fisheries information

Picarel (*Spicara smaris*) is the most important demersal fish targeted by bottom trawl fisheries in GSA 25, covering ~ 64% of the total catch. It is exploited in depths ranging from 50-100 meters mainly along the southern coast of Cyprus, and mostly distributed in depths less than 100 m. It inhabits sandy and muddy bottoms. Fishing season has duration of about 7 months starting on 7th of November and ending on 31st of May. Currently there are only 2 trawlers operating in the territorial waters of Cyprus since 2011.

3.1 Description of the fleet

Table 3-1: Description of operational units exploiting the stock

	Country	GSA	Fleet Segment	Fishing Gear Class	Group of Target Species	Species
Operational Unit 1*	CYP	GSA25	E - Trawl (12-24 metres)	03 - Trawls	33 - Demersal shelf species	SPC
Operational Unit 2	[Country2]	[GSA2]	[Fleet Segment2]	[Fishing Gear Class2]	[ISCAAP Group]	
Operational Unit 3	[Country3]	[GSA3]	[Fleet Segment3]	[Fishing Gear Class3]	[ISCAAP Group]	
Operational Unit 4	[Country4]	[GSA4]	[Fleet Segment4]	[Fishing Gear Class4]	[ISCAAP Group]	
Operational Unit 5	[Country5]	[GSA5]	[Fleet Segment5]	[Fishing Gear Class5]	[ISCAAP Group]	
Operational Unit 6	[Country6]	[GSA6]	[Fleet Segment6]	[Fishing Gear Class6]	[ISCAAP Group]	

Table 3.1-2: Catch, bycatch, discards and effort by operational unit in the reference year

Operational Units*	Fleet (n° of boats)*	Catch (T or kg of the species assessed)	Other species caught (names and weight)	Discards (species assessed)	Discards (other species caught)	Effort (units)
CYP 25 E 03 33 - SPC	2	43.3 T	Pagellus erythrinus, Pagellus acarne, Serranus cabrilla	included	Pagellus erythrinus, Serranus hepatus, Lepidotrigla	days
[Operational Unit2]						
[Operational Unit3]						
[Operational Unit4]						
[Operational Unit5]						
Total	2					

3.2 Historical trends

Landings fluctuated between 78 and 1030 t in the period 1970-2012 (data source: DCF, FAO-FishStat, DFMR reports).

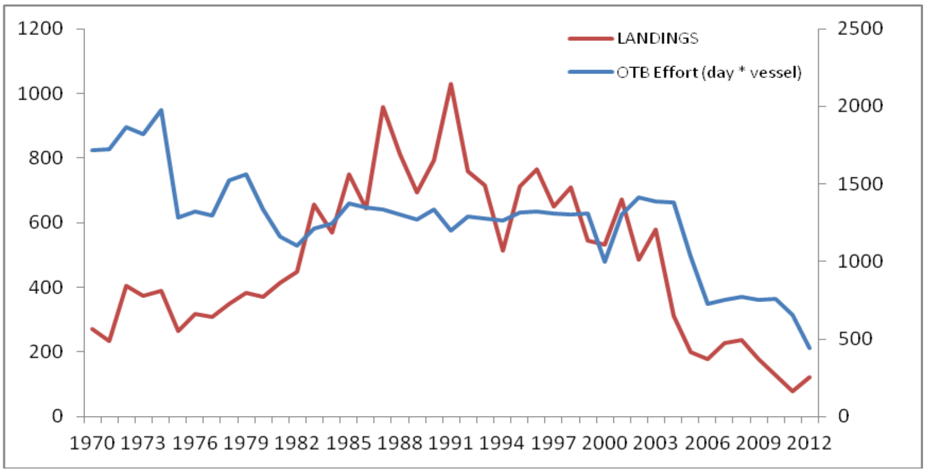

Fig. 1. Landings and effort time series for *S. smaris* in GSA 25 from bottom trawl for the period 1970-2012.

3.3 Management regulations

Maximum number of licenses restricted to 4 in 2006 and to 2 since 2011: fully observed.

Closed trawling period from 1st of June until the 7th of November (in force since 1982 implementing a management plan for the protection of the recruits): fully observed.

Minimum mesh size of trawl net at 50mm (diamond shape): fully observed. Since 2004 the 32mm diamond shape trawl net was replaced by the diamond meshed net of 40mm at the cod-end, while in 2010 it was replaced by the diamond meshed net of 50mm.

Prohibition of bottom trawling at depths less than 50m for the protection of nursery grounds.

3.4 Reference points

Table 3.3-1: List of reference points and empirical reference values previously agreed (if any)

Indicator	Limit Reference point/empirical reference value	Value	Target Reference point/empirical reference value	Value	Comments
B	$B_{0.33}$	477.89 T	$B_{0.66}$	688.78 T	
SSB					
F	F_{max}	0.25	$F_{0.1}$	0.14	
Y					

CPUE					
Index of Biomass at sea					

4 Fisheries independent information

4.1 {TYPE OF SURVEY}

Fill in one section for each of the direct methods used. The name of the section should be the name of the TYPE OF SURVEY.

4.1.1 Brief description of the directmethod used

Description of the survey and method applied. One of several tables would have to be chosen: Egg Production Method, Acoustic survey, Trawl.

Direct methods: trawl based abundance indices

Table 4.1-1: Trawl survey basic information

Survey		**Trawler/RV**	
Sampling season			
Sampling design			
Sampler (gear used)			
Cod –end mesh size as opening in mm			
Investigated depth range (m)			

Table 4.1-2: Trawl survey sampling area and number of hauls

Stratum	**Total surface (km^2)**	**Trawlable surface (km^2)**	**Swept area (km^2)**	**Number of hauls**
Total (… – … m)				

Map of hauls positions

Table 4.1-3: Trawl survey abundance and biomass results

Depth Stratum	**Years**	**kg per km²**	**CV or other**	**N per km²**	**CV or other**
	……				
	……				
	……				
	……				
	……				
Total (… – … m)	……				

*

Comments

- Specify CV or other index of variability of mean
- Specify sampling design (for example random stratified with number of haul by stratum proportional to stratum surface; or systematic on transect;…)
- Specify if catchability coefficient is assumed =1 or other

Direct methods: trawl based length/age structure of population at sea

Slicing method

Report the maturity scale and age slicing method used

Table 4.1-4: Trawl survey results by length or age class

N (Total or sex combined) byLength or Age class	Year		
	....	**....**	**.....**
Total			

Sex ratio by Length or Age class	Year		
	....	**....**	**.....**
Total			

Comments

- Specify if numbers are per km^2 or raised to the area, assuming the same catchability .
- In case maturity ogive has not been estimated by year, report information for groups of years.
- Possibility to insert graphs and trends

Direct methods: trawl based Recruitment analysis

Table 4.1-5: Trawl surveys; recruitment analysis summary

Survey		Trawler/RV	
Survey season			
Cod –end mesh size as opening in mm			
Investigated depth range (m)			
Recruitment season and peak (months)			
Age at fishing-grounds recruitment			
Length at fishing-grounds recruitment			

Table 4.1-6: Trawl surveys; recruitment analysis results

Years	Area in km^2	N of recruit per km^2	CV or other

Comments

- Specify type of recruitment:
  - continuous and diffuse
  - discrete and diffuse
  - discrete and localised
  - continuous and localised.
- Specify the method used to estimate recruit indices
- Specify if the area is the total or the swept one
- Possibility to insert graphs and trends

Direct methods: trawl based Spawner analysis

Table 4.1-7: Trawl surveys; spawners analysis summary

Survey		Trawler/RV	
Survey season			
Investigated depth range (m)			
Spawning season and peak (months)			

Table 4.1-8: Trawl surveys; spawners analysis results

Surveys	Area in km^2	N (N of individuals) of spawners per km^2	CV or other	SSB per km^2	CV or other

Comments

- Specify type of spawner:
  - total spawner
  - sequential spawner
  - presence of spawner aggregations
- Specify if the area is the total or the swept one
- Possibility to insert graphs e trends

4.1.2 Spatial distribution of the resources

Include maps with distribution of total abundance, spawners and recruits (if available)

4.1.3 Historical trends

Time series analysis (if available) and graph of the observed trends in abundance, abundance by age class, etc. for each of the directed methods used.

5 Ecological information

5.1 Protected species potentially affected by the fisheries

A list of protected species that can be potentially affected by the fishery should be incorporated here. This should also be completed with the potential effect and if available an associated value (e.g. bycatch of these species in T)

5.2 Environmental indexes

If any environmental index is used as i) a proxy for recruitment strength, ii) a proxy for carrying capacity, or any other index that is incorporated in the assessment, then it should be included here.

Other environmental indexes that are considered important for the fishery (e.g. Chla or other that may affect catchability, etc.) can be reported here.

6 Stock Assessment

6.1 {XSA}

6.1.1 Model assumptions

Considering the variability observed in the catches and effort, the assessment is based on non-equilibrium method. Fisheries Library in R statistical language was used to implement Extended Survivor Analysis (XSA) as an assessment method. For the XSA model, a shrinkage coefficient of variation (CV) was supplied in order to weight the fishing mortality (F) shrinkage by testing three values of 0.5, 1 and 2. The best model was chosen according to the diagnostics of the residuals. A plus age group was set in the assessment.

Biological reference points of $F_{0.1}$ and F_{max} were estimated from the FLBRP library in R using the Yield per Recruit analysis, while biomass of 33rd and 66th percentile was also calculated to estimate the status of current biomass.

6.1.2 Scripts

<u>FLR script in R</u>

```
#load libraries
library(FLCore)
library(FLEDA)
library(FLXSA)
library(FLAssess)
library(FLash)

#read stock file
spic.stk <- readFLStock("SPIC25.DAT", no.discards=TRUE)
#set up the stock (create the empty matrix)
units(harvest(spic.stk))<-"f"
range(spic.stk)["minfbar"] <- 0
range(spic.stk)["maxfbar"] <- 4

#Set the plus group
spic.stk <- setPlusGroup(spic.stk, 5)

#read index (tuning file)
spic.idx <- readFLIndices("SPICTUN.DAT")

###Set the control object####qage catchability =6 means that q is constant from age 6 , rage=1 q indipendent by stock
```

```
size at age (=1 no constrains),
#shk.yrs=mortality of last 2 years dependent by the previous year mort.
FLXSA.control.spic <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=0.5,
rage=0, qage=3, shk.n=TRUE, shk.f=TRUE, shk.yrs=4, shk.ages=4,
window=100, tsrange=20, tspower=3, vpa=FALSE)

###Final settings
FLXSA.control.spic1 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=1,
rage=0, qage=3, shk.n=TRUE, shk.f=TRUE, shk.yrs=4, shk.ages=4,
window=100, tsrange=20, tspower=3, vpa=FALSE)

FLXSA.control.spic2 <- FLXSA.control(x=NULL, tol=1e-09, maxit=30, min.nse=0.3, fse=2,
rage=0, qage=3, shk.n=TRUE, shk.f=TRUE, shk.yrs=4, shk.ages=4,
window=100, tsrange=20, tspower=3, vpa=FALSE)

#Running the assessments with different settings
spic.xsa <- FLXSA(spic.stk, spic.idx, FLXSA.control.spic)
spic.xsa1 <- FLXSA(spic.stk, spic.idx, FLXSA.control.spic1)
spic.xsa2 <- FLXSA(spic.stk, spic.idx, FLXSA.control.spic2)

#Add the results to the stock files
spic.stk <- spic.stk+spic.xsa
spic.stk1 <- spic.stk+spic.xsa1
spic.stk2 <- spic.stk+spic.xsa2
plot(spic.stk)
plot(spic.stk1)
plot(spic.stk2)

res <- FLQuants("Yield(t)" =quantSums(landings.n(spic.stk)*landings.wt(spic.stk)),
"Fbar(2-4)" = quantMeans(harvest(spic.stk)[as.character(2:4),,,,]),
"R(age 1)" = R <- stock.n(spic.stk)[1,,,,],
"SSB(t)" = ssb(spic.stk))

#catch matrix bubbles plot (spay does standardise the catch with an yearclass)
bubbles(age~year, data=(harvest(spic.stk)), bub.scale=10)

#Plot the different assessments   SSB
spic.ssb <- FLQuants(Sh05=ssb(spic.stk),Sh10=ssb(spic.stk1),Sh20=ssb(spic.stk2))
xyplot(data ~ year, groups = qname, data = spic.ssb, type = "l",
```

```
main = "Stock spawning biomass", ylab = "Tonnes",xlab="Year", auto.key =
list(space = "right", points = FALSE, lines = TRUE))

#Plot the different assessments recruitment
spic.rec <- FLQuants(Sh05=rec(spic.stk),Sh10=rec(spic.stk1),Sh20=rec(spic.stk2))
xyplot(data ~ year, groups = qname, data = spic.rec, type = "l",
main = "Recruitment", ylab = "Thousands",xlab="Year", auto.key =
list(space = "right", points = FALSE, lines = TRUE))

#Plot the different assessments   f at age
spic.F <- FLQuants(Sh05=harvest(spic.stk),Sh10=harvest(spic.stk1),Sh20=harvest(spic.stk2))
xyplot(data ~ year, groups = qname, data = spic.F, type = "p",
main = "F", ylab = "Fbar",xlab="Year", auto.key =
list(space = "right", points = FALSE, lines = TRUE))

#Plot the different assessments   fbar
spic.fbar <- FLQuants(Sh05=fbar(spic.stk),Sh10=fbar(spic.stk1),Sh20=fbar(spic.stk2))
xyplot(data ~ year, groups = qname, data = spic.fbar, type = "l",
main = "F bar", ylab = "F",xlab="Year", auto.key =
list(space = "right", points = FALSE, lines = TRUE))

 #  plot stock summary data for one run
#plot(spic.stk2)
#To estimate the average F per year in certain class
#flq <- apply(harvest(spic.stk)[as.character(1:2)], 2, mean)
#print(xyplot(data ~ year, data = flq, type = "l", main = "Mean f",
#ylab = ""))
#######Diagnostics
diagnostics(spic.xsa)
diagnostics(spic.xsa1)
diagnostics(spic.xsa2)
###Residuals by fleet
bubbles(age ~ year|qname, data = index.res(spic.xsa)
, main = "Proportion at age by year Sh0.5")
bubbles(age ~ year|qname, data = index.res(spic.xsa1)
, main = "Proportion at age by year Sh1")
bubbles(age ~ year|qname, data = index.res(spic.xsa2)
, main = "Proportion at age by year Sh2")
```

```
##Run the retrospective
spic.stk.retro <- retro(spic.stk, spic.idx, FLXSA.control.spic2, 2)
plot(spic.stk.retro)

#hke.stk.retro2 <- retro(hke.stk2, hke.idx, FLXSA.control.hke2, 2)
#plot(hke.stk.retro2)

#hke.stk.retro <- retro(hke.stk, hke.idx, FLXSA.control.hke, 2)
#plot(hke.stk.retro)

####Running a separable VPA
ctrl <- FLSepVPA.control()
spic.stk.svpa <- SepVPA(spic.stk,ctrl,fit.plusgroup=TRUE, ref.harvest=1)
spic.stk.svpares <- spic.stk+spic.stk.svpa

xyplot(data ~ age, groups = year, data = spic.stk@harvest[,ac(2005:2012)], type = "l",
main = "Separable VPA", ylab = "F",xlab="age", auto.key =
list(space = "right", points = FALSE, lines = TRUE))

stk.<-trim(spic.stk.svpares,year=2005:2012)
catchHat<-(harvest(stk.)/(harvest(stk.)+m(stk.))*stock.n(stk.)*(1-exp(-(harvest(stk.)+m(stk.)))))
f <- harvest(stk.)
z <- harvest(stk.)+m(stk.)
n <- stock.n(stk.)
catchHat <- f/z*n*(1-exp(-z))

#Plot the stock summary
plot(spic.stk.svpares)

#Plot the F
xyplot(data~year, data=harvest(spic.stk.svpares)[ctrl@sep.age,ac(2005:2012)],
type="l",xlab="Year", ylab="Fishing Mortality", ylim=c(0,2))
#Plot the residuals
bubbles(age~year, data=catch.n(stk.)-catchHat, col=c("black","grey"), main="Separable VPA")
library(FLBRP)
#BRP sh0.5
yprec <- brp(FLBRP(spic.stk2))
refpts(yprec)
#questa parte al momento non funge!!!!
```

```
#jpeg("figYR.tiff", 1000, 1000, quality=1000)
#pltYpr(yprec, main="Yield per recruit")
#dev.off()
#BRP Sh1.0
yprec <- brp(FLBRP(spic.stk))
refpts(yprec)
#BRP Sh2.0
yprec <- brp(FLBRP(spic.stk1))
refpts(yprec)
stock.brp1 <- FLBRP(spic.stk2, fbar=seq(0,2,by=0.04))
stock.brp1 <- brp(stock.brp1)
refpts(stock.brp1)
plot(stock.brp1)
spic.stk2
```

6.1.3 Input data and Parameters

Catches include only landings as there are no discards in this fishery (Table 1). LPUE (number/days at sea) data were used as abundance index tuning data series for picarel caught by commercial trawlers in GSA25 (Table 2). A previous study on LPUE standardization from the trawl fishery indicated no significant difference between the nominal and standardized values (Fig. 2, Table 3) (Josephides 2013).

Table 1.

	Catch-at-age (thousands)							
Age class	2005	2006	2007	2008	2009	2010	2011	2012
0	2029	448	162	664	1765	662	449	59
1	4593	1938	2581	2616	2769	2441	1011	315
2	3221	3793	5046	4477	2522	2085	691	505
3	1767	2155	2567	2852	2261	1629	806	497
4	638	792	733	1036	708	456	365	267
5+	402	382	378	369	216	91	142	159

Table 2.

6.1.4 Tuning data

	Catch-at-age (number/days at sea)							
Age class	2005	2006	2007	2008	2009	2010	2011	2012
0	1.9737	0.6171	0.2154	0.8590	2.3377	0.8733	0.6865	0.1341
1	4.4679	2.6694	3.4322	3.3842	3.6675	3.2203	1.5459	0.7159
2	3.1333	5.2245	6.7101	5.7917	3.3403	2.7506	1.0566	1.1477
3	1.7189	2.9683	3.4136	3.6895	2.9947	2.1491	1.2324	1.1295
4	0.6206	1.0909	0.9747	1.3402	0.9377	0.6016	0.5581	0.6068
5+	0.3910	0.5262	0.5026	0.4773	0.2861	0.1201	0.2171	0.3614

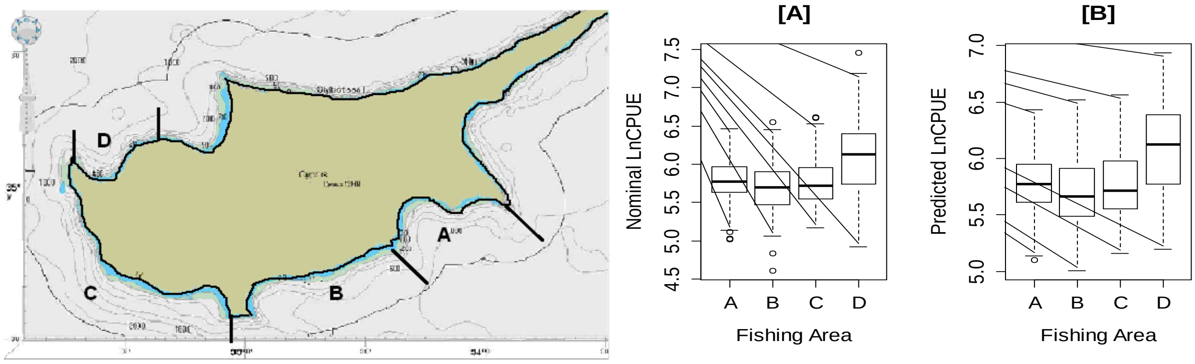

Fig. 2. Results of LPUE standardization from bottom trawl fisheries in four minor strata of GSA 25.

Table 3. Results of Two sample Kolmogorov-smirnov test between the nominal and standardized LPUE indicating no significant difference.

Two sample K-S	All data	Area (A)	Area (B)	Area (C)	Area (D)
D-criterion	0.078	0.1	0.1143	0.1429	0.1075
p-value	0.0884	0.4858	0.3200	0.1148	0.6554

6.1.5 Results

<u>State of exploitation</u>: Exploitation showed an increase from 2006 to 2009 with values of 0.38 to 0.8 respectively, while in the period 2009 to 2012 harvest has decreased rapidly, with values 0.8 to 0.1 respectively. The most recent estimate of fishing mortality ($F_{0\text{-}4}$) is 0.09 (Fig. 3).

<u>State of the juveniles (recruits):</u> Recruitment varied with a decreasing trend in the years 2005-2012, reaching a minimum in 2010.

<u>State of the adult biomass</u>: The SSB fluctuated reaching a maximum in 2007 and a minimum in 2009, while for the total biomass the minimum occurred in 2011 (Fig. 4).

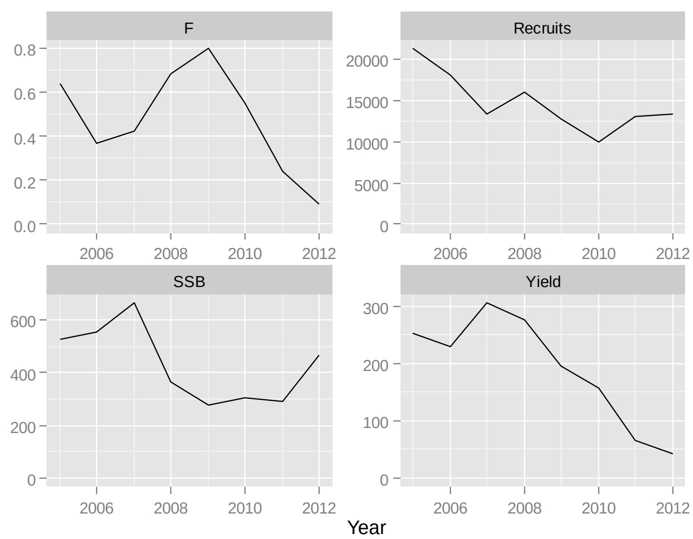

Fig. 3. Results of the XSA showing the trends of fishing mortality (F), recruits (thousands), spawning stock biomass – SSB (tones) and yield (tones) of picarel in GSA 25.

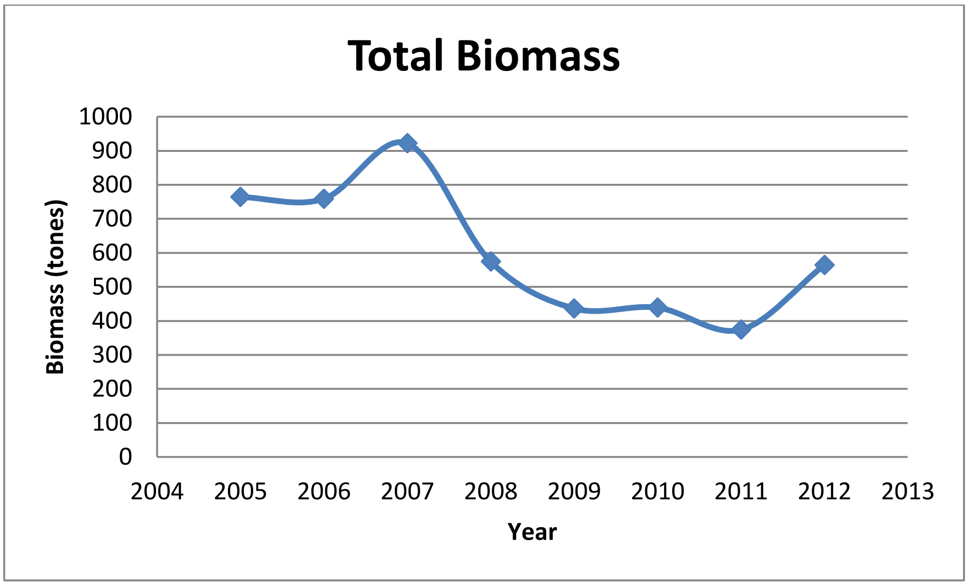

Fig. 4. Time series of picarel total biomass (2005-2012) in GSA 25

Yield per Recruit analysis showed that reference points of $F_{0.1}$ and F_{max} have values of 0.14 and 0.25 respectively (Fig. 5), while biomass of 33rd and 66th percentile have values of 477.89 and 688.78 tones respectively. The current biomass B_{cur} estimated to be 564.33 tones.

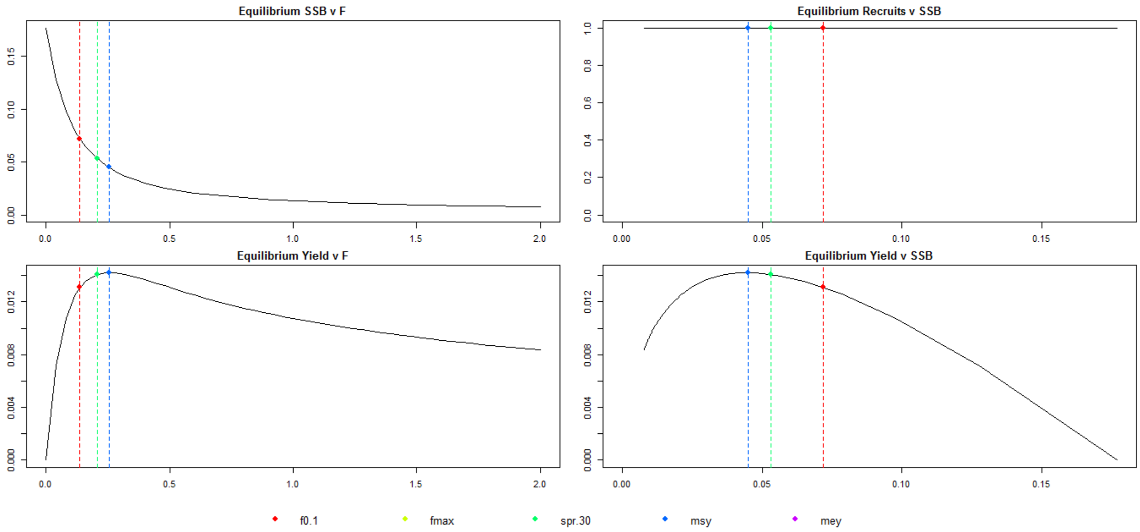

Fig. 5. Results of Yield per recruit analysis of picarel in GSA 25

6.1.6 Robustness analysis

6.1.7 Retrospective analysis, comparison between model runs, sensitivity analysis, etc.

Retrospective analysis showed a good agreement in the trend of spawning stock biomass (ssb) and harvest, indicating that the assessment was consistent (Fig. 6). A slight inconsistency for the recruitment was appeared in the year 2010 (red line).

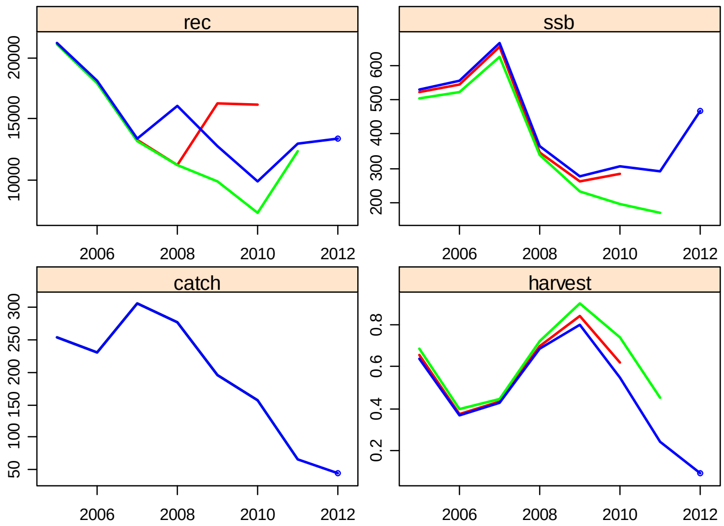

Fig. 6. Retrospective analysis for XSA model with shrinkage f=2.

6.1.8 Assessment quality

Diagnostic plots of XSA show an adequate fitting of the models and did not show any trends in the residuals that were observed, excluding the age group of 0 (Fig. 7). The reason is that the available data for the particular age group does not give representative abundance indices of CPUE because the trawl fishery starts on November, a month later when the recruitment occurs (Demetropoulos, 1985). Also, the Mediterranean Trawl Survey takes place only in June, so the abundance indices do not cover adequately the age 0 group of the species.

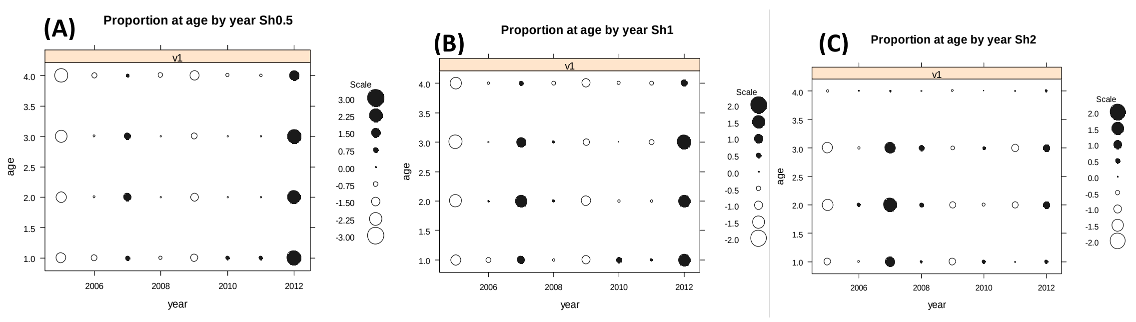

Fig. 7. Bubble plots of residuals from XSA models using shrinkage A) 0.5, B) 1 and C) 2.

7 Stock predictions

When an analytical assessment exists, predictions should be attempted. All scenarios tested (recruitment and/or fishing mortality) should be reported. The source of information/model used to predict recruitment should be documented.

7.1 Short term predictions

7.2 Medium term predictions

7.3 Long term predictions

8 Draft scientific advice

(Examples in blue)

Based on	**Indicator**	**Analytic al reference point(name and value)**	**Current value from the analysis(name and value)**	**Empirical reference value(name and value)**	**Trend(time period)**	**Stock Status**
Fishing mortality	Fishing mortality	$F_{0.1}$ = 0.14	$F_{0\text{-}4}$ = 0.09		D (2009-2012)	S
	Fishing effort				D	
	Catch				D	
Stock abundance	Biomass		B_{cur} = 564.33 T	$B_{0.33}$ = 477.89 T	I (2011-2012)	**O_I**
	SSB					
Recruitment					D	
Final Diagnosis		In sustainable exploitation with intermediate level of biomass				

The diagnosis of the stock status was based on the analytical reference point regarding the fishing mortality ($F_{0.1}$), as well as on empirical reference values of biomass (33rd and 66th percentile).

8.1 *Explanation of codes*

Trend categories

1) N - No trend
2) I - Increasing
3) D – Decreasing
4) C - Cyclic

Stock Status

Based on Fishing mortality related indicators

1) **N - Not known or uncertain** – Not much information is available to make a judgment;
2) **U - undeveloped or new fishery** - Believed to have a significant potential for expansion in total production;
3) **S - Sustainable exploitation**- fishing mortality or effort below an agreed fishing mortality or effort based Reference Point;
4) **IO –In Overfishing status**– fishing mortality or effort above the value of the agreed fishing mortality or effort based Reference Point. An agreed range of overfishing levels is provided;

Range of Overfishing levels based on fishery reference points

In order to assess the level of overfishing status when $F_{0.1}$ from a Y/R model is used as LRP, the following operational approach is proposed:

- If $Fc^*/F_{0.1}$ is below or equal to 1.33 the stock is in **(O_L): Low overfishing**
- If the $Fc/F_{0.1}$ is between 1.33 and 1.66 the stock is in **(O_I): Intermediate overfishing**
- If the $Fc/F_{0.1}$ is equal or above to 1.66 the stock is in **(O_H): High overfishing**

*Fc is current level of F

5) **C- Collapsed**- no or very few catches;

Based on Stock related indicators

1) **N - Not known or uncertain:** Not much information is available to make a judgment
2) **S - Sustainably exploited:** Standing stock above an agreed biomass based Reference Point;
3) **O - Overexploited**: Standing stock below the value of the agreed biomass based Reference Point. An agreed range of overexploited status is provided;

Empirical Reference framework for the relative level of stock biomass index

- **Relative low biomass:** Values lower than or equal to 33rd percentile of biomass index in the time series **(O_L)**
- **Relative intermediate biomass:**Values falling within this limit and 66th percentile **(O_I)**
- **Relative high biomass:**Values higher than the 66th percentile **(O_H)**

4) **D–Depleted**: Standing stock is at lowest historical levels, irrespective of the amount of fishing effort exerted;
5) **R –Recovering:** Biomass are increasing after having been depleted from a previous period;

Agreed definitions as per SAC Glossary

Overfished (or overexploited) *- A stock is considered to be overfished when its abundance is below an agreed biomass based reference target point, like B0.1 or BMSY. To apply this denomination, it should be assumed that the current state of the stock (in biomass) arises from the application of excessive fishing pressure in previous years. This classification is independent of the current level of fishing mortality.*

Stock subjected to overfishing (or overexploitation) *- A stock is subjected to overfishing if the fishing mortality applied to it exceeds the one it can sustainably stand, for a longer period. In other words, the current fishing mortality exceeds the fishing mortality that, if applied during a long period, under stable conditions, would lead the stock abundance to the reference point of the target abundance (either in terms of biomass or numbers)*