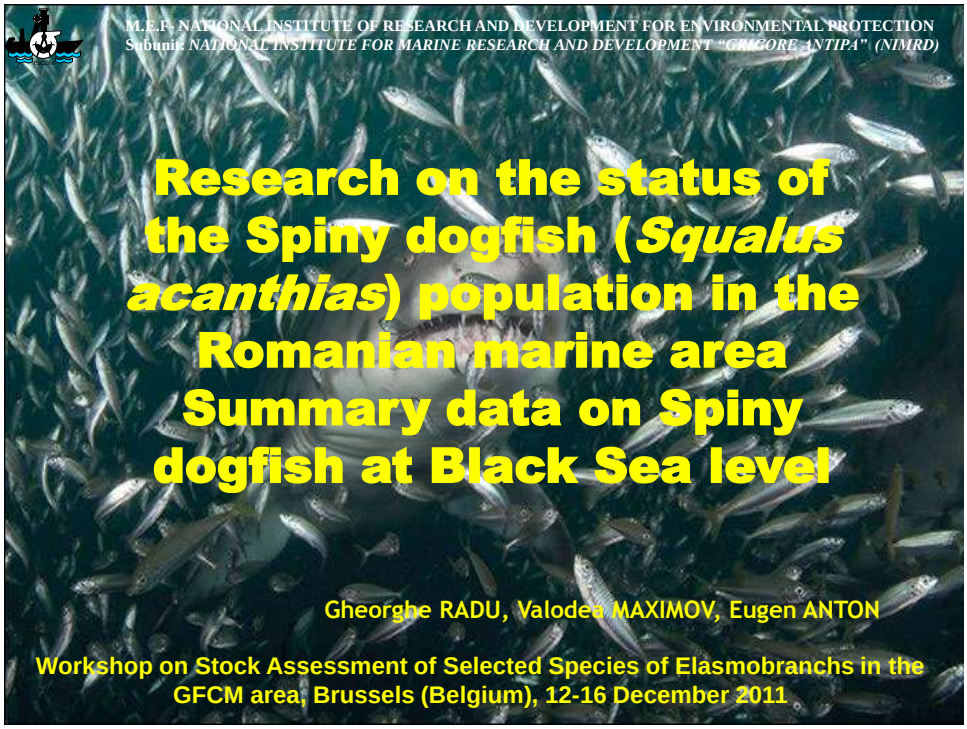

Abstract

The paper presents data on biology and ethology; distribution area, conditions and migration routes; distribution and migration routes at Romanian littoral; distribution and migration routes at Black Sea level, landings; biological parameters; stock biomass; size structure; yearly distribution of fishing agglomeration; indices of abundance on length classes, biomass on length classes; historical catch in number; stock weights at age; proportion mature at age; age/length key.

Biological features

Distribution area, conditions and migration routes

Spiny dogfish inhabits the whole Black Sea shelf at the water temperatures 6 – 15º C – Fig. 1 and Fig. 2. It undertakes extensive migrations. In autumn feeding migrations are aimed at the grounds of the formation of the wintering concentrations of anchovy and horse mackerel in the vicinity of the Crimean, Caucasus and Anatolian coasts. With their disintegration Spiny dogfish disperses all over the shelf. Reproductive migrations of viviparous Spiny dogfish take place towards the coastal shallows with two peaks of intensity – in spring and autumn. The autumn migration for reproduction covers more individuals usually. The major grounds for reproduction of Spiny dogfish in the Ukrainian waters are located in Karkinitsky Bay, in front of Kerch Strait and in Feodosia Bay.

- Spiny dogfish belongs to long-living and viviparous fish; therefore reproduction process includes copulation and birth of fries. Near the coasts of Bulgaria, Georgia, Romania, Russian Federation and Ukraine the intense spawning season is in March-May. Two peaks of birth of juveniles can be distinguished – spring period (April-May) and summer-autumn (August-September, Serobaba *et al.,* 1988). To give birth of juveniles the females approach the coastal zone in depth 10 – 30 m (Maklakova, Taranenko, 1974). At this time males keep separately from females in depth 30 – 50 m. The birth of Spiny dogfish juveniles takes place at the temperature of water 12 – 18°C.
- In autumn Spiny dogfish aggregates into large schools, accompanying anchovy and horse mackerel, which migrate to wintering grounds along eastern and western coast. During wintering the densest concentrations of Spiny dogfish are observed, where Spiny dogfish feeds intensively. They are associated, above all, with major wintering areas of anchovy in the waters of Georgia and Turkey. In the northwestern Black Sea in the waters of Ukraine and Romania in depth from 70-80 m down to 100-120 m abundant wintering concentrations of Spiny dogfish are also observed, where they are located on the grounds of whiting and sprat concentrations (Kirnosova, Lushnicova, 1990).

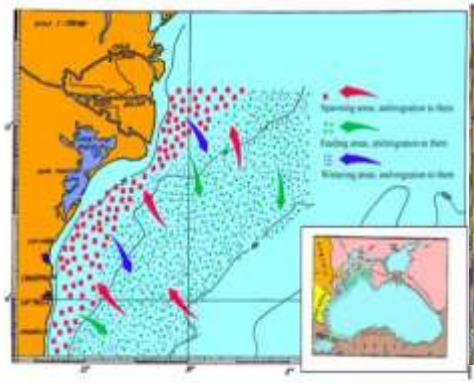

Fig. 1 Distribution and migration routes of the Spiny dogfish at Romanian littoral

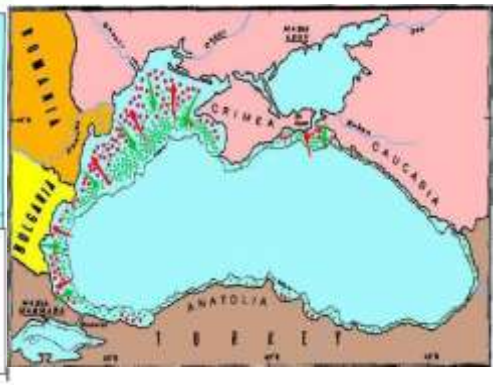

Fig. 2 Distribution and migration routes of the Spiny dogfish at Black Sea level.

Growth and Maturity

Spiny dogfish is a major demersal predator, reaching the Black Sea the length of about 1.50 m. In Romanian waters, structure analysis of length and mass classes of Spiny dogfish catches revealed the presence of large specimens, ranging from 90-130 cm length, with average mass values ranging from 3000-14950 g, the dominant classes 109-121 cm / 5755-7990 g, the average length of the body was 114.91 cm and average weight of 7388 g. Overall sex ratio of males was significantly positive with a rate of 84.29% compared to only 15.61%, as were females. Coefficients in length-weight relationship:
a = 0.0117; **b** = 2.76;
a =0.0000082; b = 3.82
Natural mortality M = 0.258 – 0.31
The population data of Spiny dogfish at the Romanian Black Sea area are given in the figures bellow – Length frequency data - Figs. 3 ÷ 10 and average weights per length class – Figs. 11÷ 14 (Maximov et al.,2010a,c; Radu et al., 2010a).

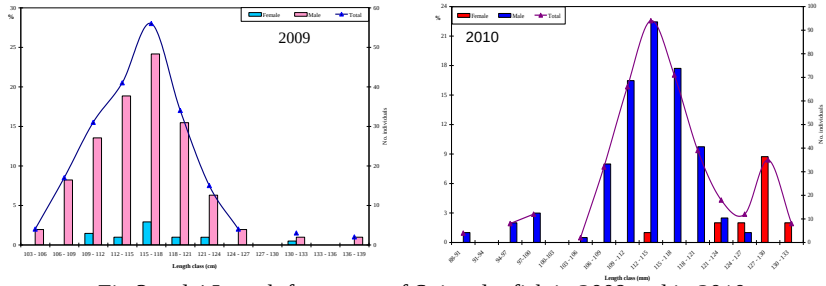

Fig.3 and 4 Length frequency of Spiny dogfish in 2009 and in 2010, Romanian Black Sea area.

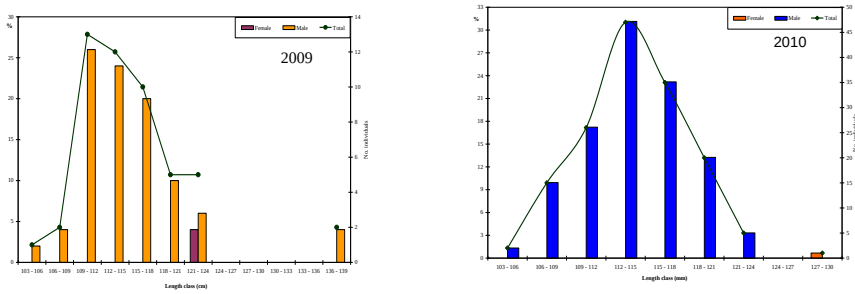

Fig.5 and 6 Length frequency of Spiny dogfish in May 2009, in May 2010 at Romanian marine area

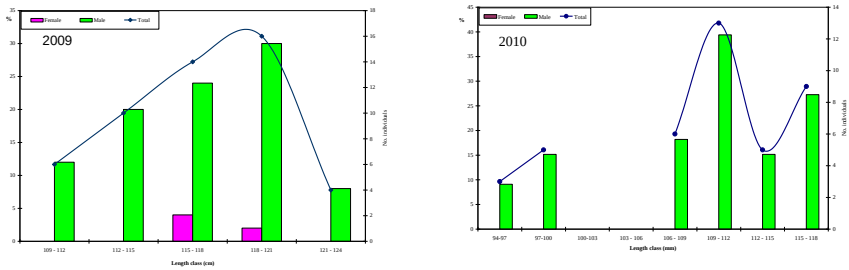

Fig.7 and 8 Length frequency of Spiny dogfish in June 2009 and in June 2010 at Romanian marine area

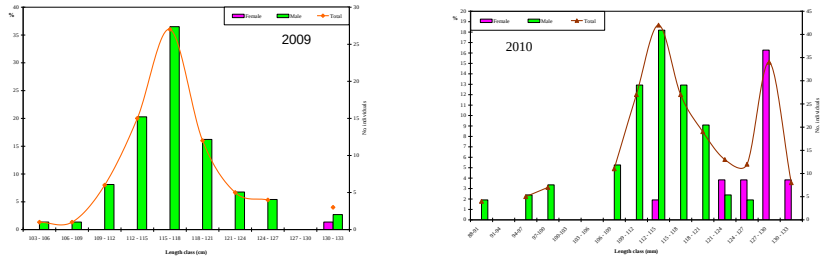

Fig.9 and 10 Length frequency of Spiny dogfish in November 2009 and in November 2010

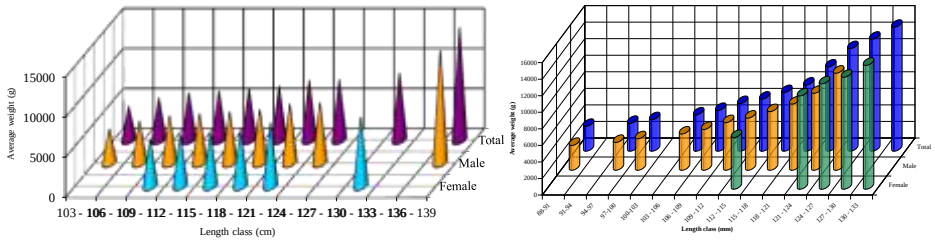

Fig.11 and 12 Spiny dogfish mean weights (g) per length class and gender in 2009 and 2010, Romanian Black Sea area.

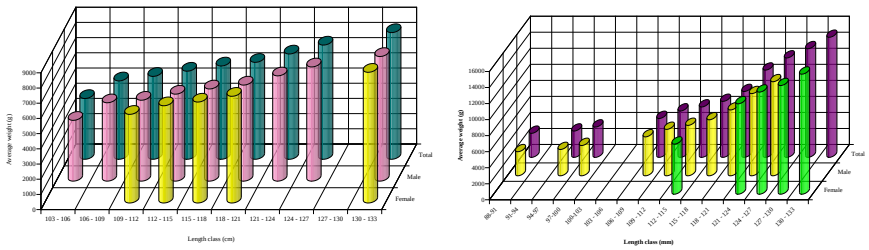

Fig.13 and 14 Spiny dogfish mean weights (g) per length class and gender in November 2009 and 2010, Romanian Black Sea area.

► According to investigations conducted in former USSR waters, Kirnosova, (1993) found that the Spiny dogfish maximum age is 20 years. The Ukrainian colleagues present the maximum age at 21 years. The parameters in VBGF and natural mortality parameters are:

Males:

$K = 0.029$ $t_0 = -3.84$; $L_\infty = 272$ cm; $W_\infty = 47$ kg; $M = 0.20 \div 0.23$

Females:

$K = 0.026$ $t_0 = -3.32$; $L_\infty = 303$ cm; $W_\infty = 196$ kg; $M = 0.15 \div 0.20$

► Age and length, at which 50% of individuals are mature, are 10.49 years and 87.57 cm for males and 11.99 years and 102.97 cm for females, respectively. Mean biennial fecundity is 19.4 eggs and 12.9 pups. The linear relationship between fecundity and length is: $F_e = 0.09$ x TLp + 2.12 ($r = 0.5$) for pups and $F_e = 0.27$ x TLp - 21.59 ($r = 0.7$) for eggs (Demirhan and Seyhan, 2007).

Life-history parameters and food diet of Spiny dogfish (*Squalus acanthias*) from the SE Black Sea were also studied (Demirhan and Seyhan, 2007). Spiny dogfish at age 1 to 14 years old were observed, with dominance of 8 years old individuals for both sexes. The length–weight relationship was $W = 0.0040*L^{2.95}$ and the mean annual linear and somatic growth rates were 7.2 cm and 540.1 g, respectively. The estimated parameters in VBGF were: $W_\infty = 12021$ (g), $L_\infty = 157$ (cm), $K = 0.12$ (year^{-1}) and $t_0 = -1.30$ (year). The size at first maturity was 82 cm for males and 88 cm for females. Mean biennial fecundity was also found to be 8 pups per female. The relationships fecundity–length, fecundity–weight and fecundity–age were found to be:

$F = -17.0842 + 0.2369*L$ ($r=0.93$)

$F = 0.3780 + 0.0018*W$ ($r=0.89$)

$F = -0.7859 + 1.1609*A$ ($r=0.94$), respectively.

Fisheries

Description of the fishing grounds and GSA

♦ The Romanian fishing fleet was operating in the area of competence of the Regional Fisheries Management Organisations - G.F.C.M., Area 37 - Mediterranean and Black Sea, Sub-area 37.4., Division 37.4.2, GSA 29.

♦ The Romanian fishing area is comprised between Sulina and Vama-Veche; coastline extends for over 240km, which can be divided into two main geographical and geomorphologic sectors:

1/ the northern sector (about 158km in length) lies between the secondary delta of the Chilia branch and Constantza, constituted of alluvial sediments;

2/ the southern sector (about 85km in length) lies between Constantza and Vama-Veche characterised by promontories with active, high cliffs, separated by large zones with accumulative beaches often protecting littoral lakes.

♦ The distance from the sea shore to the shelf limits (200m depth) varies from 100 to 200km in the northern sector and to 50 km in the southern one. The submarine slope of the shelf is very gentle in the north, while in the southern sector the slope increase very quickly (Fig. 15;16).

♦ The shallow waters up to 20m depth of the northern part are included in the Biosphere Reserve of Danube Delta (declared through the Low no. 82/1993).

♦ The marine zone of the "Danube Delta" - Biosphere Reserve constitutes a traditional zone for spawning and feeding for transboundary species as well as a passage route for anadromous species (sturgeons, Danube shad).

♦ In the South part of littoral is situated also the Vama Veche - 2 Mai reserve with the surface of 5,000 hectares (Fig.17).

♦ The marine Reserve "2 Mai - Vama Veche" is an area with a high diversity of the biotopes and biocoenosis, being settled on the migration routes of the main pelagic and benthic fish and marine mammals.

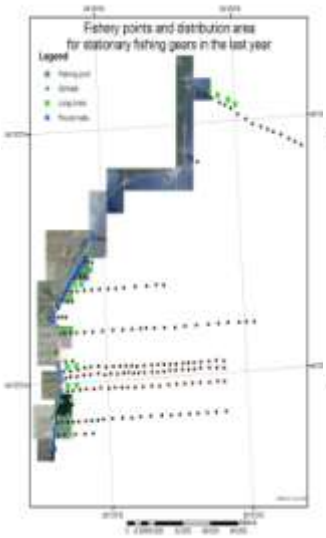

Fig. 15 Fishery points and distribution area for stationary gears in the last year

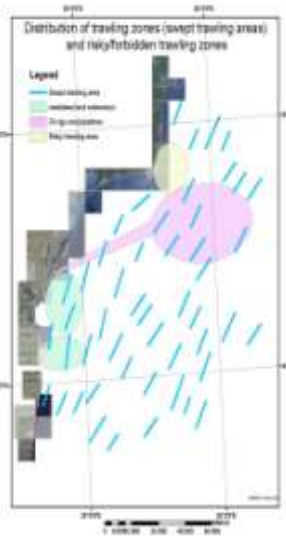

Fig. 16 Distribution of trawling zones and riskylforbidden trawling zones

Fig. 17 Romanian protected area

General description

* In the coastal zone of the Romanian marine sector with small depth, fishing with fixed gear is characterized by the concentration of activity mainly in the first three / four months of the season (April-July), when usually the turbot migrates to the coastal area for reproduction and other species migrate for feeding. In generally, total fishing season being of about eight months. The capture level and the level of fishing productivity differs from one year to another, depending on the fishing effort (number of pound nets, number of turbot nets and effective fishing days), and also depends on the evolution of hydro climatic conditions and at last but not least, the state of fish stocks.
* The structure on species of the catches mirrored only partly the composition of Black Sea ichtyofauna from the Romanian sector, because the type of gear conditions the ratio between the different fish species.

Fleet

Year after year the activity of active fishing decreased gradually to the point where, in 2010 from 20 vessels with LOA between 24-40 m registered in the last years in the Fishing Fleet Register, only one vessel was active for a very short period of time.

In 2010, the Romanian fleet capacity at the Black Sea was of 476 vessels registered in the FFR at the beginning of the year, structured on length classes as following:

- 54 boats smaller than 6m;
- 413 boats in the length class 6-12m;
- 3 boats in the length class 12-18m;
- 4 vessels in the length class of 18-24m and
- 2 vessels in the length class 24-40 m.

Unfortunately, small part of this fleet was active (206 boats/vessels)- Table 1.

Table 1: Segmentation of the Romanian fleet in 2010

Length class LOA (m)		**< 6**	**6 – <12**	**12-18**	**18 – <24**	**24 – <40**	**> 40**	**Total**
Total vessels registered		54	413	3	4	2	-	**476**
Active vessels		36	169	-	-	1	-	**206**
Midwater otter trawl	Mixed demersal and pelagic species	-	-	-	-	1	-	**1**
Pound nets	Small pelagic fish Demersal fish	3	14	-	-	-	-	**17**
Set gillnets	Demersal species	28	95			-	-	**123**
Artisanal fisheries (hand lines, set long lines, beach seine)	Other finfish	5	60	-	-	-	-	**65**

* This fleet is in poor conditions and needs improvements of safety on-board, working conditions and facilities for landing. The fisheries of this small fleet are typically artisanal type as multi-species and multi-gear fisheries, fishermen switching from one gear to another several times throughout the year.

Management regulations

► Romanian fisheries regulatory framework includes between others the following laws:
- Law on Fishing Fund, Fishery and Aquaculture No. 23 /2008;
- Annual Order on the Fishing Prohibition;
- Order no. 342/2008 on minimal size of the aquatic living resources;
- Order nr. 449/2008 on technical characteristics and practice conditions for fishing gears used in the commercial fishing.

► Regarding Spiny dogfish, for protecting the reproduction and rehabilitation of the stock were adopted the following measures:
- in period April - June, 60 days, the fishing is prohibited;
- it is banned to use the trawl in marine zone under the 20 m depths;
- mesh size for dogfish gillnets: a = 100mm, 2a = 200 mm;
- minimum admissible length in catches is 120cm (TL)

Catches

♦ In the Romanian fisheries, Spiny dogfish was mainly as by-catch in the trawlers catches. When the number of trawlers has been high, also the dogfish catches were higher.

♦ After 1989 the number of operational trawlers decreased (Table 1) and the Spiny dogfish catches have the same tendency (Table 2). In the last years, Spiny dogfish is a target species for dogfish gillnets (Table 3). In the waters of Romania, most of Spiny dogfish is harvested in spring and autumn months.

Table 2 Spiny dogfish catches at the Romanian littoral

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Catches (t)	1	5	1	6	6	6	3	1	4	3	3	8	19	92

Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Catches (t)	135	77	53	49	25	30	45	26	52	6	2	7	-	-

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Catches (t)	-	-	-	-	-	-	5	9	17	10	4.3	3.1

Table 3 Transversal and economic variables in the fishing of Spiny dogfish, 2010

Transversal and economic variables on fishing gears type	Gillnets
	DGS
Number of boats	13
Average length of boats (m)	8,46
Average age of boats (years)	13
No. fishing gears (pieces)	171
Gill nets length (m)	100
No. of trips	32
Soaking time (days)	102
No. persons	23
Fishing days	32
GT_{total}	28,13
GT fishing days	900,16
KW_{total}	413,11
KW fishing	13.219,52
Total catch on species (kg)	3,069
Landings (kg)	3,069
Landing value (lei)	30,751.38

- In the Black Sea, the largest catches of Spiny dogfish are along the coasts of Turkey, although this fish is not a target species of fisheries, being harvested as by-catch in trawl and purse seine operations mainly in the wintering period. In the 1989-1995 annual catches of Turkey are 1055-4558 t (Shlyakhov, Daskalov, 2008). In subsequent years, they have decreased about 2 times and did not exceed 2400 t. In the waters of Ukraine most of Spiny dogfish is harvested in spring and autumn months by target fishing with gill-nets of 100 mm mesh-size, long-lines, and as by-catch of sprat trawl fisheries. As in Turkish waters, in the last 20 years the maximum annual catches of Spiny dogfish are observed in 1989-1995, reaching 1200-1300 t. After 1994 the catches went down being between 20 and 200 t, Spiny dogfish lost its commercial importance in recent years. In the last 20 years, the decrease of dogfish landing may be due to over-fishing (Demirhan, PhD. thesis,)
- In the rest of countries Spiny dogfish is harvested mainly as by-catch, annual catches are usually lower than the Ukraine. The maximum annual catches of Spiny dogfish in 1989-2005 were: Bulgaria - 126 t (2001), Georgia - 550 t (1998), Romania - 52 t (1992), Russian Federation - 183 t (1990). It should be noted that in the waters of Bulgaria and Romania, the highest catches were observed in the early 2000's. In Romania, the catches decreased very much because of decreasing of the trawling effort (Maximov et al., 2008b, 2010b; Radu et al., 2009b, 2010a,b). The landings of Spiny dogfish by countries are given on Table 4.

Table 4 Spiny dogfish landings by countries (FAO Fisheries Statistics, BSC statistics)

Year	Bulgaria	Georgia	Romania	Russian Federation	Turkey	Ukraine
1989	28	217	30	135	4558	1191
1990	16	128	45	183	1059	1330
1991	21	18	26	67	2017	775
1992	15	14	52	15	2220	595
1993	12	131	6	5	1055	409
1994	12	45	2	11	2432	148
1995	80	31	7	90	1562	67
1996	64	71	-	19	1748	44
1997	40	1	-	9	1510	20
1998	28	550	-	6	855	38
1999	25	18	-	9	1478	94
2000	102	21	-	12	2390	71
2001	126	27	-	27	576	134
2002	100	65	-	19	316	97
2003	51.3	40	-	29	1840	172
2004	47.2	31	-	34	111	93
2005	14.5	35	5	19	102	75
2006	6.226	10	9	17	193	67
2007	23.98	2	17	28	91	45
2008	22.75	-	10	59	35	79
2009	9.46	-	4	14	156	47
2010	-	-	3	8.5	16	27

Scientific Surveys

♦ In Romania, the swept area method is used for evaluation the biomass of fishing agglomerations of Spiny dogfish, based on the statistic processing of productivity data obtained in sampling trawling;

♦ Results from estimated Spiny dogfish biomasses in May and November of 2009 in Romanian waters are given on Table 5 and Table 9 and Fig. 18 and Fig.20 (Maximov et al.2010b,c; Radu et al. 2009 a,b, 2010a,b). In May 2009 the biomass of dogfish was evaluated at 741 t, extrapolated to 967 t for the shelf till 50 Nm from the shore. In May 2010 the biomass of dogfish was evaluated at 2437 t, extrapolated to 5635 t for the shelf till 50 Nm from the shore. In the autumn period the biomass agglomeration increased at 2541 t (2009) and 13051 tons (2010) (Table 6, 8 and Figs. 19, 21).

Table 5 Assessment of Spiny dogfish biomass in May 2009 by demersal trawl, Romanian Black Sea area.

No. polygon	Surveyed area (Nm^2)	Range (t/Nm^2)	Average (t/Nm^2)	Total t in polygon (t)	Notes
1	1,227.13	0.00	0.00	0.0	Extrapolated at 967 t for the shelf till 50 Nm from shore
2	242.25	0.27 – 0.43	0.35	84.78	
3	165.00	0.23 – 0.28	0.26	42.90	
4	116.00	0.28	0.28	32.48	
5	724.25	0.53 0.76	0.63	456.27	
6	478.25	0.23 – 0.28	0.26	124.35	
7	265.63	0.00	0.0	0.00	
Total	3,218.5			740.78	

Table 6 Assessment of Spiny dogfish agglomeration in the Romanian area in the period May –June 2010, sampling gear demersal trawl

No. polygon	Polygon area (Nm^2)	Range (t/Nm^2)	Average (t/Nm^2)	Total tons in polygon (t)	Total on the shelf (t)
1	630.50	0.00	0.00	0.00	Extrapolated at **5635 tons** for the shelf till 50 Nm from shore (about 5000, Nm^2) including the new area (near Snake Island)
2	567.75	0.21-1.41	0.63	357.68	
3	216.75	0.24-0.68	0.47	101.87	
4	1155.00	0.56-5.62	2.11	2437.00	
Total	**2570**			**2897.00**	

Table 7 Assessment of Spiny dogfish biomass by demersal trawl in November 2009, Romanian Black Sea area.

No. polygon	Surveyed area (Nm^2)	Range (t/Nm^2)	Average (t/Nm^2)	Total t in polygon (t)	Notes
1	926.25	0.26 – 0.81	0.41	379.76	Extrapolated at 2,541 t for the shelf till 50 Nm from shore
2	2,404.13	0.39 – 2.04	0.68	1,634.81	
Total	3,330			2,015	

Table 8 Assessment of Spiny dogfish agglomeration in the Romanian area in the period October –November 2010, sampling gear demersal trawl

No. polygon	Polygon area (Nm^2)	Range (t/Nm^2)	Average (t/Nm^2)	Total tons in polygon (t)	Total on the shelf (t)
1	40	164.48	164.48	6579.2	Extrapolated at **13051 tons** for the shelf till 50 Nm from shore (about 5000 Nm2), including the new area (near Snake Island)
2	56	5.82	5.82	325.9	
3	1201	0.00-0.89	0.46	552.5	
4	315	0.00	0.00	0.00	
5	570	0.00	0.00	0.00	
6	868	0.28-1.01	0.58	503.44	
TOTAL	**3050**			**7961.04**	

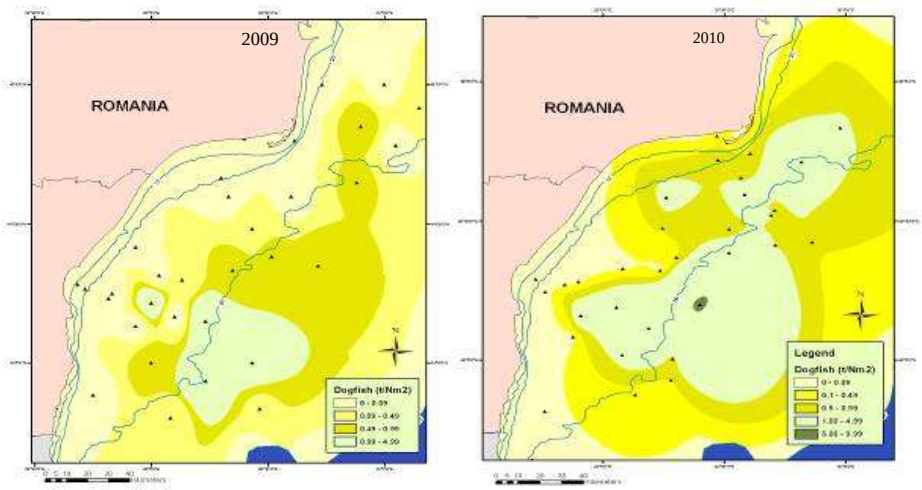

Fig.18 and 19 Distribution of Spiny dogfish agglomeration during demersal trawl survey in May 2009 and 2010, Romanian Black Sea area.

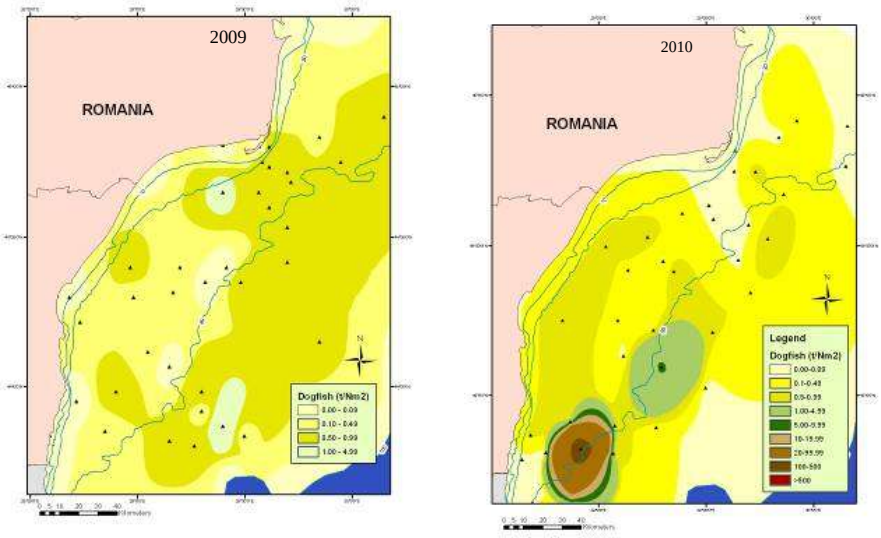

Fig. 20 and 21 Distribution of Spiny dogfish catches during demersal trawl survey in November 2009 and 2010 Romanian Black Sea area.

- In Romanian waters the agglomerations are distributed on entire shelf, but especially at depth more than 20m. Two peaks of intense spawning and of birth of juveniles are in spring and autumn period at Romanian littoral. In front of Romanian littoral, the biomass of Spiny dogfish seems to increase in the last years.
- In the former USSR and later in Ukraine, to assess the Spiny dogfish stock, the swept area technique using bottom trawl surveys, as well as dynamic model of an isolated population, were applied (Shlyakhov, 1997). The abundance and biomass of Spiny dogfish in the waters adjacent to Georgia, the Russian Federation and Ukraine were assessed. Whole population of Spiny dogfish in 1972 – 1992 was assessed by VPA (Prodanov *et al.*, 1997, Daskalov 1998). The obtained results from stock assessments in 1989 – 2005 are given in Table 9. According to the assessments, in 1989 – 2005 the stock of Spiny dogfish in the shelf area of the Black Sea and in Ukraine waters tends to be gradually reduced. Observed dynamics of stock corresponds with increasing CPUE in Turkish waters.

Table 9 Commercial stock of Spiny dogfish in the Black Sea and along the coast of the former USSR, water of Ukraine, Romania and Russia (th. tones) (BSC statistics)

Year	Whole Black Sea shelf	Waters of Ukraine, the Russian Federation and Georgia		Waters of Ukraine		Romania	Russian Federation
	VPA	Trawl survey	Modeling	Trawl survey	Modeling	Trawl survey	Modeling ???
1989	117.8	58.5	63.5	34.6	-		
1990	112.9	58.7	63.2	48.8	-		
1991	97.9	17.2/69.9*	64.0	14.4/58.5*	-		
1992	90.0	62.9	60.3	56.9	-		
1993			57.1	30.2	-		
1994			52.9	36.0	42.1		22
1995				-	37.6		22.5
1996				-	32.1		20
1997				-	31.0		20
1998				32.0	30.8		20
1999					28.0		20
2000					24.3		10
2001					22.3		10
2002					21.0	0.35	10
2003					22.1	1.205	
2004					22.3	1.250	
2005					21.0	1.0	
2006					21.0	-	5
2007					21.4	-	4.5
2008						0.883	4.5
2009						2.509	4
2010						13.51	1

* stock assessment is reduced to the average area of the registration (survey) zone.

♦ According to the assessments of Prodanov *et al.* (1997) and Daskalov (1998) Spiny dogfish stock has increased until 1981, after that it began to decrease. The authors explained the increase in Spiny dogfish with the increased abundance of main food species (whiting, sprat, anchovy and horse mackerel), and its subsequent reduction partially with intensification of the dogfish fishery during the period 1979 – 1984.

♦ Other data available (STECF/BS subgroup for stock assessment-Sofia 2011):
- Indices of abundance of the Spiny dogfish on length classes at Romanian littoral (2008÷2010);
- Biomass of Spiny dogfish on length classes at Romanian littoral (2008÷2010);
- Romanian catches in number of individuals and tons on length classes (2008÷2010);
- Ukrainian historical catch in numbers on age (1970 ÷ 2009);
- Ukrainian historical catch weights on age (1970 ÷ 2009);
- Ukrainian historical stock weights at age (1970 ÷ 2009);
- Ukrainian data regarding proportion mature at age (1970 ÷ 2009);
- Ukrainian dogfish age/length key.

Scientific advice

Short term considerations

The main characteristics of Spiny dogfish stock in the Black Sea and peculiarities of the management at regional level:

- migratory species has spawning, feeding and wintering habitats located in EEZ of different states;
- there are strong technical interactions, being exploited by different types of fishing boats and gear, and biological features, with complex predator-prey interactions involving most exploited species;
- due to their relatively low commercial interest and sometimes low number of specimens caught, Spiny dogfish are most of the times a component of the by-catch in fisheries targeting most commercially valuable species;
- in the Black Sea area is a common practice to don't report the catches and that unreported catches may exceed the officially reported ;

- presently there is no regional fishery management organization in the Black Sea area, the fisheries regulatory framework is promoted by each coastal country being not harmonized at regional level, even in the case of shared or migratory species.
- the lack of an adequate management in the Black Sea fisheries is also evidenced by the fact that in spite of decline of stocks, the fishing effort continued to increase
- the fishing is carried out in a competitive framework without any agreement between the countries on limits to fishing;
- there are large differences in the economic and technical structure of the fleets exploiting the fishery resources of the Black Sea among the countries, making regional cooperation a more demanding exercise;
- the development of small-scale fisheries, in particular in former communist countries, needs a new and transboundary approach by national authorities.
- fishery research in the Black Sea region remains sparsely equipped and funded;

Recommendations regarding the future management of this resource at regional level

- a better knowledge of the species;
- identify and manage stocks separately (if is the case).
- catch information is vital for the successful management of this species;
- strengthening the regional legal framework for sustainable management, establishing a regional organization through negotiation on signing of legally binding documents for fisheries;
- common policy of Black Sea countries for development of small-scale fisheries sector including harmonized fisheries regulation measures;
- developing and implementing regionally agreed fish stock assessment methodologies;
- harmonizing the development strategies of the fishing sector with those of environmental protection, through implementing the concept regarding the fishing management based on the ecosystemic approach and the FAO Code of Conduct for a responsible fishing;
- development of specific indicators for the Black Sea to monitor and assess the state of key resources/habitats;
- undertake concerted actions to combat illegal fishing and to establish regional consultation mechanisms between the Black Sea coastal states;
- extend/designate protected marine areas of regional significance and establish a network for the Black Sea.