

Responsible Fisheries and Biodiversity Conservation

RAMACHANDRAN C AND SHINOJ PARAPPURATHU

SEETD

ICAR-Central Marine Fisheries Research Institute

“By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on the threatened species

and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within limits” Aichi Biodiversity Target 6.

“Despite many target stocks not yet sustainably managed, fisheries approaches are progressively focusing on a broader range of biodiversity considerations, where as conservation interests are increasingly adopting more socially inclusive approaches”

Friedman et al 2018

If Biodiversity conservation so far has been a “naming and framing” game; and Fishery conservation is a “give and take” game; Is Responsible fisheries a “hide and seek” game played by both?.

Ramachandran,C

(The lecture-cum-discourse in the winter school will be an elaboration of the question placed above. The following passages are to be treated as a prelude to this discussion. The major reference used for the preparation of this chapter is Garcia et al (2014))

Biodiversity in our seas is the result of 3.5 billion years of evolution ie, natural selection working on the consequences of genetic variation. The edifice of marine fisheries has been built on this bedrock. But our understanding on the ways in which biodiversity interplays with marine productivity is nascent and expanding. This becomes important when we analyse Biodiversity conservation vis a vis fishery conservation. Before proceeding further let us get familiarized with some of the basic concepts.

Biodiversity is commonly referred to as the combination of species present in an ecosystem. It includes the totality of genes, species, and ecosystems of a region. Each species exhibits genetic diversity also (referred to as metagenome (Ardura et al.2011)). The Convention on Biological Diversity (1992) defines **biodiversity** as the variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part.

Diversity is also a measure of the complexity of an ecosystem. As a numerical measure it is a combination of the number of species in an area and their relative abundance. (species richness+abundance or evenness=diversity)..

The system of interactive relationships among organisms (eg. energy transfer) and between organisms and their physical environment (eg. habitat) in a given geographical unit is known as **ecosystem**. It has natural and human subsystems. So it is a socio-ecological system. Species diversity is considered as a major factor behind sustainability as well as stability of an ecosystem.

When we use components of biological diversity in a way and at a rate that doesn't lead to the long term decline of biological diversity it is referred to as **sustainable**. The nature, extent and process of harvesting fish from the marine ecosystem bears significant impact on the long term socio-economic resilience of the fisheries sector.

IUCN (1980) views **conservation** as the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations. It includes preservation, maintenance, sustainable utilization, restoration and enhancement of the natural environment..

Without integration of environmental concerns, fisheries management becomes meaningless. Thus, it is not difficult to see that responsible fisheries, as a global concern, is a sine qua non of marine biodiversity conservation. But we need to remember that fishing is not the only factor that impact marine biodiversity.

Responsible fisheries as praxis in a locally embedded marine biodiversity scenario is the real challenge for the governance especially in the context of the Aichi target quoted above.

A brief history of Biodiversity conservation and fishery conservation

When you study Biodiversity conservation and fishery conservation through their historical evolution You are likely to have an impression that they are like an estranged couple on the path of a recent reconciliation!.

Biodiversity as a scientific concept is a modern notion. Though the term was coined only in 1988 by E O Wilson in his book with the same title, a normative and culturally transmitted understanding of the significance of biodiversity conservation by the human race played an essential role in our survival as a species.

Traditional societies had to have inherent awareness on the extent to which they could deplete the natural resources upon which they depended for their very survival. It was coupled with a commitment to reduce or eliminate the problem through the "wise use" of the natural resources. In a way , they could identify that "we are the problem". Thus they could conserve certain number of species (including totemic ones) through community control. The case of the Bishnoi community is worth a mention here. The sect founded by Guru Jambheswar (14511536) upholds the value of conservation as a tenet. In 1730, 363 Bishnoi individuals sacrificed their lives to save Khejri trees (It is now the state tree of Rajasthan, *Prosopis cineraria* and the incident inspired the famous Chipko movement later). Royal decrees protected special areas in India more than 2000 years ago. Emperor

Asoka did establish protected areas of mammals, birds, fish and forests by 252 BC. The Arthasastra written during 321-300 BC, says that certain forests were protected as Abhyaranyas, considered as forerunners of modern day National parks. It is no wonder that Indian history is replete with such incidents because the Indian way of life had been shaped by Upanishadic teachings like "Ishavasyamidam sarvam" which, interestingly, underscored the web of life concept of modern ecology. We would call this as the "holy secret" of conservation movement in India.

But with the emergence of individual property rights and capitalism, the land elsewhere was usurped from the aborigines. The natives were identified as the cause of degradation of natural resources (The "You- We" divide). The conservation of the wilderness by exclusion of the original inhabitants became a norm in post-Industrial colonial countries. Thus came the idea of National Parks especially in the US. They opened the first National Park in 1865 in Yosemite and the second and the most famous Yellowstone Park in 1872. It is heartening to note that about 300 Shoshoni tribe (called 'grass house' people) were killed on a single day in 1863 for making this wilderness preserve. (Garcia et al 2014). In India about 7000 people were proposed to be evicted over a period of five months for the creation of the Lion Protection area in Kuno, Madhya Pradesh (Blaikie and Jeanrenaud, 1996). By 2000, around 1650 belonging to the Saharia tribe in the Kuno sanctuary (Saharia meaning companion of tiger) were evicted. The eviction of people for conservation is in fact a global phenomenon. Steven Pinker (2018) calls this as the "dirty secret" of the conservation movement.

Though biodiversity attained scientific stature only in 1988 international attempts for the conservation of nature were already on the anvil much before. A major landmark in global concern for conservation took place in 1956 when International Union for Conservation of Nature and Natural resources (IUCN) replaced International Union for the Protection of Nature (IUPN) which was established in 1948. This reflected a transition from the preservationist approach towards utilitarian aspect of conservation as rational long-term management of natural resources. In 1959 IUCN was asked to enlist and maintain Nature Parks across the world. The Antarctic treaty which gave birth to Conservation of seals (1972) and Convention on conservation of Antarctic Marine living resources (1982) was signed in the same year.

The industrial revolution had a role in fisheries development as well as its decline. Overfishing was "discovered" by John Cleghorn, a wise British fisherman, in 1854 in the context of a collapse of the herring fishery there. The fisheries crisis led to the birth of the fisheries management science in UK and Norway. In fact, Norway took the lead by establishing a commission to investigate fisheries problems through the application of science. Fishery regulations were implemented largely as measures to promote discipline in marketing and fishing operations. Conservation per se was not the objective of these regulations. But what seems as an antithesis the British under the intellectual influence of T H Huxley repealed more than 50 fisheries related acts and brought out a UK Sea fisheries Act which deregulated all fishing activities by 1885. The use of science to resolve the issue of stock fluctuations emerged gradually with the notable works of Huxley, Heinke, Johan Hjort, Baranov, Edward Russel and Ottestad.

The call to use science for the rational exploitation of seafood resources attained a significant institutionalization through the establishment of International Council for the Exploitation of the

Sea (ICES) in 1902. The scientists of ICES took up the issue of overfishing in collaborative mode of enquiry. This is a landmark event as it can be marked as the first attempt of convergence between the two separate streams of biodiversity conservation and fisheries management. In 1913 Australia established the first whale sanctuary. In the same year the world treaty on conservation proposed the formation of the International commission for the protection of wildlife.

Overfishing problem was becoming more vivid by this period. The first world war turned to be the first fishing experiment as the post-war catch rates demonstrated the reality of overfishing. The League of Nations Conference in 1930 passed a resolution to protect various species of marine fauna not only in territorial waters but also out of it. Fisheries scientists had a better grip over the overfishing problem and foundations for the development of the MSY concept were laid by Russel, Graham etc.. The British biologist Michael Graham synthesized the Great law of fishing which said “all fisheries that are unregulated become unprofitable”.

The year 1937 saw the first convention on the issue of overfishing namely the London convention for the regulation of Meshes for fishing nets and the size limits for fish (also called as London overfishing convention). (It is worth to remember here that India attained independence only in 1947 and the first marine fisheries research institute (CMFRI) was established in the same year. And only by 2016 an Indian maritime state , Kerala brought out a regulation based on size limits).

By 1945 FAO was established and the first FAO Technical Committee on Fisheries was convened. The committee viewed by catch as a ‘waste’ issue. The newly independent tropical water countries were just beginning to consider the oceanic resources as a way for economic development. But in the USA salmon was identified as overfished. And Harry Truman , the US president made the famous proclamation claiming sovereignty over the outer continental shelf and the resources therein, arguing their right to make conservation zones there. The second London overfishing conference in 1948 called for mesh size and landing size regulations. They came into effect only in 1954. The conference could not agree the regulation on fishing fleet capacity. The International convention for the regulation of whaling (Washington) adopted MSY as the basis for allocation quotas.

During 1947 -48 we can see international efforts getting mobilized for the protection of living species and habitats for endangered species from human beings. Thus the IUPN was established. The period also saw two significant publications that shaped conservation movements in the US. They are Sand County Almanac by Aldo Leopold (1949) and The Sea around us by Rachel Carlson (1951).

Following the Santiago declaration by Chile, Peru and Ecuador on 200 nautical miles in 1952 the UN proposed to give coastal nations a management authority on the 200 miles contiguous to their territorial waters for protection of ocean resources from extermination in 1953. The next year saw the launching of the industrial trawler called “Fairtry”. This opened the era of distant water fishing by factory vessels. It is an irony that the name Fairtry became an oxymoron. The UN-FAO Technical conference on the Conservation of the living resources of the sea was held in 1955. It mooted the idea of regional agreements based on the geographical distribution of the species concerned.

Beverton and Holt published their path-breaking work called “On the Dynamics of Exploited Fish Population” in 1957. The first UN conference on the Law of the Sea (UNCLOS1) was held the next year in Geneva. The first cod war between Iceland and UK happened during this time.

In our case this was the time (1953-4) when Indo Norwegian Project came to Kerala and a new method of fishing called Trawling was introduced marking the phase of “modernization” and the pink gold rush in our fisheries, thanks to the successful export of frozen shrimps to USA by Balakrishnan Nair in Kochi. When the temperate world was grappling with the “boom and bust” issues of overfishing and conservation we were just embarking on the same historical path as a greenhorn.

The early sixties saw the emergence of WWF (1961) and the IUCN Red List (1963). The Red list epitomized a species based conservation logic. The mid -sixties witnessed the pressure built by Environmental NGOs on the high mortality of dolphins caught in purse seining by Tuna fishermen resulting in dolphin safe labels. ICES scientists warned about the inadequacy of mesh size regulations against the problem of overcapacity. The first FAO Committee on fisheries was held in 1966.

The oil tanker Torrey Canyon wrecked in 1967 triggering increased pressure to conserve marine areas. The tragedy of the commons notion was explained by Hardin (1968). Atlantic fisheries introduced catch limitations after finding the impracticability of effort limitations. Early seventies saw UN launching the Man and biosphere programme, FAO estimating the world fisheries potential (100 million tons), the Ramsar convention (recognizing space based approach to conservation), and UN conference on Human environment (Stockholm, 1972). USA enacted the Marine Mammal Protection act (which aggravated the Tuna-dolphin conflict) and the Peruvian anchoveta collapsed. FAO recommended a ten year moratorium on whaling. FAO recommended to lower fishing objective from F_{msy} to $F_{0.1}$.

The Indian parliament passed the Wild Life protection Act in 1972 (21 August). It is during this period India witnessed the Chipko movement which became a benchmark for socioecological movements in forest conservation. It was in 1972 two Mexican trawlers (24 m) were brought to India for deep sea fishing operations.

A major institution relevant to species conservation namely CITES (Convention on international trade in endangered species of wild fauna and flora) comes into force by 1975. Iceland and UK had the cod war for the third time after Iceland made a unilateral extension of jurisdiction to 200 nautical miles. Australia established the Great Barrier Reef Marine Park, which is considered as a reference in Marine Protected Area. By 1976 US made a major contribution through the US Fisheries Conservation and Magnuson Act, which declared prevention of overfishing and producing optimal fishery yield as a national goal.

In 1977, India declared the 200 nautical miles as the EEZ, much ahead of the adoption of the 1982 UNCLOS.

By 1980s world begin a new discourse on sustainable development along with world conservation strategy by IUCN, WWF and UNEP. The UNCLOS which is an unprecedented effort of codification of the rules relating to all aspects of the use of marine environment by man, gets adopted. The tuna –dolphin issue reach new flashpoints.

The 1980s mark a phase transition in Indian marine fishery sector. Kerala brings in the Marine Fishing Regulation Act (1980) following the national marine fishing regulations of 1978 that was enacted in the wake of the nationwide opposition to trawling. The OBM imported from Japan were demonstrated in

Alappuzha and traditional fishers went for large scale adoption of the technology. The gear conflict between mechanized and non-mechanised fishers became a huge law and order problem. Overfishing was suspected and call for conservation measures came from the unionized fish-workers belonging mainly to the non-trawler sector. The Government engages Babu Paul IAS to conduct a study and the “Report of the committee to study the need for conservation of marine fishery resources during certain seasons of the year and allied matters” is released(1982). Based on the recommendation of a series of committees The Kerala government introduced the ban of trawling during the monsoon season (1988).

During this period (1982-83) in India technology transfer for fishery development gained priority and 110 chartered and joint venture deep sea vessels brought from abroad based at Vishakhapatnam starts operations. But once the operations were limited to 80 m by the government most of these vessels left the country. In Kerala the simmering gear conflict between mechanized fishers and traditional fishers gained a violent momentum which ultimately resulted in the Government declaring annual Monsoon trawling ban through legislation. This is diligently followed by all maritime states for the last two decades.

Kerala took the lead in legislating the MLS requirement for 58 species based on the recommendation of CMFRI (Mohamed et al 2014, GoK 2017). It has also made amendments to the Marine Fishing regulation Act in 2018 and a new set of conservation-oriented regulatory rules are in place now. In a very significant and pioneering move, a three tier Council based participatory governance also has been given legislative muscle by the Kerala government.

Our Marine Biodiversity Context :

Marine Biodiversity as an indicator of the total number of species is still uncertain to the scientific community. Mora et al (2011) estimate that out of the 8.7 million eukaryotic species globally, about 2.2 million are marine. In spite of about 250 years of taxonomic research 91% of marine species await description. The total number of known species of fish is to the tune of 33,000.

(It is interesting to note that we need about 3 lakh taxonomists working for about 1200 years to describe the remaining species on Earth. The whole exercise may cost about US\$ 360 billion at an estimated cost of US\$48500 per species and the current taxonomic description rate of 6200 species per year!)

The total number of marine fish species on which we have information on the stock status globally is hardly 1000. FAO has a database for 2033 species and 4252 fisheries which yields about 80 million ton per year on average ,caught by an estimated 3.8 million fishers using about 4.6 million vessels catering to the needs of about 3 billion people (FAO2016).

According to Joshi et al (2017) India has identified a total number of 2492 marine species belonging to 941 orders and 240 families so far. In 2017, 788 marine fish species were identified in

the landings data. (of which 618 species were landed along the west coast and 592 on east coast.). A total of 16 species have pan India presence. The Fisheries Resource Assessment Division of ICAR-CMFRI has estimated 3.83 million ton of marine fish as the total landing in 2017 (FRAD,CMFRI,2018). The estimated value at landing centre level was Rs 52 431 Crores.

The IUCN Red list of threatened species defines a number of categories of threat based on the risk of extinction in the wild. They are: critically endangered (extremely high risk), endangered (very high risk), vulnerable (high risk), near-threatened (if not managed), least concern (no imminent risk), data deficient (impossible to assess) and not evaluated. The factors that decide vulnerability of a species to extinction are: population demographics, biological characteristics (body size, trophic level, life cycle, breeding structure or social structure requirements for successful reproduction) and vulnerability due to aggregating habits, natural fluctuations in population size (dimensions of time and magnitude) and residency. Vulnerable species are taxa of three types: 1) those likely to move into the endangered category if factors like overexploitation, habitat degradation, and other environmental disturbances continue to operate 2) populations that have been seriously depleted and whose ultimate security has not been assured and 3) populations that are still abundant but are under threat from severe adverse factors throughout their range.

As many as 91 species of endemic marine fishes are known to occur in the coastal waters of India. As of today, about 50 marine fishes known from India fall into the Threatened category as per the IUCN Red List, and about 45 species are Near-Threatened and already on the path to vulnerability. However, only some species (10 elasmobranchs, 10 seahorses and one grouper) are listed in Schedule I of the Wildlife (Protection) Act, 1972 of the Government of India.

It is estimated that an acre of seagrass can support 40,000 fish and 50 million invertebrates.

Biodiversity and eco-system services : the emerging Knowledge gaps

Demonising fishing so as to attribute causative and thus spatial remedial implications consequent to Biodiversity loss is a recent scientific enterprise. The controversial but high impact paper by Worm et al 2006 was interpreted by many as a (later turned out to be misguided) wake up call. The authors demonstrated through a large body of evidence that biodiversity loss greatly reduces the ecosystem services that we obtain from the oceans, and also contained an analysis projecting “the global collapse of all taxa currently fished by the mid–21st century.

This projection of global seafood collapse by 2048 resulted in huge media attention and consequent consternation among fishery science community. In an interesting review of citation patterns of the Worm paper, Trevor Branch 2010 concluded that the real intention of the authors was to emphasise biodiversity loss than the 2048 global collapse. But the authors themselves had recognized their limitations in each of their data sources, particularly the inherent problem of inferring causality from correlation in the larger scale studies.

The linkage though strongly speculated is elusive of empirical support. According to Harrison et al (2014) who reviewed 530 studies to analyse the linkage, could find only limited number of studies that have examined how biodiversity influences timber and fish production, despite the large amount of literature on the impact of best management and/or harvesting practices on wood yield/quality and the impact of fishing on fish attributes.

Tittenser et al (2010) observe that whereas land diversity patterns and their predictors are known for

numerous taxa our understanding of global marine diversity has been more limited, with recent findings revealing some striking contrasts to widely held terrestrial paradigms. After examining data on 11567 species across 13 taxa globally they found maximum diversity among coastal species in western Pacific . Spatial regression analyses revealed sea surface temperature as the only environmental predictor highly related to diversity across all 13 taxa.. Areas of high species richness were disproportionately concentrated in regions with medium or higher human impacts. Their findings indicate a fundamental role of temperature or kinetic energy in structuring cross-taxon marine biodiversity, and indicate that changes in ocean temperature, in conjunction with other human impacts, may ultimately rearrange the global distribution of life in the ocean. The methodological issues like spatial bias in such studies are being highlighted (Gonzales et al 2016)

Brief introduction to Responsible Fisheries

The concept of Responsible Fisheries is synonymous with the FAO Code of Conduct for Responsible Fisheries (CCRF). CCRF is an international instrument for fisheries management which was developed and released by Food And Agriculture Organisation (FAO) functioning under the United Nations on 31 OCTOBER 1995 after a series of international deliberations that began in 1992. More than 160 countries , including India are signatories to this international instrument which is considered as a landmark document symbolizing the international consensus achieved on the necessity for providing guidelines to ensure sustainable utilization of fisheries resources of the world. . The most salient feature of this global instrument is its voluntary nature. The Code is often referred to as the Bible of Fisheries Management.

Why the Code?

The term “Responsible Fisheries’ may evoke a doubt whether we have been irresponsible in the way we have been developing or managing our fisheries resources. In fact such a doubt is the stepping stone to understand the concept of Responsible Fisheries.

In common parlance the term “responsibility” is immediately read with the notions of rights or ownership. We tend to have a better sense of responsibility to things we own ourselves. Thus, we feel responsible in taking care of our properties or assets like land or house or vehicle. The lesser the sense of our ownership lesser will be our sense of responsibility. Thus we feel less responsible for the affairs of our ecosystem or political system because we deem them as owned by all. A property belonging to everyone tends to be nobody’s property though nobody is excluded from its utilization. This is an important point because in the case of fisheries what we are talking about is a Common Property. Or more correctly an Open access resource. An important question here is “Who actually owns the fish or who actually owns the sea? The de jure owner of the fisheries is the State or the government. That is, fish in our waters is owned by the people. But by all practical sense the fish , once caught by the fisher, becomes his or her property. If so, what about his or her sense of responsibility to ensure its conservation? It may sound a bit puzzling . That is why the Code makes it very clear in the very first article which is given under the general principles of the Code.

“ States and users of living aquatic resources should conserve aquatic eco systems. The right to fish carries with it the obligation to do so in a responsible manner so as to ensure effective conservation and management of the living aquatic resources. ” (Article 6.1).

What is in principle a property of every one, becomes the property of none in practice. This is the most fundamental challenge in scientific fisheries management. There is a notion that if a sense of ownership is assured, the likelihood of it being taken care of in a responsible manner is more. There are people who argue that it is a misplaced notion. The above-mentioned article of the Code , in fact, is a preemptive answer to this common misunderstanding.

It is for the same reason that , of the more than 230 clauses in the Code classified under 12 articles , a large number vest the responsibility with the State. This ,in a way also, helps to clear the doubts regarding the real meaning of implementing the Code.

Another doubt could be on the real meaning of the voluntary nature of the Code. Being a voluntary instrument the question could be , “Is it something like a “barking dog that seldom bites”?. The code answers this question in its fundamental philosophy called the Precautionary Approach , which is enshrined in Article 7.5.1.

“ The absence of adequate scientific information should not be used as a reason for postponing or failing to take conservation and management measures.”

In simple words what it means is “ Better safe than sorry”. It also has a deeper meaning which implies that when a person is given the license or permission or right to fish, what is being transferred is part of the stewardship obligation of the State. One needs to clearly understand this because, when individuals operate in a common property with the sole objective of making profitable livelihoods , the sustainable utilization of such a resource becomes an impossible task in the absence of mutually respected and endorsed regulations. The precautionary principle is further elaborated under the Foundations of the Code below.

Being a global guideline there is much practical sense for keeping it as a voluntary instrument too. Each nation can contextualize the code in sync with its own local realities and requirements at the same time respecting the globally agreed principles and norms. However, there are scholars who argue for making the CCRF a binding instrument given the sorry state of fisheries governance in most parts of the world.

(For details on the concept and praxis of Responsible Fisheries You are requested to refer Ramachandran et al ,2017. Shinoj P and Ramachandran,2018))

References

- Ardura Alba et al.2011. Beyond biodiversity: Fish Metagenomes. PLoS ONE 6(8):e22592:1-7
- FAO. 1995. Code of conduct for responsible fisheries. FAO Rome
- Friedman K , Garcia SM, and J Rice.2018.Mainstreaming Biodiversity in fisheries. Marine Policy/j.marpol.2018.03.001
- Garcia,SM, Rice,J and Charles A Ed.2014. Governance of marine fisheries and bio-diversity conservation: interaction and coevolution Wiley Blackwell pp 511.

- Government of Kerala 2017. Kerala gazette extraordinary GO(P) No 11/2017/F&PD dated 17 May 2017
- Gonzales A et al. 2016 Estimating local biodiversity change: a critique of papers claiming no net loss of local diversity Ecology 97 (8) 1949-60.
- Harrison et al 2014 Linkages between biodiversity attributes and ecosystem services: a systematic review. Ecosystem services (9):191-203
- Joshi KK, Thobias PA and Varsha MS. 2017. Present status of ichthyofaunal diversity of Indian seas. In: Course manual summer school on "Advanced methods for fish stock assessment and fisheries management" Lecture Note series 2/2017.CMFRI pp1-22.
- Mishra SS and Gopi KC. 2015. Diversity of Marine Fish of India | Request PDF. Available from: https://www.researchgate.net/publication/271795846_Diversity_of_Marine_Fish_of_India [accessed Sep 14 2018].
- Mohamed KS et al 2014. Minimum Legal Size (MLS) of capture to avoid growth overfishing of commercially exploited fish and shellfish species of Kerala Mar.Fish.Infor.T&E Ser (220) :3-7
- Mora Camilo et al .2011. How many species are there on Earth and in ocean? PLOS Biology 9(8):1-8.
- Ramachandran C. 2004. Teaching Not to Fi(ni)sh: A constructivist perspective on reinventing a responsible marine fisheries extension system. CMFRI, Kochi.
- Ramachandran C and Sunilkumar Mohamed. 2015. Responsible fisheries- Kerala fishers open new path in Co-Governance. Economic & Political Weekly. L No 35:16-18.
- Ramachandran C et al. 2017. Responsible fisheries - a prelude to the concept, context and praxis In Winter school on Structure and Function of the Marine Ecosystem : Fisheries. CMFRI
- Shinoj P and Ramachandran C. 2018. Marine Fishery Regulations and Policies for Conservation in India (In this Volume)
- Shinoj P and Ramachandran 2017. Taming the Fishing Blues: On reforming the Marine fishery regulatory regime in India EPW LII (45):73-81.
- Tittensor et al 2010. Global patterns and predictors of marine biodiversity across taxa. Nature 466.1091-1101