

Proceedings and Recommendations of the Training on Tropical Finfish and Shellfish Stock Assessment cum Brainstorming Session on Indian Marine Capture Fisheries Research and the Way Forward

A training on Tropical Finfish Stock Assessment was conducted by the Finfish Fisheries Division (FFD), ICAR-CMFRI, for Fisheries Resource Management scientists at ICAR-CMFRI Headquarters, Kochi during 16-27 August 2022, in hybrid mode. The program was inaugurated by Dr. A. Gopalakrishnan, Director, ICAR-CMFRI on 16th August 2022, and was attended by Dr. Sanjay Pandey, Asst. Commissioner (Fisheries), Govt. of India, Heads of Divisions at ICAR-CMFRI Headquarters and scientists of Finfish and Shellfish Fisheries Divisions of ICAR-CMFRI. In the second phase, a training - workshop on 'Stock assessment of shellfish species' was organised from 9 -17 November 2022 by the Shellfish Fisheries Division

(SFD), with focus on specific methods for shellfish species. Scientists from the Fishery Resources Assessment, Economics and Extension Division (FRAEED), FFD and SFD were participants and resource persons in the respective programmes (Table 1).

The FFD training program commenced with an address by Dr. Gopalakrishnan who welcomed Dr. Sanjay Pandey, Dept. of Fisheries, Govt. of India to the program and gave an overview of the various Divisions functioning in ICAR-CMFRI. He highlighted the technical strength of ICAR-CMFRI in tropical marine fish stock assessment in terms of the Institutes' extensive data collection system

Table 1. List of Participants in the training program on Tropical Finfish / Shellfish Stock Assessment

Sl. no	Name	Designation	Sl. no	Name	Designation
1	Dr. A. Gopalakrishnan	Director, ICAR-CMFRI	10	Dr. Rajan Kumar**	Scientist
2	Dr. Sanjay Pandey	Asst. commissioner (Fisheries) Dept. of Fisheries, Govt. of India	11	Dr. A. P. Dineshababu +	Principal Scientist
3	Dr. E. M. Abdussamad (Overall co-ordinator)	Principal Scientist and Head(I/C), FFD	12	Dr. Somy Kuriakose +	Principal Scientist
4	Dr. P. Laxmilatha (Overall co-ordinator)	Principal Scientist and Head(I/C), SFD	13	Dr. K. G. Mini+	Principal Scientist
5	Dr. J. Jayasankar+	Principal Scientist and Head(I/C), FRAEED	14	Dr. Geetha Sasikumar+	Principal Scientist
6	Dr. Josileen Jose *	Principal Scientist	15	Dr. Dr. R. Narayana Kumar+	Principal Scientist
7	Dr. Shoba J Kizhakudan*	Principal Scientist	16	Dr. Eldho Varghese+	Senior Scientist
8	Dr. M. Muktha*	Senior Scientist	17	Dr. Vinaya Kumar Vase+	Scientist
9	Dr. Gyanaranjan Dash**	Senior Scientist	18	Dr. Sujitha Thomas	Principal Scientist
			29	Dr. U. Ganga	Principal Scientist
			20	Dr. Rekha J. Nair	Principal Scientist

Sl. no	Name	Designation
21	Dr. Shubhadeep Ghosh	Principal Scientist
22	Dr. T. M. Najmudeen	Principal Scientist
23	Dr. K. M. Rajesh	Principal Scientist
24	Dr. Margaret A. Muthu Rathinam	Principal Scientist
25	Dr. S. Lakshmi Pillai	Principal Scientist
26	Dr. Rekha Devi Chakraborty	Principal Scientist
27	Dr. V. Venkatesan	Principal Scientist
28	Dr. G. B. Purushottama	Senior Scientist
29	Dr. Anulekshmi Chellapan	Senior Scientist
30	Dr. Swatipriyanka Sen Dash	Scientist
31	Dr. Mohamed Koya	Scientist
32	Dr. K. V. Akhilesh	Scientist
33	Dr. L. Remya	Scientist
34	Dr. Subal Kumar Roul	Scientist
35	Dr. Livi Wilson	Scientist
36	Dr. V. Mahesh	Scientist
37	Dr. Shikha Rahangdale	Scientist
38	Dr. P. Abdul Azeez	Scientist
49	Dr. S. Surya	Scientist
40	Dr. H. M. Manas	Scientist
41	Shri. Nakhawa Ajay Dayaram	Scientist
42	Shri R. Vinothkumar	Scientist
43	Dr. Indira Divipala	Scientist
44	Dr. R. Vidya	Scientist
45	Dr. F. Jasmine	Scientist
46	Smt. M. Kavitha	Scientist
47	Dr. Bhendekar Santhosh Nagnath	Scientist
48	Dr. Rajesh Kumar Pradhan	Scientist
49	Shri M. Rajkumar	Scientist
50	Smt. P. Gomathi	Scientist
51	Shri Sunil Kumar S. Ail	Scientist
52	Smt. P. M. Nimija	Research Scholar
53	Smt. A. V. Rosmy	Research Scholar

+ Resource Person *Course Co-ordinator **Co-ordinator

and fish stock assessment expertise exemplified in the marine fish stock assessment literature published by the Institute, both historical as well as more recent ones in *PLoS ONE* (Mohamed *et al.*, 2021) and *ICES Journal of Marine Science* (Sathianandan *et al.*, 2021) based on catch-based methods which had been the topic of intense discussions. He mentioned the recent stock assessment exercise of FAO, ICAR-CMFRI and Bay of Bengal Programme BoBP for the marine resources from FAO Area 57 in which Dr. J. Jayasankar, Principal Scientist and Head, FRAEED, ICAR-CMFRI had participated. The Director stressed on the need to adopt biology-based stock assessment and highlighted that the stock assessment training program should focus on the necessary standard methodologies to be followed. Director also stressed on the need for hard parts (otoliths, vertebrae, gastric mill, statoliths, beak, gladius etc.) based ageing for the selected species of finfishes and shellfishes, to be included in stock assessment protocols. The points flagged by the Director to be addressed by the participants of the training program included,

- Frequency of stock assessments for different marine resources depending on their longevity and associated life history traits
- Prioritization of species for regular stock assessments
- Standard data processing protocols and methodologies for stock assessment of different groups/resources, such as teleost fishes, elasmobranchs, crustaceans, and molluscs
- Determine the Scale (national or region-wise) of biology-based stock assessments for different species, based on their distribution and genetic stock information available
- Approaches to be adopted if results of surplus production (catch based) and micro analytical (biology based) stock assessment models give divergent results. Also if the ageing based on hard parts and length frequency sampling from wild caught fish indicated divergent results, the standard procedures to be followed.
- Categories to define stock status - over-fished, optimal, under-fished and rebuilding to be defined
- Assessing sustainability of stocks through Maximum

Sustainable Yield (MSY) and/or Maximum Economic Yield (MEY) and any other indicators

- Hard-parts ageing studies (otoliths in finfishes; vertebrae in elasmobranchs; statoliths, beaks, gladius in cephalopods; gastric mill in crustaceans) and the possible validation with captive rearing experiments in select species
- Experimental fishing / exploratory surveys to obtain fish biomass estimates in fishing grounds that can be used to supplement findings from commercial fish landings based stock assessment
- Explore options for incorporating citizens in marine science research by involving selected group(s) of fishermen/skippers to provide data for selected species to get better spatial information of species distribution.
- Genetic stock identification, especially for straddling or highly migratory fishes that come under purview of Regional Fisheries Management Organisations (RFMOs)
- Strategies for applying Ecosystem Based Fisheries Management methods

Highlighting the need for a centralized database for marine fishery resources at ICAR-CMFRI which will help in prompt

replies to queries from ministries, Parliament, and other agencies, the Director indicated the formation of resource-based Working Groups (Tables 2 & 3) as a welcome beginning. This will be followed by a comprehensive data-sharing policy which will be prepared by a Committee comprising Heads of Divisions, PME and HRD for the Institute and will be implemented after appropriate discussions. Following this, the data collected under various research programs of the Institute will have to be mandatorily deposited in the centralized database within a specified time frame which will ensure credible data from ICAR-CMFRI for wider use at the national level. Concluding his remarks, the Director expressed the need for a brainstorming session on the last day of the training program, to prepare a road map for re-vitalising capture fisheries research and marine fish stock assessment programs in the country and wished all success for conduct of the training program. Dr. E. Abdussamad, HoD i/c FFD, thanked Director for his whole-hearted support in organizing the training program and the HRD Cell, ICAR-CMFRI for facilitating the same.

The program organised by the SFD was inaugurated by Dr A. Gopalakrishnan, Director, ICAR-CMFRI, on 09 November 2022. In his address, Director emphasized the need for prioritising species for fish biology-based stock assessments and stressed all to follow internationally recognised standards while bringing out stock assessment

Table 2. Working Groups constituted for finfish stock assessments

Marine Fish Stock Assessment Working Groups			
I. Finfish fishery resources			
Resource / Thematic Area	National Working Group (NWG)	NWG Leader	Groups/Genus/ Species prioritized
Sardines	Dr. K. M. Rajesh, Dr. U. Ganga, Ms. S. Surya, Dr. H. M. Manas, Dr. C. Anulekshmi, Shri. R. Vinothkumar	Dr. Prathibha Rohit	<i>Sardinella longiceps</i> , <i>S. fimbriata</i> , <i>S. gibbosa</i> , <i>Sardinella albella</i>
Indian Mackerel	Dr. Prathibha Rohit, Dr. A. Margaret Muthu Rathinam, Dr. C. Anulekshmi, Dr. H. M. Manas, Shri. Ajay D. Nakhawa	Dr. U. Ganga	<i>Rastrelliger kanagurta</i> ; <i>Rastrelliger</i> spp.

Resource / Thematic Area	National Working Group (NWG)	NWG Leader	Groups/Genus/ Species prioritized
Tunas	Dr. Prathibha Rohit, Dr. Shubhadeep Ghosh, Dr. K. M. Rajesh, Dr. K. Mohammed Koya, Dr. C. Anulekshmi, Dr. P. Abdul Azeez	Dr. E. M. Abdussamad	<i>Euthynnus affinis</i> <i>Auxis thazard</i> <i>Auxis rochei</i> <i>Thunnus albacares</i> <i>Thunnus tonggol</i> <i>Katsuwonus pelamis</i>
Live Baits	Dr. P. Abdul Azeez	Dr. K. Mohammed Koya	
Billfishes	Dr. Prathibha Rohit, Dr. E. M. Abdussamad, Dr. U. Ganga, Dr. Shubhadeep Ghosh	Dr. S. Surya	<i>Istiophorus platypterus</i> <i>Istiompax indica</i> <i>Makaira nigricans</i> <i>Xiphias gladius</i> <i>Kajikia audax</i>
Seerfishes	Dr. A. Margaret Muthu Rathinam, Dr. H. M. Manas, Shri. R. Vinothkumar, Dr. P. Abdul Azeez	Dr. Shubhadeep Ghosh / Dr. E. M. Abdussamad	<i>Scomberomorus commerson,</i> <i>S.guttatus</i>
Cobia	Dr. Prathibha Rohit, Dr. A. Margaret Muthu Rathinam, Dr. K. Mohammed Koya, Shri. R. Vinothkumar	Dr. U. Ganga	<i>Rachycentron canadum</i>
Carangids	Dr. Prathibha Rohit, Dr. E. M. Abdussamad, Dr. C. Anulekshmi, Dr. Subalkumar Roul, Shri. Ajay D. Nakhawa	Dr. H. M. Manas	<i>Decapterus russelli</i> <i>Megalaspis cordyla</i>
Ribbonfishes	Shri. K. Mohammed Koya, Dr. Prathibha Rohit, Dr. Shubhadeep Ghosh, Ms. S. Surya, Shri. Ajay D. Nakhawa	Dr. K. M. Rajesh	<i>Trichiurus lepturus</i>
Anchovies	Dr. S. Surya, Dr. C. Anulekshmi, Dr. H. M. Manas, Shri. Ajay D. Nakhawa, Shri. R. Vinothkumar	Dr. P. Abdul Azeez	<i>Coilia dussumieri</i> <i>Encrasicholina devisi</i> <i>E.punctifer</i> <i>Stolephorus waitei</i> <i>S. macrops</i> <i>S.indicus</i> <i>S.commersonii</i>
Bombay duck	Dr. P. Abdul Azeez, Dr. Subalkumar Roul, Dr. Shubhadeep Ghosh, Shri. Ajay D. Nakhawa	Dr. C. Anulekshmi	<i>Harpadon nehereus</i>
Mahi-mahi	Dr. E. M. Abdussamad, Dr. A. Margaret Muthu Rathinam, Dr. K. M. Rajesh,	Dr. K. Mohammed Koya	<i>Coryphaena hippurus</i>
Barracuda	Dr. A. Margaret Muthu Rathinam, Dr. K. M. Rajesh, Dr. Shubhadeep Ghosh, Dr. K. Mohammed Koya, Dr. Subal Kumar Roul,	Shri. R. Vinothkumar	<i>Sphyraena putnamae</i> <i>S.obtusata</i>

Resource / Thematic Area	National Working Group (NWG)	NWG Leader	Groups/Genus/ Species prioritized
Belonids	Dr. K. Mohammed Koya, Dr. S. Surya	Dr. Subalkumar Roul	<i>Ablennes hians</i> <i>Tylosurus crocodilus</i>
Shads	Dr. P. Abdul Azeez, Dr. Subalkumar Roul, Shri. R Vinothkumar	Shri. Ajay D. Nakhawa	<i>Tenualosa ilisha</i> <i>Tenualosa toli</i> <i>Chirocentrus nudus</i>
Elasmobranchs	Dr. Shoba Joe Kizhakudan, Dr. Rekha J. Nair, Dr. T. M. Najmudeen, Dr. G. B. Purushottama, Dr. Muktha Menon, Dr. Swatipriyanka Sen, Dr. K. V. Akhilesh, Dr. L. Remya, Dr. Livi Wilson, Dr. V. Mahesh, Dr. Subal Kumar Roul, Dr. Shikha Rahangdale	Dr. Sujitha Thomas	<i>Scoliodon laticaudus</i> <i>Rhizoprionodon oligolinx</i> <i>R. acutus</i> <i>Brevitrygon imbricata</i> <i>Gymnura poecilura</i>
Groupers	Dr. G. B. Purushottama, Dr. Muktha Menon, Dr. V. Mahesh, Dr. Shikha Rahangdale	Dr. Rekha J. Nair	<i>Epinephelus diacanthus</i>
Snappers	Dr. Rekha J. Nair, Dr. L. Remya, Dr. Livi Wilson, Dr. S. Surya	Dr. Muktha Menon	<i>Lutjanus johnii</i> <i>Lutjanus fulvus</i> <i>Lutjanus quinquilineatus</i> (All assessed for the south-east coast of India)
Pigface breems	Dr. L. Remya, Dr. S. Surya	Dr. T. M. Najmudeen	<i>Lethrinus lentjan</i> (SW & SE coast) <i>Lethrinus mahsena</i> (SW coast) <i>Lethrinus nebulosus</i> (SE coast)
Threadfin breems	Dr. Sujitha Thomas, Dr. V. Mahesh, Dr. Livi Wilson, Dr. Shikha Rahangdale	Dr. Shoba Joe Kizhakudan	<i>Nemipterus</i> spp. <i>Parascolopsis</i> spp. <i>Scolopsis</i> spp.
Sciaenids	Dr. Shoba J Kizhakudan, Dr. Rekha J. Nair, Dr. Swatipriyanka Sen, Dr. K. V. Akhilesh	Dr. Shikha Rahangdale	<i>Otolithes ruber</i> <i>Otolithes cuvieri</i> <i>Nibeia maculata</i> <i>Otolithoides biauritus</i> <i>Protonibeia diacanthus</i>
Silverbellies	Dr. Shoba J Kizhakudan, Dr. V. Mahesh, Dr. H. M. Manas	Dr. L. Remya	<i>Karalla dussumieri</i> <i>Gazza minuta</i>
Lizardfish	Dr. Shoba J Kizhakudan, Dr. G. B. Purushottama, Dr. K. V. Akhilesh Dr. Shikha Rahangdale	Dr. T. M. Najmudeen	<i>Saurida tumbil</i> <i>Saurida undosquomis</i>
Goatfish	Dr. Shoba J Kizhakudan, Dr. Rekha J. Nair, Dr. G. B. Purushottama	Dr. L. Remya	<i>Upeneus moluccensis</i> <i>U. supravittatus</i> <i>U. sulphureus</i>

Resource / Thematic Area	National Working Group (NWG)	NWG Leader	Groups/Genus/ Species prioritized
Flatfish	Dr Sujitha Thomas, Dr. Shoba J Kizhakudan, Dr. Swatipriyanka Sen	Dr. Rekha J. Nair	<i>C. macrostomus</i>
Catfish	Dr. Swatipriyanka Sen, Dr. Shikha Rahangdale	Dr. G. B. Purushottama	<i>Plicofollis layardi</i> <i>Arius maculatus</i> <i>Osteogeneiosus militaris</i>
Pomfrets	Dr. T. M. Najmudeen, Dr. Muktha Menon, Dr. Swatipriyanka Sen, Dr. K. V. Akhilesh	Dr. Sujitha Thomas	<i>Pampus candidus</i> <i>Pampus griseus</i> <i>Parastromateus niger</i>
Whitefish	Dr T. M. Najmudeen, Dr. K. V. Akhilesh, Dr. V. Mahesh	Dr. Sujitha Thomas	<i>Lactarius lactarius</i>
Threadfins	Dr. G. B. Purushottama, Dr. Swatipriyanka Sen	Dr. K. V. Akhilesh	<i>L. indicum</i> <i>E. tetradactylum</i>
Priacanthids	Dr G. B. Purushottama, Dr. Livi Wilson	Dr. V. Mahesh	<i>Priacanthus hamrur</i>
Eels	Dr. T. M. Najmudeen, Dr. Muktha Menon	Dr. Swatipriyanka Sen	<i>Muraenesox</i> <i>bagio</i>
Flatheads	Dr. Sujitha Thomas, Dr Muktha Menon	Dr. Livi Wilson	<i>Platycephalus indicus</i> <i>Grammoplites suppositus</i>
Puffer & trigger fishes	Dr. Sujitha Thomas, Dr. K. M. Rajesh, Dr. T. M. Najmudeen	Dr. K. V. Akhilesh	<i>Lagocephalus</i> spp. <i>Aluterus monoceros</i>
Sillago	Dr. L. Remya, Dr. Subal Kumar Roul	Dr. Shoba Joe Kizhakudan	<i>Sillago</i> spp. <i>Sillaginopsis</i> spp.
Grunters, sweetlips & sea breams	Dr. Livi Wilson, Dr. Shikha Rahangdale	Dr. Muktha Menon	<i>Pomadasy kaakan</i> (assessed for the south-east coast of India)

Table 3. Working Groups constituted for shellfish stock assessments

Shellfish fishery resources	National Working Group (NWG)	NWG Leader
Kiddi Shrimp (<i>Parapenaeopsis stylifera</i>)	Dr. A. P. Dineshbabu, Dr. S. Lakshmi Pillai, Dr. Gyanaranjan Dash, Dr. Indira Divipala	Dr. P. T. Sarada/ Dr. S. Lakshmi Pillai
Speckled Shrimp (<i>Metapenaeus monoceros</i>)	Dr. P. T. Sarada, Dr. S. Lakshmi Pillai, Dr. Indira Divipala, Dr. Gyanaranjan Dash , Dr. Rajan Kumar, Ms. M. Kavitha	Dr. A. P. Dineshbabu
Flower Tail Prawn / Thelly Shrimp / Kadal Shrimp (<i>Metapenaeus dobsoni</i>)	Dr. A. P. Dineshbabu, Dr. Gyanaranjan Dash, Dr. Indira Divipala	Dr. S. Lakshmi Pillai

Shellfish fishery resources	National Working Group (NWG)	NWG Leader
Indian White Prawn (<i>Penaeus indicus</i>)	Dr. A. P. Dineshbabu, Dr. P. T. Sarada, Dr. Indira Divipala	Dr. S. Lakshmi Pillai
Coastal mud shrimp (<i>Solenocera crassicornis</i> , <i>Solenocera</i> spp.)	Dr. A. P. Dineshbabu, Dr. Rajan Kumar, Dr. Indira Divipala	Dr. Gyanaranjan Dash
Green Tiger Prawn (<i>Penaeus semisulcatus</i>)	Dr. P. T. Sarada, Dr. Gyanaranjan Dash Ms.M. Kavitha	Mr. M. Rajkumar
Deep-sea Shrimps <i>Plesionika quasigrandis</i> <i>Heterocarpus chani</i> <i>Aristeus alcocki</i>	Dr. P. T. Sarada, Dr. Indira Divipala, Dr. F. Jasmine	Dr. Rekha Devi Chakraborty
Flower crab/ Blue Swimmer crab (<i>Portunus pelagicus</i>)	Dr. A. P. Dineshbabu, Dr. P. T. Sarada, Dr. Gyanaranjan Dash, Dr. Indira Divipala, Dr. Rajan Kumar Mr. M. Rajkumar	Dr. Josileen Jose
Blood Spotted Crab (<i>Portunus sanguinolentus</i>)	Dr. Josileen Jose, Dr. Gyanaranjan Dash, Dr. P. T. Sarada, Dr. Indira Divipala Dr. Rajesh Pradhan	Dr. A. P. Dineshbabu
Crucifix Crab (<i>Charybdis feriata</i>)	Dr. A. P. Dineshbabu, Dr. Gyanaranjan Dash Dr. Rajan kumar Dr. Rajesh Pradhan	Dr. Josileen Jose
Sand Lobster (<i>Thenus unimaculatus</i>)	Dr. P. T. Sarada, Dr. Indira Divipala, Dr. Rajan Kumar	Dr. Rekha Devi Chakraborty
Spiny Lobster <i>Panulirus polyphagus</i> , <i>Phomarus</i> , <i>Pornatus</i>	Dr. Gyanaranjan Dash, Mr. M. Rajkumar Dr. Santosh Bhendekar Dr. Sunil kumar Ail	Dr. Rajan Kumar / Dr. Rekha Devi Chakraborty
Cephalopods <i>Sepia pharaonis</i> <i>S. aculeata</i> <i>S. elliptica</i> <i>S. prashadi</i> <i>Sepiella inermis</i> <i>Sepioteuthis lessoniana</i> <i>Uroteuthis duvaucelii</i> <i>U. edulis</i> <i>Amphioctopus neglectus</i> <i>Sthenoteuthis oualaniensis</i>	Dr. Geetha Sasikumar, Dr. V. Venkatesan, Ms. M. Kavitha, Dr. F. Jasmine, Dr. R. Vidya Dr. Santosh Bhendekar, Dr. Rajesh Pradhan Mr. Sunil Kumar Ail Dr. Gyanaranjan Dash Dr. Rajan Kumar Mr. M. Rajkumar	Dr. P. Laxmilatha

Shellfish fishery resources

Bivalves (Clams, Mussels, oysters)

Paphia malabarica

Villorita cyprinoides

Meretrix casta

Perna viridis

Perna indica

Crassostrea madrasensis

Saccostrea cucullata

Pinctada fucata

Gastropods

Babylonia spirata

Chicoreus ramosus

Turbinella pyrum

National Working Group (NWG)

Dr. M. K. Anil,

Dr. R. Vidya,

Dr. V. Venkatesan

Dr. Gyanranjan Dash

Dr. F. Jasmine

Ms. P. Gomathi,

Dr. Santosh Bhendekar,

Dr. Rajesh Pradhan

Ms. M. Kavitha

NWG Leader

Dr. Geetha Sasikumar

Dr. V. Venkatesan

Ms. M. Kavitha

Dr. R. Vidya

Dr. F. Jasmine

Mr. M. Rajkumar

reports. He suggested conducting comparative ageing studies using hard parts and the length based ageing to decide their selection as inputs for further stock assessment steps. He advised the participants to attempt modelling and scenario setting for stock assessment of shellfishes, in collaboration with FRAEED, that will enable effective fisheries management. If necessary, experimental fishing with standard gears to gather information on population parameters and selectivity of concerned species must be attempted. He also mentioned that genetic stock identification for select commercially important species and principles of Ecosystem Approach to Fisheries Management (EAFM) must also be accorded due attention.

Topics covered under the Training

Hands on training was undertaken with each participant working on common data analysis procedures and protocols (for learning) and applying it to individual species-specific data that they had collected at their respective locations. Major topics covered under the training in the first phase under the FFD included –

- Overview of Finfish Stock Assessment (FSA)
- Basic Biostatistics using Microsoft Excel (*Measures of central tendency, Measures of dispersion, Applications of descriptive statistics, Regression, Correlation – Length-weight relationship, Analysis of covariance*)
- Growth estimation using Microsoft Excel & FiSAT (*Understanding VBGF Data collection – length frequency, Modal progression, Bhattacharya analysis,*

Gulland-Holt Plot, Ford-Walford Plot, ELEFAN)

- Mortality & Exploitation using Microsoft Excel & FiSAT (*Z (Length-converted catch curve), M (Pauly's empirical equation), F, E, U, Probability of capture*)
- Virtual Population Analysis using Microsoft Excel & FiSAT
- Prediction models using Microsoft Excel & FiSAT (*Thompson & Bell analysis, Beverton & Holt analysis*)
- Macro-analytical models (*Schaefer & Fox*)
- Working with R (*Introduction to R-studio – basic operations, TropFish R package*)
- Catch MSY (CMSY) and Bayesian State Space implementation of the Schaefer Production Model (BSM)

The topics covered in the second phase which was organised by the SFD, included,

- FAO fishery statistical tool FiSAT II – ELEFAN (K scan, response surface, automatic search), mortality estimation etc.
- TropFishR package in R for fisheries assessment using length-frequency data
- Length-based Bayesian Biomass estimation (LBB) using Bayesian Monte Carlo Markov Chain approach.
- Length-based Spawning Potential Ratio (LBSPR), to

assess stock status by the spawning potential ratio of a fish stock

- CMSY++, an advanced state-space stock assessment method that includes CMSY which requires only catch data, and BSM which requires additional abundance data.
- CatDyn – stock assessment based on fishery catch dynamics, using high or medium frequency catch in biomass or numbers, nominal fishing effort, and mean fish body weight by time step, from one or two fishing fleets, estimate stock abundance, natural mortality rate and fishing operational parameters.
- GMACS - General Model for Assessing Crustacean Stocks
- JABBA - Just Another Bayesian Biomass Assessment, which can rapidly generate reproducible stock status estimates for fisheries management
- SizeMat for size at maturity estimation
- Growth models using the Bayes Growth package
- FESTA package in R for standardising fishing efforts in a multi-gear, multi-species fishery
- Three Stock-Recruitment models including the Beverton & Holt, Ricker, and Cushing Models using the R program.

Brainstorming Session on Indian Marine Capture Fisheries Research

The brainstorming session was held on 27 August, 2022 with active participation of scientists from FFD and SFD. Detailed discussions were held on the need for biology based stock assessment (BSA), scale of assessment, methods used by the Institute, data requirements, data collection, issues faced and strategies to be adopted etc. Data Requirements for Biological Stock Assessment (BSA) which include time series of length frequency (LF) and other biological information (growth and mortality rates, length-weight relationship, fecundity, recruitment etc) of the species to be assessed along with gear-wise spatio-temporal landings data was discussed. It was decided

to use the term “landing” and instead of “catch” in all reports/documents. Individual measurement of length and weight of respective species, proportionally covering all size groups in the landing (gear-wise) and day’s landing to the extent possible uniformly cover entire area along the fishing range, collection of biological information-maturity and spawning seasonality, length-weight relationship, food and feeding etc especially of less studied but emerging fishery resources and monthly gear-wise landing details of the prioritised species were emphasised. The data collection, recording and documentation procedures were discussed and finalised to ensure uniform standard reporting and analysis formats for prioritised species for stock assessment by the various Working Groups. The need for innovative advanced stock assessment tools to fit the requirements of assessing typical tropical marine fisheries, regional considerations for fish stocks assessments and application of concepts of genetic stocks in fisheries management were also to be addressed by Working Groups (Tables 4,5,6,7&8).

Concerning data collection, for length measurements continuing the regimen of collecting unsorted samples giving proper representation to all major gears targeting the species, with sampling preferably on the same days selected by FRAEED under the Stratified Multi-Stage Random Sampling (SMRS) programme covering the landing centres, and the adoption of standardised fishing effort (Varghese *et al.*, 2020) for stock assessment process, were reiterated. Considering the multi-gear, multi-species fisheries with strong regional characteristics in species landed, gears employed etc, it was suggested to have a state/ region wise analysis for determining target species and gears for modelling stock biomass, following the methodology of Varghese *et al.* (2021) which can be published in the *Marine Fisheries Information Service, Technical and Extension Series* of the institute as guidelines for the biological stock assessment exercises that would henceforth be conducted regularly.

The criteria for defining unit of stock assessment and/or management can be either, “geographical scale” using life history traits or genetic “stock structure information” depending on the clarity in the spatio-temporal distribution of stock. In cases where results from these two methods differ, priority would be given to life history traits to define geographical scale. The appropriate geographical scale for marine fish stock assessment would be either on a regional (NW, SW, SE and NE) or coastwise (East and West) or national level based on expert view within Working

Table 4. List of Finfish species prioritised for stock assessment

Sl. No.	Family	Species	Stocks /Regions	Full Stock Assessment frequency	LF as TL/FL/SL/ Others	LF measurement (mm,cm)	Length Frequency interval	Hard parts age data available (Y/N)	Stock assessment method Biology based (BSA)/Catch based (CMSY/others)
1	Clupeidae	<i>Sardinella longiceps</i>	1	Annual	TL	mm	0.5 cm	Y	BSA + CMSY
2	Clupeidae	<i>Sardinella fimbriata</i>	1	Annual	TL	mm	0.5 cm	Y	BSA + CMSY
3	Clupeidae	<i>Sardinella gibbosa</i>	1	Annual	TL	mm	0.5 cm	Y	BSA + CMSY
4	Clupeidae	<i>Sardinella albella</i>	1	Annual	TL	mm	0.5 cm	Y	BSA + CMSY
5	Scombridae	<i>Rastrelliger kanagurta</i>	2 (Mainland, Andaman & Nicobar)	Biennial	TL	mm	1 cm	N	BSA + CMSY
6	Synodontidae	<i>Harpodon nehereus</i>	2 Arabian sea Bay of Bengal	Annual	TL	mm	10mm	N	BSA(West coast) +CMSY (east coast)
7	Trichiuridae	<i>Trichiurus lepturus</i>	2 East and West Coast	Triennial	TL	cm	2 cm	N	BSA + CMSY
8	Nemipteridae	<i>Nemipterus japonicus</i>	Mainland	Annual	TL	mm	10 mm	N	BSA + CMSY
9	Nemipteridae	<i>N. randalli</i>	Mainland	Annual	TL	mm	10 mm	N	BSA + CMSY
10	Stromateidae	<i>Pampus candidus</i>	Mainland	Triennial	TL	cm	1 cm	N	BSA+CMSY
11	Stromateidae	<i>P. griseus</i>	Mainland	Triennial	TL	cm	1 cm	N	BSA+CMSY
12	Carangidae	<i>Parastromateus niger</i>	Mainland	Triennial	TL	cm	1 cm	N	BSA+CMSY
13	Engraulidae	<i>Coilia dussumieri</i>	2 (NW &NE)	Annual	TL	cm	0.5 cm	N	BSA+CMSY
14	Synodontidae	<i>Saurida tumbil</i>	Mainland	Triennial	TL	mm	10 mm	N	BSA+CMSY
15	Synodontidae	<i>S. undosquamis</i>	Mainland	Triennial	TL	mm	10 mm	N	BSA+CMSY
16	Ariidae	<i>Plicofollis layardi</i>	Mainland	Triennial	TL	cm	1cm	N	BSA
17	Carangidae	<i>Decapterus russelli</i>	1, East & West coasts	Annual	TL	cm	1.5 cm	N	BSA+CMSY
18	Carangidae	<i>Megalaspis cordyla</i>	East & West coasts	Annual	TL	cm	1.5 cm	N	BSA+CMSY
19	Lactariidae	<i>Lactarius lactarius</i>	Indian coast	Triennial	TL	cm	1 cm	N	BSA+CMSY
20	Sciaenidae	<i>Otolithes ruber</i>	EC & WC	Annual	TL	cm	2 cm	N	BSA
21	Sciaenidae	<i>O. cuvieri</i>	WC	Annual	TL	cm	2 cm	N	BSA
22	Sciaenidae	<i>Otolithoides biauritus</i>	Indian coast	Triennial	TL	cm	3 cm	N	BSA+CMSY
23	Sciaenidae	<i>Protonibea diacanthus</i>	Indian coast	Triennial	TL	cm	3 cm	N	BSA+CMSY

Sl. No.	Family	Species	Stocks /Regions	Full Stock Assessment frequency	LF as TL/ FL/SL/ Others	LF measurement (mm,cm)	Length Frequency interval	Hard parts age data available (Y/N)	Stock assessment method Biology based (BSA)/Catch based (CMSY/others)
24	Sciaenidae	<i>Nibea maculata</i>	SE coast	Annual	TL	cm	1 cm	N	BSA
25	Leiognathidae	<i>Karalla dussumieri</i>	SE coast	Triennial	TL	mm	0.5cm	N	BSA
26	Leiognathidae	<i>Gazza minuta</i>	SE coast	Triennial	TL	mm	0.5cm	N	BSA
27	Mullidae	<i>Upeneus supravittatus</i>	SE coast	Triennial	TL	mm	0.5 cm	N	BSA
28	Mullidae	<i>Upeneus sulphureus</i>	SE coast	Triennial	TL	mm	1 cm	N	BSA
29	Mullidae	<i>Upeneus moluscensis</i>	NW coast	Triennial	TL	mm	1 cm	N	BSA
30	Cynoglossidae	<i>Cynoglossus macrostomus</i>	SW coast	Triennial	TL	mm	1 cm	N	BSA
31	Serranidae	<i>Epinephelus diacanthus</i>	SW/NW	Triennial	TL	mm	5 cm	N	BSA
32	Coryphaenidae	<i>Coryphaena hippurus</i>	All India	Triennial	TL	mm	2 cm	Y	BSA
33	Rachycentridae	<i>Rachycentron canadum</i>	3 stocks NW, SW, East coast	Triennial	FL	cm	5 cm	N	CMSY
34	Scombridae	<i>Scomberomorus guttatus</i>	Mainland	Annual	TL	mm	1 cm	N	BSA + CMSY
35	Scombridae	<i>S. commerson</i>	Mainland	Annual	TL	mm	1 cm	N	BSA + CMSY
36	Priacanthidae	<i>Priacanthus hamrur</i>	North west and South west	Triennial	TL	mm	1 cm	N	BSA+CMSY
37	Sphyraenidae	<i>Sphyraena putnamae</i>	South west and South east coast (Main land)	Annual	FL	mm	5 cm	N	BSA
38	Chirocentridae	<i>Chirocentrus nudus</i>	mainland	Triennial	TL	mm	20 mm	N	BSA+CMSY
39	Chirocentridae	<i>C. dorab</i>	mainland	Triennial	TL	mm	20 mm	N	BSA+CMSY
40	Haemulidae	<i>Pomadourys kaakan</i>	East coast	Triennial	TL	mm	50 mm	N	BSA
41	Muraenesocidae	<i>Muraenesox bagio</i>	Mainland	once in five years	TL	cm	5 cm	N	CMSY
42	Carcharhinidae	<i>Scoliodon laticaudus</i>	Mainland	Triennial	TL	cm	3 cm	N	BSA
43	Carcharhinidae	<i>Rhizoprionodon acutus</i>	Mainland	Triennial	TL	cm	3 cm	N	BSA
44	Carcharhinidae	<i>R. oligolinx</i>	Mainland	Triennial	TL	cm	3cm	N	BSA
45	Sphyrnidae	<i>Sphyrna lewini</i>	Mainland	Once in five years	TL	cm	5 cm	N	CMSY
46	Triakidae	<i>Iago sp</i>	Mainland	Triennial	TL	cm	1 cm	N	BSA
47	Dasyatidae	<i>Brevitrygon imbricata</i>	Mainland	Triennial	DW - disc width	cm	1 cm	N	BSA

Sl. No.	Family	Species	Stocks /Regions	Full Stock Assessment frequency	LF as TL/ FL/SL/ Others	LF measurement (mm,cm)	Length Frequency interval	Hard parts age data available (Y/N)	Stock assessment method based (BSA)/Catch based (CMSY/others)
48	Gymniridae	<i>Gymnura poecilura</i>	Mainland (South east)	Triennial	DW	cm	5 cm	N	BSA
49	Rhinobatidae	<i>Rhinobatos lionotus</i>	Mainland (East coast)	Triennial	TL	cm	5 cm	N	BSA
50	Istiophoridae	<i>Istiophorus platypterus</i>	National	Triennial					BSA
51	Clupeidae	<i>Tenualosa ilisha</i>	NW and NE	Triennial	FL	mm	10 mm	N	BSA+ CMSY
52	Xiphiidae	<i>Xiphias gladius</i>	All India	Triennial	FL	cm	2 cm	N	BSA
53	Scombridae	<i>Thunnus tonggol</i>	All India	Triennial	FL	cm	2 cm	N	BSA
54	Scombridae	<i>Euthynnus affinis</i>	All India	Biennial	FL	cm	2 cm	N	BSA
55	Scombridae	<i>Thunnus albacares</i>	All India	Triennial	FL	cm	2 cm	Y	BSA
56	Scombridae	<i>Katsuwonus pelamis</i>	All India	Biennial	FL	cm	2 cm	N	BSA
57	Scombridae	<i>Auxis rochei</i>	Mainland (southwest coast)	Annual	FL	cm	2 cm	N	BSA
58	Platycephalidae	<i>Platycephalus indicus</i>	South west	Five years	TL	mm	10 mm	N	BSA
59	Platycephalidae	<i>Grammolites suppositus</i>	south east coast	Five years	TL	mm	10 mm	N	BSA
60	Sillaginidae	<i>Sillago indica</i>	Mainland	Biennial	TL	mm	10 mm	N	BSA
61	Sillaginidae	<i>Sillago sihama</i>	Mainland	Biennial	TL	mm	10 mm	N	BSA
62	Sillaginidae	<i>Sillago vincenti</i>	Mainland	Biennial	TL	mm	10 mm	N	BSA
63	Lethrinidae	<i>Lethrinus nebulosus</i>	SE coast	Triennial	TL	cm	1 cm	N	BSA+CMSY
64	Lethrinidae	<i>Lethrinus lentjan</i>	SW & SE coasts	Triennial	TL	cm	1 cm	N	BSA+CMSY
65	Lethrinidae	<i>Lethrinus mahsena</i>	SW coast	Triennial	TL	cm	1 cm	N	BSA+CMSY

*Additionally, annual stock status reports for all species will be prepared

BSA- Biological Stock Assessment Methodologies used will be based on exploitation characteristics, life history traits and other relevant parameters derived from the age/length data of the species sampled from various fleets

CB- Catch Based methods which use Catch and Abundance (optional) data with informed priors

CMSY-Catch MSY

LF- Length Frequency, TL- Total Length, FL -Fork Length, SL – Standard Length

Table 5. List of Shellfish species prioritised for stock assessment

	Family	Species	Stocks/Regions	*Full Assessment frequency	LF measurement		Length Frequency interval	Hard parts age data available (Y/N)	Stock assessment method Biology based (BSA)/Catch based (CMSY/others)
					TL/ CL/DML/ Others	LF measurement (mm,cm)			
1	Sepiidae	<i>Sepia pharaonis</i>	NW, SW, NE	Triennial	DML	mm	10	No (in process)	BSA
2	Sepiidae	<i>S. aculeata</i>	Odisha (NE)	Triennial	DML	mm	5	No	BSA
3	Sepiidae	<i>Sepiella inermis</i>	East and West coast	Triennial	DML	mm	5	No (in process)	BSA
4	Sepiidae	<i>Sepia elliptica</i>	Kerala	Triennial	DML	mm	5	No	BSA / LBB
5	Sepiidae	<i>Sepia brevimana</i>	SE	Triennial	DML	mm	10	No	BSA/LBB
6	Loliginidae	<i>Uroteuthis (Photololigo) duvaucelli</i>	NW, SW, NE	Triennial	DML	mm	10	Yes	BSA
7	Loliginidae	<i>Uroteuthis edulis</i>	East and West coast	Triennial	DML	mm	10	No	BSA / LBB
8	Loliginidae	<i>Sepioteuthis lessoniana</i>	East coast	Triennial	DML	mm	10	Yes	BSA
9	Octopodidae	<i>Amphioctopus neglectus</i>	SW	Triennial	DML	mm	5	No	BSA
10	Octopodidae	<i>Amphioctopus aegina</i>	SE	Triennial	DML	mm	5	No	BSA
11	Octopodidae	<i>Cistopus indicus</i>	SW, SE	Triennial	DML	mm	5	No	BSA
12	Penaeidae	<i>Metapenaeus dobsoni</i>	SW & SE	Triennial	TU/CL	mm	5	No	BSA/CB
13	Penaeidae	<i>M. monoceros</i>	East & West coasts	Triennial	TU/CL	mm	5	No	BSA/CB
14	Penaeidae	<i>M. affinis</i>	NW	Triennial	TU/CL	mm	5	No	BSA/CB
15	Solenoceridae	<i>Solenocera crassicornis</i>	NE	Triennial	TU/CL	mm	5	No	BSA/CB
16	Penaeidae	<i>Parapenaeopsis stylifera</i>	West and East coast	Triennial	TU/CL	mm	5	No	BSA/CB
17	Penaeidae	<i>Penaeus semisulcatus</i>	SE	Triennial	TU/CL	mm	5	No	BSA/CB
18	Penaeidae	<i>Penaeus merguensis</i>	SE	Triennial	TU/CL	mm	5	No	BSA/CB
19	Penaeidae	<i>Metapenaeus brevicornis</i>		Triennial	TU/CL	mm	5	No	BSA/CB
20	Pandalidae	<i>Heterocarpus woodmasoni</i>		every 5 years	TU/CL	mm	5	No	BSA/CB
21	Pandalidae	<i>Heterocarpus chani</i>		every 5 years	TU/CL	mm	5	No	BSA
22	Aristeidae	<i>Aristeus alcocki</i>	SW & SE	every 5 years	TU/CL	mm	5	No	BSA
23	Portunidae	<i>Portunus sanguinolentus</i>	West and East coast	Triennial	CL/CW	mm	5/10	No	BSA
24	Portunidae	<i>P. pelagicus</i>	SW, NE, SE	Triennial	CL/CW	mm	5/10	No	BSA
25	Portunidae	<i>Charybdis feriata</i>	West and East coast	Triennial	CL/CW	mm	5/10	No	BSA
26	Scyllaridae	<i>Thenus unimaculatus</i>	SW, NW, SE	every 5 years	TU/CL/CW	mm	5	No	BSA

Family	Species	Stocks/Regions	*Full Assessment frequency	LF measurement TL/ CL/DML/ Others	LF measurement (mm,cm)	Length Frequency interval	Hard parts age data available (Y/N)	Stock assessment method Biology based (BSA)/Catch based (CMSY/others)
27	Palinuridae	<i>Panulirus homarus</i>	SE	every 5 years	TL/CL/CW	5	No	BSA/CB
28	Veneridae	<i>Paphia malabarica</i>	Ashtamudi Lake, Kerala	Annual	APW/ DVM/TH	2	No	Survey based /SPM
29	Veneridae	<i>Villorita cyprinoides</i>	Vembanad lake, Kerala	Annual	APW/ DVM/TH	2	No	Survey based /SPM
30	Veneridae	<i>Meretrix casta</i>	SW, SE	Annual	APW/ DVM/TH	2	No	Survey based stock status / SPM
31	Turbinellidae	<i>Turbinella pyrum</i>	SE	Triennial	APW/ DVM/TH	2	No	Survey based /SPM
32	Muricidae	<i>Chicoreus ramosus</i>	SE	Triennial	APW/ DVM/TH	2	No	Survey based /SPM
33	Babyloniidae	<i>Babylonia spirata</i>	SW	Triennial	APW/ DVM/TH	2	No	BSA/SPM

*Additionally, Annual Stock Status reports for all species SPM Surplus Production Model

TL-Total Length; CL-Carapace Length; CW-Carapace Width; DML-Dorsal Mantle Length; APM- Antterio-Posterior Margin; DVM- Dorsal ventral margin; TH-Total Height

BSA- Biological Stock Assessment Methodologies used will be based on exploitation characteristics, life history traits and other relevant parameters derived from the age/length data of the species ; CB- Catch Based methods which use Catch and Abundance (optional) data with informed priors

Table 6. Working group on new approaches to tropical marine fish stock assessment

Theme	National Working Group (NWG)	NWG Leader
Stock Assessment	Dr. Shubhadeep Ghosh	Dr. Jayasankar J
Techniques/Tools/ Software for an evolutionary approach to marine fish stock assessment	Dr. Muktha, M. Dr. Rajan Kumar Dr. Gyanranjan Dash Dr. Abdul Azeez Dr. Santosh Bhendekar Dr. Eldho Varghese Dr. Somy Kuriakose Dr. Mini, K. G. Dr. Ganga.U	

Table 7. Working group on Genetic Stock Identification of marine fishery resources

Theme	National Working Group (NWG)	NWG Leader
Advanced molecular markers in Genetic Stocks identification	Dr. A. Gopalakrishnan Dr. M. Sakthivel Dr. N. S. Jeena Dr. Sekar Megarajan Dr. Sajeela, K. A.	Dr. Sandhya Sukumaran

Table 8. Working Group for Zone wise Regional Marine Fish Stocks Assessment

Theme	National Working Group (NWG)
Northwest coast	Dr. Rajan Kumar and Dr. Santosh Bhendekar
Southwest coast	Dr. Dineshbabu, A. P., Dr. U. Ganga and Dr. Eldho Varghese
Southeast coast	Dr. Shoba J Kizhakudan
Northeast coast	Dr. Muktha, M. and Dr. Gyanaranjan Dash

Groups. Information is available on the occurrence of two or more distinct genetic stocks in certain resources/species but the spatio-temporal extent or stock boundaries is yet to be demarcated, for which detailed analysis covering entire distributional range of the species and all seasons needs to be undertaken (Table 9). Genetic stock studies were proposed for a few among the prioritized species, which would enable assessments at genetic stock level in the future.

Growth parameters like L_{∞} , K , t_0 , LWR, etc. are species/stock specific and population parameters with appropriate confidence limits may be estimated for each species or for all spatially segregated discrete stocks, based on available best information. A re-estimation maybe warranted only if substantial change in the fishery or ecosystem over a minimum gap of 10 years as reflected in changing size structure in the landing /samples is evident. Moreover, development of growth models (K) with independent

Table 9. Finfish and Shellfish species assessed for genetic stocks

Species	Number of Stocks identified using genetic markers / life history parameters/other parameters	Reference
<i>Sardinella longiceps</i>	2 (NW & rest of India)	Sebastian <i>et al.</i> , 2017. <i>Conservation Genetics</i> , 18, p. 951-964. Sebastian <i>et al.</i> , 2021. <i>Nature Scientific Reports</i> , p. 1-16
<i>Rastrelliger kanagartha</i>	2 (mainland & A&N)	Sukumaran <i>et al.</i> , 2017. <i>Fisheries Research</i> , 191 (2017): 1–9.
<i>Harpadon nehereus</i>	2 (West coast & East coast)	Pazhayamadom <i>et al.</i> , 2014. <i>Journal of Applied Ichthyology</i> , 31, p. 37–44.
<i>Trichiurus lepturus</i>	2 (East and West coasts)	Mukundan <i>et al.</i> , 2022; under review in <i>Marine Biodiversity</i>
<i>Nemipterus randalli</i>	2 (East and West coasts)	Raj <i>et al.</i> , Unpublished; work completed
<i>Pampus griseus</i>	1 (Bay of Bengal)	Roul <i>et al.</i> , 2021. <i>Frontiers in Marine Science</i> , 8.
<i>Coilia dussumieri</i>	2 (Northeast and Northwest)	Kathirvelpandian <i>et al.</i> , 2014. <i>Mol. Biol. Rep.</i> , 41(6):3723-31
<i>Decapterus russelli</i>	1 (all over the Indian coast)	Jose <i>et al.</i> , (Work completed, not yet published.)
<i>Lactarius lactarius</i>	2 (East and West coast)	Gopalakrishnan <i>et al.</i> , (Work completed, not yet published)
<i>Rachycentron canadum</i>	3 (Two in the Arabian sea and one along the Bay of Bengal)	Divya <i>et al.</i> , 2019. <i>Mar. Biodiv.</i> , 49, p. 381–393
<i>Scomberomorus guttatus</i>	2 major stocks (east and west coasts)	Jeena <i>et al.</i> , 2022. <i>Frontiers in Marine Science</i> , 9.
<i>Scomberomorus commerson</i>	1 (all over the Indian coast)	Jeena <i>et al.</i> , 2022. <i>Frontiers in Marine Science</i> , 9.
<i>Auxis thazard</i>	3 lineages with overlapping geography. Cannot be geographically differentiated	Kumar <i>et al.</i> , 2012. <i>Marine Biology Research</i> , 8(10): 992-1002,
<i>Scoliodon laticaudus</i>	2 stocks (East and west coasts) to the level of species (<i>S. laticaudus</i> along west coast and <i>S. cf. laticaudus</i> along east coast)	Sukumaran <i>et al.</i> , 2022. <i>Marine Biodiversity</i> . Accepted
<i>Sphyrna lewini</i>	1 stock (all along the Indian coast)	Sukumaran <i>et al.</i> , 2020. <i>Marine Biodiversity</i> , 50 (18): 1-6
<i>Carcharhinus longimanus</i>	1 stock (all along the Indian coast)	Sreelekshmi <i>et al.</i> , 2020. <i>Marine Biodiversity</i> , 50(5): 78pp
<i>Tenualosa ilisha</i>	2 found based on freshwater systems to which they migrate	Mohindra <i>et al.</i> , 2021. <i>Environ. Biol. Fish.</i> , 102, p. 939-954
<i>Thunnus tonggol</i>	1 (all along the Indian coast)	Koya <i>et al.</i> , 2021, Ph.D Thesis
<i>Euthynnus affinis</i>	1 (all along the Indian coast)	Kumar <i>et al.</i> , 2012. <i>Turkish Journal of Fisheries and Aquatic Sciences</i> , 12, p. 555-564
<i>Thunnus albacares</i>	3 (Northwest, LD & rest of India)	Kunal <i>et al.</i> , 2013 <i>Conservation Genetics</i> , 14, p. 205–213
<i>Uroteuthis (Photololigo) duvaucelii</i>	3 clades (one along west coast and 2 along the east coast)	Nisha <i>et al.</i> , Unpublished. Work completed
<i>Panulirus polyphagus</i>	2 major stocks (east and west coasts)	Jeena <i>et al.</i> , Unpublished. Work completed
<i>Perna viridis</i>	2 stocks (east and west coasts)	Divya <i>et al.</i> , 2022. <i>Mol. Biol. Rep.</i> , 49(4):3357-3363
<i>Paphia malabarica</i>	1 major stock along the Indian coast	Sukumaran <i>et al.</i> , 2020. <i>Regional Studies in Marine Science</i> , 27, p. 1-6

A&N- Andaman & Nicobar ; LD – Lakshadweep

estimates from hard part-based ageing techniques may be suitably incorporated in the stock assessment procedures. Species were prioritized for hard part ageing and training programs in hard parts based fish ageing were recommended for the young scientists to take up the work in future. Preparation of age-length keys for select species following standard methodologies and best practices (Morison *et al.*, 1998) was suggested.

In most of the well-managed fisheries across the world, assessments are done annually to have timely fisheries management interventions. As a mandatory output from the Institute, a brief stock status and possible fishery indicators for the major marine fishery resources, along with advisories for fishery managers and concerned stakeholders for facilitating timely fishery management interventions, to be released annually, preferably following the annual Institute Research Council meetings. The full stock assessment is to

be done each year (Annual) for fishes with short life span (<2 years); once in two years (Biennial) for resources of medium life span (>2 and <4 years) and every three years (Triennial) for species with longer life span (> 4 years). The BSA procedures would be followed for the data-rich (length/age based growth and mortality parameters, selectivity, recruitment rates etc.) species. For those data-limited species having only catch and/or limited length frequency data, suitable catch-based surplus production models and methods like CMSY (or as decided by the concerned working group) would be followed. The concerned Principal Investigators of the various capture fisheries monitoring projects operating in all maritime states and Working Groups constituted for various marine fishery resources will thus be able to address the needs of stakeholders for species/gear specific advisories. Also, a dynamic "Interactive web-based Atlas" for various marine fishery resources monitored to provide easily accessible information on the fish stocks for the stakeholders, will be developed by the institute and will be updated annually.

For improving data collection, adequate budgetary provision was highlighted and separate allocation for resource monitoring works at Centres also, as followed at Headquarters was promised. Small grants for case-specific research programmes, strengthening of infrastructure facilities for capture fisheries research at Centres and support for field sampling and fish biology works were requested. It was also suggested that externally funded projects may be explored to overcome the fund and manpower shortages, if any. Possibilities of inviting international experts in marine fish stock assessment to train the young scientists either with the institute's HRD funds or through similar funding programmes of the Department of Science and Technology were mooted.

Publication policy was discussed in detail. After completing full stock assessment of the resource(s), following publication protocols of the Institute, authors must ensure quality of data and results presented, preferably in a peer-reviewed science journal with NAAS rating. As part of the Publications Policy, a data disclaimer statement 'The marine fish landings data used in this study/publication are research data of ICAR-CMFRI collected through diachronic primary surveys following a stratified multi-stage random sampling design across the coastline of mainland India' to be mandatorily included in all publications made by the staff was recommended. The State Policy Briefs based on data collected under the in-house capture fisheries projects and conduct of the

stakeholders' workshops prior to the annual Institute Research Council meeting, which are prepared for the benefit of fishery managers and policy makers of each maritime state, must be updated periodically (every 5 or 10 years). The need for critical assessment and check of data quality in various reports pertaining to fish stocks in Indian EEZ should be addressed proactively by the concerned Working Groups. It was also decided to bring out special publications on the following unique marine fisheries resources of regional importance at the earliest. These included, Unicorn cod (*Bregmaceros mclellandi*) to be led by Dr. Sikha R., non-penaeid shrimp *Acetes* spp. (to be led by Dr. Rajan Kumar); Golden anchovy (to be led by Dr. Abdul Azeez; Sprats (by Drs. Mohammed Koya and Abdul Azeez); Indian mackerel (to be led by Dr. U. Ganga); Bombay duck (to be led by Dr. C. Anulekshmi) and ribbonfishes (to be led by Dr. K. M. Rajesh).

The workshop ended with vote of thanks and distribution of certificates to all participants

References for Standard methods and Good Practices

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