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REPORT OF THE SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES

STECF ADVICE FOR SPRAT AND TURBOT IN THE BLACK SEA

STECF adopted this advice by correspondence in October 2007

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1. Background

In view of the recent accession of Bulgaria and Romania to the European Union, the Community has taken over the responsibility to ensure sustainable exploitation of fish stocks in the Black Sea. With a view to start implementing, at Community level, adequate management measures for important fisheries in the Black Sea Community Waters the Commission was seeking scientific advice on sprat and turbot stocks on the basis of relevant regimes already operating in Bulgaria and Romania. To this end an ad-hoc Working Group on sustainable exploitation of sprat and turbot in the Black Sea was convened under the Chairmanship of Dr. Georgi. M. Daskalov, in order to provide scientific advice on the current state of the stocks and related fisheries and recommendations for management in terms of TAC and quotas for sprat and turbot. The Scientific, Technical and Economic Committee for Fisheries (STECF) was requested by the European Commission to review the report of the *ad-hoc* Working Group meeting, report its findings and advise the Commission accordingly.

1.1 Terms of Reference of the ad-hoc Working group on Black sea sprat and turbot

The ad-hoc Working Group on Sustainable Exploitation of Sprat and Turbot in the Black Sea, chaired by Dr. Georgi M. Daskalov (Cefas, UK) met in Constanta, Romania 10-14 September, 2007 in order to:

- Describe the EU fisheries exploiting these stocks, in terms of fleets, fishing gears, deployed fishing effort (capacity in N°-GT-kW, activity in days at sea, gear characteristics), catches and catch composition, size composition, discards, fishing grounds and seasonality.

- Determine whether fishing fleets of non-EU countries exploit the same stocks and provide relevant information if available.

- Evaluate the status of the stocks with respect to their production potential, reproductive capacity and sustainable levels of exploitation. Provide elements for establishing catch limitations in order to limit the exploitation rates in line with sustainable exploitation of the stocks.

- Evaluate whether technical measures in terms of fishing gear characteristics, fishing season and fishing-protected areas may be advisable to complement catch limitations.

- Identify other important fisheries and stocks that may be in need of specific management measures and determine whether the scientific basis needs to be further developed.

- Identify knowledge and monitoring gaps for fisheries, stocks, vital fish habitats and other environmental aspects relevant to fisheries in the area.

Suggest monitoring and scientific actions that need to be developed in the short and mid-term to fill these gaps.

2. STECF Review of the ad-hoc Expert Group report

2.1 Overview

The report of the *ad-hoc* Expert Group on the Sustainable Exploitation of Sprat and Turbot in the Black Sea is appended at ANNEX I.

STECF acknowledged the considerable amount of work undertaken by the group and the considerable amount of data and information contained in its report. STECF also noted that the majority of the information presented in the report related to the fisheries and stock components in Bulgarian and Romanian waters and hence may not be representative of the Black Sea as a whole.

Nevertheless, the work of the group represents a significant attempt to compile relevant biological and fishery-related information on the stocks of sprat and turbot in the black sea and their current status and rates of exploitation.

STECF reviewed the *ad-hoc* Expert Group report by correspondence in October 2007 and adopted its findings and advice at 0900h GMT, 11 October, 2007.

2.2 STECF statement of endorsement

While recognizing that the information presented in the report of *the ad-hoc* Expert Group on the Sustainable Exploitation of sprat and turbot in the Black Sea represented the most comprehensive recent information on sprat and turbot in the Black Sea that was available to the group, STECF notes that the quantity and quality of the biological and fishery-related data is generally inadequate for quantitative stock assessments and advice.

Furthermore while accepting the findings presented in the report of *the ad-hoc* Expert Group on the Sustainable Exploitation of sprat and turbot in the Black Sea, **STECF does not endorse the Expert Group's recommendations**. The STECF recommendations and advice are given below.

3. STECF advice on sprat and turbot in the Black Sea

The STECF observations, conclusions and advice on sprat and turbot in the Black sea which are based on the information reported by the ad-hoc group Working Group on Sustainable Exploitation of Sprat and Turbot in the Black Sea, held in Constanta, Romania from 10-14 September 2007.

3.1 STECF advice on Black Sea Sprat

Sprat is a key component of the Black Sea ecosystem, acting both as predator and prey. It is a short-lived species and the stock dynamics highly dependent on recruitment, which is in turn influenced by environmental conditions.

Sprat in the Black Sea are considered a single unit stock. The population in Bulgarian and Romanian zone of the Black Sea represents only a portion of the entire Black Sea stock.

3.1.1 Commercial landings

Reported international landings of sprat from the Black Sea have averaged about 50,000 t – 70,000 t in recent years. This compares with 80,000 t-100,000 t in mid 80 to early 90s. The reported landings over the same period for Bulgaria and Romania combined have been between about 3,000 t and 15,000 t. The fisheries of Romania and Bulgaria are also highly dependent on sprat which typically comprise about 60% of the total commercial fish landings of these countries.

3.1.2 Commercial catch rates

- The majority of the sprat landings in recent years have comprised 2 and 3-year old fish.
- Catch per-unit-effort (cpue) for the Bulgarian fishery: the data indicate that catch rates in the Bulgarian commercial fishery for Black Sea sprat have remained relatively stable and at a relatively high level in recent years.
- Cpue for the Romanian passive fishery has shown an increasing trend over the period 2000-2006 with the highest catch rate in 2006.
- Cpue for the Romanian trawl fishery has shown a decline over the period 2000 to 2006, with the lowest recorded cpue for that period in 2006.
- The group did not present any information on cpue from the zones of non-EU countries.

3.1.3 Egg and larval abundance estimates

- Sprat egg abundance estimates from the Romanian zone of the Black Sea indicate that over the past 2 decades, egg abundance has varied inter-annually without trend.
- Sprat larval abundance estimates from the Romanian zone of the Black Sea indicate that larval abundance has remained relatively constant over the past decade.
- The group did not present any information on egg and larval abundance from the Bulgarian zone of the Black sea or from the zones of non-EU countries.

Juvenile (0-group) sprat abundance estimates from surveys in the Romanian zone of the Black Sea.

- Juvenile sprat relative abundance estimates from the Romanian zone of the Black Sea over the period 2000-2006 show wide variation. The 2003

year-class appears to have been particularly strong, some three orders of magnitude greater than the long-term average. Similarly the 1997 year-class was the weakest, being about one order of magnitude lower than average. The 2006 year-class is estimated to be about 10 times the long-term average.

- The group did not present any survey information on juvenile sprat abundance from the Bulgarian zone of the Black sea or from the zones of non-EU countries.

3.1.4 VPA estimates of stock biomass and fishing mortality rates for Black Sea sprat

- Results from VPA including data from 1990 to 2004 for the Bulgarian zone indicate that stock biomass has gradually declined over that period. At the same time, recruitment has fluctuated without any clear trend.
- Results from VPA for sprat for the whole of the Black Sea from 1950-1995 indicate no clear trend in stock biomass but periods of high and low biomass following high and low pulses of recruitment respectively.
- Results from a stock production model (ASPIC) including data from 1950 up to and including 2003, indicate that relative F (i.e. F/F_{msy}) declined from a value of about 1.0 (i.e. $F = F_{msy}$) in the mid-1980s to about $F/ F_{msy} = 0.1$ in 2001. In 2002 and 2003 the model suggests that relative F has increased to about $0.6*F_{msy}$ i.e. 40% less than F_{msy}.
- The ASPIC model also suggests that B/B_{msy} mirrored the results for relative F, showing an increase from the mid 1980s (B_{msy}) to $2.5 * B_{msy}$ in 2001. The relative biomass in 2002 and 2003 appears to have been reduced to about $1.5 * B_{msy}$.
- Projections over 6-years (2004-2009) based on the results of the ASPIC model and assuming a future catch at MSY (11.38 thousand tonnes), indicate that F/ F_{msy} is likely to increase to 1.27. Relative biomass will decline to about $0.6*B_{msy}$.
- STECF notes that the precision of the above estimates for the most recent and especially for the projected years is very low. Hence the ASPIC model does not give us a precise indication of the relative exploitation rate and stock status in 2007 and 2008.

3.1.5 Estimates of stock biomass from trawl surveys

- The swept area survey estimate of stock biomass for Black Sea sprat in the Bulgarian zone of the Black Sea in 2006 is 29,000 t. STECF notes that these values are of the same order of magnitude as those derived for the Bulgarian zone using VPA.
- The swept area survey estimate of stock biomass for Black Sea sprat in the Romanian zone of the Black Sea in 2006 is between 10,000 t and 19,000 t.
- The swept area survey estimate of stock biomass for Black Sea sprat in the Romanian zone of the Black Sea in 2007 is 60,000 t.

- The combined area survey estimate for the biomass of sprat in the combined Romanian and Bulgarian zones for 2006 is estimated to be between 40,000 t and 50,000 t. STECF notes that the precision of these relative survey indices is not documented.
- There is no estimate for the biomass of sprat in 2007 for the combined Bulgarian and Romanian zones or for the whole Black Sea stock.
- STECF notes that the swept area biomass estimates represent relative stock size indices and are likely to be underestimates of the biomass of the entire Black Sea sprat stock.

3.1.6 STECF Conclusions and advice for Black Sea sprat

At present, STECF concludes that there is no reliable estimate of the current (2007) stock status for Black Sea sprat or its current rate of exploitation. Recent reported landings of sprat from the Black sea have been in the region of 60kt, with Bulgaria and Romania reporting between 3,000 t and 15,000 t. International landings from the Black Sea have been in region of 50,000 t -70,000 t in recent years, this compares with 80,000 t -100,000 t in mid 1980s to early 1990s. At that time stock biomass is estimated to have been in the region of 400,000 t -500,000 t, implying an average harvest rate of about 20%.

The Aspic surplus production model implies that catches at about MSY (11,380 t) are likely to result in F above Fmsy in short term. However, the short term effects of a particular fishing rate cannot be determined without a knowledge of the current stock status or its exploitation rate, and a reliable predictor of incoming recruitment. However it is clear that in the long term, fishing at rates above F_{msy} are undesirable.

STECF notes that the reported combined Bulgarian and Romanian landings over the past 2 decades have not exceeded about 15,000t. STECF therefore advises that given the uncertainty associated with the recent stock status and associated exploitation rates, catches of sprat from Bulgarian and Romanian water should not exceed 15,000 t until a reliable estimate of the biomass of sprat in Bulgarian and Romanian waters is available.

STECF also suggests that in the absence of a reliable estimate of stock status or its exploitation rate, it is reasonable to conclude that the upper limit for a harvest rate should be no greater than the historically observed average catch/biomass ratio. This implies an upper limit on the harvest rate of about 20% for the Black Sea as a whole. This also implies that the harvest rate in Bulgarian and Romanian waters should also not exceed 20%.

A harvest rate of 20% implies a fishing mortality rate of approximately 0.35 which assuming a natural mortality rate of 0.95 per year, leads to a maximum survival rate of about 27% year on year. In other words 73% of the stock will die each

year through a combination of fishing and natural mortality. Even in the absence of fishing, only about 38% of the stock will survive between years, highlighting the stock's dependence on recruitment. A survival rate of about 40% is the level usually proposed by fisheries scientists as being a suitable survival rate for sustainability of the stock, taking into account the possibility of consecutive years of poor recruitment.

STECF therefore suggests that a harvest rate of 20% represents a high-risk strategy and while recognising that the appropriate level of risk to accept is a management decision, STECF advises that from a stock conservation perspective, an upper limit on the harvest rate should be much lower than 20%. This advice is consistent with the advice that an appropriate level of catch for sprat in Bulgarian and Rumanian waters should be less than 15,000 t.

3.2 STECF advice on Black Sea turbot

Turbot (*Psetta maxima*) is the most valuable species in terms of price per kg. It is considered as a transboundary stock and is accessible for fishing throughout most of the year (Prodanov et al. 1997). The species is distributed all over the continental shelf to a depth of about 100 m -110 m in the North-western Black Sea area and occurs in grouped local shoals.

Turbot are predators, and their diet includes fishes, crustaceans, polychaetes and molluscs in different proportions. Black Sea turbot are long-lived and growth rate is slow. The maximum age is up to 23 years (Carausu,1952) in Romanian waters and 12-13 in Bulgarian waters (Karapetkova, 1961), reaching around 85 cm total length. (Stoyanov, 1963). Turbot mature at the age of 3-5 years.

3.2.1 Commercial landings

Turbot landings into Bulgaria and Romania varied between 0 t and 678 t over the period 1950 – 2006. Yields for both countries have declined since 1964, and the rate of decline increased after 1980. Average landings of turbot during the period 1950 – 1980 in Bulgaria are estimated at about 245 t per annum and 173 t in Romania. Over the period 1995-2001 the combined Bulgarian and Romanian landings were stable at a low level of about 60 t. In 2002 reported landings for these countries more than doubled to 136 t, and over 2003 to 2005 reported landings declined to about 40 t.

Up to 1964, the majority of reported turbot landings from the Black Sea were by the former USSR. Since 1965, Turkey has reported the majority of landings. The reported international landings in recent years have decreased to below 1,000 t per year and are probably under recorded due to illegal fishing and unrecorded quantities taken as a by-catch in the sprat fishery.

STECF notes that approximately 90% of landings in recent years comprises age groups 5 and younger. STECF advises that such a truncated age range coupled with a reduction in the mean length at age is indicative of overexploitation.

3.2.2 Technical measures for exploitation of Turbot in the Black Sea

In Romania and Bulgaria, landings of turbot are presently believed to be exclusively from gill nets. The minimum mesh size for gillnets are 180 mm and 200 mm in Bulgaria and Romania respectively. Gillnets are deployed on the shelf area throughout the whole year in Romanian waters and during spring and autumn seasons in Bulgarian waters.

There is concern regarding the incidental catch of cetaceans in gill nets set for turbot in the Black Sea, especially with regard to dolphins. Research in Romania has shown that escapement of dolphins from turbot gill nets can be enhanced if the twine thickness used is reduced to a thickness corresponding to 6,350 m/kg. STECF is unaware whether such a twine thickness has any effect on the catch of turbot.

3.2.3 Stock assessment.

There is no quantitative information on trends in the stock other than information on reported landings. There are no assessments of the recent stock status or its exploitation rate for Black Sea Turbot. Swept area estimates of exploitable biomass for the Bulgarian and Romanian continental shelves are available for 2006 although catchability for the two survey gears is known to be different, so the results are not directly comparable.

The estimated exploitable biomass (relative survey index) on the Romanian shelf area in 2006 is between 250 t and 1,000 t. For the Bulgarian shelf, the estimate of exploitable biomass (relative survey index) in 2006 is between 1,400 and 1,800 t.

3.2.4 STECF conclusions and recommendations for Black Sea turbot

The truncated age range of Black Sea turbot and the observed reduction in mean length at age, give a strong indication that the stock is currently overexploited and probably has been overexploited for many years.

There is no reliable quantitative estimate of the recent stock status or its exploitation rate. The separate estimates of exploitable biomass derived using the swept area method for the Bulgarian and Romanian zones are not directly comparable and are uncertain. STECF therefore has no objective quantitative criteria on which to base advice on an appropriate harvest level for Black Sea turbot.

Landings into Bulgaria and Romania over the period 2003-2005 have shown a steady decline and are far below those seen prior to 1980. At that time there were also more age groups represented in the catches.

There is little doubt that the stock of turbot in the Black Sea is much reduced compared to the period before 1980. Average landings of turbot during the period 1950 – 1980 are estimated at about 245 t per annum in Bulgaria and 173 t in Romania. The average annual landings since 2000 vary between 21 t (Romania) and 47 t (Bulgaria).

STECF considers that the trend in the landings is indicative that the stock decline commenced in the 1970´s and early 1980´s and the stock has remained at a very low level since that time. STECF **recommends** that, given the fact that turbot is a long lived species, matures usually at relatively older age and that has very low gear selectivity, and considering the historical trend in landings, catches of this species should be as close to 0 as possible until a sign of recovery of the stock is observed. The recovery should be assessed both in terms of absolute biomass and size structure of the stock compared to the unfished situation.

STECF **recommends** that to improve reproductive potential and increase the chance of stock rebuilding, catches of Turbot from the Black Sea should be kept to a minimum. STECF notes that this requires action on the part of other countries in addition to the current EU member states. Since 1989, the share of the reported international Black Sea turbot catch accounted for by Bulgaria and Romania has ranged from 0% to 25%, with an average of 5%. It is clear that any restriction on the catches of these countries alone, will have a minimal impact on the overall mortality rate and hence potential for rebuilding the stock.

STECF advises the harmonisation of technical conservation regulations (mesh size, minimum landing size, closed areas, closed seasons) in the black sea area to control the overall exploitation rate and age composition of catches of turbot.

STECF **recommends** that to reduce the mortality on cetaceans caused by their incidental capture in gill nets deployed to catch turbot, consideration be given to reducing the twine thickness of gill nets to a thickness corresponding to 6,350 m/kg.

STECF also recommends that the effectiveness of acoustic devices to deter dolphins and reduce their incidental capture in turbot gill nets should be investigated. If deployment of such devices can be demonstrated to be effective, STECF suggests that they be made compulsory.

STECF also agrees with the following recommendations made by the Ad Hoc expert Group:

- The main gaps in knowledge considering turbot stock in the Black Sea include absence of stock assessments by direct (holistic) methods during the period 1973 – 2003 in Romania and in 1993 – 2005 in Bulgaria. Reliable data of size and age structure of commercial landings since 1990 in Bulgaria and 2003 in Romania do not exist. Annual larval and juvenile surveys using appropriate gears and methodology are needed. Quantitative assessments of turbot by-catch in the sprat fishery need to be developed in order to improve the catch statistics including discards in all turbot fisheries.

- Turbot is highest priced demersal fish species shared as transboundary stocks between Bulgaria, Romania, Turkey and Ukraine. Turbot migrations are seasonal, linked to the feeding, spawning and wintering processes. New data, obtained by acoustic and data storage tags, for main migration routes, spawning and nursery areas in the whole North-Western part of the Black Sea is required for adequate management, TAC determination and stock protection. Joint research on this issue on regional, national and international level is recommended.

- We recommend developing of national, bilateral and regional programs and initiatives for fish stock assessments on annual basis. The co-ordination at regional level of the scientific research, harmonization of methods for sampling, assessment and data analysis is also recommended. The non-EU member states of the Black Sea should be encouraged to participate in these activities.

- The technical measures concerning gillnets mesh size, minimum landing size, seasonal fishery closures needs to be set at a European level and coordinated internationally to achieve good management of the stock. Introduction of acoustics devices protecting marine mammals populations is needed according to ACCOBAMS recommendation and agreements.
- The development of aquaculture as a means to reduce pressure on the natural population should be considered. However, STECF advises that any development of aquaculture for turbot should aim to assure that the wild stock is protected from genetic threats. In addition, aquaculture should not be used for restocking purposes unless clear guidelines on how to distinguish between the wild and cultured components in the catch can be established and agreed.

- Genetic studies at a regional and international level are required in order to increase the current knowledge on stock identity.

- Improvements in the reliability, reporting and access to fisheries statistics at regional, national and international level.

ANNEX I.

Report of the ad-hoc Working Group on Sustainable Exploitation of Sprat and Turbot in the Black Sea

10 – 14 September 2007
CONSTANTA, ROMANIA

Contents

1 Executive summary

In view of the recent accession of Bulgaria and Romania to the European Union, the Community has taken over the responsibility to ensure sustainable exploitation of fish stocks in the Black Sea. With a view to start implementing, at Community level, adequate management measures for important fisheries in the Black Sea Community Waters the Commission was seeking scientific advice on sprat and turbot stocks on the basis of relevant regimes already operating in Bulgaria and Romania. To this end an ad-hoc Working Group on sustainable exploitation of sprat and turbot in the Black Sea was convened to meet in Constanta, Romania 10-14 September. The ad-hoc WG was asked to provide scientific advice on the current state of the stocks and related fisheries and recommendations for management in terms of TAC and quotas for sprat and turbot. The advice obtained from the ad-hoc WG will be further examined by the Scientific, Technical and Economic Committee for Fisheries (STECF) of the European Commission and recommendations will be presented to decision makers for negotiations on TAC and quotas for sprat and turbot.

The ad-hoc WG reported, discussed and developed recommendations on several relevant issues including:

Described the EU fisheries exploiting the stocks, in terms of fleets, fishing gears, fishing effort, catches, size and age composition, bycatch, discards, fishing grounds and seasonality.

Discussed problems of non-EU countries exploiting the same stocks (due to shared stocks, migrations and illegal fishing in national and Community waters) and needs for cooperation with non-EU countries in terms of data exchange and analyses, joint stock assessments, and regional Black Sea fisheries management.

Evaluated the current state of the stocks and their related fisheries and provided elements for establishing catch limitations (TAC and quotas) based on management regimes already operating in Bulgaria and Romania.

Identified the need for reviewing the best available knowledge and further developing annual operational stock assessments of sprat and turbot.

Discussed and recommended other potential technical measures in terms of fishing gear, fishing season and protected areas that may be useful for the protection and sustainable management of the stocks in complement to the catch limitations.

Identified other important stocks such as anchovy, sea snail, spiny dogfish and others, that need further development of specific research and management measures

Identified gaps in knowledge and monitoring of fisheries, stocks, vital fish habitats and other environmental aspects relevant to fisheries in the area and recommended monitoring, scientific and management actions and that need to be developed in the short and mid-term to fill these gaps

The ad-hoc WG reached the main conclusions:

- Sprat and turbot stock are very important for the fisheries Bulgaria, Romania and other countries and the Black sea ecosystem.

- Biological population distributions and life cycles of sprat and turbot exceed national boundaries and relevant evaluation of the state of the stocks need to be arranged at a regional level, considering also changing environmental conditions, migrations and other relevant biological and ecological information

- Sprat stock and related fisheries have recovered after the crisis during the 1990s and in the last years reached levels comparable to the period prior to the crisis. The stock is however, considered as vulnerable due to short life cycle 4-5 years, pronounced population fluctuations and negative influence of environmental and anthropogenic factors including excessive fishing.

- The estimated sprat biomass is 29 190 t in Bulgaria and between 19 000 to 60 000 t in Romania. Taking into consideration varying environmental conditions, and anthropogenic and fisheries pressure also from other countries sharing the same stock TAC is proposed to be between 8 000 and 15 000 t. Until more reliable international stock assessment is performed it is recommended that the fishing mortality F do not exceed the half of the natural mortality M = 0.95 i.e. F_{lim}=0.475

- After a long depression in 1980s-2000s there are signs of improved stock status of turbot. However the ad-hoc WG recommend a very cautious approach provided several important circumstances: important information gaps (incomplete fishery statistics, unreported and illegal catches, research survey) and further need of reliable unified and scientifically sound monitoring and stock assessments; high market demand and related pressure of overfishing and illegal practices; high sensitivity to anthropogenic and natural impacts such as eutrophication and related hypoxia, river run-off.

- The current state of turbot stocks in front of Bulgarian and Romanian coasts during the last two years is assessed between 436 – 1066 tones in Romania and 1440 – 1779 t in Bulgaria. Sustainable levels of exploitation in Bulgarian and Romanian waters may range between 80 - 100 t.

The ad-hoc WG recommended

On a short term: 2007/2008

- **To establish a permanent and operational Working Group on Fisheries Assessment and Management in the Black Sea under the auspices of the STECF**

- **To prepare a comprehensive review of the available historical knowledge and evaluate the multi-annual dynamic and current status of sprat and turbot stocks. To use advanced analytical methodology and best available data in terms of fisheries and research information. To develop the scientific basis for sustainable management providing annualy estimates of abundance, fishing mortality, short and mid-term forecasts, and precautionary reference points**

- To develop the collaboration with leading experts and institutions from the EU and non-EU countries, which can help the WG by bringing complimentary data and methodologies

- The technical measures concerning gillnets mesh size, minimal permitted lengths, seasonal fishery closures needs to be synchronized between Bulgaria and Romania

On a medium term: next few years

- To strengthen of the operational capacity of national scientific research units through improvement of methodologies and equipment, development of information systems, training and mobility of personnel.

- To procure adequate funding and support of scientific research and fisheries related monitoring programs for performing reliable stock assessment and provision of scientific advice to fisheries managers and governments.

- To agree at national and regional level of a comprehensive list of indicators for marine living resources, habitats, key species and fisheries activities; establishing of corresponding parameters to be collected by fisheries monitoring systems.

- To develop a fisheries information system through compilation of historical and present data information, and establish a system for facilitating access to the publications at the national level

- To develop a regional network of research and information centers of fisheries and aquaculture, marine living resources habitats and biodiversity.

- To elaborate at regional level of a unified stock assessment methodology for sprat, turbot and other important species; training and practical application through regional working groups.

- To design and perform unified research surveys.

- To improve of existing procedures of setting management objectives for marine living resources, and develop unified indicators.

- To develop region wide evaluation criteria for protection of living resources, habitats and procedures for establishing of marine protected areas.

- Promote studies of genetics, migrations and population studies in order to establish stock distribution boundary.

- To develop of turbot aquaculture as a way to reduce the pressure on natural population is recommended.

2 Introduction

2.1 Scientific justification of the ad-hoc Working Group

In view of the recent accession of Bulgaria and Romania to the European Union, the Community has taken over the responsibility to ensure sustainable exploitation of fish stocks in the Black Sea. With a view to start implementing, at Community level, adequate management measures for important fisheries in the Black Sea Community Waters the Commission was seeking scientific advice on sprat and turbot stocks on the basis of relevant regimes already operating in Bulgaria and Romania. To this end an ad-hoc Working Group on sustainable exploitation of sprat and turbot in the Black Sea was convened in order to provide scientific advice on the current state of the stocks and related fisheries and recommendations for management in terms of TAC and quotas for sprat and turbot. The advice obtained from the ad-hoc WG will be further examined by the Scientific, Technical and Economic Committee for Fisheries (STECF) of the European Commission and recommendations will be presented to decision makers for negotiations on TAC and quotas for sprat and turbot.

2.2 Terms of Reference

The ad-hoc Working Group on Sustainable Exploitation of Sprat and Turbot in the Black Sea, chaired by Dr. Georgi M. Daskalov (Cefas, UK) met in Constanta, Romania 10-14 September, 2007 in order to:

- Describe the EU fisheries exploiting these stocks, in terms of fleets, fishing gears, deployed fishing effort (capacity in N°-GT-kW, activity in days at sea, gear characteristics), catches and catch composition, size composition, discards, fishing grounds and seasonality.

- Determine whether fishing fleets of non-EU countries exploit the same stocks and provide relevant information if available.

- Evaluate the status of the stocks with respect to their production potential, reproductive capacity and sustainable levels of exploitation. Provide elements for establishing catch limitations in order to limit the exploitation rates in line with sustainable exploitation of the stocks.

- Evaluate whether technical measures in terms of fishing gear characteristics, fishing season and fishing-protected areas may be advisable to complement catch limitations.

- Identify other important fisheries and stocks that may be in need of specific management measures and determine whether the scientific basis needs to be further developed.

- Identify knowledge and monitoring gaps for fisheries, stocks, vital fish habitats and other environmental aspects relevant to fisheries in the area. Suggest monitoring and scientific actions that need to be developed in the short and mid-term to fill these gaps.

3 State of the stocks and fisheries

3.1 Sprat (*Sprattus sprattus*)

The Black Sea Sprat (*Sprattus sprattus phalericus*) is a key species for the Black sea ecosystem. Together with the Anchovy (*Engraulis encrasicholus*), sprat is one of the most abundant, planktivorous, pelagic species. The level of its stocks depends on the conditions of the environment mainly and on the fishing effort.

The changes in the environment due to anthropogenic influence, affects the dry land as well as the world ocean. The level of the sea pollution and its "self-purifying" ability are completely different under different environmental regimes. There are clear indications of changes in the natural equilibrium in the corresponding ecological niches.

The commercial fishery has a large impact on the Black Sea fish populations. As a result, some of the stocks in the Black Sea have declined, are in decline or are depleted (Prodanov et al., 1997).

This decline in some stocks has excellerated over the last 10-20 years, in response to excessive exploitation, and many of the commercial species are critically endangered or vulnerable.

The abundance of a given generation of a fish stock is dependent on numnerous abiotic and biotic factors. Of major importance are: the level of fishing mortality, periodic changes in trophic levels due to mass occurrence of the ctenophore *Mnemiopsis leidyi* and algal blooms, which lead to hypoxia in the shallower waters resulting in mass mortality of bottom dwelling organisms..

The reasons for the decline of the sprat stocks in the western part of the Black Sea after 1987-1988 are complex. Intensification of the fishery in the last 20 years has had a large impact on the sprat stocks which are an important resource for the Bulgarian Black sea fishery. The commercial fishery has an important influence on the Black Sea ecosystem, because it directly affects the fish populations and the rapid intensification of the fishery together with the level of pollutants in the Black Sea has lead to a disturbance of the ecological equilibrium and to marked changes in the fish community.

The observed overexploitation of Black Sea fish stocks underlines the necessity to elaborate measures to achieve their sustainable utilization. A number of international organizations have been created with the aim of regulating and advising on the sustainable exploitation of marine living resources in the World's Oceans.

In the Black Sea, a draft "Convention for fishery in the Black Sea" has been in preparation since the early 1990s, comprisingsix member countries with the purpose to regulate fisheries in the region.

In relation to the status of the environment and living resources in the Black Sea, there is an urgent case for the implementation of measures to effect improvements to the environmental conditions and aid fish stock recovery.

Sprat migration routes in the Black Sea basin are presented on Figure 1.

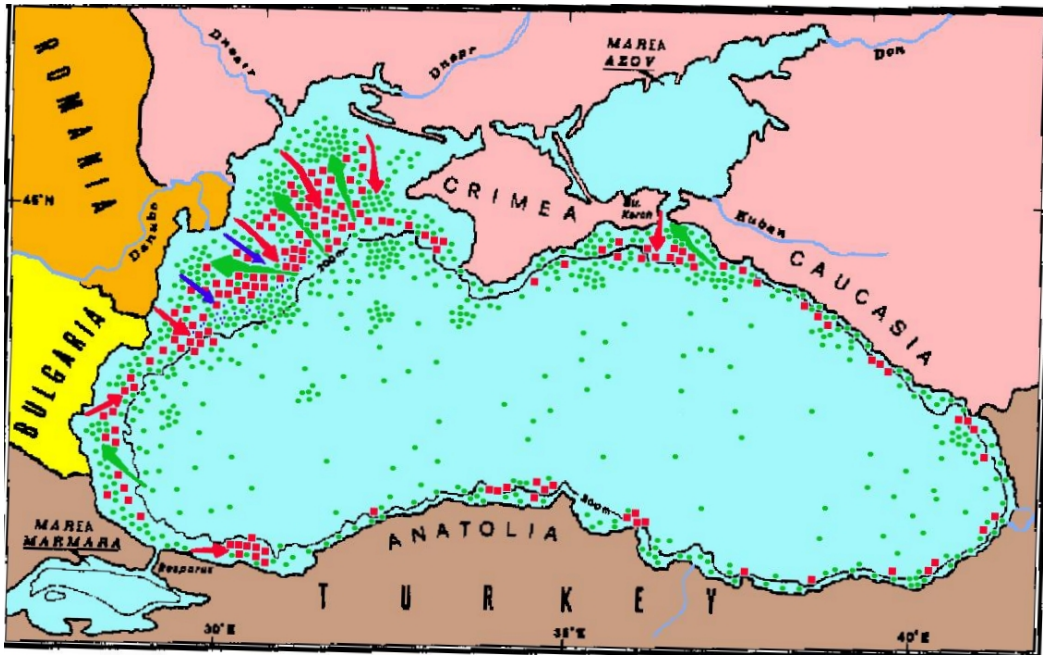


Figure 1. Sprat migration routes in the Black Sea basin.

Legend: Wintering areas and migration to them; Spawning areas and migration to them; Feeding areas and migration to them

Previous investigations:

Previous known investigations on sprat in the Black Sea are given in (Table 1):

Table 1. Previous investigations on sprat

AUTHOR	METHODS	OBJECTIVES/FINDINGS
	VPA (Pope, 1972)	1976 – 1979 years Sprat biomass variation is from 167. 5 to 204. 6 average 179.8 thousand tons
Ivanov(1983)	Age-structured VPA	1976 and 1977 being 573 600 and 595 900 ton F opt = 1.01
Prodanov (1989)	Modification Ricker's equation	Fopt = 0.68

AUTHOR	METHODS	OBJECTIVES/FINDINGS
Prodanov and Daskalov (1992)	Production model Fox (1970), Bulgarian coast	1976 – 1985 years MSY = 17.71 thousand tons Fmsy = 0.437 1986 –1990 years MSY = 11.95 thousand tons Fmsy = 0.77
Daskalov and Prodanov (1995)	LCA, Bulgaria	Average SSB ranged between 176.6 thousand tons in 1978-1980, and 23.5 thousand tons in 1990-1993
Daskalov et al. (1996)	SVPA, VPA and XSA, whole Black Sea	1970-88 Average SSB: 356.6 thousand tons F average: 0.176 1989-93 Average SSB: 185.1 thousand tons F average: 0.472
Daskalov 1998	XSA, ICA whole Black Sea	1945-1993 stock assessment in the whole Black Sea using age-structured model with catch and survey data
Daskalov 2001	ICA, Bulgaria	Average SSB was 78.5 thousand tons and average F – 0.06, for 1996-2000
Daskalov et al. 2007	ICA whole Black Sea	1950-2000 stock assessment in the whole Black Sea using age-structured model with catch and survey data (Fig., 18)
Report of the Institute of fisheries, Varna	Hydroacoustic survey, Bulgaria	1984-1991 16 thousand tons (1987) to 77 thousand tons (1986)
Prodanov et al (1997)	SVPA, VPA and XSA, whole Black Sea	1951 –1993 years avarage SSB is 199.8 thousand tons
Prodanov (2003)	VPA, Bulgaria	Average SSB: for 1994-2002 was 43.284.1 thousand tons

AUTHOR	METHODS	OBJECTIVES/FINDINGS
Panayotova and Mikhailov (2006)	LCA, VPA	1998, 1999 and 2000 SSB: (21 892 t (1998), 28 733 t (1999) t, and 10 948 t (2000); TAC: 10 968 t (1997), and 18 463 t (2000).
Raykov et al., 2007	LCA , VPA	1996-2004 SSB: range between 41.9 and 89.7 thousand tons (Fig. 17)
Raykov, 2007	ASPIC 5 Production modeling (Fig. 19)	MSY=11 380 t. Fmsy=1.922.Fnow=1.166 Projected F=1.266 (assuming yeil=MSY)

Description of main fishing grounds at the Bulagrian and Romanian littoral

The Bulgarian fishing grounds (pound nets), for sprat are situated along the entire coastline from Cape Siviburun (in the northern part) to the Rezovo river (in southern part) – Figure 2 A. Trawling activities (using mid-water trawls) have been carried out especially in the southern area (Bourgas, Sozopol, Nessebar, Cape Emine, Cape Maslen etc.). Sprat fishing takes place in waters between 40 and 100 meters depth, where the continental shelf narrows compared to Romanian waters.

The Romanian fishing area is extends between Sulina and Vama-Veche; the coastline extends for over 240 km, and can be divided into two main geographical and geomorphologic sectors (Figure 2 B):

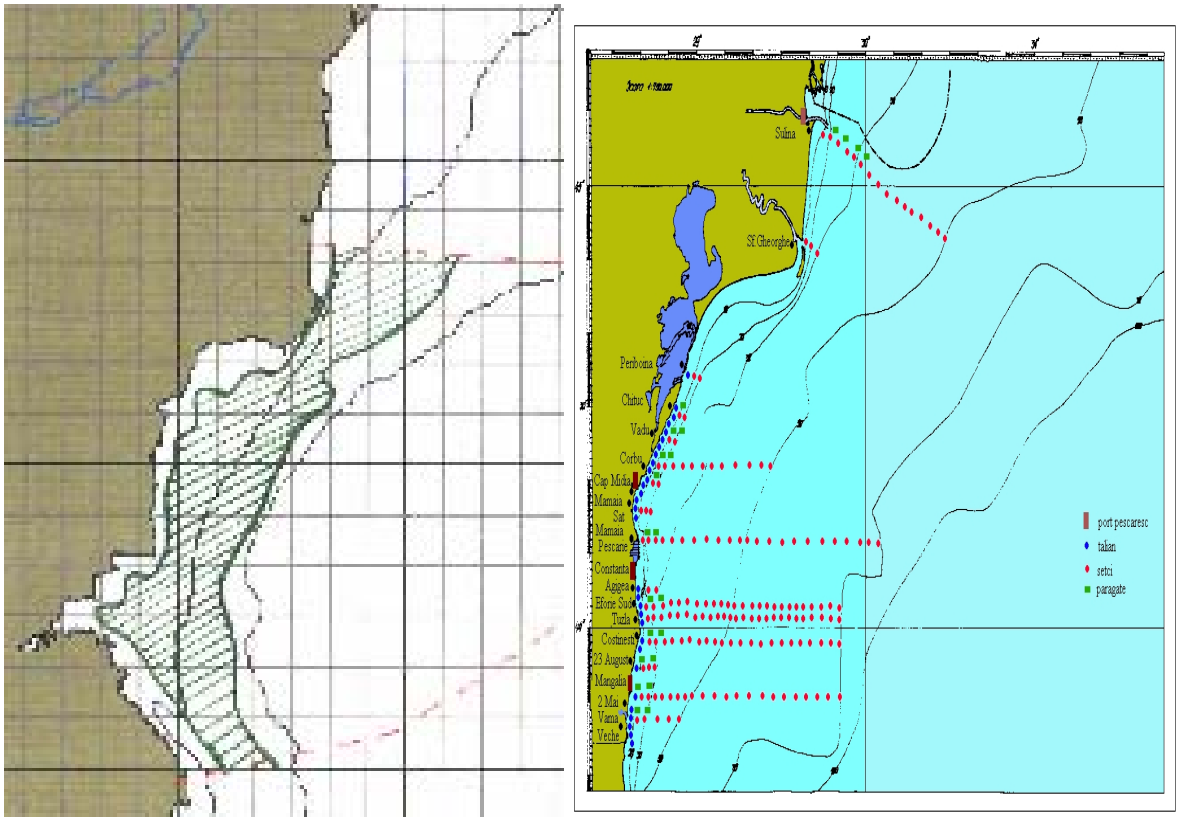
1. the northern sector (about158 km in length) lies between the secondary delta of the Chilia branch and Constantza, and the seabed is mainly made up of alluvial sediments;

2. the southern sector (about 85 km in length) lies between Constantza and Vama-Veche. It is 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 (200 m depth) varies from 100-200 km in the northern sector to 50 km in the south. The submarine slope of the shelf are very gentle in the north, with the 10 m depth contour immediately in front of Danube estuary, while in the southern sector the 10 m depth contour is almost 1.5 km offshore.

In the Black Sea it is accepted that sprat forms a single population (unit stock) and need to be assessed and managed on a regional level.

Fishery points and distribution area for active and stationary fishing gears



A B

Figure 2. Sprat fishery points in Bulgaria (A, shaded area is where commercial trawling take place) and Romania (B, red points are gill nets, blue points are pound nets, green points are long-lines, and brawn columns are fishing ports along the coast).

Fishing vessels(by length m) working in the Bulgarian Black Sea area in 2006

	Length category			
	<12 m	12 – 24 m	> 24 m	Total
Pelagic trawlers		24	12	36 (60)
Seiner	9			9
Gill nets	785	30		815
Longliners	332	18		350
Trap nets	50	1		51(active)
Total	1176	73	12	1261

Catch of sprat by differents types of fishing vessels in 2006

Species	Gillneters		Trawlers		Trap gear vessels		Total
	Tones	Percentage	Tones	Percentage	Tones	Percentage	
Sprat	62.39	2.35 %	2392.72	90.13 %	199.64	7.52 %	2654.75

Main characteristics of the trawlers operating in Romanian waters in 2006

Main characteristics	Vessel type		
	B-410	Baltica	TCMN
Total length (m)	25.66(25.8)	25.45	25.35(25.65)
Width (m)	7.2	6.8	7.2
Draught (m)	2.7	2.39	2.4
Engine power(HP)	570	300	300
GRT (t)	131.9	98.0	98.0

Number of vessels operating in Romanian waters in 2006

Year	Total no.	Vessel type						Catch (tons)
		B-410	Baltica	TCMN	Seiner-trawler	Drifter-trawler	Drifter	
2000	12	2	4	6				1890
2001	7	2	1	4				2008
2002	7	2	2	2	1			1500
2003	9	1	2	3	2	1		1175
2004	8	1	2	3	1	1		1350
2005	8	1	2	3	1	1		1430
2006	8	1	2	2	1	1	1	998
2007	9	-	2	3	2	1	1	

Presently, the Romanian trawlers operating in the Black Sea discharge the their catches into the ports of Mangalia, Constanta, Cape Midia and Sulina. Allon of these ports have limited facilities for trawlers (no fishery berth, are not refrigerated storerooms).

During the last 10 years, the number of pound nets has continually decreased along the Romanian littoral: from 80-100 during the 1990s to 27-40 in the 2000s. The number of active fishermen In Romania in recent years was between 150 and –200. This compares to between 400 and 500 in the 1980s.

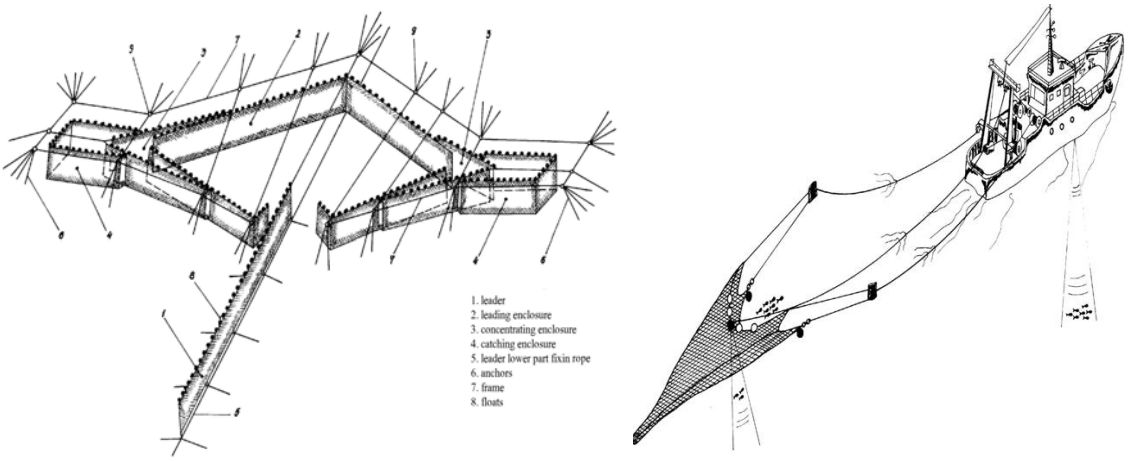


Figure 3. Pelagic trawl and pound net operating in Bulgarian and Romanian areas of the Black Sea

Catches and catch composition

During 1980-2002, the dramatic reduction, and in some instances the disappearance of the traditional predators from the Black Sea ecosystem (bluefish, Atlantic mackerel, bonito, dolphins) lead to an increase in the pelagic fish stocks (sprat, anchovy, horse mackerel) which comprised the food of these predators, and an increase in the abundance of other predators that have commercial value, such as whiting and spiny dogfish (Daskalov, 2002, Daskalov *et al.* 2007). The catches of the small-sized species which have been the main target for the fisheries in Romanian littoral during the last 20-25 years have oscillated violently and have almost collapsed.

In both the Bulgarian and Romanian littoral, the catches and fishing productivity has oscillated from year to year. Such oscillations have been a function of fishing effort (no. of vessels, no. of pound nets, effective fishing days), evolution of hydro-climatic conditions, stock status of the main fish species and anthropogenic influences. The catch composition has only partly reflected the composition of Black Sea ichtyofauna, because the selectivity of the gears used and the primary target species As a general rule, small-sized pelagic species with short life cycles continue to be dominant in the catches.

Table 2. Total catch of all species in the Bulgarian and Romanian Black Sea waters

	BULGARIA		ROMANIA		Total
	Tonnes	%	Tonnes	%	
1992	3651	50	3683	50	7334
1993	4226	52	3901	48	8127
1994	11722	79	3058	21	14780
1995	7510	70	3163	30	10673
1996	7733	74	2682	26	10415
1997	9422	71	3872	29	13294
1998	8514	66	4431	34	12945
1999	9054	78	2507	22	11561
2000	4226	63	2476	37	6702
2001	1506	38	2431	62	3937
2002	13548	86	2116	14	15664
2003	10209	86	1610	14	11819
2004	5816	76	1820	24	7636
2005	2840	59	1940	41	4780
Total	99978		39690	139667	
Average	7141	68	2835	9976	
%	72		28		

It is evident that the total catch has increased in percent in Bulgarian marine area, as the ratio in 1992 was 50/50. The total catch in Romanian waters decreased. Sprat account for approximately 60% of catches of all species for Bulgaria and Romainia combined.

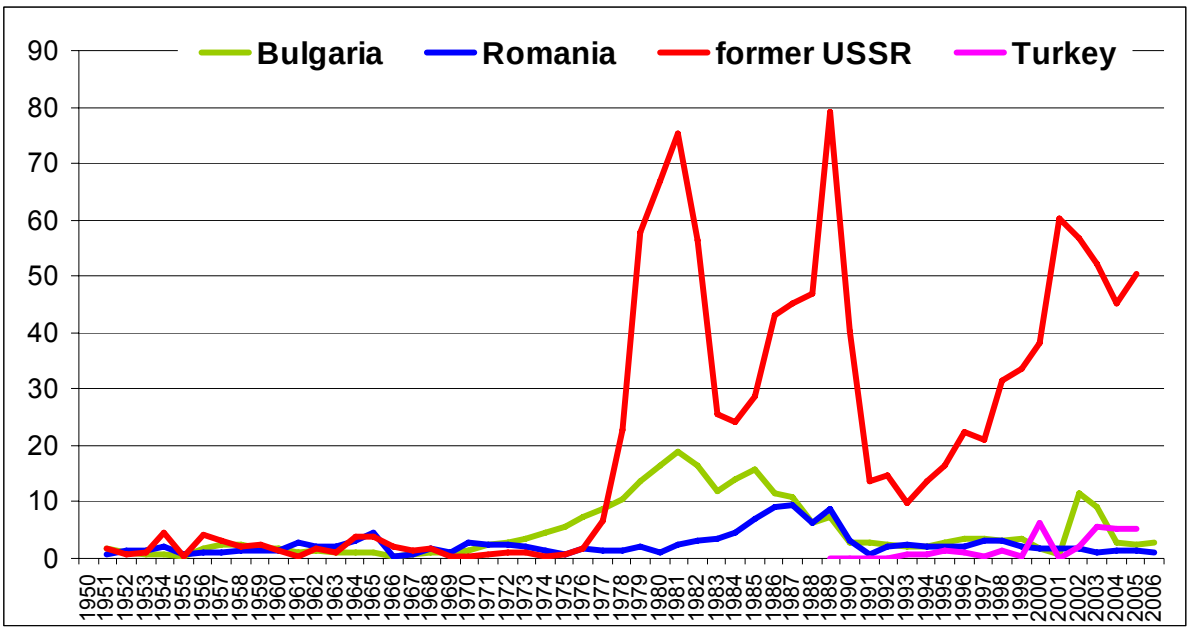


Figure 4. Sprat landings in the Black Sea area for 1950-2006 period

The greatest catch of sprat belongs to the former USSR countries (Russian Federation and Ukraine).The importance of the sprat catches in Turkey has increased and in 2003-2005 represented almost twice the catches for both Romania and Bulgaria.

Catch rates

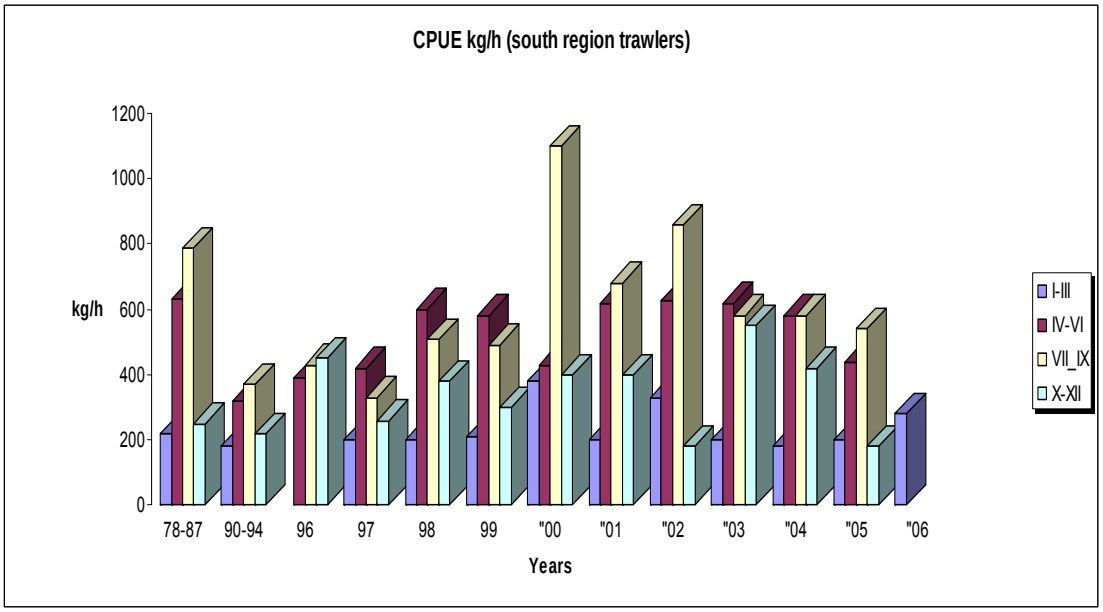


Figure 5. Quarterly CPUE of Bulgarian trawlers in southern Bulgarian waters (south of cape Emine) during the period 1978 – 2006. First quarter is in blue, second quarter – in red, third quarter in yellow and forth quarter in blue-green.

In the last few years CPUE (kg/h) from the Bulgarian commercial fishery show stable high values compared to the 1990's. The lowest catch rates are recorded in the January-March period. The highest CPUE has been detected for the summer months (July-September).

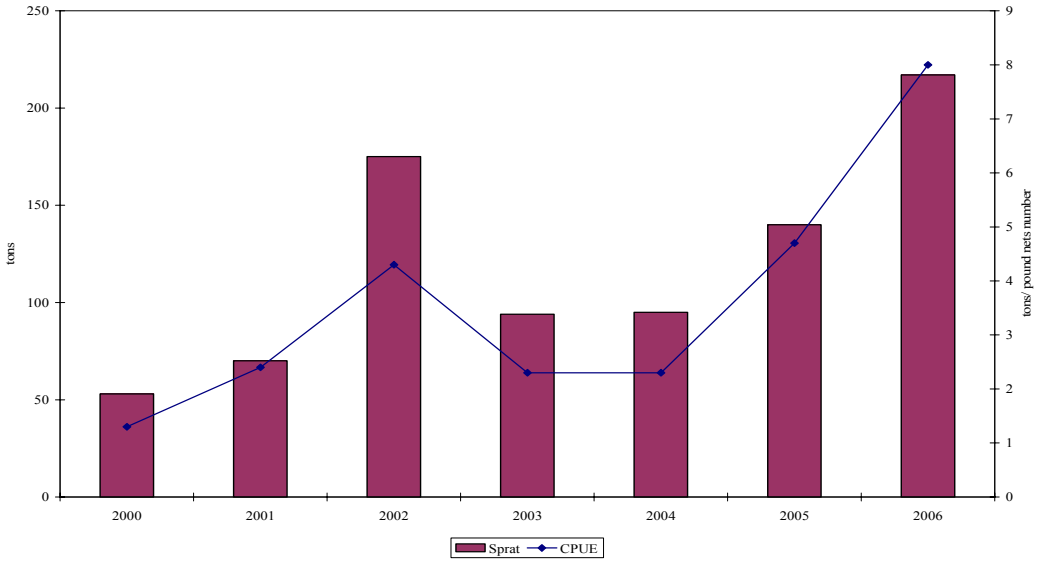


Figure 6. Catch of sprat and CPUE in the Romanian passive (pound net) fishery.

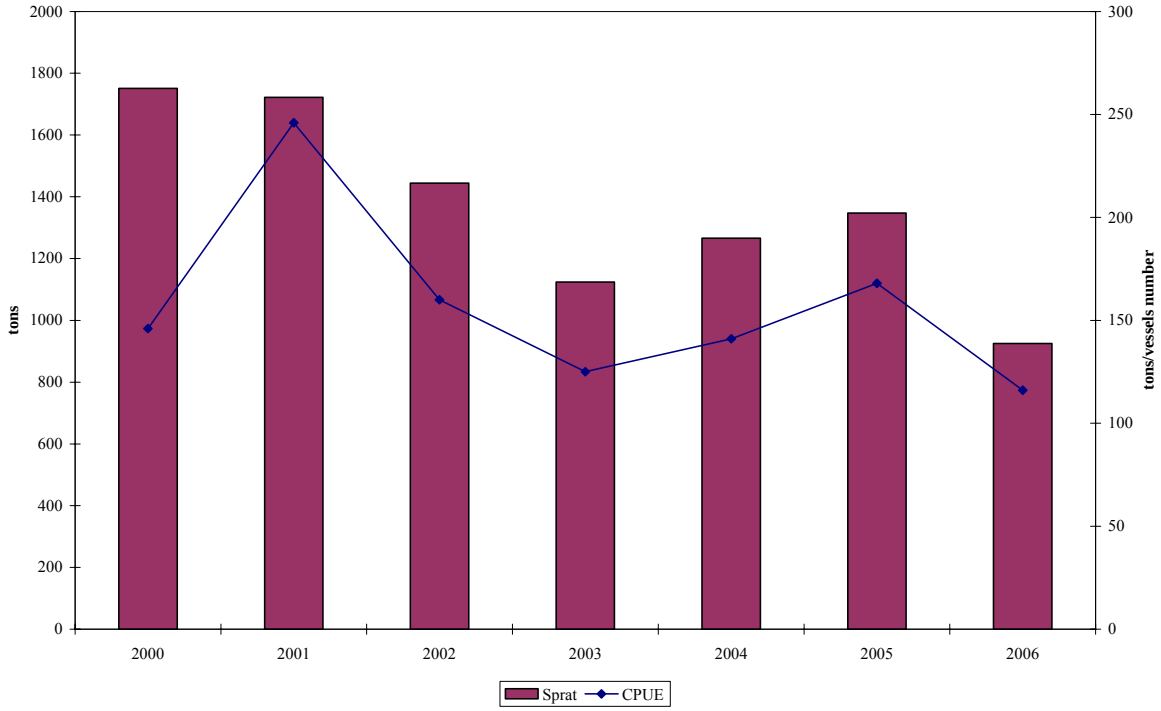


Figure 7. Catch of sprat and CPUE from commercial trawl fishery in Romanian waters

At the Romanian littoral, the level of sprat capture and fishing productivity oscillated from year to year as a function of fishing effort, evolution of hydro-climatic conditions, stocks status of the main commercial fish species and other anthropogenic factors.

Sprat population structure

The exploitable sprat population has lengths ranging from 40 mm to 130 mm (total length, TL) highest frequency pertaining to fish between 70 and 100 mm.

The whole age-range in the catches is from a half to four and a half years, with a maximum contribution of the two and three years old fishes. In 1982, age groups four and older accounted for 34% of the catch of this species. The proportion of these age classes continually decreased up to 1995, when they were no longer represented in the catch as a result of the increase in fishing pressure (Daskalov, 2001). While the proportion of age groups four and older decreased, at the same time, the prevalence of the youngest age groups increased.

During recent years, the two and three years old fishes have been prevailing, implying that the fishing pressure has remained comparatively stable and the commercial catches of sprat from both Rumania and Bulgaria have increased slightly.

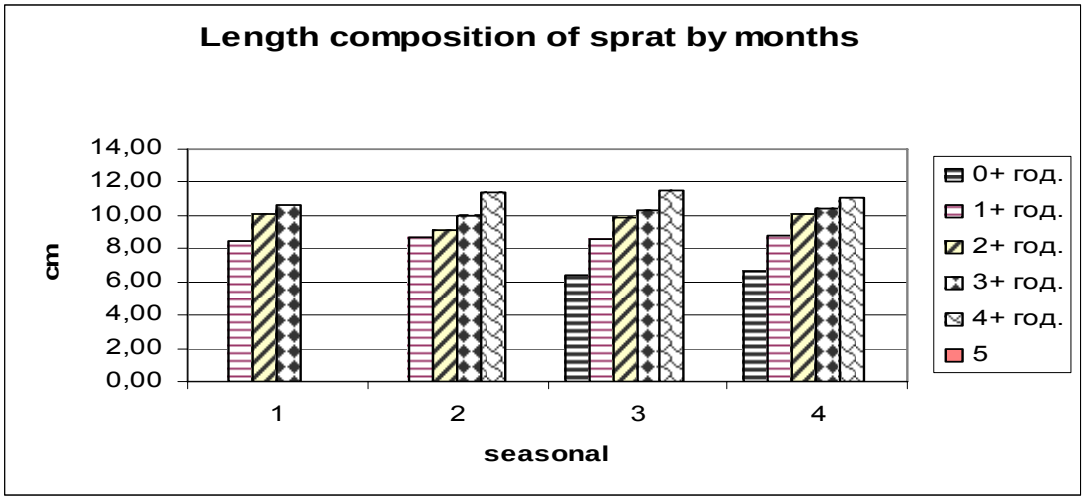


Figure 8. The mean length at age for catches of Black Sea sprat for the period 2005-2006 by quarters 1, 2, 3, and 4 respectively

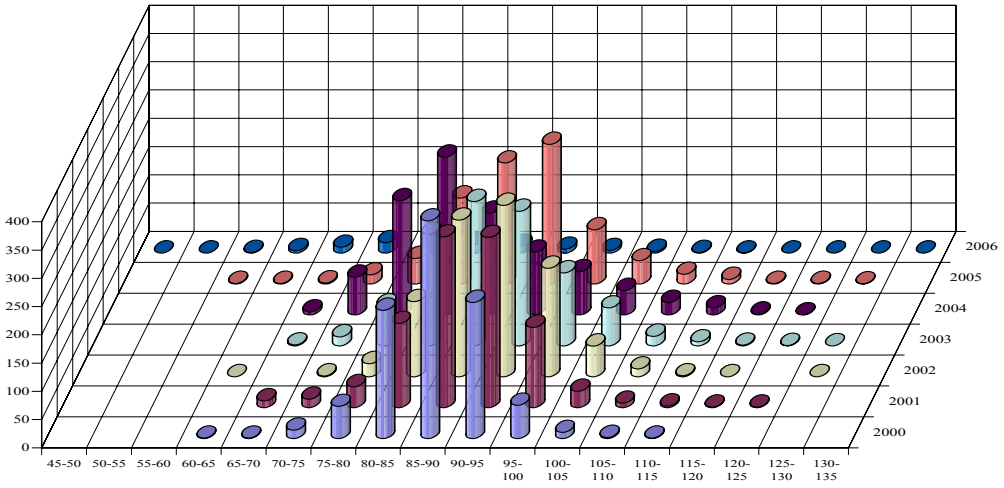


Figure 9. Size structure of sprat catches from the western part of the Black Sea 2000-2006

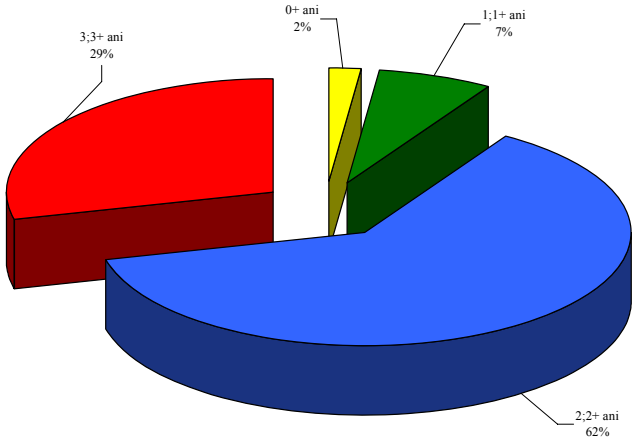


Figure 10. Age structure of sprat catchesfrom western part of the Black Sea (Romanian waters)

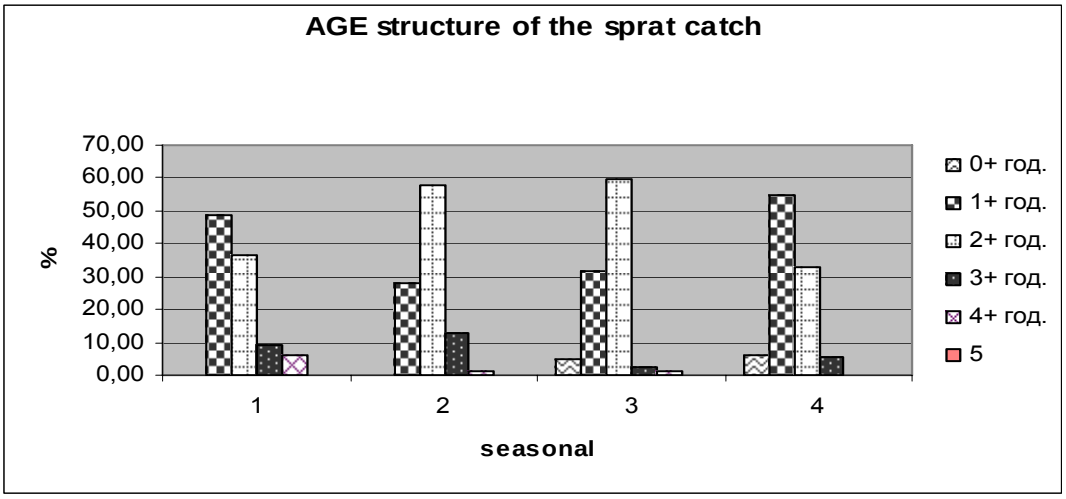
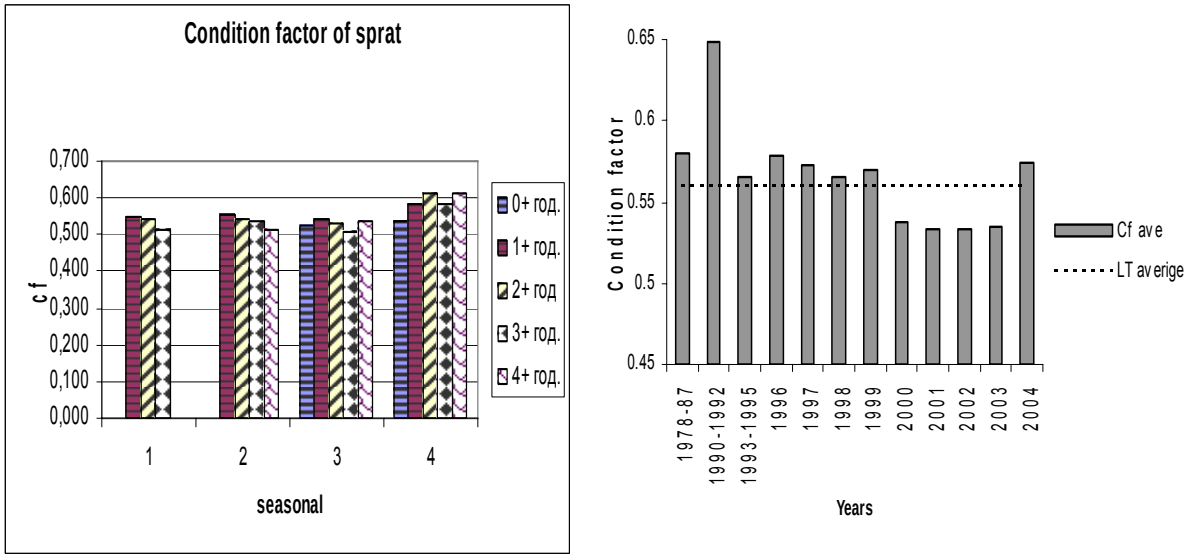


Figure 11. Proportional (%) age composition of sprat from western part of the Black Sea (Bulgarian part) by quarters 1, 2, 3, and 4 respectively

Condition factor for Black Sea sprat.



A. B.

Figure 12. Condition factor for sprat in the western part of the Black Sea for the A) 2005-2006 by quarters 1, 2, 3, and 4 respectively; B) average by age and year forthe period 1978-2004.

Examination of the long-term condition factor shows stable levels significantly below the long-term average for the period 2000-2003.reflecting a drop in the food supply of the sprat stock which can be due to decrease in zooplankton, or increase in sprat

biomass (and consumption), or both. After 2003, the condition factor returned to about the long-term average.

Status of the stocks with respect to their production potential, reproductive capacity and sustainable levels of exploitation

The spatial distribution of the sprat population is dynamic, and subject of seasonal and annual changes.The changes in distribution may cause changes in catchability, and could be wrongly interpreted as changes in resources abundance, leading to the incorrect management actions. Consequently catch per unit effort (CPUE) may not reflect stock abundance and should not used in isolation. Supplementary information about the geographic distribution of sprat over time and any trends in distribution must also be taken into account.

For comparable results between years and fishing surveys, standard, agreed sampling and assessment methods were used.

Data collection, checking, processing, analyzing, and assessment of fish aggregations used those proceduresusually employed for the Black Sea basin, and are in compliance with internationally agreed methodology.

For the Romanian continental shelf, trawl survey data and data obtained from the commercial trawl fishery were used to assess the biomass of sprat and of the main commercially important demersal species, including turbot, spiny dogfish and whiting.

Biomass estimates from trawl surveys were derived using the swept area method. The trawl gear used was a commercial pelagic trawl for adult sprat and a juvenile trawl for fingerlings. The following parameters were taken into consideration in the biomass estimatimations:

- hauling speed;
- horizontal trawl opening;
- tow duration;

To estimate sprat egg abundance and to estimate jellyfish biomass throughout the main part of the water column, Bongo nets were deployed. In estimating biomass of eggs and jellyfish the following parameters were taken into account:

- net diameter: 0.6m;
- number of rotations registered by flowmeter;

The estimates derived from trawl and bongo net surveys over time, indicate that between-year oscillations in abundance, are closely linked with variations in environmental factors, of which water temperature and quantity and quality of the food are major influences.

For stock assessment and for management of the sprat stocks in western part the following methods have been used:

- Length-Cohort analysis;

- Beverton&Holt Y/R
- Ricker's catch per recruit model
- Surplus production model (Fox and Schaefer)
- VPA, SVPA, XSA, ICA
-

The Group decided that the input information required for a comprehensive and acceptable assessment of the Black Sea sprat are as follows: catch and effort; structure on length and age classes of the catches; biologic data maturity at age/length,, length/weight relationship); general biological information (spawning season, migration, etc.); growth parameters; mortality ratios; selectivity of gears, standardization of fishing effort.

A large data-base regarding abundance of eggs, larvae and juveniles is available for the Romanian zone of the Black Sea.

Sprat spawning

During April-May (1995-2006), the assessment of the relative abundance of sprat eggs ranged between $0.289 \cdot 10^9$ individuals (May1998) and $178.7 \cdot 10^9$ individuals (January 1999). For the same period, the variation in mean egg density has an amplitude ranging between 0.5 eggs./m^2 and 87 ind./m^2.

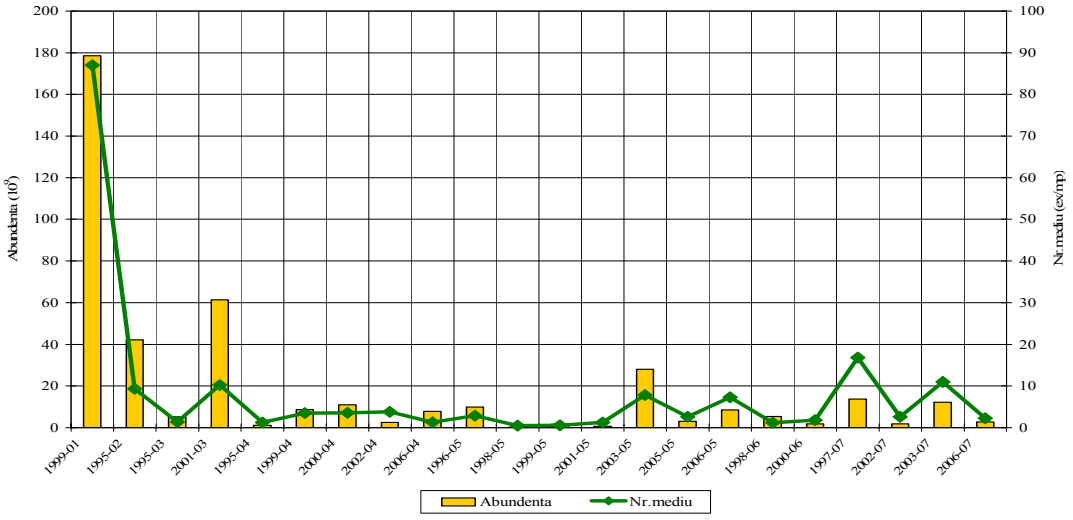


Figure 13. Relative abundance (10^9) and density (eggs/sq.m) in Romanian waters estimated for sprat eggs in the period 1995-2006. On the X-axis are year - month (e.g. January 1999, February 1995, march 1995, April 1999, etc.)

The variation in sprat larval abundance over 1995-2006 is also characterized by between year fluctuations and the spatial distribution of larvae also varies between years. Mean larval density ranges from 0.16 larvae/m^2 (May 1999) to 36.05 larvae/m^2 (April 1997), while the relative abundance ranged between 71,365•106 individuals (May 1999) and 24367•106 individuals (May 2003) (Figure 14).

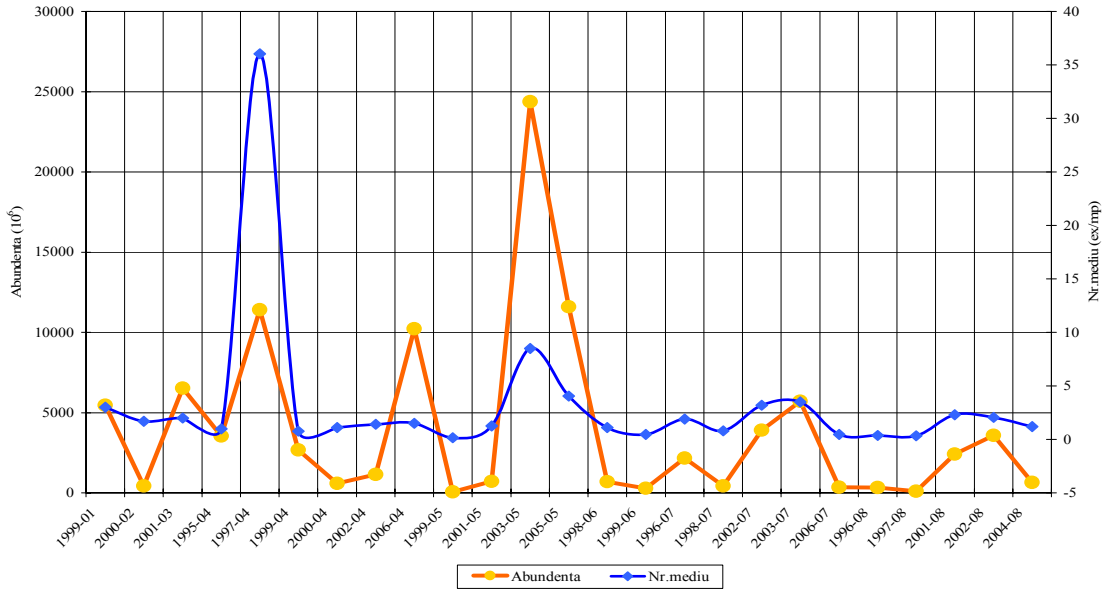


Figure 14. Relative abundance (10^6) and mean number (ex/mp) assessed for sprat larvae in the 1995-2006 period On the X-axis are year - month (e.g. January 1999, February 1995, march 1995, April 1999, etc.)

Since 1995, juvenile (0-gp, few month of age and 3-4cm size) sprat relative abundance has generally increased from a minimum in 1997 with a pronounced peak in abundance in 2003. Over the period 1995-2005 relative abundance has fluctuated between $0.95 \bullet 10^6$ (1997) and $10440.65 \bullet 10^6$ (2003) individuals (Figure 15). The 2003 year-class appears to have been particularly strong, some three orders of magnitude greater than average. Similarly the 1997 year-class appears to have been the weakest, being about one order of magnitude lower than average.

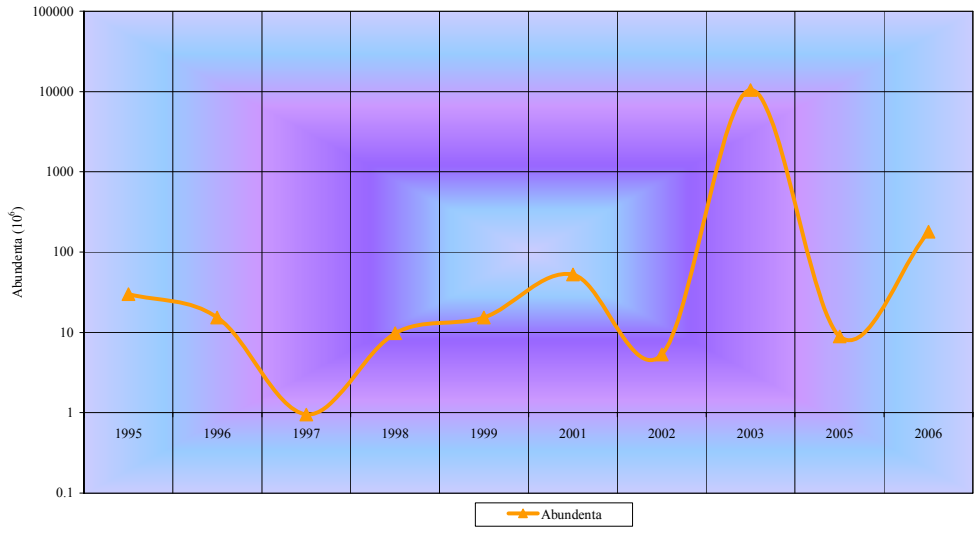
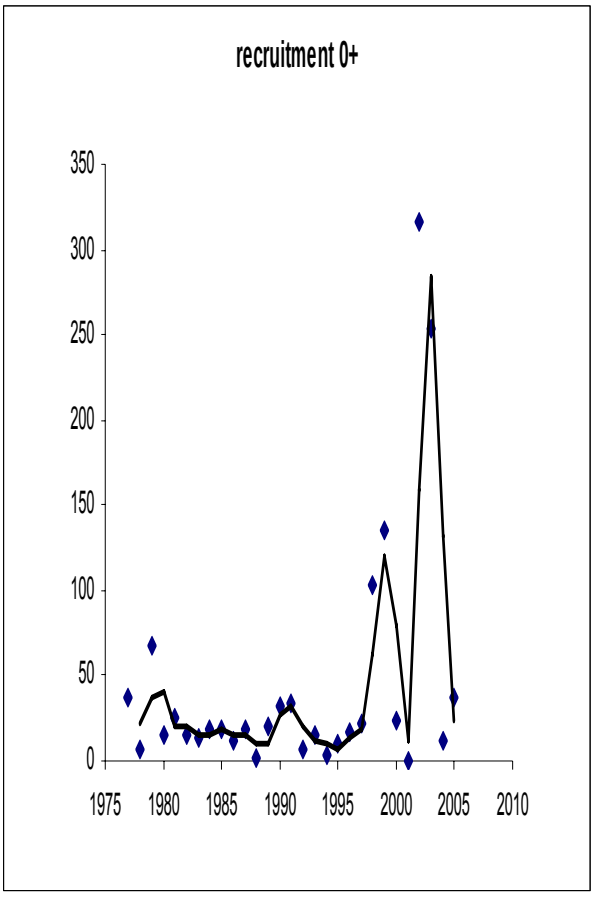
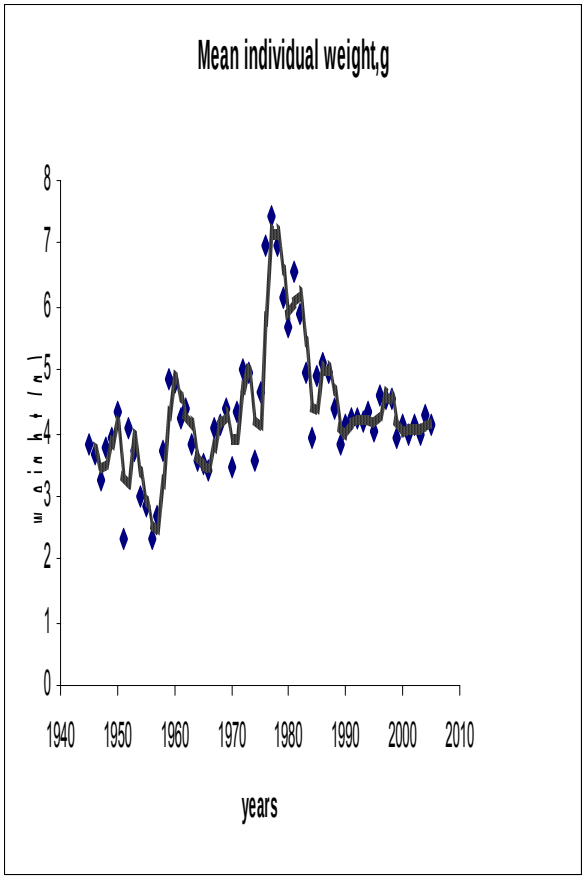


Figure 15. Trends in relative abundance of juvenile sprat in the Black Sea (Romanian zone)



A.



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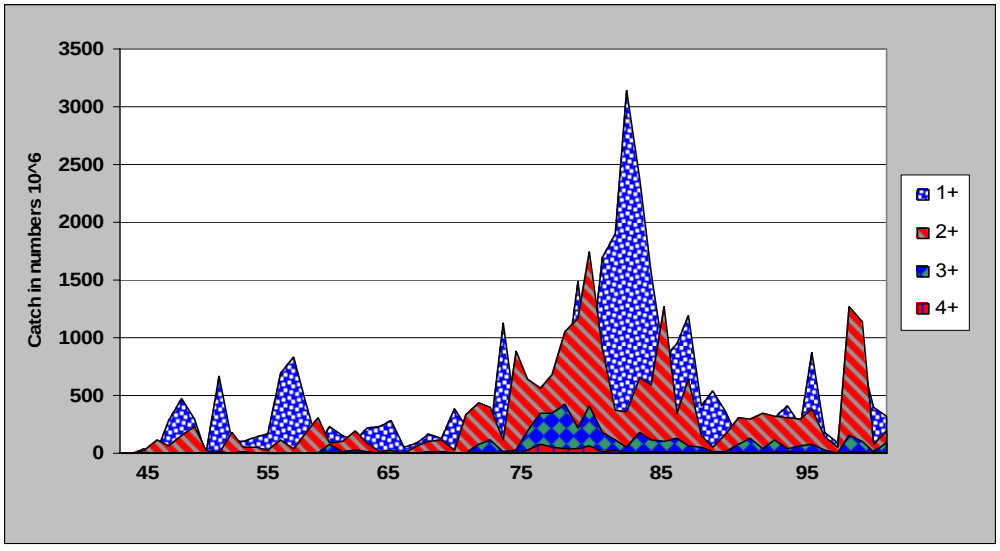


C.

Figure 16. Recruitment estimates (A), mean weight (g) in the catch (B) and catch-at-age (in numbers, C) for black Sea sprat 1995-2006

The period of high juveniles abundance in the Romanian zone coincides with high recruitment in the Bulgarian zone. Mean individual weight of adult sprat over the period from the 1990's to 2006 is also similar in both zones.

Assessment results from VPA:

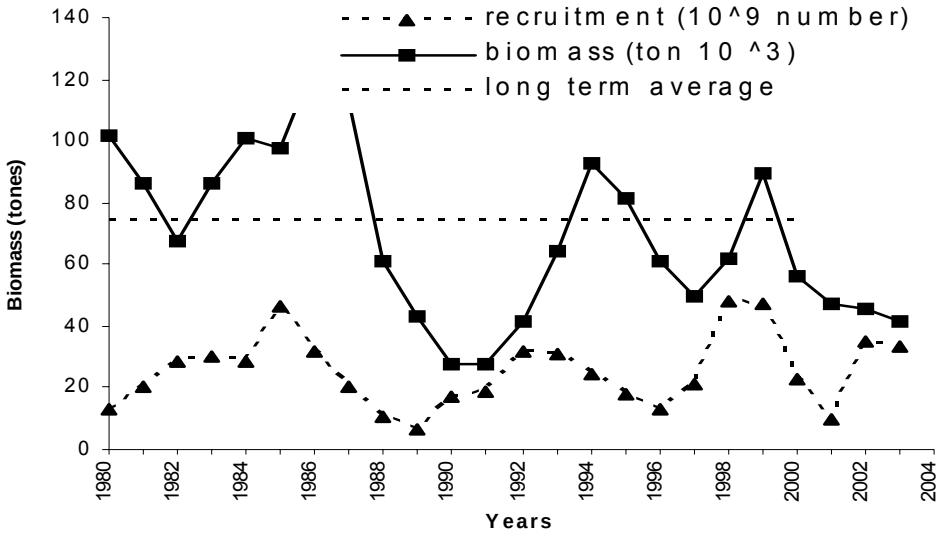


Figure 17. VPA results for the Bulgarian component of Black Sea sprat

Figure 17 shows the results from a VPA reconstruction of the sprat stock, using data collected from Bulgarian zone for the period 1990-2004. The results indicate that since 2001, while sprat biomass has decreased, recruitment has increased from the second lowest value in the time series). For the period of 1996 to 2004 the biomass ranged between $41.9*10^3$ - $89.7*10^3$ t. Between 2000 and 2004, the stock biomass ranged between $41.9*10^3$ - $55.9*10^3$. Biomass in 2004 is estimated at $37.4*10^3$ t. In 2002 and 2003 recruitment is estimated to have been above the long-term average.

The results of Daskalov *et al*., (2007) for an assessment (using ICA) of the population of sprat for the entire black Sea for the period 1950 to 2000 are summarized in Figure 18.

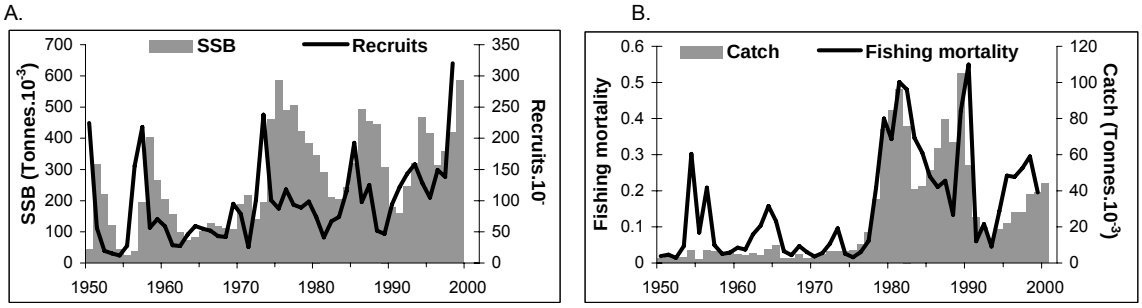


Figure 18. Time-series of recruitment (line), and spawning stock biomass (SSB, area, A), catch (area) and fishing mortality (line, B) of sprat in the whole Black Sea (from Daskalov et al. 2007)

Black sea sprat assessment from surplus production modeling:

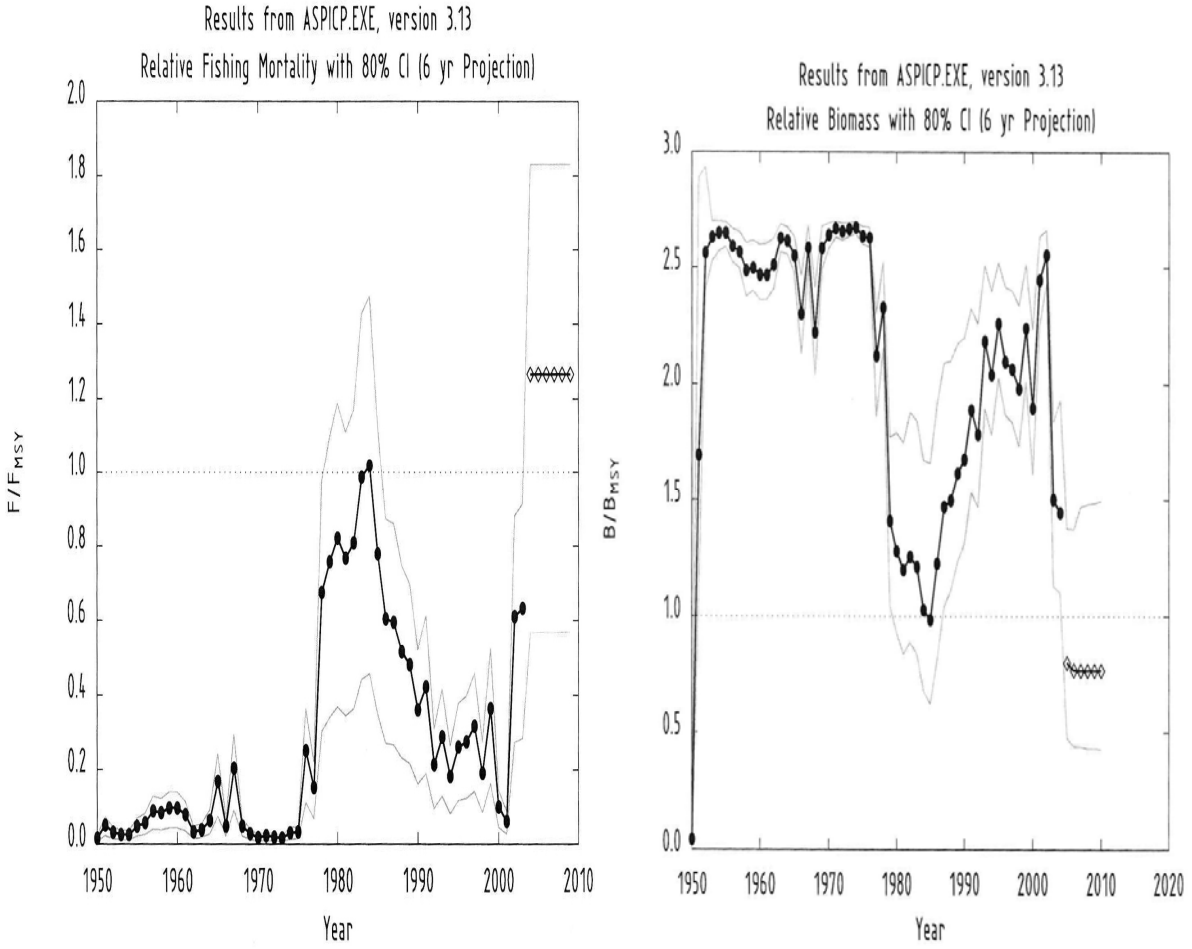


Figure 19. Sprat relative biomass and fishing mortality according to surplus model

An analysis on the evolution of relative biomass and fishing mortality for Black Sea sprat over the period 1950-2003 was undertaken using the ASPIC surplus production model. The equilibrium (Schaefer, 1954) model was fit with MSY=11.38 kt and Fmsy 1.922. The results indicate that F in 2003 (F_{now}) is 1.166 which is 60% of Fmsy. Forward projections for a six year period (2004-2009) assuming a yield at MSY (11,380 t) indicate a relative F 27% above F_{msy} (F/F_{msy} = 1.266).

Swept area estimates of sprat biomass in the Bulgarian zone of the Black sea

Bulgarian zone

Description of the sampling strategy

A stratified sampling strategy (Sparre et al, 1989; Gulland, 1966, Sparre&Venema, 1998, Foote, 1996) was adopted. The whole survey area was divided into three sub areas (strata)according to depth: first stratum – 35- 50 m., second 50-75m, and third 75-100m. The survey areawas further divided into 55 fields (sectors) defined by 5' lat. X 5' long equating approximately to 63 км^2 in area. Trawling was carried out in meridian direction. The duration of each tow was between 30 and 60 min, with an

average velocity ranging from 2.3 to2.9 knots (3.889 to 5.37 km/h). Trawling was undertaken using a pelagic otter trawl (bathy-pelagic) in 32 of the predefined areas on an opportunistic basis during the period FEBRUARY 2006 TO 15 JUNE 2007. The survey track is indicated in Figure 19.

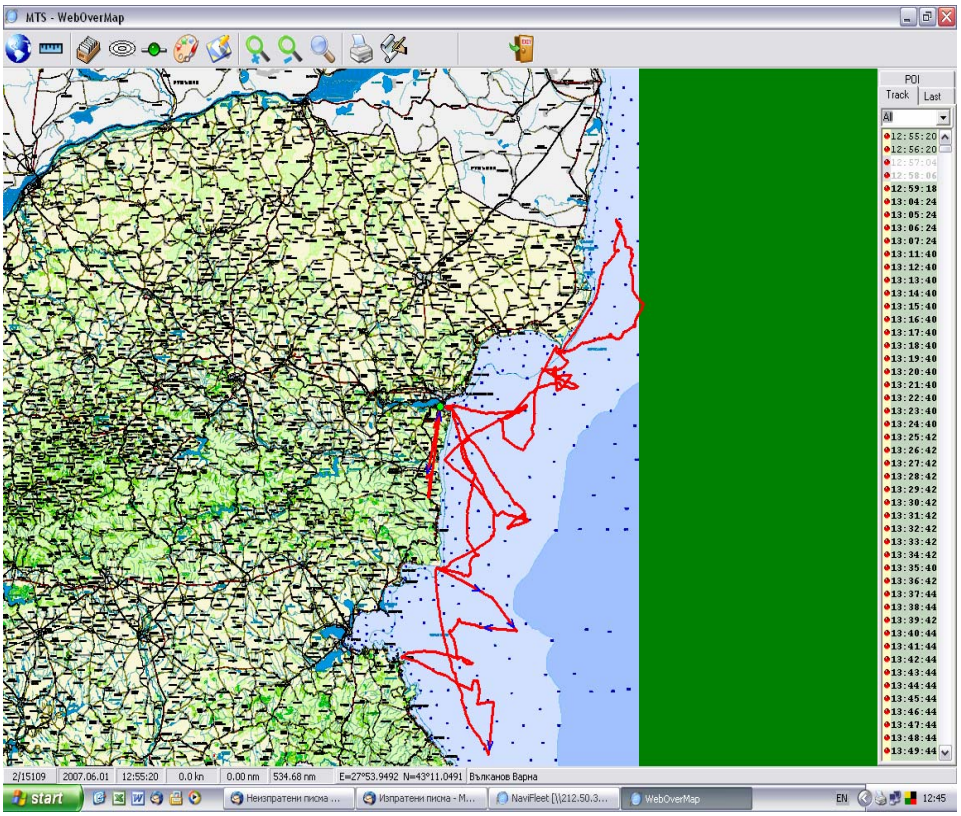


Figure 19. Transects of “swept area method” in front the Bulgarian Black Sea coast

Results:

The total catch of sprat during the survey was 7047 kg sprats, and for analysis of the population parameters, 7825 individuals were processed. Relative density of catch from survey tows are show in Figure 20. Corresponding estimates of biomass are shown in Figure 22.

Minimum catch was taken in area G14 from the 75-100m depth stratum. This represented a catch rate (cpue) of 1.0 kg/h and a catch per unit abundance (CPUA) of 13.499 кg km2. The lowest estimate of exploitable sprat biomass was also estimated for this area (844.76 kg). Maximum catch (in weight) was in area N2 (strata: 50-75м - 1000 kg), as CPUE бе 1333.33 кg/h and CPUA: 16 056.5 kg km2. Similar rates of w(kg) was established in area E19, 30-50m strata (880 kg CPUE: 1313.4 кg/h и CPUA: 16 417.9 kg km^2) and D17 strata 50-75m (660 kg CPUE: 985.07 и kg /h CPUA: 12 313.4 kg km^2).

The average catch from all areas was 220.22kg (Table 3).The average levels of CPUE from all areas was 336.54kg/h (abundance) and average CPUA = 4262.05 kg

km^2. The average levels of the biomass was 2669.19 tons. The average rates of CPUA in strata 30-50m is 3547.903 kg .km^2, in 50-75: 6243.6 kg km^2 and 2253.8 kg km^2 for strata 75-100m.

The relationships between catch weight (kg), CPUE and CPUA for the survey are given in Figure 21.

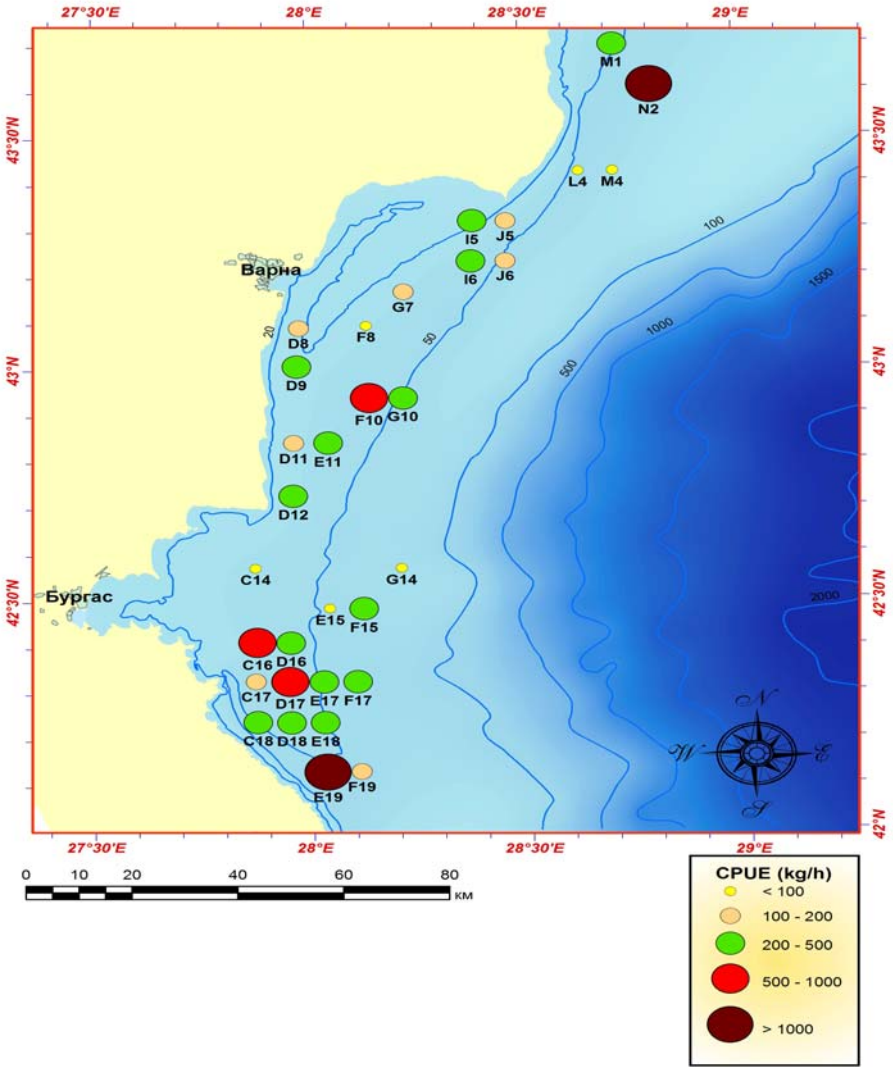


Figure 20. CPUE of sprat in front of Bulgarian Black Sea coast

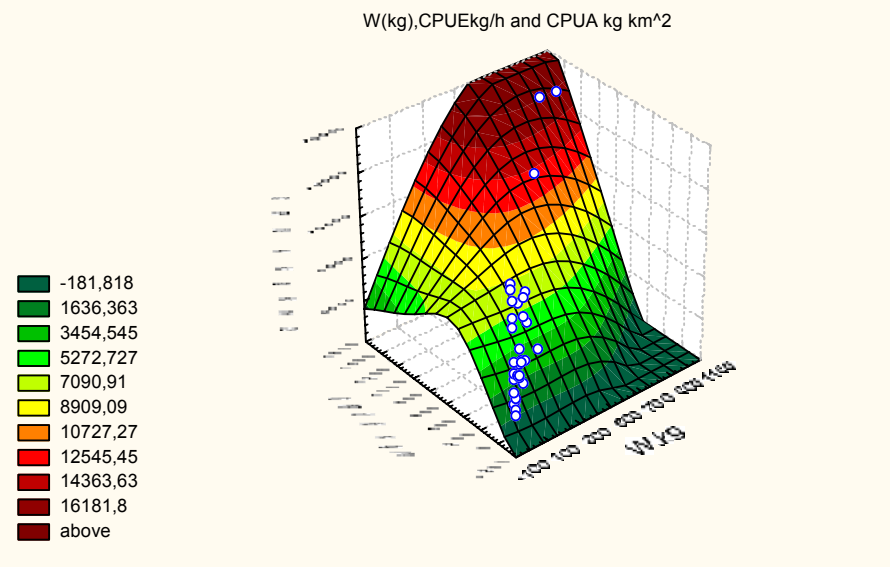


Figure 21. Relationship between catch weight (kg), CPUE and CPUA.

The bulk of the catch per unit area is under 400 kg/`h. The exception was registered just in 3 areas with close higher values of CPUE and CPUA.

Estimates of biomass of sprat in the Bulgarian zone by survey stratum are given in the text table below.

CPUA average	Strata	Biomass	Area	No.Area
3547.903	30-50	6438805	1814.82	29
6213.6	50-75	17109272	2753.52	44
2253.83	75-100	5641787	2503.20	40
Total		29189864	7071.54	

The estimated biomass of sprat in Bulgarian Black Sea marine area is 29.2 * 10^3 t.

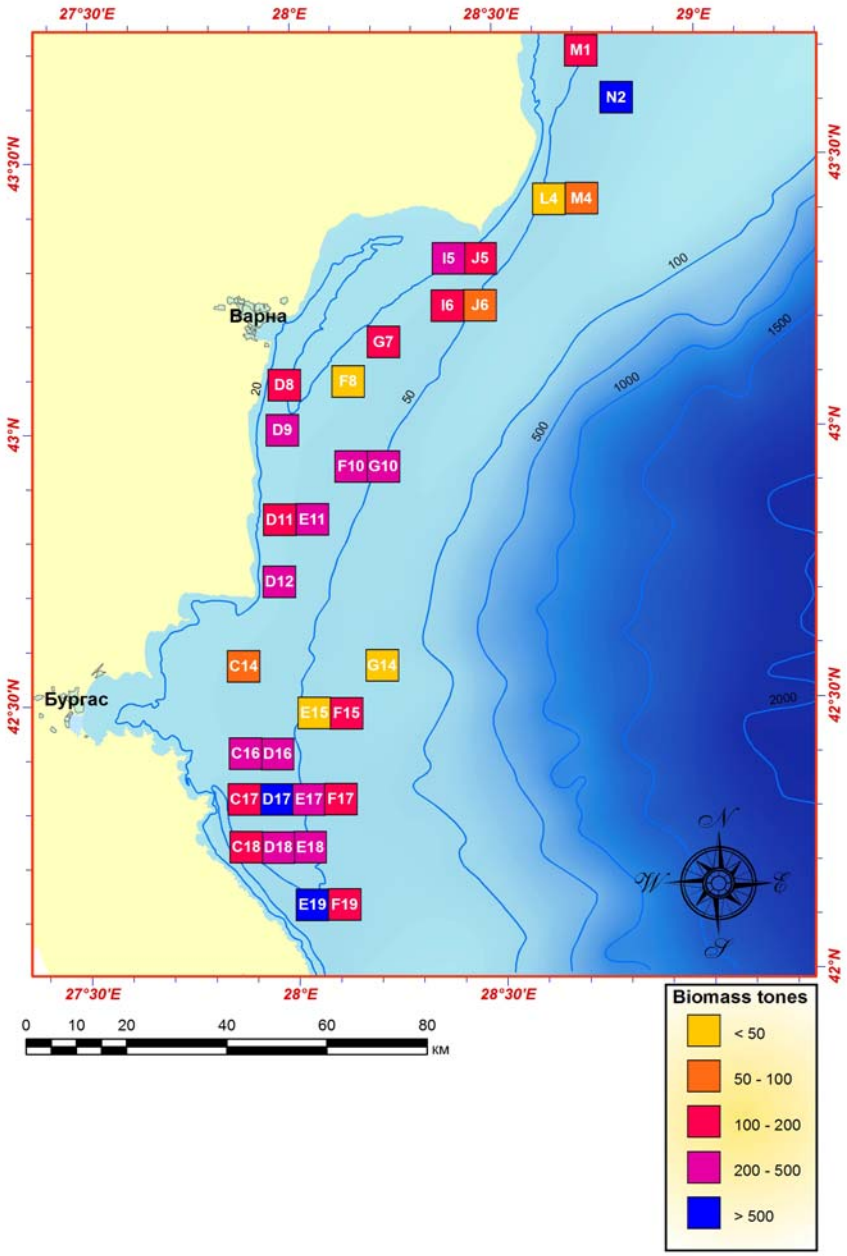


Figure 22. Stock biomass of sprat in the investigated area.

Reference points assuming different strategies for estimation the optimal level of F.

F0.1	F0.2	F0.5
1.139371	0.685821	0.256139

The resulted value of F0.1 strategy applied to the sprat stock is very high and gives high reference point. F0.2 is more restrictive strategy and gives lower values in

comparison F0.1 .The lowest levels are those calculated by F0.5 = 0.2561. F0.1 and F0.2 don't give appropriate, optimal levels of exploitation, according to the established stock using "swept area method".

Calculation of TAC

TAC(t) = F0.1* B(t) (Prodanov and Kolarov, 1983)

In the case with the Black Sea sprat in Bulgarian waters we propose to be used more restrictive management strategies for reference levels Fopt, namely: F0.5 = 8774.93 t Total Allowable Catch. The yearly catch must not exceed 8 500 to 9 000 tones.

Romanian zone

Referring to the sprat fishing agglomerations in the Romanian marine area, to have a comparative element, the results obtained in 2007 have been compared with results from 2006. For sprat sampling was used the pelagic trawl in demersal variant. Relative biomass of sprat is represented in the following Figures.

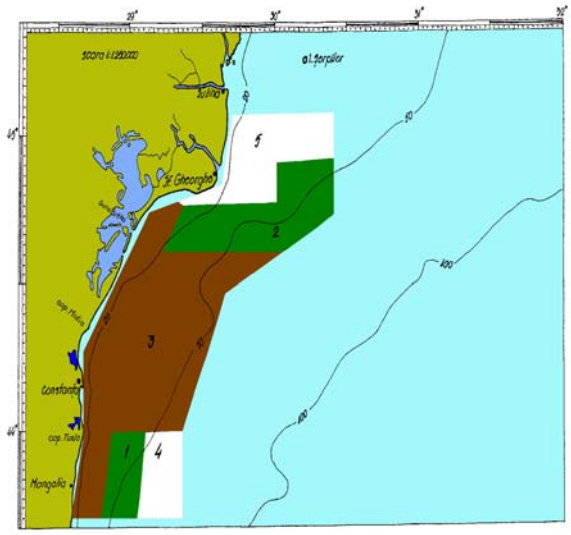
Each maps contain the surveyed surfaces, on polygons, the colors having different significance function of biomass per surface unit (t/Nm^2), such as:

0	0.01-0.4	0.5-1.0	1.0-5.0	5.0-10.0	10.0-20.0	20.0-100.0

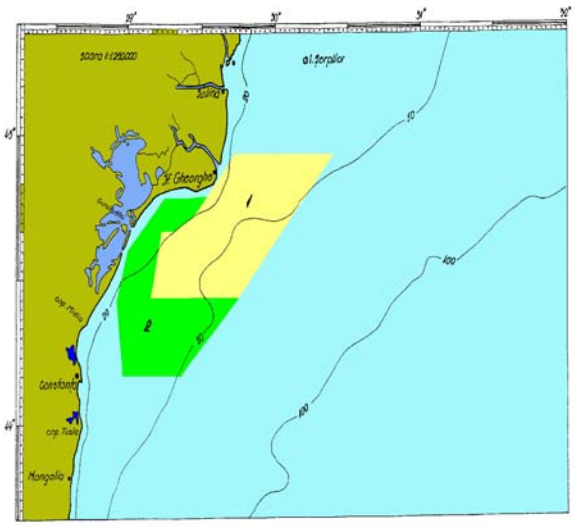
100.0-500.0	> 500

The biomass of jellyfish was also evaluated in an attempt to assess the influence of jellyfish biomass on sprat biomass and distribution.

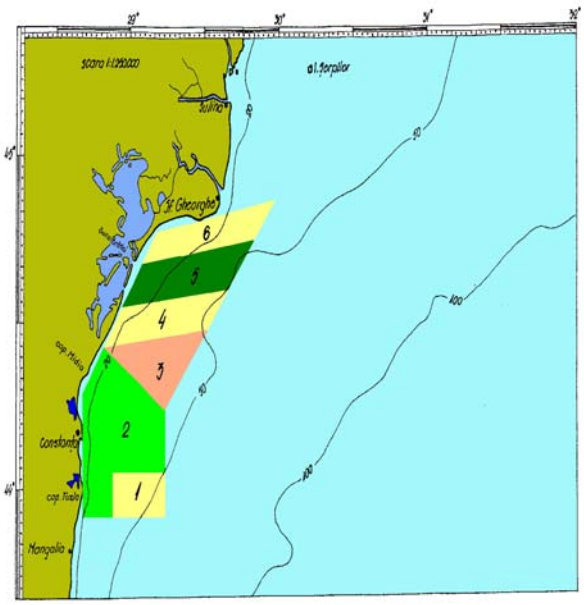
Surveys were undertaken inApril, May and June 2006, and in May and June, 2007.



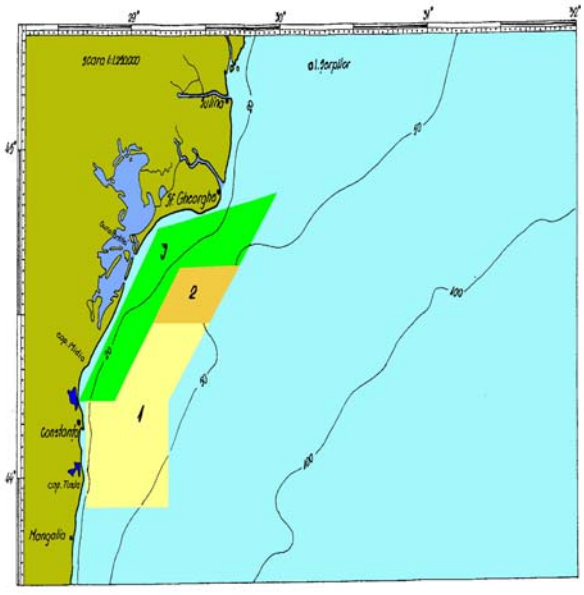
Sprat distribution and abundance in April 2006 in the Romanian area



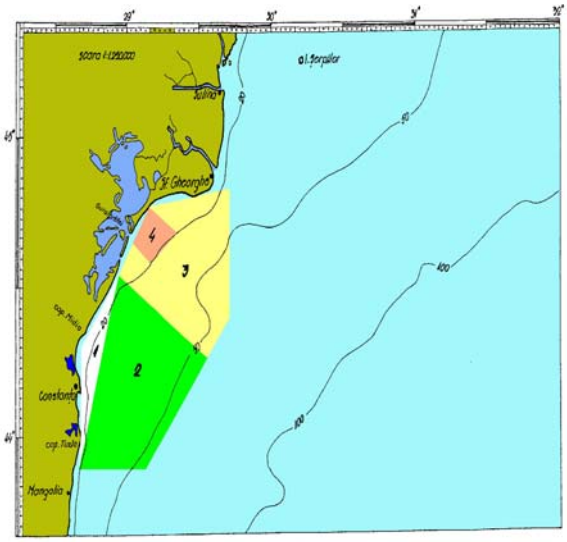
Jellyfish distribution and abundance in April 2006 in the Romanian area



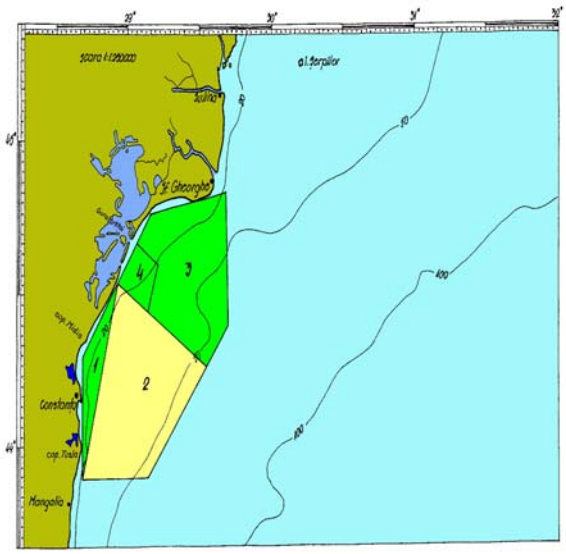
Distribution and abundance of the sprat agglomerations in May 2006 in the Romanian area



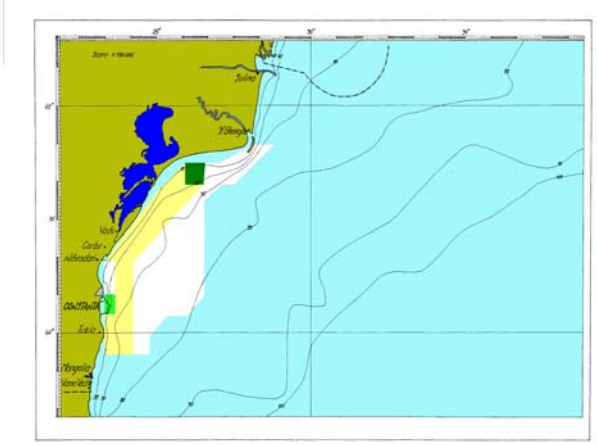
Distribution and abundance of the jellyfish agglomerations in May 2006 in the Romanian area



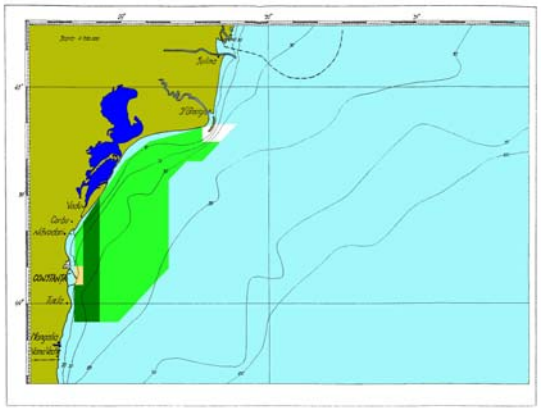
Distribution and abundance of the sprat agglomerations in July 2006 in the Romanian area



Distribution and abundance of the jellyfish agglomerations in July 2006 in the Romanian area



Distribution and abundance of the sprat agglomerations in June -July 2007 in the Romanian area



Distribution and abundance of the jellyfish agglomerations in June-July 2007 in the Romanian area

In 2006, sprat biomass was assessed between 10,380 tons and 19, 240 tons for shelf area up to 50 Nm from seashore. The obtained biomass has values of tree-four times less than former years. The situation can partially explained through extreme jellyfish agglomerations that displaced sprat from the area. To see what happens on whole water column, the samples for jellyfish have been taken with Bongo net. The obtained results shows that the values are huge, attaining in some places more than 3,000 tons/Nm2. In these conditions, an efficient commercial fishing is almost

impossible, in the areas where the jellyfish quantity was large, sprat was in small quantities.

Given the period 2006, in 2007 the distribution of sprat appears to have been lees influenced by jellyfish.

In 2007, if we take into account that, in the samples realized with pelagic trawl in demersal variant, the average sprat catch was about of 700 kg/trawling hour, on depth bigger than 20m, we can estimate the sprat biomass at Romanian littoral at 60,000 tons.

Table 3 presents the evolution of sprat biomass in the Romanian zone of the Black Sea as estimated from trawl surveys

Table 3. Evolution of the sprat biomass

Species	Biomass									
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Sprat	40,000	45,000	35,000	35,000	30,000	45,000	45,000	65,000	19,000	60,000

Conclusions

In consideration with the current state of sprat stock in the Bulgarian and Romanian Black Sea area, the Group concluded the following:

- The sprat catch represents around 80% from the total catch of Bulgaria and Romania in the Black Sea. This species is with high importance for Bulgarian and Romanian fishery. The level of exploitation varies in the years, as the fishing effort and fishing mortality have been changed during different periods with regards the changes in ecosystem and economic reasons.

- Sprat is a key species for the Black Sea ecosystem with clearly expressed indicative role as regards the changes of the trophic base (zooplankton) and condition of the predators: spiny dogfish, whiting, turbot, thornback ray etc., as well as the changes concerning climate (trough variation of climatic factor from one hand and hydro-chemical –physical parameters of the environment, from another;

- Biological population distributions and life cycles of sprat exceed national boundaries and relevant evaluation of the state of the stocks needs to be arranged at a regional level. Sprat is a species with shared stocks and transboundary distribution.

- Sprat abundance and distribution seems to be affected by outburst of gelatinous plankton (jelly-fish and ctenophores). The jellyfish swarms were especially dense and abundant in the spring - summer of 2006 that created several problems for the fisheries including damaging of the trawls and nets;

- In Romania the reduction of the fishing effort continue (in terms of fleet and time fishing) as a consequence of the economical changes. The limitation of

market demands for some periods of the year, is amplified by the fact that more than 90% of the production is delivered as salted fish. The fishery using pound nets has suffered the strongest impact (decrease in catch and number of nets) due to the change of the ecological conditions and fish migration in the coast zone.

- The estimated sprat biomass by "swept area" method is 29 190 t in Bulgaria and between 19 000 to 60 000 t in Romania. Taking into consideration varying environmental conditions, and anthropogenic and fisheries pressure also from other countries sharing the same stock TAC is proposed to be between 8 000 and 15 000 t.

- Until more reliable international stock assessment is performed it is recommended that the fishing mortality F do not exceed the half of the natural mortality M = 0.95 i.e. F_{lim}=0.475

- A regional coordination and standardization of the methods of sampling, processing, analyzing and interpreting of data as well as the assessment of the fish stocks and the environmental factors influencing them, in compliance with the international regulations is needed.

- Multi-species considerations need to be included in stock assessments

- Adequate funding and support of scientific research and fisheries related monitoring programs is crucial for performing reliable stock assessment and provision of scientific advice to fisheries managers and governments.

- Development of indicators specific for the Black Sea in order to monitor and asses the satate of key fisheries resources, related habitats. Development of an informational system including fisheries statistics, fish stock assessment, multi-disciplinary research, and ecosystem monitoring.

3.2 Turbot (*Psetta maxima*)

Among demersal species that inhabit the Black Sea, turbot (*Psetta maxima*) is the most valuable species in terms of price per kg. This species is considered as a transboundary stock and as being accessible for fishing almost throughout the year (Prodanov *et al*. 1997). Turbot is a target of intensive exploitation and the changes in stock dynamics are highly dependent on the fishing pressure, as well as on the environmental conditions in the Black Sea.

The Black Sea turbot is a bottom-living fish which makes only limited migrations into the pelagic zone which are associated with reproduction, feeding and wintering. It occurs on sandy, mixed bottoms (sand with mud) in Bulgaria and Romania and on mussel beds, which occur adjacent to the Bulgarian coast. The species is distributed all over the continental shelf to a depth of about 100 m -110 m in the North-western Black Sea area and occurs in grouped local shoals.

The spread and migration of turbot over the continental shelf shows a clear seasonality. The major part of the turbot shoals winter at depths from 60-100 m, with more dense assemblages between the 70-90 m isobaths. The spring relocation of turbot from the wintering grounds to the coastal area is temperature related but usually begins in March. At that time, the stock occurs at depths between 15 - 50 m where localised spawning takes place. In the summer months, turbot inhabit depths greater than 50 m and are spread over a larger area. Movement towards the coastal feeding areas occurs in the autumn. In addition to the seasonal migrations offshore and towards the coast, adult turbot show a tendency to move northwards. Juvenile turbot are largely confined to the coastal areas during all seasons, but as they grow older they move offshore to deeper waters. Tagging experiments in Bulgaria and Romania have been undertaken using conventional tags, but to better understand the detailed migration behaviour, it would be desirable to undertake studies using data storage tags.

Spawning of turbot takes place in spring from April to the middle of June, and peaks during the first half of May at water temperature between 8-16°C. Salinity is a limiting factor for larval survival in the region of the Danube estuary. Turbot are batch spawners and the eggs are pelagic. Fecundity is high, up to 12.8 million eggs per female per year and initially the larvae have a pelagic mode of life. Turbot grow rapidly and in approximately 2 months, they reach length of 30 mm on average and enter their demersal phase. (Stoyanov, 1963). Turbot mature at the age of 3-5 years. Turbot are predators, and their diet includes fishes, crustaceans, polychaetes and molluscs in different proportions.

Black Sea turbot are long-lived and growth rate is slow. The maximum age is up to 23 years (Carausu,1952) in Romanian waters and 12-13 in Bulgarian waters (Karapetkova, 1961), reaching around 85 cm total length. (Stoyanov, 1963).

Turbot landings have been realized only by gillnets in Romania and the use of bottom trawls to catch turbot in Bulgarian waters was prohibited by national legislation in 1984. The minimum mesh sizes for gillnets are 180 mm and 200 mm in Bulgaria and Romania respectively (Figure 23). The gillnets are deployed on the shelf area during the whole year in Romania and during spring and autumn seasons in Bulgaria. The legal mesh size of gillnets have to be synchronised and probably increased for both countries in order to protect the shared stock and improve reproductive capacity. The twine thickness of the gillnets is an important factor, and has an effect on the marine mammals populations. In order to protect dolphins, the thickness should be reduced to 6,350 m/kg according to experiments made in Romania. Acoustic devices allowing escapement of dolphins should be introduced.

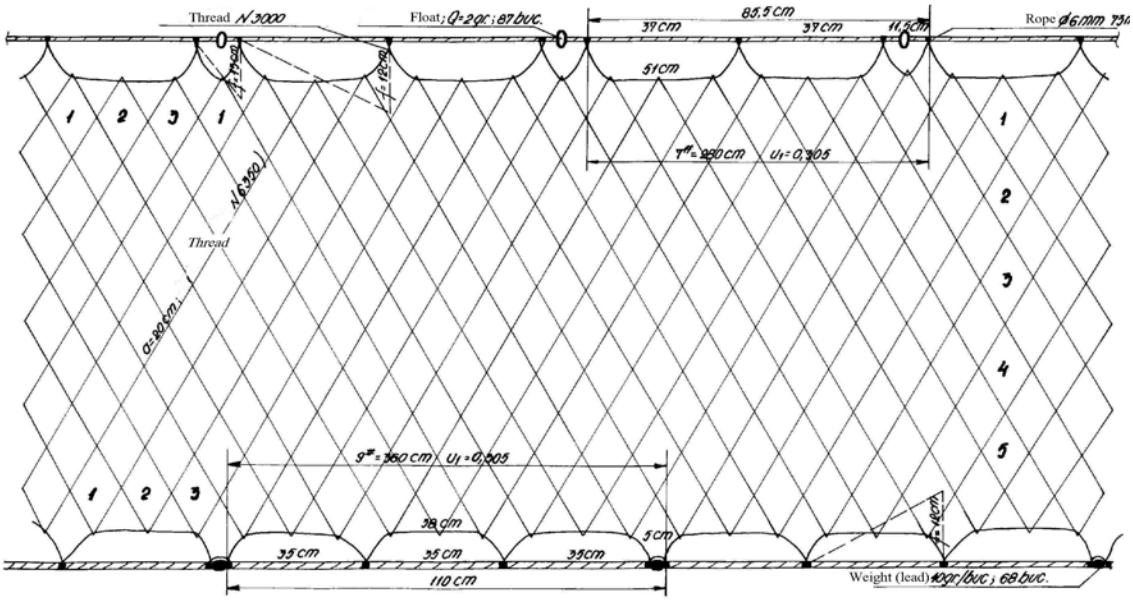


Figure 23. Turbot gillnet

Catch rates of turbot from research surveys

According to the results, obtained by fishing vessel *Hendem Mustafa* in Romanian littoral in 2003, the average realized productivity of gillnets is about 79.26 kg per day, 7.65 kg per gillnet and 3.30 kg per hour (Table 4). The most productive month was May.

Table 4.Capture, fishing effort and CPUE, obtained by the fishing vessel *Hendem Mustafa* in the Romanian sector of the Black Sea using turbot gillnets.

Month	Capture (kg)	Fishing effort			CPUE			Depth limits
		Day no.	No.. gill net	Hour no.	kg / day	kg / gill net	kg / hour	
IV	1 500	30	250	720	50	6,0	2,08	45 - 60
V	3 000	30	300	720	100	10,0	4,16	40 - 60
VII	2 000	22	300	528	90,91	6,66	3,78	30 - 70
TOTAL	6 500	82	850	1.968	79,26	7,65	3,30	30 - 70

Between 2003 – 2006, four research expeditions were organized in the Romanian zone (in April, May, July, November), over 50 trawling made, at different depths (10, 20, 30, 40, 50, 60 and 70 meters). The trawling time was of 60, 120 and 180 minutes, with a trawling speed of 3 – 3.3 N/h and a trawl opening of 20 meters. Fishing was conducted over the whole Romanian continental shelf, between Sulina and Mangalia to a depth of 70 m.

A large area was covered, and despite of the high number of tows and trawling hours, the catches were low, some tens or hundreds kg per towtrawling. The average values were between 290 – 470 kg / day, 66.92 – 168.18 kg / trawling and 39.54 – 138.23 kg / hour (Table 5).

Table 5. Capture, fishing effort and CPUE during the research fishing (Steaua de Mare-1) in the Romanian sector of the Black Sea

Month	Capture (kg)	Fishing effort			CPUE			Depth limits (m)
		Day no.	No. trawling	Hour no.	Kg/ day	Kg/ trawling	Kg/ hour	
IV	1740	6	36	72	290	48,33	24.16	8 – 70
V	5382	10	32	48	538	168,18	112.12	8 – 70
VII	4699	10	30	36	470	156,66	130.55	8 – 40
XI	2090	5	15	28	418	139,33	88.39	11 – 58
Total	**13911**	**31**	**113**	**184**	**448,74**	**123,11**	**75.60**	**8 - 70**

The total number of vessels involved in turbot fishery in Romania account 126 boats accounting for 30 trapnets, 1 500 gillnets and 10 beach seines. In Bulgaria the total number of fishing vessels is 1261 and the number of registered fishing gears till September 2007 is 2453.

Turbot landings in Bulgaria and Romania varied between 0 and 678 t during the period 1950 – 2006. The analysis of catch statistics (Figure 24), shows a decline in yields of both countries since 1964, and a steep decline after 1980. The slight signs of recovery of catch rates are observed since 1994 in Bulgaria due to 4-years closure of turbot fishery and after 2000 in Romania, but landings do not reach previous levels. Average catches of turbot during the period 1950 – 1980 in Bulgaria are estimated at about 245 t per annum in Bulgaria and 173 t in Romania. The average annual catches since 2000 vary between 21 t (RO) and 47 t (BG).

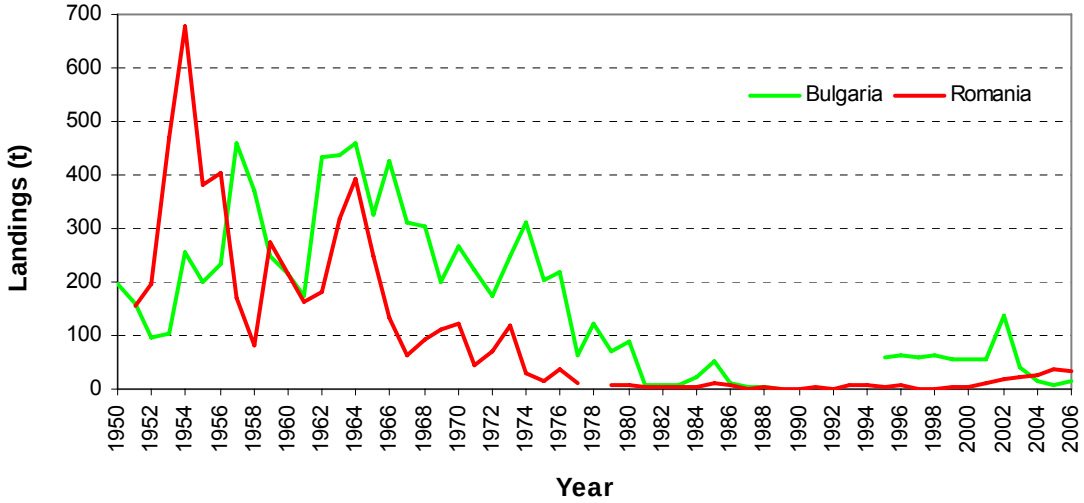


Figure 24. Turbot catches of Bulgaria and Romania during the period 1950 – 2006.

The majority of turbot landings in the Black Sea were realized by former USSR till 1964 and Turkey after 1965. The share of each country in total turbot catches in the Black Sea is presented on Figure 25.

Turbot stock in Western part of the Black Sea is exploited also by Turkey which is non-EU country. According to Prodanov et.al. (1997), the landings of Turkey include not only those, realized in front their coast but also off the coasts of other Black Sea countries. The landings in recent years are probably underrecorded due to illegal fishing and also unrecorded quantities as by-catch of sprat fishery. The majority of the international catches (in the whole Black Sea) is taken by Turkey (Table 6, Fig. 25, FAO 2007).

Table 6. Turbot landings in the Black Sea in 1989 – 2005, tons according to FAO statistics (FAO 2007)

Year	Turbot					
	Bulgaria	Georgia	Romania	Russia	Turkey	Ukraine
1989	1	8	0	0	1449	2
1990	0	1	0	0	1383	9
1991	0	0	2	0	915	18
1992	0	0	1	1	418	19
1993	0	0	6	2	1585	18
1994	0	0	6	5	2114	16
1995	60	0	2	19	2850	10
1996	62	0	4	17	1924	39
1997	59	0	1	11	911	42
1998	64	0	0	14	1468	42
1999	54	5	2	15	1804	73
2000	55	9	2	4	2639	80
2001	57	11	13	24	2323	129
2002	136	11	17	15	335	104
2003	41	1	24	15	119	124
2004	16	7	42	2	274	133
2005	13	6	28	15	548	129
$Y_{89/95}$	9	1	2	4	1531	13
$Y_{96/05}$	56	5	13	13	1235	90

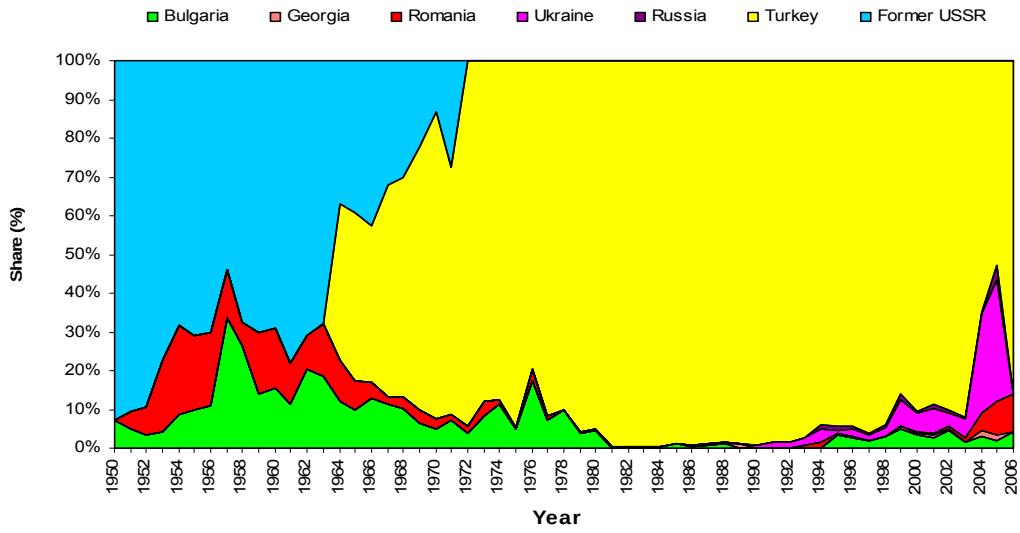


Figure 25. Share (%) in turbot catches by countries during the period 1950 – 2006.

Previous stock assessment work on Black sea turbot

The first studies on turbot stocks in the Black Sea started in 1950s when the catches began to increase and issues related to its sustainable exploitation were raised. Table 6 represents chronologically the studies on turbot biomass in the Black Sea (Zengin, 2005).

Table 6. Studies on turbot biomass and exploitation reference points in the Black Sea.

Researchers	Location	Years and periods	Biomass assessment (tons)	MSY (tons)	Methods
Martino and Karapetkova (1957)	Bulgarian coasts	March-1955	850	-	Swept area method
Popova (1967)	NW Black Sea coasts ″ ″ ″	1950-1960 1970 1975 1980	12 300 av 10 000 6 000 800	-	Swept area method
Pircalaboiu (1973)	Romanian coast	1966 - 1970	1200 - 1500		Beverton, Holt 1957
Kutaygil and Bilecik (1979)	West. Black Sea coasts, Turkey(Samsun-Kefken)	1969-1973	(ave) 180.4	-	Swept area method
Ivanov and Beverton (1985)	Bulgarian coasts ″	1963 1978	1 710 450	-	VPA

Researchers	Location	Years and periods	Biomass assessment (tons)	MSY (tons)	Methods
Acara (1985)	Eastern and Western Black Sea coasts	1983	11 225 14 137	-	Fox' production model
Effimov et al. (1989)	Former SSCB coasts ″	1975-1979 1980-1984	19 100 14 200	-	VPA
Prodanov et al. (1997)	Black Sea coasts	1979 1988	25 800 6 100	-	VPA
Bingel et al., 1996	South. Black Sea (Sinop-Georgia board) Western Black Sea	1990 1991 1992 1990	124 410 766 130.5	-	Swept area method
Zengin, 2000	South. Black Sea (Sinop-Georgia board)	1990 1991 1992 1993	686.3 250.4 222.4 134.3	96.1 26.3 24.5 15.4	Swept area method
Shlyakhov and Charova (2003)	Waters of Ukraine and the Russian Federation	1992	12200	-	Swept area method
Prodanov and Mikhailov, 2003	Bulgarian coasts	2002	761.7 - 866.7	75	Length Cohort Analysis
Shlyakhov and Charova (2003)	Ukraine coasts	1992-2002	9180 (8200-10400)	-	Swept area method
Shlyakhov and Charova (2003)	Waters of Ukraine and the Russian Federation	1992-1994	(av.) 13370	-	VPA and trawl surveys ,(Baranov'model)
Shlyakhov and Charova (2003)	Ukraine coasts	1992-2002	10590 (8200-13700)	-	VPA and trawl surveys (Baranov' model)
Zengin et al. (2005)	Southern Black sea coast (Trabzon)	2003-2004	continue	-	Tagging method
Maximov *et al.*, 2006	Waters of Romania	2003-2006	427-1066	-	Swept area method (trawl surveys)
Shlyakhov and Charova, 2003; 2006	Waters of Ukraine	1992-1995 1996-2002 2003-2005	8830 (8200-10400) 10980 (8400-13700) 9570 (8500-10200)	-	Swept area method (trawl surveys)
Shlyakhov and Charova, 2003; 2006	Waters of Ukraine	1992-2002 2003-2005	10590 (8200-13700) 8900 (8200-10200)	-	Trawl surveys and Baranov's modified equation
Panayotova *et al.*, 2006	Waters of Bulgaria	2006	1440	-	Swept area method (trawl surveys)

Researchers	Location	Years and periods	Biomass assessment (tons)	MSY (tons)	Methods
Panayotova *et al.*, 2007	Waters of Bulgaria	2007	1779	-	Swept area method (trawl surveys)

During recent years turbot stocks in Bulgaria and Romania have been assessed directly by swept area method using standard methodology for stratified random sampling. Such surveys have been introduced because of unreliable fisheries statistics and suspected misreporting of catches.

The recent stock assessments in Bulgaria and Romania show some recovery of turbot stocks. The comparison of estimated turbot biomasses in Bulgaria and Romania is not appropriate due to different catchability of trawling gears and vessel speed which were involved in the surveys. Standardization of research bottom gears which will be involved in the surveys between Bulgaria and Romania is required in order to prepare comparable assessments. The recent obtained results indicate that the current turbot stocks off Bulgarian and Romanian coasts have the production potential and the reproductive capacity to maintain the stock biomass at about the present level, but that a reduction in mean length-at-age has been observed and the age range in the population is truncated.

According to the recent assessments in Bulgaria (2006), a decreasing pattern of catch per unit area was observed from the Northern to Southern areas – Figure 26. The variability in CPUA is between 12.56 and 875 kg/km^2.

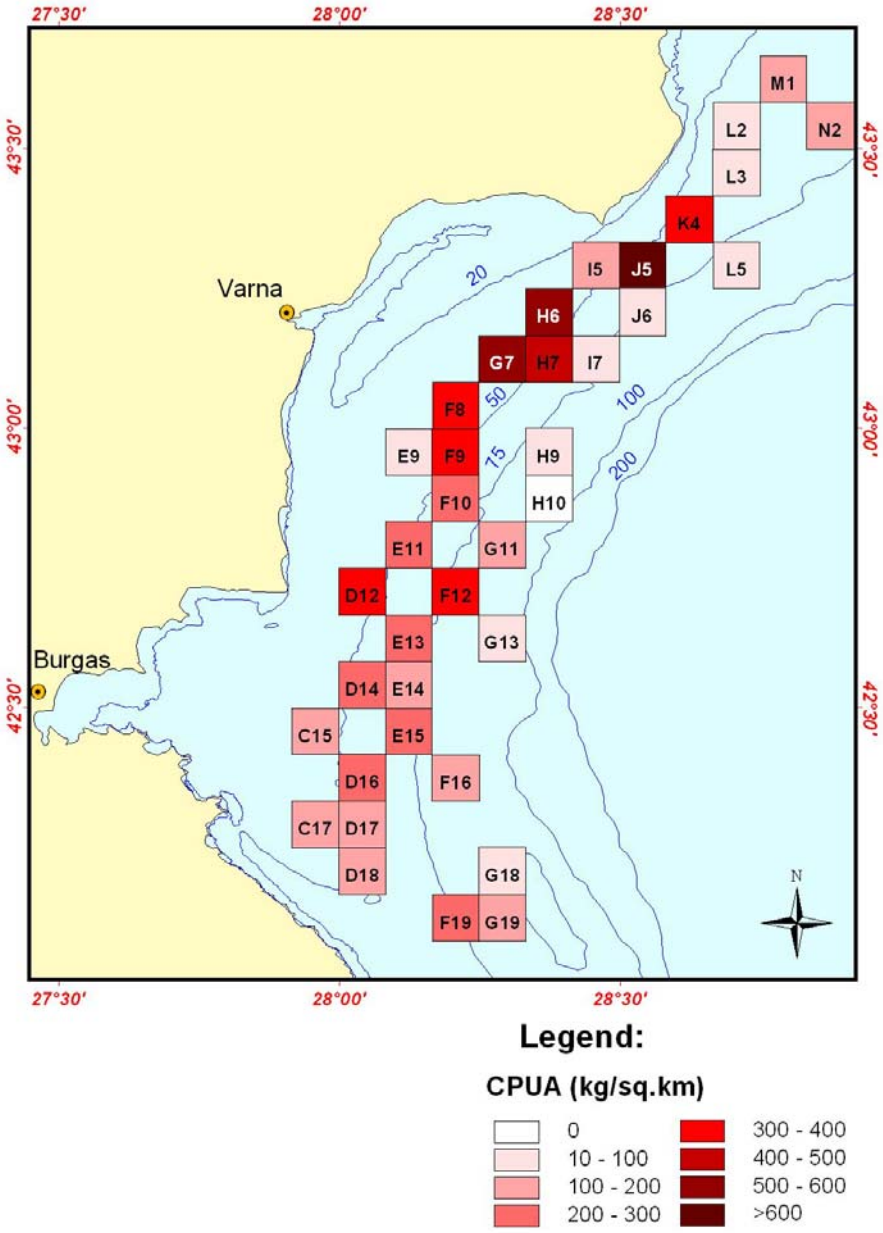


Figure 26. Distribution of turbot CPUA in the Bulgarian Black Sea during autumn-winter, 2006.

In Romanian waters (2006) the estimated biomass in the research area ranges between 92.3 and 484 kg/nm^2 – Table 7 and Figure 27 and the estimated biomass on the Romanian platform vary between 246.7 and 1 066 kg/Nm^2.

Table 7. Turbot biomass in Romanian waters, in the period April – October

Research surface (nm^2)	Distribution surface (nm^2)	Estimated biomass in the research area (t)	Estimated biomass on the Romanian platform (t)
April			
1 570	571,5	92,3	**246,7**
May			
1 570	824	257,5	**688,9**
July			
1 453	877	189,6	**548,6**
October			
1 453	1720	436,2	**1 066**

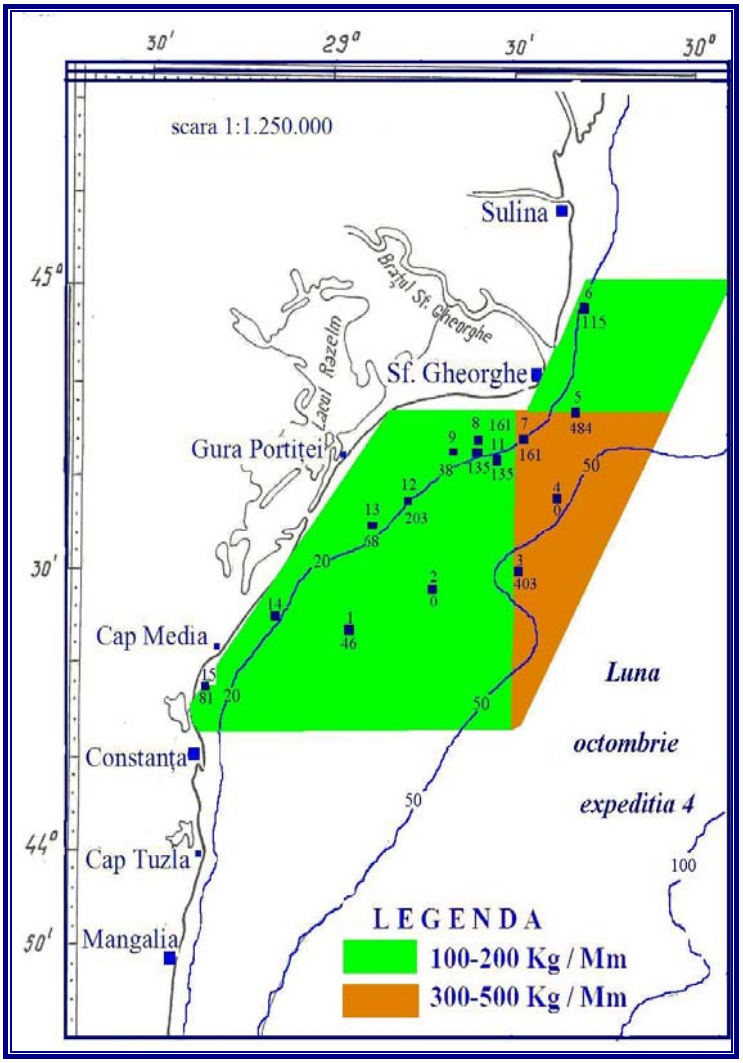


Figure 27. Turbot biomass in Romanian waters, suitable for fisheries (kg/nm^2) in October 2006

Sustainable levels of exploitation in Bulgarian and Romanian waters may range between 30 – 100 tones with quota of 30 tones in Bulgaria and 50 tones in Romania in 2007.

Size structure of catches in Bulgaria and Romania in 2007 is very similar. The presented length classes includes size groups from 23.5 cm to 74.5 cm and the percentage share of specimens from each size group in the total abundance are represented on Figure 28 for Romania and Figure 29 for Bulgaria.

These figures are evident that the highest frequency had the size groups from 40 to 58 cm, while specimens with length over 62.5 cm were only few. The size structure of catches differs from those during the 60s with a lower size class of fish predominating in the catches in recent years.

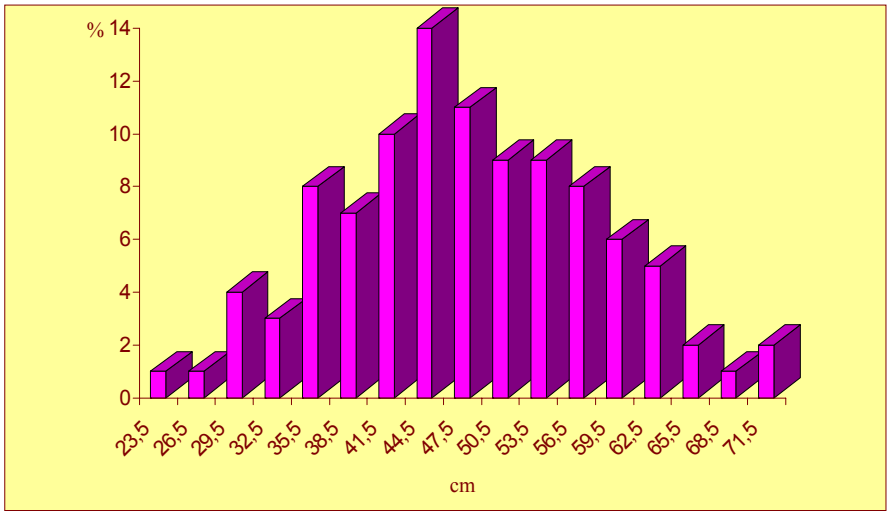


Figure 28. Length frequency of turbot population (as surveyed by the research trawl survey) in the Romanian Black Sea area in 2007

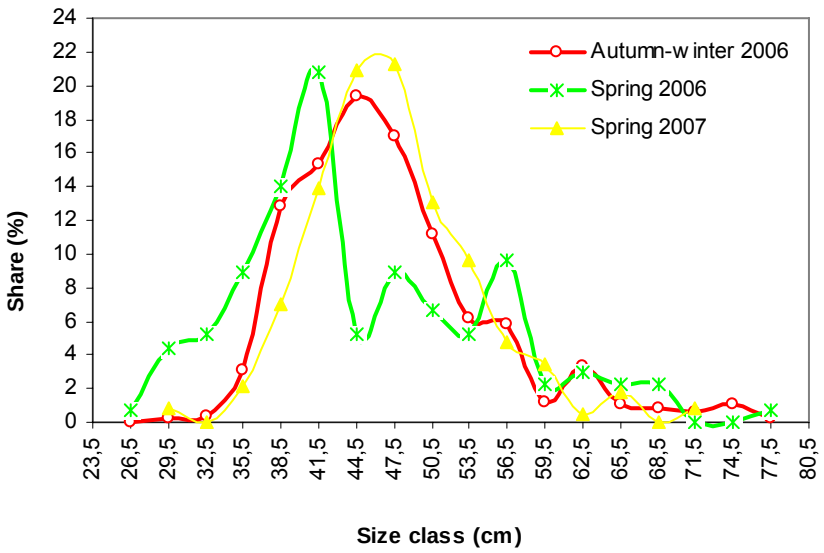


Figure 29. Length frequency of turbot population (as surveyed by the research trawl survey) in the Bulgarian Black Sea area.

Regulation on legal landing size of turbot in Bulgaria and Romania exists. The minimum permitted size in Bulgaria is 45 cm for total length and 40 cm standard length in Romania. In relation to sustainable exploitation of turbot stock in Bulgarian and Romanian waters, the harmonization of minimum permitted landing size, and a corresponding mesh size for gillnets are desirable together with closures during the during the spawning season.

The age composition of turbot catches in the Bulgarian and Romanian Black Sea area encompasses 1 to 9-years old individuals. The age structure in Bulgaria is dominated by individuals 2-5 years old, which altogether represented 75.41 % of the total abundance – Figure 30. The share of immature individuals of age up to 3 years is around 44.20 %, and individuals of age 4 and elder accounts for 55.80 % of the total abundance of turbot caught during the study.

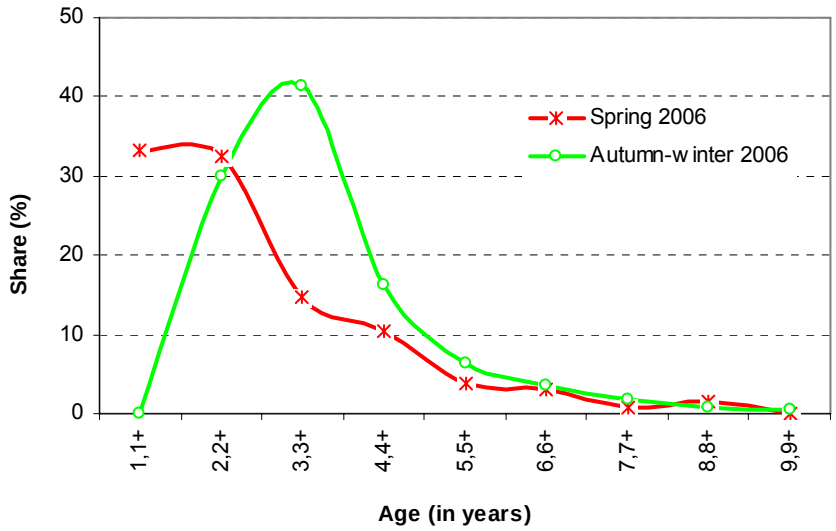
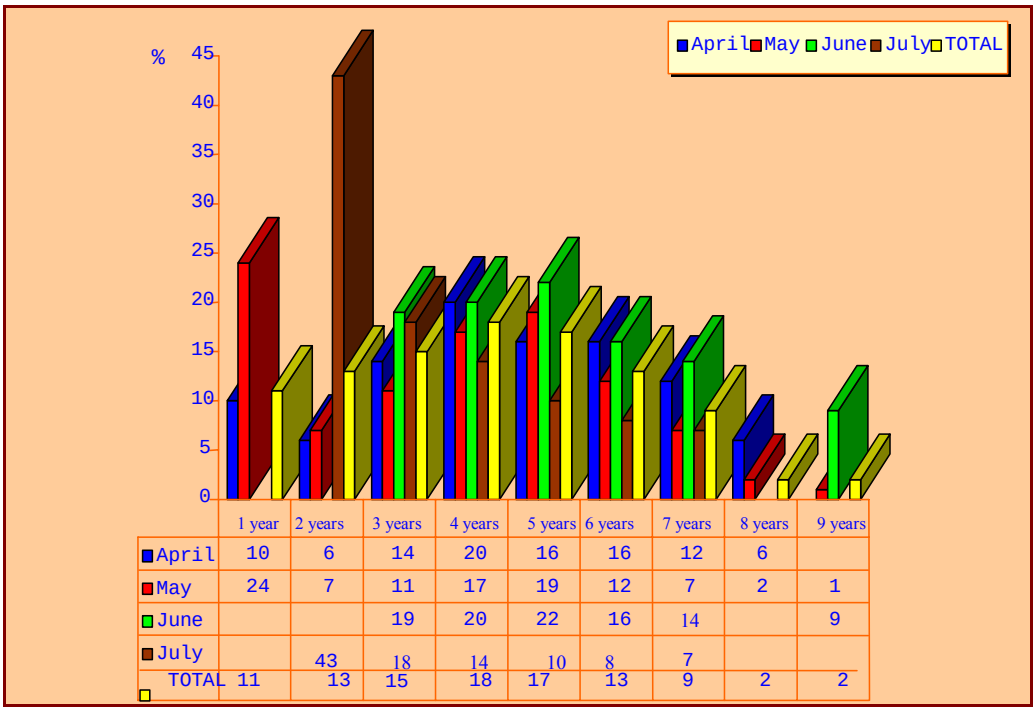


Figure 30. Age structure of turbot (as surveyed by the research trawl survey) in Bulgaria in 2006

The age composition of turbot catches in Romania is dominated by 4 and 5-years old individuals (17.67% and 17.27%), close followed by the 3 years old (14.44%) and 6 years (12.85%) - Figure 31.

The correct determination of turbot age is required in order to make reliable estimate of species growth rate which reflects the accuracy of stock assessments. Elaboration of manual for turbot agening in the Black Sea is necessary in order to overcome the errors of wrong age determination and differencies between countries.



	1 year	2 years	3 years	4 years	5 years	6 years	7 years	8 years	9 years
April	10	6	14	20	16	16	12	6	
May	24	7	11	17	19	12	7	2	1
June			19	20	22	16	14		9
July		43	18	14	10	8	7		
TOTAL	11	13	15	18	17	13	9	2	2

Figure 31. Age structure of turbot (as surveyed by the research trawl survey) in Romania in 2006

The main gaps in knowledge considering turbot stock in the Black Sea include absence of stock assessments by direct (holistic) methods during the period 1973 – 2003 in Romania and in 1993 – 2005 in Bulgaria. Reliable data of size and age structure of commercial landings since 1990 in Bulgaria and 2003 in Romania do not exist. Annual larval and juvenile surveys using appropriate gears and methodology are needed. Quantitative assessments of turbot by-catch in the sprat fishery need to be developed in order to improve the landings statistics.

Conclusions

In consideration with the current state of turbot stock in the Bulgarian and Romanian Black Sea area, the following conclusions and recommendation are made:

- Turbot is highest priced demersal fish species shared as transboundary stocks between Bulgaria, Romania, Turkey and Ukraine.
- Turbot migrations are seasonal, linked to the feeding, spawning and wintering processes. New data, obtained by acoustic and data storage tags, for main migration routes, spawning and nursery areas in the whole North-Western part of the Black Sea is required for adequate management, TAC determination and stock protection. We recommend joint research on this issue on regional and national level.
- The current state of turbot stocks in front of Bulgarian and Romanian coasts during the last two years is in relatively stable condition with values of

exploitable biomass between 436 – 1066 tones in Romania and 1440 – 1779 tones in Bulgarian area.

- Sustainable levels of exploitation in Bulgarian and Romanian waters may range between 80 - 100 tones.

- We recommend developing of national, bilateral and regional programs and initiatives for fish stock assessments on annual basis. The co-ordination at regional level of the scientific research, harmonization of methods for sampling, assessment and data analysis is recommended. The non-EU member states of the Black Sea will be encouraged to participate in these activities.

- The technical measures concerning gillnets mesh size, minimal permitted lengths, seasonal fishery closures needs to be synchronized between Bulgaria and Romania for the good management of the stock. Introduction of acoustics devices protecting marine mammals populations is needed according to ACCOBAMS recommendation and agreements.

- The development of aquaculture as a way to reduce the pressure on natural population is recommended.

- Accomplishment of genetic analysis on regional and national level is necessary in order to increase the current knowledge on species.

- Improvement of reliability, reporting and access to fisheries statistics through scientific community at national and regional level and data exchange.

- Adequate funding and support of scientific research and fisheries related monitoring programs is crucial for performing reliable stock assessment and provision of scientific advice to fisheries managers and governments.

4 Technical measures for management of sprat and turbot stocks, using inputs and outputs control

Technical measures in terms of fishing gear characteristics, fishing season and fishing-protected areas that may be advisable to complement catch limitations **(**Figure 32**)**.

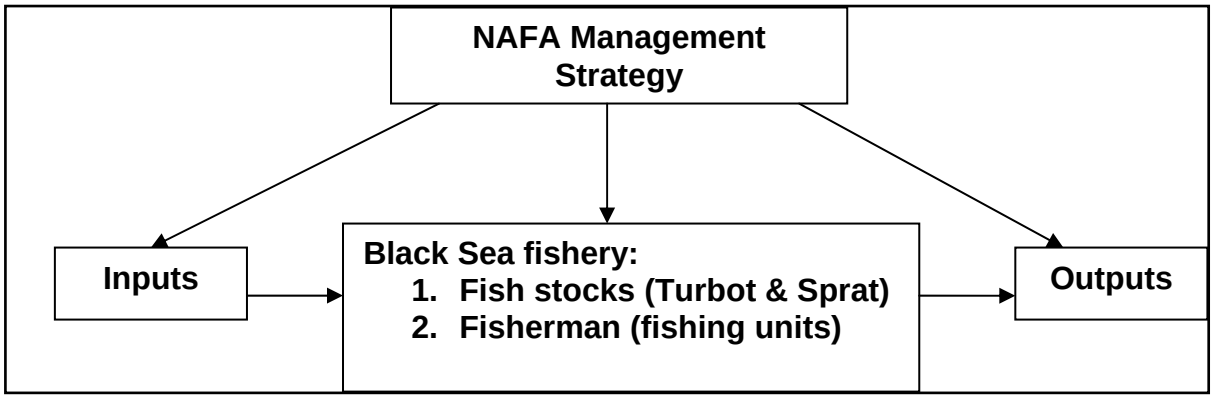


Figure 32

1. **Inputs:**

- Control of fishing effort in terms of number and characteristics of the fishing gears and fishing units.
- Limitation of entry in time by analysis of the seasonality and prohibition
- periods and in space through closed and protected areas (for turbot only).

Sprat:

The present analysis show that in the common case the fishing gears used in Romania and Bulgaria are pelagic trawls with minimum mesh size of the bag 6 to 8 mm and stationary pound nets the minimum mesh size of the enclosures is 7-24 mm.

Turbot:

The fishing gears used in Romania and Bulgaria are fixed gillnets with minimum mesh size a = 200 mm and L = 80 m to 100 m and h = 1.5 m.

The fishing vessels used in Bulgaria and Romania for sprat fishing are coastal trawlers with gross tonnage of 25 t to 200 t and the engine power vary from 110 kW to 485 kW.

There is no limitation concerning the number of the fishing gears and fishing units allowed to operate in both countries.

***Suggestions*:**

Development of the existing control techniques:

***Turbot*:**

- Researches in order to locate the breEding, wintering and feeding areas and on basis of the outcome to define prohibited areas for fishing activities all over the year in the Bulgarian and Romanian coastal waters.
- To apply the maximum prohibition period – 60 days depending on the hydro-meteorological conditions.
- Researches for more knowledge about turbot migration in order to protect them before the prohibition period through protection corridors.
- Enhancement of the existing control system: inspections at the fishing ports and on sea.
- Assessment of the NAFA technical staff available and training of the personnel to improve the inspections efficiency and to increase the percentage of the registered catches (respectively to prevent illegal fishing and commerce).
- Implementation of traceability and labeling systems, improving the catch quality and decreasing the level of illegal commerce level for both countries.
- Development of the inspections plan during the prohibition period, including cooperation with Border police and Ministry of Internal Affairs regional directorates.

***Sprat*:**

Based on the results of the assessment of sprat resources for 2007 no recommendations for enhancement of the existing control techniques will be applied.

2. Outputs

- Management of the Quota by analysis of the fishing statistics documents collected in the information system (to monitor the quantity of certain species – sprat and turbot – Figure 33).
- Cross check for the evidence of unregistered fishing activity during the prohibition period using all available sources: Catch register, detailed analysis of the inspections and VMS data (to monitor the quantity of certain species – sprat and turbot – Figure 33).
- Development of reliable system for recording of discards, bycatch and every associated species (marketable or not).
- Measures for control and monitoring of all post harvest activity operations – transport, landing, processing, whole sale and retail.

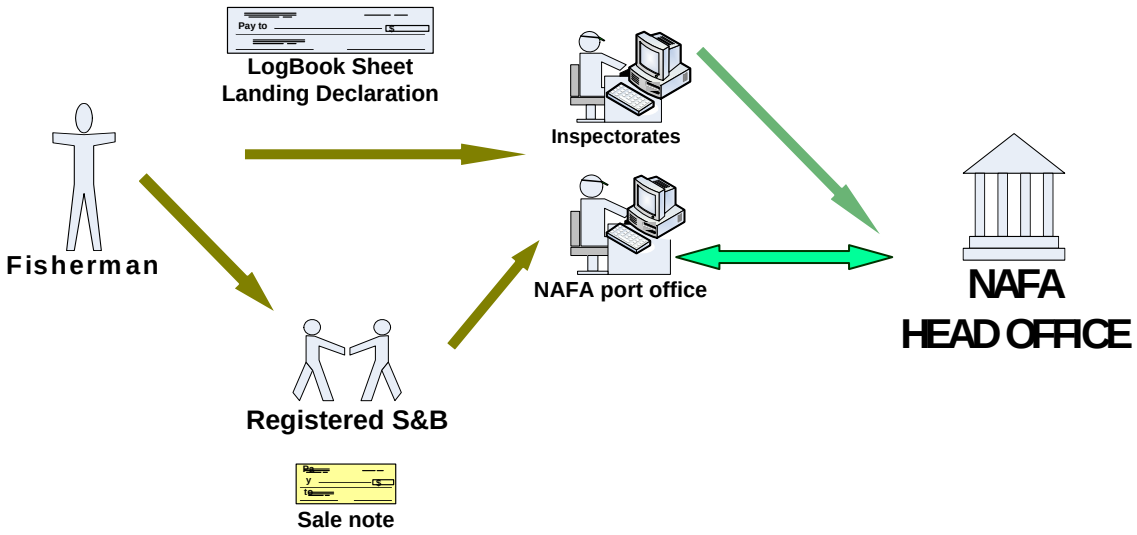


Figure 33.

- Control over the fishing activity using all available tools like VMS, information system and control offices based on the fishing ports. Inspections at sea in order to control the catch structure and the level of discards and bycatch, trying to attenuate the impact of fishing on fishery resources. Example for Black sea Romanian and Bulgarian Fishery is the presence of turbot (under the legal size, considered 45 cm) as bycatch in the sprat fishing catch.
- Preventive measures for fast identification of the gillnets at sea – flags or floating buoys.
- Mutual cooperation between Bulgaria and Romania regarding illegal fishing activity issues and exchange of information on regular basis.
- Common activities on synchronization of the quota, including researches.

Other important fish species

As per the current fishing statistic and fisheries management the ad-hoc WG suggested that the following fish stock needs specific measures:

- Anchovy (*Engraulis encrasicolus*) - migratory and heavy exploited, statistical data and common research program (Turkey, Georgia, Ukraine);
- Horse mackerel – (*Trachurus mediterraneus ponticus*) migratory and heavy exploited, statistical data and common research program (Turkey, Georgia, Ukraine);

- Sturgeons (*Huso huso, Acipenser stellatus, Acipenser gueldenstaedti*) – new projects for assessment of the resources not only in River Danube, but in the Black Sea also (the yang classes, living in Black sea under the first maturity age). Banned till 2016;

- Bonito (*Sarda sarda*) – the stock of this specie decreased drastically and in the present the catches are accidental – common plan for assessment of the resources is needed (Turkey, Romania and Bulgaria) and a management plan and recovery;

- Whiting (Merlangius merlangus)– the main bycatch specie for sprat fishery – assessment of the resources (Romania, Bulgaria and Turkey);

- Dogfish (*Squalus acanthias*) - assessment of the resources (Romania, Bulgaria and Turkey);

- Mullets (Mugilidae) - assessment of the resources (Romania, Bulgaria and Turkey);

- Rapana venosa – invasive specie and heavy exploited stock – assessment of the stock and some knowledge about the ecology.

- Dolphins (*Delphinus delphis, Phocoena phocoena, Tursiops truncatus*) – protected species and they need research on their ecology and ethology and developing a plan for prevention of accidental catch.

- The assessment of the resources to be in terms of area of distribution, migrations, growth, recruitment and mortality level, the evolution of biomass and catches and also anthropogenic impact.

5 Gaps in existing scientific information and proposals for improvement of the Black Sea information

- Insuficient and irregular funding of long-term monitoring of fish stocks and related environmental parameters

- The existing reporting system presents incomplete number of parameters. There is a need of developing a unified reporting system for a number of parameters needed for the scientific and fisheries research

- Existence of illegal and unreported catches – establishing technical measures for prevention.

- Discards of turbot in sprat trawl fishery. Improve the control measures regarding discard level, size structure and species composition.

- Institutions which hold most complete information are not always nominated. Improve the cooperation between the institutions involved in the fisheries sector

- Lack of unified regional system for monitoring and stock assessment. Need of development of effective data exchange and scientifically sound methodologies for stock monitoring and assessment

- Lack of legal regional operational system for common fisheries assessment and cooperative management. Develop the collaboration between experts and research institutions from EU and non-EU countries on a regular basis.

- The regional information systems are not effective. We recommend the establishment of a regional body for managing the information from the existing databases.

6 Main conclusions and recommendations

6.1 Conclusions

The ad-hoc WG reached the main conclusions:

- Sprat and turbot stock are very important for the fisheries Bulgaria, Romania and other countries and the Black sea ecosystem.

- Biological population distributions and life cycles of sprat and turbot exceed national boundaries and relevant evaluation of the state of the stocks need to be arranged at a regional level, considering also changing environmental conditions, migrations and other relevant biological and ecological information

- Sprat stock and related fisheries have recovered after the crisis during the 1990s and in the last years reached levels comparable to the period prior to the crisis. The stock is however, considered as vulnerable due to short life cycle 4-5 years, pronounced population fluctuations and negative influence of environmental and anthropogenic factors including excessive fishing.

- The estimated sprat biomass by “swept area” method ranged between 29 190 t in Bulgarian between 19 000 to 60 000 t in Romania. Taking into consideration varying environmental conditions, and anthropogenic and fisheries pressure also from other countries sharing the same stock TAC is proposed to be between 8 000 and 15 000 t. Until more reliable international stock assessment is performed it is recommended that the fishing mortality F do not exceed the half of the natural mortality M = 0.95 i.e. F_{lim}=0.475

- After a long depression in 1980s-2000s there are signs of improved stock status of turbot. However the ad-hoc WG recommend a very cautious approach provided several important circumstances: important information gaps (incomplete fishery statistics, unreported and illegal catches, research survey) and further need of reliable unified and scientifically sound monitoring and stock assessments; high market demand and related pressure of overfishing and illegal practices; high sensitivity to anthropogenic and natural impacts such as eutrophication and related hypoxia, river run-off.

- The current state of turbot stocks in front of Bulgarian and Romanian coasts during the last two years is assessed between 436 – 1066 tones in Romania and 1440 – 1779 t in Bulgaria. Sustainable levels of exploitation in Bulgarian and Romanian waters may range between 80 - 100 t.

- Convening the WG was assessed as a very useful and necessary step – in fact the first official and operational exercise in stock assessment and scientific advice in the area and needs to be strongly encouraged in future

6.2 Recommendations

The ad-hoc WG agreed on the following main recommendations:

6.2.1 Operational issues

6.2.1.1 On a short term: 2007/2008

- **To establish a permanent and operational Working Group on Fisheries Assessment and Management in the Black Sea under the auspices of the STECF**

- **To prepare a comprehensive review of the available historical knowledge and evaluate the multi-annual dynamic and current status of sprat and turbot stocks. To use advanced analytical methodology and best available data in terms of fisheries and research information. To develop the scientific basis for sustainable management providing annualy estimates of abundance, fishing mortality, short and mid-term forecasts, and precautionary reference points**

- To develop the collaboration with leading experts and institutions from the EU and non-EU countries, which can help the WG by bringing complimentary data and methodologies

- The technical measures concerning gillnets mesh size, minimal permitted lengths, seasonal fishery closures needs to be synchronized between Bulgaria and Romania

6.2.1.2 On a medium term: next few years

- To strengthen of the operational capacity of national scientific research units through improvement of methodologies and equipment, development of information systems, training and mobility of personnel.

- To procure adequate funding and support of scientific research and fisheries related monitoring programs for performing reliable stock assessment and provision of scientific advice to fisheries managers and governments.

- To agree at national and regional level of a comprehensive list of indicators for marine living resources, habitats, key species and fisheries activities; establishing of corresponding parameters to be collected by fisheries monitoring systems.

- To develop a fisheries information system through compilation of historical and present data information, and establish a system for facilitating access to the publications at the national level

- To develop a regional network of research and information centers of fisheries and aquaculture, marine living resources habitats and biodiversity.

- To evaluate the scientific and technical implications in the Black Sea area of the EU Common Fishery Policy and European marine strategy; development of a common platform for cooperation with GFCM, ICES, ACCOBAMS, etc.

- To create an inventory of habitats and sites with national and regional importance for the Black Sea living resources and marine mammals.

6.2.2. Methodological issues (on a medium term)

- To elaborate at regional level of a unified stock assessment methodology for sprat, turbot and other important species; training and practical application through regional working groups.
- To design and perform unified research surveys.
- To improve of existing procedures of setting management objectives for marine living resources, and develop unified indicators.
- To develop region wide evaluation criteria for protection of living resources, habitats and procedures for establishing of marine protected areas.

6.2.3 Thematic issues

- To develop of turbot aquaculture as a way to reduce the pressure on natural population is recommended.
- Developing of a framework for spatial research of phytoplankton, zooplankton and benthos; structure and function of critical habitats for marine living resources.
- Temporal and spatial monitoring and analyses of environmental conditions affecting marine living resources.
- Promote studies of genetics, migrations and population studies in order to establish stock distribution boundary.

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Appendix 1: List of participants

Name	Institution	Position	Email	Postal address
Mr. Christos THEOPHILOU	European Commission Directorate General for Fisheries and Maritime Affairs Unit A2 - Fisheries conservation: Mediterranean, Baltic and Black Seas and Environmental Issues		Christos.THEOPHILOU@ec.europa.eu	
Dr Georgi DASKALOV	Fisheries Ecosystems and Oceanography, CEFAS	Senior scientist	georgi.daskalov@cefas.co.uk	**Centre for Environment, Fisheries&Aquaculture Science** Lowestoft Laboratory, UK Pakefield Road, Lowestoft, Suffolk NR OHT UK
Dr Violin RAYKOV	Institute for Fish Resources (IFR), Varna, Bulgaria	Researcher	vio_raykov@yahoo.com	**Institute of Fishing Resources,** PO Box 72 Primorski blvd. 4, Varna, 9000 Bulgaria
Dr Marina PANAYOTOVA	Institute of Oceanology (IO), BAS, Varna, Bulgaria	Researcher	mpanayotova@io-bas.bg	**Institute of Oceanology – Bas** PO Box 152 Parninlaj 40 str. Varna, 9000 Bulgaria
Eng. Ivelina BIKARSKA	Department "Fishing Vessels Monitoring Center", NAFA, Bulgaria	Head of Unit	cnrk@nafa-bg.org ibikarska@yahoo.com	**National Agency for Fisheries and Aquaculture. FVMS** Primorski blvd. Nr. 5**,** fl.1**,** Varna, 9000 Bulgaria
Dr. Simion NICOLAEV	National Institute for Marine Research and Development " Grigore Antipa ", Romania	General Director	nicolaev@alpha.rmri.ro	**National Institute for Marine Research and Development "Grigore Antipa"** Bdul. Mamaia, nr. 300 900581 Constanta
Dr. Gheorghe RADU	National Institute for Marine Research and Development " Grigore Antipa ", Romania	Researcher	gpr@alpha.rmri.ro	**National Institute for Marine Research and Development "Grigore Antipa"** Bdul. Mamaia, nr. 300 900581 Constanta
Dr. Volodea MAXIMOV	National Institute for Marine Research and Development " Grigore Antipa ", Romania	Researcher	maxi@alpha.rmri.ro	**National Institute for Marine Research and Development "Grigore Antipa"** Bdul. Mamaia, nr. 300 900581 Constanta
Prof.Dr. George RĂZLOG	University Dunarea de Jos, Galati, Romania	Professor	george.razlog@ugal.ro	**University Dunarea de Jos**, str. Domneasca nr. 47 Galati
Eng. Cornel MIHAI	National Agency for Fisheries and Aquaculture, Romania	Director	cornel.mihai@anpa.ro	**National Agency for Fisheries and Aquaculture**, Sos. Oltenitei, nr 35-37, sector 4, Bucuresti
Dr. Ionel STAICU	National Institute for Marine Research and Development "Grigore Antipa ", Romania	Researcher, head of Ichthyology team	rmri@alpha.rmri.ro	**National Institute for Marine Research and Development "Grigore Antipa"** Bdul. Mamaia, nr. 300 900581 Constanta
Dr. Tania ZAHARIA	National Institute for Marine Research and Development " Grigore Antipa ", Romania	Researcher , head of Living Marine Resources dept.	zahar@alpha.rmri.ro	**National Institute for Marine Research and Development "Grigore Antipa"** Bdul. Mamaia, nr. 300 900581 Constanta
Victor NIȚĂ	National Institute for Marine Research and Development " Grigore Antipa ", Romania	Assistant researcher	victor_24_ct@yahoo.com	**National Institute for Marine Research and Development "Grigore Antipa"** Bdul. Mamaia, nr. 300 900581 Constanta

Appendix 2: Agenda

Provisional Agenda for the
Ad-hoc working group on sustainable exploitation of sprat and turbot in the Black Sea,

We suggest we have a regular working day e.g. 09:00 to 17:30 with lunch from 12:30 to 13:30. We could have two, 15-minute coffee breaks at e.g. 10:30 and 15:00. These times can of course be modified according to our progress during the week

Day 1, 10 Sep

9:00 –10:30
Introduction and adoption of the agenda, expected output from the WG (a report and recommendations to the Scientific, Technical and Economic Committee for Fisheries), election of reporters

The role of the EU in the assessment and management of the Black Sea fisheries, by Christos THEOPHILOU

Regional fisheries assessment and management in the Black Sea (with focus on sprat and turbot): development and current challenges, by Dr Georgi M. Daskalov

10:30-10:45 coffee/tea break

10:45 - 12:30
Romanian Marine Fisheries - general presentation dr. Simion Nicolaev - NIMRD

State of the fisheries, stock assessment and management of the Black Sea sprat in Romania by Dr. Gheorghe Radu- NIMRD

State of the fisheries, stock assessment and management of the Black Sea sprat in Bulgaria, by Violin Raykov

Discussion

12:30-13:30 lunch break

13:30 - 15:00

State of the fisheries, stock assessment and management of the Black Sea turbot in Romania by Dr. Valodia Maximov- NIMRD

State of the fisheries, stock assessment and management of the Black Sea turbot in Bulgaria, by Dr. Marina Panayotova

Discussion

15:00-15:15 coffee/tea break

15:15 -17:30

Genetic and physiological investigations of the Black Sea fish stocks with the focus to sprat and turbot, by MariaYankova and Petya Ivanova

Overview of knowledge and information gaps in the Black Sea Fisheries by dr. Simion Nicolaev - NIMRD

Discussion

Day 2, 11 Sep

9:00 –10:30

Current fisheries management practices (including transboundary issues) with focused on sprat and turbot in Romania and how they apply to the EU Common Fishery Policy by Cornel Mihai – NAFA Romania

Current fisheries management practices (including transboundary issues) with focus on sprat and turbot in Bulgaria and how they apply to the EU Common Fishery Policy, by NAFA Bulgaria by Ivelina Bikarska

Discussion

10:30-10:45 coffee/tea break

10:45 - 12:30

Assessment and advice on Sprat including:
Review of data and assessments of sprat. Can we come up with a sensible 2006 and 2007 assessments?
Discussing general principles of allocating quotas for sprat
Discussing gaps in data, surveys, assessment and plans how to overcome them
Discussing how to proceed with assessments in future: next year and in longer term
International and transboundary issues

12:30-13:30 lunch break

13:30 - 15:00

Assessment and advice on Sprat continue.

15:00-15:15 coffee/tea break

15:15 -17:30

Assessment and advice on Sprat continue.

Day3, 12 Sep

9:00 –10:30

Assessment and advice on Sprat continue.

10:30-10:45 coffee/tea break

10:45 - 12:30

Assessment and advice on Turbot including:
Review of data and assessments of turbot. Can we come up with a sensible 2006 and 2007 assessments?
Discussing general principles of allocating quotas for turbot.
Discussing gaps in data, surveys, assessment and plans how to overcome them
Discussing how to proceed with assessments in future: next year and in longer term
International and transboundary issues

12:30-13:30 lunch break

13:30 - 15:00

Assessment and advice on Turbot continue

15:00-15:15 coffee/tea break

15:15 -17:30
Assessment and advice on Turbot continue

Day 4, 14 Sep

9:00 –10:30

Assessment and advice on Turbot continue

Others relevant matters to discuss

10:30-10:45 coffee/tea break

10:45 - 12:30

Drafting the report

12:30-13:30 lunch break

13:30 - 15:00

Drafting the report

15:00-15:15 coffee/tea break

15:15 -17:30

Drafting the report

Day 5. 14 Sep

9:00 –10:30

Drafting the report

10:30-10:45 coffee/tea break

10:45 - 12:30

Drafting the report

12:30-13:30 lunch break

13:30 - 15:00

Discussion and adoption of the report

15:00-15:15 coffee/tea break

Discussion and adoption of the report

Closing the meeting

15:15 -17:30