Report of Blue Economy Working Group-3 on Fisheries, Aquaculture & Fish Processing

Submitted to:

Economic Advisory Council to the Prime Minister

December 2018

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The Economic Advisory Council to the Prime Minister (EAC-PM) in pursuance to the major thrust given to Blue Economy assigned the Working Group 3 the task of developing a road map for the sectors of Fisheries, Aquaculture and Fish Processing. This was taken up in right earnest by the Working Group.

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5. I take this opportunity to thank the EAC-PM for giving this Working Group the responsibility of designing a developmental plan for key sectors of the Blue Economy of India. I sincerely believe that this report will assist the policy makers and planners in strengthening the Blue Economy initiative.

Dr. George John
Chairman, Blue Economy Working Group - 3

List of Boxes

List of Abbreviations

ABNJ	Areas Beyond National Jurisdiction
AIS	Automatic Identification System
APFIC	Asia-Pacific Fishery Commission
AR5	Assessment Report 5
ASC	Aquaculture Stewardship Council
ASCI	Agriculture Skill Council Of India
ASCM	Agreement On Subsidies And Countervailing Measures
AU	Agricultural Universities
BIMSTEC	Bay Of Bengal Initiative For Multi-Sectoral Technical Economic Cooperation
BOBP-IGO	Bay Of Bengal Programme Inter-Governmental Organization
BOOT	Build, Own, Operate & Transfer
BRD	By-Catch Reduction Devices
CAU	Central Agricultural University
CFTRI	Central Food Technological Research Institute
CIARI	Central Island Agricultural Research Institute
CIBA	Central Institute of Brackishwater Aquaculture
CICEF	Central Institute of Coastal Engineering for Fishery
CIFA	Central Institute of Freshwater Aquaculture
CIFE	Central Institute of Fisheries Education
CIFNET	Central Institute of Fisheries Nautical and Engineering Training
CIFRI	Central Inland Fisheries Research Institute
CIFT	Central Institute of Fisheries Technology
CMFRI	Central Marine Fisheries Research Institute
CMLRE	Centre for Marine Living Resources & Ecology
CNS	Central Nervous System
CRZ	Coastal Regulation Zone
CSIR	Council for Scientific and Industrial Research
CSMCRI	Central Salt & Marine Chemicals Research Institute
DAC	Department of Agriculture, Cooperation and Farmers Welfare

DADF	Department of Animal Husbandry Dairying and Fisheries
DARE	Department of Agricultural Research and Education
DBT	Department of Biotechnology
DCFR	Directorate of Coldwater Fisheries Research
DRPCAU	Dr. Rajendra Prasad Central Agricultural University
DSF	Deep Sea Fishing
DSIR	Department of Scientific and Industrial Research
DST	Department of Science and Technology
EAFM	Ecosystem Approach To Fisheries Management
EEZs	Exclusive Economic Zones
ESSO	Earth System Science Organization
ETP	Endangered, Threatened And Protected
FAO	Food And Agriculture Organisation
FFA	Fire Fighting Appliances
FMP	Fishery Management Plans
FMR	Fishery Management Regions
FSI	Fishery Survey of India
FV	Fishing Vessel
GAA	Global Aquaculture Alliance
GDP	Gross domestic product
GEM	Genetically Engineered Microbes
GIS	Geographic Information System
GOI	Government of India
HF	High Frequency
HHF	High Hydrostatic Pressure
HP	Horse Power
ICAR	Indian Council of Agricultural Research
ICES	International Council for Exploration of Seas
ICMAM	The Integrated Coastal and Marine Area Management Project Directorate
ICT	Information and Communication Technology

IFPS	In Vitro Fish Flesh Production System
IITM	Indian Institute of Tropical Meteorology
ILO	International Labour Organisation
IMD	Indian Meteorological Department
IMO	International Maritime Organisation
IMTA	Integrated Multitrophic Aquaculture
INCOIS	Indian National Centre for Ocean Information Services
INFOFISH	Intergovernmental Organization For Marketing Information And Technical Advisory Services For Fishery Products In The Asia And Pacific Region
IOTC	Indian Ocean Tuna Commission
IPCC	Intergovernmental Panel On Climate Change
ISEAL	International Social and Environmental Accreditation and Labelling
ISRO	Indian Space Research Organisation
IUU	Illegal, Unreported, and Unregulated
JFESSD	Juvenile Fish Excluder Cum Shrimp Sorting Device
KVK	Krishi Vigyan Kendra
LP	Light Pulses
LSA	Life Saving Appliances
MAP	Modified Atmosphere Packaging
MCS	Monitoring Control and Surveillance
MFRA	Marine Fisheries Regulation Act
MHRD	Ministry of Human Resource Development
MIS	Market Intervention Scheme
MoA	Ministry of Agriculture
MoEFCC	Ministry of Environment, Forest and Climate Change
MoES	Ministry of Earth Sciences
MoST	Ministry of Science and Technology
MPEDA	Marine Products Export Development Authority
MSL	Mean Sea Level
MSP	Marine Spatial Planning

MSY	Maximum Sustainable Yield
Mt	Metric Tonnes
NABARD	National Bank For Agriculture And Rural Development
NACA	Network Of Aquaculture Centres In Asia And The Pacific
NBFGR	National Bureau of Fish Genetic Resources
NCAOR	National Centre for Antarctic and Ocean Research
NCMRWF	National Centre for Medium Range Weather Forecasting
NCSCM	National Centre for Sustainable Coastal Management
NFDB	National Fisheries Development Board
NIFPHATT	National Institute of Fisheries Post Harvest Technology and Training
NIO	National Institute of Oceanography
NIOT	National Institute of Ocean Technology
NITI Aayog	National Institution for Transforming India
nm	Nautical Mile
NPMF	National Policy on Marine Fisheries
NRM	Natural Resource Management
OMF	Oscillating Magnetic Fields
ONGC	Oil And Natural Gas Corporation Limited
PEF	Pulsed Electric Fields
PFZ	Potential Fishing Zone
POP	Persistent Organic Pollutants
PPP	Public Private Partnership
PUFA	Poly Unsaturated Fatty Acid
PYE	Potential Yield Estimate
QTL	Qualitative Trait Loci
RAS	Recirculating Aquaculture System
RFMO	Regional Fisheries Management Organisation
RGCA	Rajiv Gandhi Centre for Aquaculture
RTC	Ready To Cook
RTE	Ready To Eat

SATCORE	Satellite Coastal And Oceanography Research
SAU	State Agriculture University
SDG	Sustainable Development Goals
SEAI	Seafood Exporters Association of India
SIMP	Satellite Information Message Protocol
SLA	Sea Level Anomaly
SoDGIS	Database And Geographical Information System Of The Fisheries Sector
SPF	Specific Pathogen Free
SPR	Specific Pathogen Resistant
SST	Sea Surface Temperature
TCS	Tata Consultancy Services
TED	Turtle Excluder Device
TERI	The Energy and Resources Institute
TNFDC	Tamil Nadu Fisheries Development Corporation
UGC	University Grants Commission
UN	United Nations
UT	Union Territory
VHF	Very High Frequency
VMEs	Vulnerable Marine Ecosystems
VMS	Vessel Monitoring System
VP	Vacuum Packaging
VSS	Voluntary Sustainability Standards
WTO	World Trade Organisation

Executive Summary

1. Blue Economy promises to bring about transformational changes that aim at the sustainable use of oceanic resources, emphasizing the promotion of smart and inclusive growth in diverse, but interconnected segments such as marine fishing and allied sectors, ocean-based energy exploration; and shipping as well as coastal tourism. India has a major stake in promoting Blue Economy, since the livelihood of large number of costal inhabitants in the country depends on the wealth of the oceans. About 4 million people are directly dependent on marine fishing and allied activities for their livelihood. Those depending on coastal aquaculture, coastal tourism, shipping, sea mining, offshore energy production and other related services add to it. Another major reason why Blue Economy is poised as a game changer for India is because of its likely contribution towards the country's food security in the form of increased marine fish production. It is estimated that, by 2030 India will require about 18 million metric tonnes of fish to meet the demands. When considering the fact that today we produce about 11 million metric tonnes annually there is a gap of 7 million metric tonnes that needs to be bridged. Given the limitations of the marine capture fisheries sector and the modest enhancements that are likely from the deep sea resources, rather substantial enhancements from the land based fisheries and aquaculture systems, the focus is on mariculture. The promises are immense, so are the challenges but it is reasonable to target a production of 4-5 million metric tonnes from mariculture by 2030 with careful planning and concerted action.

2. Marine fish production in India so far has been heavily dependent on capture fishing constituted by about 1200 fish and shellfish species. Of these, stock assessment of 52 stocks have been carried out based on data collected from 2012-2016. These assessments have indicated that 55.77% of the stocks are being fished within biologically sustainable levels *i.e.,* yields from these stocks are yet to attain Maximum Sustainable Yield (MSY). India's revised annual Potential Yield Estimate (PYE 2018) is 5.31 million metric tonnes. The capture fisheries production in recent years has ranged between 3.5-3.83 million metric tonnes. However, production from capture alone is insufficient to meet the growing demand for seafood in the country. Moreover, issues of over-capacity of fishing fleets, inefficient management systems, marine pollution, declining biodiversity, habitat destruction and climate change, beset the marine fisheries sector. Another challenge is to reign in on IUU fishing which is being carried out by 5-9% of the total fishing crafts operating along India's maritime zone. Therefore, a major overhaul of the marine fisheries sector and its governance is critically needed, and avenues to sustain production from marine fish have to be strengthened.

3. One of the approaches to intensify capture fish production is exploitation of deep-sea resources, which is yet to be tapped fully. India has an estimated harvestable potential of 3.3 million metric tonnes in deep-sea areas at depths between 200-2000 meters in both Exclusive Economic Zones (EEZs) and in Areas beyond National Jurisdiction (ABNJ).

Additionally, non-conventional deep-sea resources, predominantly mesopelagic fish in the Indian Ocean, need to be harnessed to intensify catches. However, technological lag and financial constraints have been the major bottlenecks in the delayed take off the deep-sea fishing industry in India. Deep-sea fishing needs higher capital investment and recurring cost since deep-sea fishing is expensive compared to the coastal trawling operations. Promotion of Mariculture is emerging as a major option to meet the growing seafood demand. With the development of captive breeding and mass production technologies for high value marine fish species, mariculture through cage farming is being established all along the coastal waters of maritime states and Union Territories (UTs). However, production from mariculture is yet to pick-up at the commercial scale in India. Several policy measures such as identification of suitable areas, development of leasing policies, development of quality certified seed and feed production facilities and value chain development have been suggested for optimally harnessing the potential of mariculture.

4. Genetic and biotechnological interventions offer huge potential for tapping the rich resources of ocean and meeting the sustainable development goals towards realization of a Blue Economy in India. Promising biotechnological applications in the field of marine fisheries include stock structure identification using genetic tools, bioprospecting for development of pharmaceuticals and cosmetics, bioremediation and biomonitoring for ensuring sustainable production environments, *in vitro* fish meat production and climate smart biotechnology to minimize the adverse impacts of climate change.

5. Development of markets and value chain integration of marine fish is equally important for ensuring its sustainable production. Though modern and innovative marketing models are emerging in recent years, marketing practices followed presently are predominantly old and traditional in many areas with inefficiencies pervading across the value chain. In view of these, a comprehensive strategy is essential to upgrade marketing infrastructure, reform fish auctioning systems, develop niche labels for increasing profitability and ensuring quality, enhance traceability of consignments, strengthen market intelligence and promote exports. . The potential of harvest and post-harvest technologies for efficient harvesting, value addition and for ensuring fool proof quality assurance mechanisms need to be harnessed to improve the overall efficiency of the value chains. There are several demonstrated technologies such as energy efficient vessel and gear designs, use of alternate sources of energy for powering fishing operations, use of satellite-based prediction techniques to reduce fuel consumption, new fish preservation and processing technologies, better packaging systems, technologies for zero-energy waste management, and so on that can be adopted and up-scaled for the benefit of fishermen, fishery entrepreneurs and other value chain intermediaries.

6. Fisheries governance is a matter of extreme importance in the context of Blue Economy as an efficient model of resource management and governance is the key to sustainable development of its constituent sectors. In India, control and regulation of fishing

and fisheries within territorial waters is the exclusive province of the States, whereas beyond the territorial waters, it is the exclusive domain of the Union government. There is an exhaustive set of legal instruments, which have been introduced from time to time to govern fishing and allied activities along the coast. The marine fisheries regulatory Acts of the State Governments, which are the pillars of fishery regulations in the coastal states, need to be reformed and updated to address the emerging issues. There is a need to follow the ecosystem approach to fishery management to ensure sustainable development. Similarly, extensive use of technology such as GIS and remote sensing applications, vessel monitoring systems, automatic identification systems and other and management options are necessary to strengthen monitoring, control and surveillance. India also needs to harness multilateral negotiations and international cooperation to develop and expand its maritime operations.

7. Apart from the above priorities, other areas that need attention are financial support, extension, skill development and ensuring social safety nets for the people engaged in marine fisheries and allied sectors. Presently, credit for fishermen is mainly catered to by informal financial agents such as auctioneers, middlemen and private moneylenders. Inter-linked deals with such financial intermediaries often result in bondage and involve huge costs in the form of inflated interest rates and auction commission. Measures should be taken to improve financial inclusion of fishermen through provision of flexible and affordable credit which suit their unique requirements. Similarly, a strong fisheries extension system is needed to consolidate the gains in the sector as well as to address the emerging challenges by conveying the relevant information to major stakeholders, in addition to translating policy goals into action domain. To utilize emerging opportunities and tackle hindering challenges in the sector, fishermen, fish workers, value chain intermediaries and fishery department personnel have to be trained adequately. Investments need to be pumped in to plug the gaps in this regard and to develop human resources for the future growth of the sector. Finally, measures for strengthening social safety nets in the form of insurance coverage, pension schemes, social welfare programs, etc. are needed to insulate fishermen and small and marginal entrepreneurs from natural calamities and other adverse events. A larger coordination is required at the national level for strengthening the weak links in marine fisheries sector. It is envisaged that a separate Ministry created at the Centre with specific departments to cater to the requirements in marine and inland capture, aquaculture and fisheries research and education will lead to a major growth of this sector.

8. The key recommendations are summarised as:

- Creation of a separate Ministry of Fisheries and Fishermen Welfare.
- Dedicated satellite systems for the management of fisheries, mariculture and allied activities.
- Investment in the identification of fish stocks and formulation of dedicated Fishery improvement programs dedicated to the requirements of specific fish stocks adopting Ecosystem Approach to Fisheries Management (EAFM) principles.

- Strengthening of Monitoring, Control and Surveillance (MCS) by (i) mandatory licensing of all fishing boats (ii) issuing fishing licenses by clearly specifying the gear to be operated (iii) mandating regular reporting of fish catches, position of fishing operation, submission of voyage report, crew compliance *etc*. (iv) compulsory operationalizing of Vessel Monitoring System (VMS) and Automatic Identification System (AIS) in mechanized boats.
- Financial incentives to attract technology and major investment in deep-sea fishing, fishing in ABNJ and distant water fishing and value chain development of their products.
- Formation of a new implementing agency 'Sea Farming Authority of India' in order to promote mariculture and related sectors for the envisaged increase in production.
- Investments in the prevention, management and recycling of the marine pollutants including plastics and microplastics.
- Creation of a National Institute of Marine Biotechnology focusing largely on biotechnological interventions in the non food sector.
- Investment in development of genetic and genomic tools for better management of marine resources, mariculture and post-harvest activities.
- Strengthening and upgrading the landing and marketing infrastructure with legitimate certification, market interventions and market intelligence systems including automation.

Chapter 1. Overview of the Marine Fisheries, Aquaculture and Fish Processing sector

1.1 India, the second most populous country in the world with more than 130 crores people has 14% prevalence of hunger. Fish is the cheapest source of animal protein and it provides over 20% of animal protein to 2.6 billion people globally which amounts to >30% in developing countries. Thus, fish is one of the cheapest and healthiest options to eradicate hunger and nutrient deficiency amongst the poor in the country. The fisheries sector of the country has a pre-eminent role in hunger eradication in the country.

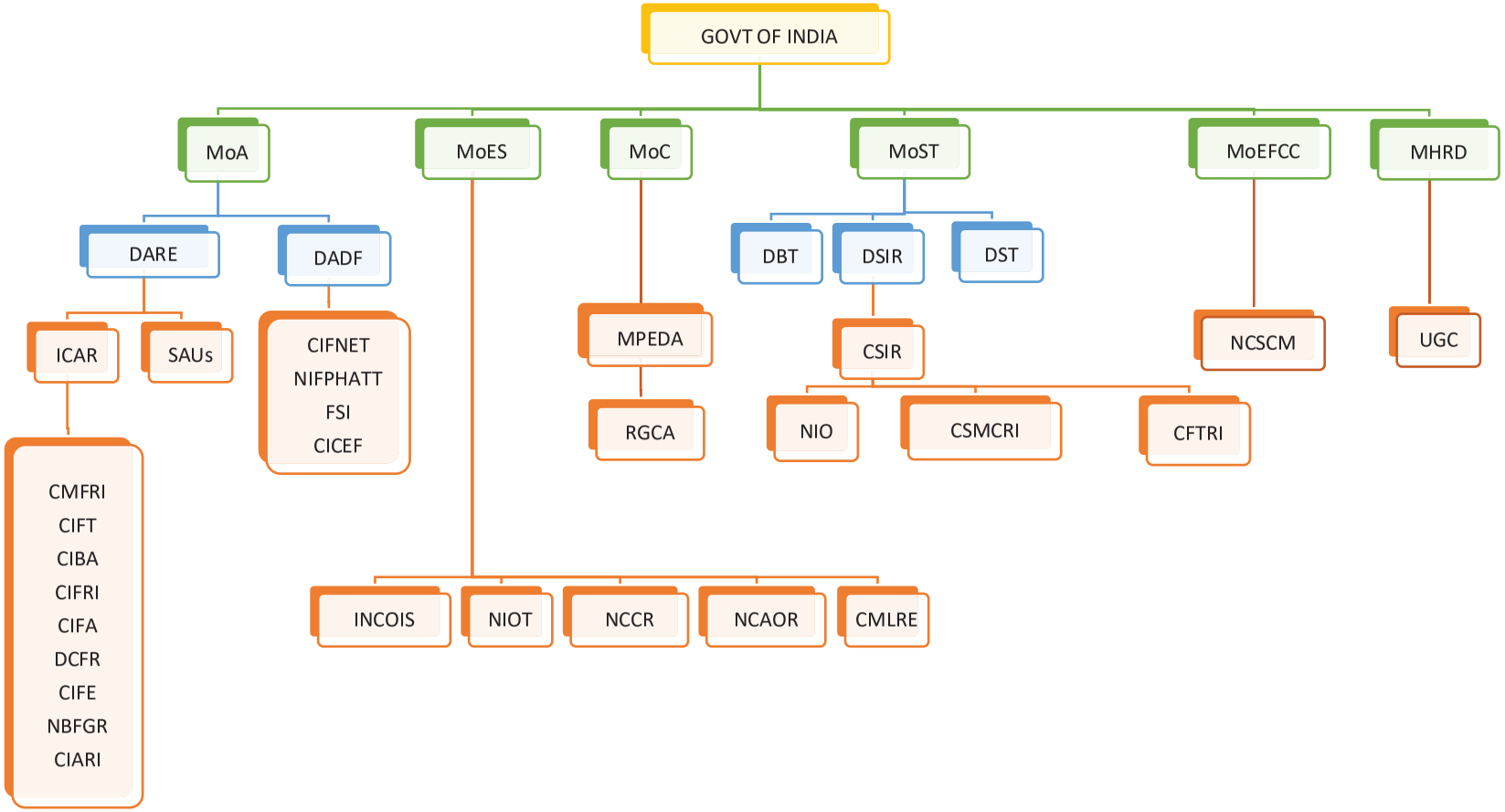
1.2 India's total fish production during 2016-17 was estimated at about 11.41 million metric tonnes. This constituted around 6% of the global production. The fisheries sector contributed to approximately 1% of the National GDP and more than 4% of the Agricultural GDP. The marine fisheries sector of India contributed 3.6 million t in 2016 making the country the sixth largest contributor to global marine capture fisheries production. Presently the marine fisheries sector provides livelihood security to nearly four million people (including one million active fishermen) either directly or indirectly. The economic wealth from marine fisheries of India is estimated at Rs. 65,000 crores. Marine exports are to the tune of Rs. 45,000 crores per year while Indian imports are about Rs. 600 crores annually.

1.3 Despite having vibrant marine fisheries, the sector has been beset by a number of challenges in recent years. Due to large dependency on inshore fisheries over the years, the production from near shore waters has reached asymptotic level which implies that there is a little scope for enhancing marine capture fisheries production. The sector is also best by issues of over-capacity of fishing fleets, inefficient management systems, marine pollution, declining biodiversity, habitat destruction and climate change. Hence, a major overhaul of the marine fisheries sector and its management is critically needed and avenues to increase production from marine fish have to be amplified.

1.4 Estimates indicate that by the year 2030 India's annual demand for fish will be about 18 million metric tonnes. Currently we produce about 11 million metric tonnes annually. Therefore, a 7 million metric tonnes is required. This calls for careful strategising and a strong action plan involving all stakeholders. The marine capture fisheries sector will not be able to contribute very significantly given the limitations and the plateauing off seen in the sector. Modest enhancements are likely from the deep sea resources and the land based fisheries and aquaculture systems. We need to aim at an increase in production in the range of 4 to 5 million metric tonnes annually from mariculture by 2030 if we are to meet the projected demand. This should be possible given the huge potential and the technology options available.

Currently, India is second only to China in terms of aquaculture food fish production. However, we still contribute only 7.1% of the global aquaculture food fish production. Aquaculture in India is dominated by freshwater carp culture. Mariculture is envisaged to play a major role in the upliftment of Indian marine fisheries. Mariculture activities in India were initiated by the research and development made by Central Marine Fisheries Research Institute (ICAR-CMFRI) in the early 1980s leading to the progress of commercial scale practices over the next three decades. NIOT and MPEDA also have significantly contributed to the development of mariculture. Despite enormous potential, mariculture has not yet developed into a major commercial enterprise and contributor of seafood production in India. However, all the components are available for bringing about a transformational change in mariculture. A sustainably farmed seafood production sector will help enhance the food and nutritional security of the country and improve the quality of life of coastal fishermen.

Key players in the Blue Economy (Diagrammatic Representation)



Chapter 2. Role of Marine Fisheries and Allied Areas in Blue Economy

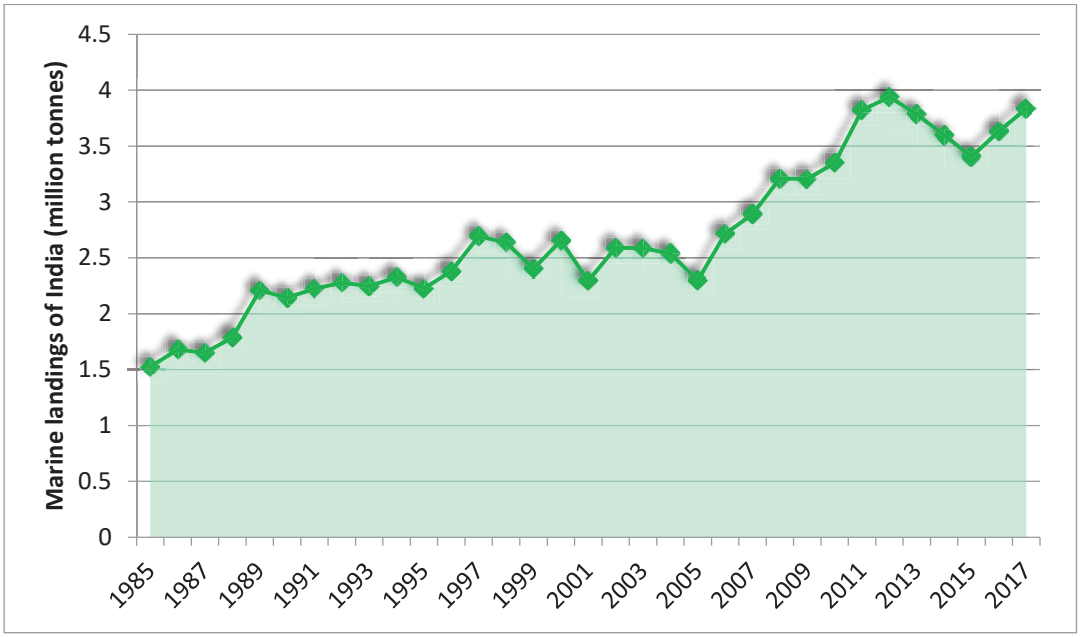
2.1 Blue Economy aims at the sustainable use of oceanic resources by a nation to increase its wealth. The foundations are the promotion of sustainable, smart and inclusive growth of the sector to provide innovative business and employment opportunities. Blue Economy has the potential to transform the economic growth rate of the country. Commercial marine fisheries form one of the traditional sectors of the Blue Economy of a maritime nation. The wild caught fishes are the marine capture fish production, which was estimated as 3.83 million metric tonnes in 2017 in India. Mariculture, particularly cage farming is being established all along the coastal waters of maritime states and Union Territories (UTs). The production from mariculture is yet to pick-up at commercial scale in India. Studies indicate that the domestic consumption pattern in India is increasing at an estimated annual average growth of about 2%. This demand is coming up when there is under-utilization of the existing seafood processing capacity for want of resources in the form of raw material. In the country, the seafood-processing sector is working at 1/3rd of its capacity. Further, there is a rising demand globally for fish and shellfish with more pressure on resources in the oceans. This calls for augmenting the production of marine fish from Indian Exclusive Economic Zone. Estimates show that we have to produce an additional 7 million metric tonnes by 2030 to meet the country's fish demand.

2.2 There is a serious thought process and implementable plan on exploiting our deep sea resources to enhance the present production from marine capture fisheries sector. Further, we have to minimize the wastage in the form of by-catch or under-utilization of high quality protein. A proper cold-chain will improve the utility of this extremely high quality protein from the sea. Further, abundant unused resources such as seaweeds and others may be included in the food chain and culinary habits. Such resources may have to find a channel in the export market also. If the demand is rising, the need for enhancing their availability through mariculture activities becomes attractive for food production and as a revenue generation option

2.3 Under the purview of the Blue Economy, we have to put in place pragmatic programmes that will aim at improving and strengthening the infrastructure and operational facilities with the motive of improving fish production. Considering the plateauing off in catches from the marine fisheries, policy makers need to address urgent requirements of the sector. With the existing binding agreements we have to work out ways to implement catch quota systems, monitoring control & surveillance; regulating illegal unregulated and unreported fishing, mariculture, diversification, improving the market value chain and other pertinent issues. There is a dire need for economic support in this direction. This working group – 3 report endeavours to address all these issues keeping in view the overall societal good and in particular the welfare of the fishermen community.

Chapter 3. Current Status of Marine Fisheries of India

3.1 India's marine landings increased from 1.52 million tonnes in 1985 to 3.83 million tonnes in 2017. India contributed 4.5% to the global marine capture fish production in 2016. From 2011-2016 India has contributed an average 4.6% of global marine capture fisheries production. Pelagic resources have always dominated India's marine landings contributing on average 51% of total marine landings during 1985-2017. Pelagic resources increased from 0.7 million tonnes in 1985 to 2.0 million tonnes in 2017. Demersal resources were the second largest resource group contributing on an average 26% of total marine landings during 1985-2017. Demersal resources ranged from 0.4 million tonnes in 1985 to 1.0 million tonnes in 2017. Crustaceans contributed on an average 15.6% and molluscans 4.3% of India's marine landings during 1985-2017.



Marine fisheries landings in India (1985-2017) Source: ICAR-CMFRI

3.2 Nearly 667 different species contributed to the marine capture fisheries of India. Of these species, stock assessment of 52 stocks of various marine finfish and shellfish species have been carried out in India based on data collected from 2012-2016. These stock assessments indicated that 55.77% of the stocks were being fished within biologically sustainable levels *i.e.,* yields from these stocks were yet to attain Maximum Sustainable Yield (MSY). This proportion of stocks being fished within biologically sustainable levels is the indicator for Sustainable Development Goal 14.4.1 of the United Nations.

3.3 India's revised Potential Yield Estimate (PYE 2018) was estimated to be 5.31 million metric tonnes. Nearly 94.5% of the MSY comes from within 500 m depth waters and 4.3% from oceanic regions. The island ecosystems contribute nearly 1.0% of the revised PYE 2018. Presently the country is landing 77.8% of its near shore PYE 2018 (up to 200m contour line).

3.4 However, despite increased landings and the possibility to increase production to achieve the PYE 2018, the near shore marine fisheries sector is facing a host of problems namely, overcapacity of fishing fleets, declining catch rates and catch per unit effort of many marine fisheries, decreasing average size of major commercial species, change in species composition, marine habitat degradation, coastal pollution among others. In the following sections, we throw light on certain aspects of marine fisheries that if supported effectively could go a long way in bolstering the marine fisheries of the nation.

Deep Sea Fishing

3.5 Deep-sea fishing takes place at great depths (between 200-2000 meters) in both, the Exclusive Economic Zones (EEZs) and in Areas Beyond National Jurisdiction (ABNJ). India has an estimated harvestable potential of 3.3 million metric tonnes in these areas. Additionally non-conventional resources predominantly mesopelagic fish have high biomass in the Indian Ocean. Though some estimates indicate that Western Arabian Sea has abundant mesopelagic resources to the tune of 94 million t, it has been suggested that about one million tonne of myctophids could be harvested by deploying appropriate vessels. The potential of purple back squid in the Lakshadweep Sea around the Islands alone is estimated at 0.63 million tonnes. Currently, long-liners operating in Indian EEZ and adjacent international waters catch around one lakh tonnes of tuna and billfishes annually. Other than such meagre production, deep-sea fisheries of India have not been harvested to their potential.

Challenges to deep sea fishing in India

3.6 Technological lag and financial constraints have been the major bottlenecks in the delayed takeoff of the deep-sea fishing industry in India. Deep sea fishing needs higher capital investment and recurring cost since deep-sea fishing is expensive compared to the coastal trawling operations. The higher cost of fishing coupled with scattered and straddling resources discourage the fishermen to invest in deep sea operations.

3.7 Another major issue in developing oceanic fisheries is the lack of sufficient skilled crew. Skill of the fishers for oceanic fishing must be enhanced through scientific awareness on the distribution pattern of pelagics and by providing proper training in long-lining operations.

3.8 As most of our inshore and deep sea, trawlers have operational limitation for fishing in oceanic waters, their redeployment for deep sea fishing needs to be made with utmost care. Instead, large long-liners with deep sea going facilities, adequate carrying capacity and on-board postharvest handling facility need to be introduced from mainland and island territories. In addition, introduction of large factory or mother vessels should be considered, so that catch can be collected afresh in the mid-sea and transported to mainland or processed on-board.

3.9 There is a need for diversification of production strategies targeting non-conventional and under-exploited resources. There is no aimed fishing for these resources along the Indian EEZ. Some myctophid species are used for production of fishmeal and oil and only a small percentage is used directly for human consumption. However, these resources have potential to become a major source of fish protein, when efficient harvesting and appropriate processing and value addition technologies are evolved. ICAR-CIFT had developed technologies for effective utilization of these resources for human consumption and as source for other bioactive compounds. Even though there is a large potential for developing the myctophids fishery, there is very little information on the commercial harvesting systems. The fishing gears used for harvesting of myctophids are not specifically designed for the targeted species. Though preliminary studies were carried out for developing harvest technologies for the purple back squid, there is no effective method for it's capture *per se*.

3.10 Finally the Deep Sea Fisheries (DSF) should be congruent with the guidelines enshrined in the FAO – International Guidelines for the Management of Deep-Sea Fisheries in the High Seas, and to Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (1995 UN Fish Stocks Agreement); for sustainable utilization of resources and protection of these Vulnerable Marine Ecosystems (VMEs).

Harnessing resources from Indian sector of Southern Ocean

3.11 India is a signatory to the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) since 1982 and the country has the right to sustainably exploit the marine fishery resources of the Indian sector of the Southern Ocean. The fisheries in the convention area currently target Patagonian toothfish (*Dissostichus eleginoides*), Antarctic toothfish (*Dissostichus mawsoni*) and mackerel icefish (*Champsocephalus gunnari*) and the Antarctic Krill (*Euphausia superba*). These fisheries are managed using the ecosystem based and precautionary approach and the management objectives maintain existing ecological relationships. Presently, India has the mandate and responsibility to undertake R&D studies in the Southern Ocean. There are geo-political implications, as India is a member of Antarctic Treaty System (ATS) of resources and biodiversity. The most targeted fishery is the Antarctic Krill (Box 1Box 1). The krill resources will be available only for five months in a year and to economise the sector other species such as oceanic squids, tunas, sharks and myctophids can be targeted during the off-season.

3.12 Long-term objective to exploit the Southern Ocean resources should be that India develops capabilities as Distant Water Fishing Nation (DWFN) by 2025 in collaboration with CCAMLR nations like Norway who have developed highly advanced skills. There should be provision to train our fishers on board such vessels and ensure that a portion of the products (krill oil and fishmeal) is sold in India. There is a need to develop skills, technical expertise in krill fishing, oil extraction *etc*. for which collaborative programmes with CCAMLR members

particularly Norway will be helpful. At present, India is not adequately equipped, as the country does not have the required skill, vessels and technical expertise in commercial krill fishing.

Stock assessment of commercially important resources

Box 1 : Prospects of harvesting Antarctic Krill

Antarctic krill, *Euphausia superba*, is a key species in the Antarctic ecosystem and is, in terms of biomass, probably the most abundant animal species on the planet (approximately 380 million tonnes). The global fish farming industry is increasingly relying on krill-based fish feed, Omega-3 rich Krill oil, and enzymes and chemicals derived from krill are included in a number of dietary and medical products. Currently, Norway is the leading country engaged in krill fishing in Antarctic waters. The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) precautionary total allowable catch (TAC) limits for this species is over 5.6 million tonnes; however, CCAMLR has decided that the catch will be regulated within a 620,000 tonne 'trigger' level which is distributed across four regions where krill fishing is being carried out. Krill is essentially used for extraction of astaxanthin and krill oil, which have a huge international market. Krill oil forms only 4% of the body weight of the animal and the krill meal after oil extraction can be used as a raw material for feed in aquaculture. To extract krill oil in an economic manner , large volumes of krill have to be caught, which requires large fishing/processing vessels. Introduction of fishing vessels having more than 105 meters OAL and with facilities for continuous krill fishing and its immediate on-board processing (cephalothorax to be removed immediately to avoid fluoride contamination as krill has an approximate quantity of 288 mg/kg of fluoride in its body) for extraction of astaxanthin and krill oil can enable India to venture into this industry. To sustain the operation, during off-season, India may also aim at fishing other species such as oceanic squids, tunas, sharks, and myctophids of the southern Ocean. If approximately 1000 tonnes of krill meal per vessel can be transported to India along with other resources, the operation can be economically feasible.

3.13 Fish stock assessment is the practice of assessing the status of a fish stock using scientific tools based on species biology, fishery characteristics and other factors, to arrive at sustainable utilization levels for the resource. In India ICAR-Central Marine Fisheries Research Institute (CMFRI) and Fishery Survey of India (FSI) are the only two organizations mandated to carry out stock assessments of marine fishery resources. As per the National Marine Fisheries Data Centre of ICAR-CMFRI, there are currently 83 resource groups being exploited across the Indian EEZ for which landings data is collected. Each resource group has a number of individual species within them whose commercial value varies by time and region. Stock assessments are carried out only for commercially important species of a particular region or state. As per latest information from ICAR-CMFRI stock assessment of 52 stocks of various marine finfish and shellfish species have been carried out in India based on data collected

from 2012-2016. Of these 55.77% of the stocks are being fished within biologically sustainable levels *i.e.,* yields from these stocks are yet to attain Maximum Sustainable Yield (MSY). This proportion of stocks being fished within biologically sustainable levels is the indicator for the Sustainable Development Goal 14.4.1 of the United Nations.

Challenges/Gaps in stock assessment in India

3.14 The National Policy on Marine Fisheries 2017 of the Govt. of India emphasizes the need for scientific inputs for fisheries management in India (Sec. 10.0). Section 12.0 of the Policy indicates that MSY will be an input for formulating measures to ensure sustainability of marine resources. The respective State governments manage their territorial fisheries through the Marine Fishing Regulation Acts. However, most of the MFRAs do not mandate the use of MSY or stock assessments for managing marine stocks rendering most stock assessment outputs quite redundant.

3.15 Presently, ICAR-CMFRI carries out stock assessments based on data collected from commercial landings. Exact information on where the fishing operation was carried out and the specifics of the fishing operation including fishing time, fishing gears, etc. is not available. For further precise stock assessments these inputs are also required which can be provided only by fishermen. Thus involving fishermen in the data acquisition system is critical. Further, the use of non-commercial data would increase the precision of stock assessment models. FSI regularly conducts surveys of marine fish resources of the country. Use of FSI's survey data along with the data collected by ICAR-CMFRI along with the inputs of fishermen would result in accurate stock assessments.

Overfishing and IUU fishing

3.16 About 30% of world's fish are stocks overfished, producing catches lower than their biological potential; 60% are fully exploited, with catches at maximum sustainable production and 10% under-fished. The main causes of overfishing include limited or ineffective harvest regulations; overcapacity of the fleets; destructive fishing practices, as well as illegal, unreported and unregulated fishing (IUU). Illegal, Unregulated and Unreported (IUU) fishing contributes greatly to the problem of overfishing. Illegal fishing refers to fishing without a license, fishing in a closed area, fishing with prohibited gear, fishing over a quota, or the fishing of prohibited species. Unreported fishing refers to fishing activities, which have not been reported, or have been misreported, by the vessels to the relevant national authority. Unregulated fishing refers to fishing activities in areas where there are no applicable management measures to regulate the catch. It also refers to fishing for highly migratory species, which is not regulated by a RFMO, and fishing activities in international waters violating the regulations established by the relevant RFMO.

3.17 IUU fishing is done by 5-9% of the total fishing crafts operating along India's maritime zone. Illegal fish catches are high in island territories, with most violators being

foreign trawlers targeting sea cucumbers, shark fins and reef fish in the Andaman Islands, while shark fins are the target of poachers in Lakshadweep archipelago. IUU fishing leads to problems in misreported catches where fish caught in one jurisdiction is reported as caught in another location. In some coastal states in India, registration is required for trawlers from neighbouring states to operate and use port facilities, but vessel skippers often contravene the regulations through landings in small harbours. Illegal fishing in Palk bay and Mandapam is due to the huge overcapacity of Indian trawlers operating along this area. The trawling grounds along the Palk Bay and Mandapam can hardly sustain fishing pressure from one third of the existing fleet. Sri Lankan tuna vessels operating in Indian waters have increased drastically, putting Indian tuna vessels at disadvantage. A recent press release from Government of India revealed that 116 Sri Lankan fishing vessels were detained. Majority of the detained vessels, *i.e.* more than 100 were multi-day tuna long liners. A common understanding exists between India and Sri Lanka, with illegal tuna vessels from Sri Lanka and illegal Indian shrimp trawlers operating in each other's jurisdiction being arrested and handed over to each other's coastguards on a regular basis.

Challenges to combating IUU fishing in India

3.18 Patrolling is found to be inadequate in proportion to the length of coastline throughout the Indian coast. In addition, absence of a uniform ban period throughout the coastline has led to fishing trawlers of several states using this legal technicality to fish where fishing ban exists and land in an adjacent state where there is no ban. With most of the coastal states having weak enforcement, due to huge gaps in allocated infrastructure, labour and monetary resources, illegal fishing persists through domestic fishing vessels in inshore waters (Boxes 2 & 3). Since, a vessel monitoring system does not exist in Indian fisheries, it is almost impossible for the Coast Guard to monitor all the Indian trawlers that operate within its EEZ.

3.19 Declaration of 5-10 km as no fishing zones on both sides of border along Indo-Pakistan coasts and Indo-Sri Lanka region can help in preventing accidental intrusion of small-scale fishers into each other's jurisdiction. In addition, marker buoys with flags can help in preventing accidental intrusions into Pakistani waters and vice versa.

Box 2 : Combating IUU fishing: the Vessel Monitoring System

The cost per vessel for installing one VMS is about Rs. 90,000 and the entire land station, including servers, internet connection, analysis workstation, graphics monitor, and software applications for VMS (database, base maps, office applications, mapping, etc.), service contracts, etc. cost a maximum of Rs. 37, 50,000. A VMS allows one employee to monitor up to 500 boats for about Rs.75/day per boat. Assuming that the investment would be taken up in a phased manner at a later stage, for a pilot study involving approximately 10% of the mechanized fleets of the country, the cost for the VMS along with the communication, software and employee would be around Rs. 540 million. Additionally, two offshore patrol vessels equipped with the most modern facilities could be introduced, one along the east coast and the other along the west coast, for monitoring the movement of foreign vessels in the high seas and the ABNJ areas. The unit cost of each vessel is approximately Rs. 4950 million and two such vessels would cost Rs. 9900 million.

Box 3 : Recommendations/Action points for increasing sustainable marine capture fisheries

Deep-sea fishing

- Introduction of financial incentives to attract technology and investment in deep sea fishing and value chain development.
- Development of national policy, legal and institutional frameworks for the effective management of DSFs, including the prevention of significant adverse impacts on VMEs.
- Establishment of RFMO like the International Council for Exploration of Seas (ICES), for regional cooperation.
- Conducting national and international training programmes for fishers and scientific observers to improve catch identification and biological data collection, including existing FAO material for the identification of commercial species, and the development of field manuals for the identification of non-commercial species, particularly for benthic invertebrates with support of international agencies like FAO.
- Dedicated satellite system for management of fisheries and allied activities

Stock assessment

- Mandatory data inputs from primary stakeholders (fishermen) via log sheets
- Integration of marine resource survey data and commercial landings data
- Regular stock assessments by ICAR-CMFRI of commercially valuable stocks in Indian waters with particular emphasis on stocks vulnerable to over-fishing
- Legislative support/mechanism to make stock assessments as mandatory inputs for fisheries management through MFRAs
- Funding to ensure regular stock assessments are carried out.
- Enforcement of boat construction by certified yards following IMO guidelines.

IUU fishing

- Strengthening Monitoring Control and Surveillance (MCS) – Mechanisms such as VMS/AIS/HF/VHF to track the movement of fishing vessels, to know where and when the fish was caught and how and by whom.
- Mandatory log sheets from fishermen on details of area of fishing
- Increasing awareness among fishermen on how to avoid IUU fishing
- Revoke licenses of Indian fishermen who indulge in IUU fishing
- Severe penalties for foreign fishermen who conduct IUU fishing in Indian waters
- Offshore patrolling in high seas and ABNJ
- Cooperation and coordination with neighboring states

Chapter 4. Mariculture

4.1 Since capture yields from fisheries are not expected to increase as required, an emphasis is being placed on the aquaculture sector's ability to provide increasing quantities of aquatic products. The shifting emphasis in production from fishing to aquaculture and mariculture, and the growth in the international trade in aquatic products are often believed to offer the potential to contribute towards poverty reduction and food security through the creation of jobs and alternative sources of food.

4.2 It is expected that an additional production of 7 million tonnes fish is needed by 2030. This increase can be met to the extent of about 4-5 million metric tonnes from mariculture by 2030 with proper planning and concerted action involving all the stakeholders. The growth of mariculture can therefore be expected to contribute significantly to the Blue Economy by enhancing food and livelihood security.

4.3 Mariculture activities in India were initiated by the research and development made by ICAR-CMFRI in the early 1980s leading to the initiation of small-scale commercial practices by the 1990s. NIOT and the MPEDA have also significantly contributed to the development of mariculture. The development perspective should be oriented towards wide spread adoption of mariculture technologies to meet the additional seafood demand.

Mariculture practices

4.4 The major mariculture activities currently under practice:

- *Shellfish culture*
  Floating long lines or hanging cages or rafts, bottom ranching, bottom cages
- *Finfish culture*
  Net pens or sea cages (inshore/offshore)
- *Seaweed culture*
  Rafts or Longlines for aquatic plants
- *Integrated Multitrophic Aquaculture Systems*
  Seaweed-Bivalve-Finfish integrated farms
- *Recirculation Aquaculture Systems*
  Land based systems for grow out and seed production
- *Hatcheries*
  Involve land-based facilities to rear and spawn broodstock
- *Nursery rearing*
  Involves the rearing of juveniles to a size conducive to growout

Available Technologies

4.5 Currently, the following technologies are available:

- Sea cage farming of finfishes
- Hatchery production of Cobia, silver Pompano, Indian Pompano, Asian sea bass and Grouper

- Seed production and farming of bivalves - Green Mussel , Edible Oyster and clam
- Seed Production and farming of the swimmer crab *Portunus pelagicus*
- Seed Production and farming of the green tiger prawn *Penaeus semisulcatus*
- Fattening protocols of spiny lobsters and crabs
- Seaweed Farming
- Production in Recirculation Aquaculture Systems
- Production through Integrated Multitrophic Aquaculture Systems
- Live feed production techniques for larviculture
- Marine Aquarium Techniques
- Hatchery production of selected marine ornamental fishes
- Marine pearl production

4.6 Improving the existing technologies to be on par with international standards, biosecurity and code of practice is the immediate need of the hour. Some of these technologies deserve special mention.

Sea cage farming

4.7 Cage culture has made possible the large-scale production of commercial finfish in many parts of the world. The rapid growth of the industry can be attributed to (i) availability of suitable sites (ii) well established breeding techniques (iii) availability of supporting industries such as feed, net manufactures, etc. (iv) strong research and development initiatives and (v) the private sector ensuring refinement and improvement of techniques. Since inception in 2007, many innovations on designing and fabrication of cages and mooring systems were made. Subsequently demonstrations of cage farming were undertaken under a participatory mode with the local fishermen. In this regard, it is necessary to follow up the development of sea cage farming and to adopt the guidelines and practises of cage farming developed in India by ICAR-CMFRI, NFDB and NIOT. A planned massive programme to commercialise sea farming will go a long way in realising the Blue Economy potential in India.

Recirculating Aquaculture System (RAS)

4.8 Recirculating aquaculture systems (RAS) are onshore systems, in which fish can be grown at high density under controlled environmental conditions. Recirculation systems use land based units to pump water in a closed loop through fish rearing tanks and consist of a series of sub-systems for regular water treatment process. These facilities can be used for both seed production and grow out of fishes in a strictly controlled environment.

Integrated Multitrophic Aquaculture (IMTA)

4.9 The idea of bio-mitigation of the environment pollution along with increased biomass production integrating commercially important species of different trophic levels is emerging as an innovation in aquaculture. Integrated Multi trophic aquaculture (IMTA) is the

practice which combines in appropriate proportions the cultivation of fed aquaculture species (E.g. fin fish / shrimp) with organic extractive aquaculture species (e.g. shell / herbivorous fish) and inorganic extractive aquaculture species (e.g. seaweed) to create balanced systems for environmental stability (bio-mitigation) economic stability (product diversification and risk reduction) and social acceptability (better management practices). Both the above practises (RAS and IMTA) need to be promoted as futuristic technologies by designing special schemes.

Mariculture sites and its leasing

4.10 Suitable sites are to be demarcated for different mariculture activities such as cage farming, bivalve farming, pen culture, seaweed culture, hatcheries and nurseries based on scientific criteria and taking into account the socio-cultural attributes and other logistics. The potential zones for mariculture development should be identified based on the criteria developed through scientific evaluation of environmental parameters suitable for the type of farming, negligible impact on environment, avoidance of conflict with other users, protecting livelihoods of local fishing communities and ensuring their access to fishing grounds. Satellite remote sensing data and GIS can be employed to provide essential tools to support. Marine Spatial Planning (MSP) can be employed for data management, analysis, modelling and decision making taking cognizance of CRZ zoning. All the agencies concerned, like ISRO, ESSO, ICAR, MoES and MoEFCC along with the relevant state government agencies should join to create a full-fledged document on different mariculture sites in India.

Offshore mariculture

4.11 On a global basis the search for additional areas to expand aquaculture to satisfy the growing local and export markets are necessitating an expansion of its activities farther off the coast. Mariculture is considered "offshore" when it is located > 2 km or out of sight from the coast, in water depths > 50 m, with wave heights of 5 m or more, ocean swells, variable winds and strong ocean currents. The economic, technological and sustainability issues of developing offshore mariculture in India needs to be explored.

Marine Ornamentals

4.12 Another immense opportunity for India is to augment marine ornamental fish production. Over 46 million marine organisms representing 2500 species are traded annually with a value exceeding 300 million USD. The long-term sustainable option for developing a marine ornamental fish trade is through hatchery production. CMFRI and other research institutions have already developed the techniques for breeding more than 20 species of ornamental fishes and further research focus is needed to develop technologies for more species and scaling up the operations. By formulating appropriate policy regulations and guidelines, India has the capacity to emerge as one of the major exporting countries for marine ornamental fish trade.

Culture of Seaweed and Microalgae

4.13 Seaweed farming offers immense scope as a livelihood opportunity and for developing a large number of by-products with several applications. Seaweed farming has the advantage of low capital input, as it is a primary producer requiring no inputs. Additionally in future years, seaweed farming can earn carbon credits to the farmers. Farmed and wild collected seaweeds do not meet the current industrial demand for raw material. Hence, research and development thrust is needed to address the issues facing seaweed farmers and to popularize seaweed farming in India. Algae are known to produce more oil per unit area than conventional oil crops. India needs to explore the opportunities of production of fuel from algae like many other countries.

Seed and Feed

4.14 To meet the additional requirement for seed of cultivable species and species-specific feeds by 2030, innovative schemes can be developed for establishing hatcheries, seed banks, rearing units and SPF/SPR/genetically improved brood banks. Centres for the supply of fresh stock of fragments and import of germplasm of seaweeds after necessary quarantine need to be set up. A system of seed certification can be developed by agencies concerned in order ensure supply of quality seed. Financial and technical backstopping needs to be provided to establish hatcheries. Establishment of a few marine finfish brood banks is needed to provide fertilized eggs/newly hatched larvae to the hatcheries where further rearing and seed production can be carried out.

Food Safety and Health Management

4.15 Traceability and record-keeping of farming activities and inputs which impact food safety can be ensured by documenting the source of inputs such as feed, seed, permitted veterinary drugs and antibiotics, additives, chemicals; type, concentration, dosage, method of administration and the rationale for their use. In Indian mariculture scenario, most of the bacterial diseases are caused by opportunistic pathogens. Fish farming favours infectious diseases and therefore requires investment in disease management. Mariculture operations need to implement aquatic animal health management programmes set up in compliance with relevant national legislation and regulations.

Farm escapees and invasive species

4.16 The impact of escapees from aquaculture operations depends on whether or not there are wild conspecifics or close relatives in the receiving environment, and whether or not the escapee is reproductively capable. Escapees can adversely affect local ecosystems through hybridization and loss of genetic diversity in native stocks, increase negative interactions within an ecosystem (such as predation and competition), disease transmission

and habitat changes (from trophic cascades and ecosystem shifts to varying sediment regimes and thus turbidity).

Aquatic Animal health management

4.17 In Indian mariculture scenario, most of the bacterial diseases are caused by opportunistic pathogens such as *Vibrio* sp., *Photobacterium* sp. and *Streptococcus* sp. resulting in significant economic losses. Similarly, the disease caused by *Perkinsus olseni* is a major threat to bivalve farming. Fish farming favours infectious diseases and therefore requires investment in disease management. A National Surveillance Programme Aquatic Animal Disease (NSPAAD) was launched in India during 2013 funded by DAHDF to monitor aquatic animal diseases covering fourteen key Indian states with passive and active surveillance in more than 100 districts.

Genetic pollution, disease, and parasite transfer

4.18 Farmed stocks are often selectively bred to increase disease and parasite resistance, as well as to improve growth rates and quality of products. Consequently, the genetic diversity within reared stocks decreases with every generation. In addition, cultured species in mariculture can harbour diseases and parasites (*e.g.,* lice) which can be introduced to wild populations upon their escape. Careful planning can minimise these problems.

Capacity Building and Extension

4.19 Increased requirement for trained labour in aquaculture in future can be developed by introducing new schemes for enhancing the skills and capabilities of the fishers and other stakeholders and popularize the vocation in India. Planned and concerted effort can be undertaken under the aegis of Skill India Mission, in order to develop adequate labour. A tailor-made capacity-building module needs to be developed involving the Agriculture Skill Council of India (ASCI) and other expert academic bodies to impart core knowledge related to the mariculture operations and governance to functionaries of the fisheries department from the coastal states and UTs.

Ecolabelling and Certification

4.20 Globally, voluntary sustainability standards (VSS) are becoming very important in the drive for ensuring sustainable seafood production. In aquaculture, two standards, which are compliant with FAO and ISEAL, are the Aquaculture Stewardship Council (ASC) and the Global Aquaculture Alliance (GAA). India's competitiveness in the global seafood market is largely dependent on meeting these standards.

Policy initiatives required

4.21 The Blue Economy is indeed a major sector whose potential needs to be unleashed to make a phenomenal contribution to the economy of the country. This requires development of appropriate instruments in terms of investment and policies. In order to manage marine fisheries, a National Policy on Marine Fisheries, 2017 is in place. It will be essential to create a separate implementing agency for effectively undertaking large-scale expansion of mariculture or sea farming. The new agency could be the 'Sea Farming Authority'. It may also be examined if a portion of the revenue generated from marine exports can be channelized into R&D activities for promoting Blue Economy.

Box 4 : Recommendations for enhancing mariculture production

- Infrastructure development for commercialization of Mariculture
  - Earmarking suitable mariculture sites in the different maritime states and UTs
  - Evolving policies for leasing the sites
  - Establishment of hatcheries and nurseries for meeting the seed requirement for farming
  - Establishment of feed mills for meeting the requirement of feeds
  - Development of quarantine facilities to control exotic pathogens
  - Infrastructure and capacity building for undertaking different mariculture practices.
- Implementation of schemes for commercial level production through Mariculture
  - Sea cage farming for finfish, Bivalve farming, Seaweed farming IMTA and RAS
  - Sale of marine ornamental fishes
  - Development of genetically resistant stocks, probiotics, prebiotics, immuno-stimulants, alternative medicines, functional feeds, diagnostic kits, vaccines, etc.
  - Reduction in the use of antibiotics to the minimum levels.
  - Need to conduct research on ecology and evolution of marine fish and shellfish diseases
  - Continued research in diagnostics, treatment, vaccine development etc.
- Development of schemes for promoting and sustaining Mariculture Production sector with focus on:
  - Environmental issues
  - Processing and value addition of farmed seafood
  - Marketing aspects
  - Insurance and financial support
  - Legal framework
- Schemes for strengthening of R & D for innovative mariculture technologies, up-gradation of existing technologies and on long-term sustainability of mariculture sector.
- Formation of a new implementing agency 'Sea Farming Authority of India'

Chapter 5. Marine Environment, Pollution and Climate Change

5.1 Almost all fishes (except some) are adapted to change in their environment to some extent due to their Poikilothermic nature. However, beyond a particular level, almost no organisms can withstand their environments without changing their habitat or by acquiring special adaptations. The major amplifying problems in marine ecosystems due to climate change are warming and acidification of seawater, salinity variations, eutrophication, near-shore current changes and spread of exotic species. The primary productivity of marine ecosystems depends on the biophysical and chemical interactions in the aquatic environment. Environmental variables such as sea surface temperature (SST), wind, currents, rainfall, sea level anomaly (SLA) and chlorophyll-a are highly influencing the fishery and primary productivity of the ocean. Variations in these environmental variables have a specific influence on fishery and optimal condition of these environmental factors helps to provide a better physical ecosystem for the marine organisms.

Blue Carbon

5.2 One of the primary natural processes that reduce carbon levels is 'Blue Carbon'. Coastal wetlands have the potential to sequester carbon in the tissues of plants and sediments, just as trees on land sequester carbon. Carbon sequestration and storage in seagrass, mangrove and wetland ecosystems is considered to be extremely high (rates of up to 5 times those of tropical forests) and turnover is low in undisturbed systems. Yet these ecosystems are the ones facing the greatest challenge from humans. India is blessed with large areas of mangroves and coastal wetlands, which give us a distinct advantage in a carbon-led economy. However, in order to utilize the economic benefits arising from 'Blue Carbon' we need to conserve these sensitive ecosystems and propagate them in the years to come. Additionally, a viable market needs to be created for carbon trading (as on land – called the Green Economy), although significant efforts are required to develop this into a reality, including adequate science and policy reform.

5.3 Microalgae exhibit higher photosynthetic efficiency, higher biomass production and faster growth compared to other energy crops. They can yield more biodiesel (methyl esters of fatty acids by transesterification or alcoholysis) for a unit area of cultivation when compared to other oil crops. Considering the vast coastal area of India (~8000 km coastline) and the immense algal biodiversity, the possibility of setting up production facilities using salt tolerant algal species is a very bright techno economically viable proposition.

5.4 With terrestrial resources exploited beyond optimum levels, greater attention is being given to increased utilization of oceans. With increasing pressure on countries to reduce carbon footprint, many policy makers find the artificial ocean fertilization experiments as a mechanism to improve carbon sequestration and reduce their pressure on carbon footprints.

As an output of the enhanced productivity, the general belief is that the secondary and tertiary productivity in the area also will improve resulting in better fish production. However, no ocean fertilization experiments have been conducted in Indian marine waters. Nevertheless, all these possibilities remain amidst the apprehensions related to serious environmental degradation, which may result in an artificial ocean fertilisation attempt that too in a land locked ocean system such as the northern Indian Ocean.

Pollution

5.5 Most of the marine animals are being impacted by the pollution due to the plastics majority of which are drained in to the sea through river discharges. Plastics once considered as the wonder material created by man is emerging as the most serious hazard. Use of plastic has permeated every aspect of our life ranging from plastic money to components in life saving devices. Nevertheless, degradation of plastics and its absorption into the environment is cause for great alarm. The possibility of plastics to absorb persistent organic pollutants (POPs) and their transfer through trophic levels presents a grave situation. Environmental contamination with plastics and micro-plastics has made us conjure frightening future scenarios of the oceans. It is estimated that in the next 30 years there may be more plastics in the ocean than fish. This should be superimposed with the fact that micro plastics in due course are ingested by marine biota. There is a good chance of its transfer across trophic levels and finally ending in the human body. The potential damage to biological systems is unknown and hence it is frightening. While we are evolving an approach to harness the Blue Economy for the Nation we must aggressively put in place very effective measures to tackle this growing problem. In addition, coastal water quality is deteriorating due to anthropogenic interferences from industry, terrestrial nutrient inflow, organic input, oil, toxic chemicals, thermal inputs from anthropogenic sources, radioactive materials, hazardous chemicals and others.

5.6 Marine oil spills are tackled by stimulating indigenous microorganisms through addition of nutrients or introduction of special consortia of naturally occurring oil-degrading microorganisms. Introduction of genetically engineered microbes microorganisms (GEMs) with special oil degrading properties have also been tried. The pioneering work of Anand Chakraborty in the US producing genetically engineered oil degrading bacteria and the first ever patent granted on a living organism remains a landmark. Microbial consortia are also produced which comprise of nitrogen fixers, phosphate solubilizers along with oil degrading heterotrophs. Plasmid assisted molecular breeding also helps in accelerating the process of natural degradation. Marine oil spills tend to be very damaging to the ecosystem. Conventional techniques such as removing oil by physical methods must be used to mitigate the damage. After removal of the oil mass, bioremediation at the site is a very effective method to clean up the remaining contaminants. As things are poised today, we would see the evolution of more efficient and cost effective methods.

5.7 Metal detoxification protocols are essential since in some cases industrial effluents entering the marine ecosystem also carry heavy metals. Some microbes are known to detoxify metal concentration either by precipitating them as oxides or as sulphides under reducing conditions. Bacteria play crucial roles in commercial mining operations, *i.e.,* "bioleaching" of metals like copper, uranium, and gold ores. Sometimes whole cells are used as absorbents of mineral cations as in detoxification of cyanide present in gold mine effluents. Marine microbes could be especially useful when treating effluents that empty into coastal waters.

5.8 Another important measure of water quality in the coastal environment is the suspended sediment load. Together with chlorophyll concentration, they determine in water light penetration, and light available for photosynthesis. Optical instruments such as spectral radiometers are able to monitor changes in chlorophyll and suspended sediment load in real time. Furthermore, such measurements can form the basis of local algorithms for application in remote sensing, allowing the results to be extrapolated to the entire study area through remote sensing. Optical methods for monitoring water quality and productivity have been established in other marine environments, for example in the USA. In India, a start in this direction has been established and operationalized by the SATCORE programme of ESSO-INCOIS.

Climate change affecting marine fisheries

5.9 Climate change induces profound influence on biological and physical characteristics of fishes (migration pattern, life cycle, behavioural changes, feeding, and reproduction) and the fish catch of a region. Life history of small pelagic fishes (highly mobile, short lifespan, plankton-based food chain) makes it more responsive to environmental variations. The catches of Indian Oil Sardine and Indian Mackerel have been highly fluctuating since 1985. Since this period, Indian Ocean faced many climatic and extreme events. Such variations influenced the pelagic fishery. According to the Intergovernmental Panel on Climate Change (IPCC AR5) synthesis report, since the times of pre-industrialization, the average global sea surface temperature of total land and ocean increased by 0.85^{o}C (0.65^{o}C to 1.06^{o}C). In addition, the report summarizes that the ocean will continue to warm, acidify and global mean sea level (MSL) tend to rise. By the mid-21st century, increase in 2^{o}C of temperature will cause species richness and higher fishery catch potential at mid and higher latitudes and a decrease at tropical latitudes and semi-enclosed seas. The biological impacts range from shifts of fishes and microalgae, increased coral mortality and bleaching, increased primary productivity at high latitudes, changes in species richness, regional species abundance changes and changes in fishery yield.

5.10 Some of the other major challenges in marine environment management are, i) to identify and map the permanent and seasonal mesoscale eddy formation in the Northern Indian Ocean, ii) to quantify the primary productivity enhancement occurring naturally in our

marine ecosystem due to natural events such as cyclones, seasonal upwelling and others, iii) to identify and map the limiting nutrients in our ecosystem and the quantum of their requirement in artificial ocean fertilization to enhance productivity, iv) to conduct *mesocosm* or lab based experiments to understand the natural ecological succession, v) to identify the potential negative impacts in case of an undesirable ecological succession that may produce large quantity of obnoxious algae and create deleterious effects on the marine food web, vi) to estimate the economics related to positive and negative impacts of artificial fertilization experiment in ocean waters.

Box 5 : Recommendations for monitoring, assessment and management of ocean health

- Automated sensor based and robotic technologies to monitor, prevent and mitigate marine pollution.
- Investment in the management and utilization of land based sources of pollution including plastics.
- Certification of low carbon fisheries through activities that improve water quality near coral reefs.
- Tradable reef credits for the farmers, companies and other resource managers to earn through activities that improve water quality near coral reefs.
- Entrepreneurship development in production of innovative technologies for the restoration of the deteriorated sensitive ecosystems like coral reefs, mangroves, wetlands
- Community managed closed areas in coastal regions with registered regulatory management bodies.
- Monitoring systems including video recording facilities in the hangars of fishing boats in order to monitor the catch.
- Integrated tracking and map based information system to indicate the closed and protected areas offshore.
- Monitoring, cataloging and control of the usage of plastic based products onboard including the fishing gears.

Chapter 6. Marine Biotechnology

6.1 Genetic and biotechnological interventions offer huge potential for tapping the rich resources of ocean and meeting the sustainable development goals towards a full-grown Blue Economy in India. Genetic and genomic tools help in characterization and documentation of biodiversity of the vast oceans, understanding the intra-specific diversity or sub-population structure of marine resources for identifying boundaries of stocks, improving traceability of aquaculture and capture fish products, detection of adaptive loci for inferring changes associated with climatic alterations. Enhancing the productivity of mariculture activities can be carried out by selective breeding using genetic and genomic tools, genetic improvement of farmed stock by way of manipulating economically important traits and nutrigenomics interventions by understanding the interrelationships and dynamics between genes and nutrition. Genetic and genomic tools are valuable in biomonitoring of pollutants in the ocean as they offer a cost effective method for rapid detection of the presence of pollutants in sentinel species. Biotechnological tools have been widely used for tapping ocean resources and ensuring sustainability of oceans for the realization of a Blue Economy. Cataloguing and characterization of marine genetic resources has been employed on a large scale. Even though Indian Ocean is a hotspot of marine biodiversity, the full potential is not yet realized. Use of Next Generation sequencing methods and genomics is still in its infancy in the fisheries sector compared to other developed nations. Gene modifying technologies involving transgenesis and the emerging CRISPR Cas9 technique will gain increased attention.

Since Mariculture is not yet a commercial activity in India, generations of captive populations of many candidates finfish species are not available and this makes selective breeding trials and QTL investigations difficult. In spite of the availability of new generation genomic technologies, the exorbitant cost and lack of expertise are limiting factors in the development of hardcore marine biotechnologies. The immense prospects of Marine Bioprospecting and its applications especially in the non-food sector needs a major thrust.

Stock structure and boundaries using genetic tools

6.2 Identifying fish stock structure and stock boundaries is fundamental to stock assessment, fish stock traceability and ultimately to ensure sustainability. Genetic and advanced genomic tools can be used for achieving the objective of understanding stock boundaries. Many of the pelagic and demersal resources of Atlantic and Pacific oceans are well characterized and their inter specific and intra specific diversity patterns understood using genetic and genomic tools, but many fish stocks of Indian ocean are yet to be characterized. Of late, the latest technologies like next generation sequencing methods are being used for whole genome sequencing, transcriptome sequencing, reduced representation sequencing, Single nucleotide polymorphism detection and characterization

of marine fin and shellfish resources. These tools help in better management, traceability and trait manipulation of these resources.

Climate smart biotechnology

6.3 Adaptations to climate related habitat alterations can be investigated using genomic tools in marine fishes which will provide a better understanding of climatic vulnerability and resilience of marine fish populations. The loci that are adapted to environmentally heterogeneous geographical locations have been characterized and these will provide vital insights into climate change.

6.4 Presently, biofuel is being produced from food crops but there is no doubt that the shift in land usage and crop utilization for biofuel will have global repercussions in the food demand-supply equation. The increasing need for renewable energy should not be at the cost of food production systems. Marine algae as a source of biofuels present immense possibilities for both India and the world. India can build a framework to integrate the algal biofuel-based bio-refinery, with other industries such as livestock farming, ligno-cellulosic industries and aquaculture. The various co-products from algal biofuel processing can be used as inputs for a number of other industries for e.g. the pharmaceutical industry. Thus, there will be spinning off benefits from the algal biofuel industry. Policy and regulatory initiatives for synergistic development of the algal biofuel sector with other industries can bring many sustainable solutions.

Interventions in Mariculture

6.5 The productivity of mariculture activities can be enhanced by interventions through selective breeding, QTL analysis and genetic improvement through standard methods. Nutrigenomic tools can be successfully employed for finding out gene expression trends in relation to feed ingredients so that better ingredients shall be incorporated to feed for improving the expression of genes that control the desired trait. Around 70 % of operational cost in aquaculture activities is related to feed. Fishmeal is an integral protein source input for feed production. There is a serious exploitation of seafood protein in the form of juvenile fishing and IUU fishing for meeting the fishmeal requirement. The food conversion ratio for major marine fishes is very high. Therefore, mariculture activities that promote undue harvesting of protein form the sea should be discouraged. Insects and its larvae can form an important alternative source of protein for fishmeal.

Bioprospecting and focus on the non-food sector.

6.6 Oceans harbour a rich diversity various flora and fauna adapted to extremely complicated habitats like deep-sea vents and cold climates. Due to their inherent ability to adapt, these organisms can be explored as a source of novel genes which gives them the special capability to adapt and these genes could be used for further manipulation in

terrestrial organisms and humans. This aspect has received only sporadic support and interest in the country. The limitations are in the form of technology and manpower besides the undisputed lack of sophisticated facilities especially to grow extremophilic organisms. India perhaps is the only country that has such a long coastline and rich bioresources, but without a dedicated centre that focuses primarily on the non food sector of hardcore marine biotechnology.

6.7 Though the 'Sagar Mala' programme focuses on development of maritime infrastructure, it will have significant spin off benefits for the marine biotechnology sector. The hope that the oceans are a treasure trove of bioactive compounds, elixirs and life saving drugs has been sustained ever since the days of 'Sagar Manthan' narrative. With the appropriate policy, R & D support and a dedicated institution we should be able to tap the truly immense potential.

6.8 Several medicinal compounds like anticancer and pain relieving chemicals have been isolated from marine sponges and molluscs. Development of drugs from the sea is something that India needs to invest heavily, in a focussed manner. India's multicentric programme 'Drugs from the Sea' is arguably one of the pioneering initiatives globally. More than 13000 compounds were tested and 143 of them showed bioactivity and 18 lead compounds were identified. Of the 2 investigational new drugs developed one was taken up for clinical trials. The experience shows that more effort should go into this area in a more focussed manner.

6.9 For the bigger investor there is ample scope for bio-prospecting from marine organisms, producing biofuel from algae, development of novel biomaterial, bio-composites and nano material. The pharmaceutical and medical applications are in the categories related to CNS, anti- inflammatory agents, anticancer agents, antiviral agents and metabolites that control cellular processes. Marine biomaterials comprise a heterogeneous assemblage of organic, ceramic, and polysaccharide based polymers that can be used for a range of applications. High-value biomedical products based on chitin are possible for drug-delivery units. The enormous supply of chitin and chitosan biopolymers serve as a base for hydrogel-like hosts for delivering drugs. Storage biopolymers, particularly those derived from polyhydroxybutyrates integrated with coral fragments can be used to construct scaffolds for bone repair. The possibilities are truly immense.

6.10 Archaea and bacteria are unique organisms that flourish under unfavourable and extreme conditions of temperatures and pressure, high radiation and even toxic compounds. To enable this, they have evolved complex biological mechanisms and enzymatic pathways. The major impetus for research on extremophiles is the biotechnological potential associated with these microorganisms and their cellular products. Novel cellular components and pathways identified in extremophiles have provided scope for a burgeoning new

biotechnology industry. A dedicated facility will prove to be a gamechanger in developing new technologies and commercializing them.

6.11 The science for in vitro fish (Factory fish) meat is an outgrowth of the field of biotechnology known as tissue engineering. Fish produced in vitro that has never been part of a living animal has been proposed as a humane, safe and environmentally beneficial alternative to slaughtered animal/fish flesh as a source of nutritional muscle tissue. The basic methodology of an in vitro fish flesh production system (IFPS) involves culturing muscle tissue in a liquid medium on a large scale. A major advantage of an IFPS is that the conditions are controlled and can be manipulated. From animal models, it is concluded that the overall environmental impacts of cultured meat production are substantially lower than those of conventionally produced meat.

Bioremediation and biomonitoring

6.12 Bioremediation involving the use of microorganisms or their processes to remove pollutants from an environment is gaining increased acceptance. It works on the principle of artificially accelerating the natural process of biodegradation. Protocols are available for treatment of non-toxic liquid and solid wastes, contaminated ground water, and in some cases toxic and hazardous wastes. Several microbial consortia have been developed to degrade petroleum components. TERI has developed a consortia of microorganisms marketed as 'Oil Zapper' to treat oil spill pollution. It has been found effective and ONGC and others are using the technology. Introduction of genetically engineered microbes (GEMs) with special oil degrading properties have also been tried. Metal detoxification protocols are essential since in some cases industrial effluents entering the marine ecosystem also carry heavy metals. Some microbes are known to detoxify metal concentration either by precipitating them as oxides or as sulphides under reducing conditions. Marine environment is being increasingly polluted due to dumping of anthropogenic wastes to the sea on a large scale. In addition, plastic pollution has been reported to affect the environments well as organisms inhabiting the ocean ecosystem. The immediate responses to high levels of pollution can be monitored using genetic and genomic tools. Gene expression patterns of organisms can be studied using transcriptome analysis and some of the genes and their expression profiles can be used for development field level biomarkers and biosensors. Some of these cross cutting issues have been examined under Chapter 5.

Box 6 : Policies and Investment options for Marine biotechnology and bio-prospecting

- The biodiversity of the ocean should be characterized genetically and a germplasm inventory generated. This will facilitate well informed decisions on conservation of oceanic resources.
- Assessment of subpopulation structure of commercially important marine fin and shell fishes will help in marine fishery certification, tracing geographic origin, improving sustainability, improving income for fishermen, devising management measures and preventing overfishing
- Whole genome characterization of important marine fin and shell fishes should be carried out so that genes important in climatic adaptations and genes regulating economically important traits like growth, reproduction, and stress tolerance are identified. Genome adaptations to climate change can also be studied.
- Interventions in mariculture by selective breeding, QTL analysis, trait manipulation etc. will contribute to enhanced productivity of mariculture activities
- Development of genetic and genomic tools for bio monitoring for better management of ocean environment and enhancement of sustainability of oceans.
- As noted in Articles 22 and 23 of the Nagoya Protocol, marine bio prospecting should be regarded as an opportunity to build scientific capacity and to transfer appropriate technology and access to technology from developed countries and institutions.
- In international negotiations, the TRIPS signatory countries should support improved disclosure of the origin of material in patent applications to ensure greater transparency and improved tracking of the source of the material. Detailed information about the geographical and phylogenetic origins of marine genetic resources would help states to settle disputes over the ownership of material. Conservation of the natural habitats of these resources should be strengthened.
- A National coordinated project on "Use of Marine genomics technologies to improve marine fishery and mariculture" may be formulated.
- A National coordinated project on "Marine Bio prospecting to Develop Bioactive Compounds for Human Health Applications" may be formulated.
- A separate institution for "Marine Biotechnology" that focuses on the non food sector is most essential for generation of new technologies for commercialization.

Chapter 7. Fisheries Market Development

Domestic fish marketing system in India: An overview

7.1 About three-fourths of total marine fish produced in India is marketed domestically, which translates to around 2.7 million metric tonnes. The transactions were valued at Rs. 52,431 crores at landing centre and at Rs. 78,408 crores at retail level in 2017. The marine fish marketing system in India is highly complex, involves multiple stakeholders, intermediaries and benefactors with diversity in structure and conducts across regions, and based on the products transacted. Though modern and innovative marketing models are emerging in recent years, marketing practices followed are predominantly old and traditional in many areas with inefficiencies across the value chain. The main contributing factors to market inefficiencies include insufficient landing centres, wholesale and retail market infrastructure, cold chain deficiencies and logistic shortfalls, particularly those associated with small-scale operators in the sector. Dearth of credit to augment investment in marketing services, inadequate institutional support, excessive involvement of market intermediaries and associated exploitative and fraudulent practices as well as delayed and ad hoc government response during market crises also holds back development of marine fishery marketing system in India.

7.2 The fish landing facilities/infrastructure in India presently includes 7 major fishing harbours (2 in West Bengal and 1 each in Odisha, Andhra Pradesh, Tamil Nadu, Kerala and Maharashtra); 52 commissioned minor fishing harbours and 181 commissioned fish landing centres. Other than these, there are over 1300 beach landing centres that mainly cater to the needs of artisanal fishermen. Modern fishing harbours typically requires facilities such as safe mooring area, provision for utilities (water, fuel and workshops), fish handling infrastructure (ice supply, cold storage, sorting areas, processing facilities) marketing infrastructure and associated connectivity. Besides, other modern amenities such as slip ways, auction hall, effluent/sewage treatment plant, net repair sheds, fish drying yard, diesel outlet, gear shed, drinking water supply, rest room complexes, sanitary disposal, administrative building, fire protection, power supply technology unit, ATM, parking facilities and canteen are essential to ensure efficient fish handling and marketing. Similarly, fish landing centres are required to have protected bay, beach landing, fresh water, ice and fuel supply utilities, protected area for fish auction, shore processing and packing facilities, slipways and road connectivity. However, only a handful of the harbours/landing centres have all the above-mentioned facilities. Lack of basic facilities and other modern amenities limits hygienic handing of fish, efficient storage and transportation. Last mile road connectivity and adequate telecommunication facilities is short in most of the small fish landing centres. Fuel dispensing facilities are often far from the landing centres. Similarly, facilities for auctioning, storage and primary processing are constrained at most locations. Considerable investments are required to plug these gaps so that fishermen do not have to travel longer distances to ensure

efficient marketing of their catch. Further, new harbours and landing centres with modern amenities need to be established in potential areas. Public–private partnerships can be explored in this respect. The Build, Own, Operate & Transfer (BOOT) model followed in constructing and operation of Jeppiar fishing harbour in Muttom, Tamil Nadu is an excellent example..

7.3 Fish auctioning systems being followed in majority of the harbours, fish landing centres and wholesale markets are rather archaic with verbal bidding methods, which in turn are strongly dominated by auctioneers and other market intermediaries. Reforms are needed to revamp the existing system with active mediation by the designated market committees or co-operative fishermen societies of the respective landings centers/markets.

7.4 Wholesale fish markets in India vary widely in terms of fish handled, that generally range from 1 tonne to 100 tonnes. Private traders mostly carry out marketing with large number of intermediaries, thereby reducing fishermen's share in consumers' rupee. The main constraints associated with majority of wholesale markets include dearth/lack of cold storage facilities, provision for slurry ice, proper facilities for sanitation, effluent treatment plants, waste disposal mechanisms and other basic amenities. The markets also lack any mechanisms for ensuring/certifying quality and safety of the fish sold. This assumes significance in the wake of use of unauthorized preservatives and other harmful chemicals for enhancing keeping quality of fish. The retail markets are miniature versions of wholesale markets and almost all the constraints mentioned above are applicable to them. Wastage in the fish value chains is very high due to unscientific handling practices, dearth of cold chains and other inefficiencies. In view of this, there is a dire need to channelize capital investments to modernise infrastructure requirements for enhancing efficiency of fish marketing.

7.5 One of the primary reasons behind inefficiency in domestic fish markets is that fish is mostly sold in bulk without any labels attached to it. Niche labels attached to specific coastal regions need to be developed at all levels (by public fish marketing agencies, cooperative fish marketing societies, public-private partnership companies, self-help groups) across the country so that quality considerations would be strongly attached with each label and that consumers strongly identify the labels for the quality being maintained by them. Further, it is important to enable traceability of fish consignments along the entire supply chain to the landing centre level so that mandatory recalls can be effected in case of contamination/health hazards.

Box 7 : Existing Initiatives for market development

There are several initiatives being undertaken by the government of India for the development of fish markets and fishery value chains in the country. They are outlined below:

- Centrally sponsored scheme on development of marine fisheries, infrastructure and post- harvest operation' - The main components include development of fishing crafts through technological up gradation; establishment of fishing harbors and landing centers; development of deep sea fishing; developing market infrastructure, preservation and storage infrastructure, and so on.
- National scheme on 'welfare of fishermen' – Includes programs for model fishermen villages; group accident insurance for active fishermen; saving-cum-relief programs as well as training and extension programs.
- Central sector scheme on 'strengthening database and information networking for the fisheries sector'. This involves sample survey estimation of fishery resource potential, catch assessment surveys, improvement of information technology systems, conducting Census, development of GIS, monitoring control and surveillance programs as well as conducting evaluation studies.
- National Fisheries Development Board (NFDB) conducts various activities for developing the value chains of coastal aquaculture, mariculture, for promoting seaweed collection and marketing, development of landing and market infrastructure, improving processing infrastructure, technology up-gradation along fish value chains as well as for development of deep-sea fishing.

Since December 2015, the above schemes have been integrated to a restructured plan scheme on "Blue Revolution: Integrated Development and Management of Fisheries" with a total outlay of Rs. 3000 crores for the period 2015-16 to 2019-20.

Fish marketing in the islands

7.6 Lakshadweep and A&N islands presently contribute to about 45,000 tonnes of fish catch which is about 1 per cent of total fish landed in the Indian Union. The average landing from the islands is however only about 10-15 per cent of the estimated fishable potential. Given that the EEZ encompassing the islands is close to half of India's total EEZ, there is substantial untapped potential that could be harnessed by investing more on island fisheries. High value fishes like tunas, barracudas, billfishes, elasmobranchs and squids, constitute most of the island resources. The development priorities in fisheries in the islands are quite different from that of the mainland. Islanders are mainly dependent on reef and deep sea

resources for their livelihood. The major constraints in the island fishing economy includes lack of skills for hygienic fish handling, proper on-board processing of tuna and other high value fishes for maintaining quality, constraints related to bait fish management, poor landing and berthing facilities, poor marketing infrastructure and so on. The islands also lack good processing infrastructure to cater to the requirements of exports and other high-value supply chains. The fishermen get low price for the consignments send to mainland due to several intermediaries involved in transportation and subsequent sale of fish.

Export promotion

7.7 India is one of the leading exporters of marine fish and fish products globally. Out of the total seafood exports which is pegged at 1.13 million tonnes and valued at Rs.37,871 crores in 2016-17, about 70 per cent is contributed by marine capture fish. This translates to about 0.81 million tonnes in quantity and Rs. 17,040 crores in value. USA and South East Asia are the major export markets of Indian seafood with a share of 32.7% and 31.6% respectively, followed by EU (15.7%), Japan (6.3%), Middle East (4.10%) and China. However, it is worth noting that, about 90 per cent of all exports are either in live, fresh, chilled or frozen forms. This indicates that only about 10% of seafood exports are in higher order value added forms. Because of this, the unit values realized on exported products are much lower, and many a time lower than prices realized in domestic markets.

Box 8 : Policy measures and investment priorities for reforming fishery marketing

- Strengthening/upgrading landing and marketing infrastructure.
- Establishment of quality certification units at all major wholesale and retail markets for certifying the consignments handled on a daily basis.
- Establishment of mobile quality checking units to undertake random checks in individual fish stalls/vending units.
- Regular centralized drives to identify un-licensed/ clandestine intermediaries and middlemen who indulge in exploitative and unscrupulous marketing practices.
- Reforming fish auctioning by introducing automated/electronic auctioning systems. Latest developments in secure block chain technology may be explored in this regard.
- Enhancing traceability of fish consignments by installing computerized bar-coding, systems for forward and backward tracking of consignments and alert mechanisms.
- Encouraging online marketing of fish under public and PPP mode.
- Development of niche labels for domestic fish as in the case of Mastsyafed, Kerala; Neithal fish mart, TNFDC, Tamil Nadu.
- Introduction of Market Intervention Scheme (MIS) in marine fisheries so as to insulate fishermen and fish vendors against extreme price fluctuations.
- Popularizing refrigeration enabled mobile fish vending kiosk to aid hygienic handling and marketing practices of fisher folk, small scale vendors and retailers.
- Strengthening market intelligence network in fisheries by replicating the model of agmarknet.gov.in in agriculture.
- Measures to augment processing capacity of export processing units towards tertiary processing (ready to eat products, heat and serve products, re-heated airline meals, canned/tinned products, etc.).
- Focusing on import substitution of ornamental fish by developing hatcheries and mass production facilities.
- Investments to comply with mandatory food safety and quality requirements of high-end markets by placing emphasis on traceability and product certification.

Chapter 8. Harvest and Post-harvest Technologies

Fishing gears with by-catch reduction technologies

8.1 Generation of by-catch, which affects the ecosystem either directly or indirectly at different tropic levels, is a serious concern in commercial fishing around the world. Trawl nets, due to their low selectivity and high efficiency, often generate large quantities of by-catch and are the most destructive in terms of juvenile catches. More than 50% of the catches along the Indian coast is landed by trawlers, which also shows the importance for regulations in this sector. The by-catch discards from mechanized trawlers operating in Indian EEZ is estimated to be 1.2 million tonnes. The same study estimated 56.3% of the total catch of shrimp trawlers as by-catch. Use of By-catch Reduction Devices (BRD) based on the fishing operation is one solution to reduce the incidence of by-catch. Square mesh cod ends, Sieve Net BRD, Fish Eye BRD, JFESSD etc. are some of the by-catch reduction devices that were field tried along the Indian coast. States like Gujarat, Maharashtra and Kerala have stipulated the use of square mesh cod ends in trawl nets, in order to reduce the incidence of juvenile catches

8.2 Species like Turtles and other Endangered Threatened and Protected (ETP) species, which are already at risk due to the impact of climate-induced changes often, form a by-catch in different gear systems like trawls and long lines. Use of Turtle Excluder Devices (TEDs) that help release turtles getting in the way of trawl nets and circle hooks that reduce the incidence of deep hooking that leads to mortality have been field tested by ICAR-CIFT. Use of pingers as deterrent to Cetaceans is found to significantly reduce the cetacean interactions with fishing gear like seine nets.

8.3 The by-catch exclusion from different BRDs tested by CIFT are given below:

BRD	By-catch exclusion
Bigeye BRD	11%-37%
Fisheye BRD	46%-62%
Oval grid BRD	57%-58%
Sieve net BRD	15%
JFE-SSD	43%
Square mesh BRD	20%-25%

8.4 In general, passive gears like traps, gillnets and long lines have lower impact compared to the active gears like trawls. Use of modified trawls like the Semi-pelagic trawls, which are found to be more selective, energy efficient and eco-friendly are to be encouraged. Cut-away top belly, short belly trawl and high opening bottom trawls are other trawl designs for selective trawling developed by ICAR-CIFT. Large mesh gillnets which were introduced for purse seines during 2009-10, had effectively improved the catch of small pelagics by the vessels and also had to a certain extent reduced the competition for small pelagics in the near shore waters.

Energy efficient vessel designs

8.5 Fuel use for navigation and scouting operations by fishing vessels constitute a significant component of the fishing cost of capture of fisheries and to the GHG emissions. Often the vessels using active gear like trawlers contribute most to emissions. One important strategy is to adopt technologies that are right sizing the engine and the length of the vessel. Energy-efficient, multi-purpose green fishing vessel developed by ICAR-CIFT, christened FV Sagar Harita for deep sea fishing operations is a promising option worth scaling-up. This vessel may be adopted as a standard for deep sea fishing vessels under the sub- 24m category. The horsepower specifications for different classes of fishing vessel for optimum performance, as recommended by ICAR-CIFT are given below:

8.6 The maximum allowable power (HP) for different classes of fishing vessels

LOA of fishing vessel	Maximum allowable horse power
Up to 15 meters	140 HP
15 to 17.5 meters	200 HP
17 to 20.0 meters	250 HP
20.0 to 22.5 meters	350 HP
22.5 to 25.0 meters	500 HP

Living conditions on fishing boats

8.7 Presently, mechanized multiday fishing vessels do not have basic sanitary facilities such as toilets, kitchen (galley) space and sleeping (berthing) arrangement. Space for all these basic facilities are now used for increasing fish hold capacity. These basic human necessities are to be provided on board for the crew as per the provisions of ILO Convention 188 of the International Labour Organization (ILO). The basic human necessities are to be provided for the crew on board mechanised multiday fishing vessels as per provisions of the Articles 25-28 of ILO C188.

Energy efficient fishing gears

8.8 Resistance offered by the gear material forms about 60 percent of the total drag offered by active fishing gears like trawls. Experimental studies using low-drag trawls using UHMWPE has shown to reduce the drag and concurrent reduction in fuel consumption by 10-15%. Adoption of standard designs of fishing gears should be made mandatory for each class of fishing vessel. Approval of concerned authority should be made mandatory for any change to be made in the gear design. Provisions for minor changes in the gear should only be allowed, without changing the overall dimensions of the unit gear.

Tapping of alternate sources of energy for powering fishing operation

8.9 Though solar power for propulsion is successful in boats operating in inland waters, more research is required for developing seafaring vessels that propel exclusively on solar power. Research and development in the area of solar panels should be a priority. ICAR-CIFT has developed a solar powered boat for inland waters that is exclusively powered by solar power.

Use of satellite based prediction techniques to reduce fuel consumption

8.10 Identification of fish shoals based on chlorophyll content and temperature derived using satellites, reduces fuel consumption during fishing by considerably reducing searching time for fish shoals. The saving in terms of monetary benefit is around 7-10% of fuel cost alone, in addition to indirect effects with regard to reduction in emissions. One such promising intervention includes dissemination of potential fishing zone (PFZ) advisories to the fishermen. The m@krishi service launched by ICAR-CMFRI in partnership with INCOIS, Hyderabad and Tata Consultancy Service (TCS) for the fishermen of Maharashtra is an excellent example which can be emulated in this milieu. Based on a survey conducted by the CMFRI at Maharashtra coast, it is estimated that adoption of m@krishi service has resulted in 30-40 per cent increase in fish catch and 30 per cent saving in fuel costs.

Fish preservation and processing technologies

8.11 Preservation and processing, is a crucial part of commercial fisheries. Ideally, any method of preservation and processing should ensure minimum quality loss and maximum nutritional retention. Traditionally, low temperature preservation such as icing and chilling is the most accepted method of preservation. Icing is effective for short term preservation such as that needed to transport landed fish to nearby markets, where as long term preservation for several months demands freezing. Drying is a traditionally followed method of preservation, especially to handle the glut catches. Drying may be coupled with salting to improve the flavour and shelf life of the material. Smoking is another widely preferred processing method, especially in Northeast states of India, and in islands. Smoking imparts a unique flavour to the fish apart from enhancing the shelf life of the product. The advantage

of drying and smoking is that these are cost effective technologies, which may be promoted over a vast range of communities, with minimum investment. Recent innovations in food processing and quality assurance are boosted with the innovative concept of non-thermal processing technique, where the food is subjected to minimum heat treatment, thus favours the maximum retention of flavours, essential nutrients and vitamins with adequate microbiological safety. There are several ways for non-thermal processing viz. irradiation, high hydrostatic pressure (HHP), freeze-drying, the use of antimicrobials, bacteriocins, or chemicals, ultrasound, micro and ultrafiltration, and electrical methods such as pulsed electric fields (PEF), light pulses (LP), and oscillating magnetic fields (OMF). Each of these techniques can be used either alone or in combination to optimize product quality, processing time, and bacterial and enzyme inactivation.

Value addition

8.12 India, being the largest producer of several agri-commodities, there are many opportunities for value addition and product development, especially ready-to-eat/ ready-to-cook (RTE/RTC) products for the domestic as well as export market. Ethnic recipes of Indian tastes like fish/shrimp pickle, fish/shrimp dishes of different cultural populations, marinated fish with Indian spices etc. offer attractive opportunities for seafood processors. In spite of having a number of lean varieties of candidate species globally identified for surimi manufacturing, it remains as a least explored area of value addition in the country. Shell fish analogue products from surimi fetches good demand in both domestic and export markets. Thermal processing, even though an investment intensive processing aid, the products fall under the category of 'ready to eat/serve products', hence receives high price realization in the market. In India, canning is primarily limited to tuna and allied species. Curing and drying, even though an age-old practice opens up new dimension and possibilities towards value addition in domestic as well as overseas markets. However, there are several factors hindering the industry from the adoption of dried fishery products in the product profile. The major one is that drying is still considered as a traditional method of processing, and hence standard operating procedures are seldom followed. Moreover, there is a general impression that drying is a secondary method for preserving low value varieties and quality compromised materials. Attempts towards improving the handling practices right from the point of raw material harvesting until marketing, popularization of improved packaging practices, use of hygienic energy efficient mechanical driers, and adequate extension services can facilitate better adoption of drying practice in the seafood sector. Similarly, fish based extruded products are a class of popular products that have very high market potential particularly among the urban elites. The technology can be employed for profitable utilization of by-catch and low value fish besides providing ample generation of employment opportunities. Battering and breading have contributed significantly to the value addition of fishes, shellfishes and molluscs. The first commercially successful coated fish item was fish fingers. Later several other products like fish cutlets, fish balls, fish nuggets, etc. came into the market. Coated butterfly shrimp, squid rings, stuffed squid rings etc. are among the fancy

items that cater to the luxury markets. Sophisticated equipment like meat bone separator, meat strainer, portioning and forming equipment, pre-duster, battering and breading machine, fryer, freezer and packaging machineries are in the market for preparation of a wide variety of coated products. Inevitably, a solid effort for encouraging value addition in seafood sector emphasizes the primary requirement of appropriate mechanization for reducing drudgeries, up-gradation of capacity and efficiency for cold chain system, as well as development of intelligent and smart packaging techniques for increased shelf life. Moreover, parallel developments should be reflected in Government policies and investor friendly incentives, in order to make the industry globally competitive.

Packaging techniques

8.13 Seafood sectors demand flexible packaging solutions that guarantee high quality products. A number of advancements are reported in this area with the urge for high quality and safe, minimally processed seafood commodities. Some of the promising packaging techniques that need funding support for large scale adoption are vacuum packaging (VP), modified atmosphere packaging (MAP), active packaging: antimicrobial packaging, Intelligent packaging and more recently smart packaging.

Zero waste approach and value addition of process discards

8.14 Invariably, the term 'waste management' in fisheries sector is gradually changing to 'value addition of process discards'. A considerable quantity of fish waste is generated which may go as high as 70% of raw material, and is even more costly to dispose. Considering the proteinaceous nature and abundance of biomolecules of medicinal therapeutic value, fish processing waste is classified as 'a certified or prescribed waste'. Process discards, which is primarily composed of head, scale, skin, bone, viscera, fins, eyes, and gills is a major reservoir of high value by-products such as protein fish oil, PUFA, collagen, gelatin, bioactive peptides, chitin, chitosan, glucosamine, squalene, calcium, pigments, hydroxyapatite etc.

8.15 Estimates of fish waste generated in India, 2016-17, across inland and marine sectors

Item		Production (Mt)	Fish waste generated (Mt)
Inland fish	Total	7.08	3.22
Marine fish	Finfish	2.87	1.43
	Crustaceans	0.44	0.31
	Mollusc	0.23	0.16
	others	0.79	0.04
	Total	4.33	1.94
Total		11.41	5.16

8.16 Bulk reduction technologies help in the conversion of these discards to protein and mineral rich farm inputs such as manure, fertilizer, foliar spray, aquaculture feeds, poultry and

pet feed etc. by less capital-intensive methodologies. A successful waste management programme depends primarily on the strengthening of the baseline data viz. quantum of discard generation, local collection and sorting facilities, current disposal plan, major stakeholders etc. Development of efficient means of networking and establishing inter-industrial linkages, generation of mobile pilot technological platforms for testing and demonstrating different technologies, encouraging public-private partnerships (incubation centres for pilot production), etc. are the few immediate elements to be sourced out in this regard.

Transportation of live fish

8.17 Though live fish trade is established globally, especially in most of the South-East Asian countries, in the Indian scenario, more attention has been gained in the recent years only. Initially live fish transportation was confined to farmed varieties, but due to the increased commodity demand, currently its trade is gaining popularity for commercially important marine species as well as for waterless transportation of shrimp, crab and lobster. On a commercial level, insulated or non-insulated containers with ice or cooling gels in large trucks are employed for small distance transportation. Hauling trucks with more sophisticated facilities such as assembly for filtration, oxygen generation, refrigeration and reticulation of water are used for large-scale operations involving long distance transport of high value seafood but are very expensive. In India, a customized design of live fish container to facilitate the transportation of a variety of fishes economically is presently not available. Hence, research and development need to be focused towards this aspect to bring about a compact device considering the economic factors to meet the demand of seafood consumers. Filling this gap can facilitate the availability of fresh and quality fish to the customers in different parts of the country. Intense research has been initiated by ICAR-CIFT in this regard for the design and development of a model live fish transportation system.

Chapter 9. Legal and Regulatory Issues

Fisheries Governance structure in India

9.1 Entry 57 of List 1 of Seventh Schedule of the Constitution of India specifies Fishing and Fisheries beyond Territorial Waters as Union Subject, whereas Entry 21 of List II speaks of Fisheries as a State Subject. Reading both the Entries together, it follows that control and regulation of fishing and fisheries within territorial waters is the exclusive province of the State, whereas beyond the territorial waters, it is the exclusive domain of the Union. The Union Government acts as a facilitator and coordinator responsible for policy formulation, carrying out fishery research and channelling funding support to the states in line with the national priorities and the commitments made to the State/UT Governments. The Ministry of Agriculture & Farmers' Welfare (DAHD&F) within the purview of its allocated business helps the coastal States and the UTs in development of fisheries within the territorial waters, besides attending to the requirements of the sector in the EEZ. The Fisheries Division in the DAHD&F acts as the focal point for fisheries development and management in the country. Therefore, management of fishery exploitation in the EEZ requires close coordination between the Union and the States.

National laws governing marine fisheries

9.2 The Indian Parliament enacted the Territorial Sea, Continental Shelf, Exclusive Economic Zone and other Maritime Zones Acts in 1976, which paved the way for establishment of a 200 nautical mile (nm) EEZ. Since then, India has also enacted a number of other laws and regulations which have a bearing on the sustainable exploitation of the marine fisheries resources in the Indian EEZ, including the Indian Coast Guard Act, 1978; the Maritime Zones of India (Regulation of Fishing by Foreign Vessels), Act, 1981 and the related Rules of August, 1982; the Environment Protection Act, 1986, *etc*. The other Union legislations, which have important bearing on the fisheries sector, include the Merchant Shipping Act, 1958, the Marine Products Export Development Authority Act, 1972; the Wildlife (Protection) Act, 1972 and the Biological Diversity Act, 2002. However, there is still no law to regulate the Indian-owned fishing vessels operating in the EEZ. The provisions under the Wildlife (Protection) Act, 1972 have been used to set up marine parks/ sanctuaries along the coastline in India. While the larger objectives have been towards protection/ conservation of fauna and flora, in some cases these reserves have infringed on the livelihoods of the traditional fishers.

9.3 In 2004, the Government of India brought out the first Comprehensive Marine Fishing Policy, which set a framework for sustainable development of the fisheries sector in the new millennium. As the sector is dynamic and has been unfolding new requirements from both harvest and sustainability point of view, the Government brought out, after elaborate

stakeholder consultation process, the National Policy on Marine Fisheries, 2017. The NPMF is intended to lead the coordination and management of the sector in the country for the next ten years. The NPMF is also a commitment of the Government to usher in Blue Revolution in the country while ensuring healthy seas and sustainable fisheries.

Marine Fishing Regulation Acts of the coastal States/ Union Territories

9.4 The Marine Fishing Regulation Act of the coastal States/UTs in India was conceived in response to the growing conflicts in the coastal waters during the late seventies. To reduce the conflicts and allow for regulation of fisheries in the territorial waters, the Ministry of Agriculture formulated a Model bill, which was circulated to the coastal States/UTs in 1979. Based on the Model Bill, all the coastal States/UTs have enacted the Marine Fishing Regulation Act (MFRA) and the rules and regulations there under. The MFRAs have provisions for regulating fishing and conservation measures in the territorial waters. These include regulation of mesh size to avoid catching of juvenile fish, maximum-minimum fish sizes, regulation of gear to avoid over-exploitation of certain species, reservation of zones for various fishing sectors to provide exclusive rights to traditional fishermen to fish unhindered in near shore areas and also for declaration of closed seasons during fish breeding period to avoid catching of young juvenile fish. Other important aspects include vessel movement control, vessel inspection, registration and license and colour coding.

9.5 The MFRAs of the maritime States/UT Governments and the deep sea fishing schemes as provided under the Maritime Zones of India (Regulation of Foreign Fishing Vessels) Act, 1981 of the Government of India provide for prohibition of fishing by mechanized fishing vessels in the areas earmarked for the traditional and small-motorized crafts. Presently, the Union Government exercises closure of fishing for two months in a year with relation to fishing in the EEZ. This closure coincides with the closure enforced by the coastal State/UTs for fishing in their territorial waters and is done through 'Executive Orders'. Measures such as issue of biometric cards to fishermen, registration of fishing boats and colour code to fishing boats have been taken up by the Governments and is in the process of completion. These steps will facilitate better sea safety arrangements as well as monitoring boat movements.

Central Sector Schemes under "Blue Revolution: Integrated development and management of Fisheries"

9.6 GOI, MoA&FW, DADF, New Delhi approved the Central Sponsored Scheme "Blue Revolution: Integrated Development and Management of Fisheries" (both marine and inland) in December 2015 at a total cost of Rs 3000 crore for implementation in all the States and UTs during a period of five years (2015-16 to 2019-20). All the on-going schemes under XII Five Year Plan and newly proposed schemes have been brought under the scheme "Blue revolution". The important components of the Scheme include (i) assisting National Fisheries

Development Board and its activities (NFDB) (ii) strengthening of Database and Geographical Information System of the Fisheries Sector (SoDGIS) (iii) monitoring, Control, and Surveillance and other need-based Interventions (MCS) (iv) institutional arrangements for Fisheries Sector (v) development of Inland Fisheries and Aquaculture (vi) development of marine Fisheries, Infrastructure and Post-harvest Operations and (vii) national scheme of welfare of Fishermen.

Box 9 : Recommendations for legal and regulatory reforms

- **Creation of a separate Ministry of Fisheries and Fishermen Welfare**
- **Regulation for sustainable use of resources beyond territorial waters**: Considering intensive exploitation of the resources in waters beyond 12 nautical miles, there is an urgent need to enact a comprehensive legislation for regulation of Marine fisheries between 12 and 200 nm within the Indian Exclusive Economic Zone (EEZ).
- **Expanding and revising the scope of Marine Fishing Regulation Acts (MFRAs):** In the last 30 years, the marine fisheries in the country have undergone several changes and new issues and challenges have emerged. Government of India may guide the maritime States/UTs for revising the MFRA by enlarging its scope.
- **Fishery Management Regions (FMRs):** Fisheries management presently remains bounded by historical jurisdictions rather than ecological ones. FMRs may be established for licensing of fishing boats, issuing guidelines on fishing areas and landings within each region.
- **Ecosystem Approach to Fisheries Management (EAFM):** EAFM offers a practical and effective means to manage fisheries more sustainably and holistically. EAFM approach needs to be adopted in fisheries management plans that not only work locally, but also fit into broader fishery/ecosystem strategies.
- **Increasing the Marine Conservation Areas:** In view of India's commitments to SDG 14 goal that mandates increasing the areas of conservation to 10%, new conservation areas, fish refugia and, fish sanctuaries may be designated.
- **Fishery Management Plans (FMPs):** Dedicated FMPs may be developed to meet the management requirements of specific fish stocks. For example, FMPs may be developed for oceanic tuna fisheries, shark fisheries (under National Plan of Action – Sharks) and oil sardine fisheries.
- **Adapting marine fisheries to climate change:** It is necessary to mainstream climate change adaptation into the MFRAs and develop capacity development and awareness drives as an integral component of the action plans.

- **Further strengthening of Monitoring, Control and Surveillance (MCS):** The states should strengthen MCS by (i) mandatory licensing of all fishing boats (ii) issuing fishing licenses by clearly specifying the gear to be operated (iii) mandating regular reporting of fish catches, position of fishing operation, submission of voyage report, crew compliance etc. need to be done (iv) compulsory operationalization of Vessel Monitoring System (VMS) and Automatic Identification System (AIS) in mechanized boats.
- **Promoting co-management:** The approach of co-management may be integrated in fishery governance by suitably modifying the MFRAs of state governments. The initiatives taken by Government of Kerala in this regard may be replicated.
- **Regulating fishing practices:** Fishing effort may be optimized by (i) Regulating fishing vessel construction (ii) mandating standard norms and certification of vessels (iii) regulating fishing gear w.r.t. mesh size, gear dimension, maximum size of fishing nets, and so on (iv) regulating destructive fishing methods such as pair trawling, mini trawling and bull trawling (iv) specifying minimum legal size (MLS) of fish caught and (v) strict implementation of spatial zoning.
- **Revising fishing closure season:** The closure period may be reconsidered based on improved information from time-to-time on spawning and other vital characteristics of the fisheries.
- **Ensuring safety-at-Sea:** It should be made mandatory that all fishing vessels be fitted with appropriate lights and flags for signaling as per international maritime norms. They should also possess Life Saving Appliances (LSA) and Fire Fighting Appliances (FFA) as per sea safety norms.
- **Reorganizing subsidies in marine fisheries:** Replacing existing market-distorting subsidies with those that encourage fishers to adopt sea safety measures and establishing communication facilities in fishing boats.

- **Regulating fish meal plants to minimize juvenile fishing**

Issues on international/regional cooperation

9.7 India is a signatory to a number of international instruments and agreements. These obligations need to be implemented to make fisheries sustainable as well as to ensure compliance. International cooperation is particularly important as fish stocks such as tunas, tuna-like species and sharks are migratory and straddling and shared by neighbouring countries. Cooperation with neighbouring countries to ensure safety and security of fishermen is also necessary as the Bay of Bengal and Arabian Sea witness increasing events of storms and cyclones.

9.8 Some of the important international instruments and agreements (both binding and non-binding) to which India is signatory and have profound bearing on the development of Indian fisheries/marine fisheries include (i) United Nations Convention on the Law of the Sea, 1982 (ii) United Nations Convention on the Law of the Sea, 1982 (iii) UN Convention on Biological Diversity, 1995 (iv) The FAO Code of Conduct for Responsible Fisheries and International Plan of Actions related to marine fisheries, 1995 (v) The Kyoto Declaration and Plan of Action, 1995 (vi) Safety and health of fishers at Sea: the ILO requirements and (vii) Sustainable Development Goals (SDG 14: Life Below Water.

Regional Instruments and Regional Cooperation

9.9 India is member of various regional fisheries bodies including the Asia-Pacific Fishery Commission (APFIC); Network of Aquaculture Centres in Asia and the Pacific (NACA); Intergovernmental Organization for Marketing Information and Technical Advisory Services for Fishery Products in the Asia and Pacific Region (INFOFISH); Indian Ocean Tuna Commission (IOTC) and the Bay of Bengal Programme Inter-Governmental Organization (BOBP-IGO). Besides, it is also member of other regional bodies that deal with environment (e.g. South Asian Cooperative Environment Programme, International Union for Conservation of Nature) and Trade (Bay of Bengal Initiative for Multi-Sectoral Technical Economic Cooperation- BIMSTEC). Even economic and geopolitical set-ups such as South Asian Association for Regional Cooperation or SAARC have undertaken initiatives in both fisheries and environment related matters form time to time.

9.10 Most of the regional organizations to which India is a party (APFIC, BOBP-IGO, and NACA) are advisory in nature and as such, their roles and functions are limited to policy advocacy and capacity building. However, other organizations like the Indian Ocean Tuna Commission (IOTC) have management and regulatory mandates, making the decisions of the Commission binding on the member-states. Regional Fisheries Management Organizations such as IOTC are international organizations formed by countries with fishing interests in an area. Some of them manage all the fish stocks found in a specific area, while others focus on particular highly migratory species, notably tuna, throughout vast geographical areas. They are usually tasked with collecting fisheries statistics, assessing resources, making management decisions and monitoring activities. RFMOs play a pivotal role in facilitating intergovernmental cooperation in fisheries management. India provides IOTC with catch and effort statistics on tuna species in addition to insights on BRP's and stock status.

Fisheries Subsidies Negotiations in the WTO

9.11 The WTO Agreement on Subsidies and Countervailing Measures (ASCM) deals with trade impact of the subsidies and the available remedies thereof. It covers any form of subsidies being provided to any product including the fish and fish products. ASCM discipline covers:

Prohibited Subsidies: No country should provide such subsidies. As of now, only 2 categories of subsidies are prohibited namely, subsidies being provided on exports or subsidies which are available only when the beneficiary uses the domestically produced inputs.

Actionable subsidies: Though members can provide subsidies, the importing country may take action by imposition of Anti Subsidy Duties (Countervailing Duties) on such exports.

9.12 Presently, Subsidies being provided to fisheries sector (whether at the Central Govt. or State Govt. levels) are actionable but not prohibited as these are not covered by the aforesaid two provisions. Since the WTO Agreements are enforceable, some of the WTO members (Friends of Fish) have been reiterating to bring new discipline under ASCM by trying to bring certain fisheries subsidies under the Prohibited category citing time bound commitment on sustainable development under these international agreements or conventions and the UN SDG 14.6 goals. They consider that since subsidies provide the incentives for the exploitation of marine resources, all harmful subsidies should be prohibited. Hence, they consider that the best way to tackle this is by developing discipline under ASCM, thereby prohibiting certain subsidies which lead to (i) Illegal, Unreported and Unregulated (IUU) Fishing (ii) Fishing in stocks declared as overfished (iv) Overfishing and overcapacity.

9.13 There had been persistent push of international civil society, NGOs, FAO members etc. supplemented by the World Bank reports highlighting that subsidies granted by governments to their fishing fleets had contributed to the depletion of global marine fish stocks as a result of over exploitation of fishery resources. Accordingly, negotiations under the WTO were taking place. The negotiations have entered into an intensive phase after the WTO Ministerial Conference held in December 2017 in Buenos Aires where the Ministerial Decision was made to conclude negotiations for comprehensive disciplines on fisheries subsidies by the next Ministerial conference in December 2019.

Prohibition of subsidies for IUU fishing

9.14 The fisheries subsidies negotiations now require binding commitment in WTO to prohibit subsidies that contribute to IUU fishing in all waters. Hence, Governments at all levels will have to be mindful about the level of compliance with the FAO International Plan of Action to prevent, deter and eliminate IUU fishing. There are legal framework and implementation issues for developing countries. While most of the Members of WTO consider that subsidies for IUU fishing should be prohibited, developing countries face capacity challenges in implementing particularly in respect of the requirements of 'Unreported' and 'Unregulated'. It would require comprehensive and effective monitoring, control and surveillance of fishing from its commencement through the point of landing to final destination. However, the Central and the State Governments have to ensure that the elements of IUU are properly adhered to by each fishing vessel.

Prohibition on subsidies for fishing in areas declared as "Overfished Stocks"

9.15 It entails prohibition on subsidies for fishing in areas where stocks are over fished. In the national jurisdictional waters, it will be the national authority to regularly take stock assessment and for RFMO areas, it is the RFMO. However, the debate is going on for waters in high seas, which is not within the RFMO jurisdiction. In the national jurisdictional areas, it raises the question of the capacity and capability of the coastal states to assess fish stock, particularly when it is a multi-species area. Similarly, the issue of straddling fish is to be addressed as required under the UN Fish Stock Agreement.

Prohibition on subsidies leading to overcapacity and overfishing

9.16 Subsidies leading to overcapacity and overfishing need to be rationalized under this commitment. However, there are outstanding issues that are yet to be resolved such as (i) what would be the yardstick for such determinations (ii) whether there should be a Listing approach i.e., a positive list of subsidies (Non-harmful subsidies) which will never be prohibited and a negative list of subsidies (Harmful subsidies) which will never be allowed.

9.17 So far as transparency is concerned, India is amongst a few countries who had notified most of its marine fisheries subsidies in time in collaboration with the fisheries departments of the State Governments. These subsidies are operating cost subsidies such as fuel subsidy (both de-taxation and price rebate and constitute majority of India's subsidies), capital cost subsidies such as the ship replacement/acquisition/modernization subsidy, infrastructural subsidy or fishermen welfare subsidies etc. Though taken together both at the Central and the State level, the quantum of subsidy is miniscule in comparison to the quantum being provided by the developed countries, and need to be notified in time to WTO (as of now, every two years and India has notified till 2017-18).

9.18 There have been a few instances of IUU fishing by Indian vessels. We need to be vigilant that our vessels are not engaged in such activities and if found doing so, appropriate action needs to be taken. This has become important not only on account of the catch certificate requirement on exports to EU and now for the US (SIMP) as well, but also on account of the discipline being negotiated in WTO which will also be applicable for marine catches being used for domestic purposes as well. India's National Marine Fisheries Policy 2017 indicates the course of action for implementing FAO Regulations and guidelines on sustainability.

Chapter 10. Financial Support, Extension, Skill Development and Social Safety Nets

Credit in fisheries

10.1 Fishermen need credit for funding their fishing operations on a regular basis. Presently, credit for fishermen is mainly catered to by informal financial agents such as auctioneers, middlemen and private moneylenders. Inter-linked deals with such financial intermediaries often result in bondage and involve huge costs in the form of inflated interest rates and auction commission. Measures should be taken to improve financial inclusion of fishers through provision of flexible and affordable credit that suit their unique requirements.

Box 10 : Recommendations to improve financial inclusion in marine fishery marketing system

a. Earmarking of at least 10% of the total priority sector lending for fishermen. The need of the fish processing industry is to be addressed separately and out of the purview of priority sector lending.

b. Encouraging fishermen credit cooperatives to design flexible credit schemes with provision to charge interest on loans as a share of their harvests. The model of Matsyafed in Kerala can be emulated by other maritime states.

c. Reforming the market systems to provide first right over the sale to the fishermen directly and without agents.

d. One prime reason for the fishermen to depend on the informal credit source is flexibilities of the terms of credit lending, with minimal requirement of the formalities. In this context, the cooperative sector has an edge over the commercial banks and needs to be promoted.

e. Design interest subvention schemes and credit subsidy programs to encourage sustainable fishing and fish marketing practices. For instance, subsidies can be provided to equip fishing vessels with automatic identification systems. Similarly, self-help groups engaged in labeled fish retailing and primary processing could be subsidized for their capital investments.

Fisheries extension and technology commercialization

10.2 A strong fisheries extension system is needed to consolidate the gains in the sector as well as to address the emerging challenges by conveying the relevant information to major stakeholders, in addition to translating policy goals into action domain. Though the expenditure on fisheries extension has increased from about Rs. 50 million in 1974-75 to Rs.

319 million (real price, 2004-05 base) by 2014-15, it appears to be quite meagre, considering the potential and significance of the sector. Since the potential of the sector is being affected by deficits in information, advisories, capacity building and support services, the investment in fisheries extension needs to be augmented.

Skill development / Training

10.3 The fishermen, fish workers, value chain intermediaries and fishery department personnel have to be trained adequately so as to hone their skills to utilize new opportunities and tackle emerging challenges in the sector. Similarly, skills and expertise required for fisheries managers and scientists can be sharpened with proper training. It is suggested to devise tailor-made training courses for specific purpose and stakeholders. The purpose of capacity building in fisheries and environment is to enhance the skill in (i) resource assessment, (ii) ecosystem assessment, and (iii) management system implementation and governance enhancement.

10.4 Adapting the trainings and capacity building programmes conducted by research institutes and fisheries colleges/universities to the skill ecosystem is an important issue. In addition, the auditability of the trainees, availability of resources and training partners, etc. have to be assessed. Emphasis should be on development of a proper training infrastructure. Technical skills alone cannot help in achieving the desired results. Further non-technical skills like effective communication, negotiation, group mobilization, *etc.* are also needed. Skills in planning and implementation of viable projects are important in the context of emerging entrepreneurship age.

10.5 Some important fields, which require skill development, are:

- Efficient and hygienic handling of fish onboard as well as post-landing.
- Sea safety
- Sustainable and responsible fishing practices
- Legal and regulatory issues in fishery sector
- Value chain management and business development
- Sustainable waste management

10.6 The personnel in the department of fisheries are to be trained in the following specific areas:

- Developments in monitoring, control and surveillance systems
- Legal and regulatory issues in fishery sector
- Entrepreneurship development in fisheries
- Catch data analytics and market intelligence systems in fisheries
- Resource monitoring techniques
- Climate change impacts on fishery ecosystems

Enhancing social safety nets for fishermen and fish workers

10.7 Presently, the social safety nets available for fisher folk and fish workers are scant. Marine capture fishing is one of the riskiest professions in the world. Insurance is needed to cover the risks faced by sea-going fishermen, costal fishery entrepreneurs and fish workers engaged in various types of processing and marketing activities, particularly women associated with various stages of the fishery value chain. The present level of adoption of insurance in marine fishery sector indicated serious shortfalls and needs attention. Similarly, other social safety nets such as financial support during closed seasons, savings schemes and other relief and rehabilitation schemes need enhanced government support.

Box 11 : Recommendations to improve the coverage of insurance

- Develop innovative insurance products to cover multiple risks faced by the fishermen including life, loss of craft and gear, other assets and means of livelihood.
- Popularize adoption of insurance products by involving communities and other change agents and provide adequate state support.
- Ensuring participation of grass-root level organizations as intermediaries/partners in insurance administration.
- Deployment of a brigade of rural insurance agents/service providers to strengthen grass-root level support services.
- Popularization of micro-insurance among fisher folk by involving SHGs/Micro Finance Institutions.
- Bringing flexibility in insurance schemes through options such as installment payment of premiums, partial coverage of insured units, covering partial damage for claims, augmented coverage of fishing equipment and so on.
- ICT interventions for efficient claim settlement.

Chapter 11. Main Action Points

11.1 Following table gives the main action points along with the agencies identified for implementing the same.

Sl. No.	Main action points/ policies recommended for each Subsector	Institution/Office responsible for implementation	Schemes under which implementable
1.	Fish harvesting including deep sea fishing- investment, capacity building and legal and institutional frameworks	DADF in collaboration with ICAR-CMFRI, ICAR-CIFT, FSI, ESSO-CMLRE and CIFNET	DADF scheme on 'Blue revolution'
2.	Stock assessment and related activities	DADF in collaboration with ICAR-CMFRI, ESSO-CMLRE & FSI	Special committees constituted by DADF such as Working group on revalidation of marine fisheries potential (2010; 2018).
3.	Combating IUU fishing – Strengthening MCS, installation of VMS and AIS/ Awareness generation	DADF in collaboration with INCOIS, ICAR-CIFT, Coast Guard/Indian Navy and respective state governments	Sagarmala project of ministry of shipping; DADF scheme on 'Blue revolution', various schemes of state governments.
4.	Mariculture development- Institutional and policy mechanisms, technology generation and commercialization; extension.	DADF, NFDB, ICAR-CMFRI, CSMCRI, RGCA, State governments	DADF scheme on 'Blue revolution'; various NFDB programs and state government schemes
5.	Technology development for control of marine pollution and climate change adaptation and mitigation.	MoEFCC, MoES, ISRO, CSIR-NIO, IITM ICAR-CMFRI, ICAR-CIFT, NIOT, CMLRE and DBT	Funded projects
6.	Coordination and Implementation of marine pollution and climate change adaptation and mitigation schemes.	DADF, MoEFCC, State governments	Various department schemes
7.	Setting up of a dedicated institute for marine biotechnology and bioprospecting	DBT	R & D Schemes

8.	Market infrastructure and value chain development.	DADF, NFDB, FSSAI, State governments	DADF scheme on 'Blue revolution'; NFDB and state government schemes.
9.	Export promotion and quality assurance.	MPEDA, EIC, DADF, ICAR-CIFT, SEAI	Various on-going schemes of ministry of commerce and industry.
10.	Post-harvest technology development and dissemination	ICAR-CIFT, NIFPHATT, MoFPI	Funded projects
11.	Legal and regulatory reforms; International and regional cooperation	DADF, NFDB, ICAR-CMFRI, ICAR-CIFT, NITI Aayog, State governments and Indian Coast Guard	Special committees constituted from time to time.
12.	Financial support for fishermen	DADF, NFDB, NABARD and State-level financial institutions	DADF scheme on 'Blue revolution, Various ongoing schemes of NABARD and state governments
13.	Extension and skill development	ASCI, CIFNET, FSI, ICAR-CMFRI, ICAR-CIFT, KVKs	DADF scheme on 'Blue revolution', Other central sector schemes on skill development and extension.
14.	Social safety net interventions	DADF, NFDB, State governments	DADF scheme on 'Blue revolution', Pradhan Mantri Suraksha Bhima Yojana and other central sector schemes on insurance and social safety nets.
15.	Development of food safety and quality standards and monitoring	FSSAI, EIA, ICAR-CIFT and BIS	Existing departmental schemes
16.	Development of standards for fishing craft, gear and accessories	ICAR-CIFT, Ministry of Shipping, MMD and BIS	Existing departmental schemes

11.2 Suggested timeline for achieving major targets

		Jan-19	Feb-19	Mar-19	Jun-19	Sep-19	Dec-19	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
1	**National Policy on Marine Fisheries-2017.** The Policy has been notified. However, there is a need for developing a comprehensive action plan that will include detailed Marine Spatial Planning in the 12 -200 nautical miles region. Following this, the policy will be made operational.																	
2	**National Policy on Mariculture.** The final draft has been prepared by the committee constituted for the purpose and the same has been submitted to NFDB. Following this there will be stakeholder consultations for necessary amendments and subsequent notification by GOI.																	
3	Establishment of a National Institute of Marine Biotechnology with focus on the non-food sector. The Dept. of Biotechnology, GOI has developed the proposal which is in the final stages of approval. All support should be accorded so that that institute, the first of its kind is set up at the earliest. This will be a significant achievement under the Blue Economy programme of the Government of India.																	
4	**Mariculture** The additional 7 mmt fish required by 2030 is expected to come largely from the marine sector through mariculture. The projected expansion will aim at reaching a production of 5 mmt per year by 2030. The comprehensive plan strategy will address multiuser issues and ensure sustainable development. The plan will be developed in collaboration with Coastal States and UTs. It is also proposed to set up a separate implementing agency such as a **'Sea Farming Authority'.**																	
4a	Mariculture production. Target of 1 million metric tonnes/year																	
4b	Mariculture production. Target of 2 million metric tonnes/year																	

4c	Mariculture production. Target of 3 million metric tonnes/year																	
4d	Mariculture production. Target of 4 million metric tonnes/year																	
4e	Mariculture production. Target of 5 million metric tonnes/year																	
5	**Modernisation of Marine fish landing centres and Marine fish processing centres in all Coastal States.** This will have a bearing on our export potential and production of value added products. It is essential to meet international standards so that our products find a growing market.																	
6	**Marine Pollution Mitigation.** Preparation of master plans to ensure reduction of pollution and minimise threat to marine bio resources. Plastics is emerging as a major threat in addition to threats posed by industrial pollution, discarded fishing gear and nets. The coastline can be divided into segments and action plans specific to the regions should be developed. This should take into consideration the type of pollution. This will be a massive effort that will require commitment at the highest levels. Perhaps in terms of size, it may be equivalent to that of many Ganga Action Plans, but it is something that has to be undertaken to save our oceans and the foundations of Blue Economy from peril.																	

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Government of India
Economic Advisory Council to the Prime Minister
NITI Aayog Bhawan, Parliament Street, New Delhi - 110 001
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F.No. JS/EAC-PM/BE/2018/04 **30th August, 2018**

OFFICE MEMORANDUM

As discussed during the Steering Committee meeting held on 3rd August 2018, the following Working Groups have been constituted on National Blue Economy and Sustainable Development Policy:

S. No.	Working Group	Composition	Convener of the Working Group
1.	National Accounting Framework for Blue Economy and Ocean Governance	1. Dr. M. Rajeevan, Secretary, M/o Earth Sciences (CHAIRMAN) 2. Shri K.V. Eapen, Secretary or his nominee, M/o S&PI 3. Shri Pravin Srivastava, Addl Director General (NAD), MOSPI 4. Shri S.V. Ramana Murthy, Dy. Director General (NAD), MOSPI 5. Prof. S.K. Mohanty, Research and Information System for Developing Countries (RIS) 6. Shri Amey Sapre, Consultant, NIPFP	Shri K. Rajeswara Rao, Adviser, assisted by Ms Aparajita Gupta, YP
2.	Coastal Marine Spatial Planning, Tourism and Wellness	1. Shri R.H. Khwaja, Former Secretary to Government of India (CHAIRMAN) 2. Secretary or his nominee, Ministry of Tourism 3. Secretary or his nominee, Ministry of Earth Sciences 4. Secretary or his nominee, M/o MoEF 5. Vice Admiral Vinay Badhwar NM, Chief Hydrographer, National Hydrographic Office, Dehradun 6. Prof. V.N. Attri, Chair in Indian Ocean Studies, Indian Ocean Rim Association (IORA) 7. Dr. K. Somasundar, Scientist – G, Ministry of Earth Sciences 8. Prof. Ramchandra Bhatta, Emeritus Scientist (Economics), Indian Council of	Dr. Sumita Misra, JS, assisted by Ms Ritika Singh, YP

		Agricultural Research 9. Shri Satyajeet Rajan, Director General, Tourism, Ministry of Tourism, GOI 10. Shri Subhash Goyal, Chairman, STIC Travels Group; Past President, IATO and Member, CII Expert Committee on Tourism 11. Dr. Sudheeshna Babu. S, Nodal Officer, National Institute of Watersports	
3.	Fisheries, Aqua Culture and Fish Processing	1. Dr. George John, Former Vice Chancellor, Birsa Agricultural University, Ranchi and Former Sr. Adviser/Scientist-H, Deptt of Biotechnology (CHAIRMAN). 2. Secretary or his nominee, Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture 3. Secretary or his nominee, Ministry of Food Processing Industries 4. Dr. A. Gopalakrishnan, Director, CMFRI 5. Dr. Ravi Shankar, Director, Central Institute of Fishery Technology, Kochi 6. Vice-Admiral Pradeep Chauhan, Director, National Maritime Foundation	Shri K. Rajeswara Rao, Adviser, assisted by Ms Aparajita Gupta, YP
4.	Manufacturing, Emerging Industries, Trade, Technology, Services and Skill Development	1. Dr. Vishwapati Trivedi, Former Secretary to GOI (CHAIRMAN) 2. Secretary or his nominee, Department of Science & Technology, Ministry of Science and Technology 3. Secretary (HI) or his nominee, Department of Heavy Industries, M/o HI&PE 4. Commerce Secretary or his nominee, Department of Commerce, M/o Commerce and Industry 5. Secretary (FS) or his nominee, Department of Financial Services, M/o Finance 6. Dr. Nitya Nanda, Associate Director, The Energy & Resources Institute 7. Dr. S.K. Mohanty, Research and Information System for Developing Countries (RIS) 8. Prof. Rupa Chanda, Economics & Social Sciences, Indian Institute of Management 9. Dr. H. Purushotham, Chairman &	Shri B.N. Satpathy, Sr Consultant, assisted by Ms Shri Diwakar Jhurani, YP

		Managing Director, National Research Development Corporation 10. Dr. Satyaki Roy, Associate Professor, Institute for Studies in Industrial Development (ISID) 11. Dr. Bala Pisupati, Research and Information System for Developing Countries (RIS) 12. Ms. Madhura Roy, Deputy Director, M/o Skill Development & Entrepreneurship	
5.	Logistics, Infrastructure and Shipping (including transhipments)	1. Admiral R.K. Dhowan, PVSM, AVSM, YSM (Retd.), Chairman, National Maritime foundation (CHAIRMAN) 2. Secretary or his nominee, Ministry of Shipping 3. Shri Alok Chaturvedi, IAS, Director General of Foreign Trade 4. Mr. Sujeet Samaddar, Senior Consultant, NITI Aayog 5. Dr. Vishwapati Trivedi, Former Secretary to GoI 6. Dr. Malini Shankar, Director General and Spl. Secretary, M/o Shipping, Mumbai 7. Professor Sachin Chaturvedi, Director General, Research and Information System for Developing Countries (RIS) 8. Shri R.C.M. Reddy, Managing Director and CEO, IL&FS Education and Technology Services Limited, 9. Shri Saibal De, Whole Time Director and Chief Executive, IL&FS Maritime Infrastructure Co. Ltd. 10. Shri Anant Swarup, Joint Secretary, M/o Commerce and Industry Logistics and Social Media	Shri V. Appa Rao, Director, assisted by Shri Venkatesan Seeralan, RA
6.	Coastal & Deep Sea Mining and Offshore Energy	1. Dr. Shailesh Nayak, Director, National Institute of Advanced Studies (CHAIRMAN) 2. Secretary or his nominee, M/o Mines 3. Secretary or his nominee, M/o New and Renewable Energy 4. Secretary or his nominee, M/o Petroleum	Shri Kishore Desai, OSD, assisted by Ms Phalasha Nagpal, YP

		& Natural Gas 5. Vice Admiral Vinay Badhwar NM, Chief Hydrographer, National Hydrographic Office, Dehradun 6. Dr. M.A. Atmanand, Former Director, National Institute of Ocean Technology, M/o Earth Sciences 7. Dr. Rahul K. Sharma, Chief Scientist, Geological Oceanography, CSIR-National Institute of Oceanography 8. Dr. Loveson, V.J., Senior Principal Scientist, National Institute of Oceanography Headquarters, Goa 9. Prof. H.P. Rajan, Dy. Director (Retd.), Division for Ocean Affairs and Law of the Sea, UNITED NATIONS, New Delhi 10. Shri Bhanu Pratap Yadav, Joint Secretary (Wind Energy), M/o New & Renewable Energy 11. Dr. K. Balaraman, Director General, National Institute of Wind Energy (NIWE) (formerly known as "Centre for Wind Energy Technology" under the M/o New and Renewable Energy)	
7.	Security, Strategic Dimensions & International Engagements	1. Ambassador K.V. Bhagirath, Secretary General, Indian Ocean Rim Association (IORA) (CHAIRMAN) 2. Foreign Secretary or his nominee, M/o External Affairs 3. Defence Secretary or his nominee, M/o Defence 4. Secretary or his nominee, Deptt, of Science & Technology 5. Ambassador Anup K. Mudgal, Member, FICCI Task Force on Blue Economy (CHAIRMAN) 6. Admiral R.K. Dhowan, PVSM, AVSM, YSM (Retd.), Chairman, National Maritime Foundation 7. Vice-Admiral Pradeep Chauhan, Director, National Maritime Foundation 8. Dr. Pankaj Jha, Assistant Professor, International Cooperation for	Ms Deepika Shrivastava, Sr Consultant, assisted by Shri Himanshu Arora, YP

		Development, Assistant Professor & Assistant Dean for Global Engagement, O.P. Jindal University School of International Affairs 9. Dr. Ruchita Beri, Senior Research Associate, Institute for Defence Studies & Analyses (IDSA) 10. Prof. V.N. Attri, Chair in Indian Ocean Studies, Indian Ocean Rim Association (IORA), University of Mauritius	

2. The above Working Groups are expected to undertake the following activities and expected to submit their reports within 2-3 months' time:-

- Identify key issues and challenges related to each sector underpinning the Blue Economy;
- Examine the existing schemes and policy initiatives of the Government which are in place to address these challenges;
- Study the global best practices, standards and guidelines that are essential to develop a sustainable Blue Economy and promote doing business in the country;
- Suggest actionable policy measures which may cover initiatives involving multiple Ministries. Timelines for implementation of the reforms in terms of short, medium and long term are to be laid down along with the department responsible for implementation of such measures.
- Special focus on integrating flagship schemes of Government of India

30/8/2018

(K. Rajeswara Rao)
Adviser

Distribution:

1. Chairpersons and Members of all Working Groups
2. Convenors of all Working Groups and YPs assisting them

Copy for information to:

i) Chairman, EAC-PM
ii) Member Secretary, EAC-PM

3. Fisheries, Aquaculture and Fish Processing

Dr. George John **Chair** Former Vice Chancellor, Birsa Agricultural University, Ranchi and Former Sr. Adviser/Scientist-H, Deptt of Biotechnology Flat No. 5140, B-7 Vasant Kunj, New Delhi-110 070 M: 9818419488 Email: gjohn@nic.in Secretary or his nominee, Department of Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture Room No. 218, Krishi Bhawan, Tel No. 23382608 Email: secyahd@nic.in Secretary or his nominee, Ministry of Food Processing Industries Room No. 201, Panchsheel Bhawan, August Kranti Marg, Khel Gaon, New Delhi-110 049 Tel No. 26493225 Email: secy.mofpi@nic.in **Dr. A. Gopalakrishnan** Director Central Marine Fisheries Research Institute Kochi- 682018 Kerala email agopalkochi@gmail.com email director@cmfri.org.in Mobile 9847115515 **Dr. C.N.Ravishankar,** Director, Central Institute of Fishery Technology, Kochi-682029 Email: cnrs2000@gmail.com Mobile: 9446474368 **Vice-Admiral Pradeep Chauhan,** Director, National Maritime Foundation Varuna Complex, NH-8, New Delhi Tele: 26156520, 26154901 Mob. 8412933225 Email: director.nmf@gmail.com	**Convenor of the Working Group:** **Shri K. Rajeswara, Rao,** Adviser, EAC-PM Telephone: 23096511 Email ID: rajesh_konedana@yahoo.com