Data Quality Assurance and Data Quality Control for *in situ* sampling, measurements and laboratory research in IFR - Varna, IO - BAS and IFA - Plovdiv

1.Introduction

The monitoring program of IFR-Varna, Institute of Oceanology-BAS and IFR-Plovdiv aims at estimations of the hydrological, hydrochemical and biological parameters (composition, abundance of plankton and benthos, fish stocks dynamics) in the Bulgarian Black Sea waters. Additional purposes are to monitor long-term trends of the environmental factors and interactions within the ecosystem.
On the basis of the monitoring programs, all organisations represent semi-annual and yearly reports, with overviews of the distribution of the studied variables have been given, together with an interpretation of the ecological significance of these results.
Data Quality System in the Institutes is related to the representative sampling programs, trained personnel, accurate analytical measurements, reporting, suitable storage and pre-treatment procedures, and data assessment procedures.
IFA-Varna, IO-BAS and IFA-Plovdiv provide the following resources: expertise in estimations of hydrological and hydrochemical data, reference species collections; field gears and ship equipped for the sample collections, and laboratories and experts, performing data analysis and interpretation.

The international guidelines used in elaboration of DQC system in Bulgaria

- JRC Fisheries Data Collection: https://datacollection.jrc.ec.europa.eu/guidelines
- General Fisheries Commission for the Mediterranean – GFCM: http://www.fao.org/gfcm/data/dcrf/en/
- MEDITS: https://www.sibm.it/MEDITS%202011/docs/Medits_Handbook_2017_version_9_5-60417r.pdf
- MEDIAS: http://www.medias-project.eu/medias/website/
- 2013, MANUAL OF PROTOCOLS ON THE METHODS USED TO ASSESS FISH STOCKS IN THE BLACK SEA THROUGH ANALYTICAL METHODS: Strengthening the regional capacity to support the sustainable management of the Black Sea Fisheries (SRCSSMBS – Black Sea)
- 2013, Best practice guideline on scientific surveys and holistic methods in the Black Sea Strengthening the regional capacity to support the sustainable management of the Black Sea Fisheries (SRCSSMBS – Black Sea)
- HELCOM: Manual for Marine Monitoring in the COMBINE Programme of HELCOM: General guidelines on quality assurance for monitoring in the Baltic Sea; http://www.helcom.fi/groups/monas/CombineManual/en_GB/main/
- "Methods for hydrochemical investigations of oceans", Borodovskii&Ivanenkov (1977);
- "Manual on chemical analysis of marine waters" of Hydrometeoizdat, St. Petersburg 1993;
- Manual for Marine Monitoring in the COMBINE Program of HELCOM: Program for monitoring of eutrophication and its effects:
- HELCOM ANNEX C-2 Hydrographic and hydrochemical variables
- HELCOM ANNEX C-4 Phytoplankton chlorophyll-a
- HELCOM ANNEX C-6 Phytoplankton species composition, abundance and biomass.
- HELCOM ANNEX C-7 Mesozooplankton: http://sea.helcom.fi/Monas/CombineManual2/PartC/anxc7.html
- Manual for zooplankton sampling and analysis in the Black Sea Region, complied by KorshenkoA.&B. Aleksandrov on the basis of HELCOM Manual

- ICES WGMDM Guidelines for Biological Plankton Data http://ioc.unesco.org/oceanteacher/OceanTeacher2/06_OcDtaMgtProc/01_DataOps/02_DtaMgtPol&Guides/Guidelines_for_biological_plankton_data_v2.pdf
- HELCOM ANNEX C-8 Soft bottom macrozoobenthos
- HELCOM ANNEX C-10 Guidelines for fish coastal monitoring
- Environmental Protection Agency Quality System: http://www.epa.gov/quality/exmural.html
- Manual of quality control procedures for validation of oceanographic data [UNESCO/IOC/IODE, 1993]
- Intergovernmental Oceanographic Commission: Manuals and Guides 36: Methodological guide to integrated coastal management; UNESCO, 1997.
- Availability and Access to Data on Europe's Marine Environment Technical Report No. 4

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- ESCAP guidelines for programme monitoring, review, and evaluation United Nations Economic and Social Council E/ESCAP/CPR (2)/11 21
- Guidance on Assessing Quality Systems EPA QA/G -3 EPA/240/R-03/002

National guidelines:

- Improved quantitative method for mesozooplankton calculations. Dimov I, 1959. BAN Reports, 12, 5, 427-429.
- Catalog on the Bulgarian Black Sea Fauna, Valkanov A. 1957. Works of the Marine Biological Station – Varna, 19, 1-51.

DQC PROCEDURES:

-PROFILE CHECKS: Date/time, latitude/longitude, types and values of all profiles, and instrument type have to be written in final cruise reports and archived. The profile checks include checks of ranges, depths for all known parameter types (e.g. temperature, salinity, oxygen, nitrates, etc.). Profile checks consist observations for spikes, outliers, gradients that are too pronounced, for density inversions (when temperature and salinity are present), and for temperature inversions.
-DUPLICATE SAMPLING:
-REFERENCE SPECIES COLLECTIONS:
-DEVELOPMENT OF SAMPLE COLLECTION AND ANALYSIS PROTOCOLS:
-INTERCALIBRATIONs and training of the stuff: Since the start of numerous international projects in 2000, all sampling and analysis methodologies between project parties have been harmonized. In this relation many intercalibrations procedures have been performed: for the hudrochemistry analysis, phyto-, meso-, macrozooplankton, and benthos sampling, counting, ichthyological sampling and analysis.

PARTICIPATION OF THE RESEARCH INSTITUTES IN THE NATIONAL AND INTERNATIONAL TRAININGS & WORKSHOPS DURING THE LAST YEARS:

July 2021, Subregional Group on Stock Assessment in the Black Sea (SGSABS)
July 2021, Benchmark session for the assessment of Black Sea anchovy in GSA 29 http://www.fao.org/gfcm/meetings/info/en/c/1411005/?fbclid=IwAR2L0mg6RVxOn85mMwvYfnbTubl1JZTrtui_GiZiqgmpUulcfCKOuK17b6Q
July 2021, Ninth meeting of the Working Group on the Black Sea (WGBS)
May - June 2021, Demersal surveys data workshop and Data preparation meeting for the Black Sea priority species,
2020, State-space assessment models (SAM).
2020, Black Sea Rapa whelk survey protocol

2020, Multispecies modelling of Black Sea resources using mass-balance models (Ecopath with Ecosim, EwE) and Biological Reference Points,
2019, Advanced Course Fisheries Biology in R, Greece;
September 2019, WGBS meetings: Turbot Benchmark, BlackSea4Fish Steering Committee, WGBS 8,
July 2019, SGSABS Benchmark session for the assessment of Turbot in the Black Sea, Burgas,Bulgaria;
http://www.fao.org/gfcm/meetings/info/en/c/1195813/?fbclid=IwAR3MlPLNpts8zh4BuVrwyv3oolralxaF9H6S-NAbW5njQ2dHts07svpOjI0
May, 2019, Data preparation for benchmark data analysis session for turbot, WGBS, SGSABS, Burgas, Bulgaria;
Nov, 2018, Benchmark session for the assessment of sprat in GSA 29 http://www.fao.org/gfcm/technical-meetings/detail/en/c/1206472/?fbclid=IwAR3Mp4pwfAgGgB6KAWvoU1NVuA2g8Bt7zYYxRR0kojj0jdfuULihxJkLvS4
December 2018, Subregional Group on Stock Assessment in the Black Sea (SGSABS), Constanta, Romania;
July 2018, Working Group on the Black Sea (WGBS), Seventh session, Burgas, Bulgaria;
October 2017, Beginner's course on "Integrated Assessments using Stock Synthesis", Rome, Italy;
June 2017, Workshop to assess measures to manage fishing for turbot in the Black Sea (WKMSE) and the sixth meeting of the working group of the GFCM of the Black Sea, Constanta, Romania.;
November 2015, Regional meeting on stock assessment in the Black Sea, General Fisheries Commission for the Mediterranean (GFCM), Bourgas.;
February 2014, Ecosystem approach to fisheries in the Mediterranean and Black Seas. Scientific Bases, CREAM Project,Varna, Bulgaria
September 2013, Methods for sampling, processing, analyzing and interpretation of data and results, fishery statistics and analytical stock assessment methods used in EU, organized by the project Strengthening the regional capacity to support the sustainable management of the Black Sea Fisheries" (SRCSSMBSF-88), organized by YugNIRO, Kerch, Crimea

A. QUALITY SYSTEM FOR BIOLOGICAL DATA

By definition, **Quality Assurance (QA)** includes all planned and systematic actions necessary to provide adequate confidence so a product will satisfy given requirements of quality. This includes AQC, audit, training, documentation of methods, calibration schedules, etc., while **Quality Control (QC)** stands for the operational techniques and activities that are used to fulfil requirements for quality. The objective of a quality assurance programme is to reduce analytical errors to the required limits and to assure that the results have a high probability of being of good quality. Having developed an analytical system, suitable for producing analytical results of the required accuracy, it is of eminent importance to establish a continuous control over the system. In other words, continuous quantitative experimental evidence must be provided in order to demonstrate that the stated performance characteristics of the method chosen remain constant.
The bounds of quality are given by • requirements from legislation • standards of analytical methods and requirements for internal quality control (IQC) • the laboratory-specific precision and trueness of the analytical value, which had to be ensured • the valuation of laboratory-intern known data of the same sample type. The basic principle is that the validity of biological and ecological assessments depends on the accuracy and precision of all activities, involved in the

collection and analysis of data. Major variables include the characteristics of the taxonomic groups, the number of observations or measurements, their statistical distribution, the accuracy of identification guides, measuring devices or other methods and the skill of analysts in using these. The procedures encompassed in DQA include: study design, surveying and sampling, analysis and identification, computing, validation, data interpretation and reporting, and training of personnel.

QA/QC FOR FIELD SAMPLING - SAMPLE PRESERVATION AND STORAGE

Survey and sample records must include sufficient information to enable the location of the sample or survey site to be identified precisely by future workers e.g. geo-referencing for mapping. Appropriate information may include grid references, plus notes, sketch maps and photographs. Survey and sample records, must have unique identifiers linking them to the time and place of collection. Sufficient meta-data must be recorded to ensure data traceability.

QUALITY ASSESSMENT FOR ICHTHYOLOGICL LABORATORY ANALYSIS

All samples were collected in accordance with the variation statistics from significant landings in terms of quantity where is possible. The samples were processed in laboratory conditions. Fish total length (TL, ± 0.5 cm precision) was measured, and the total weight was measured using an electronic analytical balance (W, ±1g precision).
For estimation of the age of small pelagic fishes (otoliths reading), some of the samples were checked by 3 readers. Otoliths were removed and dried in the laboratory and stored in labelled envelopes. On a regular basis, intra-laboratory comparison tests should be performed to avoid/minimize age reading data differences between analysts. Age readings were compared using a signed-rank statistical test.
The condition factor was obtained from Fulton´s equation (Ricker, 1975): where W is total weight (g) and L is length (cm) cubed, multiplied by 100 to represent values as percentages.

$$K = \frac{W}{L^3} * 100$$

The condition factor 'K' was computed for each age groups separately for different months. For all the samples "Age-Length" (Weight) Keys were created. The share (in %) of individuals per age groups and length groups were reflected in the analysis as well.
The coefficient of variation (CV) is defined as the ratio of the standard deviation σ to the mean μ:

$$c_v = \frac{\sigma}{\mu}$$

The coefficient of variation is useful because the standard deviation of data must always be understood in the context of the mean of the data. For comparison between data sets with different units or widely different means, one should use the coefficient of variation instead of the standard deviation.
Batch fecundity: All fish were measured to the nearest 1 mm in the Total Length (TL) and weighted to the nearest 1 g. Gonads of the fish were examined under a dissecting microscope for its external features such as turgidity and colour in order to determine a maturity stage. The sex ratio also calculated in this study (i.e., No. of males/No. of females (Simon et al., 2012). The female was determined by the macroscopic observation of matured ovary (Laevastu, 1965a).
Batch fecundity can vary considerably during the short spawning season, low at the beginning, peaking during high spawning season and declining again towards the end. Annual egg

production is the product of the number of batches spawned per year and the average number of eggs spawned per batch. Batch fecundity of sprat was determined as 'Hydrated Oocyte Method' (HUNTER et ale 1985).
Gonadosomatic Index (GSI) was determined monthly. GSI was calculated as:

$$GSI = \frac{GW}{SW} X\ 100$$

where, GW is gonads weight and SW is somatic weight (represents the BW without GW)
The length – weight relationship is obtained by the following equation:

$$W_t = qL_t^{\ n}$$

where: q – condition factor, constant in length-weight relationship; n – constant in length-weight relationship.

Re-analysis: Ten (10%) percent of all fish/shellfish samples should be reanalyzed by another analyst, and the results compared for QA purposes
Qualitative uncertainty: Related to mis- or wrong age determination. This part of uncertainty can only be dealt with in a general statement based on inter- (if available) and intra-laboratory comparisons.
Improving precision: the precision can also be improved by a step-by-step approach to find the causes of random error. The total precision of an analytical method can be improved by examining its individual procedural steps to find the one which contributes most to the total error.

B. QUALITY ASSURANCE OF DATA REPORTING

Documentation: All biological data, produced in a laboratory, should be completely documented ("metainformation") and should be traceable back to its origin. The necessary documentation should contain a description of sampling equipment and procedures, reference to standard operating procedures (SOP) for sample handling and analytical procedures involved, and the names of persons responsible for Quality Control.

Data management: For the adequate management of the data obtained (especially when different laboratories are involved), an information management system is essential. The database should allow the storage/management of the full set of information relating to the data (including QA procedures, and summaries of analytical methods). A proper reporting format or data entry system should allow the submission of the required information in order to describe fully, and if necessary to trace back, the data/samples. Data checks performed by the data manager should only be carried out on a data set that has already been subject to quality control procedures by the reporting institution. Therefore, information on QA/AQC procedures and outcomes has to accompany the data or, better, has to be regarded as part of the data submission. A central data management system should guarantee safe archiving (regular back-ups, computer virus checks, multiple storage, etc.) and access to the data. Check routines performed by the data management system should look for: • format compliance; • completeness of data/information; • compliance with the program and guidelines; • deviations from previous sampling/processing/analysis procedures; • plausibility (involving screening for outliers, e.g., arising from errors in position-fixing, or • improbably high/low data values); • conformity with agreed taxonomic nomenclature (parallel considerations include correct application of international coding systems, taxonomic updates, and synonyms); • species occurrences additional to those in standard lists which may include non-native species. "Quick-look" visualization of the data/information (e.g., in the form of track plots or charts) should be

provided by the data center, as well as meta-information relating to the submission of the data, including its state of validation. All biological data, produced by a laboratory, should be completely documented ("metainformation") and should be traceable back to its origin. The necessary documentation should contain a description of sampling equipment and procedures, reference to standard operating procedures (SOP) for the sampling, sample handling and analytical procedures involved, and the names of persons responsible for Quality Control. In general, one signed protocol should accompany a sample through all steps of processing.

Data management: For the adequate management of the data obtained (especially when different laboratories are involved), an information management system is essential. The database should allow the storage/management of the full set of information relating to the data (including QA procedures, and summaries of analytical methods). A proper reporting format or data entry system should allow the submission of the required information in order to describe fully, and if necessary to trace back, the data/samples. Data checks performed by the data manager should only be carried out on a data set that has already been subject to quality control procedures by the reporting institution. Therefore, information on QA/AQC procedures and outcomes has to accompany the data or, better, has to be regarded as part of the data submission. A central data management system should guarantee safe archiving (regular back-ups, computer virus checks, multiple storage, etc.) and access to the data. Check routines performed by the data management system should look for: • format compliance; • completeness of data/information; • compliance with the program and guidelines; • deviations from previous sampling/processing/analysis procedures; • plausibility (involving screening for outliers, e.g., arising from errors in position-fixing, or • improbably high/low data values); • conformity with agreed taxonomic nomenclature (parallel considerations include correct application of international coding systems, taxonomic updates, and synonyms); • species occurrences additional to those in standard lists which may include non-native species. "Quick-look" visualization of the data/information (e.g., in the form of track plots or charts) should be provided by the data centre, as well as meta-information relating to the submission of the data, including its state of validation.

METADATA REPORTING FORM
DATASET-NAME
PROJECT
PLATFORM/SHIP
STATION COORDINATES
GEOGRAPHIC-COVERAGE
DATE & HOUR
BOTTOM DEPTH [m]
SAMPLING DEPTH [m]
OBSERVED-PARAMETERS
MEASURED/DETERMINED PARAMETERS
COMPUTED/CONVERTED PARAMETERS
SAMPLING INSTRUMENTS AND METHODS

2. Ichthyological studies

The present methodology was elaborated within The Advisory Group on Environmental Aspects of Management of Fisheries and Other Marine Living Resources Black Sea Commission (AG FOMR BSC), its basic concepts were discussed and approved at the Joint meeting General Fisheries Commission for the Mediterranean (GFCM), Scientific Advisory Committee (SAC), Subcommittee on Stock Assessment (SCSA) and AG FOMR BSC on Stock

Assessment Methodology and Workshop on Black Sea Assessment of Pelagic and Demersal Fish Stocks.

While revising and harmonizing the Methodology the experience of realization of the bilateral research project was used: Bulgaria-Rumania: BPS-24/Contract P-8/22.06.2005: "*Knowledge of status and tendencies of the evolution of main gregarious fish stocks from the Romanian and Bulgarian marine zones, aiming to the harmonization of assessment methods and measures for their sustainable development*" has been considered.

HARMONIZED METHODOLOGY FOR BLACK SEA ANCHOVY (*ENGRAULIS ENCRASICOLUS PONTICUS* ALEKSANDROV) ASSESSMENT. (All measures applied here should be implemented also to the all species of small pelagic fish species).

According to the contemporary concepts there are two geographical races of anchovy in the Black Sea: the Black Sea race – *Engraulis encrasicolus ponticus* Aleksandrov and the Azov race – *Engraulis encrasicolus maeoticus* Pusanov. They are independent stock units. The Azov race as a target for fisheries is exploited only in the waters of the Russian Federation and Ukraine. Although wintering areas of both anchovy races partially overlap in the Black Sea and the problem with their identification exists, the present Methodology deals with the Black Sea race only.

Black sea anchovy is harvested in all the countries of the region. Its greater part is caught with active fishing gears on the wintering grounds in the waters of Georgia and Turkey (sometimes of Ukraine as well) from November till March. At the rest time of a year either migrating schools of anchovy or fish approaching to the coastal zone in the spawning and pasturing period are yielded in the waters of all the Black Sea countries.

Bulgarian anchovy fisheries are based exclusively on migrating schools, the main fishing seasons being spring and autumn. The main fishing gears are the trap-nets and to a lower extent the beach-seines. Regular trawl fishery or any kind of active fishery for anchovy is not conducted.

At the Romanian littoral area the anchovy-fishing season lasts mainly from May up to September. The fishing gear used is the pound net. The anchovy proportion in the passive fishing is about 35-40%.

In the warm period of a year (May – September) within the territorial sea of the Russian Federation anchovy is in loose state, being of extremely low abundance (fish density makes up almost 0.1-0.5 kg per a hour of trawling). Anchovy is found on the southern shelf within the area of Lazarevskaya – Adler. In winter the Black Sea anchovy commercial aggregations are not registered in the territorial sea of the Russian Federation. In the coastal waters of the Russian Federation anchovy is occasionally harvested in a low quantity with stationary nets in the warm period of the year. For separate years in autumn during the sprat trawl fishing anchovy schools migrating to the wintering grounds are fished as well. For the recent 15 years Black Sea anchovy does not have any commercial value for the Russian fisheries.

Along the coast of Georgia from November till March anchovy is harvested with purse seines and with trawls (to the smaller extent). Besides Georgian fishing vessels, Ukrainian vessels are engaged in fisheries as well under the bilateral intergovernmental agreement. Anchovy fisheries in other seasons do not have significant commercial value.

The major amount of anchovy in the region is yielded along the Turkish coasts. The major fishing ground is located eastwards off Sinop. The season of active anchovy fishing with purse seines takes place from November till March, the largest landing falling on December (27.3%) and January (43.3%). The fishing gear used is completely a purse seine. But, besides sprat fishing, opening the mid-water trawl fishing season in the middle of the Black Sea Region (Samsun), some anchovies are caught between November and January. Anchovy fisheries in other seasons are of no significant value.

Ukraine yields more than 80% of Black Sea anchovy catch in its waters in December-March during wintering along the Crimean coasts with midwater trawls as a by-catch of sprat fishing. Approximately once for 5 years wintering concentrations of Black Sea anchovy along the Crimean coasts allow to conduct anchovy target fishing with purse seines. For the warm period of the year in the Black Sea waters of Ukraine anchovy keeps sparsely and fished off only with stationary (pound) nets.

Collection of the primary fishing biological information

a/ Sampling of catch

Fishing seasons are limited in that way proceeding from the fact that the major catch of anchovy falls on November-March. Therefore, Black Sea countries agreed take the beginning of the biological year from the 1st of November and the end till the 31st of October.

In order to study the fish populations, the method of random extracted samples is used; a sample represents a share from the whole population able to offer sufficient information for characterizing the population.

As it was established the sample extracted for to study the biological parameters must have 200 individuals of anchovies.

The sampling frequency must be at least one sample per a week.

b/ Sampling for determination of length frequency

The sampling analyses include: counting, biometry (measurements), gravimeter (weightings), and sampling of otholits for aging, determination of sex and gonads maturation.

The characteristics determined by biometry measurements are as follows: plastic characters (length, weight, thickness), and meristic characters (radii, scales, branchial spines).

Within these analyses, the following elements important for growth parameter assessments are important for growth parameter:

- the structure of length and age classes
- the weight of length and age classes
- sex ratios

In the fishery biological studies the most utilized method refers to the measurement of linear dimensions of the fish or its different parts. Among numerous measurements, which can be made, the easiest one is the total length. Other parameters, such as weight and age, are correlates with the total length, so each of them can be determined by length data. Measurements for determination the frequency of lengths of the fishing populations are used for assessment of their population stock.

As was established the measurements should be made on total fish length (TL), and when necessary, the standard length (SL), and at fork length (FL) to establish some correlations between them.

The measurements centralization will be carried out on interval classes of 0.5 cm, the measurements being centralized at inferior cm. For instance, the species with total length comprised between 11.0 and 11.4 cm are registered in length class of 11.00 cm.

The summarized information on the length composition of anchovy catches for each Black Sea country is given in the Blank-form «Length» (Appendix 1).

c/ Collecting of material for determination of fish age

The samples for age determination will be collected using the stratified method, providing a constant number of material - 10 individuals (preferably 5 males and 5 females) from the sample for length frequency study for each length class.

The material used for age determination is represented basically by the otholiths.

The summarized information on age composition of anchovy catches (per month, season, calendar or biological year) for each Black Sea country is given in the Blank-form «Age» (Appendix 2).

d/ Establishing the gonads maturation degree

Once with the biometric measurements are made, the degree of gonads maturation shall be determined. The scale for visual appreciation with six stages (Nikolski, ICSEAF) will be used for determination of gonads maturation stage.

If necessary the gonads are weighed, both for females and males. It is indicated as these samplings to be made for the same sample collected for age determination. The gonads will be carefully collected from females at advanced stages, not to hurt the ovary walls. The samples are labelled as follows: the trawling number, the number of individual from the sample collected.

e/ Determination of spawning intensity and completion level for Black Sea anchovy

The period for research surveys will be established by each Black Sea country in accordance with the optimal conditions specific for each geographic zone.

Black Sea countries agreed that they would use the proper networks for sampling, to provide the continuity in observation. For each station, the following data would be noted: station, date of sampling, geographic coordinates of station, water depth (m), level to which the net was launched (m), number of rotations registered on the net device (flowmeter).

The spawning intensity for anchovy will be determined using the BONGO net for ichthyoplanktonic sampling, using the circular method; the vessel speed - 2.5-3 knots. The surveys shall be planned in the period June-July-August. The sampling will be made from the water column above the thermocline.

In order to make qualitative and quantitative inventories for anchovy juveniles, one survey/year have to be organized in late summer (August-September-October).

The summarized information for each survey is given in the Blank-form «I/P» (Appendix 3).

Assessment of eggs, larvae and juveniles abundance will be made using the areas methods. The biomass of spawners will be determined using the method of daily eggs and larvae production (Parker, Sette-Ahlstrom).

f/ Fishery statistic.

Black Sea countries agreed that the data on fishing efforts would be collected every month for following kinds of anchovy fisheries: target fisheries with purse seines and trawls; non-target fisheries (by-catch); coastal stationary fishing (trap nets). Data needed to be collected are as follows:

- target fishing / purse seine or trawl
  - fishing area
  - type of fishing gear
  - average length of vessels
  - average gross tonnage of vessels
  - average HP of vessels
  - number of hours fished
  - number of sea days fished
  - number of sets
  - number of fishing units operating
  - number fishermen / vessel’s crew
  - catch of anchovy / month / year / biological year
  - by-catch of other species
- non-target fishing / trawl or purse seine

- fishing area
- type of fishing gear
- average length of vessels
- average gross tonnage of vessels
- average HP of vessels
- number of hours fished
- number of sea days fished
- number of sets
- number of fishing units operating
- number fishermen / vessel crew
- by-catch of anchovy / month / year / biological year

- stationary fishing - trap nets
  - fishing area
  - number of pound nets (fishing units operating)
  - number of sea days fished
  - number of fishermen
  - total catch / month / year / biological year
  - catch of anchovy

The summarized statistical information for anchovy catch (per month, season, calendar or biological year) for each Black Sea country is given in the Blank-form «Fishery statistics» (Appendix 4).

g/ The hydroclimatic parameters

The environmental conditions are the most important factors for formation and maintenance the fishing agglomerations of anchovy. That is the way to study the dynamics of environmental factors in correlation with the results of fishing to establish their influence on the fishing is necessary. The systematic observations are necessary of the values registered by the hydroclimatic parameters.

During the surveys, the values of following parameters will be registered with adequate devices or visual observation:

- water temperature
- salinity
- wind (direction, intensity)
- state of sea roughness
- thermocline level

The phyto- and zooplankton sampling should be performed additionally; also the presence of sea birds and dolphins should be noted.

3.The harmonization of assessment methods of anchovy stocks

Black Sea countries agreed that two groups of methods – patterns, built on the analyses of fishery statistics, and direct assessments of the data of surveys should be applied for the anchovy stock assessments in the Black Sea.

4.Analytical models and surplus production models

Analytical models: analysis of catch-at-age data (Virtual Population Analysis, VPA) or length frequency data (Length Cohort Analysis, LCA). The database for analytical models may be made by all the countries according to the routine scheme:

- monthly collection of standardized data for all countries;
- age reading of fish (otholith) samples to determine age composition;
- common reporting procedures (see Appendices 1, 2, 4)

Analytical models offer good results and need many input parameters obtained on the whole distribution area of the stock. The parameters are:

- growing parameters L_∞, k, t_0;
- mortality ratios M (natural mortality), F (fishing mortality) and Z (total mortality Z=M+F);
- data about the selectivity of gears

Many of the Black Sea countries have the necessary data; only some efforts are needed in order to put together these data in the collaboration with the rest of coastal states which manage the common stocks.

Surplus production models have an orientation role and will be used when the data of catch and effort are good and represent a long period of time. For to assess the maximum sustainable yield (MSY), the Schaefer and Fox methods will be used.

5.Direct evaluation of stock biomass

The following assessment methods will be used depending on the available data and their quality:

- daily eggs and larvae production method (DEPM);
- hydro-acoustical method

DEPM. The biomass of spawners will be determined using the method of daily eggs and larvae production (Parker, Sette-Ahlstrom).

Hydroacoustic method enables to obtain the current characteristics of the available for fisheries part of stock immediately in the fishing season. Anchovy hydro acoustic surveys should be carried out in the major wintering area and active fisheries, that is, in the waters of Georgia and Turkey. Approximately once for 5 years wintering concentrations of Black Sea anchovy along the Crimean coasts allow conducting anchovy target fishing with purse seines. In such years anchovy hydro-acoustical surveys may be conducted in the waters of Ukraine as well. December and January are the best period for the survey. It is desirable to employ one vessel. If different vessels are employed in waters of these countries, inter-calibration of their devices will be foreseen. At the two countries littoral, Romania and Bulgaria, this method can be used when the anchovy begin to make agglomerations for migration toward the wintering places. By late January assessments of the biomass of anchovy schools may be ready.

Appendix 1

Blank-form «Length». Structure by length classes of the anchovy (*Engraulis encrasicolus ponticus*) caught at Ukrainian water (November – March)* and the Romanian littoral (April – October)* in 1999/2000 biological year***

Classes length (cm)	Y E A R / S E A S O N					
	1999/00 (November – March)			1999/00 (April – October)		
	No.	%	W_m	No.	%	W_m
6				3	0.1	1.31
6.5				3	0.1	1.82
7				11	0.5	2.15
7.5				23	0.9	2.74
8	1	0.3		51	2.1	3.42
8.5	2	0.6		98	4.0	3.85
9	7	2.2		117	4.8	4.56
9.5	22	7.0		245	10.0	5.61
10	60	19.1		412	16.8	6.39
10.5	84	26.7		495	20.2	7.29
11	70	22.2		450	18.4	8.26
11.5	33	10.5		300	12.3	9.03
12	18	5.7		145	5.9	10.4
12	8	2.5		62	2.5	11.9
13	5	1.6		22	0.9	13.8
13.5	3	1.0		7	0.3	15.5
14	2	0.6		4	0.1	17.5
No. total	**315**			**2,448**		
L. med.	**10.8**			**10.7**		
W. med.				**7.35**		

* - FL
** - TL
** - In this blank-form the data are summarized for fishing seasons of biological year 1999/2000

Appendix 2

Blank-form «Age». Structure by age classes (No.) of the anchovy (*Engraulis encrasicolus ponticus*) caught at Ukrainian water (November – March) and the Romanian littoral (April – October) in 1999/2000 biological year

Classes length (cm)	Y E A R / S E A S O N							
	1999/00 (November – March)				1999/00 (April – October)			
	0+	1+	2+	3+	0+	1+	2+	3+
6					3			
6.5					3			
7					11			
7.5					20	3		
8	1				42	9		
8.5	2				64	34		
9	7				51	66		
9.5	18	4			6	239		
10	38	20	2			354	58	
10.5	24	51	9			266	229	
11	13	50	7			213	237	
11.5		28	5			77	192	31
12		14	4			14	101	30
12.5		5	3			2	32	28
13		2	3	1			12	10
13.5			1	2			1	6
14			1	1				4
No. total	**103**	**174**	**35**	**4**	**200**	**1277**	**862**	**109**
%	**32.6**	**55.1**	**11.1**	**1.2**	**8.2**	**52.2**	**35.2**	**4.4**
L med.	**10.3**	**11.2**	**11.7**	**13.8**	**8.6**	**10.4**	**11.4**	**12.5**
G med.					**3.7**	**6.8**	**8.6**	**11.4**

Appendix 3
Blank-form «I/P»

No.	Indicators	Data
1	The date of commencing and finishing ichthyoplanton survey	
2	Survey Area	
3	Square area of recording in the survey	
4	The number of ichthyoplankton stations	
5	The duration of the spawning season	
6	The average density of the eggs in the zone of recording in individuals under square meter	
7	Eggs distribution according to the maturation stages (in Rass's 4-number scale)	
8	The average duration of the eggs maturation	
9	The average density of larvae and fingerlings in the area of recording under the square meter	
10	The average individual fecundity of females	
11	The relative portioned fecundity of females	
12	The percentage of daily spawning females	
13	The percentage of females in the school	
14	The average percentage of fish in the spawning stock	
15	The weight ratio of sexes in the brood stock	

Appendix 4

Blank form «Fishery statistic - target fishing». Fishing season 1999/00, target fishing of the anchovy (*Engraulis encrasicolus ponticus*) in the Ukrainian waters of the Black Sea

No	Indicators	Fishing area - Crimea, purse seine					
		November	December	January	February	March	Total 1999/00
1	Capture production, tons	-	275	150	-	-	425
2	An average length of fishing vessels	-	-	-	-	-	-
3	An average gross tonnage of vessels	-	110	110	-	-	-
4	An average HP of vessels	-	280	280	-	-	-
5	Number of hours fished	-	-	-	-	-	-
6	Number of sea days fished	-	7	5	-	-	11
7	Number of sets	-	15	10	-	-	7
8	Number of fishing units operating	-	5	5	-	-	-
9	Number of fishermen	-	40	40	-	-	-
10	By-catch on other species	-	-	-	-	-	-

Blank form «Fishery statistic – non-target fishing». Fishing season 1999/00, by-catch of the anchovy (*Engraulis encrasicolus ponticus*) in the Ukrainian waters of the Black Sea in trawl fishing of sprat

No	Indicators	Fishing area - Crimea, trawls					
		November	December	January	February	March	Total 1999/00
1	By-catch of anchovy, tons	-	1195	1050	625	50	2920
2	An average length of fishing vessels	-	-	-	-	-	-
3	An average gross tonnage of vessels	-	600	600	600	600	-
4	An average HP of vessels	-	400	400	400	400	-
5	Number of hours fished	-	2020	1930	1850	2140	7940
6	Number of sea days fished	-	15	12	12	15	54
7	Number of sets	-	675	550	600	860	2685
8	Number of fishing units operating	-	15	16	15	15	-
9	Number of fishermen	-	210	218	210	210	-