**Food and Agriculture
Organization of the
United Nations**

Report of the

FAO TECHNICAL WORKSHOP ON "BEST-PRACTICES FOR THE IMPLEMENTATION AND REPORTING OF SDG INDICATOR 14.4.1 – PERCENTAGE OF BIOLOGICALLY SUSTAINABLE FISH STOCKS"

Rome, Italy, 21–24 November 2017

Report of the

FAO TECHNICAL WORKSHOP ON "BEST-PRACTICES FOR THE IMPLEMENTATION AND
REPORTING OF SDG INDICATOR 14.4.1 – PERCENTAGE OF BIOLOGICALLY SUSTAINABLE
FISH STOCKS"

Rome, Italy, 21–24 November 2017

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2018

PREPARATION OF THIS DOCUMENT

This document is the report of the FAO Technical Workshop on "Best-practices for the implementation and reporting of SDG indicator 14.4.1 – Percentage of biologically sustainable fish stocks" held in Rome, Italy, from 21 to 24 November 2017. The workshop is a FAO initiative to support the process of the Sustainable Development Goals (SDGs). FAO as the custodian agency for SDG Indicator 14.4.1 has been requested to report progress of this indicator at global level and to provide technical support to member states in reporting and monitoring of SDG 14.4.1 at the country level. This includes improving the capacity of countries to undertake fish stock assessments, through developing guidelines and manuals and delivering a comprehensive training programme featuring workshops and seminars. This report summarizes the presentations and main discussions of the Workshop, and provides recommendations for facilitating the work by countries on SDG indicator 14.4.1. The document was prepared by Mr Yimin Ye (Chief of the Marine and Inland Fisheries Branch, FIAF), Mr Edoardo Mostarda (FAO Consultant for the Marine and Inland Fisheries Branch, FAO) and Mr Marcelo Vasconcellos (Fishery Resources Officer of the Marine and Inland Fisheries Branch, FAO).

ABSTRACT

The FAO Technical Workshop on "Best-practices for the implementation and reporting of SDG Indicator 14.4.1 – Percentage of biologically sustainable fish stocks took place in Rome, Italy, from 21 to 24 November 2017. The overall objectives of the workshop were to i) raise awareness of SDG 14.4.1's significance and global reporting process, ii) provide technical training to national practitioners in data requirements, data collection process, and the analytical methods to produce Indicator 14.4.1, iii) facilitate and provide support to the global reporting process and iv) look for examples of datasets and indicators relating to this target, from which best practices can be compiled. It was attended by 12 participants, with specific expertise on fish stock assessment, who contributed in their individual capacities to the discussions and delivered presentations focusing on their country's fisheries, resource management, stock assessment, and monitoring of resource sustainability. Results of the workshop showed that a number of participating countries are currently undertaking fish stock assessments and would therefore not have much difficulty in conducting some meta-analysis for producing SDG Indicator 14.4.1. However, other countries still seem to have limited data and capacity for stock assessment and therefore may face various challenges in the production of the Indicator. It also showed that the institutions carrying out fish stock assessments are not aware of their responsibilities towards the reporting of SDG Indicator 14.4.1. Therefore, communication and coordination between national statistical agencies, stock assessment institutions and those responsible for reporting and implementing SDG Indicator 14.4.1 should be improved. The workshop concluded by setting out best practices that countries should follow for facilitating the work on SDG indicator 14.4.1.

CONTENTS

ABBREVIATIONS AND ACRONYMS

ADNAP	National Fisheries Administration Mozambique
AFMA	Australian Fisheries Management Authority
B	Biomass
BAC	Biologically Acceptable Catch
CECAF	Fishery Committee for the Eastern Central Atlantic
CFP	Common Fisheries Policy
CMFRI	Central Marine Fisheries Research Institute India
CNR	National Research Council Italy
CONAPESCA	National Commission of Aquaculture and Fisheries Mexico
CPUA	Catch Per Unit Area
CPUE	Catch Per Unit Effort
EC	European Commission
EEZ	Exclusive Economic Zone
ELEFAN	Pauly's (1987) length-based growth rate estimator, as used in LFDA, FiSAT, etc.
ERAEF	Ecological Risk Assessment for Effect of Fishing
EU	European Union
F	Instantaneous coefficient of fishing mortality
FADs	Fishing Aggregating Devices
FAO	Food and Agriculture Organization of the United Nations
FiSAT II	FAO-ICLARM stock assessment tools software
FRDC	Fisheries Research and Development Corporation
FSSI	Fish Stock Sustainability Index
GDP	Gross domestic product
GFCM	General Fisheries Commission for the Mediterranean
HSP	Commonwealth Fisheries Harvest Strategy Policy
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
IFOP	Instituto de Fomento Pesquero Chile
IFREMER	Institut Français de Recherche pour l'Exploitation de la Mer
IFSRI	Iranian Fisheries Science Research Institute
IIP	Instituto Nacional de Investigação Pesqueira
IMARPE	Instituto Del Mar Del Peru
INAPESCA	National Fisheries Institute Mexico
INRH	National Institute for Fisheries Research of Morocco
IOTC	Indian Ocean Tuna Commission
IUU Fishing	Illegal, Unreported, and Unregulated Fishing
JRC	Joint Research Center
KISR	Kuwait Institute for Scientific Research
KMFRI	Kenya Marine and Fisheries Research Institute
MDGs	Millennium Development Goals

MLS	Minimum Landing Size
MSY	Maximum Sustainable Yield
NER	Net Economic Returns
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
RFBs	Regional Fishery Bodies
RFMOs	Regional Fisheries Management Organizations
RPs	Reference points
SAGARPA	Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food Mexico
SBPR	Stock biomass-per-recruit or spawning potential per recruit analysis
SDGs	Sustainable Development Goals
SSB	Spawning stock biomass
STECF	Scientific, Technical and Economic Committee for Fisheries
TACs	Total Allowable Catches
UN	United Nations
UN DESA	United Nations Department of Economic and Social Affairs
VPA	Virtual Population Analysis
YPR	Yield per recruit

TECHNICAL REFERENCE POINTS

$B_{0.1}$	Biomass produced when $F=F_{0.1}$ in equilibrium conditions
B_{lim}	Limit reference point biomass
B_{MSY}	Biomass that would produce the MSY
$F_{\%SPR}$	Fishing mortality rate that allows for a defined percentage of the spawning biomass potential (i.e. $F_{20\%SPR}$, $F_{35\%SPR}$, etc.)
$F_{0.1}$	F at which the slope of the YPR curve is 10 percent of its slope at the origin (also $F_{0.2}$, $F_{0.x}$ etc.)
F_{max}	F giving the maximum YPR in a dynamic pool model
F_{MSY}	F that would produce the MSY
MSY	Maximum Sustainable Yield
SSB_{MSY}	Spawning stock biomass that would produce the MSY

DAY 1

Opening of the workshop

1. Within the framework of the Sustainable Development Goals (SDGs), the Food and Agriculture Organization of the United Nations (FAO) organized the Technical Workshop on "Best-practices for the implementation and reporting of SDG Indicator 14.4.1 – Percentage of biologically sustainable fish stocks" which took place from the 21 to 24 November 2017 at FAO headquarters in Rome, Italy.

2. The workshop was attended by 12 participants with specific expertise on fish stock assessment and from countries listed in Appendix 1.

3. The meeting was opened by Mr Yimin Ye, Chief of the Marine and Inland Fisheries Branch, who welcomed the participants and invited them to introduce themselves. Mr Ye also thanked Mr Ernesto Jardim and Mr Paris Vasilakopoulos of the Joint Research Center (JRC) of the European Commission (EC) for accepting FAO's invitation to support the workshop by sharing their practice and experience concerning the production and reporting of SDG Indicator 14.4.1.

4. The agenda was introduced by Mr Marcelo Vasconcellos, FAO Fisheries Officer, and adopted with no amendments as under Appendix 2.

5. Mr Ye explained that the workshop was the first initiative taken by FAO aimed at assisting countries in the reporting of Indicator 14.4.1 and that a process of selection of the participants had been carried out to ensure a balanced involvement of developing countries from South and Central America, Africa, and Asia and a good level of competence and engagement during the workshop. A recommendation to participate actively in the discussions was made to ensure that different perspectives are considered in the drafting of guidelines to produce SDG Indicator 14.4.1.

6. Mr Ye presented the objectives and expected outputs of the workshop. It was clarified that the first objective was to raise awareness of the SDGs and in particular of SDG 14 and its Targets and Indicators, with specific emphasis on Indicator 14.4.1. The second objective was to provide technical training in data requirements, the data collection process, the analytical methods to produce the indicator, and the monitoring process. In this respect, it was explained that training on the use of a specific online tool for estimating stock status, specifically developed for this purpose, was going to be the focus of day three of the workshop. The third objective was to discuss the practicality of estimating and reporting the indicator at a country level compared to the current practice of estimating stock status by FAO statistical Area. As not many developing countries are known to be self-monitoring fish stock status, attention should be paid to producing specific guidelines that consider the problems faced by these countries in terms of capacity and data availability. Finally, the last objective was to provide guidance on the best practices in the estimation and reporting of Indicator 14.4.1 in support of the countries that could not be involved.

The 2030 Agenda for Sustainable Development, its targets and fisheries-related indicators

7. Mr Ye delivered the first presentation "Transforming our world: the 2030 Agenda for Sustainable Development". The Agenda and its 17 SDGs, otherwise known as the Global Goals, was adopted in 2015 by 193 countries and is a follow up of the Millennium Development Goals (MDGs), which has 8 goals. The SDGs, with 169 targets and 268 indicators, are broader in scope and go further than the MDGs. They are universal and apply to all countries, whereas the MDGs are intended for action in developing countries only. The MDGs address environmental sustainability through Goal 7 and fisheries through Indicator 7.4 - Proportion of fish stocks within safe biological limits. The SDGs include a specific goal - Goal 14 – aimed at conserving and sustainably using the oceans, seas and marine resources for sustainable development. It includes 10 Targets, of which several aim at addressing the root causes of overfishing and the marine ecosystem degradation which impacts stock levels. In particular, Target 14.4 states: "By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce Maximum Sustainable Yield (MSY) as determined by their biological characteristics".

Progress by countries towards this Target will be measured and monitored through the annual reporting of SDG Indicator 14.4.1 - Proportion of fish stocks within biologically sustainable levels. FAO is the 'custodian' United Nations (UN) agency for this and additional 20 indicators and a contributing agency for four more.

8. During the presentation, several points were raised by the participants. The question was raised as to whether guidelines established by the UN for the production and reporting of the indicators and adopted by the countries were already in place. It was explained that no guidance was provided on how to produce and report indicator 14.4.1 by FAO and that this workshop was the first step in this direction. Moreover, it is FAO responsibility to provide technical support to facilitate the assessments and the reporting of the indicators, but the countries must show interest and demonstrate the will to be assisted. The reporting of SDG indicators by each country is mandatory but the countries have the authority to decide which indicator to report. If for some reasons, such as the lack of capacity or data, a country does not consider the reporting of a specific indicator feasible, it can decide not to report it. The need for a set of standards that countries should follow to report the indicator in a consistent manner and a clear definition of what is a "biologically sustainable fish stock" was stressed. Participants noted that since there are links between SDG goals, achieving success in one of the targets, such as Target 14.4 could influence the progress and success of other goals and targets. For example, in order to reduce overfishing, a country could decide to reduce the capacity of the fishing fleet and therefore the number of people employed, and this could have a negative impact on the target that promotes employment. It was explained that it's each country's responsibility to consider the interactions between the targets and to define priorities and that FAO is only responsible for providing technical advice on how to estimate, monitor and report an indicator. However, FAO can highlight these links and encourages the people assessing the different indicators to work together. Participants added that each country should look at the totality of the SDGs and set up a system where progress is measured not necessarily by looking at each single indicator but at the SDGs as a whole. It was asked if FAO is monitoring the work of the countries with respect to the reporting of SDGs indicators. It was clarified that the United Nations Department of Economic and Social Affairs (UN DESA) has the overall responsibility of monitoring which countries are reporting SDGs but for specific goals this responsibility has been assigned to other agencies and institutions. Participants inquired whether countries should assess shared stocks and what links should the countries have with the Regional Fishery Bodies (RFBs). It was explained that countries should exclude the migrating and shared stocks from the estimation of the indicator as the estimation of these stocks require data from all relevant countries and thus should be handled by the RFBs.

Practice and experience in the assessment and reporting of fishery resource status and trends in the United States and Australia

9. Mr. Moustahfid, FAO Senior Fisheries Officer, delivered a presentation regarding the United States' practice and experience in assessment and reporting of fishery resources status and trends. U.S. commercial and recreational fishing generated $208 billion in sales, contributed $97 billion to the gross domestic product and supported 1.6 million jobs in 2015. Fisheries in the U.S. is handled by the National Marine Fisheries Service (NMFS) that is a United States federal agency, informally known as National Oceanic and Atmospheric Administration (NOAA) Fisheries. NMFS is responsible for the stewardship and management of the nation's living marine resources and their habitat within the United States' Exclusive Economic Zone, which extends seaward 200 nautical miles from the coastline. Using the tools provided by the Magnuson-Stevens Fishery Conservation and Management Act, the NMFS assesses and predicts the status of fish stocks, ensures compliance with fisheries regulations and works to end wasteful fishing practices. Under the Marine Mammal Protection Act and the Endangered Species Act, the agency is also tasked with recovering protected marine species such as wild salmon, whales and sea turtles. With the help of the six regional science centers, eight regional fisheries management councils, the coastal states and territories, and three interstate fisheries management commissions, NMFS conserves and manages marine fisheries to promote sustainability and to prevent lost economic potential associated with overfishing, declining species, and degraded habitats. The agency also attempts to balance competing public needs for the natural resources under its management. NMFS's Office of Sustainable Fisheries is responsible for updating the status of fish stocks managed under federal fishery management plans in quarterly basis.

NMFS measures the performance of U.S. federal fisheries through the Fish Stock Sustainability Index (FSSI). First implemented in 2005, the FSSI is a quarterly index that currently includes 199 fish stocks selected because of their importance to commercial and recreational fisheries. The FSSI measures the performance of these important fish stocks, which represent 85 percent of total catch. The FSSI increases when NOAA Fisheries determines the status of a stock and when a stock's status improves (either no longer subject to overfishing, no longer overfished, biomass increases to at least 80 percent of target, or is rebuilt). The number of stocks in the index may be revised as new fisheries develop and stocks are assessed. The FSSI has shown significant progress since 2000 ranging, on a 1000 points scale, from 382.5 points to 754 points in 2016.

10. During Mr Moustahfid's presentation, workshop participants asked for clarifications regarding i) the criteria for selecting the stocks included in the FSSI index, ii) the criteria for calculating the FSSI index, iii) the criteria for defining RPs, iv), the need for taking into account the changes in the RPs for each stock and v) the advantages and disadvantages of using a composite indicator. They also noted that the use of a composite indicator, such as the FSSI is useful only to measure the trend of fish stocks status in a country, but is not suitable for comparisons among countries as different criteria may be employed. Participants stressed the need for maximum transparency regarding the criteria and methods employed to define stock status. All participants agreed that particular attention should be given to the definition of criteria and cut points for the selection of a reference list of stocks to be assessed and used to produce and report Indicator 14.4.1. Since a composite indicator is also difficult to communicate to the fisheries stakeholders, participants stressed the need for maximum transparency regarding the criteria and methods employed to define stock status. All participants agreed that particular attention should be given to the definition of criteria and cut points for the selection of a reference list of stocks to be assessed and used to produce and report Indicator 14.4.1.

11. Mr Ye delivered a presentation focusing on Australia's practice and experience in assessment and reporting of fishery resource status and trends. Fisheries management and the sustainable use of fisheries resources in Australia is carried out by Australian states out to 3 nautical miles and by the Australian Government from 3 to 200 nautical miles. Australia's marine fisheries production is about 250 000 tonnes of which 90 000 tonnes are from Aquaculture. The export of fish products is still lower than the import and the latter varies greatly from year to year due to the variation of the exchange rate. Annual fish consumption is 27 kg/person, which is higher than the world average, but still lower than most developed countries. The Agency responsible for assessing fisheries and providing management advice is the Australian Fisheries Management Authority (AFMA) together with the Fisheries Research and Development Corporation (FRDC). Each fishery is covered by a resource assessment group and management advisory committee. The assessment groups, mainly composed of scientists, provide advice and recommendations to management advisory committees on the status of fish stocks and on the impact of fishing on the marine environment. The advisory committees, formed by a wider range of stakeholders, is responsible for adopting or rejecting the advice. The main law governing fisheries management is the Fisheries Management Act adopted in 1991. The Act's objective is to maintain fish stocks at ecologically sustainable levels and, within this context, maximize the Net Economic Returns (NER) to the Australian community. Stock status is expressed in relation to the RPs prescribed by the Commonwealth Fisheries Harvest Strategy Policy (HSP) as a function of both biomass (B) and fishing mortality (F). In 2015, 93 stocks were assessed and in terms of biomass, 69 were considered not overfished, 11 overfished and 13 uncertain if overfished. In general, the trends show an improvement of the performance in terms of the biological status of fish stocks in Australian Government–managed fisheries. Metadata is made available by means of annual reports and several internet sources ensuring full transparency and accessibility.

12. Participants noted that Australia reports fish stock status in an explicit and effective way. In fact, the raw number of stocks that are known to be overfished, not overfished and uncertain if overfished are provided instead of a percentage or a composite index. However, they also emphasized weaknesses in this approach such as the variability in the number of assessed stock by year and the high number of stocks that for a lack of data cannot be assessed even if important. In estimating a percentage of overfished stocks, the decision of including or excluding the uncertain stocks would have to be taken and it would be subjective. Therefore, the

participants suggested that, ideally, the reference list of stocks to be assessed should only include those for which data are available.

European Union practice and experience in the production and reporting of SDG indicator 14.4.1

13. Mr Jardim presented the European Union (EU) practice and experience in the production and reporting of SDG 14.4.1. The computing of an indicator of fish stocks status started from a specific request of the European Parliament under the remit of the Common Fisheries Policy (CFP), a set of rules for managing European fisheries and for conserving fish stocks. The CFP's basic quantifiable objectives are that stocks should be fished at their MSY ($F \leq F_{msy}$) and their spawning stock biomass (SSB) should be above the MSY reference level ($SSB \geq SSB_{msy}$). Of these two indicators, the EU will use the former to compute indicator 14.4.1 and to monitor progress on achieving SDG Target 14.4. Most likely a single indicator for Northeast Atlantic stocks will be reported to the UN as these are all shared by at least two countries. The reporting of an indicator for the Mediterranean stocks is still under discussion due to the high annual variability in the number of stocks assessed, which makes the percentages difficult to compare. The process for computing and reporting the indicator includes data collection and scientific research by institutes of member states who then contribute with the best scientific information available to RFMOs such as GFCM, ICES and ICCAT. These organizations are then responsible for undertaking stock assessments and providing advice that feeds back into the EU and its member states. Stock assessments for EU stocks in the Mediterranean are also produced by the Scientific, Technical and Economic Committee for Fisheries (STECF). Next, the Joint Research Center (JRC) on behalf of STECF computes CFP indicators based on the available stock assessments for each region. Finally, EUROSTAT, who's responsible for reporting indicator 14.4.1 to the United Nations, uses the indicator computed by STECF/JRC avoiding duplicating work and guaranteeing consistency. The indicator is computed annually based on reference points that may change over time. When this happens, the new reference points are applied to the entire time series and the annual indicators are recomputed. The reference list of stocks used for producing the indicator is composed of species that (i) have total allowable catches (North East Atlantic), or (ii) are either important in terms of production, value, or both (Mediterranean). If required other traditionally important species may be added to the list.

14. During the presentation the advantages and disadvantages of reporting only one indicator were highlighted. The benefits of reporting the percentage of biologically sustainable fish stocks is that it is easy to compute and to communicate to both the general public and stakeholders. However, the downsides of producing a single indicator are that i) it has a high sensitivity to the variation of the number of assessed stocks through time, ii) it assigns the same weight to each stock independently of their size and extent, and iii) it does not provide any information about the distance of each stock from the reference points. Regarding this last point, it was explained that the EU is proposing that a second indicator be reported to the UN to provide a more accurate picture of stock status and this is the average trend of F/F_{msy}. Finally, it was recommended that a protocol for producing indicator 14.4.1 be developed and maintained unchanged for a couple of years. The protocol should include the following elements i) a reference list of stocks to be considered, ii) criteria for the selection of a specific indicator, iii) the definition of update rules in the event of changes in the number of stocks, reference points, etc., iv) the technical details about the way the indicator is computed. It is also recommended using data that are publicly available and assessments that have been accepted.

15. Mr Vasilakopoulos chaired a technical session during which participants were asked to work with an Excel spreadsheet including time series data of F/F_{MSY} for a number of Mediterranean fish stocks that had been analytically assessed. It was stressed that in the Mediterranean, the number of assessed stocks varied greatly by year, with a remarkable increase in data availability after the late 90's, and that not all stocks were assessed every year. The participants were asked to decide which period of time they would select to provide a good representation of the past and current status of Mediterranean fish stocks, and a number of different choices were discussed. Then, it was shown that stocks were assigned to categories such as small pelagic fish, demersal fish and crustaceans and that the status of each category was very different. For example, demersal fishes had generally higher values of F/F_{MSY} than small pelagic fishes. Moreover, the number of assessed stocks in each category was different, i.e. more stocks of demersal fish than small pelagics and crustaceans. Based on these facts, it was asked that the effect of stocks' selection on the indicator's trend be checked. The results showed

that the indicator changed considerably when certain stocks were excluded from the analysis. Therefore, it was recommended that high consideration be given to the criteria for selecting the stocks and a balanced contribution of stocks with different degrees of resilience should be taken into account. The last exercise was carried out on a dataset where stocks were weighed by value and by Spawning Stock Biomass and it was followed by a discussion on the effectiveness of the weighting process. Participants agreed that weighting should be undertaken only if there is an interest at looking at stock status from either an economic, ecological or food security perspective. Moreover, a first weighting process is undertaken when the reference list of stocks is built, and stocks are included according to their importance in terms of value, biomass or ecological role.

DAY 2

Country's presentations: fishery stock assessment, management, and monitoring of resource sustainability

16. The second day of the workshop was dedicated to the presentations by each participant focusing on their country's fisheries, resource management, stock assessment, and monitoring of resource sustainability.

17. The first presentation was delivered by Mr Juan-Carlos Quiroz, Head of the Stock Assessment Department of the Fisheries Research Division, Instituto de Fomento Pesquero (IFOP) of Chile. The first part of the presentation focused on the Chilean Fishery Sector and on the role of IFOP. Details about the monitoring system and data gathered, together with a description of the main sampling sites and species groups for which data are collected, were provided. The main Chilean fisheries target three main groups, i.e. demersal and pelagic fishes, and crustaceans. These groups are those for which the greatest quantity and quality of data is available. Eighteen demersal, four small pelagic and six crustacean species are monitored in two zones, i.e. central-southern and austral zones. These are caught by both the industrial and artisanal fishing fleet. Small pelagics are the most important group in terms of total catches but less information is available for carrying out stock assessment compared to the demersal species. Among the crustaceans, two species of king crabs, which are caught in the austral zone, are very important in terms of value. The second part of the presentation focused on the fishery management framework. Up to 2008, the management process was carried out only by government managers without scientific feed-back. In 2009, a scientific advisory committee was established but had no right to make decisions about Total Allowable Catches (TACs). In 2013, significant amendments to the Fishery Act (1992) were made and subsequently, a tiers system to categorize the information available, establish the technical standards and demarcate the available methods for estimating RPs was established. The new Fisheries Act mandates the use of F_{MSY}, Stock Biomass (B_{MSY}) and associated B_{lim} as the primary RPs for fishery management. Between 2014 and 2017, phase plots have been used to determine the exploitation status according to proxy-MSY RPs. The characteristics of the tiers system were illustrated. Tier 1 focuses on 20 stocks that are assessed by means of complex methods, such as length or age integrated models, whereas Tier 2 and 3 focus on 7 data poor species which are assessed with simpler models such as catch MSY and CPUE methods. Finally, results from age-structured and other models for stocks assessed under each Tier were presented.

18. Mr Yongjun Tian, scientist at the Laboratory of Fisheries Oceanography, Ocean University of China provided an overview of marine capture fisheries in China. Chinese fisheries have a large impact on global fisheries trends as capture fisheries and aquaculture contribute largely to the world's fisheries production. China's total fisheries production increased greatly since the '90s, due to the development of the aquaculture sector. Marine capture production increased remarkably between 1980 and 2000 but remained stable afterwards. On the other hand, Catch per Unit Effort (CPUE) declined sharply in the '50s and has remained at low-levels since the '80s. In terms of fishing effort, the number of fishing boats first increased rapidly between 1980 and 2000 and it then decreased, but this reduction mostly concerned the smaller and less powerful boats. China also has an important distant water fishing fleet that has increased in the last 30 years both in terms of catch and effort. Regarding the marine catch composition, about 70 percent is represented by fishes, but invertebrates have increased in the last 35 years. China's main fisheries law was adopted in 1986. One of its main objectives was to develop distant-water fisheries, while maintaining the coastal fisheries at a reasonable level of exploitation by means of fisheries management actions. Recently, catch quota and fishing license

systems have been implemented, but with limited success. Moreover, a Summer Fishing Moratorium System has also been enforced since 1995. In 2017, this moratorium will affect almost all Chinese waters between the 1st of May to the 16th of September for all fisheries except for the one targeting angler fish. This system seems to be working but the effect needs to be scientifically evaluated. The ten dominant marine capture species have not changed in the last 30 years. The most important species is the large-head hairtail. Its catches have increased remarkably since the '90s but the percentage of older individuals (5+ years) has declined significantly. The small yellow croaker seems to be recovering despite over-exploitation, but catches are dominated by 1-year individuals. Other examples of declining trends in the average length of important fish species were shown. Stock assessment in China is not carried out systematically by national institutions. Assessments are undertaken by research institutes and universities but are mainly based on catch or survey data.

19. Ms Ching Villanueva, Marine Ecology and food web research scientist of IFREMER, delivered a presentation entitled "Fisheries assessment: Martinique dilemma". Martinique is one of the overseas French territories. It has a small Exclusive Economic Zone (EEZ) and continental shelf and its population in gradually declining. The contribution of the fisheries sector to the Gross domestic product (GDP) is one percent and aquaculture is under development. The fishing fleet is mainly artisanal and there is a large number of landing sites (>100 all around the island). Data on landings are unsystematic and show that catches, characterized by a high diversity of species, have increased between 1987 and 1992 followed by a decrease in 1994. Demersal fishes are overfished and pelagics' exploitation has increased because of the growing utilization of Fishing Aggregating Devices (FADs) since their introduction during the early 1980s. However, catches of all species groups, especially the demersal fishes, have declined in the last 25 years. The decline of off-shore pelagic catches is due to the decline in fish consumption and an increase in fish imports. Small pelagic fish catches have decreased but the assessment of these species, because of their biological characteristics is not considered necessary and only landings and effort data are collected. In contrast, the assessment of demersal resources, exploited on the insular shelf and subject to an increasing fishing pressure, is required but difficult to accomplish. The main policy objectives in the last 20 years have been to i) preserve the highest level of employment, ii) increase fishers' income and, iii) protect and conserve resources, especially in coastal areas. To reach these objectives, fisheries management measures, such as subsidies, conservation measures and the regulation of access to resources, have been implemented. Several issues make stock assessment difficult. The main ones are i) difficulties in collecting data because of the high number of ports and limited infrastructures, ii) lack of knowledge on multi-species composition and biology of caught species, iii) inconsistent catch/gear declarations, iv) development of illegal FADs, and v) increase of recreational boats.

20. Ms Muktha Menon, scientist at the Central Marine Fisheries Research Institute (CMFRI) of India, delivered a presentation focusing on Marine Fisheries of India. The country's total fish production in 2016 was 10.79 million tonnes, and 3.58 million tonnes came from marine capture fisheries. India is the 7th largest contributor to global marine catches and it lands mainly pelagic (52 percent) and demersal species (29 percent). The marine fishing fleet comprises three sectors, mechanized (both vessel and gear mechanized), motorized (only vessel mechanized) and artisanal vessels (no mechanization). The major fishing gears are trawls, bagnets and gillnets and there are more than 30 craft gear combinations. Fisheries management is carried out at two levels: resources within 12 nm are managed by the 10 coastal States respectively, whereas the central government manages those between 12 and 200 nm. The main Policy pertaining to fisheries is the "National Policy and Marine Fisheries 2017" which has 62 statements covering all aspects of marine fisheries. Additionally, each State has its own Marine Fishing Regulation Act which regulates fishing in its territorial waters. The research carried out by CMFRI supports both the States and the central government. Landing data is estimated by means of a stratified multistage random sampling design. Resources for stock assessment are selected based on local commercial importance and other factors. Length frequency data is collected from commercial fishery data and samples are brought to the laboratory for reproduction and trophic ecology studies. Based on the collected data, stock status is assessed, and the main methods used are length based fish stock assessment models for the estimation of growth and mortality parameters, length-cohort analysis (Virtual Population Analysis) and the Thompson and Bell Model. The Beverton and Holt Yield-per-recruit model is also used. Based on the Stock Status Plot methodology, the status of the nation's marine fish resources (n=63) indicates that 82.5 percent of them are fully exploited, 9.5 percent are over exploited, 4.8 percent are collapsed

and 3.2 percent are recovering. Of 29 stocks of pelagic species assessed, 8 have F/F_{msy} >1. Of 25 demersal stocks assessed, 4 have F/F_{msy} >1. Of 19 Crustacean stocks assessed 5 have F/F_{msy} >1 and of 7 molluscan stocks assessed 3 have F/F_{msy} >1.

21. Mr Tooraj Valinassab, scientist of the Iranian Fisheries Science Research Institute (IFSRI), presented an overview of fisheries management and monitoring surveys on different resources in the Iranian waters. Overall, the Iranian fisheries sector provides employment to about 143 000 people and the fishing fleet is composed of about 11 500 vessels, half of which target tunas. Total production in 2013 was about 885 000 tonnes and tunas account for about 180 000 tonnes. The main fisheries institution is the Iran Fisheries Organization (IFO) which conceives, implements, and coordinates the State's fisheries and marine resource policy and research, whereas the IFSRI is responsible for carrying out stocks assessment. Demersal resources are assessed by means of a survey covering Iranian waters and during which data on species composition, Catch per Unit Area (CPUA), biomass and distribution patterns are collected. The protocol entails the collection of data on 103 Species, Genera or Fish groups of both commercial and non-commercial importance. CPUA trends are analyzed and compared to previous years' trends to detect changes in catches by area. Length data are also collected for about 20 important species to determine their length at maturity, define a Minimum Landing Size (MLS), standardize mesh size for gillnets or trawls and to detect trends in the mean length over time. The ratio between by-catch and total catch of bottom trawlers is also calculated. Mesopelagic fish is an important fisheries resource for the production of fishmeal and is mainly harvested in the Oman Sea. Different methods are used to conduct stock assessment, including yield per recruit and biomass depletion models.

22. Mr Paul Tuda, PhD candidate at the Leibniz Centre for Tropical Marine Research of Bremen, delivered a presentation entitled "Kenyan coastal fishery: challenges for its assessment". In Kenya, fisheries contribute significantly to the livelihoods of over 1.2 million people (~ 3 percent), with the inland sector being the most important one (85 percent of total production), followed by fish farming and marine capture fisheries (6 percent of total production). The marine fisheries are predominantly artisanal with most vessels being non-motorized, and with only three trawlers targeting prawns. Fifty distant water vessels are also fishing in Kenya waters. Recreational fisheries are also important, but no information is available regarding its extent. The main fisheries resources are demersal (50 percent) and pelagic (28 percent) species. These two groups are also those whose catches have increased the most over the last 30 years, but this seems due to the improvements made in data collection. The main fisheries law is the Fisheries Act, which was revised in 1991 and which regulates, for example, the registration of fishing vessels and licensing provisions, offences and enforcements and general provisions. Other important legal instruments are the Wildlife Act, and the National Oceans and Fisheries Policy which provides a broad framework for addressing fisheries management. The primary fisheries institution is the Fisheries Department of the Ministry of Agriculture Livestock and Fisheries which is mandated to manage and conserve fishery resources, control stock status, collect fisheries statistics and enforce fisheries legislation. The Kenya Marine and Fisheries Research Institute (KMFRI) also conducts research on fishery matters including stock assessment. Fisheries data are collected by several public and private organizations but there is no harmonization of the data collection protocol and data accessibility is limited. The objective set by the Fisheries Department is to exploit the marine natural resources at MSY. Currently, the estimated MSY is 8 781 tonnes but current extraction is 9 800 tonnes. In terms of effort, an optimal fishing effort would be 4 625 boats but there are 5 600 boats currently fishing. Therefore, concerns of over-exploitation have been raised since the '80s and a recent case study on the southern coast of Kenya confirmed these concerns. The reporting of SDG indicator 14.4.1 could be an opportunity to improve the data collection system leading to improved stock assessment and management.

23. Mr Mohsen Al-Husaini, scientist at the Kuwait Institute for Scientific Research (KISR), delivered a presentation entitled "Kuwait's Fishery: Structure, Management, and Aspects of Stock Assessment". Kuwait has a multi-gear and multispecies fishery with about 25 commercial species. Fish landings in the past two decades have declined from about 11 000 tonnes in the late '80s to 4 288 tonnes in 2015 (excluding shrimps). A number of Kuwait's iconic species have seen the largest declines in production. As a consequence, local production now meets only 16 percent of domestic demand resulting in a high dependence on imported fish. The main fishing gears are trawls (targeting shrimps), traps (targeting various demersal species) and gillnets

(targeting medium pelagic species). The main regulations and conservation measures include i) closed fishing seasons, ii) closed fishing areas, iii) mesh-size regulations and, iv) minimum marketable lengths. Fisheries data are collected regularly by KISR for research purposes and the Kuwait Central Statistical Bureau has been collecting landings data since 1972. Moreover, surveys at sea have been conducted but they have become irregular after 1991. There have been no catch and effort or stock monitoring systems since 1991. Research activities started in 1977 with FAO's assistance on stock assessment of shrimp fishery and stock assessment of fin-fish started in 1979. Other 31 projects for collecting data to be used in stock assessment studies have been carried out since then. The major fisheries challenges faced by Kuwait are the high demand of fresh fish, illegal, unreported, and unregulated (IUU) fishing, environmental changes, i.e. reduction of fresh water input, habitat destruction caused by trawling and urban development, and the lack of surveillance and enforcement. The main stock assessment methods in use are production models, length-based methods, growth models, age-based biomass model, yield-per-recruit model, age-based VPA (improved) and Ecological Risk Assessment for Effect of Fishing (ERAEF). Recently, a project was developed to identify the causes for the decline in the landings and to prepare a management road map of what actions need to be undertaken to increase the sustainable production of Kuwait's fish resources. In this respect, a modified ERAEF method was used to address the impact of fishing on the ecosystem. Results show that most fish stocks are at risk due to overfishing and the changes in water salinity.

24. Mr Jesus Jurado-Molina, scientist at the Universidad Autónoma Metropolitana, Departamento del Hombre y su Ambiente of Mexico City, provided an overview of Mexican fisheries. Fisheries is an economic activity with great value and social importance. In 2013, the national production was 1.764 million t with a value of around 20 billion pesos. Eighty-five percent of the production comes from Pacific coast and 13 percent from the Gulf of Mexico and Caribbean Sea fisheries. The legal framework consists of the general law of sustainable fisheries and aquaculture, the national fishing chart and additional legal instruments. The main institutions dealing with fisheries are the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) and the National Commission of Aquaculture and Fisheries (CONAPESCA), which is an administrative entity of SAGARPA and is responsible for the management, coordination and development of policies regarding the use and sustainable exploitation of fisheries and aquatic resources. The Commission has the support of the National Fisheries Institute (INAPESCA), which has several research centers and conducts scientific and technological research and advises on preservation, repopulation and management of fishing resources. One of the main fisheries resources is the Yellowfin tuna *Thunnus albacares* which is managed by the Inter-American Tropical Tuna Commission (IATTC) in the Pacific and by the International Commission for the Conservation of Atlantic Tunas (ICCAT) in the Gulf of Mexico and Caribbean Sea. Detailed data for this species are collected and various RPs and stock assessment models are employed. The fishery targeting shrimps is very important in the Pacific, but no stock assessment is used for the management of the fishery. Closed seasons have been established with the purpose of limiting fishing effort. Small pelagic fisheries in the Pacific produce the largest proportion of Mexican catches. A minimum landing size has been established for the main small pelagic species and stock assessment is carried out. The RPs are MSY (~ 700 000 tonnes) and a biologically acceptable catch (BAC) computed as a fraction of the estimated MSY. The octopus fishery in Yucatan is the fifth most important fishery in Mexico due to its commercial value. The main management measures for this resource include a minimum size of capture, a quota system and a closed season and, even if data for stock assessment is available, it is not carried out. Finally, a number of areas of improvement for fisheries management, such as transparency, capacity building, stock definition, stock assessment, adequate use of RPs, and improvement of management plans were illustrated.

25. Mr Jilali Bensbai, scientist at the National Institute for Fisheries Research (INRH) of Morocco, provided an overview of Moroccan marine capture fisheries and management schemes. In 2015, Morocco's fisheries production was more than 1 million tonnes, ranking 1st among African countries. The main fishery resources are small pelagics (84 percent of total production), followed by cephalopods and other fish species. However, in terms of value, cephalopods are more important than small pelagic fishes. The national fleet is composed of a high number of artisanal vessels, but coastal and deep-water vessels are also widespread. The main fisheries management objective regarding resource sustainability is to have 95 percent of stocks sustainably fished by 2020. To achieve this objective, a number of fisheries management plans are in place. Plans for small pelagics,

octopus, shrimps, hakes, tunas, swordfish, sharks, corals, seaweeds and lobsters entail the use of several conservation and management measures such as TACs, spatio-temporal closings, effort, gears and minimum size measures, etc. Other relevant legislation exists in support of fisheries management. Data collection is carried out by three institutes and the INRH is the institution responsible for collecting data relevant to fish stock assessment. Data are collected by means of scientific surveys, commercial fleet boarding, biological sampling, socio-economic monitoring and oceanographic and environmental monitoring. The collected data are prepared by researchers at INRH and analyzed annually by a national working group on stock assessment. Data are also presented and analyzed by other regional working groups such as CECAF and GFCM. Different models (dynamic version of the Schaefer model, length composition analysis & yield per recruit, VPA and CMSY-method) are used according to data availability, life cycle of species, consistency with the previous assessments and model's adjustment quality. The availability and quality of data for most stocks is high but there are gaps regarding age data. The main limit RPs are B/B_{MSY} and F/F_{MSY} and the target reference point are $B/B_{0.1}$ and $F/F_{0.1}$. In Morocco, $F_{0.1}$ is approximated to 90 percent of F_{MSY} and it is a precautionary proxy of F_{MSY}, whereas $B_{0.1}$ is assumed to be 110 percent of B_{MSY}, a precautionary proxy of B_{MSY}. Finally, the challenges that Moroccan research on stock assessment is facing were illustrated.

26. Mr Osvaldo Chacate, scientist of the Fisheries Research Institute (IIP) of the Ministry of the Sea, Inland Waters and Fisheries of Mozambique, delivered a presentation entitled "Fisheries sector: data collection, stock assessment & management in Mozambique". Mozambique, located in Southeast Africa has the third longest coastline in the Indian Ocean. It comprises 7 coastal and 3 inland provinces and fisheries institutions are present in all provinces. Fisheries is an important sector, employing about 100 000 fishers, 70 percent of which are marine fishers. In terms of catches, the current marine production is about 200 000 tonnes and the artisanal sector is by far the most important. Data collection is carried out by four institutions. The National Fisheries Administration (ADNAP) is responsible for the collection of catch data, vessels statistics and CPUE data from the semi-industrial, industrial and recreational sectors. IIP collects length frequency and observer data from all sectors and catch and CPUE data from artisanal fisheries. In this latter case, a stratified random sampling system is adopted with the landing site as the basic sampling unit. The semi-industrial and industrial sectors are monitored by means of on board scientific observers, logbook information, and by recording catch when it is landed. Surveys for the estimation of the biomass of shrimps are also conducted. The main resources are i) shallow water shrimps, yearly assessed by means of traditional models, ii) deep-water crustaceans, assessed every 3 years, iii) demersal fishes, assessed every 4 years, iv) large pelagic fish, assessed by the Indian Ocean Tuna Commission (IOTC) and v) small pelagic fish, assessed every 5 years. Six stocks are formally assessed following FAO's assessment methodology. An example of the assessment of line fishery resources carried out in 2015 was illustrated. Results show that these resources are moderately exploited in northern Mozambique, fully exploited in the inner and intermediate shelf of central Mozambique and overexploited in shallow reefs of the southern areas. Management plans for these resources and shallow water shrimps have been adopted in the last years.

27. Mr Miguel Ñiquen Carranza, general director of the Research on Pelagic Resources division of the Instituto Del Mar Del Peru (IMARPE), presented "Fisheries Monitoring, Stock assessment and Management of marine resources in Peru". The upwelling ecosystem off Peru (Humboldt current), is one of the most productive marine ecosystems in the world. This high primary and secondary productivity supports 10 to 15 percent of total world landings. In 2016, total landings of Peruvian fisheries were about 4 million tonnes. This important fishery is supported by a likewise important data collection system capable of monitoring fisheries catches. This system entails daily samplings at about 100 landing points and from about 10 percent of the active fishing vessels by means of on-board observers who collect and report data by mobile phone. Satellite data are also used to monitor the position and number of fishing vessels and oceanographic conditions. A daily report of capture and size structure of the catch by fishing zone, including the by-catch of juveniles is published online on IMARPE's webpage. Two biomass assessment surveys for pelagic and one for demersal species are conducted every year. The main fishery resource is the Anchoveta *Engraulis ringens* and two stocks are managed in Peruvian waters. Its production is strongly influenced by the impact of El-Ninho. Characteristics of the assessment of the main Peruvian fisheries were highlighted. Sixteen stocks are currently assessed. Overall, 46 percent of these are fully exploited, 30 percent overexploited, 20 percent recovering and 4 percent

underexploited. The management framework comprises IMARPE, the main scientific advisory institution, which reports to the Department of Fisheries Affairs and Development and to the Department of Surveillance and Inspection of the Vice-ministry of Fisheries under the umbrella of the Ministry of Production. The main law regarding fisheries is the General Fisheries Law (based on the FAO Code of Conduct for Responsible Fisheries) and management plans for hake, tuna, jumbo flying squid and toothfish are in place.

28. Mr Ali Cemal Gücü, scientist at the Middle East Technical University, Institute of Marine Sciences of Turkey delivered a presentation on "Fishery stock assessment, management, and monitoring of resource sustainability". Turkey's total capture production has increased until the late '80s (peak at ~ 600 000 tonnes), then declined and in the last years oscillated around 300 000 tonnes. With respect to the exploited species, the European anchovy, which is mainly caught in the Black Sea, is by far the most important species. This species spawns off the northeast and northwest coasts of the Black Sea and then migrates to the Turkish coast in winter where it forms dense aggregations and where it is caught by means of purse-seines over a two-month period. As the great production cannot be consumed entirely, anchovy is used as a fertilizer, fish meal for cultured species or transformed into fish oil and fishmeal. Turkey's total fleet comprised about 14 500 vessels. Eight percent of these are trawlers and purse-seines which contribute to about 95 percent of total landings. Fisheries is regulated by the Ministry of Food Agriculture and Livestock and by its two Directorate-Generals (DG), DG-Fisheries and Aquaculture and DG-Research and Policy. The former DG is responsible for the management, whereas the latter is responsible for collecting data and carrying out research activities. A number of Universities are also authorized by the Ministry to conduct research on fisheries. Stocks assessment is often not carried out, for the following reasons: Black Sea resources are subject to rapid environmental changes that affect the biomass of certain species and modify the structure and composition of the pelagic food-web. In the Mediterranean Sea, the migration of Lessepsian immigrants and annual variation in their number and biomass, which causes changes in the structure of the ecosystem and in the number of commercially important species. These issues make stock assessment and fisheries management problematic and regulations are fishery-specific rather than stock-specific. The main fisheries regulation is a 5-month seasonal closure for the entire fishing fleet. Moreover, to reduce fishing pressure on the stocks, the fleet has been reduced in number by a voluntary buy-back program. Finally, the assessment of shared resources is carried out by regional management organizations, such as GFCM.

DAY 3

Methods for the definition and estimation of stock status: methodologies and online facilities

29. Mr Vasconcellos opened the third day of the workshop by providing a summary of the main points that emerged from the country's presentation in terms of data availability, capacity, gaps and requirements in relation to the reporting of SDG Indicator 14.4.1. It was emphasized that no presentation referred to the reporting of the indicator, suggesting a lack of communication between each country's focal point for the SDGs and the institutions responsible for producing the indicator or a lack of clarity about the process for reporting the indicator. The presentations showed that several countries either collect sufficient data for carrying out fish stock assessments or already formally assess their main fish stocks. Therefore, the reporting of SDG indicator 14.4.1 for these countries is feasible and the only challenges seem to be related to the type of indicator to report to make it comparable to other countries' indicators. However, it appeared clear that the production and reporting of this indicator by other countries is more difficult due to the absence of, i) well-established management systems linking stock status to management decisions, ii) defined targets or RPs in the institutional arrangements, iii) defined criteria used to define stock status, iv) resources for carrying out stock assessments especially when multi-species and artisanal fisheries are predominant, v) capacity for transforming available data into an indicator of stock status.

30. In a following discussion, participants stressed the need for establishing a national reporting system on the status and trends of indicator 14.4.1 as it would also represent an opportunity to improve each country's fisheries management framework. The need for guidance from FAO on both the process for producing the indicator and the way of reporting it was also requested. In particular, there seems to be a lack of clarity regarding the identification of the national focal point for the SDGs. It was clarified that each country's

statistical department should have appointed a focal point responsible for the reporting on all SDGs. However, since countries can decide which indicator to report and given the difficulties in the production of indicator 14.4.1, focal point might still not have contacted fisheries departments. It was therefore recommended that each participant make an effort to identify and pro-actively engage with the focal point.

31. Mr Ye delivered a presentation on the status and trends of global marine fisheries resources. FAO classifies fish stock status into three categories, i.e. overfished, fully-exploited and non-fully exploited. Stock status is mainly based on its abundance levels, with defined MSY-based RPs. This criterion has been adopted in accordance with a number of legal instruments that require maintaining fish stocks at the biomass that can produce MSY, such as the Nations Convention on the Law of the Sea (UN, 1982), the United Nations Fish Stocks Agreement (UN, 1995), and the FAO Code of Conduct for Responsible Fisheries (FAO, 1995). SDG Target 14.4 also makes specific reference to stock levels that can produce MSY and therefore indicator 14.4.1 is also based on MSY. FAO carries out stock status assessment on a regional basis and results show a large geographical variation in the percentage of overfished stocks. The highest percentages of overfished stocks are in the Mediterranean Sea and the Southwest Atlantic, whereas the area with the lowest percentage is the Eastern Central Pacific. At the global level, trends in marine fish stock status show an increase in both the percentage of overfished and fully fished stocks and a decrease of the non-fully fished stocks. As the concept of fully fished stocks was perceived with a negative connotation, contrarily to FAO's intents, stocks are now classified as sustainably and unsustainably managed. The former category includes both the non-fully and fully exploited stocks, whereas the latter only the overfished stocks. Currently, 30 percent of the world's stocks are unsustainably managed but, in recent years, progress has been made especially by developed countries that have reduced or dislocated their fishing effort. As the developed countries are often importing fish from or directly fishing in developing countries' waters, these should contribute to relieving fishing pressures and thus improving management and governance in developed countries.

32. Mr Ye gave a presentation about the methods used to determine stock status. A stock assessment model is a mathematical simplification of a fish population and how it interacts with a fishery. A wide range of models combine basic equations describing the influences of fishing, recruitment, growth and natural mortality on the biomass of the stock. Three main categories of RPs are used to define stock status in practice, i.e spawner-recruit, dynamic pool and surplus production-based. Spawner-recruit-based RPs aim to produce maximum recruitment by controlling fishing at the level of Smax, i.e. the spawners needed to produce maximum recruitment. Dynamic pool-based RPs are i) Fmax - the fishing mortality rate that generates the maximum yield per recruit in accordance with the yield per recruit model. Its precautionary substitute $F_{0.1}$, the fishing mortality rate corresponding to 10 percent of the slope of the yield-per-recruit curve at the origin. And ii) $F_{20\%SPR}$ or $F_{35\%SPR}$, i.e. the fishing mortality rate that allows for 20 percent or 35 percent of the spawning biomass potential. Finally, surplus production-based RPs help achieving MSY by controlling fishing at F_{MSY} or B_{MSY}, the fishing mortality or stock biomass which correspond to the MSY. A list of different models that are used in practical stock assessment were presented and a mapping between model outputs and the three types of RPs was described.

33. Participants discussed the requirements for the selection of a specific stock assessment model and resulting indicator. It was explained that all the above-mentioned models are very demanding in terms of technical expertise and resources required to gather the data. Simpler and less demanding models exist but, of course, their outputs contain a greater deal of uncertainty. The decision as to which model to use largely depends on the type and quality of available data. When this is high, it is recommended that different models be used, and their outputs compared. In data poor situations, simpler methods should be preferred.

34. Mr Ye introduced the main tools used for the estimation of stock status in relation to the data possessed and Mr Gianpaolo Coro, scientist at the National Research Council (CNR) of Pisa, Italy, presented the online facility, specifically developed with the aim of assisting the technical workshop, comprising a set of stock assessment tools (see details in Appendix 3).

35. The first tool that was presented was a combination of ELEFAN, empirical models of estimating natural mortality rates and yield-per-recruit model. This simple tool was designed to estimate growth parameters, natural and fishing mortality rates and F_{max} or $F_{0.1}$ when only length frequency data are available. By comparing the current fishing mortality to the reference one, stock status is then determined. The second tool that was described was the CMSY, used when only catch or landing time series data is available. It assumes that the population dynamic follows a certain production model (usually Schaefer's production model). In addition, it also requires prior information on r and K, which can be derived from biological resilience information of the stock and on the stock level at the beginning and last year of the time series relative to carrying capacity K, which can be estimated by comparing the corresponding year's catch with the maximum catch observed. The output of the analysis are the trends of B/B_{MSY} and F/F_{MSY}. The advantages and disadvantages of using this method were emphasized. In general, it was recommended to use this method only for estimating stock status of a high number of stocks from a single region rather than for providing management advice on a single stock. Finally, two additional tools, a spawning stock biomass-per-recruit or spawning potential per recruit (SBPR) analysis and yield-per-recruit (YPR) analysis, were presented. These methods can be used to estimate the corresponding fishing mortality given the RP of SBPR or YPR is set in situations where growth and natural mortality rate of the species are known.

36. It was emphasized at the workshop that formal stock assessment is the most reliable method to determine stock status. Whenever possible, a formal stock assessment should be pursued. However, there is no such thing as the best method, as the best method should be chosen based on the data availability, biological characteristics and technical obtainability. The simple methods introduced here should be considered as the last resort as their results involve great uncertainty and often lack reliability, particularly when used to estimate a specific single stock. The possibility of using such simple methods should not be used as excuses for not investing in data collection and capacity building.

37. Participants practiced executing all methods by using the online tools with both sample datasheets and personal data.

DAY 4

Best practices for reporting on SDG indicator 14.4.1.

38. During the last day of the workshop, the participants discussed the need for drafting recommendations for the production and reporting of SDG indicator 14.4.1. The outcome of the discussion was a list of best practices that countries and FAO should follow for facilitating the work on SDG indicator 14.4.1:

1) The reporting of SDG indicator 14.4.1 should always be attempted by countries even in data-limited situations. Such reporting should build on existing fisheries monitoring programs established to inform fisheries management at a national level.

2) To ensure consistency and transparency in the reporting of fish stock status, the adoption of a SDG Indicator 14.4.1 protocol is recommended, defining:

   a. A reference list of stocks. In the development of the reference list, consideration should be given to the importance of the stock in terms of both volume and value, and ecological importance. The list should include stocks representative of different types of marine resources, including demersal fish, pelagic fish, crustaceans and other invertebrates. In lack of clearly defined stock units, countries should at least try to report the species or group at the country level. In multispecies fisheries, indicator stocks or species complex could be used. The list should remain unchanged for a number of years to allow for comparability. The list of stocks should include only those that are not shared between countries or assessed by Regional Fisheries Bodies (RFBs). In the absence of RFBs, countries are encouraged to collaborate for reporting on the status of shared resources.

b. Data and methods. Methods for the estimation of stock status should be selected based on the availability of data, biological characteristics of the species and environmental factors. Whenever possible, the estimation of stock status should be based on multiple sources of information and methods. To ensure transparency, the methods, data and full references should be clearly stated. When possible, metadata should be made available.

c. Reference points (RPs). The use of FAO's RPs (SOFIA, 2016) is encouraged. Whenever the RPs used to define stock status are revised and changed, the changes should be applied to the whole time series of stock status indicators. When RPs at the country level are considered different from those adopted by FAO, it is recommended that countries map them to FAO's system or report the differences.

d. Stock status indicators. The use of FAO's indicators (SOFIA, 2016[1]) is encouraged. Whenever possible, the status of fish stock should account for both fishing intensity (F) and stock abundance (B). In principle, stock status indicators should be updated annually.

3) In principle, this protocol should remain unchanged unless necessary.

4) A guideline document needs to be developed for the estimation and reporting of SDG indicator 14.4.1 while taking into consideration of the above elements.

5) Countries should establish a mechanism for the reporting of SDG 14.4.1, if not accomplished so far. The institutes responsible for stock assessment are encouraged to liaise with the fisheries authorities and the national institution responsible for reporting on SDG indicators to raise awareness about the reporting requirements and to ensure that the workflow is well understood. Given the relationships between SDG indicators and multiple institutions involved in their monitoring and reporting, strong coordination among national institutions is recommended.

6) FAO should bring to the attention of COFI members the needs and requirements for reporting SDG Target 14.4 and Indicator 14.4.1.

7) FAO should provide technical assistance to countries not yet in a condition to report stock status indicators due to limitations in data and/or technical capacities for stock assessment. In this regard, the implementation of training activities and the dissemination of online tools should be promoted.

8) Regional Fisheries Management Organizations and other Regional Fishery Bodies have an important role to play and are therefore encouraged to assist member countries in facilitating and supporting the reporting of SDG indicator 14.4.1.

9) FAO as a custodian agency for SDG Indicator 14.4.1 is responsible for compiling the indicator at a global level and reporting to the United Nations SDG framework.

Concluding remarks

39. The main conclusions of the workshop were as follows:

- A number of participating countries are periodically conducting fish stock assessments and would therefore not have much difficulty in producing SDG Indicator 14.4.1, provided that a standard

---

[1] FAO. 2016. *The State of World Fisheries and Aquaculture 2016. Contributing to food security and nutrition for all*. Rome. 200 pp.

reference list of stocks can be established and criteria for stock status determination can be harmonized for comparability. In contrast, other countries still seem to have limited data and capacity for stock assessment and therefore may face various challenges in the production of the Indicator.

- There is an obvious need for capacity development and guidance on how to estimate and report SDG Indicator 14.4.1, as far as the countries present at the workshop are concerned. Therefore, FAO shall continue to provide technical assistance to countries not yet in a condition to assess and report the Indicator by means of training activities and the dissemination of online tools for the estimation of fish stock status.

- The estimation of fish stock status is a data-demanding, skill intensive and costly process and developing countries should invest in both data collection and stock assessment. If formal stock assessment is impossible due to the lack of time series data or technical capacity, other less data-demanding, simple methods can be tried for estimating fish stock status, as long as due attention is given to the potential uncertainty involved in the results.

- The institutions carrying out fish stock assessments do not seem to be aware of their responsibilities towards the reporting of SDG Indicator 14.4.1. Therefore, communication and coordination between national statistical agencies, stock assessment institutions and those responsible for reporting and implementing SDG Indicator 14.4.1 should be improved.

- It is recommended that FAO develops guidelines for producing and reporting SDG Indicator 14.4.1 including data requirements, stock assessment methods, and reporting standards and procedures in different data and knowledge scenarios.

40. Participants found the workshop very useful and, by participating actively to the discussions and providing important information contributed significantly to its success.

41. The workshop closed with a group photo (Figure 1).

Figure 1 – Workshop participants

APPENDIX 1

List of participants (in alphabetical order by surname)

Mohsen AL-HUSAINI
Kuwait Institute for Scientific Research (KISR)
Kuwait City, Kuwait
Email: mhusaini@kisr.edu.kw

Jilali BENSBAI
Chef URD Exploitation et Gestion Des Pêches
Institut National de Recherche Halieutique
(INRH-Casa)
Email: j.bensbai@gmail.com

Osvaldo Ernesto CHACATE
Instituto Nacional de Investigação Pesqueira (IIP)
Maputo, Mozambique
Email: chacatemz@gmail.com

Ali Cemal GÜCÜ
Middle East technical University
Institute of Marine Science
Erdemli Mersin TURKEY 33731
Email: gucu@ims.metu.edu.tr

Ernesto JARDIM
Joint Research Center, European Commission
Ispra, Italy
Email: Ernesto.JARDIM@ec.europa.eu

Jesus JURADO-MOLINA
Universidad Autónoma Metropolitana,
Departamento del Hombre y su Ambiente
México City, México
Email: jesus1015@gmail.com

Muktha MENON
Central Marine Fisheries Research Institute
(CMFRI)
Vizag, India
Email: muktham@gmail.com

Miguel ÑIQUEN CARRANZA
Investigaciones de Recursos Pelágicos, Neríticos y
Oceánicos, Instituto Del Mar Del Peru (IMARPE)
Callao, Peru
Email: mniquen@imarpe.gob.pe

Juan-Carlos QUIROZ
Fisheries Research Division, Instituto de Fomento
Pesquero (IFOP)
Valparaiso, Chile
Email: juancarlos.quiroz@ifop.cl

Yongjun TIAN
Laboratory of Fisheries Oceanography, Ocean
University of China
Qingdao, China
Email: yjtian@ouc.edu.cn

Paul TUDA
Leibniz Centre for Tropical Marine Research
(ZMT)
Bremen, Germany
Email: paul.tuda@leibniz-zmt.de

Tooraj VALINASSAB
Iranian Fisheries Science Research Institute
Teheran, Iran
Email: t_valinassab@yahoo.com

Paris VASILAKOPOULOS
Joint Research Center, European Commission
Ispra, Italy
Email: paris.vasilakopoulos@ec.europa.eu

Ching VILLANUEVA
Institut Français de Recherche pour l'Exploitation
de la Mer (IFREMER)
Brest, France
Email: Ching.Villanueva@ifremer.fr

FAO

Yimin YE
Chief
Marine and Inland Fisheries Branch (FIAF)
Email: Yimin.ye@fao.org

Marcelo VASCONCELLOS
Fishery Resources Officer
Marine and Inland Fisheries Branch (FIAF)
Email: marcelo.vasconcellos@fao.org

Hassan MOUSTAHFID
Senior Fishery Resources Officer
Marine and Inland Fisheries Branch (FIAF)
Email: hassan.moustahfid@fao.org

Edoardo MOSTARDA
Fisheries Information Consultant
Marine and Inland Fisheries Branch (FIAF)
Email: edoardo.mostarda@fao.org

Marc TACONET
Senior Fishery Officer
Statistics and Information Branch (FIAS)
Email: Marc.Taconet@fao.org

Giulia GORELLI
Fisheries Information Manager
Statistics and Information Branch (FIAS)
Email: giulia.gorelli@fao.org

APPENDIX 2

Technical workshop on "Best-practices for the implementation and reporting of SDG Indicator 14.4.1 - Percentage of biologically sustainable fish stocks"

FAO Headquarters – India Room - November 21 to 24, 2017

Workshop Agenda

Day 1: Tuesday 21 November 2017	
09:00 – 10:30 Chair: (Vasconcellos, FAO)	***Opening and introduction of the 2030 Agenda and SDGS*** Welcome address by FAO Fishery Officers/workshop facilitators - Self-introduction of participants - Overview of the workshop objectives, activities and expected outputs (Yimin Ye, FAO) - The 2030 Agenda for Sustainable Development and the 17 Sustainable Development Goals (SDGs) (Yimin Ye, FAO) - SDG Target 14.4 and its Indicator: rationale for monitoring, significance, relevance to other SDG indicators, reporting process, current situation, and way forward (Yimin Ye, FAO)
10:30 – 11:00	*Refreshment break*
11:00 – 13:00 Chair: (Vasconcellos, FAO)	***Practice and experience in United States and Australia*** - United States practice and experience in assessment and reporting of fishery resource status and trends (Hassan Moustahfid, FAO) - Australian practice and experience in assessment and reporting of fishery resource status and trends (Yimin Ye, FAO) - Discussion
13:00 – 14:00	*Lunch*
14:00 – 15:30 Chair (Ye, FAO)	***Practice and lessons learnt in the EU*** - EU practice and experience in production and reporting of SDG 14.4.1 (Ernesto Jardim, Paris Vasilakopoulos, JRC)
15:30 – 16:00	*Coffee break*
16:00 – 17:00 Chair (Ye, FAO)	***Practice and lessons learnt in the EU (continued)*** - EU practice and experience - Discussion on the lessons learnt from EU's production and reporting of SDG 14.4.1 (Ernesto Jardim, Paris Vasilakopoulos, JRC) - Wrap up discussion (Questions, clarifications, review of day's work)
17:00	- *Day closure*

Day 2: Wednesday 22 November 2017	
09:00 – 10:30 Chair: (Vasconcellos, FAO)	*Country presentations: fishery stock assessment, management, and monitoring of resource sustainability)* - Chile - China - French Caribbean
10:30 – 11:00	*Refreshment break*
11:00 – 13:00 Chair: (Vasconcellos, FAO)	*Country presentations* - India - Iran - Kenya - Kuwait
13:00 – 14:00	*Lunch*
14:00 – 15:30 Chair: (Vasconcellos, FAO)	*Country presentations* - Mexico - Morocco - Mozambique
15:30 – 16:00	*Coffee break*
16:00 – 17:00 Chair: (Vasconcellos, FAO)	*Country presentation* - Peru - Turkey - Wrap up discussion (Questions, clarifications, review of day's work)
17:00	*Day closure*

Day 3: Thursday 23 November 2017	
09:00 – 10:30	*Definition and Estimation of SDG 14.4.1 (Yimin Ye)* - The status and trends of global marine fisheries resources - SDG 14.4.1 – How it was estimated at global level and its current status - Determination of stock status I – Through formal stock assessment
10:30 – 11:00	*Refreshment break*
11:00 – 13:00	*Determination of stock status II (Yimin Ye, FAO)* - Estimation of growth parameters from length frequency data - Estimation of natural and fishing mortalities - Assessment of stock status

	- Demonstration and practice of the above methods based on online facilities
13:00 – 14:00	*Lunch*
14:00 – 15:30	***Determination of stock status III (Yimin Ye, FAO)*** - Estimation of surplus production model parameters from catch time series data - Assessment of stock status - Demonstration and practice of the above methods based on online facilities
15:30 – 16:00	*Coffee break*
16:00 – 17:00	***Determination of stock status IV (Yimin Ye, FAO)*** - Empirical methods for stock status determination - Demonstration and practice of the above methods based on online facilities
17:00	*Day closure*

Day 4: Friday 24 November 2017	
09:00 – 10:30 Chair: (Vasconcellos, FAO)	***Discussion*** - Data requirements and availability in developing countries - How to adapt to the estimation and reporting of SDG 14.4.1 in data-limited circumstances - The need for capacity building
10:30 – 11:00	*Refreshment break*
11:00 – 13:00 Chair: (Vasconcellos, FAO)	***Recommendations for best practices in the estimation and reporting of SDG 14.4.1***
13:00	*Workshop closure*

APPENDIX 3

Stock assessment tools

Stock assessment tools included in the Virtual Research Environment (VRE) created to support the technical workshop

1) *CMSY - Catch Maximum, Sustainable Yield*

    a. The **CMSY method** for data-limited stock assessment. Described in Froese, R., et al. (2016)

    b. **CMSY Vectorized** is a new adaptation of CMSY designed to increase fitting speed to enable implementation in management strategy evaluation. This is achieved by adding adaptive parameter search bounds to restrict the inspected r-K space and automatically increase depletion priors if necessary.

2) *ELEFAN methods by TropFishR*

    a. **ELEFAN**

    b. **ELEFAN GA** (generic algorithm)

    c. **ELEFAN SA** (simulated annealing)

3) *FISHMETHODS: Fishery science methods and models from published literature and contributions from colleagues.*

    a. **SBPR** Spawning stock biomass-per-recruit (SBPR) analysis is conducted following Gabriel et al. (1989). RPs of F and SBPR for a percentage of maximum spawning potential are calculated.

    b. **YPR** Yield-per-recruit (YPR) analysis is conducted following the modified Thompson-Bell algorithm. RPs Fmax and F0.1 are calculated.

The FAO Technical Workshop on "Best-practices for the implementation and reporting of SDG indicator 14.4.1 – Percentage of biologically sustainable fish stocks" was held in Rome, Italy, from 21 to 24 November 2017. The purpose of the Workshop was to raise awareness of SDG 14.4.1's significance and global reporting process, provide technical training to national practitioners on the analytical methods to produce Indicator 14.4.1, and look for examples of datasets and indicators from which best practices can be compiled. It was attended by 12 participants, with specific expertise on fish stock assessment, who contributed in their individual capacities to the discussions and delivered presentations focusing on their country's fisheries, resource management, stock assessment, and monitoring of resource sustainability. This report summarizes the presentations and main discussions of the Workshop, and provides recommendations for facilitating the work by countries on SDG indicator 14.4.1.