

CMFRI Booklet Series No. 32/2023

Marine Fish Stock Status of India 2022



Indian Council of Agricultural Research
ICAR-Central Marine Fisheries Research Institute



Marine Fish Stock Status of India, 2022

CMFRI Booklet Series No. 32/2023



Indian Council of Agricultural Research
ICAR-Central Marine Fisheries Research Institute

Marine Fish Stock Status of India, 2022

CMFRI Booklet Series No. 32/2023

Published by

Dr. A. Gopalakrishnan
Director, ICAR-Central Marine Fisheries Research Institute
Post Box No.1603, Ernakulam North P. O.
Kochi -682018, Kerala, India

www.cmfri.org.in

Email: director@cmfri.org.in

Tel No: +91-0484-2394867

Fax No: +91-0484-2394909

Compiled by:

Marine Fish Stock Status (MFSS) Report Committee: Geetha Sasikumar, Ganga U., Shoba Joe Kizhakudan, Gyanaranjan Dash, Anulekshmi Chellappan, Muktha M., Santosh Bhendekar, Rajan Kumar, Sandhya Sukumaran

Contributors:

Finfish Fisheries Division: E. M. Abdussamad, Prathibha Rohit, Sujitha Thomas, Shoba Joe Kizhakudan, Muktha M., Ganga U., Anulekshmi Chellappan, Swatipriyanka Sen, Akhilesh K. V., Remya L., Shikha Rahangdale, K. M. Rajesh, Shubhadeep Ghosh, Rekha J. Nair, T. M. Najmudeen, G. B. Purushottama, Mohamed Koya, Subal Kumar Roul, V. Mahesh, Livi Wilson, P. Abdul Azeez, S. Surya, H. M. Manas, D. Ajay Nakhawa, R. Vinothkumar, A. Margaret Muthu Rathinam.

Shellfish Fisheries Division: P. Laxmilatha, Geetha Sasikumar, Rajan Kumar, Gyanaranjan Dash, Josileen Jose, A.P. Dineshbabu, Lakshmi Pillai, P. T. Sarada, Rekha Devi Chakraborty, Santosh Bhendekar, V. Venkatesan, Indira Divipala, R. Vidya, F. Jasmine, M. Kavitha, Rajesh Kumar Pradhan, M. Rajkumar, P. Gomathi, Sunil Kumar Ail.

Fishery Resource Assessment, Economics and Extension Division: J. Jayasankar, Somy Kuriakose, Mini K.G., Eldho Varghese, Vinay Kumar Vase.

Design: Graficreations, Kochi

Cover design & Illustrations: Abhilash P.R. & K.M. David, ICAR-CMFRI, Kochi

Publication, Production & Co-ordination

Library & Documentation Centre, ICAR-CMFRI

© 2023 ICAR- Central Marine Fisheries Research Institute

All rights reserved. Material contained in this publication may not be reproduced in any form without the permission of the publisher

Citation: CMFRI. 2023. Marine Fish Stock Status of India, 2022. CMFRI Booklet Series No. 32/2023, ICAR-Central Marine Fisheries Research Institute (CMFRI), Kochi, Kerala, India, 22p.

India has a coastline of 8,118 km and an Exclusive Economic Zone of 2.02 million sq.km, which harbours 2,275 species of teleosts, 174 species of elasmobranchs, 3,400 species of molluscs, 2,783 species of crustaceans, 936 species of seaweeds, 14 species of seagrasses, 765 species of echinoderms and 486 sponges^{1,2,3}. Of these ~1000 species contribute to commercial fisheries, and are harvested by nearly 30 fishing craft-gear combinations operating in various regions of the Indian seas. In 2022, the landing centre value of marine fisheries of mainland India was estimated at ₹58,247 crores⁴, providing livelihood and nutritional security to over 28 million stakeholders⁵.

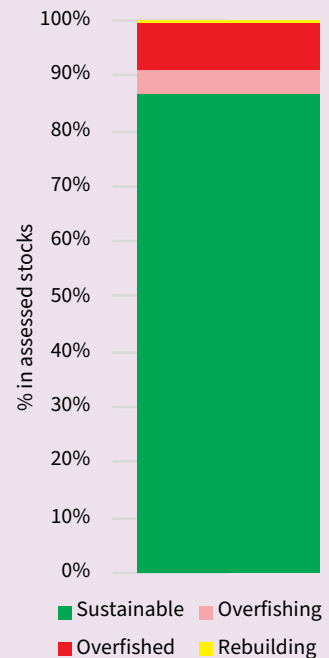
The ICAR-Central Marine Fisheries Research Institute (CMFRI) is the largest organization dedicated to marine fisheries research in the country. Established by the Government



India's Marine Fish Stock Status – An Overview

70 species (including 49 finfishes and 21 shellfishes) were assessed in one or more regions of their availability along the Indian coast.

Of the 135 fish stocks assessed, 91.1% were healthy, with 86.7% being sustainable, 4.4% subject to overfishing, 8.2% overfished and 0.7% rebuilding. None of the assessed stocks had collapsed.





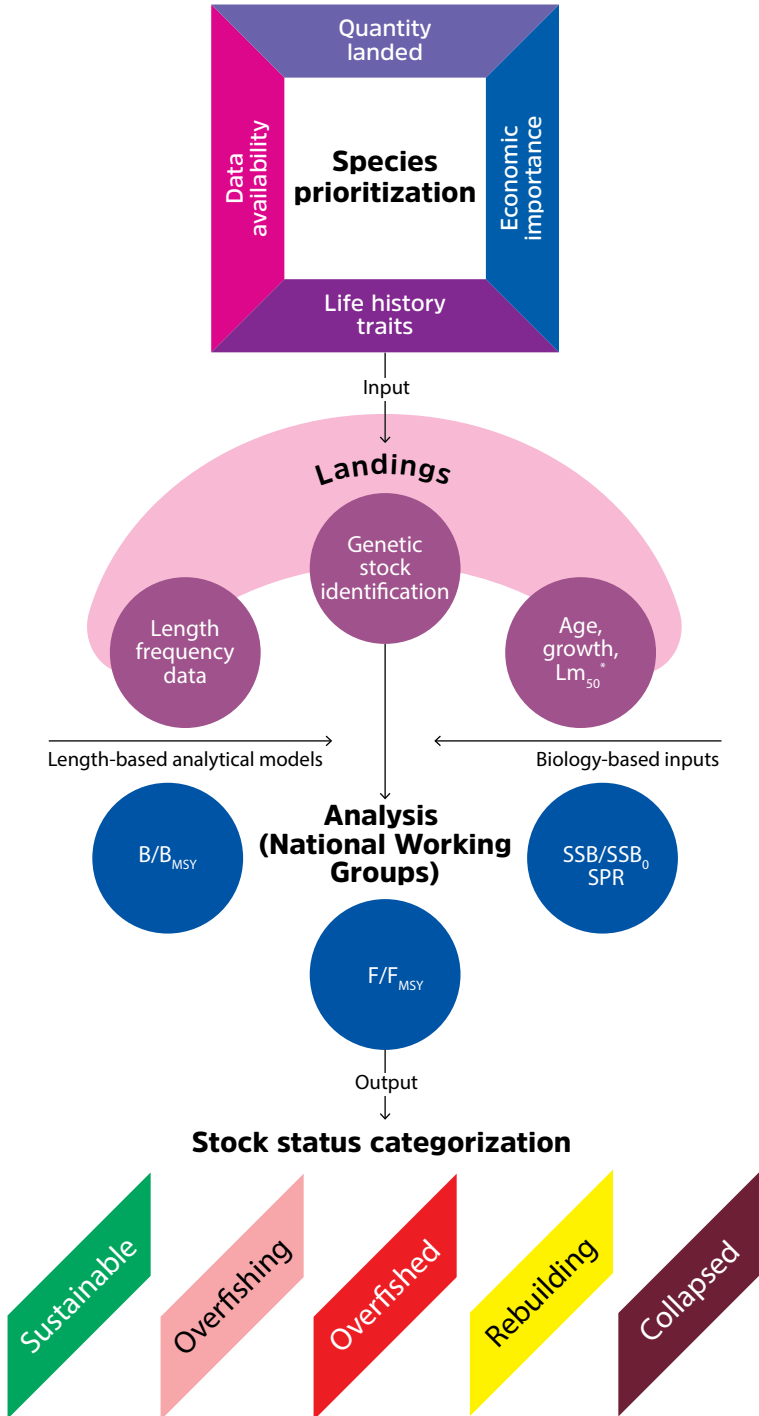
of India on 3rd February 1947 under the Ministry of Agriculture (re-named now as Ministry of Agriculture and Farmers' Welfare), CMFRI joined the ICAR family in 1967. Over the course of 75 years, ICAR-CMFRI has emerged as a leading tropical marine fisheries research institute in the world with research focus on sustainable marine fisheries and mariculture. The research focus in marine capture fisheries is on the estimation of marine fisheries landings, species diversity, stock assessments, genetic stock identification, taxonomy of marine organisms and bio-economic characteristics of the exploited stocks of finfish and shellfish. The Institute's multidisciplinary approach to research in marine capture and culture fisheries has won it recognition as a premier institute comparable to any well-established marine fisheries research organization in the world.

Marking the first endeavour of its kind for the country, ICAR-CMFRI is bringing out this report on the marine fish stock status of India to present an overview of the health of the marine fish stocks in the country¹. The objective of this report is to assess the status and provide a synoptic picture of the marine fish stocks of national and regional importance under the currently prevalent fisheries management regime in the country. Fish stocks^{**} as defined by their management unit (regions) were assessed for biological sustainability based on the abundance and level of harvest. Other dimensions of sustainability such as economic, environmental and social were not considered in this analysis, as they were beyond the scope of this document. This report will set the stage for a Management Strategy Evaluation (MSE) framework for marine fisheries in the country. It is anticipated that this, and subsequent fish stock status reports will be a guiding tool for fishery managers, policymakers, researchers and other stakeholders involved in the marine fisheries sector to enhance the sustainability of our marine fish resources.

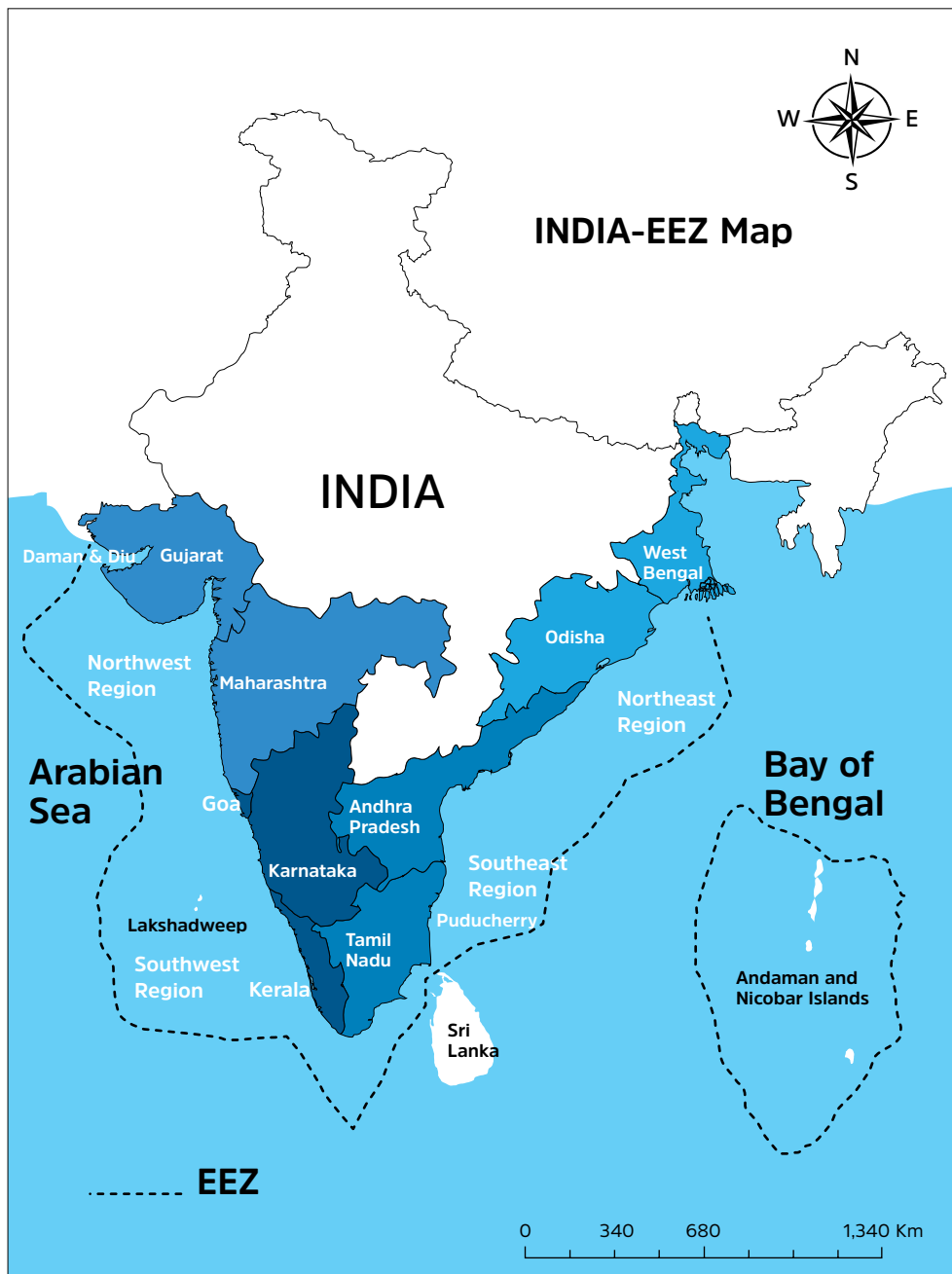
Species-wise length-frequency data were collected from landings by different gears in four regions of the Indian coast (northwest, southwest, northeast, southeast) and Lakshadweep. Stock assessments were carried out by National Working Groups⁶ using length-based micro-analytical models⁷, which incorporate species-specific biological information on growth, mortality, recruitment and age of fish. Wherever necessary, spawning stock biomass based on length at first maturity and juvenile abundance in the fisheries were used as precautionary management reference points to categorize the stock status. Globally accepted indicators for marine fish stock assessments were used to categorize the stock status.

* Disclaimer: The marine fish landings and species biology 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 India.

** A fish stock is defined as an intraspecific group of randomly mating individuals with temporal and spatial integrity¹⁴.



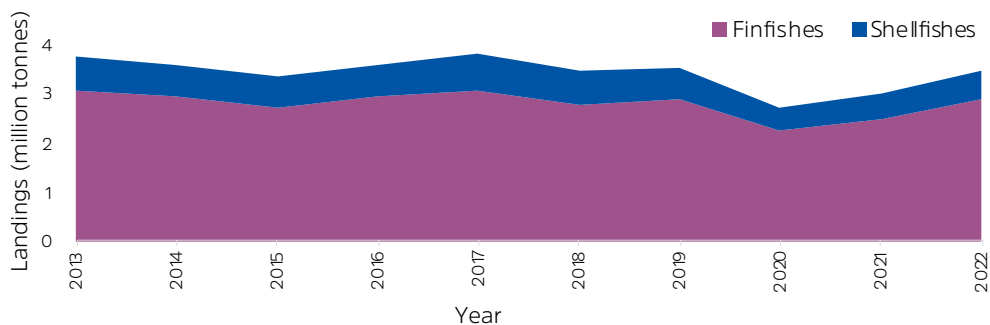
* $L_{m_{50}}$ - Length at 50% maturity



Contribution to marine fish landings (%) by region (2022)



Total annual landings in the country/mainland India ranged between 2.7 to 3.8 million tonnes during 2013-2022, with the average annual landings estimated at 3.5 million tonnes.



Indicators of Stock Health⁸

These are primarily based on estimates of stock biomass and fishing intensity in relation to set management goals, such as the level of biomass and fishing intensity that produce the Maximum Sustainable Yield ($MSY-B_{MSY}$ and F_{MSY}).

Sustainable: A fish stock having high biomass at low fishing pressure, enabling it to sustain its biomass at or above the MSY level.

Overfishing: A fish stock having high biomass above the MSY level, but is presently at high fishing pressure, and if continued at the same level may jeopardize stock replenishment and biomass abundance.

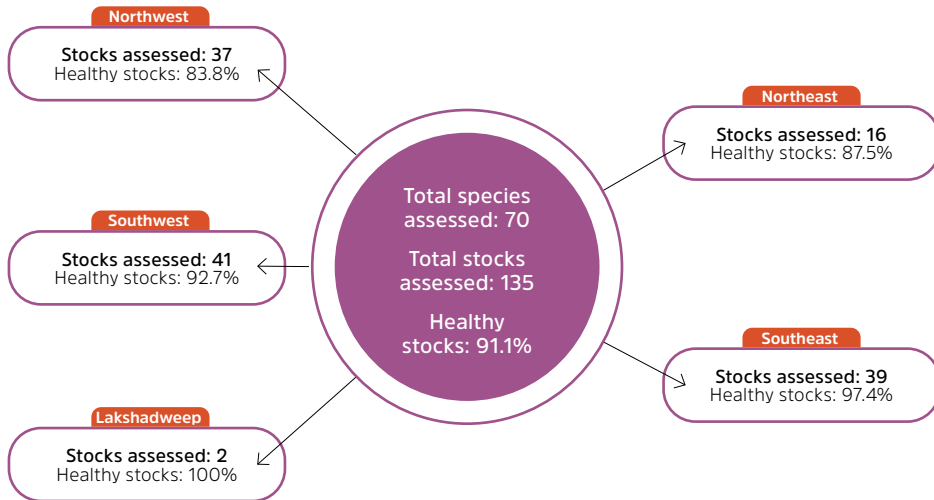
Overfished: A fish stock, whose biomass has been reduced to below the MSY level due to continuing high fishing pressure, jeopardizing its ability to produce its MSY.

Rebuilding: A fish stock whose biomass had fallen to a precariously low level due to excessive fishing but is presently in a state of biomass increase after regulating fishing pressure.

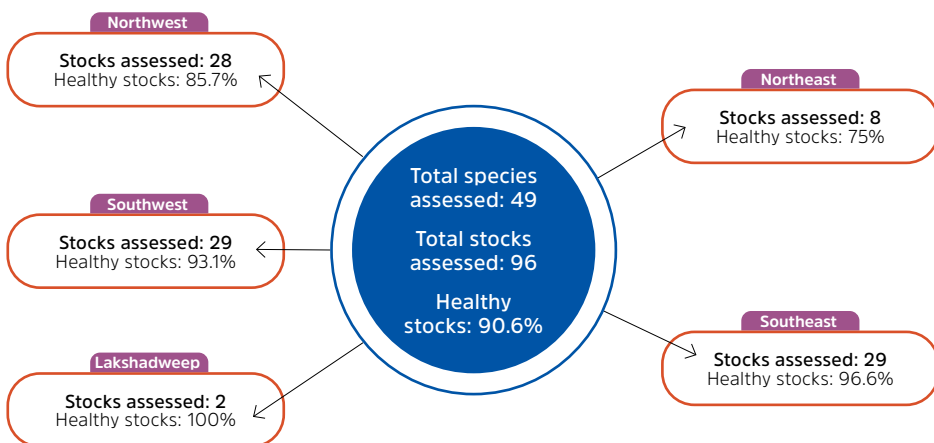
Collapsed: A fish stock whose biomass has fallen to an extremely low level which impairs recruitment, and thereby fails to recover within a set time frame.

Fish stocks that fall in the **Sustainable** and **Overfishing** categories are considered **Healthy** for the given year, based on the current biomass level.

Marine fish stock status of India, 2022

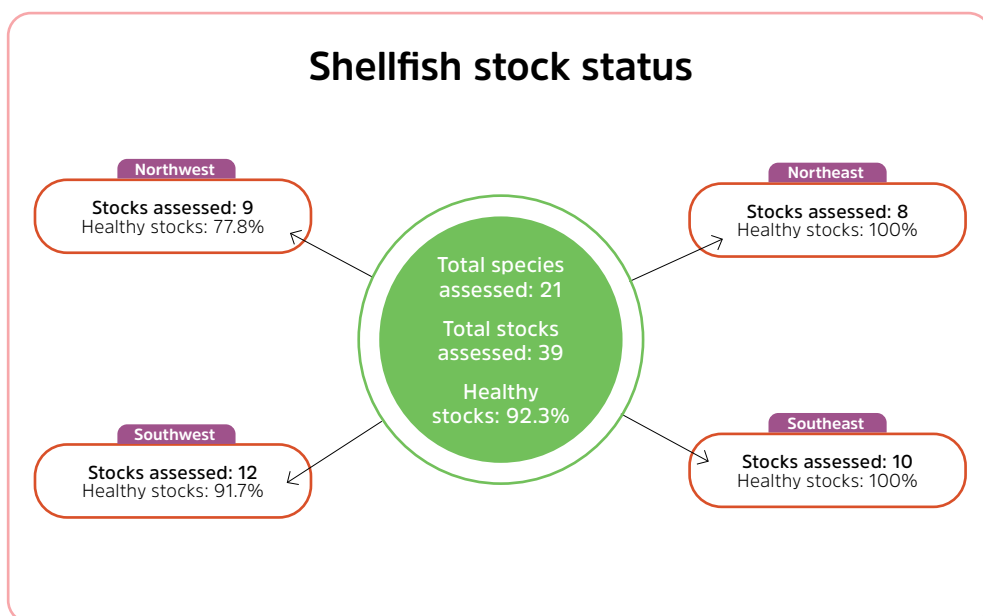


Finfish stock status



Criteria* and threshold values for categories of finfish stocks¹³

Category	B/B _{MSY}	F/F _{MSY}	Colour Code
Sustainable	>1.0	<1.0	Green
Overfishing	>1.0	>1.0	Light Red
Overfished	<1.0	>1.0	Red
Rebuilding	<1.0	<1.0	Yellow
Collapsed	<0.3	-	Dark Red



Criteria* and threshold values for categories of shellfish stocks

Criteria A		Criteria B		
Category	B/B _{MSY}	F/F _{MSY}	Colour Code	
Sustainable	SSB/SSB ₀ or SPR >0.25	>0.8	<1.2	Green
Overfishing	→ Criteria B	>0.8	>1.2	Light Red
Overfished		<0.8	>0.8	Red
Rebuilding		<0.8	<0.8	Yellow
Collapsed		<0.3	-	Dark Red
Not Sustainable		SSB/SSB ₀ or SPR <0.25		

*B - Biomass (current); B_{MSY} - Biomass at MSY; F - Fishing mortality (current); F_{MSY} - Fishing mortality at MSY; SSB - Spawning Stock Biomass (current); SSB₀ - Virgin Spawning Stock Biomass (when F = 0); SPR - Spawning Potential Ratio

Higher threshold values for B/B_{msy} (1.0) and lower threshold for F/F_{msy} (1.0) were set for finfishes compared to shellfishes as a precautionary approach considering slower growth & longer life span.¹³

Stock status of major commercially important marine fishery resources

Resource	Species Common name	Major fishery	Status
FINFISHES			
TELEOSTS			
Anchovies	<i>Coilia dussumieri</i>	NW dol net fishery	●
	Goldspotted grenadier anchovy	NE trawl fishery	●
Barracudas	<i>Sphyraena putnamae</i>	SW trawl/gillnet fishery	●
	Sawtooth barracuda	SE trawl fishery	●
Big-jawed jumper	<i>Lactarius lactarius</i>	NW trawl fishery	●
	False trevally	SW trawl fishery	●
Billfishes	<i>Istiompax indica</i> Black marlin	NW longline/gillnet fishery	●
		SW longline/gillnet fishery	●
		SE longline/gillnet fishery	●
	<i>Istiophorus platypterus</i> Indo-Pacific sailfish	NW longline/gillnet fishery	●
		SW longline/gillnet fishery	●
		SE longline/gillnet fishery	●
	<i>Makaira nigricans</i> Blue marlin	Lakshadweep line fishery	●
		NW longline/gillnet fishery	●
		SW longline/gillnet fishery	●
		SE longline/gillnet fishery	●
<i>Xiphias gladius</i> Swordfish	NW longline/gillnet fishery	●	
	SW longline/gillnet fishery	●	
	SE longline/gillnet fishery	●	

Resource	Species		Major fishery	Status
	Common name			
Bull's eye	<i>Priacanthus hamrur</i>		NW trawl fishery	●
	Moontail bull's eye		SW trawl fishery	●
Bombayduck	<i>Harpadon nehereus</i> Bombayduck		NW <i>dol</i> net/trawl fishery	●
Catfishes	<i>Plicofollis layardi</i> Thinspine sea catfish		NW purse seine/gillnet/trawl fishery	●
	<i>Chirocentrus nudus</i> Whitefin wolf-herring		NW gillnet/trawl/ <i>dol</i> net fishery	●
Clupeids			NW seine fishery	●
	<i>Sardinella longiceps</i> Indian oil sardine		SW seine fishery	●
			NE gillnet/trawl fishery	●
			SE gillnet/trawl fishery	●
Cobia	<i>Rachycentron canadum</i> Cobia		SW trawl fishery	●
	<i>Nibea maculata</i> Blotched croaker		SE trawl fishery	●
Croakers	<i>Otolithes cuvieri</i> Lesser tigertooth croaker		NW trawl fishery	●
			SW trawl fishery	●
			NW trawl fishery	●
	<i>Otolithes ruber</i> Tigertooth croaker		SW trawl fishery	●
			NE trawl fishery	●
Dolphinfish			SE trawl fishery	●
	<i>Coryphaena hippurus</i> Common dolphinfish		NW line/gillnet fishery	●
			SW trawl fishery	●
Eels			SE line/gillnet fishery	●
	<i>Muraenesox bagio</i> Common pike conger		NW trawl/ <i>dol</i> net fishery	●
			SW trawl fishery	●

Resource	Species Common name	Major fishery	Status
Flatheads	<i>Gammoplites suppositus</i> Spotfin flathead	SW trawl fishery	●
	<i>Platycephalus indicus</i> Bartail flathead	SE gillnet fishery	●
Grunters	<i>Pomadasys kaakan</i> Javelin grunter	SE hook & line/gillnet fishery	●
Goatfishes	<i>Upeneus moluccensis</i> Goldband goatfish	NW trawl fishery	●
	<i>Upeneus sulphureus</i> Sulphur goatfish	SE trawl/gillnet fishery	●
	<i>Upeneus supravittatus</i> Longfin goatfish	SE trawl/gillnet fishery	●
Fullbeaks	<i>Ablennes hians</i> Flat needlefish	NW gillnet/hook & line/trawl fishery	●
		SW gillnet/hook & line/trawl fishery	●
Lizardfishes		NW trawl fishery	●
	<i>Saurida tumbil</i> Greater lizardfish	SW trawl fishery	●
		SE trawl fishery	●
		NW trawl fishery	●
	<i>Saurida undosquamis</i> Brushtooth lizardfish	SW trawl fishery	●
		SE trawl fishery	●
Mackerels	<i>Rastrelliger kanagurta</i> Indian mackerel	SW seine fishery	●
Pomfrets		NW trawl fishery	●
	<i>Pampus candidus</i> Indian silver pomfret	SW trawl fishery	●
		SE trawl fishery	●
	<i>Pampus griseus</i> Bengal silver pomfret	NE trawl fishery	●
		SE trawl fishery	●

Resource	Species Common name	Major fishery	Status
Ribbonfish	<i>Trichiurus lepturus</i> Largehead hairtail	NW trawl fishery	●
		SW trawl fishery	●
		NE trawl fishery	●
		SE trawl fishery	●
Rockcods	<i>Epinephelus diacanthus</i> Spinycheek grouper	NW trawl fishery	●
		SW trawl fishery	●
Scads	<i>Decapterus russelli</i> Indian scad	SW trawl fishery	●
Silverbellies	<i>Gazza minuta</i> Toothed ponyfish	SE trawl fishery	●
	<i>Karalla dussumieri</i> Dussumier's ponyfish	SE trawl fishery	●
Snappers	<i>Lutjanus fulvus</i> Blacktail snapper	SE gillnet/mixed gear fishery	●
	<i>Lutjanus johnii</i> John's snapper	SE gillnet/hook & line fishery	●
	<i>Lutjanus quinquilineatus</i> Five-lined snapper	SE trawl/gillnet fishery	●
Threadfin breams	<i>Nemipterus japonicus</i> Japanese threadfin bream	NW trawl fishery	●
		SW trawl fishery	●
		NE trawl fishery	●
		SE trawl fishery	●
	<i>Nemipterus randalli</i> Randall's threadfin bream	NW trawl fishery	●
		SW trawl fishery	●
	SE trawl fishery	●	

Resource	Species Common name	Major fishery	Status
Tunas	<i>Euthynnus affinis</i> Little tuna	NW gillnet/purse seine fishery	●
		SW hook & line/gillnet fishery	●
		NE hook & line/gillnet fishery	●
	<i>Auxis rochei</i> Bullet tuna	SW hook & line/gillnet fishery	●
		NW gillnet/purse seine fishery	●
	<i>Auxis thazard</i> Frigate tuna	SW hook & line/gillnet fishery	●
		SW hook & line/gillnet fishery	●
	<i>Katsuwonus pelamis</i> Skipjack tuna	SE hook & line/gillnet fishery	●
		Lakshadweep pole & line fishery	●
		SW hook & line/gillnet fishery	●
<i>Thunnus albacares</i> Yellowfin tuna	SW hook & line/gillnet fishery	●	
	SE hook & line/gillnet fishery	●	
ELASMOBRANCHS			
Guitarfishes	<i>Rhinobatos lionotus</i> Smoothback guitarfish	NE trawl fishery	●
Rays	<i>Brevitrygon imbricata</i> Bengal whipray	NW trawl fishery	●
		SE trawl fishery	●
	<i>Gymnura poecilura</i> Longtail butterfly ray	SE trawl fishery	●
Sharks	<i>Rhizoprionodon oligolinx</i> Grey sharpnose shark	NW trawl fishery	●
SHELLFISHES			
CRUSTACEANS			
Crabs	<i>Charybdis feriata</i> Crucifix crab	SW trawl fishery	●
		NE trawl fishery	●
	<i>Portunus pelagicus</i> Blue swimming crab	SW trawl fishery	●
		SW trawl fishery	●
	<i>Portunus sanguinolentus</i> Three spot swimming crab	NE trawl fishery	●
		SE trawl fishery	●

Resource	Species Common name	Major fishery	Status
Lobsters	<i>Thenus unimaculatus</i> Shovel-nosed lobster	NW trawl fishery	●
		SW trawl fishery	●
		SE trawl fishery	●
Non-penaeid prawns	<i>Acetes</i> spp. Paste shrimp	NW <i>dol</i> net fishery	●
	<i>Heterocarpus chani</i> Deep-sea pandalid shrimp	SW trawl fishery	●
Penaeid prawns	<i>Aristeus alcocki</i> Arabian red shrimp	SW trawl fishery	●
	<i>Metapenaeus affinis</i> Jinga shrimp	NW trawl/ <i>dol</i> net fishery	●
	<i>Metapenaeus dobsoni</i> Brown shrimp	SW trawl fishery	●
		SE trawl fishery	●
	<i>Metapenaeus monoceros</i> Speckled shrimp	NW trawl/ <i>dol</i> net fishery	●
		SW trawl fishery	●
		SE trawl fishery	●
	<i>Parapenaeopsis stylifera</i> Coromandel shrimp	NW trawl/ <i>dol</i> net fishery	●
		SW trawl fishery	●
		NE trawl fishery	●
<i>Penaeus semisulcatus</i> Flower shrimp	SE trawl fishery	●	
<i>Solenocera crassicornis</i> Coastal mud shrimp	NW trawl/ <i>dol</i> net fishery	●	
	NE trawl fishery	●	

Resource	Species Common name	Major fishery	Status
MOLLUSCS - CEPHALOPODS			
Cuttlefishes	<i>Sepia aculeata</i> Needle cuttlefish	NE trawl fishery	●
		SE trawl fishery	●
	<i>Sepia brevimana</i> Shortclub cuttlefish	SE trawl fishery	●
		SW trawl fishery	●
	<i>Sepia pharaonis</i> Pharaoh cuttlefish	NE trawl fishery	●
		SE trawl fishery	●
	<i>Sepiella inermis</i> Spineless cuttlefish	NW trawl/dol net fishery	●
		NE trawl fishery	●
Octopuses	<i>Amphioctopus neglectus</i> Neglected ocellate octopus	SW trawl fishery	●
	<i>Cistopus indicus</i> Old woman octopus	NW trawl fishery	●
Squids		NW trawl fishery	●
	<i>Uroteuthis (Photololigo) duvaucelii</i> Indian squid	SW trawl fishery	●
		NE trawl fishery	●
		SE trawl fishery	●
	<i>Uroteuthis (Photololigo) singhalensis</i> Long barrel squid	SE trawl fishery	●

Management measures: species in the spotlight

Plicofollis layardi

Thinspine sea catfish

Current Status: Overfished

- Males exhibit parental care with buccal incubation
- Aggregations of brooding males are extremely vulnerable to surface fishing gears
- Recommended management measures –
 - > Immediate fishing closure in spawning grounds and seasons through participatory actions
 - > Strict enforcement of Minimum Legal Size (MLS) to stop juvenile exploitation
 - > Increasing mesh size in fishing gears
 - > Continuous monitoring and periodic stock assessment



Epinephelus diacanthus

Spinycheek grouper

Current Status: Overfished

- Slow-growing protogynous hermaphrodite
- Juveniles aggregating in coastal waters are vulnerable to trawl fishing
- Spawning aggregations are exposed to passive selective gears
- Recommended management measures –
 - > Regulating/restricting fishing in spawning grounds
 - > Strict implementation of MLS, and mesh-size regulation in coastal trawl fisheries
 - > Continuous monitoring of landings, regular stock assessment and monitoring of annual recruitment to the fishery

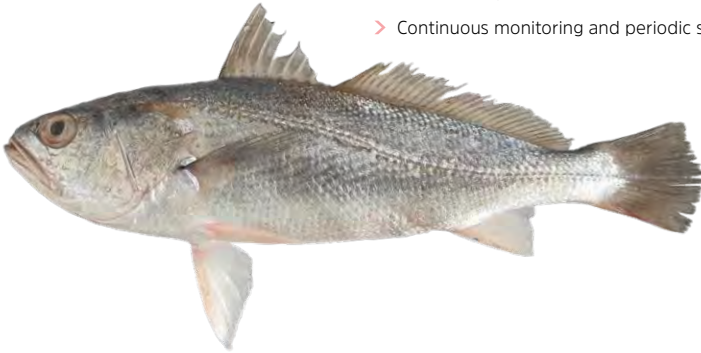


Otolithes cuvieri

Lesser tigertooth croaker

Current Status: Overfished

- Exploited by non-selective (bottom trawls and *dol* nets) and selective (bottomset gillnets) gears along the NW coast
- Recommended management measures –
 - > Strict implementation of MLS with mesh-size regulation in non-selective fishing gears
 - > Fishing closure in spawning grounds during peak spawning seasons
 - > Fleet size cap for *dol* nets
 - > Continuous monitoring and periodic stock assessment



Otolithes ruber

Tigertooth croaker

Current Status: Overfished

- Bycatch in coastal trawl fisheries; minor bycatch in bottomset gillnets
- Seasonal, sporadic aggregations of breeding adults are exploited by seines (SE coast)
- Recommended management measures –
 - > Strict implementation of MLS, mesh-size regulation
 - > Fishing closure in spawning grounds during peak spawning seasons
 - > Continuous monitoring and periodic stock assessment



Rhinobatos lionotus

Smoothback guitarfish

Current Status: Overfished

- Bycatch in coastal trawl fisheries
- "Critically Endangered" on IUCN Red List
- Recommended management measures –
 - > Strict implementation of Minimum Legal Size and Maximum Legal Size to reduce juveniles and gravid fish in the landings
 - > Incentive schemes to encourage return of incidental bycatch in live condition to sea
 - > Continuous monitoring and regular stock assessments
 - > Awareness generation and participatory management to reduce bycatch of this species



Rhizoprionodon oliginx

Grey sharpnose shark

Current Status: Overfished

- Major constituent of elasmobranch landings by trawls on the NW coast
- Recommended management measures –
 - > Strict implementation of Minimum Legal Size and Maximum Legal Size to reduce juveniles and gravid fish in the landings
 - > Continuous monitoring and regular stock assessments
 - > Awareness generation and participatory management to reduce bycatch of this species
 - > Incentive programs to encourage release of live animals back to sea



Thenus unimaculatus

Slipper lobster

Current Status: Overfished

- Bycatch in trawl fisheries along NW and SW coasts
- Recommended management measures –
 - > Implementation of MLS to reduce juveniles in the landings
 - > Incentive schemes/awareness programmes to encourage the release of live and berried females back to sea
 - > Continuous monitoring and periodic stock assessments



Uroteuthis (Photololigo)

duvaucelii

Indian squid

Current Status: Rebuilding

- Targeted in trawls
- Short-lived and highly resilient
- Reduced biomass in the NW region has led to overall reduction in fishing effort in the trawling grounds
- Recommended management measures –
 - > Implementation of MLS
 - > Use of recommended square mesh trawl cod end to avoid exploitation of juvenile squids
 - > Reduction of fishing pressure in nearshore trawling grounds during post-monsoon season for excluding potential spawning grounds
 - > Continuous monitoring to check effectiveness of implemented management measures



Challenges in the management of marine fish stocks in India

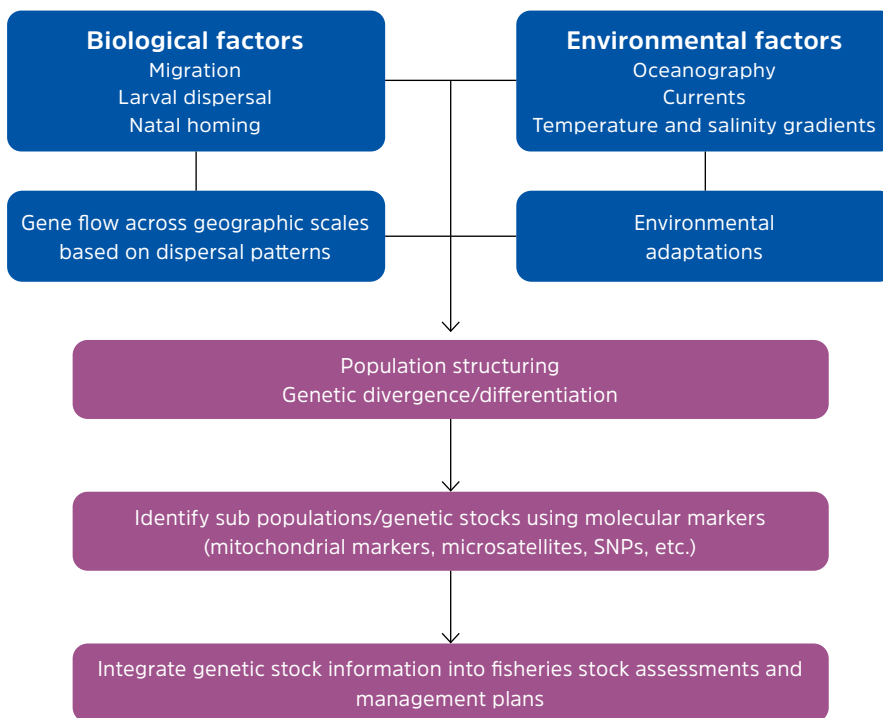
India's marine fisheries, like most tropical marine fisheries, are highly dynamic and multi-faceted in terms of the types of crafts and gears used, the number of species captured leading to mixed species fisheries, the communities involved and the overlapping of fishing zones. Assessing the status of marine fish stocks in such a dynamic system is challenging and regular stock assessments necessitate appropriate funding, exhaustive data collection, stakeholder participation for voluntary data submission, skilled scientific manpower for stock assessments and policy support. In the context of a largely multi-species, multi-gear scenario, single-species evaluations require a close look into the dynamics of the fishery as well as the biology of the species caught. Innovative applications of stock assessment methods based on an ecosystem approach and risk assessment frameworks are required⁹. Challenges emerging due to global phenomena such as climate change impacting the ocean dynamics and the fishery resources living there require multi-pronged approaches, solutions, and firm policy support consistent with the National Fisheries Policy.

Generic measures currently in place

Several generic measures such as mesh size /type regulations, closed fishing seasons, closed areas like Marine Protected Areas (MPAs) and fleet size regulation, among others, serve quite well in regulating the fishery of species requiring immediate attention. In addition, research is being focussed on assessing the vulnerability of different species to climate change, and studies are ongoing to monitor changes in fishing grounds of fish stocks due to climate change effects (primarily increase in sea surface temperature) and habitat degradation for stocks that are most at risk of depletion. Measures are in place to divert fishing pressure from inshore areas to offshore waters to harvest potential resources like oceanic squids, oceanic tunas, and non-conventional resources.



The concept of genetic stock identification (GSI) and integration into fisheries management programmes



Genetic stock identification using advanced genomic tools to support fisheries management

A 'stock' is a subset of a species inhabiting a particular geographic area, sharing a common gene pool and a common spawning ground, and is thus reproductively isolated from other similar entities¹⁰. A 'genetic stock' is a reproductively isolated unit that is genetically differentiated from other units/stocks¹¹. The incorporation of information on stock structure into the assessment and management of fish stocks is considered essential to ensure the conservation of genetic diversity and bio-complexity in fish populations. The use of advanced genetic and genomic tools has enabled the delineation of the stock structure of many commercially important fish species along the Indian coast. So far, genetic stock identification of 24 species has been undertaken using molecular markers⁶. Most of the species exhibited genetic differentiation mainly between the east and west coasts of India, indicating the presence of oceanographic and environmental barriers that limit their migration, larval dispersal, and subsequent mixing. Signals of localized adaptation have also been found in commercially important and widely distributed species like Indian oil sardine¹². Genetic stock structure information pertaining to all the assessed species is to be generated further so that fish stock assessment and management can be carried out based on the defined stock boundaries.



Scope of this Marine Fish Stock Status Report

The report provides an overall assessment of the fish stock status under the prevalent fisheries management regime in the country, following the FAO's sustainability indicators criteria based on the MSY concept. It covers a wide variety of fisheries resources harvested along the Indian coast ranging from the long-lived, slow-growing elasmobranchs to the fast-growing and short-lived invertebrates such as squids and penaeid prawns. In its present form, it should not be considered to be a certification of the fisheries. However, it paves the way for an MSE process for the Indian marine fisheries sector. The report has used widely accepted micro-analytical assessment models to arrive at the stock status. Currently only 70 species have been assessed, however resources, such as seerfishes, shads (Hilsa), threadfins and other prioritised species can be evaluated in the future. Appreciating the difference in life history traits and response to fishing efforts among species, an in-depth individual assessment report for each species/stock using multi-model assessments with stock-specific reference points is recommended.

Marine fish stock status is inherently dynamic, and hence can change across assessment periods. A stock indicated as healthy does not imply that management measures are not needed. Instead, it indicates that current management measures are adequate in the prevailing circumstances. Such fish stocks need to be moved to a higher level of fishery controls only in exceptional cases, as and when determined from the periodic stock assessments. The status indicated for different species by region indicates the rationale for implementing regional management measures; suitable amendments can be made within the scope of the Marine Fisheries Regulation Acts (MFRA) of concerned maritime states. Emphasis on regional approaches for gear-based evaluation of fishing activities and developing Fisheries Management Plans to address concerns about specific fishery resources is recommended. We hope that this document will bring together multiple stakeholders in the Indian marine fisheries sector, to develop appropriate policies in a timely manner.

Acknowledgements

Dr. A. Gopalakrishnan, Director, ICAR-CMFRI, for his continued support and encouragement.

ICAR for funding the Institute-run projects on resource assessment and management frameworks for sustainable fisheries across the maritime states of India.

Dr. C. Ramachandran, Principal Scientist, FRAEED, ICAR-CMFRI for invaluable advice.

ICAR-CMFRI's FRAEED team for technical support in systematically collecting field data from 1,168 landing centers across the Indian Coast.

Technical and supporting staff attached to Finfish and Shellfish Fisheries Divisions in Headquarters and all the Regional Centres and Stations of ICAR-CMFRI for assisting in species-wise length frequency and biology data collection and digitization.

References

1. Venkataraman K. and Raghunathan C. 2015. Coastal and Marine Biodiversity of India. In: Venkataraman Krishnamoorthy and Sivaperuman Chandrakasan (eds.) *Marine Faunal Diversity in India: Taxonomy, Ecology and Conservation*. Academic Press, Elsevier, London, UK, pp.303-347.
2. Raghunathan, C., Raghuraman, R., and Choudhury, S. 2019. Coastal and Marine Biodiversity of India: Challenges for Conservation. In: Krishnamurthy R.R., Jonathan M.P., Srinivasalu S., Glaeser B. (eds.), *Coastal Management: Global Challenges and Innovations*, Academic Press, Elsevier, London, UK, pp. 201-250.
3. Akhilesh, K. V., Kizhakudan, S. J., Muktha, M., Najmudeen, T. M., Thomas, S., Karnad, D., Sutaria, D., Fernandes, M., Gupta, T., Namboothri, N., Patankar, V., Dash, S. S., Varghese, Sijo P., Biju Kumar, A., Barnes, A., Bineesh, K. K., John, S., Gangal, M., Manjebayakath, H., Malayilethu, V., Tyabji, Z., Vaz, M., Sukumaran, S., Purushottama, G. B., Wilson, L., Mahesh, V., Nair, R. J., Remya, L., Rahangdale, S., Manojkumar, P. P., Sivakumar, K., Vivekanandan, E., Zacharia, P. U. and Gopalakrishnan, A. 2023. Elasmobranch conservation, challenges and management strategy in India: recommendations from a national consultative meeting. *Current Science*, 124 (3). pp. 292-303.
4. FRAEED, CMFRI. 2023. *Marine Fish Landings in India - 2022*. Technical Report. CMFRI Booklet Series 31/2023, ICAR-Central Marine Fisheries Research Institute, Kochi.
5. DoF, 2021. <https://pib.gov.in/Pressreleaseshare.aspx?PRID=1682945>
6. Muktha, M., Kizhakudan, S.J., Josileen, J., Pillai, S.L., Dash, G., Kumar, R., Sukumaran, S., Sasikumar, G., Jayasankar, J., Abdussamad, E.M., Laxmilatha, P. and Ganga, U. 2022. 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. *Marine Fisheries Information Service; Technical and Extension Series*, 254: 11-27. ISSN ISSN 0254-380 X
7. Sparre, P. and Venema, S.C. 1998. *Introduction to Tropical Fish Stock Assessment. Part I - Manual*. FAO Technical Paper No. 306/1, Rev. 2. Rome, FAO, 407p.
8. NOAA. 2016. *Status of Stocks 2015*. Annual Report to the Congress on the Status of U.S. Fisheries. 7p.
9. Mohamed, K. S., Sathianandan, T. V., Vivekanandan, E., Kuriakose, S., Ganga, U., Pillai, S. L., Nair, R. J. 2021. Application of biological and fisheries attributes to assess the vulnerability and resilience of tropical marine fish species. *PLoS ONE*. pp. 1-31.
10. Cadrin S.X., Karr L.A. and Mariani S. 2014. *Stock identification methods: Applications in Fishery Science*. 566 p. Elsevier Inc. USA.
11. Carvalho, G.R. and Hauser, L. 1994. Molecular genetics and the stock concept in fisheries. *Reviews in Fish Biology and Fisheries* 4, 326-350. <https://doi.org/10.1007/BF00042908>.
12. Sebastian, W., Sukumaran, S., Abdul Azeez, S., Muraleedharan, K. R., Dinesh Kumar, P. K., Zacharia, P. U. and Gopalakrishnan, A. 2021. Genomic investigations provide insights into the mechanisms of resilience to heterogeneous habitats of the Indian Ocean in a pelagic fish. *Nature Scientific Reports*. pp. 1-16.
13. Palomares M. L., Froese R., Derrick B., Nöel S. L., Tsui G., Woroniak J., et al. 2018. "A preliminary global assessment of the status of exploited marine fish and invertebrate populations," A report prepared by the Sea around us for OCEANA (Vancouver: The University of British Columbia), 64p.
14. Ihssen, P.E., Booke, H.E., Casselman, J.M., McGlade, J., Payne, N.R. and Utter, F.M. 1981. Stock identification: materials and methods. *Canadian Journal of Fisheries and Aquatic Sciences*, 38: 1838 -1855.



ICAR-Central Marine Fisheries Research Institute (CMFRI)

Department of Agricultural Research and Education
Ministry of Agriculture and Farmers' Welfare, Govt. of India
Kochi- 682 018, Kerala, India, Web: www.cmfri.org.in