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SICILY CHANNEL/TUNISIAN PLATEAU: STATUS AND CONSERVATION OF FISHERIES

With financial support of the European Commission

RAC/SPA – Tunis, 2015

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This document has been prepared in the framework of the project MedOpenSeas for supporting the establishment of MPAs in open seas, including deep seas; with financial support of the European Commission.

The original version of this document was prepared for the Regional Activity Centre for Specially Protected Areas (RAC/SPA) by: Henri FARRUGIO, RAC/SPA Consultant. Under the supervision of: Dr. Daniel Cebrian, RAC/SPA. Edited by Cebrian. D and Requena, S.

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1 Brief introduction to the Sicily channel/Tunisian plateau

The Sicily channel/Tunisian plateau, also called Straits of Sicily is about 100 miles (160 km) wide and divides the Tyrrhenian Sea and the western Mediterranean Sea from the eastern Mediterranean. It is one of the most important fishing areas of the Mediterranean Sea, where significant fleets operate with high fish production.

Along the southern coast of Sicily, the shelf is characterized by two wide and shallow (100 m depth) banks in the western (Adventure Bank) and eastern sectors (Malta Bank), separated by a narrow shelf in the middle part. The North African shelf is very wide, especially along the Tunisian coasts.

The topography of the sea bed below the 200 m depth between Sicily and Tunisia is extremely irregular, incised by many canyons, deep trenches and steep slopes, whereas it is very gentle (average depth of less than 300 m) between Malta and Libya. East of the Malta Bank (Malta Escarpment) the shelf break is very steep (Fig.1).

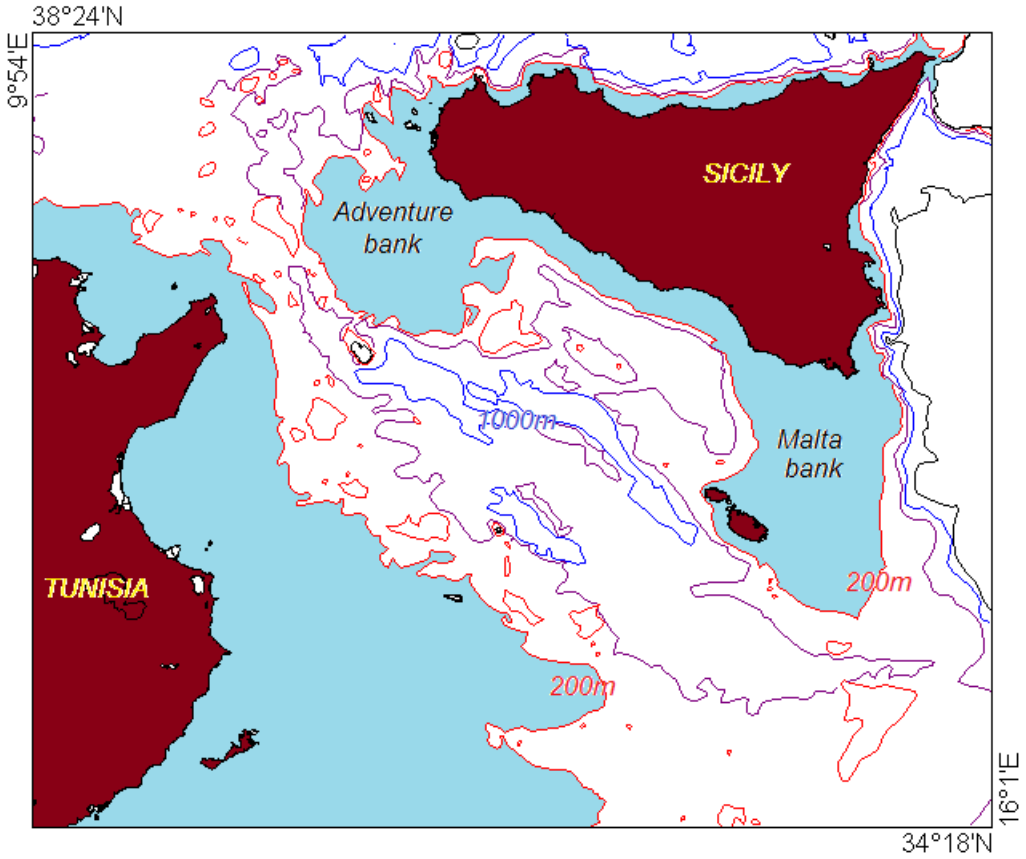

Fig.1. Bathymetric map of the Sicily channel/Tunisian plateau

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This area has important hydrodynamical processes which determine the water-mass exchanges between the western and eastern Mediterranean basins (fig.2a), For the purpose of fisheries management the fisheries of the Sicily channel/Tunisian plateau are divided in five GFCM Geographical Sub-Areas (fig.2b).

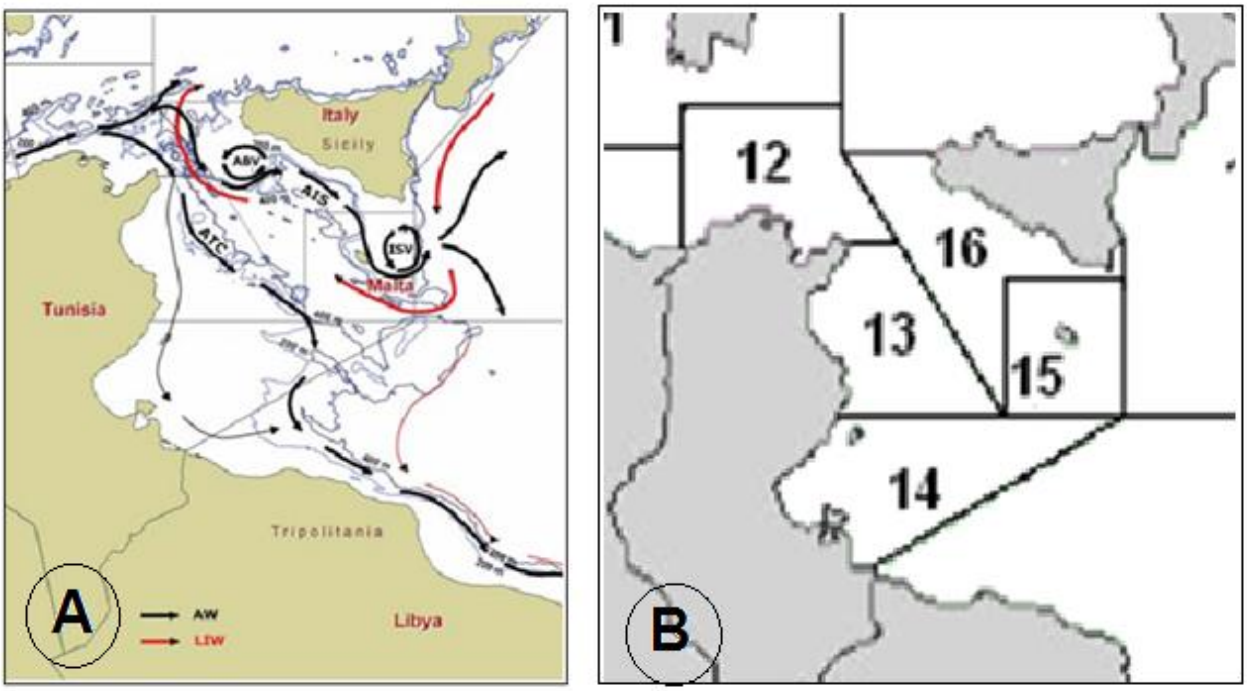


Fig.2. A: Water mass circulation in the Sicily channel/Tunisian plateau (AW Atlantic Water, ABV Adventure Bank Vortex, ISV Ionian Stream vortex, AIS Atlantic Ionian Stream, ATC Atlantic Tunisian Current, LIW Levantine Ionian water.(Source: doc n° 32). **2.B**: GFCM Geographical Sub Areas (GSA)

2 Fisheries activities conducted within the area

2.1 Fleets operating in the area

2.1.1 The Italian fleet:

The Italian fleet operating in the Sicily channel/Tunisian plateau (tab. 1, 2) consists of about 476 bottom trawlers, 9 pelagic trawlers, 26 purse-seiners, 45 longliners and 669 small scale boats based in Sicilian harbours. The Sicilian trawlers are based in seven main ports along the southern Sicilian coast. Among them, Mazara del Vallo is the main Sicilian port for demersal fisheries. Its fleet represents the main commercial fleet of trawlers of the area and one of the most important in the Mediterranean and consisted in 2008 of 278 vessels.

The main fleet segment (around 50%) is represented by demersal trawlers with an overall length between 24 and 40 metres. This fleet is specialised in catching crustaceans (mainly red shrimp, deepwater rose shrimp, norway lobster, hake and red mullets.) in deep sea water. Initially these vessels were used to fish in the GSAs from 12 to 16 (Sicily channel/Tunisian plateau and adjacent areas), but since 2004 their activity has been extended to the Aegean and South-Levantin waters. They usually engage in long fishing trips (15–25 days) within the national and in the international waters of the Sicily channel/Tunisian plateau, operating over the continental shelf and over deep bottoms (down to 700–800 m depth). The remainder of the Mazara fleet comprises small trawlers (<130 GRT) that make short fishing trips (4–5 days) operating in shallow waters and on the continental shelf.

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.

Given the peculiarities of the local fishing activity, the Mazara fleet is particularly affected by restrictions due to areas closures (as the 2006 Libya decision to extend their territorial waters of additional 62 miles). Also the mesh size restriction planned by the Mediterranean Regulation 1967/2006 will likely affect more Mazara than the rest of Sicily, given the predominance of demersal fisheries.

Sicilian coastal trawlers (LOA between 12 and 24 m) targeting deep water rose shrimp are based in seven harbours along the southern coasts of Sicily. These trawlers operate mainly on short-distance fishing trips, which range from 1 to 2 days at sea, and fishing taking place on the outer shelf and upper slope. With 250 registered vessels, this is the largest component of the fleet targeting rose shrimp in 2009. Sicilian trawlers over 24 m in length have longer fishing trips, which may have duration of up to 4 weeks.

Tab. 1. The Italian fleet operating in the Sicily channel/Tunisian plateau (Source: GFCM task 1 *Operational Units Statistical Bulletin [2010]).*

GSA 16. SOUTH OF SICILY 2011	Nb of vessels	Surrounding nets	Seinenets	Trawls	Dredges	Lift nets	Falling gear	Gillnets ans Entangling nets	Traps	Hooks and Line	Miscellaneous	Other
A - Polyvalent small-scale without engine <12m												
B - Polyvalent small-scale with engine <6m	**200**		**10**	**10**				**165**		**43**		
C - Polyvalent small-scale with engine 6-12m	**469**	**62**						**375**		**146**		
D - Trawlers (<12 m)												
E - Trawlers (12-24m)	**322**			**541**						**3**		
F - Trawlers (<24m)	**154**			**239**								
G - Purse seiners (6-12m)												
H - Purse seiners (> 12m)	**26**	**38**										
I - Longliners (> 6m)	**45**	**8**										
J - Pelagic trawlers (> 6m)	**9**		**13**									
K - Tuna seiners (> 12m)												
L - Dredgers (>6m)												
M - Polyvalent vessels (>12m)	**39**	**25**						**32**	**4**	**15**		
TOTAL	**1264**	**133**	**23**	**790**	**0**	**0**	**0**	**572**	**4**	**207**	**0**	**0**

Tab.2. Fleet segments in Mazara Del Vallo in 2008 (source IREPA).

Segment (length class)	Number of vessels	main gears used	Number of crew (average)	Main species fished (list at least 3 and up to 5 for all fleet types)	Main fishing locations (GSA)	Trip length (average days)
VL1224	21	Demersal trawlers	3-4	deepwater rose shrimp, European hake, striped mullet, cephalopods	16	1-2
VL2440	137	Demersal trawlers	7-8	deepwater rose shrimp, red shrimp, Norway lobster, European hake, striped mullet, red mullet	12, 13, 14, 15, 16 22, 23, 24, 25, 26	7-24
VLXX12	99	Small scale fishery	1-2	finfishes nei, common cuttlefish	16	1
VL1224	5	Polyvalent passive	2-3	finfishes nei, swordfish	16	1
VL1224	3	Longlines	3	swordfish, finfishes nei, albacore	12, 13, 16	1-6
VL40XX	13	Oceanic fleet	n.a.	crustaceans, cephalopods, finfishes nei	Mauritania, South Oriental Africa, Guinea Bissau	

Small scale fishery represents the second Sicilian fleet segment. These use many different fishing gears, like pots trammel nets, bottom and floating longlines for large pelagics and fish a large number of species mainly in the coastal area of GSA 16.

2.1.2 The Tunisian fleet

The Tunisian fleet is very large; according to the GFCM task 1 data, this fleet accounted for 11082 vessels in 2010, from which 10388 (94%) where various small scale boats, 321 purse seiners and 373 trawlers (tab.3).

Tab. 3. The Tunisian fleet operating in the Sicily channel/Tunisian plateau (Source: GFCM task 1 *Operational Units Statistical Bulletin [2010]).*

GSA 12. NORTHERN TUNISIA 2011	Nb of vessels	Surrounding nets	Seinenets	Trawls	Dredges	Lift nets	Falling gear	Gillnets ans Entangling nets	Traps	Hooks and Line	Miscellaneous	Other
A - Polyvalent small-scale without engine <12m	**957**							**957**		**215**		
B - Polyvalent small-scale with engine <6m	**150**							**150**		**40**		
C - Polyvalent small-scale with engine 6-12m	**935**							**935**		**300**		**100**
D - Trawlers (<12 m)												
E - Trawlers (12-24m)	**29**			**29**								
F - Trawlers (<24m)	**33**			**33**								
G - Purse seiners (6-12m)	**3**	**3**										
H - Purse seiners (> 12m)	**114**	**114**										
I - Longliners (> 6m)												
J - Pelagic trawlers (> 6m)	**6**			**6**								
K - Tuna seiners (> 12m)												
L - Dredgers (>6m)												
M - Polyvalent vessels (12m)	**150**							**150**	**80**			**23**
TOTAL	**2377**	**117**	**0**	**68**	**0**	**0**	**0**	**2192**	**80**	**555**	**0**	**123**

Tab. 3 (*cont*). The Tunisian fleet operating in the Sicily channel/Tunisian plateau (Source: GFCM task 1 *Operational Units Statistical Bulletin [2010]).*

GSA 13. GULF OF HAMMAMET 2011	Nb of vessels	Surrounding nets	Seinenets	Trawls	Dredges	Lift nets	Falling gear	Gillnets ans Entangling nets	Traps	Hooks and Line	Miscellaneous	Other
A - Polyvalent small-scale without engine <12m	**107**							**107**		**250**		
B - Polyvalent small-scale with engine <6m	**150**							**150**		**20**		
C - Polyvalent small-scale with engine 6-12m	**664**							**664**	**100**	**300**		
D - Trawlers (<12 m)												
E - Trawlers (12-24m)	**64**			**34**								
F - Trawlers (<24m)	**38**			**38**								
G - Purse seiners (6-12m)	**10**	**10**										
H - Purse seiners (> 12m)	**152**	**152**										
I - Longliners (> 6m)												
J - Pelagic trawlers (> 6m)												
K - Tuna seiners (> 12m)	**2**	**9**										
L - Dredgers (>6m)												
M - Polyvalent vessels (>12m)								**200**	**50**	**100**		
TOTAL	**215**	**171**	**0**	**72**	**0**	**0**	**0**	**209**	**150**	**670**	**0**	**0**
GSA 14. GULF OF GABES 2011	**Nb of vessels**	**Surrounding nets**	**Seinenets**	**Trawls**	**Dredges**	**Lift nets**	**Falling gear**	**Gillnets ans Entangling nets**	**Traps**	**Hooks and Line**	**Miscellaneous**	**Other**
A - Polyvalent small-scale without engine <12m	**3885**							**3885**	**300**	**2000**		**200**
B - Polyvalent small-scale with engine <6m	**200**							**200**	**40**	**20**		
C - Polyvalent small-scale with engine 6-12m	**2031**							**2031**	**800**	**300**		
D - Trawlers (<12 m)												
E - Trawlers (12-24m)	**192**			**192**								
F - Trawlers (<24m)	**84**			**84**								
G - Purse seiners (6-12m)	**18**	**18**										
H - Purse seiners (> 12m)	**104**	**104**										
I - Longliners (> 6m)												
J - Pelagic trawlers (> 6m)				**4**								
K - Tuna seiners (> 12m)	**33**	**33**										
L - Dredgers (>6m)												
M - Polyvalent vessels (>12m)								**100**	**60**	**50**		
TOTAL	**6547**	**155**	**0**	**280**	**0**	**0**	**0**	**6216**	**1200**	**2370**	**0**	**200**

2.1.3 The Maltese fleet

The most recent information on the Maltese fisheries has been presented in a National Report for the reference year 2013 prepared by the Ministry for Sustainable Development, the Environment and Climate Change for the Sixteenth session of the GFCM Scientific Advisory Committee which was held in St Julian's, Malta, 17-20 March 2014. This report indicates that fisheries in Malta are a relatively small industry where its social significance far outweighs its economic importance. The industry is mainly artisanal and fairly typical of the fisheries found in many Mediterranean countries. There are no inland fisheries in Malta, The average value of catches is around 0,10% of Malta's Gross Domestic Product (GDP), with the industry's direct contribution to GDP estimated at around two-thirds of this figure when the cost of imported inputs, particularly fuel, is considered. According to the Fishing Vessels Register, the commercial fleet capacity of registered vessels in 2013 was 1040 of which 411 (39.5%) vessels and 629 (60.5%) vessels were commercial full-time and part-time vessels respectively (tab.4). The total gross tonnage and power of main engine for the full-time and part-time commercial vessels totaled 7785.92 t and 76064.3 kW respectively. The length of full-time and part-time registered vessels ranged between 3.45 to 37.70 m and 3.05 to 18.50 m respectively.

Tab.4. The Maltese fleet operating in the Sicily channel/Tunisian plateau (source: Maltese Ministry for Sustainable Development, the Environment and Climate Change.

Registration type	**Number of vessels by length class**				
	VL0006	**VL0612**	**VL1224**	**VL2440**	**N° of vessels**
Full-time commercial	132	205	63	11	411
Part-time commercial	389	239	1	-	629
	521	444	64	11	1040
Registration type	**Gross tonnage (GT) by vessel length class**				
	VL0006	**VL0612**	**VL1224**	**VL2440**	**Total GT**
Full-time commercial	139.5	955.0	3507.7	1939.8	6542.02
Part-time commercial	400.3	791.5	52.1	-	1243.9
Grand Total	539.8	1746.5	3559.8	1939.8	7785.92
Registration type	**Power of main engine (kW) by vessel length class**				
	VL0006	**VL0612**	**VL1224**	**VL2440**	**Total kW**
Full-time commercial	4037.2	19615.7	16411.0	5531.4	45595.3
Part-time commercial	10142.2	20088.0	238.7	-	30469.0
Grand Total	14179.4	39703.7	16649.7	5531.4	76064.3

2.2 Fishing gears

The Italian trawlers operating in the Sicily channel/Tunisian plateau use the same type of trawl net, known as the “Italian trawl net”. Although there are some differences in material between the nets used in shallow water (“banco” net) and those employed in deeper water (“fondale” net), the Italian trawl net is characterized by a low vertical opening (up to 1.5 m), with the main dimensions depending mainly on a vessel’s engine power. Recently, the minimum stretched-mesh size of 28 mm opening was changed to 40 mm, which is the minimum legal size recommended by GFCM for the whole Mediterranean.

Inshore trawling is mainly based on the exploitation of the continental shelf, accomplish usually 2 hauls 4-5 hours long per day, going out for fishing in early morning and coming back in port to sell fish in the afternoon. Offshore trawling is conducted by trawlers generally over 24 m length belonging to the Mazara del Vallo port. This fleet exploits fishery resources in international waters working both on the continental shelf and slope up to 700-800 m depth. Italian trawlers generally undertake long fishing trips (15-30 days) also exploiting areas in other GSAs inside the Sicily channel/Tunisian plateau (i.e GSA 12, 13, 14, 15, 16 and 21).

2.3 Targeted species

2.3.1 Pelagic species

In the Sicily channel/Tunisian plateau, there is one of the main pelagic resources for both the purse-seine and midwater pair-trawl fleets. Anchovies are well represented in the catch throughout the year, except in winter, when landings decrease to low levels.

According to the last GFCM Maltese national report, in 2013 the catches of the Maltese fleet were dominated by swordfish (Xiphias gladius), dolphin fish (Coryphaena hippurus), chub mackerel, (Scomber japonicas), round sardines (Sardinella aurita), and blue fin tuna (Thunnus thynnus), in decreasing order of importance. Catches of dolphinfish occur mainly between the 15 August and 31 December mostly by the Fish Aggregating Device (FAD) fishery. Between the months of April and July the market is dominated by the landings of bluefin tuna and swordfish. Both these species are targeted by the same method that is pelagic drifting long-lines.

Several small-pelagic species cohabit in Tunisian water. Those of commercial interest are the sardine (*Sardina pilchardus*), the allache or round sardinella (*Sardinella aurita*), the bogue (*Boops boops*) and the anchovy (*Engraulis encrasicolus*).

The Tunisian landings of small pelagic species come essentially from the Light attracting purse seine fishery operating in the eastern coast and from the small scale fleet (5).

2.3.2 Demersals

A number of commercially important species are shared by the various fleets operating in the Sicily channel/Tunisian plateau (tab 5, 6)

Tab.5. Main species caught by the various national fleets exploiting the resources of the Sicily channel/Tunisian plateau.

Hake	*Merluccius merluccius*	Sicily Channel (GSA 12,13,14,15,16,21)	Italy, Tunisia, Libya & Malta
Hake	*Merluccius merluccius*	Alboran sea (GSA1, 3, 4)	Spain, Morocco & Algeria
Red mullet	*Mullus barbatus*	Sicily Channel (GSA 12,13,14,15,16,21)	Italy, Tunisia, Libya and Malta
Pink shrimp	*Parapenaeus longirostris*	Sicily Channel (GSA 12,13,14,15,16,21)	Italy, Tunisia, Libya & Malta
Red shrimp	*Aristeomorpha foliacea*	Sicily Channel (GSA 13, 14, 15, 16, 21)	Italy, Tunisia and Malta
Common octopus	*Octopus vulgaris*	Sicily Channel (GSA 13, 14, 15, 16, 21)	Italy, Tunisia, Libya & Malta
Common spiny lobster	*Palinurus elephas*	Sicily Channel GSA12 , GSA13 ,GSA16	Tunisia & Italy
Pink spiny lobster	*Palinurus. Mauritanicus*	Sicily Channel GSA12 , GSA13 ,GSA16	Tunisia & Italy
Dolphin fish	*Coryphaena hippurus*	Western Mediterranean	Italy. Malta, Spain & Tunisia
Porbeagle	*Lamna nassus*	All Mediterranean	All countries

The species showing the highest value are represented by giant red shrimp, blue and red shrimp and Norway lobster with a first sale price equal to 19.66 €/kg, 18.30 €/kg and 17.85 €/kg respectively (2008 data). In the last two years, all these species show a declining trend in their prices after having reached a maximum level in 2006 equal to 22.03 €/kg, 23.68 €/kg and 21.52 €/kg respectively. Giant red shrimp and Norway lobster are important not only for their price, but also because these species contribute significantly to the total income. A quarter of total landing value is due to giant red shrimp and a 10% to Norway lobster. However, the most important species in terms of contribution to the total income is represented by deepwater rose shrimp (30%). Also the price of this species shows a reduction in the last year passing from 13.47 €/kg to 9.24 €/kg

Tab.6. Catch composition of trawling fisheries in the Sicily channel/Tunisian plateau in 2011.

Case study *Parapenaeus longirsotris* fisheries - Total landing (tons) of main associated species - 2011									
Country	Species 1	Landing	Species 2	Landing	Species 3	Landing	Species 4	Landing	Total landing
Tunisia (industrial)	*Parapenaeus longirostris*	1500 (25%)	*Merluccius merlucius*	594 (10%)	*Mullus barbatus*	300 (5%)	*Trachurus tracurus*	n.a.	6000
Malta	*Parapenaeus longirostris*	21.4 (10%)	*Mullus surmuletus*	52.6 (24%)	*Aristaeomorpha foliacea*	41.4 (19%)	*Mullus barbatus*	14.5 (7%)	215
Italy (Distant)	*Parapenaeus longirostris*	1260 (31%)	*Aristaeomorpha foliacea*	1553 (38%)	*Merluccius merlucius*	226 (6%)	*Mullus surmuletus*	70 (2%)	4042
Italy (Coastal)	*Parapenaeus longirostris*	6184 (47%)	*Merluccius merlucius*	1037 (8%)	*Mullus surmuletus*	730 (6%)	*Nephrops norvegicus*	264 (2%)	13146

2.4 Fishing sectors

The Sicily channel/Tunisian plateau is a very intensively fished area. The Mazara del Vallo Italian trawl fleet, one of the biggest in the Mediterranean Sea, swept from about 30 years the trawlable grounds of the eastern part of the Sicily channel/Tunisian plateau.

As shown in figures 3 and 4, the geographical distribution of the fishing pressure of the Italian trawlers in the Sicily channel/Tunisian plateau varies according the seasons.

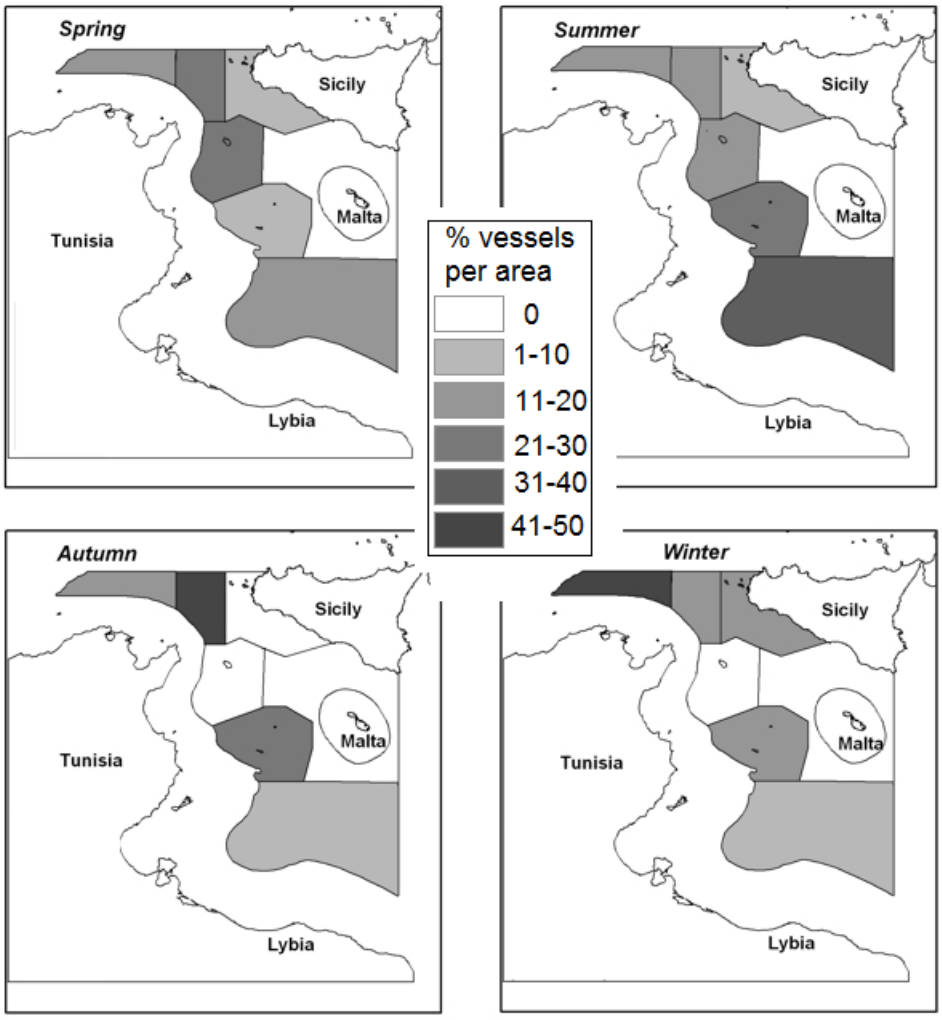


Fig.3. Seasonal distribution of the fishing pressure of the Italian trawlers (25).

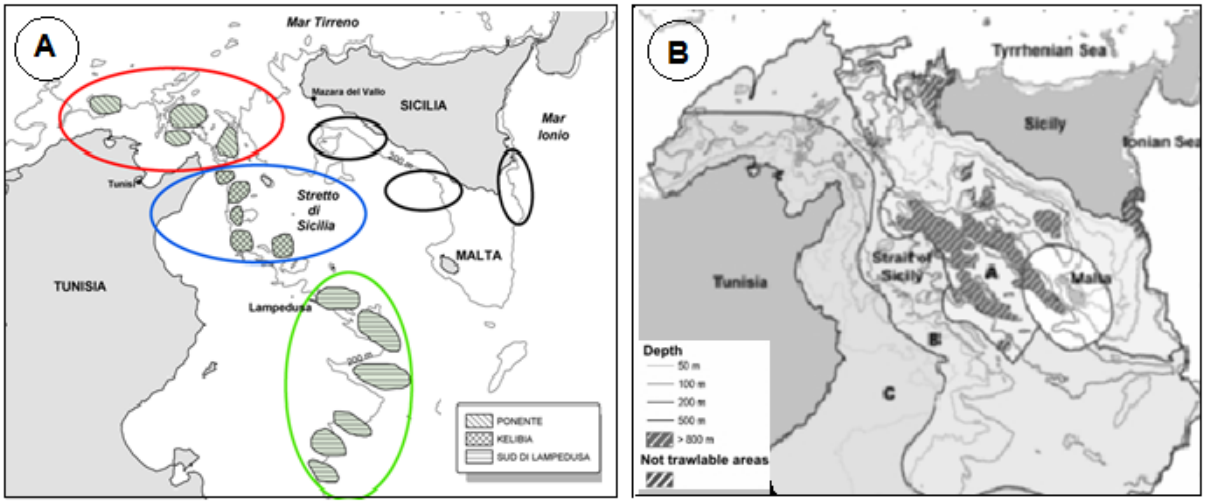


Fig. 4. Main fishing areas for Sicilian trawlers (27, 56).

The major fishing area of the Maltese fleet is GSA15, however the long-line and trawling fleet also operates in the neighbouring GSAs. Landings of other species originate from trawling, bottom long-lines and fixed net operations (trammel and gill nets).

Traditionally, Sicilian off-shore trawlers targeting the deep water pink shrimp *Parapeneus Longirostris* concentrate on three main fishing grounds: from North-West to South-East, these are known as “Ponente” (West in the figrue), “Kelibia” and “South Lampedusa”. Each fishing ground is, in turn, further subdivided into distinct fishing banks (45) (Fig. 5 B).

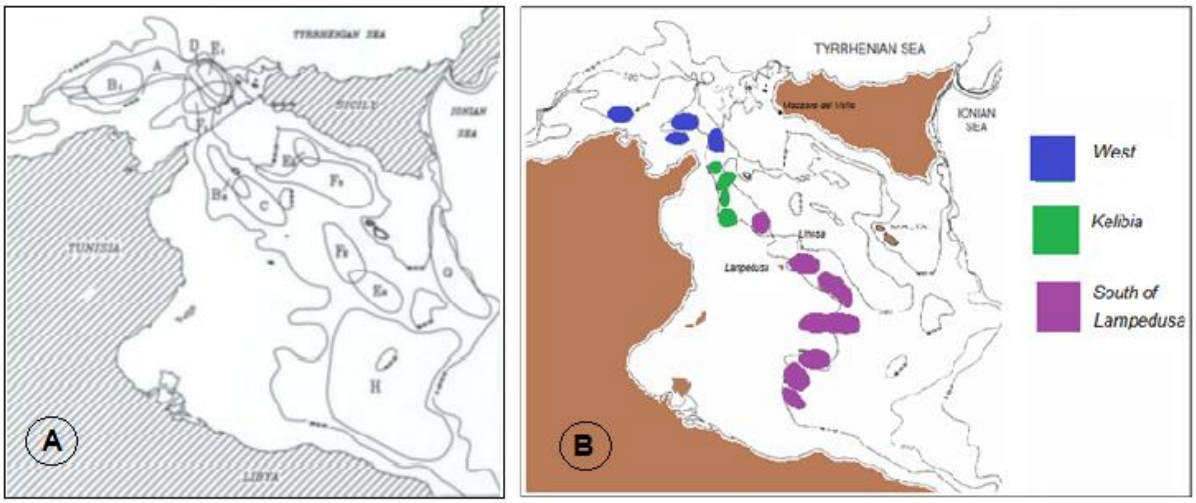
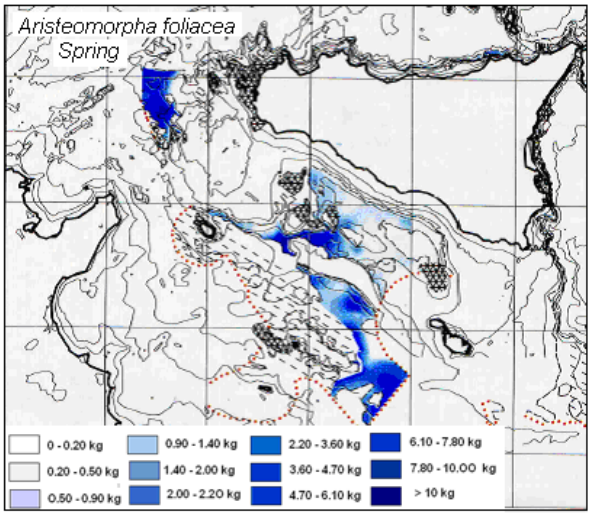
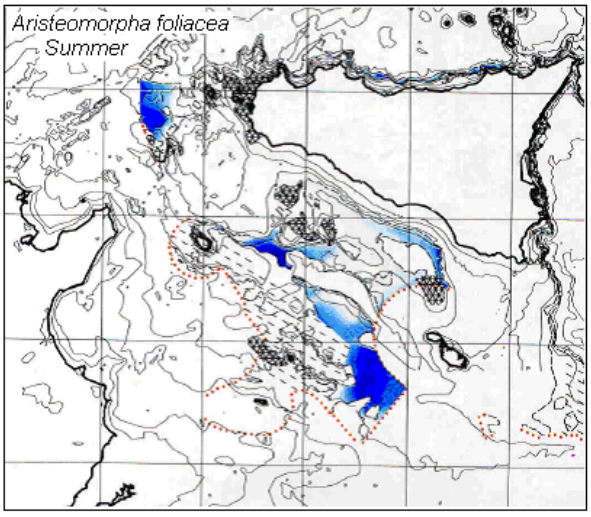
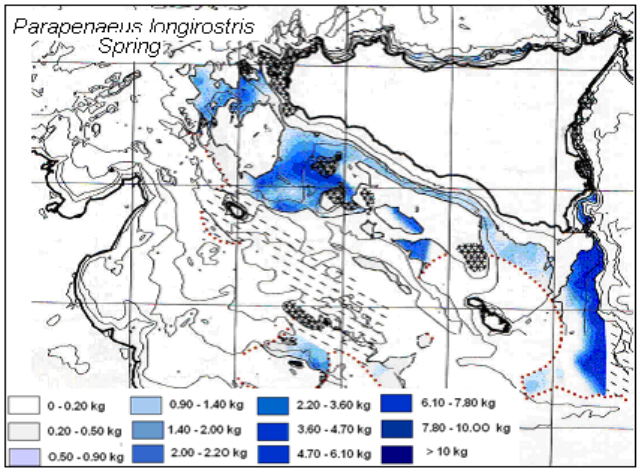


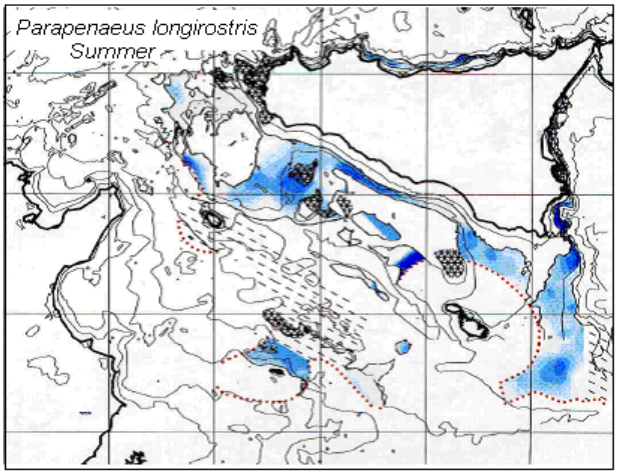
Fig.5.A. Main fishing grounds of *Aristaeomorpha foliacea* targeted by Sicilian fishermen (44).

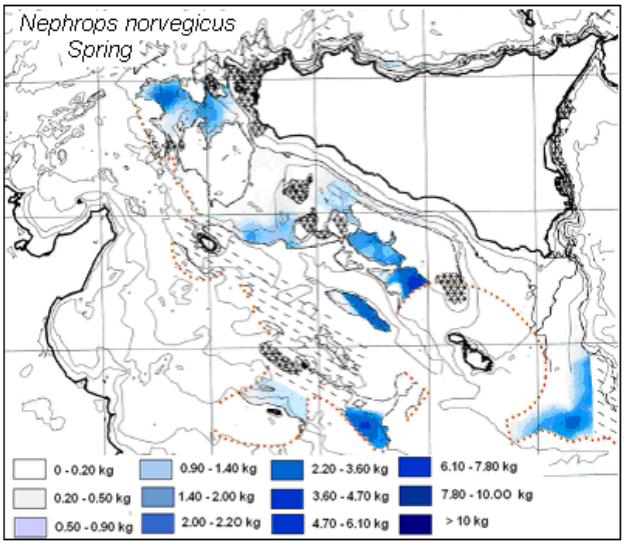
5.B. The three main fishing areas for *P. longirostris* in the Sicily channel/Tunisian plateau. Each fishing area is divided into several fishing grounds (44).

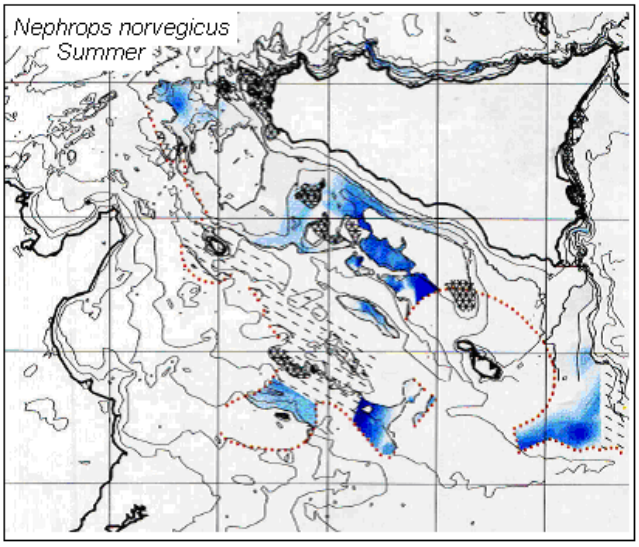

Aristeomorpha foliacea
Spring
0 - 0.20 kg
0.20 - 0.50 kg
0.50 - 0.90 kg
0.90 - 1.40 kg
1.40 - 2.00 kg
2.00 - 2.20 kg
2.20 - 3.60 kg
3.60 - 4.70 kg
4.70 - 6.10 kg
6.10 - 7.80 kg
7.80 - 10.00 kg
> 10 kg

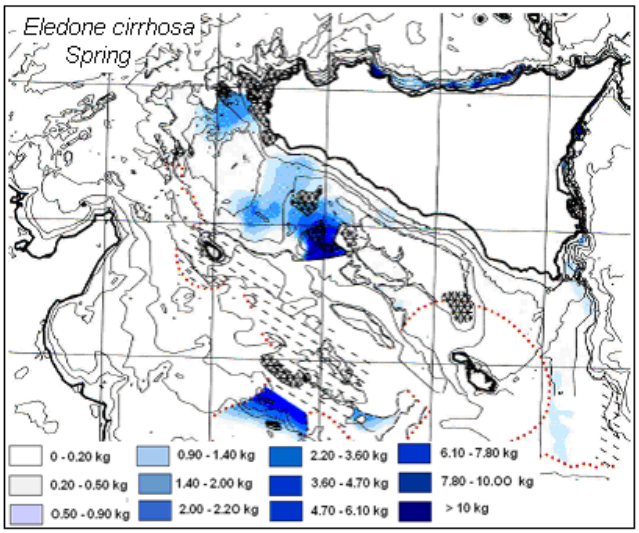

Aristeomorpha foliacea
Summer

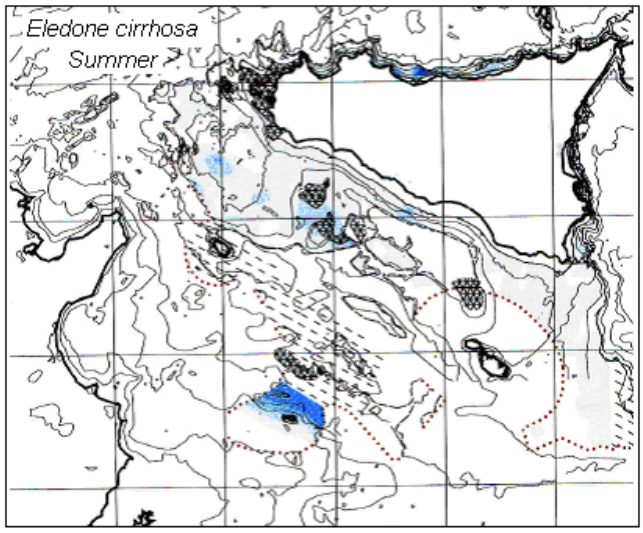

Parapenaeus longirostris
Spring
0 - 0.20 kg
0.20 - 0.50 kg
0.50 - 0.90 kg
0.90 - 1.40 kg
1.40 - 2.00 kg
2.00 - 2.20 kg
2.20 - 3.60 kg
3.60 - 4.70 kg
4.70 - 6.10 kg
6.10 - 7.80 kg
7.80 - 10.00 kg
> 10 kg

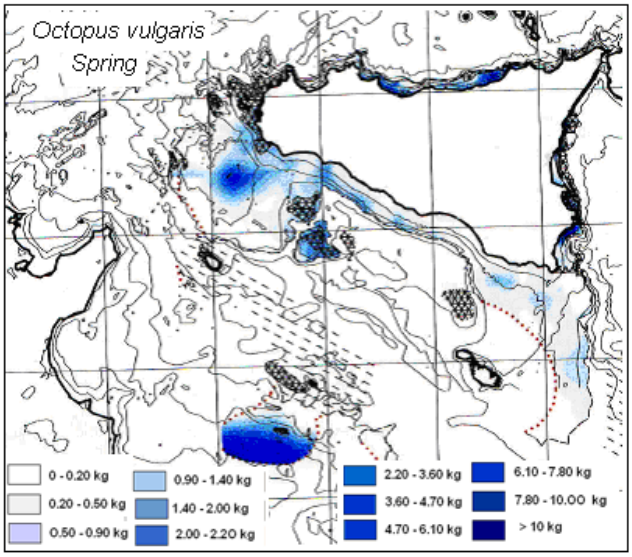

Parapenaeus longirostris
Summer

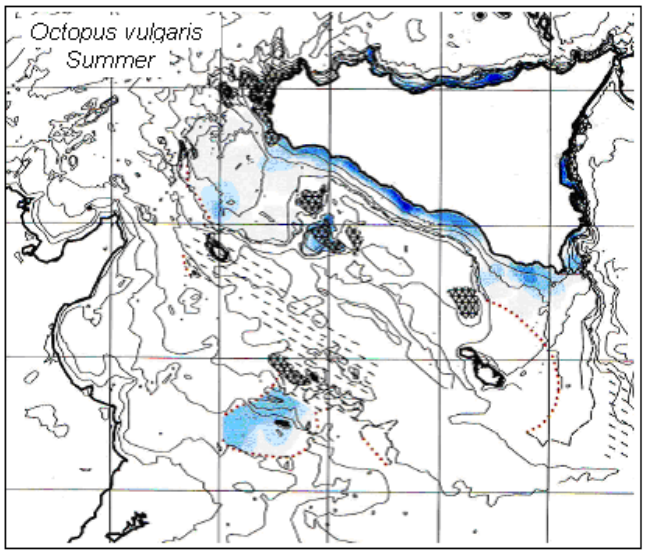

Nephrops norvegicus
Spring
0 - 0.20 kg
0.20 - 0.50 kg
0.50 - 0.90 kg
0.90 - 1.40 kg
1.40 - 2.00 kg
2.00 - 2.20 kg
2.20 - 3.60 kg
3.60 - 4.70 kg
4.70 - 6.10 kg
6.10 - 7.80 kg
7.80 - 10.00 kg
> 10 kg

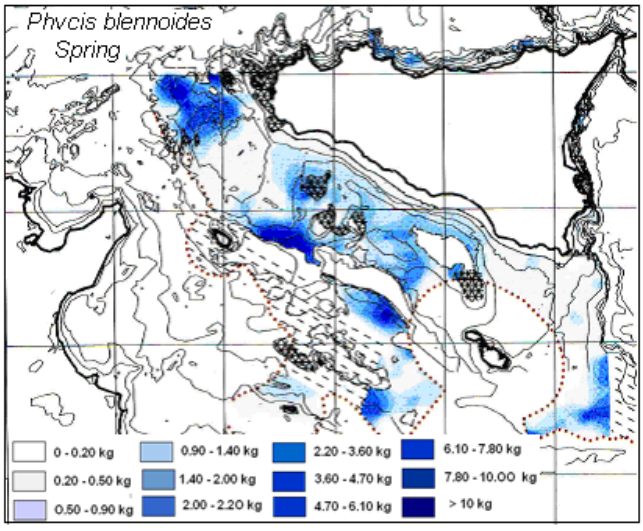

Nephrops norvegicus
Summer

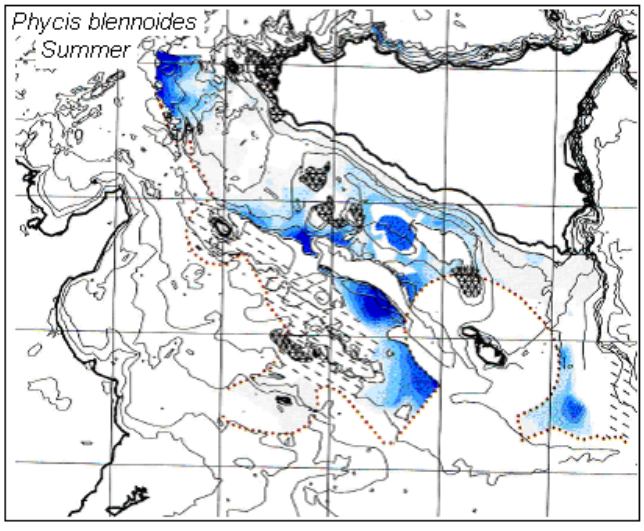

Eledone cirrhosa
Spring
0 - 0.20 kg
0.20 - 0.50 kg
0.50 - 0.90 kg
0.90 - 1.40 kg
1.40 - 2.00 kg
2.00 - 2.20 kg
2.20 - 3.60 kg
3.60 - 4.70 kg
4.70 - 6.10 kg
6.10 - 7.80 kg
7.80 - 10.00 kg
> 10 kg


Eledone cirrhosa
Summer


Octopus vulgaris
Spring
0 - 0.20 kg
0.20 - 0.50 kg
0.50 - 0.90 kg
0.90 - 1.40 kg
1.40 - 2.00 kg
2.00 - 2.20 kg
2.20 - 3.60 kg
3.60 - 4.70 kg
4.70 - 6.10 kg
6.10 - 7.80 kg
7.80 - 10.00 kg
> 10 kg


Octopus vulgaris
Summer


Phycis blennoides
Spring
0 - 0.20 kg
0.20 - 0.50 kg
0.50 - 0.90 kg
0.90 - 1.40 kg
1.40 - 2.00 kg
2.00 - 2.20 kg
2.20 - 3.60 kg
3.60 - 4.70 kg
4.70 - 6.10 kg
6.10 - 7.80 kg
7.80 - 10.00 kg
> 10 kg


Phycis blennoides
Summer

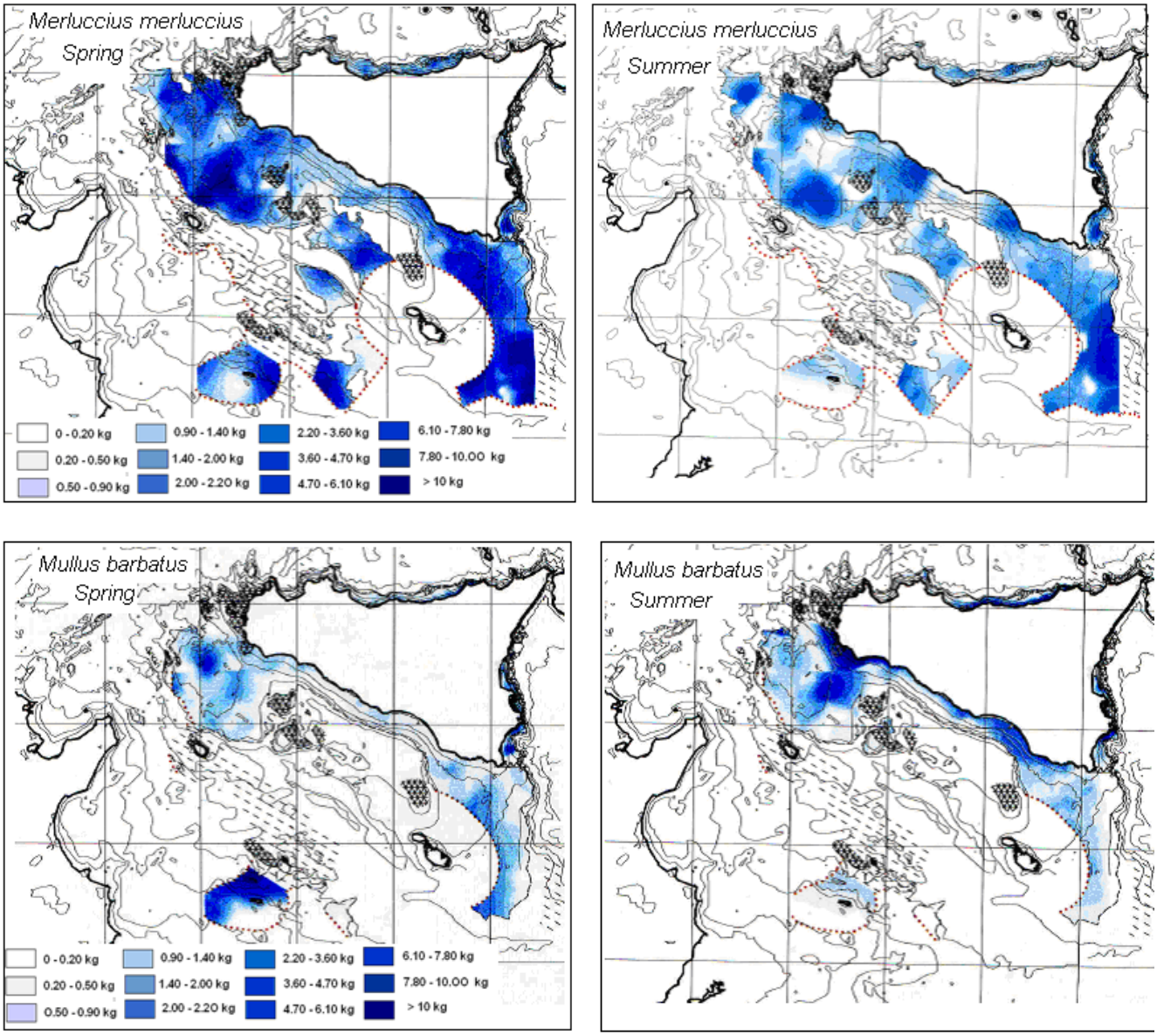
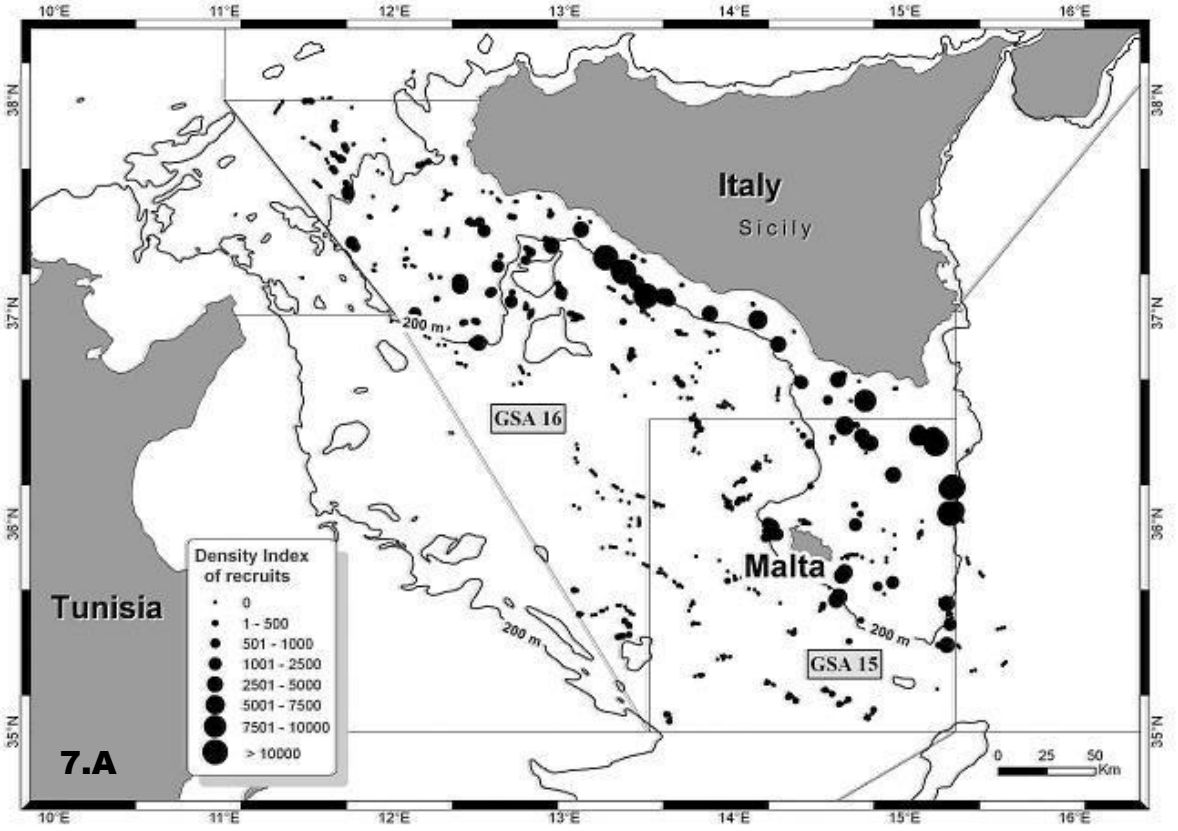
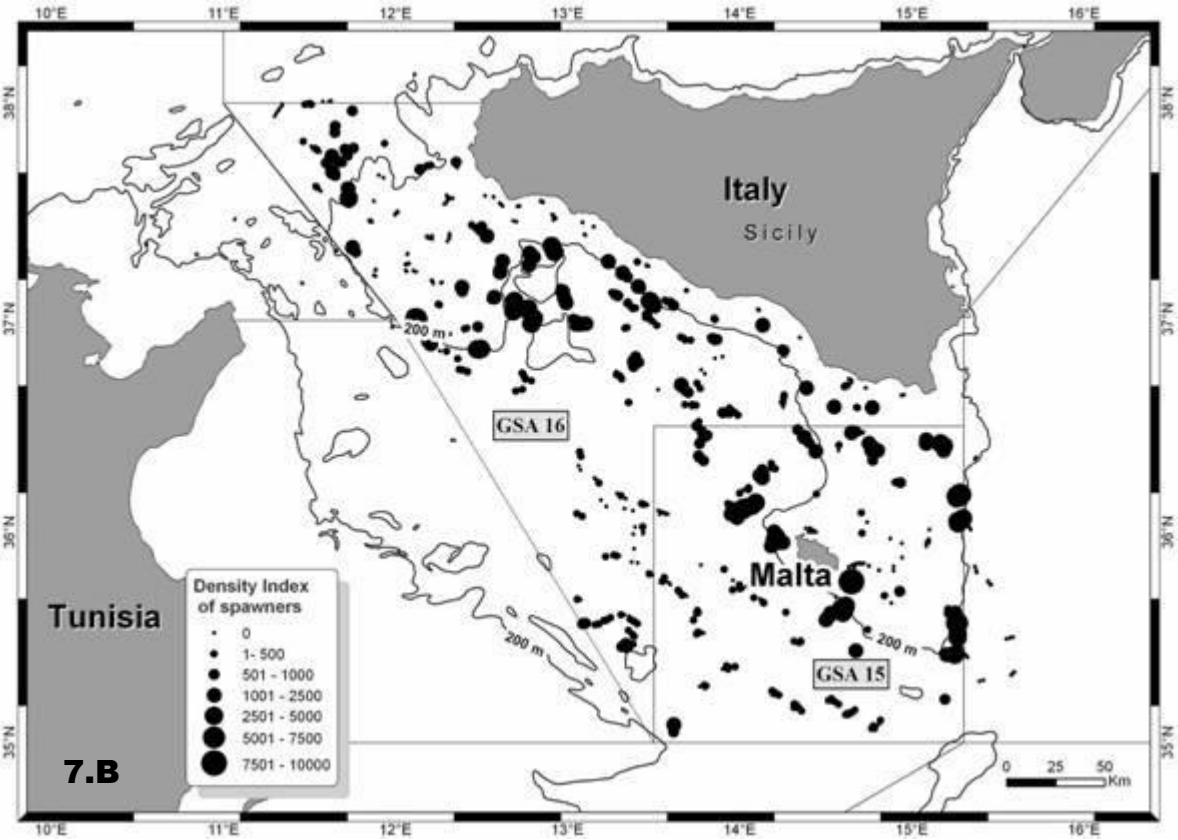
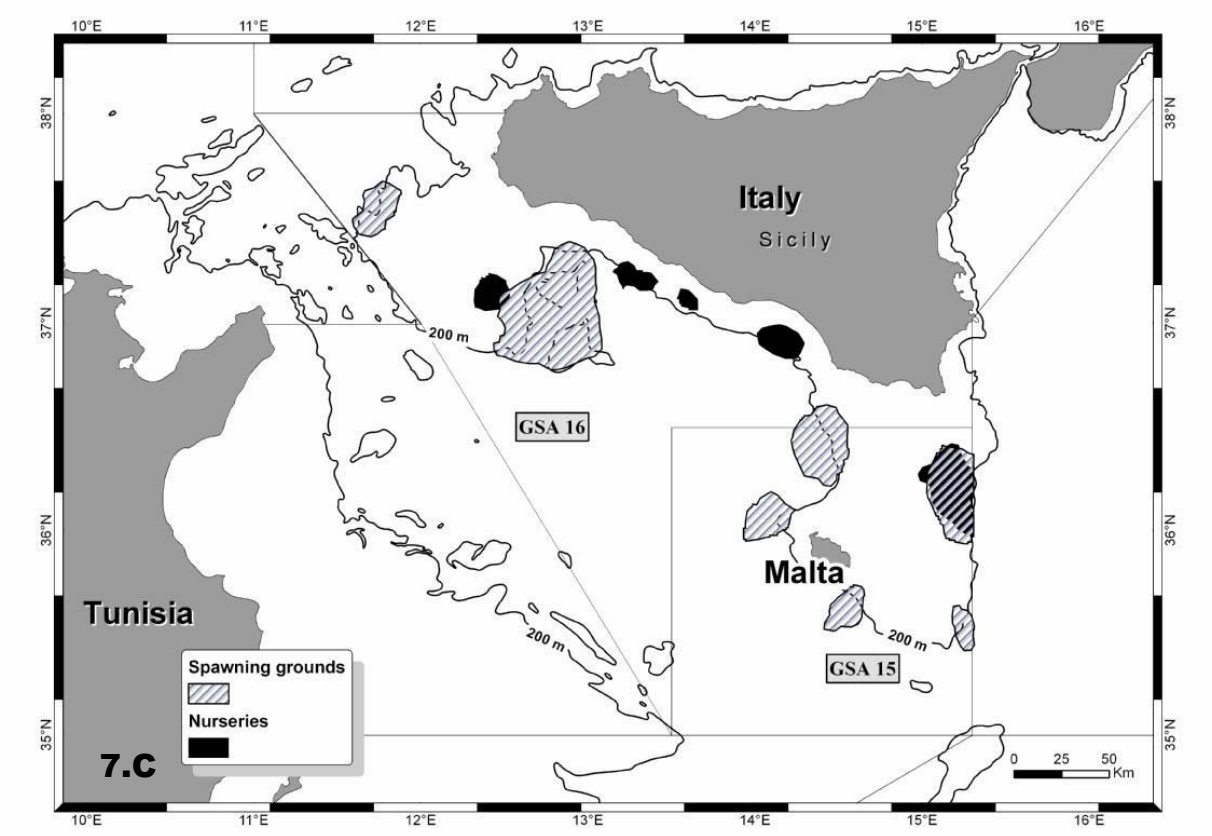


Fig. 6. Geographical distribution of some main species fished in the Sicily channel/Tunisian plateau (2 bis).


Italy
Sicily
Tunisia
Malta
GSA 16
GSA 15
200 m
Density Index of recruits
0
1 - 500
501 - 1000
1001 - 2500
2501 - 5000
5001 - 7500
7501 - 10000
> 10000
0 25 50 Km
7.A


Italy
Sicily
Tunisia
Malta
GSA 16
GSA 15
200 m
Density Index of spawners
0
1- 500
501 - 1000
1001 - 2500
2501 - 5000
5001 - 7500
7501 - 10000
0 25 50 Km
7.B



Figs. 7.A, 7.B and 7.C. *Parapenaeus longirostris* : Preliminary results of the MedSudMed and CopeMed II Working Group *(5 bis).*

3 Information available on the status of the main stocks of commercial species in the Sicily channel/Tunisian plateau

3.1 Small pelagic species in the eastern part of the area

3.1.1 Anchovy (Engraulis encrasicolus)

The high and increasing yearly harvest rates, as estimated by the ratio between total landings and stock sizes, indicate fishing mortality far above the sustainable values at current biomass levels levels and according to the current assessments the anchovy stocks of the Sicily channel/Tunisian plateau should be considered as being overexploited.

The situation in GSA 16 (57, 33a)

In GSA 16, the Italian “lampara” purse seiners and midwaters pair trawlers are mainly based in Sciacca port. Midwaters trawlers receive a special permission from Sicilian Authorities on an annual basis. The main technical measures regulating fishing concern minimum landing size (9 cm), 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. A previous fleet based in some northern Sicilian ports and targeting juveniles until 2010 is presently closed.

Large inter-annual fluctuations of anchovy landings in Sciacca port where observed over the period 1998-2011. 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, landings levels over the same period remained relatively high, indicating high levels of vulnerability in the resource (Fig. 8).

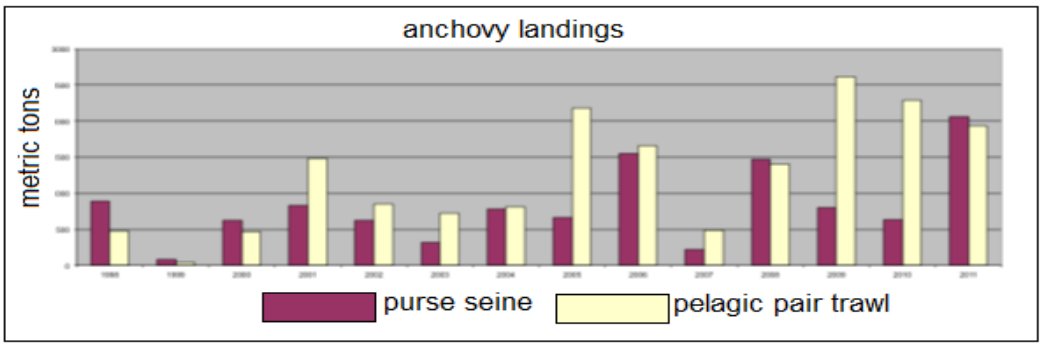


Fig. 8. Inter-annual fluctuations of anchovy landings in Sciacca port (52).

Fishery independent information regarding the state of the anchovy stock in GSA 16 was derived from the acoustics. Figure 9 displays the estimated trend in anchovy total biomass (estimated by acoustics) for GSA 16. The stock appeared to partially recover in 2010, but current 2011 estimate is close to the lowest values observed in the times series.

Fig. 9. Trend in anchovy total biomass (estimated by acoustics) for GSA 16.

Current knowledge suggests that observed changes could be linked to strong environmental forcings (3, 4, 52) as 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). 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).

The results of the first formal assessment approach, based on the implementation of a logistic surplus production model, are consistent with the previous considerations. Fishing mortality experienced very high values during the considered period, frequently well above the reference limit and current fishing mortality is far above the sustainable fishing mortality at current biomass levels. In addition B/BMSY values was below 100% over the entire time series decade, all these elements indicating the stock being exploited unsustainably.

3.1.2 Sardine (Sardina pilchardus)

The situation in GSA 16:

In GSA 16, the two operational units fishing for small pelagic are present, mainly based in Sciacca port (accounting for about 2/3 of total landings): 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. In both OUs, anchovy represents the main target species due to the higher market price. 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. 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 increased again above the average in 2011. Fishing effort remained quite stable over the last decade.

This stock should be considered as exploited unsustainably. 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 (Fig 10). The fluctuations in

stock biomass cannot be explained solely by the observed fishing pattern. Taking into account data on chlorophyll concentration has shown to have a positive effect on the yearly population intrinsic growth rate. Fishing mortality experienced very high values during the considered period and current and fishing mortality is far above the sustainable fishing mortality at current biomass levels. Finally, current sustainable production is about the 73% of the MSY (Fig. 11).

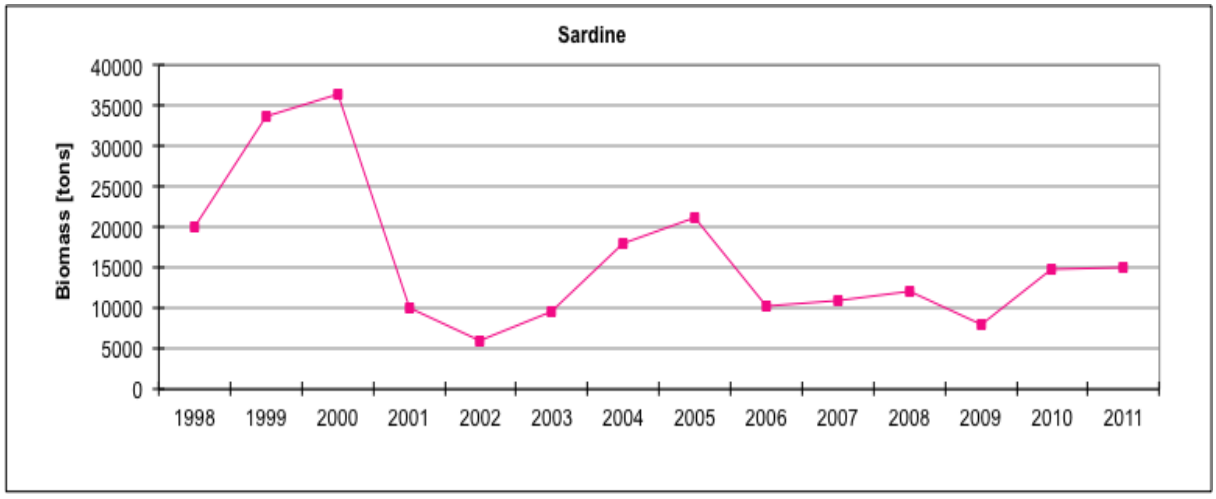


Fig. 10. Estimated sardine biomass indices for GSA 16, years 1998-2011.

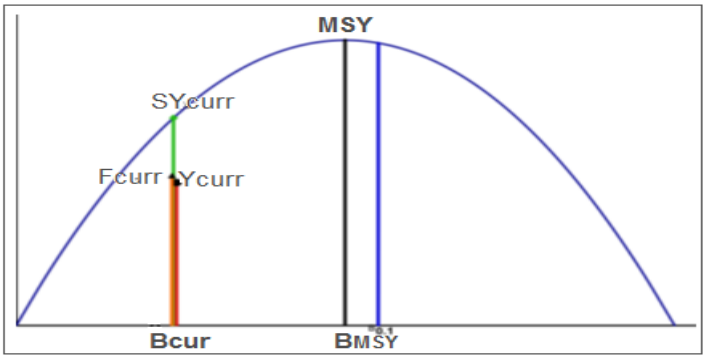


Fig. 11. Current situation of the sardine stock in GSA 16.

3.2 Small pelagics in the western part of the area

Several species of small pelagic fishes are caught by the Tunisian fleet: *Sardina pilchardus, Sardinella aurita, Engraulis encrasicolus, Trachurus trachurus, Trachurus mediterraneus, Trachurus picturatus, Scomber scombrus, Scomber pneumatophorus* and *Boops boops*.

The available information on the small pelagic fishery along the Tunisian coasts is not recent, it comes from a series of trawl surveys realized in the frame of various national and international surveys at sea during the period 1976-1999. The data collected during two OASIS echosurveys realized in 1998 and 2000 (5) have allowed to describe the distribution and abundance of the main small pelagic species (Figs. 12-13).

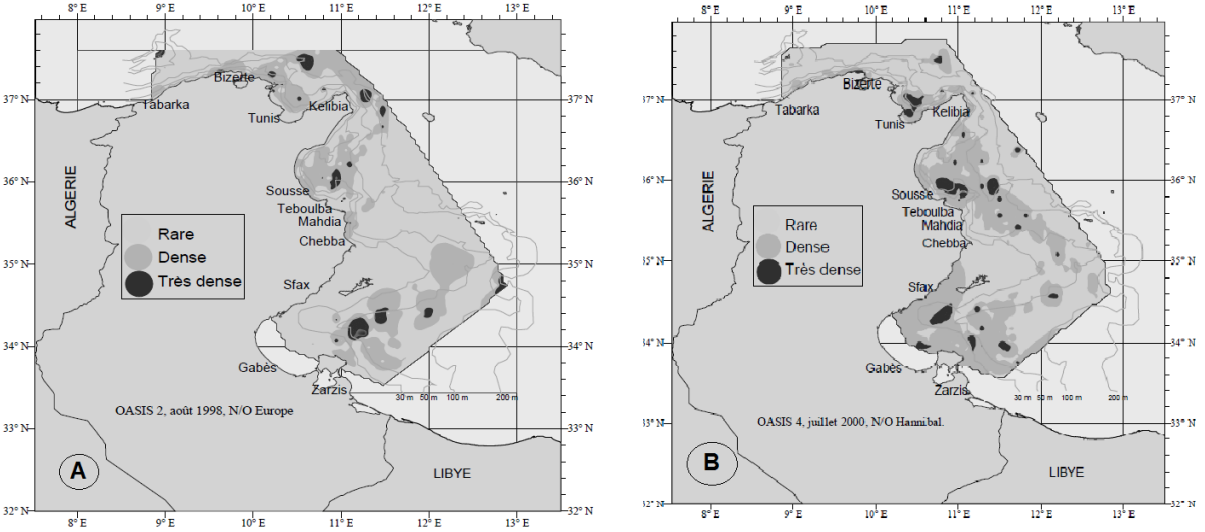


Fig 12. A: Distribution of the absolute densities OASIS survey, August 1998. **B**: Distribution of the absolute densities OASIS survey, July 2000.

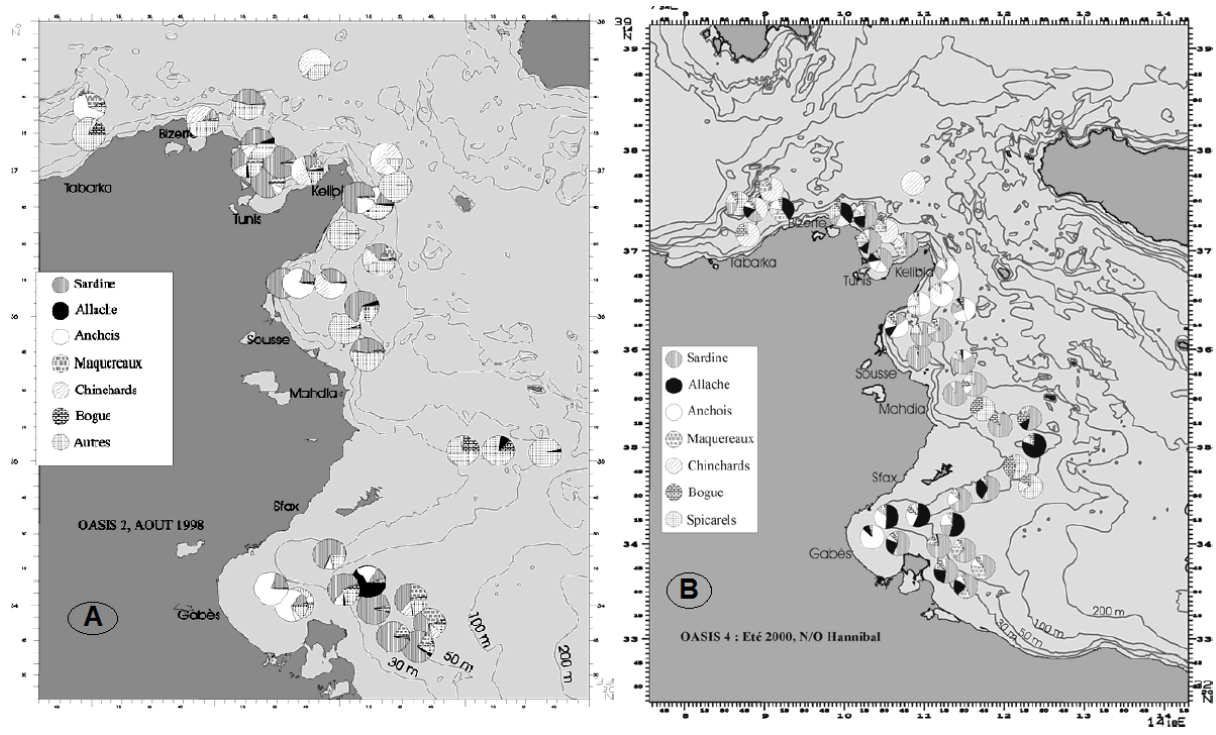


Fig 13. Catch composition (A: OASIS survey, August 1998 and B: OASIS survey, July 2000).

3.2.1 *Spicara flexuosa*

Apart from a handful of specimens found in deep water, this species was caught almost exclusively on the shelf (Fig. 15) indicating a more restricted preferential depth range of 50–100 m.

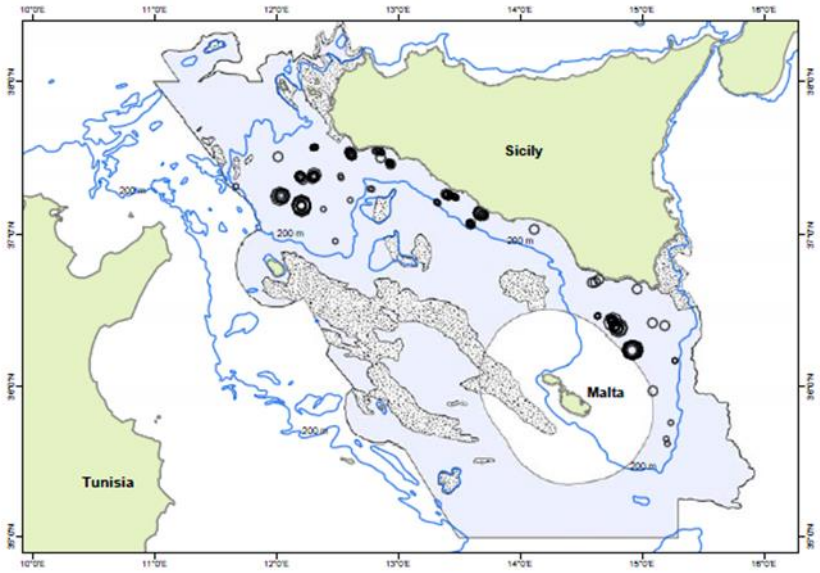


Fig. 14. Density (DI=N/km2) distribution for Spicara flexuosa (1994–2002, average) in the Sicily channel/Tunisian plateau. (Source: Medits)

3.2.2 *Trachurus mediterraneus*

Although captures during the trawl surveys were scanty in the upper part of the slope (down to 300 m depth), this species was caught on the shelf over practically all the investigated area (Fig. 16), though with a narrower preferential depth range (20–80 m).

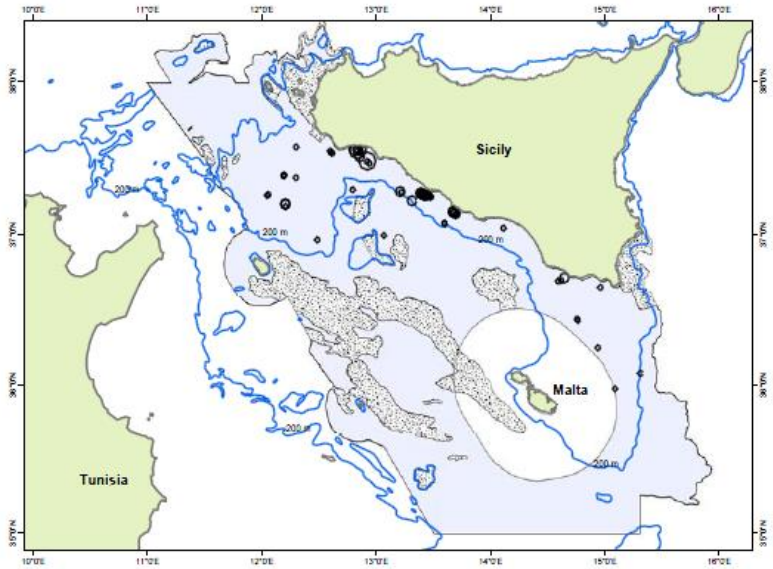


Fig. 15. Density (DI=N/km2) distribution for *Trachurus mediterraneus* (1994–2002, average) in the Sicily channel/Tunisian plateau (Source: Medits).

3.2.3 Trachurus trachurus

Some catch of this species was recorded also in deep water (down to 600 m depth or more), especially in the first two years. Overall, it occurred exclusively on the shelf (see Fig. 17), showing a preference for the external edge (100−200 m) off the southern coast of Sicily

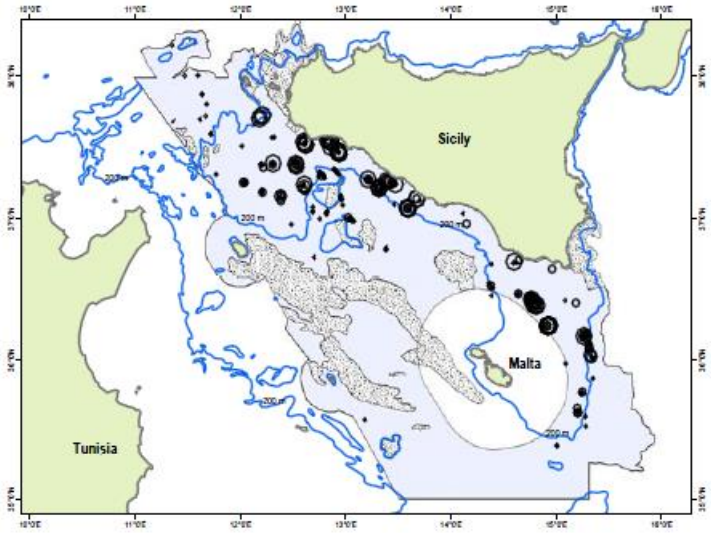


Fig. 16. Density (DI=N/km2) distribution for *Trachurus trachurus* (1994−2002, average) in the Sicily channel/Tunisian plateau (Source: Medits).

3.3 Demersal species

The recent assessments have shown a status of overexploitation for some of the species landed by the Mazara fleet. In GSA 15 and GSA 16, European hake, pink shrimp and giant red shrimp are considered overexploited. These species represent an important part of demersal landings and the effects of overfishing are highlighted also by the reduction in the production levels. As matter of fact, the bulk of the trawl catches in the Sicily channel/Tunisian plateau is nowadays composed of recruits whose growth is enhanced by the reduced inter-specific competition. Recruits also represent the most abundant specimens (up 90%) in the MEDITS and the GRUND catches.

An historical retrospective indicates that the capacity of fleets fishing in the Sicily channel/Tunisian plateau corresponding to the maximum sustainable yield for all demersal species was surpassed during the late 1970s–early 1980s (40). As an example of such decline, the hourly catch rate for the pooled demersal resources trawled along the upper slope decreased from about 30–40 kg in the early 1970s to 10–20 kg in the late 1990s (47). Another example comes from the analysis of the discard rate: from 1996 to 2000, the percentage of the total catch of Mazara trawlers discarded decreased from 50% to 20% (in the mid-1980s these discards consisted of about 60–70% of the trawler catches (47). Further indexes of overexploitation can be found in the rarefaction of the large-size sedentary and slow-growing fishes, such as *Peristedion cataphractum* and *Helicolenus dactylopterus.*

Most of the biological information on groundfish in the Sicily channel/Tunisian plateau was obtained within the framework of two main programmes of assessment of demersal resources: the GRUND programme started in 1985 and funded by the Italian government and the international programme MEDITS, started in 1994 and supported also by the Europen Union (tab. 7).

Tab. 7. Information on groundfish in the Sicily channel/Tunisian plateau from the GRUND and MEDITS survey.

Helicolenus dactylopterus	Occurs both on the shelf and on the slope, but the bulk of the catch was taken on the slope; high discard rate among the long-distance trawlers.
Lepidorhombus boscii	Almost exclusively observed on the slope, always in low quantity
Merluccius merluccius	Fished in a wide bathymetric depth range; almost disappeared below 500 m; high discard rate for specimens below 15 cm in length; no evident trend
Mullus barbatus	Caught nowadays almost exclusively on the shelf; low discard rate for specimens below 10 cm in length; widespread distribution of recruits, although some nursery areas can be defined. A fluctuating pattern in the BI within the range 6–10 kg was detected
Mullus surmuletus	Occurs mainly on the shelf
Pagellus erythrinus	Fished exclusively on the shelf
Peristedion cataphractum	Fished both on the shelf and on the slope although the highest value of BI occurs on the slope
Phycis blennoides	Mainly found on the slope. Only slight irregular variations of 5–7 kg were evident in the BI
Galeus melastomus	Collected only on the slope and fished over a wide depth range (250–680 m); totally discarded. No trend evident
Mustelus mustelus	Collected only on the shelf
Raja clavata	Caught in a wide depth range. Abundance indexes showed an irregular temporal pattern. A sharp decline has been noticed in the most recent surveys
Scyliorhinus canicula	Found both on the slope and the shelf
Aristaeomorpha foliacea	Exclusively caught in the deep waters although occasionally found at lesser depth (150–250 m); almost all sizes are retained (no or very low discard); not considering the 1994 datum, a positive trend was detected. An inversion of the trend has been noted in the most recent surveys
Nephrops norvegicus	Sought after by fishermen almost exclusively on the upper slope; only a scanty catch is taken on the outer edge of the shelf; no trend
Parapenaeus longirostris	Wide bathymetric distribution (80–700 m) but fishing grounds located mainly between 100 and 500 m; low discard incidence below CL of 20 mm; some nursery areas were identified. With the only exception of 1997 data, a positive and significant trend was detected for the DI. An inversion of the trend has been noted in the most recent surveys
Eledone cirrhosa	Juveniles are highly prized
Eledone moschata	A more "coastal" species than the congener; caught exclusively on the shelf
Illex coindetii	In spite of a wide depth distribution, this squid was mainly found on the shelf

3.3.1 Merluccius merluccius:

Merluccius merluccius, is one of the most important demersal target species of the commercial fisheries in the Sicily channel/Tunisian plateau and North of Tunisia (GFCM-GSA12-16). In this area, hake is exploited by 5 fishing fleet components: Italian coastal trawlers, Italian distant trawlers, Tunisian trawlers, Tunisian gillnets and Maltese trawlers. Annual landings of hake for 2010-2011 is around a mean value of 2,000 t. Trawlers hake's fishery exploits a highly diversified species assemblage: Striped mullet (*Mullus surmuletus*), Red mullet (*Mullus barbatus*), Angler (*Lophius piscatorius*), Black-bellied angler (*Lophius budegassa*), European conger (*Conger conger*). Length catches of hake range between 8 and 66 cm total length (TL), with an average size of 20 cm TL.

Preliminary information on the identification of the fish nursery areas in the Sicily channel/Tunisian plateau has been derived from 1995 and 1996 MEDITS data (38). More recently, the spatio-temporal distribution and abundance of hake recruits (0 group) in the Sicily channel/Tunisian plateau was studied (23). The estimation of the abundance of recruits derived from the MEDITS programme (1994–1999) on the entire Sicilian side of the Sicily channel/Tunisian plateau showed that hake recruitment was quite stable throughout the period of investigation time. Although some inter-annual variability in the distribution of the nurseries was evident, two stable areas could be identified for *M. merluccius* (Figs. 17 A and 18) which

are probably connected to the presence of mesoscale oceanographic processes. These nurseries were located on the eastern side of the Adventure and Malta Banks, mainly between 100 and 200 m depth.

On the basis of the MEDITS Trawl Survey data (1994–1999), hake was found in GSAs 15 and 16 with an overall frequency exceeding 65% of the hauls, and occurred more often over the shelf (> 80%) than on the slope (about 55% of the hauls) (62). Information on the northern sector of the Sicily channel/Tunisian plateau (GSA 16) indicates that the outer shelf on the western side of Adventure Bank might be a hake spawning area (Fiorentino et al., 2006a). According to the literature, spawning should occur over the outer shelf–upper slope *Recruitment and nursery areas.* Despite the presence of very small specimens of 3.5 cm TL in catches during the fine-mesh trawl surveys, hake is only considered fully recruited to the fishing grounds at 10 cm TL (62). In contrast to other areas of the Mediterranean, where two main recruitment pulses are known to occur, the analysis of the length–frequency distribution throughout the year suggests that, in GSAs 15 and 16, recruits reach the fishing grounds all year round (62).

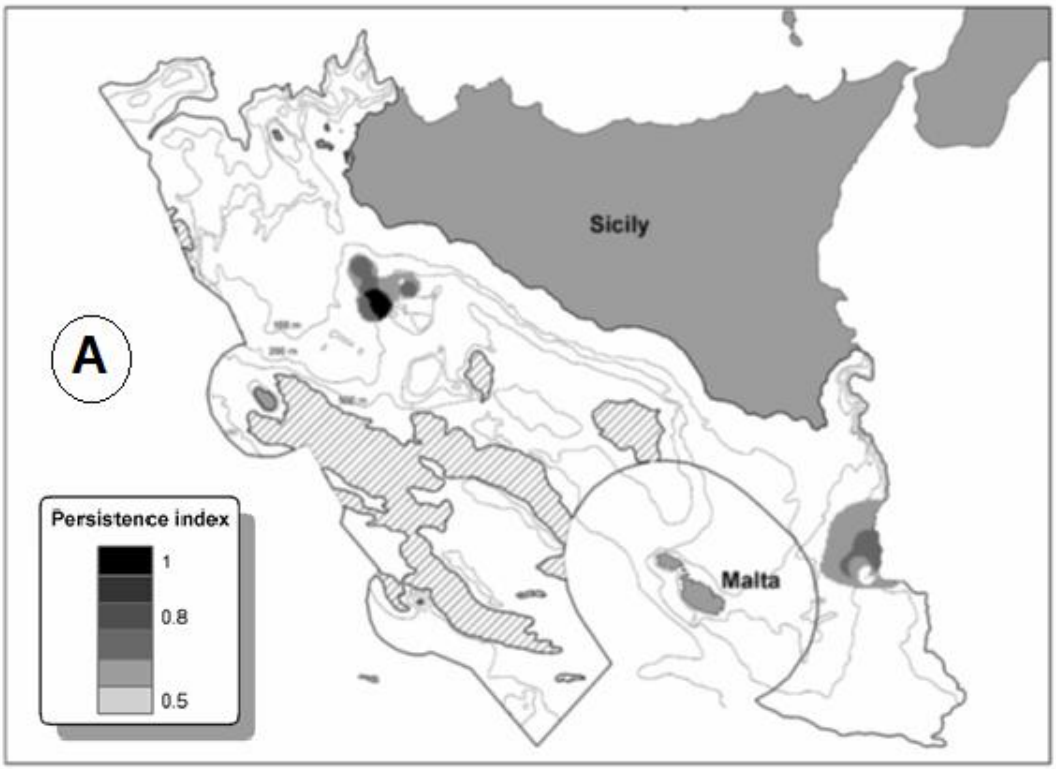


Fig. 17: *Merlucius merluccius*, stable nurseries (24).

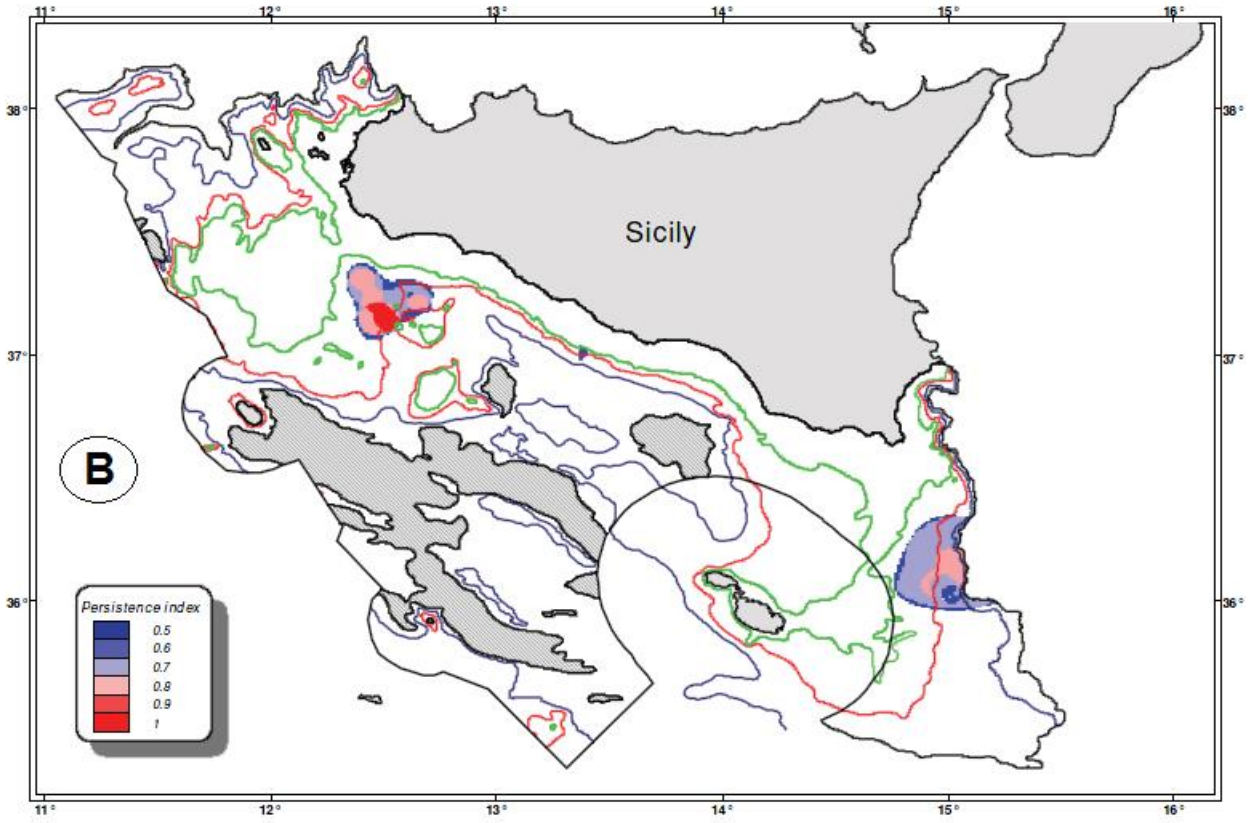


Fig. 18: Areas showing stable presence of recruits of *M. merluccius* between 1994 and 1999 in GSAs 16 and 15, excluding the Maltese Fisheries Management Zone (24).

In the northern sector (GSAs 15 and 16), although some inter-annual variability in the distribution of the nursery areas is evident, two stable nursery areas for hake have been identified, which are related to the presence of meso-scale ocean processes (24). These nurseries are on the eastern sides of the Adventure and Malta Banks, between 100 and 200m depth.

The stock structure of hake in the Sicily channel/Tunisian plateau is still not well known and needs further studies. The comparison between the growth of *M. merluccius* in the Mediterranean (48) has shown quite a similar pattern in individuals from the northern side of the Sicily channel/Tunisian plateau (GSA15 and 16) and those caught in the Gulf of Gabès (GSA 14). No evidence of genetic subdivisions or significant differences in allelic frequencies, between samples near Sicily and those from the mid-line was found (49). More recently, electrophoretic, morphometric and growth analyses have been done to test the hypothesis of the existence of a unique stock of hake in the Sicily channel/Tunisian plateau, which includes part of the North African continental shelf off the Tunisian coast and the shelf off the southern Sicilian coast (46). Although the level of genetic variation detected at five selected sampling sites was very low, morphometric analyses and otolith readings revealed some significant differences at a phenotypic level, mainly in females. On the basis of the spatial distribution of spawning and nursery areas compared with the current patterns in the Sicily channel/Tunisian plateau the existence of genetic exchange between hake sub-populations inhabiting GSAs 15 and 16 has been suggested.

Along the Tunisian coast (GSAs 12, 13 and 14), the artisanal fishery (longlines and gillnets) is remarkable, being responsible for about 13 % of the total Tunisian hake catches (6). In contrast, in the northern sector of the Sicily channel/Tunisian plateau (GSAs 15 and 16), the majority of the hake catches (more than 95%) is obtained by bottomtrawling, although the species is fished also by longlines and gillnets (6). Although hake is not the target of a specific fishery, it is the third species in term of biomass landed in GSA 16 (26). Hake is caught by trawling in a wide depth range (50–500m), together with other important species, such as *Nephrops norvegicus*, *Parapenaeus longirostris*, *Eledone* spp., *Illex coindetii, Todaropsis eblanae*, *Lophius* spp., *Mullus* spp., *Pagellus* spp., *Zeus faber, Raja* spp.

Of the fishing gears used in the Sicily channel/Tunisian plateau, only trawling has produced relevant amounts of discards of undersized hakes. The discarded fraction of hake is very variable, according to the season and the type of fishery. In the late-1990s, Sicilian trawlers fishing offshore (trips of 15–25 days) have a higher discard of hake (86% by number and 31% by weight) than the inshore trawlers (trips of 1–2 days; 32% by number and 9% by weight) (Anon., 2000). For the distant fisheries, the first modal group (10–12 cm) in the catches is totally discarded. This is due to the intensive use of the work time and the cold-storage space available for high-priced crustaceans. Conversely, trawlers fishing more inshore tend to reduce the discarded fraction to the smallest specimens of the first age group present in the catches.

In 2013 the joint stock assessment for pink shrimp (Parapenaeus longirostris) and hake (Merluccius miraculous) in GSAs 12-16, was updated by Maltese, Tunisian and Italian scientists, combining data collected throughout the Central Mediterranean. This stock assessment was conducted under the auspices of the FAO MedSudMed project, and finalised at the 2014 GFCM demersal working group workshop. Stock assessments were also carried out by Maltese scientists in collaboration with Italian scientists based at CNR-IAMC in Sicily combining GSAs 15 and 16 for the following species: Striped red mullet (Mullus surmuletus) and Norway lobster (Nephrops norvegicus). These assessments were done at stock assessment working groups organised by the GFCM Subcommittee on Stock Assessment (ASCA). As shown on table 7b only one of these stocks (the Norway lobster) was considered as sustainably exploited while the others are overexploited.

Tab. 7b. Status of the stocks assessed in 2013 for the GSA's 12-16. (source: Maltese National report for GFCM-SAC 2014).

GSA	English Name	Scientific Name	Stock status
12-16	Hake	*Merluccius merluccius*	Overexploited
12-16	Deep-water pink shrimp	*Parapenaeus longirostris*	Overexploited
15-16	Striped red mullet	*Mullus surmuletus*	Overexploited
15-16	Norway lobster	*Nephrops norvegicus*	Sustainable

3.4 Spatial distribution of biomass and density indices, nursery and spawning areas of hake:

Figure 19 shows the areas where the highest hake biomass indices occurred. In the Italian–Maltese sub-region, the resource was preferentially located over the offshore banks, the Adventure Bank in GSA 16 and the Malta Bank in GSA 15, and their south-eastern border. Off

the Tunisian coasts, two large concentration areas were found in GSA 12 and GSA 13, whereas low abundances were observed in the Gulf of Gabès (GSA 14). Along the Libyan coast, significant abundances were found in the Gulf of Sidra (Gulf of Syrta, western part of GSA 21), whereas the resource was very scanty along the Cyrenaica coast (GSA 21 east).

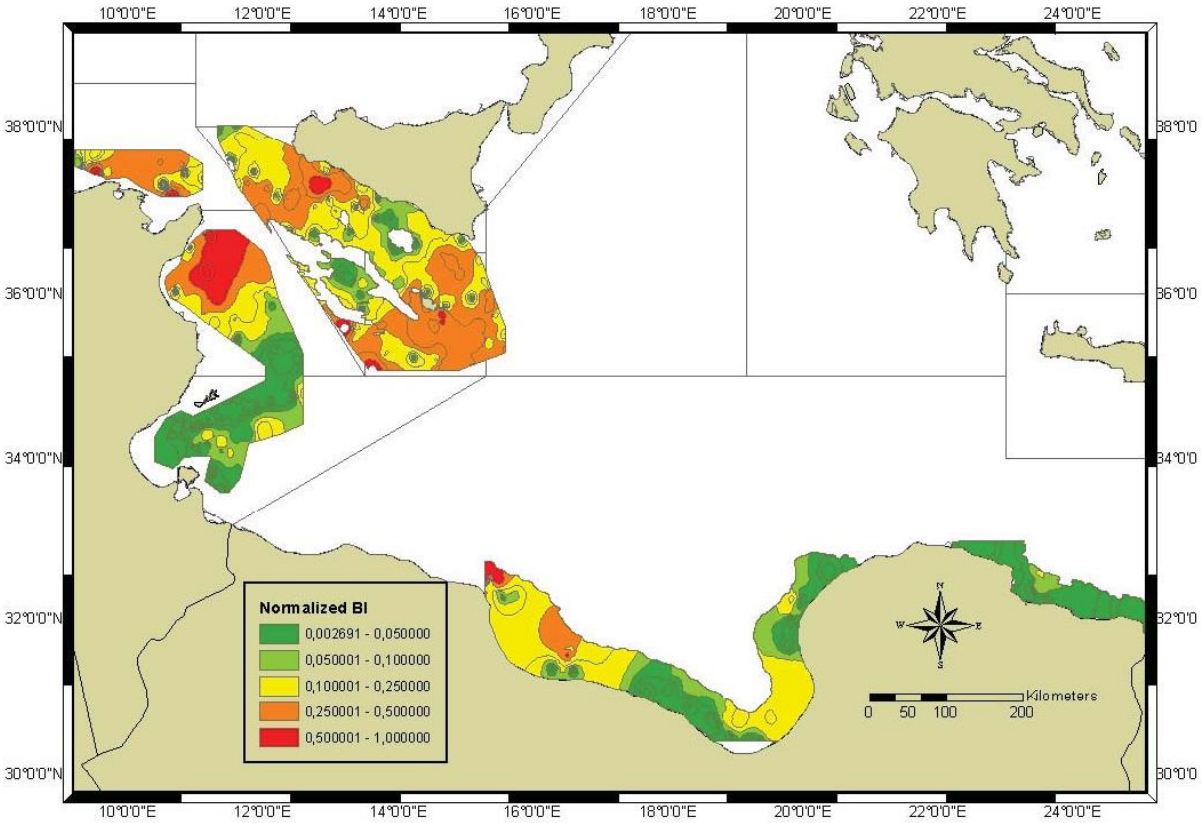


Fig. 19. Spatial distribution of normalized biomass index (BI) of hake (spring–summer 2003).

3.4.1 Mullus barbatus

M. barbatus is one of the main demersal resources of coastal fisheries of GSA 15 and 16. It is exploited by otter trawlers and small-scale vessels using trammelnets, along with other several shelf species, such as *Mullus surmuletus, Merluccius merluccius, Pagellus spp., Uranoscopus scaber, Raja spp., Trachinus spp., Octopus vulgaris, Sepia officinalis, Eledone spp.* and *Lophius spp*. Landings data collected within the E.U. Data Collection Framework (DCF) showed a decrease from 1,409 t in 2005 to 608.5 t in 2011. More than 95% of the annual landing is due to bottom otter trawlers. The contribution of the Maltese fleet was less than 5% in 2005-2011. The annual amount of discards, estimated within the DCF for trawlers smaller than 24 m LOA, ranged between 32 and 117 tons in the period 2006-2011 in GSA 16. The effort of Italian otter trawlers of 12-24 m LOA remained quite constant (800,000 - 10,000.000 KW day-1) in 2004-2011. A decreasing pattern was evident for both Italian and Maltese small scale vessels (6-12 m) equipped with trammel nets.

Although the red mullet is a typical coastal resource, the peculiarity of the Sicily channel/Tunisian plateau (two shelves on the Sicilian and African sides separated by deep bottoms and the existence of large offshore banks), together with the distant-water fisheries

practised by the Mazara del Vallo trawlers, make *M. barbatus* and its congener, *M. surmuletus*, a stock shared amongst the riparian countries.

Figure 20 shows two major and clearly separate spawning areas exist on the northern side of the area (30). They are located over the Adventure Bank, off the south-western coast of Sicily and over the Malta Bank, between Sicily and the Maltese Islands (GSA 15), respectively, at approximately 100 m depth. Although recruits had a widespread distribution throughout the coastal waters, four main areas, showing high abundance and the almost exclusive presence of recruits, were found within GS 16 (southern coast of Sicily), between 20 and 50 m depth.

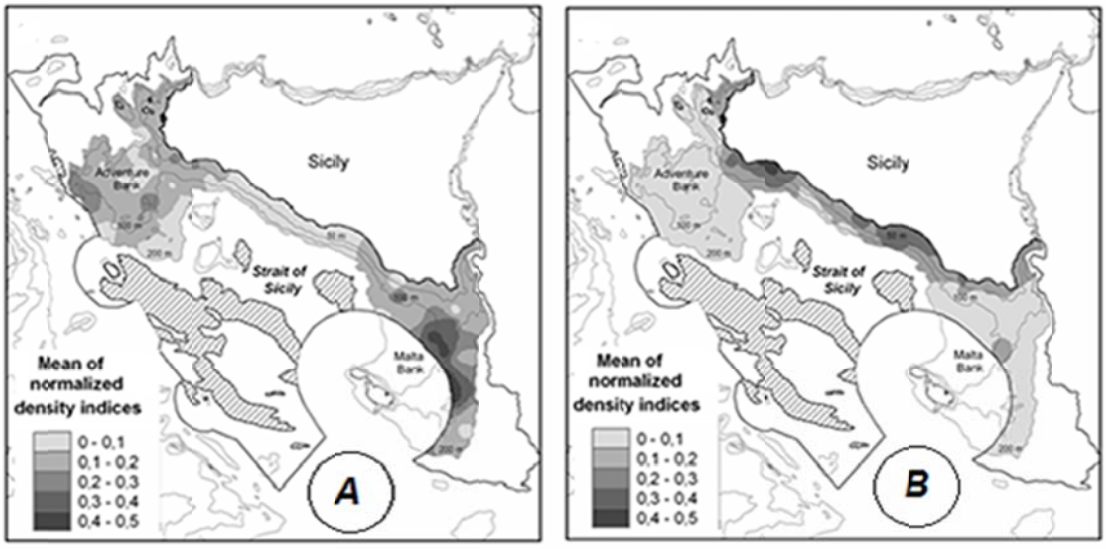


Fig. 20. Spawning (A) and nursery (B) areas of *Mullus barbatus* (30).

On the northern side of the Sicily channel/Tunisian plateau (GSAs 15 and 16), this species was found almost exclusively over the shelf (44 to 69 % of the hauls) (62). *Spawning* Red mullet reproduction in GSA 13 occurs near the coast, from May to June–July (16, 34). Spawning of red mullet in GSAs 15 and 16 takes place in May (41). Recent research on the Marine Protected Area of Castellammare del Golfo (northwestern coast of Sicily – GSA 10), where trawling has been forbidden since 1990, has shown that the oldest spawners prefer deeper bottoms (100–200 m depth), whereas the young ones are found in shallower areas (<50m depth) (27).

As in other areas of the Mediterranean, recruitment in GSAs 15 and 16 occurs over coastal bottoms in summer–early autumn (41, 46). The smallest specimens registered during trawl surveys in GSA 15 and 16 were 3.5 cm TL. Although recruits exhibited a widespread distribution throughout the coastal waters, four main areas showing high abundance and the almost exclusive presence of recruits were found within GSA 16 (southwestern coast of Sicily), between 20 and 50 m depth (Figure 21 A and B).

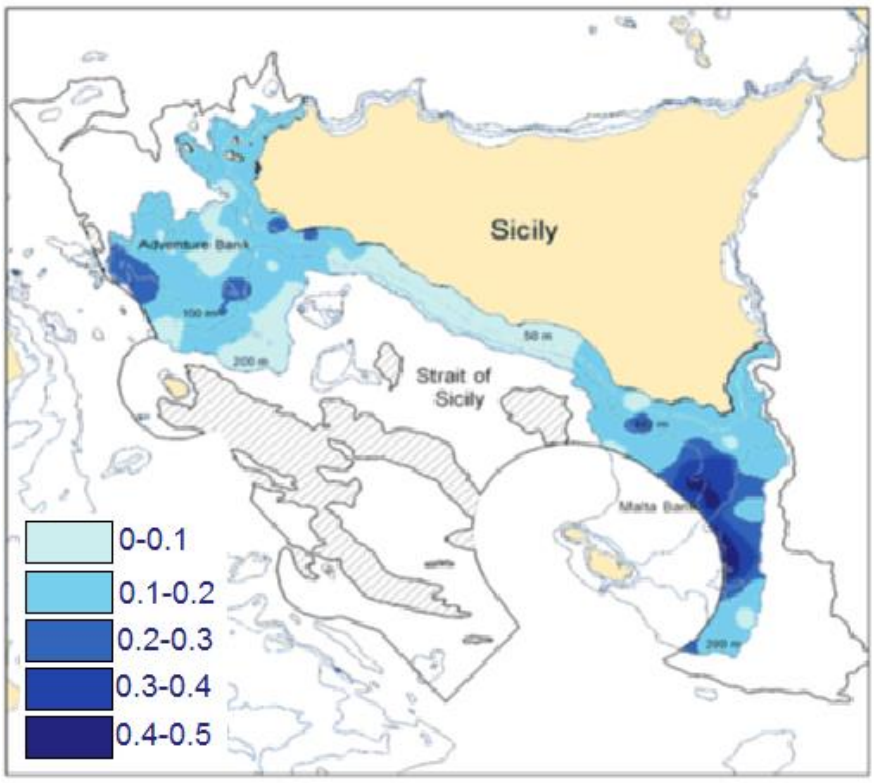


Fig. 21. A: Map of the average distribution of *M. barbatus* spawners in GSAs 15 and 16 (excluding the Maltese Fisheries Management Zone).

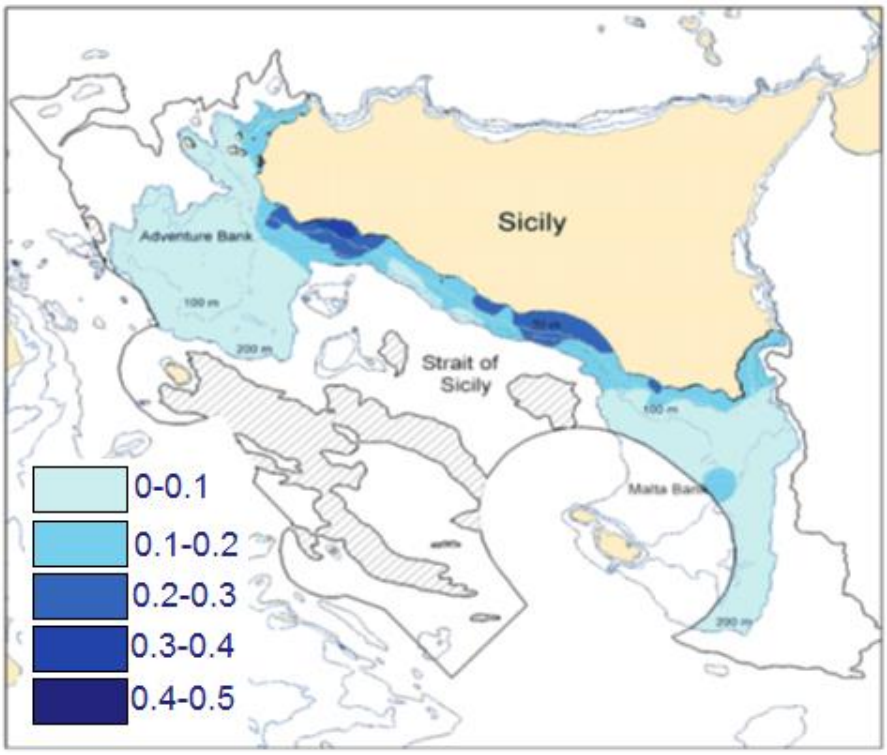


Fig. 21 B: Map of the average distribution of *M. barbatus* recruits in GSAs 15 and 16 (excluding the Maltese Fisheries Management Zone).

Since the red mullet is a typical coastal resource, the peculiarity of the Sicily channel/Tunisian plateau (two shelfs – the European and the African – separated by narrow deep bottoms) supports the hypothesis of the existence of different subpopulations in the area.

In GSAs 15 and 16, red mullet is caught almost exclusively by inshore trawlers operating on shelf fishing-grounds. The discarded fraction of red mullet catches varies with season and type of fishery. Sicilian trawlers fishing inshore have a low-discard fraction, since they normally land all their catch. In summer, the smallest *M. barbatus* landed may be 7–8 cm TL. The biggest trawlers, which undertake 15–25-day trips and fish far offshore, discard red mullet smaller than about 12 cm TL. This discard fraction may be significant during the summer and autumn. The high discard rate is due to the necessity of using the available cold-storage space almost exclusively for high-priced crustaceans. In this situation, the first modal group (9–10 cm TL) in the catches is totally discarded. Figure 22 shows the spatial distribution of red mullet biomass indices. In the GSA 16, the resource preferentially occurred in the shallow waters close to the coast of Sicily (southwestern corner of Sicily over the Adventure Bank and from the middle to the south-eastern coast of Sicily), whereas in GSA 15, the highest biomass values were in offshore waters east of Malta. As regards the GSAs 12, 13, 14 and 21, red mullet showed a more widespread distribution. The most important concentration areas were located in the Gulf of Hammamet (GSA 13) and in the Gulf of Sidra (Gulf of Syrta, western part of GSA 21).

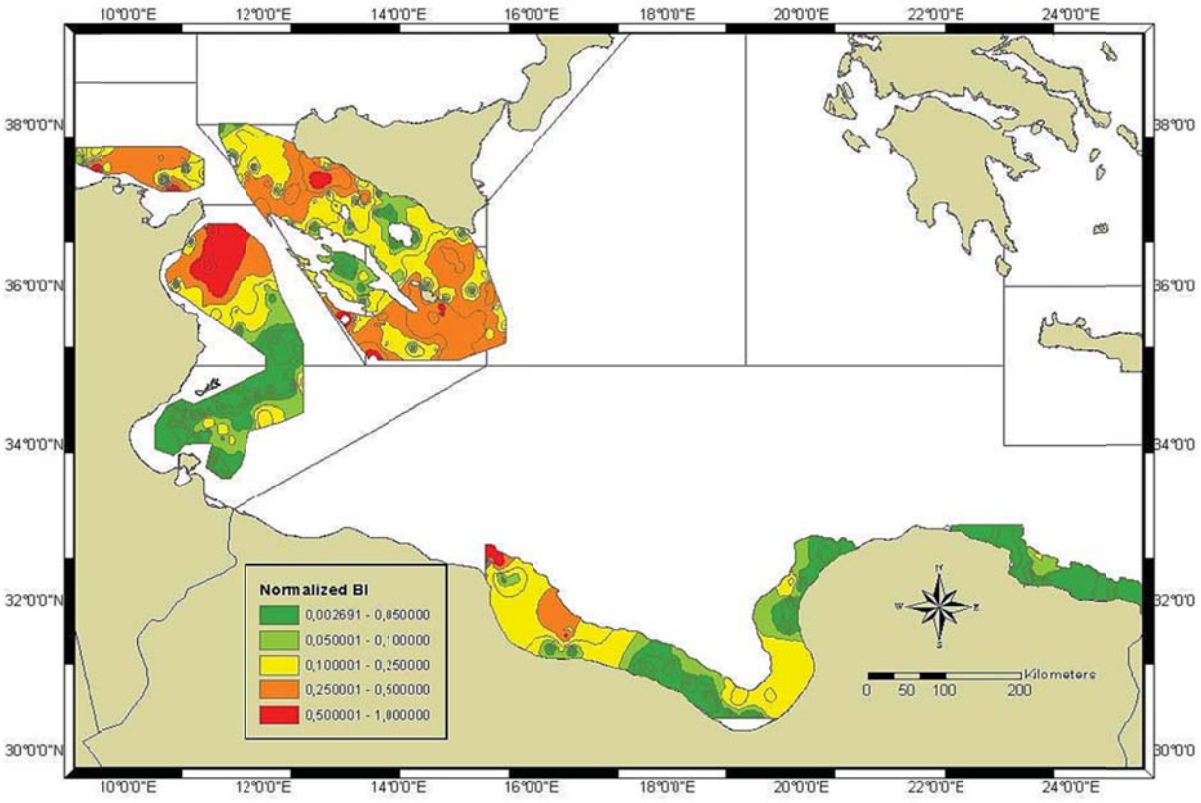


Fig. 22. Spatial distribution of normalized red mullet biomass index (BI) (spring–summer 2003).

Two geographically distinct nursery and spawning grounds of *Merluccius merluccius* on the northern side of the Sicily channel/Tunisian plateau suggest the existence of two main stocks sub-units, one over the Adventure Bank (GSA 16) and the other over the Malta Bank (GSA 15). In contrast, there is no clear picture of stocks diversification along the southern side of the Sicily channel/Tunisian plateau (GSAs 12, 13, 14 and 21), where several different spawning and

nursery grounds have been identified, partially overlap each other and are probably interconnected. Given the pattern of main currents in the Sicily channel/Tunisian plateau, passive dispersion of larvae may be responsible for a certain degree of stocks mixing, not only along the Italian–Maltese and the North African coasts, but also between the two sides of the Sicily channel/Tunisian plateau. The entire life-cycle of the hake populations generally occurs over large areas extending across the boundaries of national maritime jurisdiction and the adjacent high seas.

The available data also suggest that there are two separate stocks of *Mullus barbatus,* one on the northern and one on the southern side of the Sicily channel/Tunisian plateau.

MEDITS survey indices show an increasing of relative SSB from 1994 to 2006 followed by a decline in 2007-2011. The recruitment also showed a decreasing trend from 2006 to 2011. The total biomass consequently declined in the same period and the stock is considered exploited unsustainably.

Furthermore there is currently a high discarding rate of juveniles of the 0 group wich could be reduced by improving the trawl net selectivity (i.e. adoption of sorting grids) and through the reduction of fishing effort on the continental shelf in autumn.

3.4.2 Pagellus erythrinus

Pandora is an important demersal fishery resource through the Mediterranean, including in the Sicily channel/Tunisian plateau. Trawling is carried out on the continental shelf of the Central Mediterranean throughout the year, and catches include common Pandora (*Pagellus erythrinus*), pink shrimp (*Parapenaeus longirostris*), Norway lobster (*Nephrops norvegicus*), giant red shrimp (*Aristaeomorpha foliacea*), violet shrimp hake (*Merluccius merluccius*), violet shrimp (*Aristeus antennatus*), scorpionfish (*Helicolenus dactylopterus*), grater forkbeard (*Phicys blennioides*), red Pandora (*Pagellus bogaraveo)* and monkfish (*Lophius* spp.). In addition to trawling, common Pandora is targeted by several artisanal gears, including set gillnets, trammel nets, pots and traps and set longlines. Considering data from both GSAs combined, catches by the OTB fleet have declined in 2006-2011, whilst catches from the artisanal fleet have remained stable since 2008. Trawlers were responsible for 80% of common Pandora landings in 2011. On average the Maltese fleet was responsible for only 3% of total landings in GSAs 15 and 16 in 2006-2011.

The current assessments for GSA 15 and 16 show for both SSB and recruitment clear decreasing trends during the period 2006-2011. However in 2011 the recruitment increased. The current fishing mortality is higher than the F0.1 reference point (a proxy of FMSY), thus overfishing of the stock of common Pandora in GSA 15 and GSA 16 is currently taking place. As a consequence F needs consistent reduction from the current F towards the limit reference point.

3.4.3 Lophius budegassa

In the Sicily channel/Tunisian plateau the black bellied anglerfish is a high value commercial species. It is fished almost exclusively by trawlers operating mainly on the outer shelf-upper slope, together with other important species, such as *Mullus* spp*., Pagellus* spp*., Merluccius merluccius, Zeus faber, Raja* spp*, Eledone* spp*., Illex coindetii, Todaropsis eblanae, Parapenaeus longirostris* and *Nephrops norvegicus*. In the last three years the landings of both the Italian and Maltese trawlers ranged between 250 and 285 t, the Italian landings amounting

to more than 98% of the totals. The recent alyses show that the SSB or this species clearly increased from 2002 to 2006, showing thereafter a slight decrease. Recruitment remained quite stable from 2002 to 2008, followed by an increase in 2009 and 2010, and a large decrease in 2011. Current F is largely above the F0.1 reference point (a proxy of FMSY) and the stock is considered in overfishing.

3.4.4 Octopus vulgaris

In the Sicily channel/Tunisian plateau the common octopus is found at depths down to 150 m (58). No information on the recruitment period is available for the Sicily channel/Tunisian plateau. The smallest specimens registered during trawl surveys in GSAs 15 and 16 were 20 mm DML.

3.4.5 Illex coindetii

On the basis of the MEDITS spring surveys (1999–2000), it has been shown (58) that this species was more abundant in the western-central sector of the area. It is interesting to note that the numerical abundance observed was remarkably different when considering the two survey years separately: that of spring 2000 being up to ten times more abundant than that of spring 1999. In both years, juveniles were highly concentrated in the central zone. These main nurseries were related to the presence of a frontal zone located approximately in the middle of the area (the Gela Basin), which was evident in both years, although more sharply defined in spring 1999 (Fig. 23).

3.4.6 Eledone cirrhosa:

No evident relationship was found between adult and juvenile distributions, even though in both years (1999 and 2000), a major concentration of both was observed in the western sector (58). No striking difference in abundance between the two years' catches was observed; however, *E. cirrhosa* juveniles were considerably more abundant in spring 2000, when an important presence of adults on the Malta Bank (eastern sector) was also detected (Fig. 24).

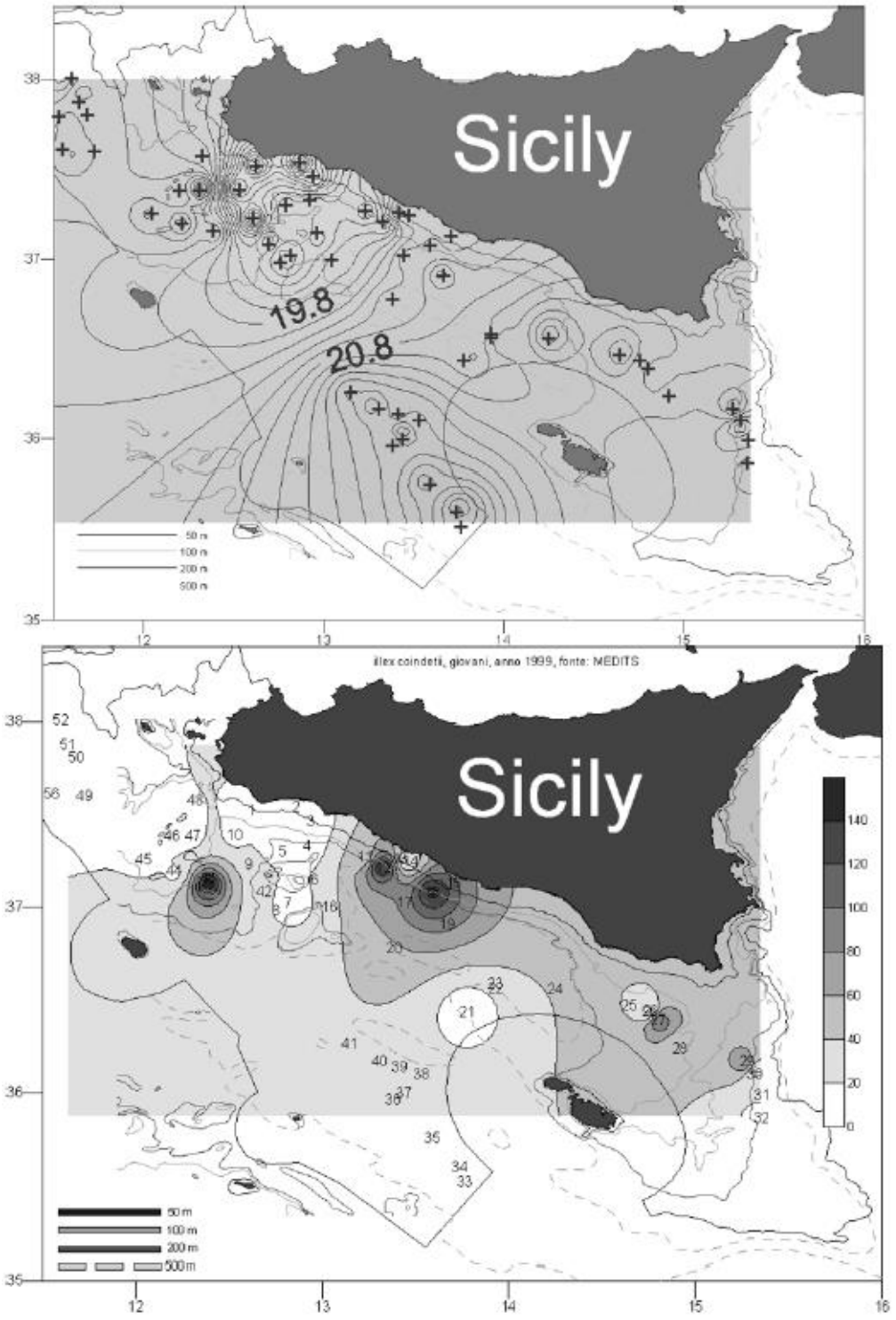


Fig. 23. *Ilex Coindetti* Frontal system derived from sea surface temperature (left panel) and distribution of nursery areas (right panel) in the eastern part of the Sicily channel/Tunisian plateau (36).

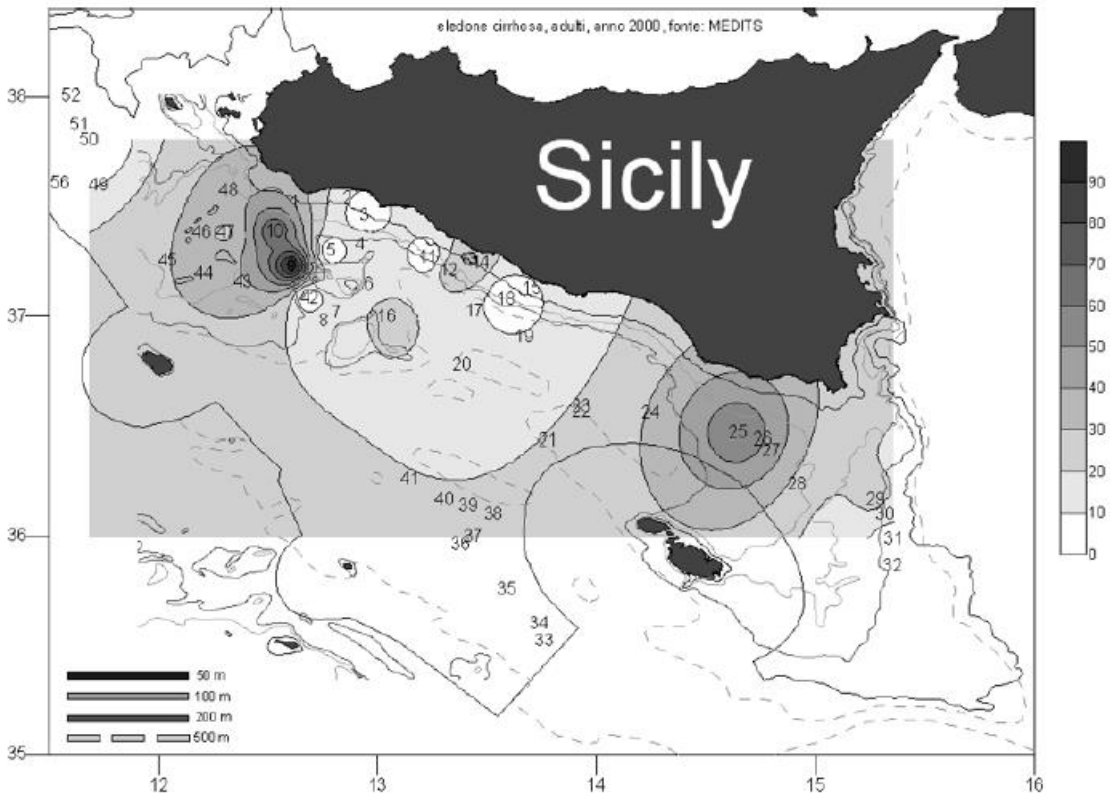


Fig. 24. *Eledone cirrhosa*: distribution of adults (36).

3.4.7 Parapenaeus longirostris

This deep-water pink shrimp is one of the most evidently shared resources of the Sicily channel/Tunisian plateau, with most of the catches being made in deep international waters in the central area. Available Scientific data indicates that exploitation by the fishing fleets of Tunisia, Malta, Libya and Italy is targeting a single shared stock of deep water rose shrimp. However, a better understanding of the *P. longirostris* stock distribution in the different GSs into which the Sicily channel/Tunisian plateau is needed. A preliminary hypothesis on an east–west migration was put forward (45) but no specific studies have been carried up to date.

The Pink shrimp is the main species targeted by trawlers in GSA 16. Different fishing patterns according to the trawler sizes are reported. Italian trawlers with an overall between 12 and 24 m mainly catch the smaller shrimp, including undersized juvenile. Conversely larger trawlers almost exclusively catch pink shrimp larger than 20mm carapace lenght. This difference is due to the fishing behaviour of trawler segments, operating the smaller boats with poor selective gears and inside the main nurseries of the Sicilian southern coast. Trawlers catches often include Norway lobster (*Nephrops norvegicus*), giant red shrimp (*Aristaeomorpha foliacea*), hake (*Merluccius merluccius*), violet shrimp (*Aristeus antennatus*), scorpionfish (*Helicolenus dactylopterus*), greater forkbeard (*Phicys blennioides*), red Pandora (*Pagellus bogaraveo),* common Pandora (*Pagellus erythrinus*) and monkfish (*Lophius* spp.). Tunisian trawlers operating in the Sicily channel/Tunisian plateau target mainly pink shrimp. They measure around 24 m in length, and operate primarily in Northern Tunisia where 90% of the country's total *P. longirostris* catches originate. The great majority of these catches are landed in the town of Bizerte and Kelibia. The number of Tunisian trawlers targeting rose shrimp has increased from 40 in 1996 to around 70 in 2009.

A preliminary geographical representation of nurseries on the northern side of the Area was provided in 2002 (22). The annual variability with respect to nurseries was low. One important nursery was located off Capo Rossello, in the western-central part of the area, and another on the eastern side of the Malta Bank, close to 200 m depth.

P. longirostris is a demersal species that can be found at depths between 20 and 700 m, but it is common and abundant on sandy–muddy bottoms between 70 and 400 m depths.The Sicily channel/Tunisian plateau, together with the seas around Greece, presents the highest abundance of the species in the Mediterranean (1, 44). *P. longirostris* shows a bathymetric distribution related to size: the smaller specimens are caught more frequently on the outer continental shelf (50–200 m depth) (2, 18, 66), whereas the larger ones are mainly distributed along the upper slope down to 500 m depth (15, 17, 39).

Mature females are found in GSAs 15 and 16 all year round, although a wide maturity peak extends from November to February and another occurred in April. The stock structure of the species in the Sicily channel/Tunisian plateau is not well known. A flux, from east to west, of eggs, larvae and juveniles of *P. longirostris* carried by the Levantine Intermediate Water (LIW) current has been hypothesized (45).

More recently, the existence of at least two sub-populations on the northern side of the area (GSAs 15 and 16) was advanced. This idea is based on the occurrence of local spawning and nursery areas that are connected by the Atlantic Ionian Stream flow (0–150 m depth range), which is considered to be the current in which the larvae and juveniles develop. These local sub-populations, one on the Adventure Bank and one on the Malta Bank, are separated by a wide area in which the species' abundance is very low. Current F is largely above the F0.1 reference point (a proxy of FMSY) the stock is considered in overfishing

3.4.8 Aristeomorpha foliacea

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 mainly in the central – eastern side of the Sicily channel/Tunisian plateau. 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).

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*).

Trawlers from Egypt, Tunisia and Libya also operate in the Central Mediterranean, however only few vessels target giant red shrimp. Giant red shrimp has been listed 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 (51). However compared to the large volumes of giant red shrimp caught by the Sicilian trawl fleet, landings by Tunisian vessels can be considered negligible.

The most recent stock analyses (33a) show that 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.

The giant red shrimp stock is considered exploited unsustainably. Moreover the current fishing mortality exceeds the exploitation limit reference point Fmax.

3.4.9 Phycis blennoides

The recruits of *P. blennoides* were highly and exclusively concentrated on both the western and the eastern side of Adventure Bank, with a remarkable annual consistency (23). Furthermore, only in 1998 and 1999 was a high abundance of recruits found along the eastern border of the Malta bank (Fig. 25). The abundances of *P. blennoides* recruits were more variable than those of hake. The analysis of the persistence of the spatial distribution of recruits throughout the period studied showed that the main nurseries of *P. blennoides* were on deeper bottoms, mainly from 200 to 400 m depth. Regarding the 1994–1999 period, it is worth noting that the greater forkbeard recruitment was significantly correlated with that of hake, the strongest recruitment of both species occurring in 1998, whereas the lowest was in 1997.

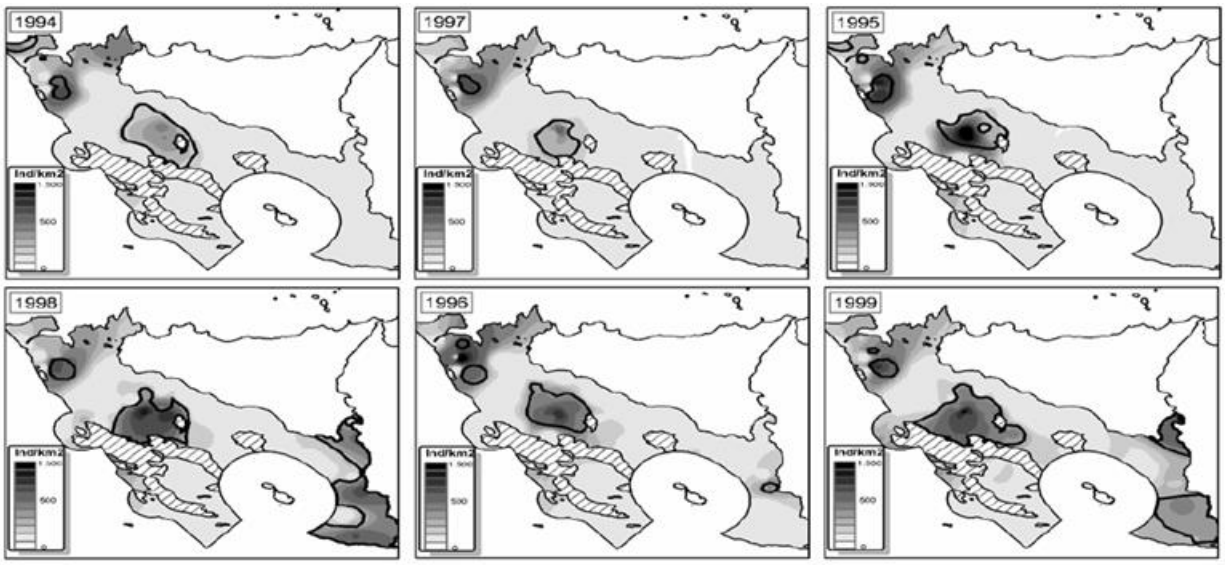


Fig.25. Nurseries of *Phycis blennoides* (23).

4 Information on Elasmobranchs in the Sicily channel/Tunisian plateau

The complete checklist of elasmobranch species inhabiting, permanently or occasionally visiting, Sicily channel/Tunisian plateau/Tunisian Plateau region does not exist, as this region is not considered as a unique region of similar characteristics, thus, all the lists are made separately for a several smaller areas. Consequently, the list of elasmobranch species for this region can be made only by combining already known lists (Tab. 8).

Tab. 8. List of elasmobranch species in Tunisian waters.

SHARK AND CHIAMERA SPECIES RECORDED IN TUNISIAN WATERS	RAY SPECIES RECORDED IN TUNISIAN WATERS
Heptranchias perlo	*Dasyatis centroura*
Hexanchus griseus	*Dasyatis pastinaca*
Squalus acanthias	*Dasyatis tortonesei*
Squalus blainvillei	*Dasyatis chrysonota*
Dalatias licha	*Pteroplatytrygon violacea*
Etmopterus spinax	*Taeniura grabata*
Oxynotus centrina	*Torpedo marmorata*
Centrophorus granulosus	*Torpedo nobiliana*
Squatina squatina	*Torpedo torpedo*
Squatina aculeata	*Rhinobatos rhinobatos*
Squatina oculata	*Rhinobatos cemiculus*
Alopias vulpinus	*Myliobatis aquila*
Cetorhinus maximus	*Pteromylaeus bovinus*
Carcharodon carcharias	*Mobula mobular*
Isurus oxyrinchus	*Gymnura altavela*
Lamna nasus	*Raja clavata*
Sphyrna zygaena	*Raja radula*
Carcharias taurus	*Raja miraletus*
Odontaspis ferox	*Raja asterias*
Galeus melastomus	*Raja montagui*
Scyliorhinus canicula	*Raja brachyura*
Scyliorhinus stellaris	*Raja polystigma*
Galeorhinus galeus	*Raja africana*
Mustelus asterias	*Dipturus oxyrinchus*
Mustelus mustelus	*Leucoraja fullonica*

SHARK AND CHIAMERA SPECIES RECORDED IN TUNISIAN WATERS	RAY SPECIES RECORDED IN TUNISIAN WATERS
Mustelus punctulatus	*Leucoraja circularis*
Carcharhinus brevipinna	*Leucoraja naevus*
Carcharhinus melanopterus	*Leucoraja melitensis*
Carcharhinus falciformis	*Rostroraja alba*
Carcharhinus limbatus	
Carcharhinus obscurus	
Carcharhinus plumbeus	
Prionace glauca	
Chimaera monstrosa	

Tunisian Plateau is the area often investigated by scientists. Thus, it is known that, so far, 63 elasmobranch species (33 sharks, 29 rays and one chimaera) have been recorded in Tunisian waters, representing about 19 % of Tunisian ichthyofauna. Within that number 23 sharks and 21 ray species are recorded in Gulf of Gabes, the most important fishing area. Apart of a situation in other Mediterranean areas, most of these species are commercially exploited in Tunisia (8, 10).

Maltese Islands are a part of Sicily channel/Tunisian plateau/Tunisian Plateau region and 37 species of sharks and 26 species of rays are recorded in that area. Apart of species reported in Tunisian waters 5 other shark and 4 ray species are listed for Maltese Islands area (65). In table 9 it is given the list of additional species that are reported for Maltese waters, but not and in Tunisian ones.

Tab. 9. List of elasmobranch species in Maltese waters that are not reported in Tunisian waters.

ADDITIONAL SHARK SPECIES RECORDED IN MALTESE WATERS	ADDITIONAL RAY SPECIES RECORDED IN MALTESE WATERS
Echinorhinus brucus	*Pristis pristis*
Centrophorus uyato	*Pristis pectinata*
Alopias superciliosus	*Dipturus batis*
Carcharhinus brachyurus	*Rhinoptera marginata*
Sphyrna tudes	

Recent investigation of a Central Mediterranean area reported additional species that are recorded neither in Tunisian, nor in Maltese waters. The analysed data refer to a demersal species from a wide area located between the southern coasts of Sicily, including the Maltese Islands, and the Northern Coasts of Tunisia and Libya. That investigation listed additional 2 species of sharks, *Squalus megalops* and *Somniosus rostratus*, both reported for Sicilian waters (55).

Hence, another hammerhead species, *Sphyrna lewini*, was reported for waters close to Sicily, so due to a migratory behavior of this, in the Mediterranean, rare shark, it can be presumed that this species also inhabits Sicily channel/Tunisian plateau/Tunisian Plateau region (67).

Altogether, the complete checklist of elasmobranchs in Sicily channel/Tunisian plateau/Tunisian Plateau region (Tab. 10) contains 75 species (41 sharks, 33 rays and one chimaera) which is nearly 90 % of all elasmobranch species in the Mediterranean (84 species are reported for a whole Mediterranean area).

Tab. 10. The complete checklist of elasmobranchs in Sicily channel/Tunisian plateau region.

SHARK AND CHIAMERA SPECIES	RAY SPECIES
Heptranchias perlo	*Pristis pristis*
Hexanchus griseus	*Pristis pectinata*
Squalus acanthias	*Dasyatis pastinaca*
Squalus blainvillei	*Dasyatis tortonesei*
Squalus megalops	*Dasyatis chrysonota*
Dalatias licha	*Dasyatis centroura*
Etmopterus spinax	*Dipturus batis*
Oxynotus centrina	*Pteroplatytrygon violacea*
Centrophorus granulosus	*Taeniura grabata*
Centrophorus uyato	*Torpedo marmorata*
Echinorhinus brucus	*Torpedo nobiliana*
Somniosus rostratus	*Torpedo torpedo*

SHARK AND CHIAMERA SPECIES	RAY SPECIES
Squatina squatina	*Rhinobatos rhinobatos*
Squatina aculeata	*Rhinobatos cemiculus*
Squatina oculata	*Myliobatis aquila*
Alopias vulpinus	*Pteromylaeus bovinus*
Alopias superciliosus	*Mobula mobular*
Cetorhinus maximus	*Gymnura altavela*
Carcharodon carcharias	*Rhinoptera marginata*
Isurus oxyrinchus	*Raja clavata*
Lamna nasus	*Raja radula*
Sphyrna zygaena	Raja miraletus
Sphyrna tudes	Raja asterias
Sphyrna lewini	Raja montagui
Carcharias taurus	Raja brachyura
Odontaspis ferox	Raja polystigma
Galeus melastomus	Raja africana
Scyliorhinus canicula	Dipturus oxyrinchus
Scyliorhinus stellaris	Leucoraja fullonica
Galeorhinus galeus	Leucoraja circularis
Mustelus asterias	Leucoraja naevus
Mustelus mustelus	Leucoraja melitensis
Mustelus punctulatus	Rostroraja alba
Carcharhinus brevipinna	
Carcharhinus melanopterus	
Carcharhinus falciformis	
Carcharhinus limbatus	
Carcharhinus obscurus	
Carcharhinus plumbeus	
Carcharhinus brachyurus	
Prionace glauca	
Chimaera monstrosa	

However, it has to be noted that presence of some species listed for the Sicily channel/Tunisian plateau/Tunisian Plateau region, as well as the Mediterranean Sea, is considered doubtful by some authors. E.g. the status of *Squalus megalops* was questionable, although besides the longnose spurdog *Squalus blainvillei* occurring in the Gulf of Gabès (southern Tunisia), a short

snout spurdog of the *Squalus megalops-cubensis* group was identified in this area. Morphometrical and meristic data along with genetic analysis (DNA Inter Simple Sequence Repeats markers and molecular Barcoding methods) support the assignation of this short snout spurdog to *Squalus megalops*. Thus, the presence of this species in the Mediterranean is confirmed and, even more, it seems that S. megalops is more common than *S. blainvillei* (11).

The presence of *Carcharhinus melanopterus*, as an Indo-Pacific species present in the Red Sea, was also considered questionable. However, it is known that this species is very rare in the Gulf of Gabes where it is reported for the first time in 70's of the last century. Later, the capture of a male specimen of one meter long in the Gulf of Gabes, in December 1993, confirmed the presence of *C. melanopterus* in the south Tunisia. Another Carcharhinid species, *Carcharhinus obscurus*, presence was doubtful, due to its occasional records within the Mediterranean area, but as it was recorded in Malta, Gulf of Gabès, and in Levantine waters, its presence should not be questioned (11).

Tiger shark *Galeocerdo cuvier* is a very rare tropical Atlantic species, and its occurrence in the Mediterranean is reported twice, within one record is from a Sicilian waters, but, until further confirmation, its presence is considered as very doubtful. Consequently, it is not listed as a valid species for this region (11).

Gulper sharks *Centrophorus granulosus* and *Centrophorus uyato* are both listed as valid species for a region but it has to be noted that a whole genus needs revision worldwide (6).

Glaucostegus halavi was recorded for the first time by Vinciguerra (1884) in the Tunisian waters but following morphologic description given by the author, it was considered as Rhinobatos cemiculus. Later a single specimen was recorded from the Gulf of Gabès but this record seems to be doubtful and a reconsideration of the specimen in question is necessary. Thus, *G. halavi* is not considered as valid species for a Sicily channel/Tunisian plateau/Tunisian Plateau region (11).

Regarding *Dasyatis chrysonota* there is a taxonomical problem as is it confused with *Dasyatis marmorata.* Moreover, *D. marmorata* is closely related to D. pastinaca and, therefore, these two species are additionally often confused and misidentified. Some authors, considering tail spine characteristics of stingrays, distinguished *D. chrysonata* and *D. marmorata*. Until a genetic study formally resolve the validity of *D. marmorata* and redefine the two species, *D. chrysonata*, which is usually reported, will be considered as a valid species for this region, instead of *D. marmorata* (11).

The validity of *Raja africana* is questioned by some authors, but until further investigation it is considered as a valid for this region (11).

Both species of sawfish were once common in the Mediterranean and eastern Atlantic, but it has now been probably extirpated from Europe and the Mediterranean. So far, only historical records exist, but as it were present before, and due to some unconfirmed info of their recent records, Pristis pectinata and Pristis pristis are listed in the checklist of elasmobranchs for this region.

It is known that in the Sicily channel/Tunisian plateau area the fishing fleets that operating are arriving mainly from Italy, Tunisia and Malta. At the Regional level, Tunisia and Italy, along with Turkey are the main countries that are contributing to the total elasmobranch landings in the Mediterranean, as they realize 76% of the production of elasmobranchs during the last 30 years.

Official statistics of elasmobranch are not available as the region is composed of several smaller areas for which landings of these species are not reported separately out of the total country landings. However, a bibliographic analysis through 661 papers dealing with elasmobranchs in the GFCM area that has been published in 2012 by the GFCM (11) has shown that cartilaginous species, including sharks, rays and chimaeras, are by far the most endangered group of marine fish in the Mediterranean Sea, with 31 species (40 percent of all) critically endangered, endangered or vulnerable. This GFCM publication also shows that a constant decline in cartilaginous fish species landings has been observed since 1983 while fishing effort has generally increased and that overfishing, wide use of non-selective fishing practices and habitat degradation are leading to dramatic declines of these species in the Mediterranean Sea.

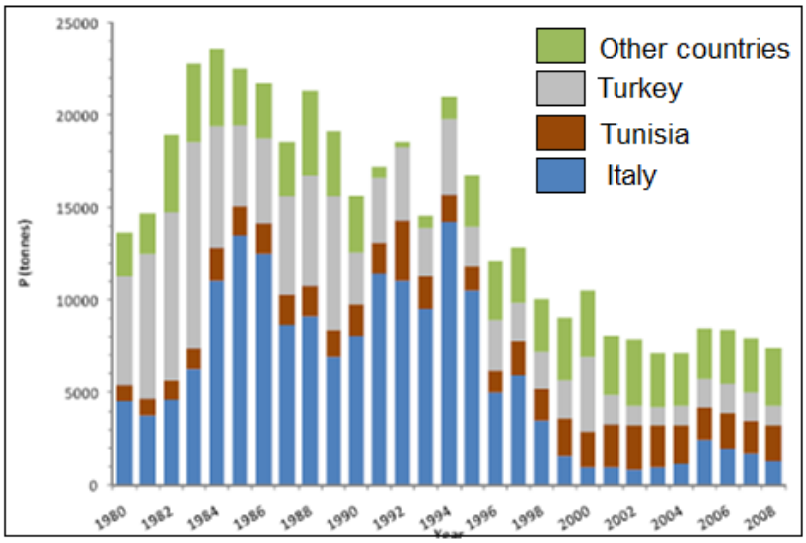


Fig. 26. Contribution of Italy, Tunisia and Turkey in the elasmobranch production of the Mediterranean and Black Sea 1980-2008.

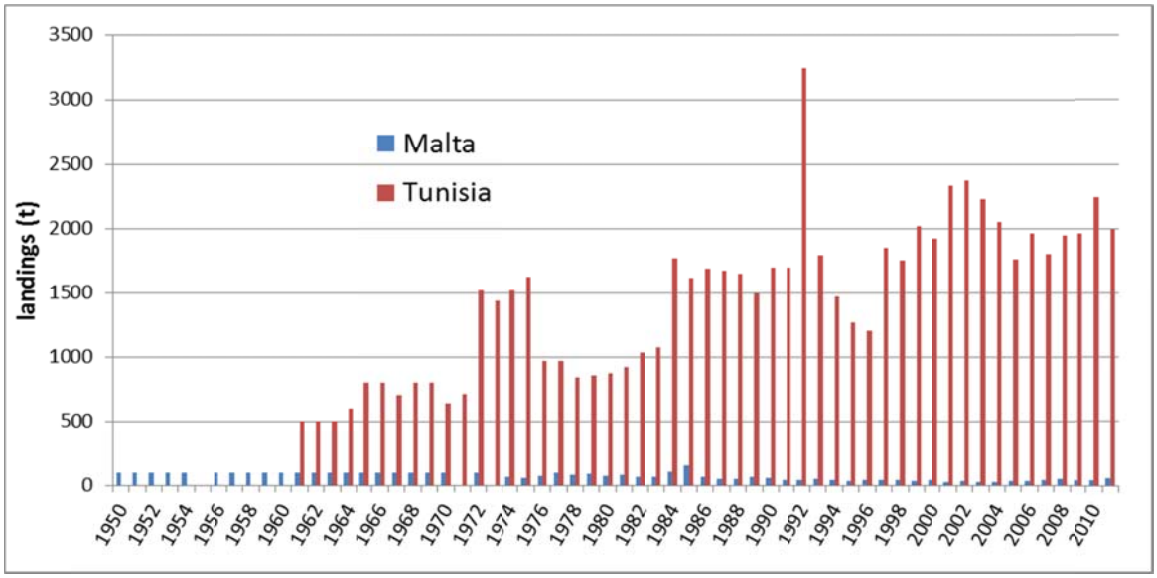


Fig. 27. Landings of „Sharks, rays, chimaeras“ for Tunisia and Malta in the period 1950 to 2011, according to FAO - Fisheries and Aquaculture Information and Statistics Service.

Analysis of a FAO statistics on the total landings of the elasmobranch fisheries, reported as Sharks, rays, chimaeras“ group, for Tunisia and Malta in the period 1950-2011, a 61 year-long period, showed that a maximum landing has been reached in 1992, when 3286 tons were reported, of which 3241 tons were landed by Tunisian fleet, while 45 tons by Malta. Looking to the period of a last 30 years the minimum landing was reported in 1996 when these two countries reported 1245 tons, Tunisia 1202 and Malta 43, respectively. In the recent period, annual landings of elasmobranchs for these two countries are around average of 2000 tons.

Official landing statistic for a Italian fleet fishing in a Sicily channel/Tunisian plateau/Tunisian Plateau region was not available as landings of „Sharks, rays, *chimaeras*“ group are given only in total, and separately for Adriatic, Ionian and Sardinian area.

Recently published report, based on a scientific surveys from the International Bottom Trawl Survey - MEDITS and GRUppo Nazionale Demersali surveys - GRUND, on abundances of demersal sharks and *chimaera* from 1994-2009 scientific surveys in the Central Mediterranean Sea, refer to a wide area located between the Southern Coasts of Sicily, including the Maltese Islands, and the Northern Coasts of Tunisia and Libya (GFCM areas 13, 14, 15 and 16, including a part of area 21). Results showed that a three species (Echinorhinus brucus, Squalus megalops and Somniosus rostratus) that were previously reported in the investigated area, and listed in the checklist of species in a region, were never sampled during the scientific surveys (55).

From obtained results it is visible that rabbitfish *Chimaera monstrosa*, is quite common in the trawl catches, mainly between 400-500 m, off the Southern Coasts of Sicily. Surveys indicated a wide, regular and exclusive occurrence in the bathyal zone (289-799 m) throughout the whole region. Sharpnose sevengill shark *Heptranchias perlo* was reported as a sporadic off the Southern Coasts of Sicily, with low abundance indices in the Gulf of Gabès, while it represents an appreciated by-catch in Sicily and Malta. For a Bluntnose sixgill shark *Hexanchus griseus* surveys indicated no catch within the Maltese Islands and a few occasional, very scattered (both on spatial and temporal scale), occurrences through the bathyal zones (217-706 m) of the South Sicily and in wider area between Tunisia and Malta.

Tab. 11. Percentage frequency of occurrence (f%), mean Density Index N/km2 (DI), mean Biomass Index kg/km2 (BI) by depth stratum (10-200 m, shelf; 200-800 m, slope; 10-800 m, overall) for all species sampled in SS-South Sicily and MI-Malta Island (spring-summer) investigated zones between 1994-2009 (MEDITS) (55).

species	Rabbitfish	Sharpnose sevengill shark	Bluntnose sixgill shark	Squalus sp (see text for details)	Piked dogfish	Longnose spurdog	Gulper shark	Velvet belly	Angular roughshark	Kitefin shark	Sawback angel shark	Smoothback angel shark	Angelshark	Blackmouth catshark	Small-spotted catshark	Nursehound	Tope shark	Starry smooth-hound	Smooth-hound	Blackspotted smoothhound
Zone: Maltese island																				
Ns	11	11	-	-	-	11	11	11	11	11	-	-	-	11	11	2	-	5	8	-
DS	slope	overall	-	-	-	overall	slope	slope	overall	slope	-	-	-	slope	overall	shelf	-	shelf	shelf	-
f%	30.8	10.2	-	-	-	21.2	22.1	55.0	3.9	11.2	-	-	-	80.0	37.5	7.9	-	5.7	14.4	-
sd	14.4	6.5	-	-	-	7.8	14.0	16.2	4.5	10.0	-	-	-	13.4	17.5	3.7	-	5.8	8.3	-
r	0.55	0.61*	-	-	-	-0.17	-0.23	0.48	-0.42	-0.53	-	-	-	0.13	0.58	-	-	-0.11	-0.32	-
DI	11.8	2.3	-	-	-	25.7	5.5	102.6	0.7	1.4	-	-	-	199.7	93.5	1.7	-	1.4	4.4	-
sd	8.9	1.6	-	-	-	24.5	4.1	61.3	0.9	1.5	-	-	-	89.7	78.5	0.8	-	1.5	2.7	-
r	0.52	0.64*	-	-	-	-0.40	-0.19	0.50	-0.26	-0.61	-	-	-	0.35	0.87*	-	-	0.13	-0.13	-
BI	4.8	6.1	-	-	-	9.7	18.7	5.9	1.1	2.0	-	-	-	29.0	9.3	0.8	-	2.3	17.9	-
Sd	4.9	5.0	-	-	-	3.7	12.0	3.5	1.5	3.4	-	-	-	13.6	8.7	1.0	-	2.8	23.9	-
r	0.68*	0.44	-	-	-	-0.19	-0.30	0.66*	-0.27	0.15	-	-	-	0.29	0.84*	-	-	0.54	-0.03	-
Zone: South of Sicily																				
Ns	16	15	16	3	2	16	16	16	16	16	-	-	-	16	16	16	-	5	16	6
DS	slope	overall	slope	overall	slope	overall	slope	slope	overall	slope	-	-	-	slope	overall	shelf	-	shelf	shelf	shelf
f%	39.0	1.5	1.0	2.9	2.8	8.7	13.4	48.5	0.8	8.3	-	-	-	74.3	27.0	1.3	-	2.7	17.6	1.8
sd	8.0	1.3	1.7	0.5	1.7	7.2	6.5	10.5	1.3	5.1	-	-	-	10.1	5.9	3.4	-	2.2	7.8	2.3
r	0.58*	0.55*	-0.44	-	-	0.85*	0.56*	0.70*	0.11	0.67*	-	-	-	0.78*	0.79*	-0.29	-	-0.20	0.46	0.18
DI	12.9	0.2	0.1	1.1	0.5	18.4	3.7	51.1	0.1	1.2	-	-	-	195.1	48.6	0.3	-	1.3	13.6	0.8
sd	4.4	0.3	0.2	0.9	0.5	24.1	2.8	27.3	0.2	0.8	-	-	-	154.1	23.5	0.7	-	1.4	10.9	1.0
r	0.25	0.68*	-0.37	-	-	0.85*	0.59*	0.22	-0.06	0.78*	-	-	-	0.85*	0.36	-0.29	-	-0.08	0.51*	0.18
BI	5.0	0.4	1.0	1.0	0.9	8.5	14.9	3.9	0.2	3.0	-	-	-	28.4	7.6	0.4	-	1.0	15.3	0.6
sd	2.0	0.4	2.3	1.0	0.6	10.6	9.1	1.6	0.4	2.1	-	-	-	19.9	3.0	1.3	-	1.0	12.7	0.7
r	0.14	0.33	-0.31	-	-	0.88*	0.51*	0.58*	0.07	0.82*	-	-	-	0.84*	0.34	-0.27	-	0.02	0.63*	0.47

NS, number of surveys; DS, deep stratum; sd, standard deviation; r, Pearson index.

*. Significance level at p=0.05 (degree of freedom NS - 2).

species	Rabbitfish	Sharpnose sevengill shark	Bluntnose sixgill shark	*Squalus* sp (see text for details)	Piked dogfish	Longnose spurdog	Gulper shark	Velvet belly	Angular roughshark	Kitefin shark	Sawback angel shark	Smoothback angel shark	Angelshark	Blackmouth catshark	Small-spotted catshark	Nursehound	Tope shark	Starry smooth-hound	Smooth-hound	Blackspotted smoothhound
Zone: Maltese island																				
NS	11	12	-	1	-	9	8	12	12	10	-	2	1	12	12	12	-	9	12	-
DS	slope	overall	-	slope	-	overall	slope	slope	overall	slope	-	shelf	shelf	slope	overall	overall	-	shelf	shelf	-
f%	53.3	16.6	-	4.3	-	32.8	17.9	67.1	4.9	12.0	-	19.1	9.1	84.5	58.0	4.1	-	25.0	23.1	-
Sd	19.6	10.7	-	-	-	7.6	9.1	18.6	5.2	2.9	-	1.3	-	12.0	11.5	5.1	-	19.2	13.5	-
R	-0.03	0.01	-	-	-	-0.38	-0.27	0.04	-0.65*	0.57	-	-	-	-0.07	0.74*	0.13	-	0.56	-0.28	-
DI	15.1	2.2	-	0.3	-	26.4	2.5	114.7	0.4	0.9	-	3.2	1.3	355.0	130.6	0.4	-	3.4	5.4	-
Sd	8.8	1.9	-	0.6	-	27.1	1.6	65.1	0.4	0.2	-	2.6	1.1	155.2	75.6	0.7	-	3.1	4.4	-
R	0.13	-0.11	-	-	-	-0.24	-0.34	0.69*	-0.70*	0.70*	-	-	-	0.47	0.79*	0.26	-	0.76*	0.04	-
BI	5.5	2.7	-	0.22	-	12.2	7.9	6.6	0.4	1.0	-	2.7	0.2	35.0	15.8	0.6	-	6.8	16.7	-
Sd	3.3	1.4	-	0.40	-	6.5	4.8	3.5	0.5	0.9	-	3.5	0.2	14.1	11.8	0.8	-	7.2	25.8	-
R	0.24	0.32	-	-	-	-0.05	-0.33	0.79*	-0.56	0.12	-	-	-	0.37	0.82*	-0.06	-	0.68*	0.16	-
Zone: South of Sicily																				
NS	13	13	2	2	2	10	10	13	13	13	-	-	-	13	13	13	1	2	13	1
DS	slope	overall	slope	slope	slope	overall	slope	slope	shelf	slope	-	-	-	slope	overall	overall	slope	shelf	shelf	shelf
f%	43.1	1.6	3.5	2.4	5.4	15.8	13.4	58.0	1.1	10.2	-	-	-	77.1	31.1	1.2	3.6	4.9	26.5	3.7
Sd	7.1	1.9	2.1	0.1	2.9	5.8	6.0	8.1	1.6	4.3	-	-	-	5.0	7.0	1.0	-	2.9	10.7	-
R	-0.60*	-0.07	-		-	0.25	-0.51	-0.67*	0.06	-0.41	-	-	-	0.06	-0.13	-0.48	-	-	-0.55*	-
DI	10.7	0.2	0.25	0.7	0.4	33.5	2.2	37.9	0.1	0.9	-	-	-	234.8	87.4	0.1	0.2	1.8	16.1	0.9
Sd	3.0	0.3	0.03	0.7	0.2	27.2	1.6	11.3	0.1	0.5	-	-	-	92.4	36.5	0.2	0.5	0.3	11.0	1.6
R	-0.48	0.21	-	-	-	0.92*	-0.25	0.21	0.19	-0.25	-	-	-	0.42	-0.50	-0.03	-	-	-0.54	-
BI	3.7	0.3	4.1	1.2	0.4	12.2	6.3	3.3	0.2	2.0	-	-	-	32.4	12.4	0.1	0.03	2.3	17.2	0.5
Sd	1.3	0.4	1.9	1.5	0.3	9.2	5.4	1.1	0.3	1.5	-	-	-	11.8	4.4	0.2	0.06	2.4	12.1	0.9
R	-0.04	0.08	-	-	-	0.94*	-0.14	0.32	-0.06	-0.02	-	-	-	0.39	-0.53	-0.26	-	-	-0.20	-
Zone: BZ																				
NS	6	6	6	1	4	4	4	6	6	6	1	1	-	6	6	6	1	6	6	1
DS	slope	overall	slope	slope	slope	overall	slope	slope	overall	slope	shelf	overall	-	slope	overall	overall	slope	overall	shelf	slope
f%	32.5	17.9	1.1	1.7	1.5	43.7	6.9	28.2	1.7	2.1	2.0	1.1	-	42.8	80.6	4.2	0.8	3.7	14.9	1.7
sd	6.8	2.8	1.0	-	1.1	5.4	4.3	6.4	1.7	1.5	-	-	-	11.1	4.1	0.6	-	3.1	8.1	-
r	-0.70	-0.49	-0.18	-	-0.68	0.38	-0.90	-0.85*	0.43	-0.24	-	-	-	-0.93*	0.91*	0.50	-	-0.31	-0.90*	-
DI	9.8	4.1	0.1	0.5	0.1	54.5	1.1	66.2	0.1	0.1	0.5	0.1	-	230.2	498.8	1.0	0.1	0.5	3.1	0.1

species	Rabbitfish	Sharpnose sevengill shark	Bluntnose sixgill shark	*Squalus* sp (see text for details)	Piked dogfish	Longnose spurdog	Gulper shark	Velvet belly	Angular roughshark	Kitefin shark	Sawback angel shark	Smoothback angel shark	Angelshark	Blackmouth catshark	Small-spotted catshark	Nursehound	Tope shark	Starry smooth-hound	Smooth-hound	Blackspotted smoothhound
sd	4.0	1.2	0.1	1.7	0.1	9.1	0.7	25.9	0.1	0.1	1.1	0.2	-	104.1	64.1	0.5	0.2	0.4	1.7	0.3
r	-0.83*	-0.39	-0.21	-	-0.65	-0.58	-0.84	-0.39	0.40	-0.28	-	-	-	-0.89*	-0.89*	-0.75	-	-0.13	-0.86*	-
BI	3.6	1.7	0.3	0.3	0.2	29.1	3.5	3.5	0.1	0.2	0.4	2.5	-	19.4	40.4	0.4	0.9	0.7	5.6	0.01
sd	1.4	0.5	0.4	1.0	0.3	4.0	2.2	1.2	0.2	0.2	0.9	5.8	-	7.8	5.6	0.2	3.5	0.6	4.3	-
r	-0.40	-0.10	0.50	-	-0.74	0.05	-0.68	-0.34	0.61	-0.36	-	-	-	-0.84*	-0.71	-0.17	-	0.06	-0.89*	-

NS, number of surveys; DS, deep stratum; sd, standard deviation; r, Pearson index.

*. Significance level at p=0.05 (degree of freedom NS - 2).

Tab. 12. Percentage frequency of occurrence (f%), mean Density Index N/km2 (DI), mean Biomass Index kg/km2 (BI) by depth stratum (10-200 m, shelf; 200-800 m, slope; 10-800 m, overall) for all species sampled in SS-South Sicily and MI-Malta Island and BZ-Intermediate Zone (autumn) investigated zones between 1994-2008 (GRUND) (400).

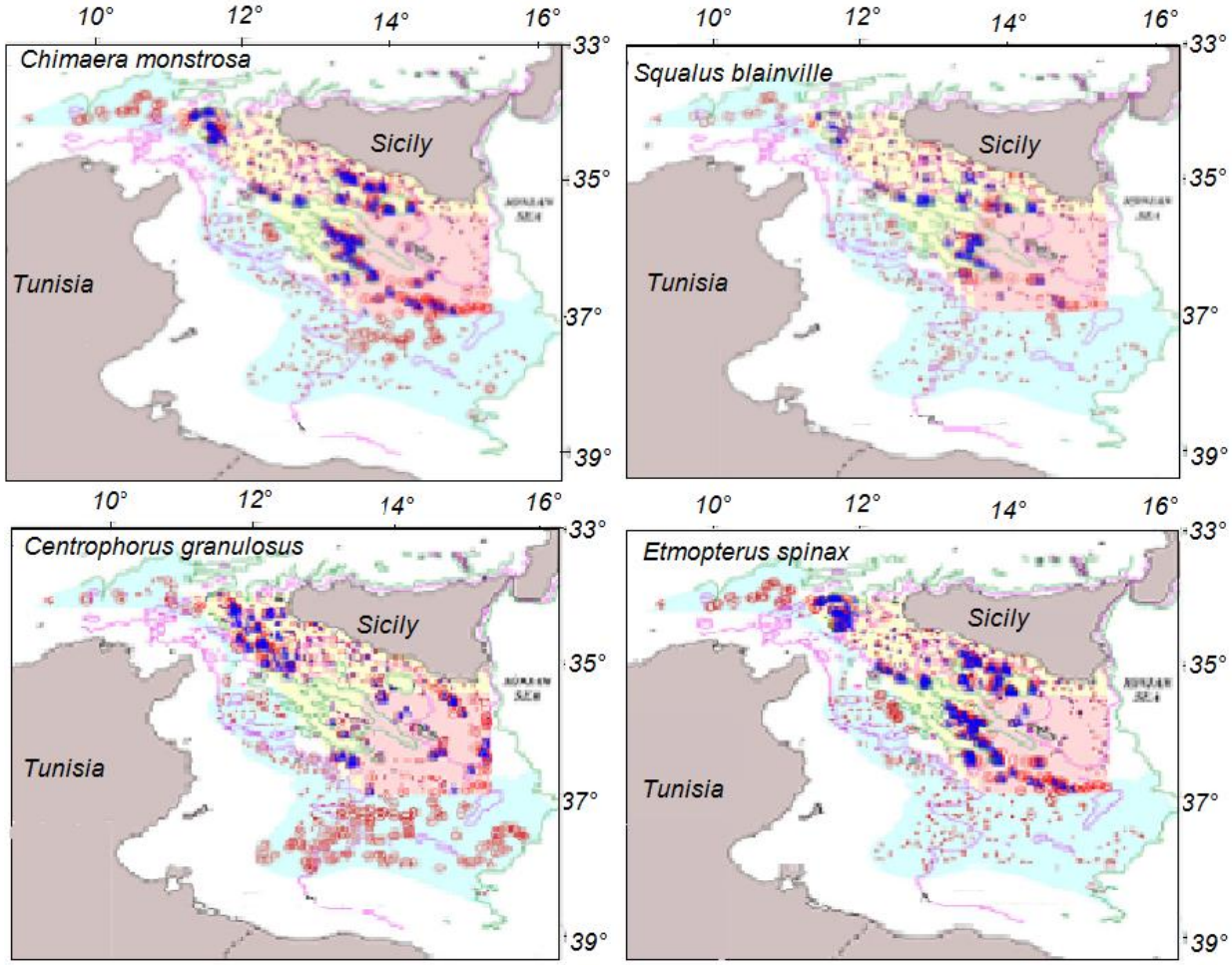


Fig. 28. Spatial distribution of *Chimaera monstrosa*, *Squalus blainville*, *Centrophorus granulosus* and *Etmopterus spinax* in South Sicily (yellow), Malta Island (light red) and Intermediate Zone (cyan). Total number of hauls conducted by MEDITS survey from 1994 to 2009 (blue symbols) and GRUND survey from 1994-2008 (red symbols) between the bathymetric of 200 and 800 m (55).

Piked dogfish *Squalus acanthias* was occasionally caught in deep bottoms Off the Southern Coasts of Sicily and it was regularly found in the fish markets, but nowadays it has almost disappeared. Surveys indicated the non-occurrence of this species in Maltese waters and in the shelf of Southern Sicily and waters between Malta and Tunisia (BZ). Occasional localized (South Sicily) and wide although very scattered (BZ) occurrence were recorded on the bathyal zone (355-684 m). Other Squallus species Longnose spurdog *Squalus blainville* is reported as common off the Southern Coasts of Sicily, with specimens up to 90 cm TL on the outer shelf and epi-bathyal (50-600 m), representing a commercialized bycatch, depending on the fishing zone. Surveys indicated a wide occurrence of a species with a preference for the outer shelf and epi-bathyal zones (50-677 m) of the whole region (55).

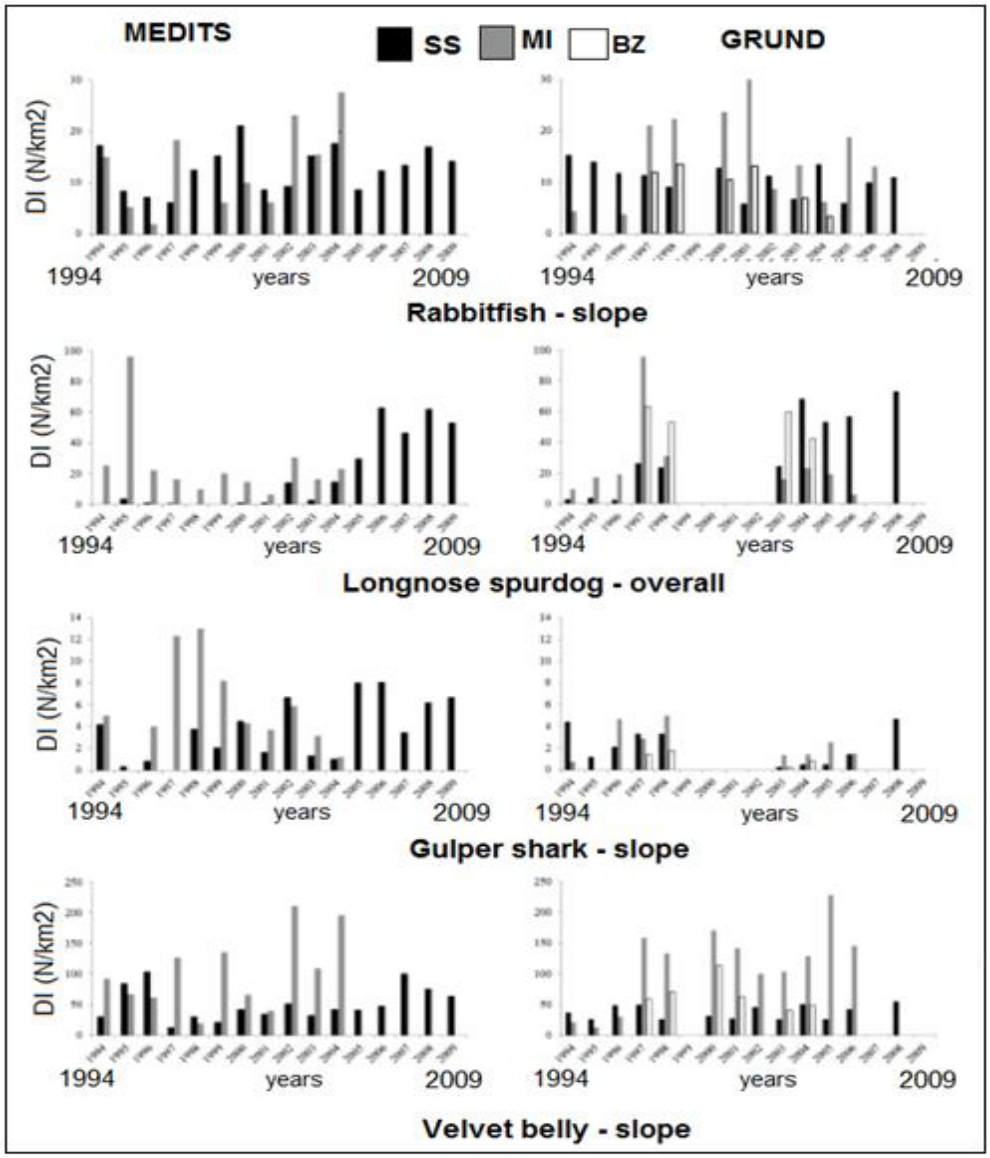


Fig. 29. Density Index N/km2 (DI) of Chimaera monstrosa, Squalus blainville, Centrophorus granulosus and Etmopterus spinax by depth stratum (10-200 m, shelf; 200-800 m, slope; 10-800 m, overall) and survey's typology (MEDITS-GRUND); SS-South Sicily and MI-Malta Island (spring-summer) investigated zones between 1994-2009 (MEDITS), and SS-South Sicily and MI-Malta Island and BZ-Intermediate Zone (autumn) investigated zones between 1994-2008 (GRUND) (55).

For a Gulper shark *Centrophorus granulosus* surveys indicated a wide (101-800 m), but almost preferential occurrence through the bathyal (especially below 400 m) of the whole region. In addition, some sporadic shelf catches were realized only in the waters between Malta and Tunisia (BZ) in 1997 and 1998, but nowadays only the bathyal occurence was considered. Velvet belly Etmopterus spinax is a species with a wide (71-800 m), but almost exclusive occurrence throughout the bathyal zone of the whole region. Similar to a gulper shark, some sporadic shelf catches of velvet belly were recorded only in the BZ in 2000. The highest abundance in numbers was recorded in a narrow preferential depth interval (400-600 m). Angular roughshark *Oxynotus centrina* is caught by trawling or accidentally bottom long-lining off the Southern Coasts of Sicily, from a few meters until deeper waters, especially on the SE of Pantelleria. Interestingly, it is immediately returned to the sea by fisherman from Mazara

because they believe that it will bring a bad luck. Surveys indicated a wide, although scattered, occurrence irregularly distributed between shelf and bathyal hauls (52-741 m), but always with low values (55).

Results from a survey data for a Kitefin shark *Dalatias licha* indicated an exclusive bathyal presence (376-783 m) throughout the whole area, but with a preference for the central and eastern grounds and deeper waters (550-783 m).

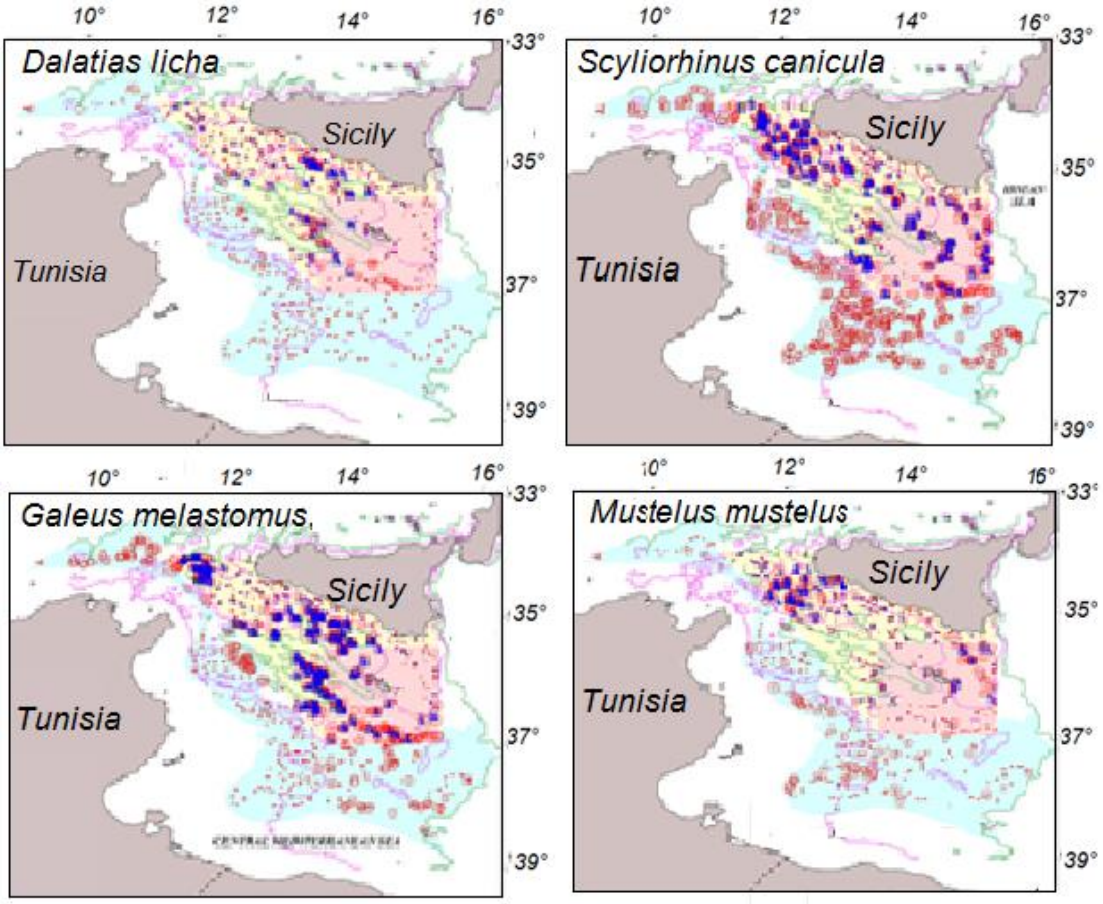


Fig. 30. Spatial distribution of *Dalatias licha*, *Galeus melastomus*, *Scyliorhinus canicula* and *Mustelus mustelus* in South Sicily (yellow), Malta Island (light red) and Intermediate Zone (cyan). Total number of hauls conducted by MEDITS survey from 1994 to 2009 (blue symbols) and GRUND survey from 1994-2008 (red symbols) between the bathymetric of 200 and 800 m

(55).

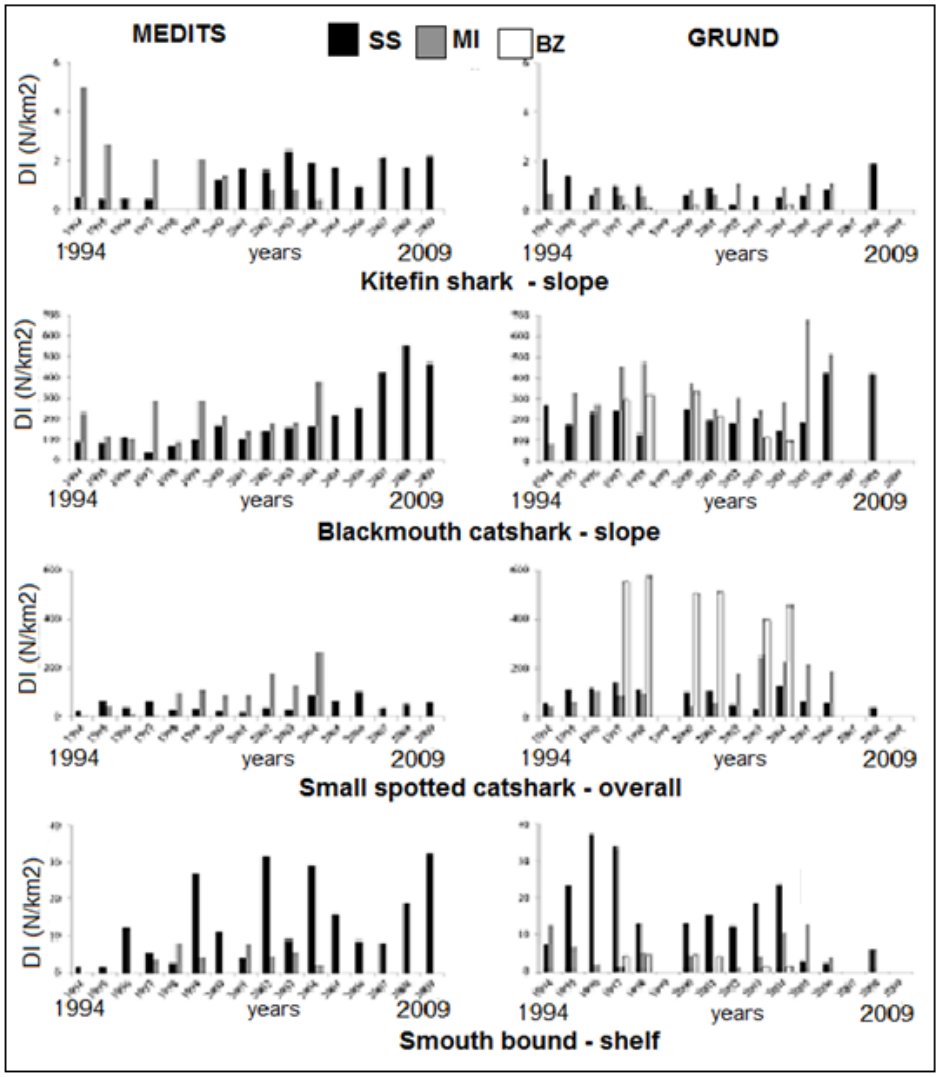


Fig. 31. Density Index N/km2 (DI) of *Dalatias licha*, *Galeus melastomus*, *Scyliorhinus canicula* and *Mustelus mustelus* by depth stratum (10-200 m, shelf; 200-800 m, slope; 10-800 m, overall) and survey's typology (MEDITS-GRUND) ; SS-South Sicily and MI-Malta Island (spring-summer) investigated zones between 1994-2009 (MEDITS) and SS-South Sicily, MI-Malta Island and BZ-Intermediate Zone (autumn) investigated zones between 1994-2008 (GRUND) (55).

Sawback angelshark *Squatina aculeata* within region was confirmed only in Tunisia, but always as rare occurrences. Similar case is even with Smoothback angelshark *Squatina oculata*, although it has to be mentioned that sporadic catches of this species in both shelf and slope were recorded in 1997 in waters between Malta and Tunisia and in two shelf hauls in the years 1998 and 2006 in Maltese waters. Surveys also confirmed the rarity of Angelshark Squatina squatina, as the only one capture was realized at 128 m in autumn 2005, close to the Maltese Islands (55).

Data obtained for a Blackmouth catshark *Galeus melastomus* indicated a wide (92-800 m), but almost exclusive occurrence throughout the bathyal zones of the whole region with some occasional and sporadic shelf catches. The abundance by depth showed a parabolic shape with a downward profile with the maximum abundances between 400 and 600 m (55).

Another catshark species, Small-spotted *Scyliorhinus canicula* is a very common catch off the Southern Coasts of Sicily, but only specimens larger than 35cm TL are landed and sold. Results indicated a wide and abundant occurrence in both shelf and bathyal (29-794 m) of the whole region, with a preferential depth interval of 100-400 m. Historical data for a Nursehound *Scyliorhinus stellaris* indicate that it was captured in some locations (e.g. North Pantelleria) and commonly discarded, but nowadays, it has almost disappeared in many Sicilian fishing grounds and remain common only in Tunisian and Maltese waters with a very scattered occurrence and irregular distribution on shelf and bathyal (52-667 m) (55).

Tope shark *Galeorhinus galeus* was considered as absent in Sicily and rare along the Northern Coasts of Africa and Maltese waters. Nowadays, it is quite common in Tunisian waters, with very rare occurrences in Sicily and Malta (55).

Starry smooth-hound *Mustelus asterias* is considered rare in Sicily, nowadays. Results from a surveys indicated both seasonal and temporal high variability and a wide (70-551 m), although preferential, occurrence through the outer shelf (70-200 m) of the whole region. On the other hand, Smooth-hound *Mustelus mustelus* is considered still common off the Southern Coasts of Sicily, as well as in the Gulf of Gabès with a wide (29-557 m), although preferential, occurrence through the shelf of the whole region. Surveys indicated the absence of a Blackspotted smoothhound *Mustelus punctulatus* in Maltese waters and a scattered and occasional occurrence in South Sicily and BZ, between 71 and 303 m (55).

Results from this newest study are in agreement with previous conclusions from similar studies that the present Mediterranean cartilaginous fish occurrence and abundance appear well below the historical opinion and their catches show a clear decreasing trend. In particular, this study has shown, on a qualitative base at least, that the present occurrence and abundance of demersal sharks and chimaera in the Sicily channel/Tunisian plateau/Tunisian Plateau region are in general less than the previously recorded historical reports. However, the present state seems quite stable or even improving when one considers the correlations for the South Sicily zone.

This analysis also supports the fact that the three zones examined have different demersal shark and chimaera features; for example, the highest values were mainly found in the Maltese Islands and, at least in the first surveys, the transitional zone between Maltese and Tunisian waters (BZ).

Hence, the results are coherent with the conclusion that off the Southern Coasts of Sicily, strictly neritic species are almost locally extinct (*Squatina* spp.) or highly depleted (*S. stellaris*), whereas widely distributed (ubiquist) species are stable (only large *S. canicula* are landed) or even increasing, at least in South Sicily area (*S. blainville and M. mustelus*). Furthermore, deep species (for example *G. melastomus*), which habitats go well beyond the usual deepest commercial trawling limit (cca. 750 m), show a stable or even increasing abundance off the Southern Coasts of Sicily, with high resilience to repeated trawling activities (63).

Three explanations can be found for this pattern (55):

1. there are evidences that most part of trawled Mediterranean discarded neritic and epi-bathyal sharks were able to survive, given the limited temperature variation (due to the homeothermy, especially in winter-spring seasons, and the minimum barotrauma suffered (due to the lack of swimming bladder);

2. the scavengers or generalist feeders may find at the bottom a large amount of dead bony fish and invertebrates, which are discarded or damaged by trawls which is another food source and a further supply of energy;

3. the recent displacement (mainly out the South Sicily), significant since 2004, of Sicilian large bottom trawlers migrating towards more productive red shrimps fishing grounds have (at least temporarily) mitigated the fishing pressure in the traditional bathyal zones and worsened the situation in the new exploited grounds.

Study on elasmobranch species as a catch component of trawl fishery, that was performed during 1995-1999 period in a three zones of Sicily channel/Tunisian plateau/Tunisian Plateau region, showed that *Raja oxyrhinchus, Raja asterias* and *Raja clavata* overlap in the shallower stratum but *Raja oxyrhinchus* become prevailing with the depth increase. The other ray species were caught in scarce amount and few considerations can be argued about. Hence, *Raja polystigma* and *Raja melitensis* are considered species endemic of waters around Malta Island, while *Raja montagui* and *Raja naevus* are considered as little known species and identification misleading are frequent by cause of taxonomic confusion. Moreover, obtained data indicated that *Raja miraletus,* although thought quite common in other Mediterranean areas, resulted with scarce occurrence in some zones of a region and principally fished in 300-400 meters stratum (64).

Torpedinidae show a peculiar depth distribution with *Torpedo torpedo* biomass peaking in the shallowest and deepest strata and *Torpedo marmorata* biomass peaking in 150-200 metres depth.

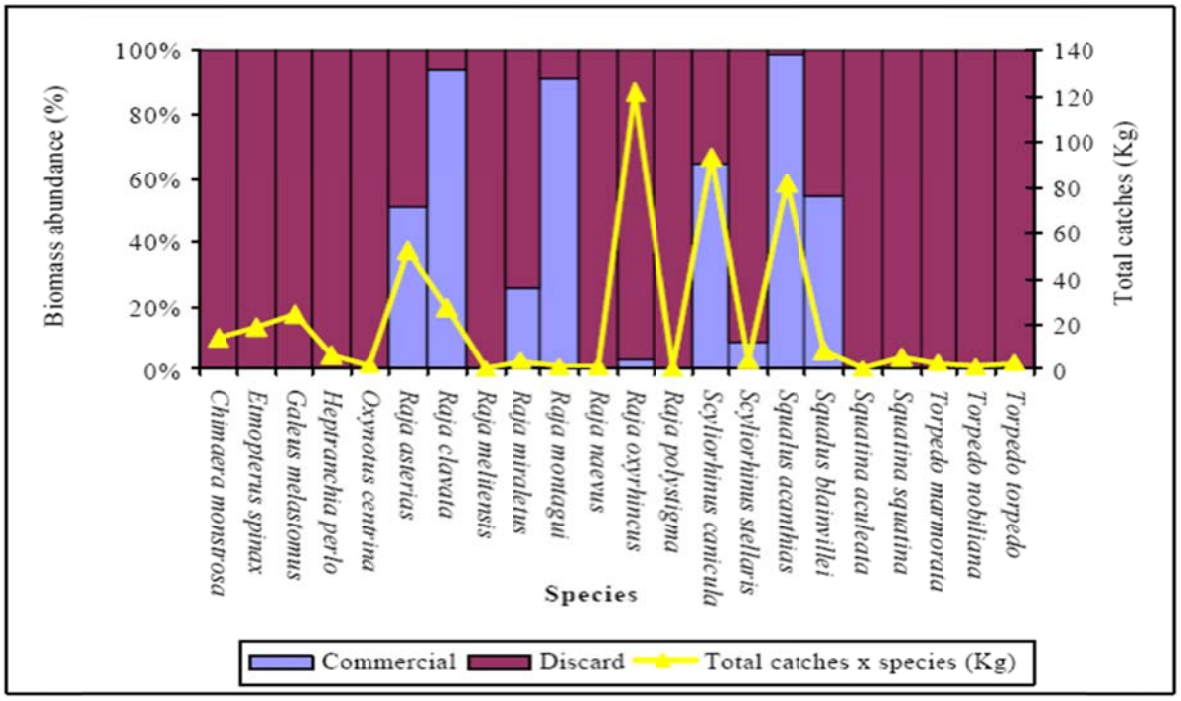


Fig. 32. Relative biomass percentages of discard and commercial fractions of elasmobranch species.

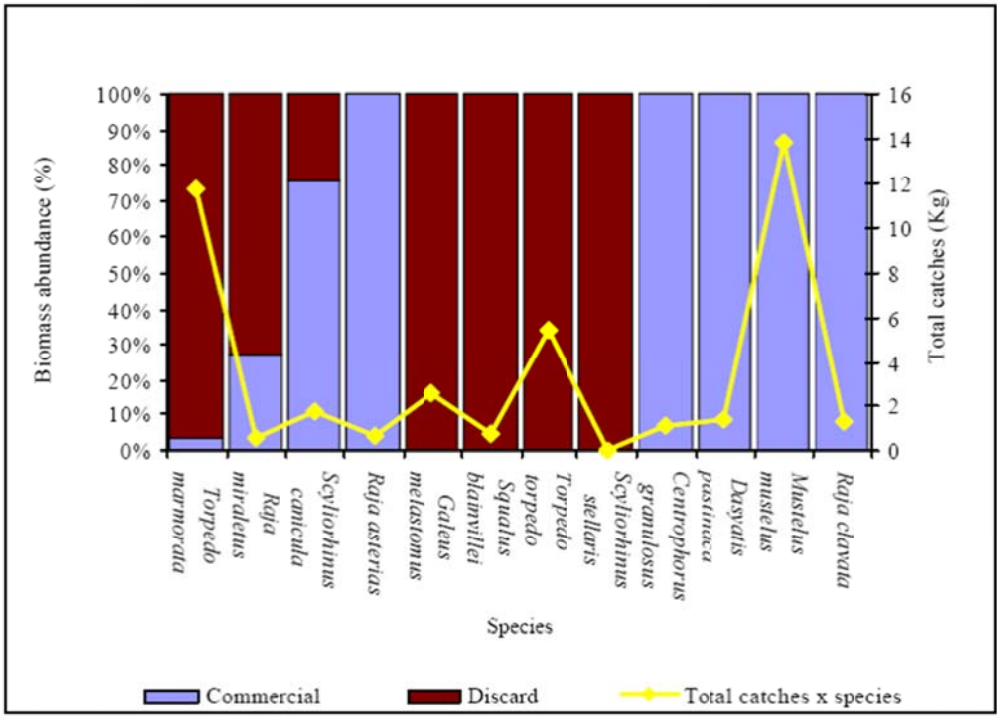


Fig. 33. Relative biomass percentages of discard and commercial fractions of elasmobranch species (64).

Regarding elasmobranchs discards from a trawl catches only a few species are fully commercialized. Three main commercial species are represented by *S. acanthias* (around 100% of total catches), *R. clavata* (around 95%) and *R. montagui* (around 90%). Partially commercial species are *S. canicula* (around 70%), *R. asterias* and *S. blainvillei* (both around 50%). Occasionally commercial species are *R. miraletus* (around 30%), *S. stellaris* (around 9%) and *R. oxyrhincus* (around only 3%). All other species are completely discarded (64).

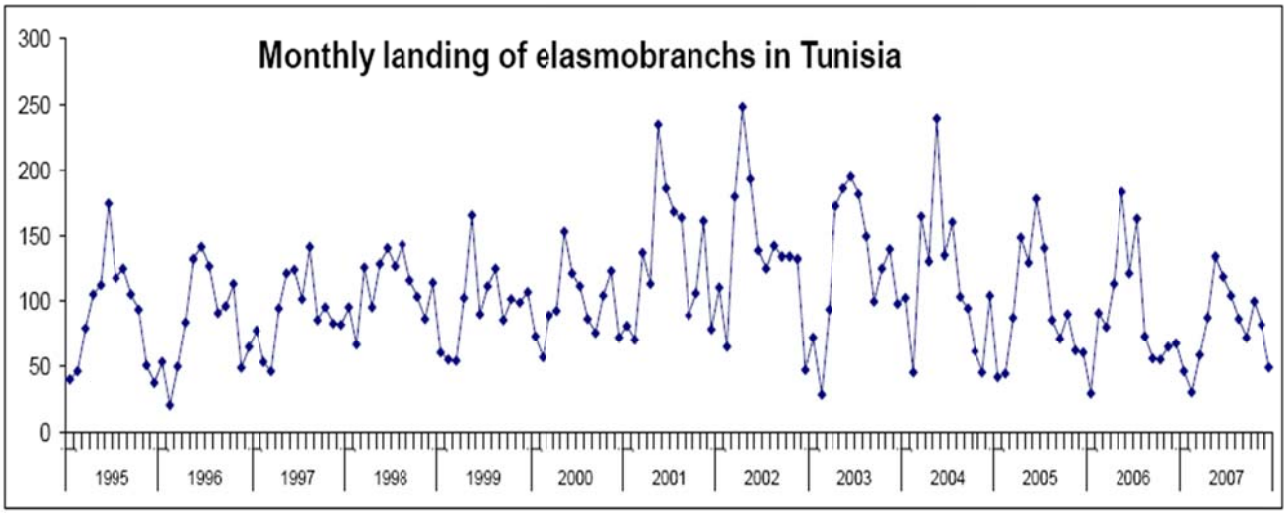


Fig. 35. Monthly landings of elasmobranchs in Tunisia.

According to FAO statistics shark landings represent 3.2% of the total Tunisian fisheries production. The main part of this production is landed in the Gulf of Gabes, an area that is thought to be a nursery for most benthic species, including elasmobranchs (10, 11).

Sharks are caught as bycatch in trawling, longlines, pelagic tuna and swordfish fisheries, but also targeted by a small gillnet fishery in the south of Tunisia. In general, elasmobranchs landings are very dependent on season as the highest are obtained during warmer months, while the lowest during the coldest months.

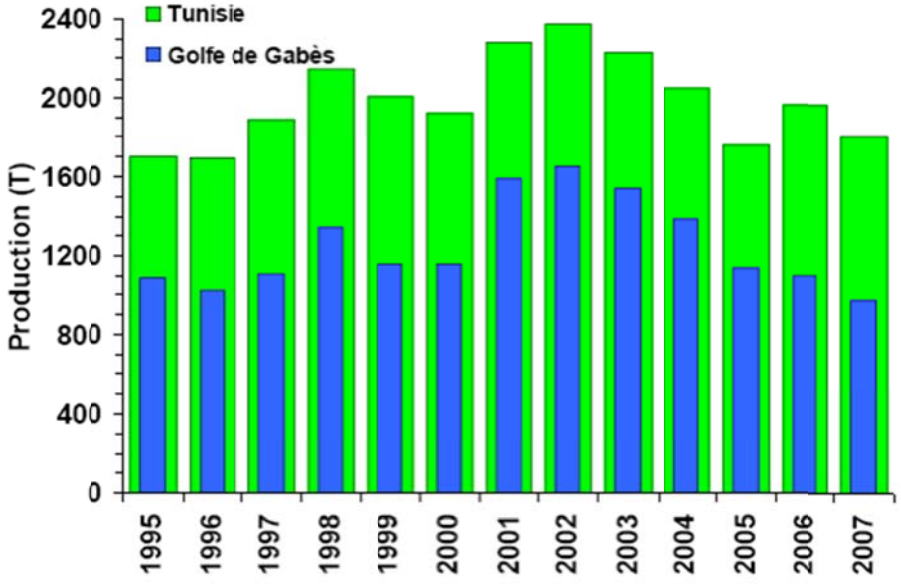


Fig. 36. Proportion of elasmobranch landings from Gulf of Gabes in total Tunisian elasmobranch landings during the period 1995-2007 (37).

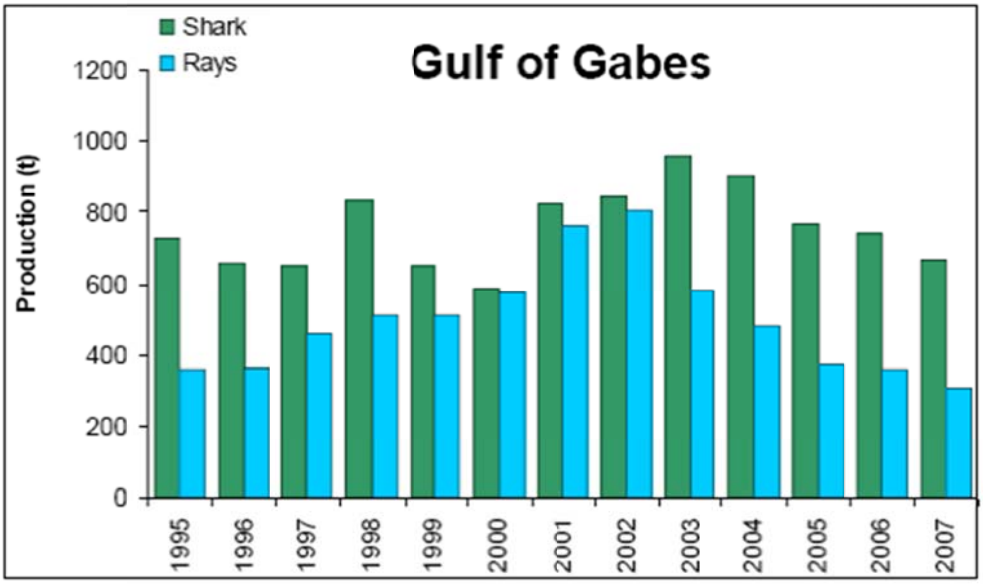


Fig. 37. Proportion of sharks and rays in elasmobranch landings from Gulf of Gabes during the period 1995-2007 (37).

The study in the Gulf of Gabès shows that elasmobranchs bycatch averaged 5,42 % of the total landing (1,7 % sharks and 3,7 % rays). Fishes, cephalopods and crustaceans represent respectively 74,15 %, 12,32 % and 9,4 % of the total landings. The CPUE was estimated at 70,10 kg/landing (CPUE=23,25 kg/landing for shark and 46,75 for rajiforms). The CPUE (kg/landings) for the major elasmobranch families caught in the Gulf of Gabès by bottom trawlers are shown in the next table (11).

Tab. 13. CPUE (kg/landings) for the major elasmobranch families in Gulf of Gabes.

Families	CPUE
CARCHARHINIDAE	0.8087
TORPEDINIDAE	1.4407
SCYLIORHINIDAE	2.5908
RHINOBATIDAE	5.1687
SQUALIDAE	5.2494
RAJIDAE	14.0726
TRIAKIDAE	15.0187
MYLIOBATIDAE	17.7554
DASYATIDAE	19.6659

Bycatch varies greatly, not only in terms of weight, but also in the number of species. The abundance indices (CPUE) was estimated for rare species; Raja alba (0.1 specimens/landing), Gymnura altavela (0.05 specimens/landing), Heptranchias perlo (0.05 specimens/landing), Mustellus asterias (0.019 specimens/landing), Carcharodon carcharias (0.014 specimens/landing) (11).

Within Sicily channel/Tunisian plateau/Tunisian Plateau region, as well as whole Mediterranean Sea, the Gulf of Gabes is considered as one of the most important critical habitats for elasmobranchs, especially for a sharks. In total 26 shark species have been reported for the Gulf of Gabes and within them, 4 species are mainly landed along the year: *Mustelus mustelus, Mustelus punctulatus, Carcharhinus plumbeus* and *Carcharhinus brevipinna.*

Gulf of Gabes is considered as critical habitat for a many elasmobranch species (61). All life stages of *Mustelus mustelus* are encountered along the year in the Gulf of Gabès. The presence of gravid females and free swimming neonates and juveniles suggested that this species exploits the coastal waters of the area a year-round as both primary and secondary nurseries. Although newborns can be found over a variety of habitats, the north part has the highest abundance, suggesting that is a primary nursery for this species (60, 61).

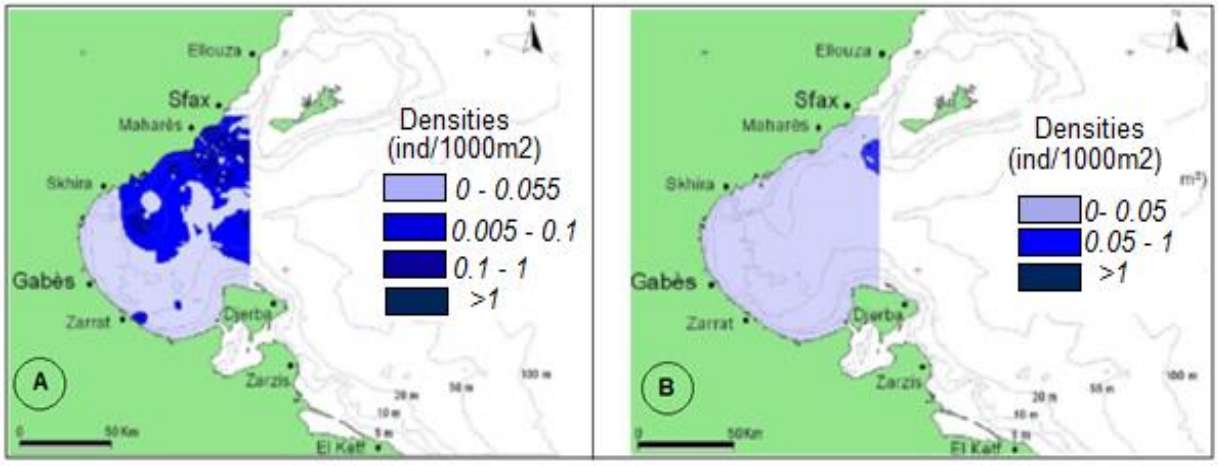


Fig. 38. A: Distribution of a relative abundance (N/1000 m2) for a new born *Mustelus mustelus* **B:** Distribution of a relative abundance (N/1000 m2) for a new born *Mustelus punctulatus* (61).

Mustelus punctulatus is common along Tunisian coasts, but mainly in the Gulf of Gabès where it forms an important component of the multi-species catch of commercial fisheries. The

occurrence of gravid females and free swimming neonates and juveniles along the year in the Gulf of Gabès suggested that this species found the favorable condition to reproduce and develop in that area. Similar to a case of *M. mustelus*, the north part of the Gulf of Gabès may represent a primary nursery area for *M. punctulatus* (61).

The sandbar shark *Carcharhinus plumbeus* is frequently and abundantly landed in fishing sites in the Gulf of Gabès where this species is captured throughout the year and especially targeted in spring and early summer. The landings consisted of juveniles of both sexes and adult females, usually near-term pregnant females that apparently approached the coast to give birth in the area with favorable environmental conditions. Pregnant females were observed between March and July, afterward it disappeared from catches. Soon after, neonates exhibiting an unhealed umbilical scar on the ventral surface and post-partum females were captured from July to October. Juveniles are captured along the year. The year round encounter of juveniles and the regularly occurrence of gravid females during summer suggested that this species use the Gulf of Gabès as primary and secondary nursery area (9, 61).

Juveniles of *Carcharhinus brevipinna* are taken throughout the year in the Gulf of Gabès. Newborns are observed during August and September, while adult individuals are observed during summer. The yearly presence of juveniles and observations suggest that this species finds in the Gulf of Gabes favorable conditions to reproduce and to grow, and that this area is a primary and secondary nursery area for this species (61).

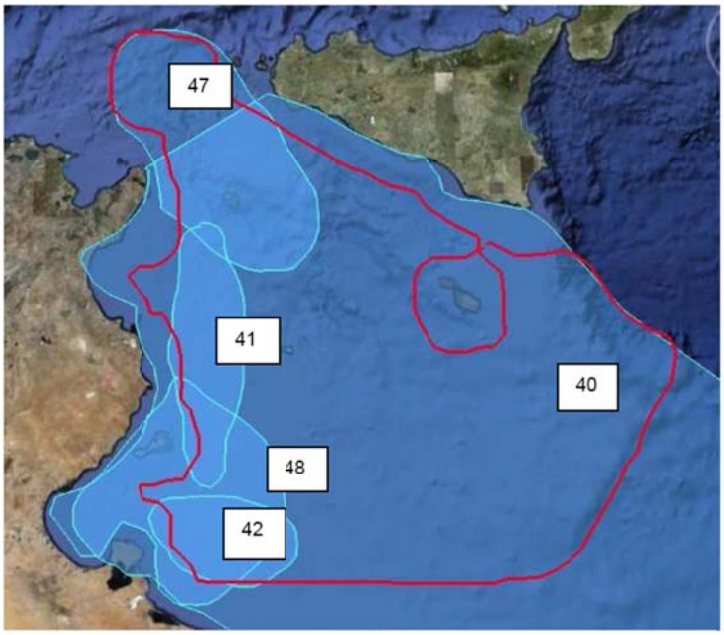


Fig. 39. Indicated nursery area for fishes in Sicily channel/Tunisian plateau, within 41, 47 and 48 are indicated as the great white shark nursery areas and 42 as a nursery area for white shark and several batoid species (zone No. 40 is indicated as Bluefin tuna breeding area) .Source: ref. n°59.

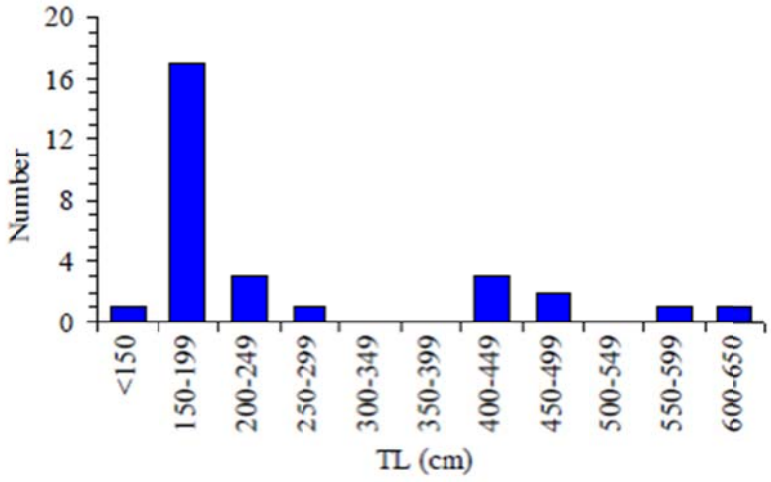


Fig. 40. Length frequencies of landed *Carcharodon carcharias* (61).

Since Postel (1958) (53), captures of *Carcharodon carcharias* were reported off the Tunisian coast. In 1992, a first pregnant female carrying two embryos was captured off Cape Bon (northeastern Tunisia). On 26 February 2004, a second pregnant female was caught in the Gulf of Gabès. Fergusson (2002) (20) stated that 41% of white shark records in Mediterranean sea are reported from the Sicilian Channel and its adjacent areas (Gulf of Gabès). Monitoring of fishery landings in the Gulf of Gabès revealed that newborn of *C. caracharias* are captured yearly. Among 30 examined specimens in this area 18 have TL less than 200 cm (the size at birth of this species varies in fact between 120 and 180 cm).

Rhinobatos cemiculus females with encapsulated eggs are capture in shallow waters, neonates also, while juveniles are captured along the year by bottom trawlers. The presence of all size classes of this species in south-east region of the Gulf of Gabes (Zarzis, Djerba) suggest that *R. cemiculus* find in this area a favourable conditions to reproduce and develop, which indicates that it could be considered as a nursery area for the species.

Unfortunately, although the Gulf of Gabes is obviously a nursery area for a many elasmobranch species, a level of protection, from elasmobranch conservation point of view, is rather low. Hence, certain species, such as *Mustelus sp., Carcharhinus plumbeus* and *Rhinobatos sp.* are even target species of a trammel nets and gillnets fisheries. Some other species are landed along the year in significant quantities such as *Dasyatids, S. blainvillei, P. bovinus* and catsharks. However, these species are considered as the bycatch. Another important bycatch are Prionace glauca and Isurus oxyrinchus, which are considered as the main bycatch in tuna and swordfish fisheries. *Cetorhinus maximus* and *Alopias vulpinus* are also caught as a bycatch along the Tunisian coast, but these catches are considered as incidental (10, 11).

Although a variety of fishing gear is used in elasmobranch fisheries, the main problem for all elasmobranchs represents trawling, as use of a small mesh size allow only minimal, or none, escapement of the elasmobranch species. Comparison of trawl catches with catches of other fishing gear, reveal that the most of trawl catches are consisted of immature specimens, regardless of species.

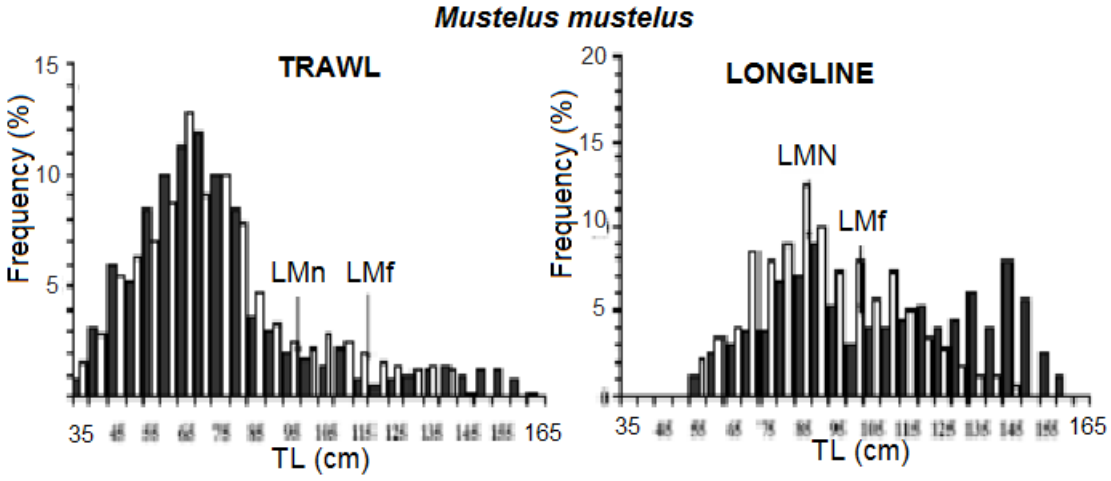


Fig. 41. Size distribution in trawl and longline landings of *Mustelus mustelus* in the Gulf of Gabès. LMm and LMf: Size at first maturity respectively of males and females (59).

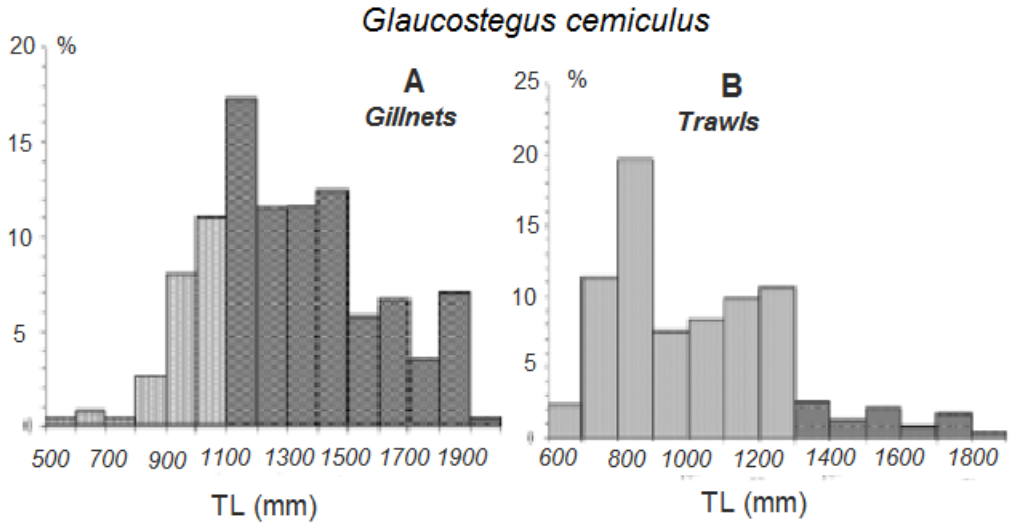


Fig. 42. Size distribution in gillnets (A) and trawl (B) landings of *Glaucostegus cemiculus*. Darker bars indicate the landed mature individuals (59).

Apart of a trawl, important fishing gear are gillnets, especially those of 300-400 mm streched mesh that are used for fishing *C. plumbeus* and *Rhinobatos sp.* Gillnets with smaller streched mesh size, from 120 to 160 mm, are used for targeting smooth-hounds, especially from February to June, Another important fishing gear for catching of C. plumbeus are longlines, pelagic, but also and bottom-set. Pelagic longlines are mainly used during summer months, from June to August, while the main season for a use of bottom longlines is period August-October.

Along with the Gulf of Gabes the Bahiret el Biban, a hyperhaline brackish area located in southeastern Tunisia and adjacent to the Gulf of Gabes, is known as nursery area for several species of benthic invertebrates and bony fishes, but also indicated as possible nursery area for some elasmobranchs. However, that hypothesis is not confirmed and needs to be further investigated (14).

The Lagoon of Bizerte is a another brackish water area located in north-eastern Tunisia, which is indicated as the potential nursery area for some elasmobranchs, but as in the case of the Bahiret El Biban, this hypothesis still needs confirmation (19).

Within Sicily channel/Tunisian plateau/Tunisian Plateau region a several management measures with the aim for elasmobranch conservation are practiced, e.g. in Tunisia it is prohibited to fish rays and skates less than 40 cm and torpedos below 20 cm in length, measured from tip of snout to start of tail (Decree 28.9.1995, Minister of Agriculture). In Maltese waters a strict protection is given for *Carcharodon carcharias, Cetorhinus maximus* and *Mobula mobular*. Hence, there are an additional fourteen species of national interest whose taking in the wild and exploitation may be subject to management measures: *Alopias vulpinus, Carcharhinus brevipinna, Carcharhinus limbatus, Carcharhinus plumbeus, Carcharias taurus, Galeorhinus galeus, Hexanchus griseus, Isurus oxyrinchus, Lamna nasus, Leucoraja melitensis, Prionace glauca, Pristis pristis, Rostroraja alba* and *Squatina squatina* (11).

In Italy management measures apply to the species listed for strict protection under Barcelona Protocol, Bern Convention and in CITES Appendices (11).

5 Aquaculture production

5.1 Italian aquaculture

Aquaculture in Sicily today consists of large farms, operating with high-technology sea-based structures, a solid economic base, high levels of production, integrated with the national and international markets and linked to mass distribution network, and of a series of small farms, built with modest investments and with limited production, aimed mainly at small-scale local distribution. These smaller farms, often in financial difficulties, determine the instability of the sector and the uncertainties of Sicilian aquaculture. The large facilities use high technology cages and production is mainly focused on species such as sea bass (*Dicentrarchus labrax*) and gilthead bream (*Sparus aurata*), with volumes of 2,500 and 3,000 tonnes/year, corresponding to around 15% of national production, as well as other valuable fish species, including sharpsnout seabream (*Diplodus puntazzo*), common dentex (*Dentex dentex*), greater amberjack (*Seriola dumerilii*) and, to a lesser extent, red porgy (*Pagrus pagrus*) and meagre (*Argyrosomus regius*), with very modest production levels that do not exceed 1% of regional production in the sector. From a technological perspective high-technology semi-submersible and highly durable cages are used in the most exposed sites, as well as anchored floating cages resistant to exposed environments and small-sized cages suitable for sheltered environments.

A separate discussion can be made for the extensive and semi-extensive aquaculture practised in the Trapani salt pans. Although the level of production is quite modest, it has a high niche value, due to the quality of the product and the role it plays in the promotion of the local area and preservation of the life of these basins. Some plants still operate with the salt-fish integration system, while others have developed production in salt tanks that are no longer in use. These account for an annual production of around 30 tonnes, including sea bass, gilthead bream, sharpsnout seabream and mullet, which are sold directly from the plant and in local restaurants.

In recent years there has also been interest in bluefin tuna (*Thunnus thynnus*) farming, with the opening of two seasonal farms, which, until 2009, were producing around 1,300 tonnes of bluefin tuna, fattened for around 5 months and intended for export to Japanese and North American markets. This type of farming provides a high-quality product for the preparation of sushi and sashimi in a seasonally adjusted manner. Production was recently suspended following the TAC (total allowable catches) imposed on the fishing of this species.

In recent times there has also been interest in the potential use of some farms for the culture of new native species. In collaboration with regional research centres, universities and the National Research Council, trials are being carried out with new species, such as dusky grouper (*Epinephelus marginatus*), tub gurnard (*Trigla lucerna*), sole (*Solea solea*), grey mullets and invertebrates such as octopus (*Octopus vulgaris*) and sea urchins (*Paracentrotus lividus*). In regard to sea urchins, the research is focussed on fattening under controlled conditions, using low-cost high-performance feeds.

There are also some mussel farms, mainly in the province of Messina, with a fairly modest production, varying from 500 to 700 tonnes/year. Freshwater aquaculture is also practised on a modest scale, producing trout, including Mediterranean trout (*Salmo cettii*) and rainbow trout (*Oncorhynchus mykiss*), and, at the Department of Agriculture and Forestry regional pilot centre

for aquaculture, freshwater shrimp (*Cherax* spp.), which could have a potential development in the future, considering the large number of internal basins in the region. With the exception of the semi-intensive plants in the salt pans of Trapani and Acqua Azzurra, and the large plant in Pachino, in the province of Syracuse, which has a considerable volume of land-based tanks, all the farms currently operating in Sicily use sea-cage production, even if they obviously have land-based support facilities, such as offices, laboratories and logistics centres for the storage of feed and packaging and sale of the product.

Only two farms have hatcheries, the fish farm in Pachino and Acquacoltura Lampedusa, which in addition to supplying regional needs, export over 50% of their production, which varies between 16-18 million fry/year for the former and 7-9 million for the latter. These hatcheries obviously focus on consolidated production of sea bass and gilthead bream, in a ratio of 55% to 45%, even if experiments are carried out on other innovative species. Acquacoltura Lampedusa in particular is engaged in research on the induced spawning of large pelagic fish, such as the greater amberjack and bluefin tuna.

5.2 Tunisian Aquaculture

(FAO data)

Both marine and inland species are currently being farmed. The main marine aquaculture production zone is in the Governorate of Sousse (in the east of the country, producing about 900 tonnes of seabream in 2004). A secondary marine aquaculture production zone is in the south of Tunisia (Gouvernorate of Médenine) where an average of 150 tonnes of European seabass and gilthead seabream are produced.

Shellfish farming is relatively an old activity in Tunisia. Most of the shellfish production (Mediterranean mussel, *Mytilus galloprovincialis* and the Pacific cupped oyster, *Crassostrea gigas*) comes from northern Tunisia, and mainly from the Governorate of Bizerte, with production and varying widely from one year to the next. Over the past 10 years average production has been around 100 tonnes. Shellfish farming is mainly practiced in the lake of Bizerte, where there are five private facilities located in the north west zone of the lake. Early attempts have involved raising mussel Mytilus galloprovincialis, and then the National Office of Fisheries has developed this activity since its establishment in 1958 and extended it to the breeding of the oyster Crassostrea gigas. However, mussel and oyster breeding remains undeveloped in Tunisia despite the antiquity of this activity and the average annual production has not exceeded the cap of 200 tons. Breeding is practiced according to suspension technique on fixed tables in the lake of Bizerte. Currently, more than 10 projects are located in the marine zone of Bizerte where breeding is done using net fishing technique.

The first initiative of marine fish farming began in 1984 in the Boughrara lagoon (south of the Djerba Island) producing 400 tons per year of sea bass (*Dicentrarchus labrax)* and sea bream (*Sparus aurata*) in floating cages. Several natural disasters such toxic phytoplankton blooms have destabilized the farm 's productivity. The second initiative was set at 50 km north of Sousse and designed to produce seabass and seabream in land based raceways. In 1995, the PDA has recommended the installation of land based fish farms on the north coast, local fish food manufacturing and the creation of subdivisions including several farms which the basic infrastructure (access, servicing, water intake and discharge ...) will be covered by the state in

order to reach a production of 10,000 tons, ten years later. Since then, investment in this sector does not evolve as expected despite the development actions taken by the Government. Thus, the Ninth Development Plan (1997-2001), has set as target producing 3000 t of marine fish by 2001, the completion rate recorded is only 24%. The Tenth Development Plan (2002-2006) has set a production target of about 2100 tons. Reported production in 2006 was only 1,252 tons. In 2007, investment in this sector has regained his balance after the installation of three seabass and seabream farms in floating and submersible cages. The number of farms operating this new technique (floating and submersible cages) has quickly evolved to 23, in early 2011.

5,837 tons of marine fish (bass and sea bream) are produced by 21 projects in full production, where 17 projects are offshore farms and four of them are onshore farms. The latter date back since the birth of aquaculture in Tunisia where the breeding is done in raceway ponds. Production is likely to grow up very soon especially that there are 12 other offshore aquaculture farms fishponds but not yet productive.

Tab. 14. Reported production of Tunisian marine pisciculture

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Production en tonnes	909	1000	985	1145	1210	1252	1583	1901	2804	4000	5837

An activity of fattening bluefin tuna began in 2003 with the aim of better commercial promotion by the fattening of small fish caught in the campaign of bluefin tuna fishing. Four farms were created by tuna Ship ownersAlpha in association with foreign professionals in this field. They are located offshore Mahdia and Hergla. The annual production of these farms have an average of 2400 tons. It is totally sold to foreign clients on husbandry areas.

6 Data to build GIS layers of the spatial distribution of both fisheries resources and relevant fishing activities

In the last 30 years, an important amount of environmental and fisheries related information in the Mediterranean has been collected from different sources like national and EU funded research projects and studies, data collection framework and surveys at sea (GRUND and MEDITS in particular). Existing information is mostly dispersed and refer to different spatial and temporal scales. Georeferenced organization of this information by using Geographical Information System techniques will allow making this information homogeneous and improve their usability. Most of the original data are still not available to the scientific community at large as the accessibility to datasets by end users is generally limited, however it is more and more possible to overcome this problem by collaborating with the scientific bodies in charge of the databases management.

Since 1982, the Italian government has provided financial support for scientific and technical research on biological resources evaluation to improve marine fisheries management. In this framework, national experimental trawl surveys started in 1984 on a seasonal basis. All Italian seas (except part of the Ionian Sea east of Sicily) were considered; 15 Operative Units including more than 120 researchers and technicians were involved with 17 motor-trawlers. The collected data were uploaded in a data bank, which first application -thanks to the financial support of the European Commission and the Italian Agricultural Politics Ministry- has been the use of the data collected in the years 1985 to 1987 to produce an atlas (2 bis) of distribution and abundance of the 10 main Italian demersal species *(Aristaeomorpha foliacea, Aristeus antennatus, Parapenaeus longirostris, Nephrops norvegicus, Eledone cirrhosa, Octopus vulgaris, Phycis blennoides, Micromesistius poutassou, Merluccius merluccius* and *Mullus barbatus* in spring and summer towards a Geographic Information System based on ARC/INFO.

Contacts for Experimental GRUND trawl surveys in the Sicily channel/Tunisian plateau:

Operative Unit n° 8 - Dipartimento di Biologia Animale ed Ecologia Marina dell'Università di Messina, Prof. F. Faranda e Dr. G. Cavallaro

Operative Unit n° n° 9 - Istituto Talassografico del C.N.R. di Messina, Dr. A. Cavallaro

Operative Unit n° 10 - Istituto di Zoologia dell'Università di Cagliari, Prof. A. Cau

Operative Unit n° 15 - Istituto Tecnologia Pesca e Pescato CNR, Mazara del Vallo,

In 2000 an Arc-View extension software which provides the geographical representation of abundance indices relative to MEDITS surveys was presented in Madrid at the meeting of the Scientific Advisory Committee of the GFCM. This Extension uses a database providing the basic standard files of the MEDITS surveys. It is already available in a CD which supplies suitable to be used by any researcher, not only MEDITS partners.

Contact for Experimental MEDITS trawl surveys:

Dr Anna Maria Spedicato, MEDITS project leader, COISPA Tecnologia & Ricerca s.c.r.l. Via dei Trulli 18/20, 70126 Torre a Mare (Bari) E-mail: coispa@tin.it

In 2008 the EU Council Regulation No 199/2008 concerning the establishment of a Community framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy regulation underlines that It is in the interest of the scientific community that data which does not allow for personal identification is available to any party who has an interest in its analysis. These data, in particular those georeferenced collected during the MEDITS surveys at sea are relative to the hauls, catches by species, and size and maturity status and are put into national computerized databases and they are accessible to the Commission and Member States shall make detailed and aggregated data available to end-users to support scientific analysis as a basis for advice to fisheries management, including to Regional Advisory Councils, in the interest of public debate and stakeholder participation in policy development and for scientific publication.

According to the 199/2008 regulation Member States shall transmit detailed and aggregated data in a secure electronic format. Where detailed and aggregated data are requested for scientific publication, Member States may, in order to protect the professional interests of the data collectors, withhold data transmission to the end-users for a period of three years following the date of collection of the data. Member States shall inform the end-users and the Commission of any such decisions. In duly justified cases the Commission may authorise that period to be extended.

The end-users of data shall be responsible for correct and appropriate use of the data with regard to scientific ethics; they shall inform the Commission and the Member States concerned of any suspected problems with the data and provide the Member States concerned and the Commission with references to the results of the use of the data.

In order to obtain access rights, end users need to contact the national correspondents for the EU data colletion, or submit a request by sending an e-mail to the following address: datasubmission@jrc.ec.europa.eu (Contact information : STECF secretariat, TP 051, 21027 Ispra (VA), Italy)

More recently one of the objectives of the MEDISEH project (wich is part of the EU consortium MAREA “Mediterranean Halieutic Resources Evaluation and Advice” project consortium regards the Mediterranean Sensitive Habitats. It consists in compiling historical and current data from the Mediterranean regarding in particular: (1) habitats protected under the Mediterranean regulation, (2) nursery areas and spawning aggregations of demersal and small pelagic fish and (3) areas under any form of protection within national and international legislation. The final target is the Compilation and mapping of environmental and fisheries related information in the Mediterranean Sea by means of Geographical Information Systems.

MEDISEH Contacts:

MEDISEH Coordinator: Dr M. Giannoulaki (HCMR), marianna@hcmr.gr

Task 1.4 Reviewing and mapping of all types of existing marine protected areas in different GSAs in the Mediterranean basin; Scientific Responsible: C. Smith (HCMR), csmith@hcmr.gr Partners involved: HCMR, CoNISMa, CNR-IAMC, CNR-ISMAR, COISPA, IEO, CIBM, MRRA

Task 2.1 Mapping of nursery and spawning grounds of small pelagic fish Scientific Responsible: Dr M. Giannoulaki (HCMR), marianna@hcmr.gr Partners involved: HCMR, CNR-IAMC, CNR-ISMAR, IEO

TASK 2.2 Mapping of nursery and spawning grounds of demersal fish Scientific Responsible: Dr F.Colloca (CNR-IAMC), francesco.colloca@iamc.cnr.it Partners involved: CIBM, COISPA, HCMR, CNR-IAMC, CNR-ISMAR, IEO, CoNISMa

WP3. GIS rendering: GIS Toolbox and geo-reference database Scientific Responsible: V. Valavanis (HCMR), vasilis@hcmr.gr Partners involved: HCMR, CNR-IAMC, CNR-ISMAR, IEO,CIBM

Contact for Tunisian surveys data :

Institut National des Sciences et Technologies de la Mer (INSTM), 28 rue 2 mars 1934 2025 Salammbô, Tunisia

7 Likely development of fishing activities within the area in the future

Generally speaking, a large percentage of the stocks is overexploited with high pressure on small sizes (growth overexploitation). This situation could not be sustained for long and it is necessary to reverse the current trends, in particular by adopting management systems capable of intervening effectively to achieve long-term sustainability. This is necessary to ensure both the conservation of fish resources and the survival of economic activities providing stable incomes and employment. The GFCM member countries have recognized that there is a need to implement regional management plans which consider both a reduction of fishing pressure and an improvement of the protection of juveniles, for example through Marine Protected Areas.

Some concerns also exist regarding the negative impact of bottom trawlers on habitat. The importance of protecting deeper waters areas has to be highlighted since it can be expected that, with the overexploitation of shallower water stocks, fishermen would search for new opportunities in deeper waters. Deep water corals should also be protected from fisheries impacts.

Following the GFCM guidelines on management plans a list of issues and priorities have been recently established in order to “guarantee a low risk of stocks falling outside safe biological limits” and to “ensure protection of biodiversity to avoid undermining ecosystem’s structure and functioning” (33b).

The first objective could be reached by maintaining the biomass of target species above agreed precautionary biological reference points and by maintaining indicators of stock status and fishing pressure at levels which ensure the sustainability of the fishery.

The second objective could be reached by decreasing the discards of commercial and non-commercial species, decreasing the incidental catch of protected and endangered species and preventing significant adverse impacts of bottom trawling fisheries on sensitive habitats by increasing the protection of areas where these habitats are known or are likely to occur. It has been suggested in particular to establish provisions to minimize the encounter of bottom trawlers with unmapped sensitive habitats through the implementation of “move-on” rules.

Currently, two Italian management plans are in force since 2010 to improve the situation of the deep-water rose shrimp and associated species in the Sicilian channel/Tunisia plateau: one for trawlers smaller than 18 m LOA and another for trawlers larger than 18 m, mainly engaged in distant fisheries. These plans were prepared taking into account both biological and socio-economic aspects of demersal fisheries, including the assessment of the effects of management measures on the stock status and fisheries performance. They are currently under revision and combine measures on the reduction of fishing capacity as well as technical measures (trawling ban, protection of juvenile, etc.). In relation with the sustainability of deep-water red shrimps stocks, the recruitment of *A. foliacea* and *A.*

antennatus, did not seem to be stable in space, and this affect the effectiveness of spatial restrictions to protect nursery areas.

In Malta, a national management plan for hake and shrimp has been elaborated and accepted by the EU on 1st October 2013.

In Tunisia fishing activity for trawlers is currently subject to annual authorizations. The main objective for Tunisia is to maintain the same fishing effort.

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