

The Status of Fisheries Science in India

- Including results of certain field developments, the results of application of innovations resulting from fisheries science work

V. SRIRAMACHANDRA MURTY²

Focal Points at a Glance: The author, in this contribution, narrates how core fisheries science has lost its sheen and why, as implemented, it could be detrimental. He further brings out points in favour of streamlining of fisheries research in India through non-overlap of research goals. An informative write-up.

"The student of fishery science should have knowledge of what fish populations are— how they wax and wane in abundance — how one goes about determining their size and their reaction to exploitation — before he delves into the particular. This approach is by analysis rather than synthesis, in keeping with the best traditions of fishery science which has developed largely in the field, not in the laboratory. A fish population — like a swarm of bees — is as much a biological entity as the individuals that compose it. In beginning with populations one comes to realize the need for, and use of, much of the more detailed material that follows. The age of fish for example is of great value in making accurate estimates of population size". (Rounsefell and Everhart, 1953:2)

I. INTRODUCTION

According to the Chambers Twentieth Century Dictionary (Geddie, 1968), the term "Fishery" means the "business of catching fish". This business of catching fish ranges from a mere subsistence activity to that of a gigantic industrial activity with significant impact on social, economic, livelihood, environment, food and other cognate areas. Fish stocks (Fish,

according to the Dictionary also means "any exclusively aquatic animal", not merely a finfish) are influenced by fishing, the variations in the characteristics of the aquatic environment (algal blooms, rainfall in the sea and on land, river discharge, hydrographic conditions, productivity, production, floods, currents, upwelling and others) and the others like pollution/oil spill, oil prospecting, constructions, and others.

According to FAO (1999), 'Fishery' means "1) The sum (or range) of all fishing activities on a given resource (e.g. a hake fishery or shrimp fishery). It may also refer to the activities of a single type or style of fishing (e.g. beach seine fishery or trawl fishery). The fishery can be artisanal, or/and industrial, commercial, subsistence, and recreational, and can be annual or seasonal."

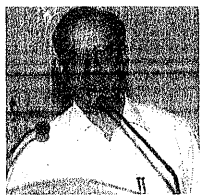
"2) Activity of catching fish, from one or more stocks of fish, that can be treated as a unit for purposes of conservation and management and that is identified on the basis of geographic, scientific, technical, recreational, social or economic characteristics, and/or method of catch."

"Fishery management" according to FAO means "The integrated process of information gathering, analysis, planning, decision-making, allocation of resources and formulation and enforcement of

fishery regulations by which the fishery management authority controls the present and future behaviour of interested parties in the fisheries, in order to ensure the continued productivity of the living resources". And,

"Fishing" means "Any activity, other than scientific research conducted by a scientific research vessel, that involves the catching, taking, or harvesting of fish; or any attempt to do so; or any activity that can reasonably be expected to result in the catching, taking, or harvesting of fish and any operations at sea in support of it" (p.107)

To understand the dynamics of exploited populations, knowledge of their taxonomy and biology, the aquatic environment and the ecosystems is very important. Besides, knowledge on fishing gear technology, the fishing effort, the species wise and gear wise landing statistics is also essential for studying population dynamics. Broadly, making an integrated study of all these component subjects and then assessing the stock sizes of each species to offer advice and a range of options to the government for taking informed decisions on development and management, constitutes what is known as Fishery Science. The Government of India,



¹This article is based on the author's experience of working in the CMFRI, the published work, the websites of some ministries, departments in the central and state governments, and some data supplied by the Director, CMFRI, Kochi. The author is thankful to Dr. A. Gopalakrishnan, Director CMFRI, Kochi for promptly supplying the data. The author is grateful to Dr P. Vedavyasa Rao former ly Director of CMFRI Kochi, for review of the MS and for the comments.

Though the objective is to deal with the status of Fishery Science in general terms, the article deals predominantly with marine fisheries examples, because of the experience of the author in marine fisheries research for nearly four decades; it is believed to make little difference any way.

² Formerly, Head, Demersal Fisheries Division, Central Marine Fisheries Research Institute, Kochi. The views expressed by the author in this article are solely his personal and do not necessarily reflect the views of the organisations he served or the Journal publishing this article.

Postal Address: E-102, Shriram Sahana, Dodballapur Main Road, Suryavamsi Layout, Yelahanka, Bengaluru 560064)

E-Mail: murtybangalore@gmail.com

Ministry of Statistics and Programme Implementation (Anon. 2011), adopted the above definitions.

Globally, fisheries have grown substantially over the past half century, contributing significantly to fish food security, national economy, livelihood security, employment generation and several others. Fishery science also has grown in the form of development of models, methodologies, simple methods to assess the stocks and computer software packages to process the data and fit complicated equations. In spite of such a growth during this period, Fishery Science is still largely not appreciated in India. This concern was earlier expressed in a subtle manner by the CMFRI in the Vision 2020 (CMFRI, 1997) document by stating "There is also a lack of appreciation of the value of research in capture fisheries as the most important tool in fisheries management, sustained production and conservation (p. 30) and "There is a genuine feeling that Fisheries Science, in contrast to Agriculture and Animal Sciences, in the ARS system of ICAR is stagnating..." (p. 32). A similar concern was expressed by the present author by stating that "adequate attention was not paid to this area of research [capture fisheries] and also to those who were pursuing it. I would even say that this area of science was looked down upon." Moreover, "Though I continued in capture fisheries and have been putting arguments in its favour in different high level meetings, I have been nursing the pain for the total lack of appreciation and recognition for it" (Murty, 2007, p. 66). Gulland (1983), an expert in fish population dynamics, stated:

"In fisheries it is the fashion now among administrators and scientists to talk a lot about stock assessment, and how important it is. This importance is often better recognised in words than in practice. Adequate support is often not given to scientific research; when support exists, the research actually carried out may not be well directed towards the more important problems, and when good research is done it is often not properly used. This is largely due to lack of understanding – of why stock assessment is done, how it is done, and how the results are used. The last is the most important. Once the policy makers in national

fishery administrations (and also in the fishing industry) appreciate how useful, indeed vital, is the advice that can come from stock assessment studies, to the decisions they have to take, then they will see that stock assessment studies are done. They will also see that they are done in an effective and relevant way." (p. 1)

Looking at the way the Fishery Science has been treated and is being treated now in India it is feared that this science would never get its status amply recognised in the country! This is the situation, one feels forlorn to note, in spite of completing 67 years of organised fisheries R & D in the country. The most throbbing thing is that even some of those responsible for fisheries policy seem to be offering little or no recognition to Fishery Science. The fact that a fisheries research institute established in the year 1947, has an "Agricultural Economics Section" even in 2014, instead of a 'Fisheries Economics Section' speaks about the recognition that the Fishery Science enjoys. Having completed nearly half a century of association with Indian Fisheries including nearly four decades of working in marine fisheries research, and having seen, heard/listened to and spoken to several people – politicians, bureaucrats, fisheries scientists, fisheries administrators, fisheries managers, fisheries research administrators, fish business persons, international organisations, fisher folk and a host of others connected to fisheries and Fishery Science and also teachers of Fishery Science in universities, the author feels it his erudite responsibility to record some of his comprehensions along with his concerns on what he feels are important to Fishery Science, Fisheries Scientists and Fisheries Research Institutes in this country, though for historical reasons, he does not expect any change immediately.

II. THE BEGINNING

The beginning for a nonspecialised/ generalised treatment to fisheries was made long ago when it was made a part of the Ministry of Agriculture and adding different activities to different other ministries later on as shown below. Of course at that time Fishery Science was not known/understood by many including a large number of Fisheries Research Officers. This is mainly because "Fisheries Research is a comparatively recent development in the scientific research activity of the nation." (Jones, 1958, p.1). Fishery Science was not taught in the Universities/Colleges, degrees in Fishery

Science were not awarded, organised fisheries research was initiated only in 1947, real fisheries experts were not available in the country and, more than anything else fisheries itself was not developed being just at a subsistence level and there was little appreciation for research support to fisheries development. Nevertheless the statement of Dr S. Jones (Jones, 1958, p. 1):

"The need to take up research as a responsibility of the Centre so that the fishing industry could be fostered and developed along modern lines was realised as recently as during Second World War when the whole country suffered very acute shortage of food"

Clearly reveals that fisheries research was initiated in this country to help increase yield from the wild stocks. In the beginning the main thrust of research was biology (growth, reproduction, food and feeding habits and length composition of catch). Subsequently, the research was directed towards understanding population dynamics and managing exploited resources. India today has experts in Fishery Science capable of effectively addressing any R & D issue in tropical fisheries with authority and success, but sadly the subject has still not received recognition as an important science in the country.

III. MULTIMINISTERIAL JURISDICTION

In India, Fisheries (development, conservation, trade and research) as a whole is dealt by seven central ministries with their institutions. While the nodal ministry for fisheries at the center is the Ministry of Agriculture (with the Department of Animal Husbandry, Dairying and Fisheries), all the other ministries involved, also carry out quite some fisheries related work. The various ministries and organisations are listed hereunder only to show the colossal volume of fisheries work carried out in the country by different departments though it is well-known.

A. Development/ Management/Trade/ Administration

I. CENTRAL GOVERNMENT:

1. THE MINISTRY OF AGRICULTURE WITH THE DEPARTMENT OF ANIMAL HUSBANDRY, DAIRYING AND FISHERIES WITH INSTITUTES:

- Central Institute of Fisheries Nautical & Engineering Training (CIFNET)
- Central Institute of Coastal Engineering for Fishery (CICEF)



- Fishery Survey of India (FSI)
- National Institute of Fishers Post Harvest Technology and Training, Cochin (NIFPHATT)
- Coastal Aquaculture Authority (CAA)
- National Fisheries Development Board (NFDB), and a number of other activities.

2. MINISTRY OF ENVIRONMENT, FORESTS AND CLIMATE CHANGE (MOEFCC):

- Zoological Survey of India-Surveys, Taxonomy
- The Wildlife (Protection) Act, 1972 (53 of 1972)
- The Environment (Protection), Act, 1986 (29 of 1986)
- Biosphere reserve programme, biodiversity conservation
- Wildlife Institute of India

3. MINISTRY OF EARTH SCIENCES

- Centre for Marine Living Resources & Ecology (CMLRE)
- Integrated Coastal and Marine Area Management Project Directorate (ICMAAM)
- National Institute of Ocean Technology (NIOT)
- Indian National Centre for Ocean Information Services (INCOIS)

4. Ministry of Commerce and Industry

- The Marine Products Export Development Authority (MPEDA/ RGCA)

5. MINISTRY OF FOOD PROCESSING INDUSTRIES:

- National fish processing development council
- Technology upgradation/modernisation of fish processing units

6. MINISTRY OF SCIENCE AND TECHNOLOGY

- The Department of Biotechnology,
- Council of scientific and industrial research
 - National Institute of Oceanography (NIO)
 - Central Salt and Marine Chemicals Research Institute (CSMCRI)

7. MINISTRY OF DEFENSE

- Coast Guard-MCS

II. STATE GOVERNMENTS

- Ministries of Fisheries in each state

B. Research/Education/Training

1. ICAR (DEPARTMENT OF AGRICULTURAL RESEARCH AND EDUCATION - MINISTRY OF AGRICULTURE, GOVERNMENT OF INDIA)

The second major decision in giving nonspecialised treatment to fisheries science was taken when the then existing Fisheries Research Institutes in the central Government (under the then ministry of Food and Agriculture) were transferred to the Indian Council of Agricultural Research. The Department of Agricultural Research and Education (DARE) coordinates and promotes agricultural research & education in the country. DARE provides the necessary government linkages for the Indian Council of Agricultural Research (ICAR), the premier research organization for coordinating, guiding and managing research and education in agriculture including horticulture, fisheries and animal sciences in the entire country. Under the ICAR, there are five research institutes, one deemed university, one bureau and one directorate besides three network/outreach programmes as shown below in the Fishery Science:

- Central Institute of Fisheries Education (CIFE), Mumbai
- Central Inland Fisheries Research Institute (CIFRI), Barrackpore
- Central Institute Brackish water Aquaculture (CIBA), Chennai
- Central Institute of Fisheries Technology, (CIFT), Kochi
- Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar
- Central Marine Fisheries Research Institute (CMFRI), Kochi
- National Bureau of Fish Genetic Resources (NBFGR), Lucknow
- Directorate of Cold Water Fisheries Research, Bhimtal, Nainital

Besides, there are a few institutes of the ICAR like the Central Agricultural Research Institute (CARI) and ICAR Research Complexes in different places to offer research and development support to local/area-specific fisheries problems.

2. CENTRAL AND STATE AGRICULTURAL UNIVERSITIES

- Central Institute of Fisheries Education, Mumbai-Deemed

University of the ICAR

- Central Agricultural University, Iroisemba, Imphal, Manipur
- Central/State Agricultural Universities

IV. IMPACT OF MULTIMINISTERIAL JURISDICTION—SOME EXAMPLES

The multitude of institutions/organisations/departments under different ministries as mentioned above, with their different objectives, the fishery Science is addressed by different ministries departments rather independently. There is a great possibility for the objectives/mandate or part of it to be overlapping in different ministries/departments resulting in duplication of effort. While effort duplication is not quite undesirable always, such a dispensation will force the concerned ministry/department to take decisions on the basis of their mandate/objective/priorities independently and such decisions can be in conflict with the work in the same subject of another ministry/department or duplicate the work or the decisions so taken may not be implementable for various reasons, political, administrative and so on. It is also possible that a multimministerial dispensation can lead to avoidable and unnecessary expenditure. Some examples are described below.

1. Conflicting Decision: The Department of Animal Husbandry Dairying and Fisheries, under the Ministry of Agriculture, Government of India is the nodal department for fisheries development and management in the Indian Exclusive Zone, beyond the area of territorial waters. The Ministry of Environment Forests and Climate Change has the mandate on ecosystems in coastal areas and on wild life protection. In July 2001, this ministry placed all elasmobranchs (sharks, skates and rays) under schedule I of the wildlife (protection) act 1972 and banned fishing of elasmobranchs and a few other related activities, which has led to wide-spread resentment in the industry and government organizations like the MPEDA because the export industry procured material could not be exported (e.g. shark fins). The ban was also impracticable as fishing could not exclude the elasmobranchs (selective fishing in the context of fishing with trawlers for example). The nodal ministry dealing with fisheries apparently had no role in this. This forced the environment ministry to reconsider the decision. Consequently, a meeting of all the stakeholders was called by the Ministry of Environment and Forests in which this author also participated as the



representative of the CMFRI and made a comprehensive presentation showing that 1) the basis for the ban on elasmobranch fishing was not strong etc. 2) adequate scientific data were not available to take informed decisions 3) as long as the neighboring countries (Pakistan, Bangladesh, Sri Lanka) continue to exploit these resources, the ban by India alone would not help conserve the resources and bringing out a great need for a comprehensive research on elasmobranch fisheries of India. What the ministry did later is not important in the context, but, such conflicts/disturbances would not occur if there were consultations in the beginning between all the stakeholders or if all the fisheries activities are controlled by one ministry. This is believed to be due to fisheries being the multiministerial responsibility without proper mechanism for coordination or even when such a mechanism is available on paper that may not be working as envisaged.

2. Jurisdiction of Governments: In India, at the level of States, the State agricultural universities with colleges of fisheries, some general universities and State fisheries departments carry out R & D in fisheries of local importance/relevance. Fisheries is in the concurrent list and hence fisheries development and management are with the State governments. In the case of marine fisheries, the region from the shore to 12 nautical miles (territorial waters) is in the domain of the concerned state government and therefore all development and management rights are with the concerned State governments. The area beyond the territorial waters and up to and beyond the exclusive economic zone is within the purview of the central government (See Silas, 2003). There is thus a sort of diarchy. The country is living with this arrangement—a tough one indeed—ever since, in spite of the problems but no attempt seems to have been made to correct this for better and more efficient mechanism of development and management. A large number of resources are exploited both in the territorial waters and also beyond the territorial waters in the EEZ and it is unrealistic even to think of different management regimes for the resources on the ground that they are under the control of different governments, leave alone, actually managing them by different governments. According to Rounsefell and Everhart (1953):

"In managing a particular fishery it is essential to know whether the catch comes from one population or perhaps from

several. When the entire fishery depends wholly on one stock of fish it will be affected by the quantities caught in any one locality. If on the contrary the stocks of fish are local in their distribution, each must be treated as a separate unit, and it becomes possible to reduce the numbers of fish in one locality greatly without affecting them elsewhere". (p. 52).

The situation can become even more challenging and 'dangerous' as the species exploited in two neighbouring maritime states belong to the same stock as assumed/accepted as of now (or at least there is no evidence to show that the populations in the two regions represent two different stocks) but the managements can go in opposite directions because of political/economic or jurisdictional or other considerations/compulsions. It must be remembered that the impact of any change (over- or underexploitation or indiscriminate and excessive exploitation of spawners as happened in the case of catfish, indiscriminate juvenile exploitation as happens in certain fishes along the SW coast; see DAHD, 2005) in one region is automatically felt in the other region in case the population under consideration belongs to one unit stock. Under the Indian conditions, if the political party ruling a maritime state and the one ruling at the center are different or if the neighboring states are ruled by Governments headed by different political parties, it is likely that the development and management of marine fisheries gets into crisis. There are certain issues like pollution affecting fisheries in coastal waters, multiday/distant water fishing, capture and culture fisheries in coastal waters, sharing of resources by different sectors, seasonal ban on fishing and so on which all involve different ministries/governments. Moreover demarcation of international maritime boundaries involve defense, external affairs, home and agriculture ministries. It is due to this that Silas (2003) felt that "there is an imperative need for promulgating a new Fisheries Act" (p 503).

3. Marine Fish Landing Statistics : Historically, the collection of marine fisheries statistics and estimation of landings and effort are made by the Central Marine Fisheries Research Institute (CMFRI), which was recognised as the nodal institute for the purpose (Silas *et al.*, 1984). This Institute has developed the Stratified Multistage Random Sampling Scheme

and has been collecting the statistics and making estimates of marine fish landings from all along the country's coast on a gearwise, district/statewise, species/groupwise basis almost right from its inception. This is primarily done as a support system to implement the research projects of the institute under capture fisheries — to study the population dynamics of exploited species, suggest the maximum sustainable yield and the fishing effort required for the same, to estimate potential yield in the country's EEZ and so on. The methodology adopted by the institute is recognised as the best under the existing conditions and the estimates made are acknowledged as the most reliable. These data are used by the central and State governments as the official marine fisheries statistics for taking policy decisions right from the time of independence and the international organisations like the FAO were using these statistics for various purposes regularly and continuously. The CMFRI has been furnishing this data to the State governments, different departments of the central government and other user agencies for purpose of taking informed decisions on development and for carrying out research etc.

This arrangement was going on uninterrupted/unquestioned for a very long time (over forty years) till perhaps, around 1990, when the maritime state governments ostensibly, wanted to take over the responsibility for themselves. The concerned State governments perhaps were under the impression that there was no specialisation involved in this work and that they could go ahead with the programme without any hassles and with certain political/developmental mileage accruing to them. However, in addition to being a highly specialised one, this scientific work is resource intensive involving heavy expenditure; indeed, an amount of Rs 65 crores was provided for meeting the expenditure on Strengthening of Database & Geographical Information System of the Fisheries Sector during the 12th plan period by the central government; (see DAHDF, 2014). In any case, the CMFRI was asked to stop this work with immediate effect probably being under the wrong impression that the Institute was doing this work *only* to provide data to the other organisations and State governments. The most important point here is that there was no recognition to the fact that the CMFRI being a research institute having responsibility over the entire nation, was doing this work as a part of their own research project work and it is only by



the way, offering the data to the ministries/departments of the central and state governments and that the institute has all the expertise, facilities and budget to perform the task. Fortunately, the CMFRI took a decision to continue the work undisturbed because the output of this work constitutes the most important input for several research projects of the Institute and they cannot afford to depend upon the data generated by the state governments for research purposes. Interestingly, it is now understood that the governments were still unable to handle this programme satisfactorily in spite of completing about a quarter century of taking over the work. The working group constituted by the Planning Commission on Development and Management of Fisheries and Aquaculture during the 12th plan (Planning Commission, 2012) is of the view that the Departments of Fisheries in the States

“... over the years have diluted their attention on data gathering, resulting in poor data quality as also time lag in providing the information. On the other hand, CMFRI has been continuing with its data collection programme, which unlike the DoF information is more robust and is carried out systematically following standard methodology. Further, CMFRI being a national institute with international repute, has the wherewithal to improvise, tweak, streamline and regularize the information flow on scientifically established norms as and when required”. (p.97). And, “The CMFRI, as a specialized research agency focusing on R&D needs of the country, which no other agency in the country can perform, has always been basing its assessment investigations on the precise data assiduously collected by it. (p.98).

The CMFRI has been doing the work since its inception very satisfactorily and supporting all those who needed the data; it could have been in the fitness of things to continue the practice but because of the opportunity for diarchy is available in the law, understandably the governments took decisions against utilising the data of CMFRI resulting in confusion, unnecessary expenditure etc. If suitable legislations were made this would not have happened. Fishery resources by their very nature, unlike any other resource on land require a different approach for management and development. It is therefore desirable, to make separate laws to govern utilisation

of and implementation of all other activities related to aquatic resources.

While it is simply not correct even to attempt to partition the marine living resources on the basis of land-based boundaries and manage the marine fisheries through convenience-based governance, the need for correcting the age-old arrangement by bringing all marine fisheries-based management under the control of central government or a consortium of State governments to be decided after thorough debate/deliberations and through proper legislations, is imminent. It is important to acknowledge that the approach is only to facilitate effective and controversy-free management by one single agency/organisation and the States should not be under the view that their right is taken away. The marine fisheries otherwise, cannot be managed proficiently and successfully. It is in this context that the creation of full ministry of fisheries at the center becomes more critical though in that case also the same problems/issues are likely to persist if proper caution is not exercised. Parallels should not be drawn between fisheries and other subjects like agriculture and animal husbandry for the simple reason that the fisheries resources are aquatic and require a very different and specialised approach. Fisheries, particularly marine fisheries is a unique subject and therefore requires a different treatment from that of agriculture for example; it is important that the central government with the help of State governments brings out suitable policy and legislations at the earliest. In any case it must be accepted that development of the sector is of fundamental significance, however much the fisheries decisions would be preferred to be influenced by political/administrative considerations/compulsions.

V. FISHERY SCIENCE- THE PERCEPTIONS

A. Fishery Science—the perceptions

Certain scientific organizations, Science Academies and concerned agencies have their own perceptions which form the basis for assessment/evaluation of the research work of individual Scientists for conferring Awards, Fellowships or for sanctioning research grants and such others. For instance there are cases of treating subjects like fish nutrition, fish pathology, fish biotechnology, fish genetics, fish processing technology and aquatic animal health under the major area of

Fishery Science without even mentioning fishery biology, fish stock assessment/population dynamics, survey and assessment of fisheries resources under the same major area. Interestingly many of those subjects included under the area of “Fisheries Sciences” as mentioned above cannot indeed be treated as part of or constituting Fishery Science (see the description/definitions given at the very beginning). What is the result of this action? The contributions in biology, fish stock assessment, survey and assessment of resources made by well-designed experiments, conscientious field data collection and researches over protracted periods in Fishery Science and achieving most useful and reliable results for taking most informed decisions for development/management of fisheries and more than anything else embrace the real fisheries science, have not been receiving recognition. An excellent example in this respect is given here: during the early nineties the CMFRI made a concerted effort to process the data collected in its research projects during the previous 5-10 years till 1988, on major exploited resources of finfish, crustaceans and molluscs and published the results in three special numbers of the *Indian Journal of Fisheries* (Vol. 39 and 40) in a total of 28 scientific papers covering 49 species which together constitute a major portion of the totalexploited marine fishery resources. This was a classical work of the kind never done before in the country or even in the region. These papers on the whole gave the status of the exploited stocks and the management measures required to achieve sustainable yields. However the organisation or the scientists responsible for that did not receive any appreciation/award/recognition for such an exciting and valuable contribution. It must be noted that the work mentioned above constituted a major research effort by a national marine fisheries laboratory in the country. As mentioned elsewhere in this article, the importance/outcome of research in Fishery Science is treated in a rather routine manner. Incidentally, in spite of nearly a quarter century having passed since the the completion of the above mentioned study, attempts do not seem to have been made to examine the data collected subsequently and bring out updated reports on the status of the exploited stocks. It is only this type of attitude/management that has led to the very poor recognition to Fishery Science in India and to the persons pursuing it. In certain instances scientists working in Fishery Science have even ‘migrated’ to aquaculture apparently in search of

better recognition to them and their work. It needs to be acknowledged that the work for example on Nervous system, Osteology, Genetics, Anatomy, Biochemistry or Physiology of 'fish' do not constitute work in Fishery Science.

A very prominent Science Academy in India conferred Fellowships on certain scientists for their contributions in "Fisheries Sciences". From the given specialisations of the Fellows, one will notice that *all* those recognised for the fellowship made outstanding contributions in very important areas such as genomics, genetics, molecular genetics, DNA barcoding, marine biotechnology, fish culture, aquatic microbiology, larviculture, fish processing technology, biochemistry, food technology, aquaculture management, pathology, toxins, nutrition, endocrinology, physiology, alien species and/or freshwater and brackish water aquaculture. The most incredible revelation, however, is that even one expert of Fishery Science is not found in the list of those recognised, though all those recognised so far were stated to be in the area of "Fisheries Sciences". Hence a very pertinent question crops up - is it that this country did/does not have even one scientist who had/has contributed to Fishery Science/capture fisheries research significantly till now so as to receive recognition from a scientific organisation/science academy or some such agency? If the answer is yes, is it not high time to take a review of the situation with regard to this area of research being carried out in the national laboratories and the fisheries colleges of the agricultural universities and take steps to 'correct' the state of affairs immediately to be able to produce 'quality research' in this area at least from now on? Moreover, is it not true that one finds it difficult/impossible to comprehend how the Government and the industry took initiatives and policy decisions all these years for fisheries development to attain the status it enjoys today, how the marine fish production in India for example grew from about 50,000 tonnes in the early fifties to the 3.93 million tons in 2012 (see CMFRI, 2014), how important management measures like seasonal closure of fisheries during monsoon were formulated and implemented, how the deep-sea fishing policy was formulated, how potential yield estimates were made, how stock sizes of certain unexploited resources were estimated, how certain regulatory measures were formulated for implementation, how some excellent taxonomic revisions were made, how several other initiatives were taken and more than anything else how the multimillion dollar fishery industry stands

where it is today contributing significantly to export market and national economy and livelihoods without adequate research contributions? This author is aware of and strongly believes, however, that there are quite a good number of scientists who made really outstanding contributions in the area of Fishery Science in the subjects of Taxonomy, Biology, stock assessment of species of several families of finfish and shellfish, survey and assessment, fishery environment, design and development of suitable fishing gear and others which have helped the government take appropriate and informed decisions for development, management, education, training etc. At the end of it one realises that the government and the industry became the beneficiaries of the research in Fishery Science but the 'poor fishery scientists' who contributed for all the developments with their research support, became the victims of circumstances—the lack of recognition for their contribution to Fishery Science which is largely due to the ostensible lack of understanding of what fishery science is (also see Gulland, 1983) or because there is no interest in the subject due its perceived lack of 'attraction'. It is sad that only aquaculture and its related subjects including fish processing technology are recognised as constituting Fishery Science as shown above but the work done in biology, stock assessment, survey and assessment of resources, taxonomy, biodiversity, fishery environment, fishing gear technology have not been considered under Fishery Science. It is believed necessary that the concerned organisations/agencies review the situation and take suitable action to get the most appropriate definition of Fishery Science and Aquaculture while attempting to measure performances of people, institutions and so on. After all there is great sense of doing justice or fulfilling the responsibility in the most desirable/appropriate manner if the merits/performances of people/institutions are assessed considering comparable attributes. One wonders how one can realistically compare a work on taxonomic revision of a family of fishes represented by 30 nominal genera and 75 nominal species or another work on a national basis on stock assessment of certain species representing 75% of total landing for example with that of a work in aquatic animal health or fish genetics?

B. Issues of Visibility

Another factor, indeed the most important, that is responsible for the lack of recognition to Fishery Science appears to be the issue of 'visibility' because it

cannot produce 'eye-catching' or 'attractive' results. It can only give the status of the exploited stocks with reference to exploitation, advice on increase or decrease of fishing effort, regulation of gear/mesh, fishing ban during certain season/s like peak spawning period, control of fishing in certain grounds where brooders/juveniles are abundant and a few others. These are only useful to take policy/management decisions and therefore fail to attract the attention of politicians or administrators who may be looking for "success stories" in regard to increased production and development of new variety/breed and so on. Moreover, in the case of research in Fishery Science, the results/recommendations need to be translated into policy after duly consulting all the stake holders, as the decisions are likely to affect the people/the fisher folk/the biodiversity/the resources/the export market/the state or national economy and several others. The fishery resources are renewable and therefore the fisheries decisions are influenced by issues such as social, political, economic, livelihood, environmental and others to ensure sustainability and protect livelihoods. Hence there is considerable time lag before decisions are taken unlike in agriculture/aquaculture. Occasionally any decision may not also be taken even when the scientific data warrant one, due for example to socio-political-economic compulsions as in the case of operation of certain nets in inshore waters along the south west coast or other compulsions, as in the case of mesh size, effort of commercial trawlers and so on (see DAHDF, 2005). The fishery management decisions are principally made by considering socio-political priorities and socioeconomic conditions and even the best, most reliable and desirable scientific advice may receive consideration/attention only after the political or rather the non-fisheries considerations are met. Similarly, development decision/implementation of the recommendations is delayed presumably because of certain above-mentioned reasons. Under certain socioeconomic or sociopolitical situations the accomplishments of a well-planned and implemented research programme may not lead to implementation by the governments leading to a situation where even the most outstanding scientific work gets into crisis of credibility! It has to be realized that unless the inherent value of a work/achievement is recognized and rewarded the Fishery Science in India will continue to stagnate and quality talent may not enter the field. And the nation



would face in future a situation of total lack of expert scientists to address real fisheries issues when they are likely to become more serious and critical due to changing conditions. One should not lose sight of what the negligence to taxonomy research has caused to the nation when it became most essential for addressing the issues of for example aquatic biodiversity. It is worthwhile to quote:

"Although management difficulties often stem from unrealistic visions of 'managing' marine resources in dynamic ocean systems, with biological goals compromised by political, economic and social considerations, the failure of fisheries science and scientific institutions to provide adequate stock information upon which to base management must be acknowledged" (Finlayson, 1994; Walters and Maguire, 1996, as cited by Rose, G. A. 1997).

VI. INSTITUTIONS AND SPECIALISATIONS

1. Aquaculture Research

By around the beginning of seventies, the shrimp aquaculture started growing very fast and the industry was even getting the expertise from outside the country. Almost around this period, the then existing fisheries research institutes of ICAR diverted a major part of their research effort to aquaculture because of the fast growing export market mainly for penaeid shrimps. Naturally, the CMFRI which has the mandate of research in marine organisms was within its right to implement research programmes in shrimp culture and CIFRI was also within its right to do the same work in brackish water ponds since this region was under that Institute's mandate.

With the increased attention to coastal and brackish water aquaculture and considering the major research work conducted in freshwater aquaculture at the then CIFRI, the ICAR decided to provide focused attention to aquaculture sector. Consequently two new research institutes (CIFA and CIBA) separately for freshwater and brackish water aquaculture were established by drawing personnel and also certain programmes from CIFRI and CMFRI.

The mandate of CIBA affords the Institute to select any species that can tolerate wide ranges of salinity, thrive in

brackish water environment and fulfil the requirements of cultivable species. There are primarily marine and primarily freshwater organisms some of which tolerate wide range of salinities and therefore are distributed in the estuaries also at different levels (regions of confluence of rivers and seas and showing gradient in salinity depending upon the proximity to rivers or seas) of salinity. It is for this reason, this author believes that any species, irrespective of whether it is a freshwater or marine species, can be taken to develop technologies for culture in brackish water by the CIBA. This is the reason why, seemingly, the CIBA earlier worked on a species of grouper (which is primarily marine and lives in deep seas extending up to 150m depth in coralline/rocky regions and reproduces in the sea and grows there) whereas the CMFRI has a major research programme on grouper aquaculture. Of course the CIBA conducts research on milkfish, mullet, pearl spot, Asian Seabass, some ornamental species like *Scatophagus argus* and achieved success in many areas.

Presently the CIBA has another marine fish species (*Cobia-Rachycentron canadum*, see annual report, CIBA, 2014) on the list of species studied by the Institute; the CIBA states:

"Regarding finfishes, Cobia appears to be a very promising species looking into its tremendous potential for growth. We are in the process of looking into various aspects of this species so that the farmer can culture this with confidence. The pearlspot is another fish which is being experimented upon for seed production and culture" (CIBA, 2014; p. 5-6)

Interestingly, the CMFRI has a major research programme on cobia culture and made significant progress in breeding, larval production and culture. However, despite establishing separate institutes, the ICAR research institutes (CMFRI, CIBA, and CIFRI) work in same or similar projects or work on same species as revealed by the Institutes' reports. Added to this, certain organisations in other ministries also have overlap in the mandate/research programmes of these institutes as can be seen for example from the programmes of the Marine Products Export Development Authority (MPEDA). The MPEDA under the control of the Ministry of Commerce and Industry has R & D programmes in "promotion of aquaculture for production of shrimp and prawn for

export, promotion of Tuna fishery, implementation of organic farming and conservation and management" in addition to its major mandate of export promotion. To fulfil its mandate in aquaculture research and development, the MPEDA has established the Rajiv Gandhi Center for Aquaculture (RGCA) with centres at different places in the country including Andamans. The CIBA and RGCA work under different ministries of the Government of India doing more or less the same work. The RGCA is governed by an Executive Committee of which the Director CIBA is a member along with members from different central and State government organisations. The "Technical/Scientific programmes involved in implementing various projects of RGCA are conceptualized and finalized" by a Scientific Advisory Committee, which has, among others, the Deputy Director-General Fisheries ICAR, some senior level scientists of the CIBA and others as the members (see <http://www.rgca.org.in/aboutus.php>). Besides, the CIBA and RGCA have research projects in cobia culture, a marine species, though another institute, the CMFRI has already worked in the breeding and seed production of this species. Earlier the CIBA worked on grouper, a marine fish species but seems to have dropped it later. The RGCA implements grouper aquaculture from Andamans. The CMFRI however is continuing research on this species also and achieved breakthrough in breeding and seed production.

It is thus clear that certain research institutes under the government of India/ICAR are working on the same species simultaneously for aquaculture development. These organisations have to implement projects without duplication or have to work together with consultations and if necessary sharing the facilities. It is most desirable however that these organisations should grow with their individual specialisations, and grow into centers of excellence in those subject areas. But who will decide?

2. Fishery Resources Assessment and Database Development

a. ICAR Research Institutes: The country is blessed with 55 estuaries spread over an estimated area of 300, 00, 00 ha (Jha *et al.* 2008), a significant part of it supporting brackish water fisheries with the productivity ranging from 45 to 75 kg/ha and offering livelihood opportunities to a large number of people and it is desirable that adequate research support is offered to this area also. The Indian estuaries

support fisheries of stocks like hilsa, mullets, prawns, crabs etc., with high market demand, fetching good return to the fishers (Jha *et al.*, 2008).

The CIBA has the mandate "To act as a repository of information on brackish water fishery resources with a systematic database" (CIBA, 2014, p. 18) but being a research institute primarily on brackish water aquaculture the institute needs to develop separate and additional manpower to undertake this programme. Resources data collection, estimation of yield and related aspects constitute another specialised area – the Fishery Science and therefore need to have separate manpower exclusively meant for this. Moreover, it is believed that a research institute in brackish water aquaculture has to be mandated to do only aquaculture research so that the institute will grow in that direction, offering research support to any problem/issue on coastal/brackishwater aquaculture nationally. Hence, there is need to transfer the work pertaining to "information on brackish water fishery resources with a systematic database" to another institute dealing with and has the expertise in that subject. The CIFRI is collecting data from Sunderbans on mangrove plants and fishery of important species like Bombay-duck and also attempting to study the biodiversity in the region conforming to their mandate (see CIFRI, 2014) because the institute is specialised in fishery science and has all the expertise required to implement research projects.

The CMFRI, is a premier research institute of great reputation and recognition for their contributions and expertise not only in India but in the world particularly in the Indo-west Pacific Region. The Institute was principally established to help increase marine fish production through research in capture fisheries (Jones, 1958). The research initially was totally focused to address the Fishery Science and many contributions of great scientific value to the capture fisheries and biodiversity were made. By the beginning of seventies, the Institute diverted major research effort to 'mariculture' starting with penaeid shrimps, pearl oyster, moving to mussel, edible oyster, clams, sacred chank, finfish (grouper, mullet, pearlspot and others), seaweeds and a few others. This mariculture effort lead to the development of various technologies and the impact on increased production can be seen in a large volume of beautiful publications. Indeed this effort also led to HRD in Mariculture – a large number

of postgraduates and doctorates in mariculture were produced. The publications, newsletters etc. from the Institute in recent times take one to believe that CMFRI has major focus on mariculture. The mariculture division of the CMFRI has more than 25% of the scientists and the biotechnology division which implements research programmes relating to mariculture has 9.1% of the scientists of the Institute. Thus more than one third of the scientists of the Institute (38 out of 110 available) is engaged in mariculture research. There may be even some more involved in areas like extension research and others from other divisions and the remaining scientists are shared by 8 other scientific divisions. The type of facilities and infrastructure developed at Mandapam and certain other centres bear eloquent testimony to the importance accorded to mariculture at the Institute. This 'tilting' towards mariculture appears to be primarily due to the fact that capture fisheries research in addition to 'suffering' from lack of support/recognition, is time-consuming and laborious involving adequate and meticulous data collection in the field/onboard, analyse enormous data collected over a number of years, interpret and draw conclusions, finally arriving at a set of conclusions helpful to industry and the government develop policy for the development of fisheries. However, the results and the recommendations are brief running in a line or two as for example: 'the fishing effort may be reduced by 30%' or 'the mesh size of the gear may be increased by 20%', or 'the fishing ground may be closed for fishing during Months' etc. The results are not 'attractive' and occasionally can even be 'uncomfortable' to the politicians and the administrators. All this naturally detracts anybody from doing anything in Fishery Science. A similar effort in aquaculture, on the other hand, is likely to produce quick results which may be visible, attractive and can impress politicians, bureaucrats and science managers; the personnel concerned get the recognition or even rewards and awards of different kinds. Interestingly the Institute also gets a very high visibility and appreciation. It is due to this, it is believed, that there is considerable fascination for such work in the institutions. It needs to be borne in mind that every aspect of scientific research has its own value/importance and needs to be recognised on the basis of the contribution without unduly 'crediting' some and totally 'rejecting' others on rather flimsy grounds. There is however no denying the fact that in the

fisheries sector today, research in aquaculture is most important for increasing production (as evident from the growth of freshwater aquaculture in India) as the wild stocks can support yield only to certain levels and hence increased research effort in aquaculture/mariculture is most desirable and essential in the context of contributing to fish food security. And, research in Fishery Science is equally if not more important in view of the infrastructure, employment, economy, fish food nutrition, livelihoods and others related to capture fisheries production.

The effort made by the CMFRI on fishery resources, their exploitation and management, including biodiversity and fishery environment indeed forms the basis for policy decisions like seasonal fishing ban, regulating fishing effort, regulating fishing gear, conservation of the resources, protection of environment, ecosystem based fisheries management, formulating plan proposals and several important decisions, but the required thrust is not forthcoming. In future there are going to be greater challenges in the most sensitive area of shared stocks (different neighboring countries exploiting the same species stocks) and cooperative research and management of fisheries by different nations together becomes a reality. Till now there does not seem to be any effort in this direction and not even a beginning is made. The International Council for the Exploration of the Sea (ICES) and its work are not able to enthuse India and perhaps the countries in the neighborhood apparently because of the type of respect to Fishery Science in addition to of course the subject of shared stocks being a very sensitive one. And the stock assessment of exploited stocks done by any one single country and the management decisions flowing therefrom have limited meaning, in the context of the same species stock being exploited by different nations, as long as data from all countries exploiting the same species stock are not considered. Those who are responsible in the region for example the BOBLME seems to be paying some attention to this but such an effort needs to be strengthened greatly. It is believed, however, that the SAARC should possibly take the initiative in this direction.

b. Fishery Survey of India (FSI): FSI is primarily a survey (exploratory) organisation under the Agriculture Ministry having its mandate/objective:

→ Survey and assessment of fish stocks and charting of fishing grounds in the



Indian Exclusive Economic Zone (EEZ) and adjoining high seas.

- Monitoring of fishery resources for fisheries regulation, management and conservation

The FSI with its fleet of vessels, conducts surveys using different gears targeting different species at different depths and makes estimation of the size of the populations (instantaneous) and report the survey results to the Governments. During the past the FSI was conducting the so called exploratory surveys and furnishing the data to the CMFRI which has the major mandate on the marine fisheries of the nation to put together the data on exploited stocks and the exploratory fishing and for making assessments.

According to the Report of the Working Group on Development and Management of Fisheries and Aquaculture for the XII Five Year Plan: 2012-17 (Planning Commission, 2012: 103-104) the four institutes (FSI, CIFNET, CICEF and NIFPHATT) under the ministry of agriculture

"... have also weakened considerably in terms of their manpower and wherewithal. Some of them have also lost their relevance to a considerable extent and are undertaking work that has little impact on the sector *per se*. Presently, a sound review of their performance might conclude that their continuation or otherwise may not have much impact on the fisheries sector."

"...Therefore, it is proposed that all the four institutes be merged into a single institute..."

"...which may be named as the Indian Fisheries Development Institute (IFDI). Further the Report says "In the process, some of redundant activities carried out by these Institutes could be stopped and only need-based activities would be allowed."

It is hoped that the Government will suitably redefine the work of FSI soon by involving the right people in the decision making in addition to but not restricting to the internal (serving) personnel. Since this is a survey organisation, it is desirable that they develop a linkage with the CMFRI the only national research institute on marine fisheries, conduct surveys in consultation with the CMFRI and furnish

all the data collected in the cruises to the CMFRI for further analysis in conjunction with the data on exploited stocks. Similar linkages have to be developed with the CIFRI for inland fisheries.

c. The Ministry of Environment, Forests and Climate Change (MOEFCC) has the mandate related to fisheries, of (MOEFCC 2014):

- Environment and Ecology, including environment in coastal waters, in mangroves and coral reefs but excluding marine environment on the high seas.
- Survey and Exploration of Natural Resources particularly of Forest, Flora, Fauna, Ecosystems (Estuarine ecosystem, Marine /Island ecosystem, Biosphere Reserve / Conservation areas) etc.
- The Wildlife (Protection) Act, 1972 (53 of 1972) with the wild life institute at Dehra dun
- The Environment (Protection), Act, 1986 (29 of 1986).
- Zoological Survey of India a premier organisation, with the primary objective of survey, collection, documentation (including the traditional knowledge associated with animals) and *ex situ* conservation of wild animal diversity of the country.
- Coastal Zone Management

Though it is understood that the development and management side of the mandate is with this ministry, the wildlife protection in aquatic environment, (which is nothing but protection of wild stocks/species in the seas, rivers and reservoirs and is only a fisheries matter and therefore the DAHDF becomes the nodal department to address this issue), protecting coral reefs, Survey and Exploration of Natural Resources particularly the flora and fauna of Estuarine ecosystem, Marine ecosystem and biosphere reserves, the responsibility is with the Ministry of Agriculture and the concerned state governments. It is in such situations that there is conflict of interest. While such a situation cannot perhaps be avoided, there is need to constitute interministerial working groups with scientists and the industry representatives to formulate suitable management measures instead of independent action by one particular ministry/department when several ministries/departments are looking at the same general subject.

d. Centre for Marine Living Resources and Ecology (CMLRE) Under the Ministry of Earth Sciences:

The mandate of this organisation is

- To develop management strategies for marine living resources through Ecosystem monitoring and modelling efforts.
- Evolving, coordinating and implementing time targeted national / regional R&D programmes in the field of marine living resources and ecology through effective utilisation of Fishery and Oceanographic Research Vessel *Sagar Sampada*.
- Strengthening of research on marine living resources and Ecology including establishment of a data center for storage and dissemination of data/information to end users.
- Coordinating the national programmes relating to Southern Ocean Living Resources (Antarctic marine living resources)

In spite of such an overarching mandate on marine living resources, so far as this author is aware, the CMLRE only plays a facilitating role in vessel-based research. The Research Vessel *FORVSagar Sampada* attached to the CMLRE, Kochi is regarded as the national facility and is available to the staff and students of research institutes and universities dealing with marine living resources, for regular cruises. The CMLRE sanctions research projects to implement using this vessel facility and also sanctions positions of Research scholars for carrying out the work thus helping develop HRD in Taxonomy, survey and assessment, biology and stock assessment of Marine Living Resources.

VII. SOME ISSUES IN CAPTURE FISHERIES RESEARCH

1.R & D programmes for implementation

The commercially and economically important activities such as exploration and exploitation of gases and oils from the marine environments, mining of sea bottom for minerals and sands, establishment of floating power plants in the seas, culture of commercially important organisms, establishment of artificial reefs, increased use of nearshore waters for recreation and sport and harvesting the living resources from the coastal waters and deep seas to contribute to fish food security, national economy and so on have stimulated substantial interest in the use of the seas. However the dynamic nature of the marine living resources spreading over different ecological zones, non-demarcation of territorial

boundaries as in land, invisible nature of the resources and the open access nature of fisheries make the research and management of the resources difficult. Further, increasing pollution of the marine region is greatly affecting the ecology and resources of the region. Thus meaningful research on fishery resources including the habitat and ecosystem becomes highly complex. The major R & D programmes to be implemented at the present juncture are on:

- Stock assessment of exploited stocks and management advice for sustainable yields and protecting livelihoods,
- Pollution of the seas by different industrial and domestic activities including tourism,
- Demarcation of coastal areas for mariculture and capture fisheries,
- Exploitation of deep-sea resources,
- Seasonal fishing ban in Indian seas,
- Coastal zone management,
- Improving the quality of the data,
- Developing/improving methodologies for assessment of tropical marine fish stocks,
- Taxonomic revisions
- Describing the biodiversity and conserve the same,
- Identifying MPAs and formulate strategies for their management/conservation,
- Estimation of potential yield from the Indian EEZ at intervals for taking important policy decisions,
- Management of Large Marine Ecosystems-BOBLME,
- Developing joint research programmes with neighboring countries –cooperative research by SAARC countries,
- Taking suitable action to understand the impact of climate change on fish stocks and the fishery environment

It is essential that mission-oriented research is planned to implement the above-mentioned R & D programmes

2. Fishery Science – Imperative need for encouraging basic research

Fishery Science is nearly 300 years old having originated in the temperate regions. The resources in these regions are characterised by smaller number of species and those contributing to the fisheries not exceeding about a dozen or two. The growth rates are slower and almost all species live up to higher ages

reaching larger lengths and weights. These species spawn during short and well-defined periods in a year. Method of ageing these fishes using hard parts has been well established and a very good and reliable system of reading scales and otoliths relatively easily and satisfactorily has been developed and it became easier to age individual specimens in the catches which facilitates estimation of age composition of catches and mortality rates easily and with reasonable confidence. This ability has facilitated the catch forecasting also.

In the case of India, a tropical country, there was no formal fisheries education till long after independence resulting in the lack of knowledge or ability to carry out fisheries research efficiently. Consequently personnel with Zoology/marine biology qualifications were performing the research function mainly adopting the methodology developed for temperate species. The tropical fisheries like those of India, are constituted by a large number of species which grow at faster rates and live for shorter periods of 3-6 years with maximum length of majority (excepting tunas, seer fishes, elasmobranchs, some sciaenids, groupers, snappers, some carangids and a few others) not exceeding 30-40 cm. These species spawn almost continuously in batches and recruitment is also continuous, making it difficult to age these fishes using length. Aging the tropical species using hard parts is yet to be developed and validated; though a few studies were made, there is no convincing evidence to show that the growth checks on scales and otoliths are indeed valid indicators of age. In the case of certain freshwater species it was shown beyond doubt that the well-defined growth checks present in the scales are not valid in determining age (Murty, 1976). Necessarily, therefore the researchers depend on length data and the computer programmes. In recent years, the availability of software, in spite of shortcomings/limitations has led to increased use of length frequency data for studies on growth and population dynamics. However, the inability to age fishes using hard parts has led to the inability to age individual specimens and estimation of age composition of catch to carry out virtual population analysis and even the forecasting of future catches.

When organised and responsive fisheries research was initiated in India in 1947, the objective was production and increased production resulted in the major research effort going into exploitation and its strategies rather than

establishing firm research base in Fishery Science; this happened also because of the lack of trained manpower in the country to guide research in Fishery Science so that firm database could be developed. This in its turn has led the scientists working on aspects of biology/natural history adapting the methodology developed for species in temperate regions. While this is not correct, the field of Fishery Science remained a generalised subject, even after nearly seven decades of initiating organised research in the country with anybody, experts as well as amateurs talking of Fishery Science with more or less equal 'expertise', as if anybody can formulate/implement research programmes. One sees a rather casual attitude among some researchers of fishery science while working on certain aspects of biology. As an example, even now it is seen that researchers in 'big' laboratories and universities 'estimate' fecundity of fractional spawners using inappropriate material and methods. There are also instances of researchers classifying the gonads of Indian marine fishes into different maturation stages following the scale developed for fish in the North Sea! Or simply classifying the maturation stages rather arbitrarily and without any biological meaning. Similarly certain 'researches' are done on ova diameter frequency distributions in some species without looking at the biological significance/meaning of the diameter. Some Papers are published on age determination using scales/otoliths/fin spines/bones using smaller, rather inadequate samples and without convincingly validating the growth checks or without satisfactorily deducing evidence to establish the periodicity in the formation of growth checks. The results of such studies cannot be utilised because they do not help/facilitate reading the hard parts on a routine basis to determine age of individual fish, estimation of age composition and other characteristics of the exploited populations such as mortality rates. This is the consequence of attaching poor/casual attention to Fishery Science. It is time that the Research organisations concerned strengthen basic research, critically scrutinise and evaluate the methodologies of research in biology/natural history and help develop a strong research base in Fishery Science.

3. CMFRI and Marine Fisheries Research along the Andhra Pradesh Coast

The CMFRI implements its research projects through the regional/research



centres established along the coast of the country to be able to address the research needs of the different hydro-climatic regions. Along the east coast maximum landing by trawlers takes place at Kakinada. The data on the District wise marine fish production in Andhra Pradesh during 1980-1999 show that the East Godavari district-in which Kakinada is the most important center- produced 31.42% of the landings in the state whereas the Visakhapatnam district in which Visakhapatnam fishing harbor is the largest, contributed only 13.62% (Fig. 1); less than half of East Godavari district. Incidentally the east Godavari district contributes the maximum trawl landings in the state (followed by Srikakulam, Visakhapatnam, Nellore and the rest). The trawl landing data of the period 1997-2013 reveal that the total annual landings ranged from 5970 t to 67394 t at Visakhapatnam with the annual average of 33932 t whereas the same ranged from 27144 t to 69917 t with the annual average of 39389 t at Kakinada. Further down south at Chennai fishing harbour, the estimated landings by the trawlers ranged from 10959 t to 39204 with an annual average of 23110 (Fig. 2). The shrimp landings during the same period at Visakhapatnam ranged from 1171 t to 10053 t with an annual average of 5542 t, at Kakinada, the same ranged from 6998 t to 19563 t with an average of 10171 t and at Chennai the shrimp landings by trawlers ranged from 1235 t to 5299 t with an annual average of 2819 t. (Fig. 3). Moreover, the landing centers at Dummulapeta and Uppada in the Kakinada region are also very important for gillnet landings of tunas, sharks, carangids, clupeoids, ribbonfish and others. Thus Kakinada emerges as the most important center among these centers in terms of total landings, variety of landings and the penaeid prawn landings. It is well known that research center at a place of maximum landings is most desirable for sampling and research. And probably because of this consideration, the research center was established at Kakinada. This center carried out commendable work in Fishery Science and published quality research papers in refereed journals. However, recently, the research Centre of CMFRI at Kakinada which was offering research support for development and management of marine fisheries very effectively was closed without any provocation/justification. It is a mystery even today how and why one of the two research centers in Andhra Pradesh having a coast length of 974 km, the third longest among maritime states of the mainland, was closed while retaining all

Fig. 1. District wise proportion (%) of estimated annual average landings in Andhra Pradesh during 1980-1999 (Source CMFRI)

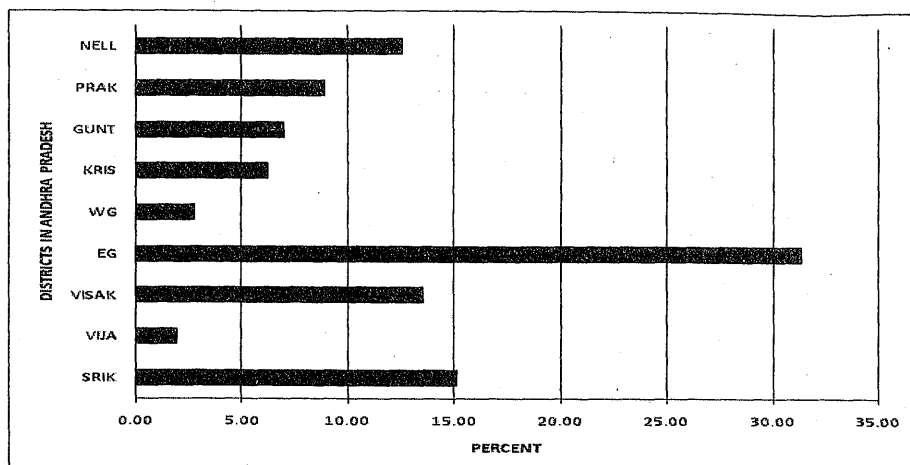


Figure 2: Total Annual Trawl landings at three centres along the East Coast of India during 1997 - 2013 (Source : CMFRI)

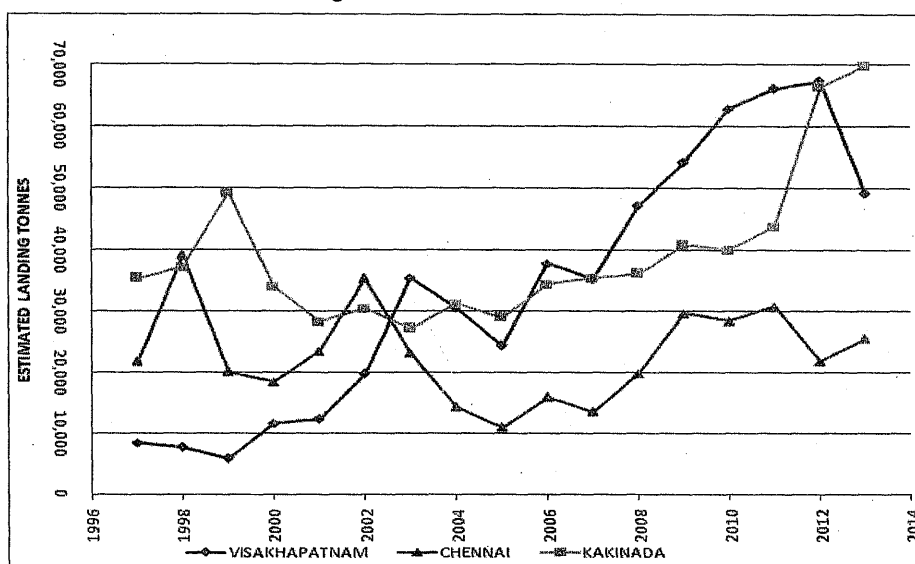
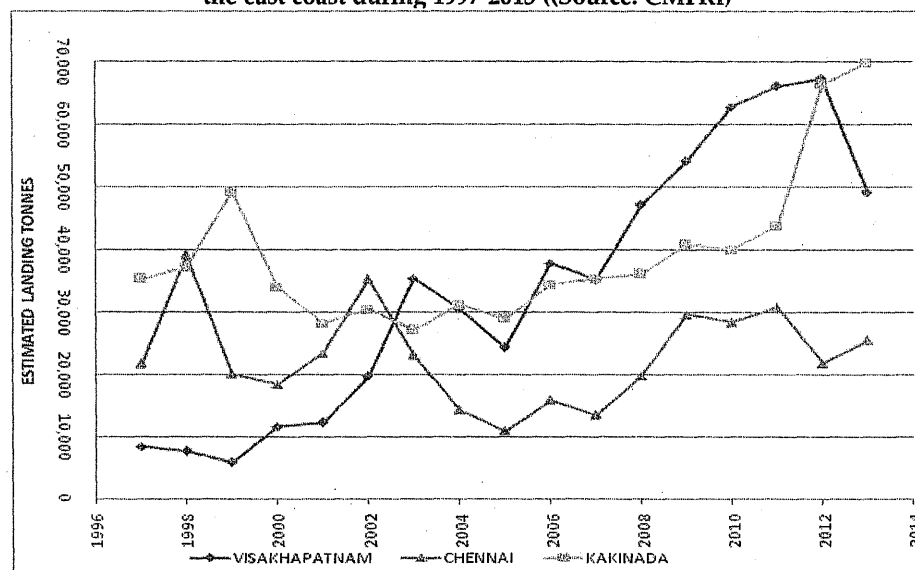


Figure 3 Estimated landings of shrimps by trawlers at three different centers along the east coast during 1997-2013 ((Source: CMFRI)



the other research centers of the Institute which are not as important as Kakinada. Kakinada is very important for capture fisheries research and therefore there is urgent need for reestablishing the Research center of CMFRI there. As shown above Kakinada occupies the first position in terms of trawl landings in comparison to Visakhapatnam and Chennai and it is only reasonable to have the research center reestablished for more efficient and effective capture fisheries research.

4. Taxonomy and its status

Several Indian researchers did taxonomy research and published taxonomic reviews of very high quality on different organisms starting from Protozoa to Vertebrata (Fishes) which are indispensable reference works for anybody carrying out any research or development work. However, historically there has been criticism against such work in Fisheries Research institutes, indeed there was discouragement for this work totally disregarding the relationship of taxonomy with any research work on ecology and fisheries science. The Ph.D. students and some staff in CMFRI were vigorously pursuing taxonomy research about half a century ago on both invertebrates (Porifera, Coelenterata, Polychaeta, Mollusca, Crustacea, Echinodermata) and vertebrates (finfishes) due to the strong determination of visionaries like Dr S. Jones, the former Director of CMFRI but by around mid-seventies this was totally stopped. No attempt was made to utilise the available expertise in the taxonomy of different phyla, resulting in the lack of qualified and experienced taxonomists on various phyla/groups. Even now, the concerned agencies do not seem to be making efforts to utilise the services of the retired personnel for the benefit of the institutions/organisations involved in aquatic biodiversity. It is unfortunate that the institutions concerned are not also making attempts to consolidate the existing knowledge on taxonomy by publishing monographs taking the help of those experts who spent 30-40 years in working on taxonomy of particular phyla/groups. If the institutions were allowed to continue their work on taxonomy then, the country would have been in a better position to address marine biodiversity conservation now. However India is pursuing research in taxonomy only to be able to understand the biodiversity now. Meanwhile some of the experts in Taxonomy of certain groups/phyla left service by superannuation etc without

developing the next line of young taxonomists in the concerned groups. It takes quite a long time to develop such expertise to implement the tasks in biodiversity.

The fish family Carangidae is one of the largest families of fishes from India with about 32 genera and 140 species of which 62 species belonging to 20 genera are known from India (Joshi *et al.*, 2011). After Day (1878) who described 38 species (see also Talwar and Kacker, 1984) there was no taxonomic work incorporating the descriptions of all the known 62 species and 20 genera making it very difficult to correctly identify the species. Besides, considerable intraspecific variation with growth is known in carangid fishes which can lead to identification of specimens of different lengths of the same species as different species. Joshi (*et al.*, 2011) made a comprehensive study and gave adequate descriptions, data, distribution charts, photographs of species and taxonomic discussions in addition to a comprehensive study of all the length groups of different species taking into account the variation with growth. Another example is the family Platycephalidae which was in total chaos in not having adequate descriptions, not having keys for identifications of genera and species and not having figures/photographs for facilitating identification. Besides, the nomenclature was also in utter confusion with a large number of nominal genera (31) and nominal species (70), all leading to incorrect identification of species often. More than anything else there was no single publication which gives the descriptions of all known species from the country. A taxonomic revision of this family was carried out and the results published giving original data, revised descriptions of species, descriptions of type specimens, redescription of type species, keys for identification of genera and species, discussions on the synonyms, new interpretations and finally showing that only 8 genera are valid (of these, only five genera are known from India) with only 14 valid species from India (Murty and Manikyan, 2007). The work of the nature and size (which, among others, involves study of all the literature from the time of Linnaeus, examination of all type material of all species in the type repositories in the world and examination of preserved specimens and a large number of fresh specimens and others), as any qualified and well-trained taxonomist would understand, normally take a few years by a dedicated team of scientists. This author believes that the

above works are the most indispensable for all those working on biology, conservation, biodiversity conservation, biotechnology etc. of these families.

One must appreciate that most of the original descriptions of species and genera are based on one or a few specimens and therefore did not take the intraspecific variation into account leading to the original descriptions being inadequate for purposes of identification and necessitating redescription of species using adequate number of specimens and taxonomic reviews. Research or development of any kind cannot be carried out meaningfully without consulting the type of taxonomic research that is mentioned above. However, unfortunately such quality work would not receive any recognition though nothing can move forward without constantly referring to the taxonomic work cited. Fortunately, "In order to encourage work of excellence in taxonomy and also to encourage young students and scholars to work in this field of science" (<http://envfor.nic.in/sites/default/files/fellowships/Rules>) the Ministry of Environment, Forests and Climate Change instituted an award for work in taxonomy called as "E.K. Janaki Ammal National Award on Animal Taxonomy". Considering the volume of taxonomy work required in different aquatic animals, there is need to institute more such awards and create employment opportunities in Taxonomy/Biodiversity to encourage young personnel to enter this field and continue. The MOEFCC may consider increasing the awards to at least 5 for aquatic organisms. The ICAR having the mandate on Biodiversity must also institute some high value awards for encouraging outstanding research in taxonomy and biodiversity of aquatic organisms.

5. Working groups to "Estimate" Potential yield

For quite some time, at certain intervals, the government of India has been constituting "working groups" to estimate/revalidate potential yield of marine fishery resources. Such working groups were constituted with retired as well as working personnel including scientists as chairperson and members. The Director, CMFRI and the DG FSI are always there in the working group as member and member-secretary respectively. The TOR of this working group (see Anon. 2000 for example) is:

→ "To revalidate the potential yield estimates of marine fishery resources made in the year on



the basis of subsequent research, survey and.....EEZ"

- "To estimate the additional harvestable yield that could be obtained....EEZ"
- "To give suggestions on conservation of fishery stocks....."

The working group was given six months to submit the report.

Any working group, conceptually, has members representing different organisations or if in the same organisation, different divisions/specialisations/disciplines etc, and all of them contribute to the work of the working group with their own data and specialisation on a particular project. The data and infrastructure required to fulfil the TOR in the present case (briefly given above) are available with only a couple of institutions and only those organisations actually do the work for the working group. Hence the so called working group in reality is not a working group but only a committee.

The experience shows that it is the CMFRI that does the major work of estimating the potential yield because of the database on several aspects of exploited stocks in the EEZ and the expertise that the institute possesses. The FSI supplements the work of CMFRI with its data on exploratory surveys. Thus it is these two organisations that do all the work pertaining to estimation of potential yield. In fact no other organisation in the country is in a position to do this work. While "Working Groups" of the nature of the one constituted in the present case or the "Committees" cannot be expected to make estimates of potential yield and the like, more particularly for the type of tall TOR given to this working group, one fails to see reason for constituting these working groups for the purpose instead of simply mandating the concerned national research institutes to implement the programme on their own and come up with the required estimates/knowledge/information. The Research Institutions specialised in Fishery Science like the CMFRI could be entrusted with the responsibility of the entire work of the working group, but the generosity of the Government in constituting working group for the purpose has unwelcome impact on the institutes concerned with the credit that is totally due to CMFRI and FSI does not go to them and the working group consisting of people from other organisations and associating with the work for just six months receive the credit. On the other hand, these Institutions which are responsible for

database development and making the estimates over a period of several years and also have experts in the concerned area, just get the credit of only "assisting the committee/working group". In fact the working group constitutes two subgroups one each from the CMFRI and FSI "to analyse the data and workout the potential yield estimates on the basis of data collected by both the organisations." (This author was a member of the subgroup from CMFRI in the year 2000).

It is most desirable to dispense with the practice of constituting working groups for the purpose of estimating potential yield to begin with and then mandate the CMFRI suitably to do the work of the estimation of potential yield in association with FSI. In reality this is what is done even under the present arrangement of working groups. If additional inputs are required these two organisations can get the same on their own. And, if necessary the final report can be discussed in a workshop with the association of organisations and people the government wants and in fact wants to place them in the working group and the required consensus/clarity/transparency can be achieved without the working group and with a great sense of involvement and achievement by the concerned institutions and scientists.

6. Ban on trawling during Monsoon

During the early seventies and later, the marine fishing activities expanded by extension of fishing into relatively deeper waters and fishing during monsoon months along the west coast particularly along Kerala Coast. This development in its wake brought certain economic/socio economic issues into the scene resulting in clashes between artisanal and mechanised fishing groups sharing the same resources and the State governments imposing ban on trawling in the territorial waters during monsoon period. Naturally all this has bearing on the fish/shrimp/mollusc stocks that are exploited. The CMFRI took a proactive step and on its own, made a special study on the Monsoon Fisheries of the West coast of India (Rao *et al.* 1992) and brought out 17 scientific papers (one each on Oceanography and Productivity, 13 on exploited major finfish and shellfish stocks and one each on socio-economic aspects of fishing during monsoon and impact of fishing during monsoon period on the resources including certain suggestions and recommendations. The publication, which was the most relevant and need-based at that time (indeed, possibly even now), could only be rated as an outstanding

scientific contribution to the subject of ban on monsoon fishing having high reference value for all concerned governments for taking informed decisions. This publication was issued in October 1992. The concerned State Governments in India however, continued to appoint committees to go into the matter of monsoon fishing. Thus it became a socio-political and socio-economic issue. The Kerala government constituted "expert" committees 10 times from 1981 to 2003 on monsoon trawl ban in Kerala and four times (see Ghosh, 2004) even after the above-mentioned publication of CMFRI was brought out.

Perhaps the CMFRI should have a continuing research programme on this subject and advise the concerned government every year in the month of May. However, the State governments approached this issue independently because the subject is in their jurisdiction and they are entitled to do so independently. Any State government could straightaway request the CMFRI to give their view on the subject and go ahead with action. But this would not always happen!!!

The maritime State Governments and the Government of India have been issuing ban orders for fishing operations in certain periods during the monsoon months every year. The Government of India constituted a Committee on 1st January, 2004 to study and report the impact of such closed fishing season on the marine fishery resources of the country (DAHD, 2005) with the TOR as below, which this author believes is as large and broad-based as the mandate of a large marine fisheries research institute and to fulfil the TOR will take at least 3-4 years for the type of the committee constituted:

- To carry out an evaluation study on the impact of closed season in increasing the fishery resources of the Indian EEZ
- To study the population dynamics, recruitment, fecundity, natural death, catch etc. and the MSY and MEY in the Indian coasts
- To study the diurnal oscillation, eutrophication and upwelling season, migration, productivity of waters during and after monsoon months (closed season)
- Whether all fishing including fishing by non-mechanized traditional crafts with OBM/IBM to be banned during closed season or the type of crafts which can be allowed during closed season

Similar to the working group on potential yield mentioned above, this committee was also given six months' time to submit the report. This committee has only fisheries departments of certain State governments as members in addition to the CMFRI and the FSI. Again, as above, here also only the CMFRI and the FSI possess the database and the expertise to implement the task as per the TOR. The constitution of committees for such purposes when there are specialised research institutions doing the work will undermine the institutions. The government which has established these institutions should not themselves be responsible for such undermining.

VIII. DEMAND FOR SEPARATE MINISTRY OF FISHERIES

Highlighting the subject of Fisheries being handled by different ministries/ departments, the Central Marine Fisheries Research Institute in their Vision 2020 (CMFRI, 1997) stated that

"any setup like this in the absence of any mandatory linkages may cause hurdles/bottlenecks in the process of development besides often resulting in duplication of effort" and therefore suggested that "at least all the activities related to marine fisheries should be brought under the control of an independent agency as for example "Marine Fisheries Research and Development Authority to be wholly manned by scientists..."

Due to a major concern that Fisheries and Fishery Science have not been receiving due attention, several organizations/ committees/ individuals have been making recommendations/ demands for the creation of an independent Ministry of Fisheries at the center for quite some time and the recent suggestion of creation of Ministry of Fisheries in the Central Government by James (2014), is most welcome. The concerned ministry/ governments however, have not been paying adequate attention to such suggestions. The committee to review the Deep-Sea Fishing Policy 1991 (also known as the Murari Committee) of which this author was a member, made 21 recommendations and the Government accepted all the recommendations. The recommendation 13 states:

"All types of marine fisheries should come under one Ministry. The Government should also consider setting up a Fishery Authority of India to function in the

manner in which such authorities set up in other countries function and to be responsible for formulation of policies as well as their implementation."

And curiously, in spite of accepting all the recommendations of the committee, the Government simply added "Fisheries" to the already existing "Department of Animal Husbandry and Dairying" and retained it under the Ministry of Agriculture. The central Government must have thought it prudent, rightly so, that as long as the activities do not change and as long as the other ministries/ departments continue to indulge in fisheries related work creation of a ministry exclusively for fisheries is not going to help improve the situation. The aspiration of all those concerned with fisheries is that the subject has become very important during the past, at least, two-three decades and therefore a fully dedicated Ministry of Fisheries at the center alone will be able address everything in fisheries efficiently and effectively, thus leading to the recognition of fisheries as a very important and specialised subject. Thus the demand for a separate ministry of fisheries or R & D Authority has been there for quite some time but nothing significant in the direction has happened. All this has happened/ happening because Fisheries did not receive its due recognition of a highly specialised and complex subject requiring expert scientists to handle various issues. Unfortunately people who matter chose to offer a blind eye and deaf ear to this. However, it is most astounding that all the State governments have ministries of cabinet rank of fisheries whereas the central government with much greater and broader national responsibilities do not have one that too in spite of demands from various sections and suggestions from important committees constituted by the government themselves.

IX. THEN WHAT SHOULD BE THE FUTURE LIKE?

The above narration of facts, views, perceptions and experiences reveals that the involvement of different ministries in addressing fisheries issues has its own difficulties/ disadvantages, there is quite some duplication of effort by certain national organisations, the government and research organisations still follow the old practice of appointing zoology (e.g. physiology/ parasitology/ marine biology) academics on the expert committees on fisheries when a large number of fisheries scientists, administrators and fisheries professionals both working and retired are

available, suitable important legislations are yet to be made and so on. Though a significant proportion of manpower and budget are utilised for research in Fishery Science, in different fisheries research laboratories, the work done in Biology, Population Dynamics/ Stock assessment, Taxonomy, Biodiversity, fishery environment, fishing gear technology and such others, the recipients of honours/ Fellowships in the "Fisheries Science" are not experts in these subjects but belong to subjects in the area of aquaculture. Whereas these two subjects are different, they are treated as synonyms resulting in the subjects under aquaculture getting recognised and the scientists working in aquaculture getting rewarded. It is critical that certain very important decisions are taken and implemented to support Fishery Science receive its due recognition.

India is the second largest fish producing nation in the world with the estimated annual fish production of the order of 9.5 million tonnes and export earnings of Rs 30213.26 crores (DAHDF, 2014), about 14.5 million people depend on fisheries in India for their livelihoods. The contribution of fisheries in 2012-13 at current prices GDP from Fisheries was Rs 78053 crores; the contribution of the fisheries sector to total GDP was 0.83% while that of agriculture sector was 4.75% (DAHDF, 2014).

The marine fisheries is a very important sector in India with 8129 km of coast line, 0.5 million sq km of continental shelf and an EEZ area of 2.02 million sq km. The marine fishing is carried out from 3288 fishing villages and the catch is landed at 1511 landing centers along the coast. The total marine fisher folk population is 4.0 million of which 2.544 million are engaged in fishing and related activities. A total of 1.52 million are engaged in active fishing of which 1.292 million have full time work. There are 194490 fishing crafts in the fishery of which 71961 are mechanised, 71961 are Motorised and 50568 Non-motorised (CMFRI 2012). The value of the marine fish landings at the landing center level (point of first sales) was estimated at Rs 24372 crores and the point of last sales was found to be Rs 38152 crores (CMFRI, 2012). The estimated potential yield of marine fish in the Indian EEZ is of the order of 4.41 million tonnes (Anon. 2011).

The inland fisheries sector is also a very important one in India with 195095 km of rivers and canals, 29.26 lakh ha of reservoirs 24.24 lakh ha of tanks and ponds, 7.98 lakh ha of Flood plain Lakes & Derelict Water bodies. The total inland fish



production forms about 63% of total fish production of the country (DAHDF, 2014) and freshwater aquaculture accounts for 80% of freshwater fish production.

1. Central Ministry of Fisheries and Aquaculture (MFA) and National Task Forces

A sector of the above magnitude is not only 'tagged' to agriculture ministry as a part of a department in the central government but even serviced by different other ministries/departments in the central as well as State governments. The impact of such a dispensation is explained above with certain examples. Besides, there has been a demand from the public and certain committees appointed by the central government for the establishment of a separate ministry of fisheries in the Centre. The first and foremost action required from the central government, therefore, is to immediately establish a **Ministry of Fisheries and Aquaculture (MFA)** (not merely a Ministry of Fisheries) and transfer the fisheries portion of the DAHDF to this new ministry. The other ministries having fisheries mandate/role to be included in a task force to be named as Task Force on Fisheries R&D separately for marine and fresh water fisheries and also for aquaculture/coastal aquaculture by the new MFA and all the others as members. All matters related to national fisheries shall be discussed in the task force meetings and the nodal ministry (MFA) would implement action. This will prevent duplication of effort, conflicting/controversial decisions and facilitate fast and efficient decision making. More than anything else, fisheries represents a major food sector in India being next only to agriculture and a dedicated ministry of fisheries at the center is not too much to demand/expect. Essentially, it must be understood that it is not the Ministry of Fisheries that is going to do everything in Fisheries and Aquaculture all on a sudden but it is the sense of belonging/involvement/satisfaction of the people working in implementing the programmes of fisheries that matters very much if there is a full-fledged Ministry of Fisheries and Aquaculture at the center.

2. Fisheries Research Institutes under a different Umbrella

Fisheries itself as subject is highly diversified because of:

- The environments: Marine, Estuarine, Brackish water, Freshwater (including cold water)
- The animal resources: Finfish (Elasmobranchs, teleosts),

Crustaceans (crabs, lobsters, prawns), Molluscs (octopuses, squids, cuttlefishes, oysters, mussels, gastropods)

- Plant resources: Marine algae (including seaweeds), sea grasses, freshwater algae, plants and
- A large number of other living resources (coral reefs, turtles, mammals), sensitive ecosystems.

All the above resources exhibit very different biological characteristics and require expert involvement/intervention at regular and frequent intervals to their study. The fish populations are influenced by the oceanographic or limnological characteristics and productivity of the seas, rivers, lakes and expert oceanographers, limnologists are required to address research issues. Exploitation of resources in the seas in depths extending up to and beyond 500 m depth, in the rivers and different other aquatic environments requires very different, scientifically designed and tested fishing gears. Fisheries resources are natural and renewable and therefore the wild stocks have to be exploited in a sustainable manner to be able to help the posterity and help protect the biodiversity and the ecosystems. Obviously focus on Fishery Science, which is very different from Agriculture/Animal Husbandry, becomes the topmost priority. Being aquatic, the fisheries require a very different and difficult approach to address research issues in monitoring the resources, fishing methods, study of biological characteristics on continual basis to develop database taking into account seasonal and annual variations, study of fisheries environment and its influence on the availability and abundance of fish stocks, estimation of potential yield, monsoon or seasonal fishing ban and a large number of others including impact of climate change which require highly specialised, data intensive researches and to facilitate taking informed and timely decisions for development and management.

There is also need for addressing a large number of research issues in coastal aquaculture, mariculture and freshwater aquaculture to help increase production and related matters. There are also issues of livelihoods of a large number of people exclusively dependent on fishing and associated sectors. Such a very unique field should not continue on a long term basis under agriculture for its improved and sustained growth and effective implementation of all programmes. To ensure most effective direction and guidance from the best informed and expert fishery scientists,

the fisheries and aquaculture research needs to be put under a separate umbrella preferably by establishing Indian Council of Fisheries Research (ICFR) which will function in a manner similar to that of the ICAR and transfer the existing research institutions to its control.

3. Constitution of working groups

The different organisations/institutes dealing with fisheries under different ministries/departments appear to have overlapping mandate/objectives and are implementing same or similar work programmes resulting in unnecessary duplication of effort. These are already mentioned above: RGCA and CIBA are working on brackish water aquaculture of same species and also working on a species of marine fish in which CMFRI is also working and made considerable progress. There are several other organisations where similar duplication of effort is seen. The MoFiAq/ICFR has to constitute working groups to see that the duplication of effort is utilised to the best of the requirement if the same could not be avoided by distributing responsibilities or even by reorganising the research by establishing a couple of new institutions and redefining the work of some of the existing organisations.

The working groups shall be in areas of:

- Brackish water aquaculture
- Brackish water fisheries
- Marine fisheries
- Riverine Fisheries
- Reservoir/lacustrine fisheries
- Freshwater aquaculture
- Coastal aquaculture and Mariculture

4. Identity of Fishery Science

This author strongly believes that ever since aquaculture research in national fisheries laboratories started receiving importance, the Fishery Science became a casualty and started receiving no or very poor attention for reasons sufficiently described/discussed elsewhere in this article. Though there was very good performance by some scientists committed to Fishery Science their work did not receive adequate attention/recognition and was treated in a rather routine manner. This situation arose partly because of the notion that Aquaculture and Fishery Science are the same. While certain facts on this are mentioned above, it is necessary that these two sciences are viewed separately for assessing/

reviewing/recognising the achievements of people and the institutions. There is urgent need to understand/realise that there are vast natural resources of fisheries which need to be managed by well-planned policies/decisions which result from an adequate database, study of various aspects of exploited stocks and related environment. It is highly desirable that the concerned organisations/agencies/academies treat aquaculture (including all those sciences related to it) and Fishery Science (including Taxonomy, biodiversity, biology, Population Dynamics, fisheries environment, fishing gear technology) separately for purposes of assessment/recognition etc.

5. Specialisation of Research Institutes

As mentioned above, different institutes are doing research on same species at different places or even at the same place. This practice has ostensibly resulted in ignoring certain major research programmes and in some cases necessitating development of separate expertise and infrastructure. There are also instances of the institutes moving away from their areas of major focus for various reasons including "visibility". There is overarching necessity for the research institutes to develop specialisations/expertise so that there is adequate focus on particular area/s of science and achievements become easier and faster. More importantly, the Institutes grow in stature and eventually become centers of excellence in the concerned field. To achieve this it appears desirable that:

- The CMFRI devotes full attention to researches in marine capture fisheries and biodiversity including catch monitoring, database development on exploited stocks, stock assessment/population dynamics, Taxonomy, biodiversity assessment and conservation, ecosystem based assessment/identification and management of marine protected areas, marine fishery environment, climate change and its impact, socioeconomics and extension with particular emphasis to livelihoods. Moreover the estimation and periodic revalidation of potential yield and the advice on seasonal ban on fishing can be more effectively achieved by the nodal institute in India- the CMFRI. Hence the CMFRI needs to be mandated accordingly. Moreover all the mariculture activities at Mandapam and certain research centers of the CMFRI should be transferred to a new Institute named as **Central Institute**

of Coastal Aquaculture and Mariculture (CICAM). Alternatively the culture activities presently carried out at the CMFRI be merged with the CIBA and rename it as CICAM.

- The activity pertaining to database on brackish water fisheries presently with the CIBA be transferred to CIFRI because CIFRI is "the custodian of estuarine research in the country" (Jha *et al.*, 2008, p 18).
- The RGCA and CIBA (= CICAM) work out modalities of working together without duplicating their efforts on the same species simultaneously.

This approach is expected to lead to greater focus to research in capture fisheries, biodiversity conservation and global warming and climate change in the CMFRI and, the CIBA (to be renamed as CICAM) will be more efficient in implementing all brackish water aquaculture and mariculture projects and the CIFRI will have its mandate on inland fisheries overall. Moreover the institutes will be able to maintain their specialisations, grow into centers of excellence and avoid duplication of effort. It needs to be noted that since 1987 the CIFRI

"is working on fisheries management and enhancement of fish production from these large water bodies. Accordingly, the mandate, vision and mission of the institute were modified time to time. Presently the Institute is working in Natural Resource Management mode ..." (CIFRI, 2014: p. 13).

Perhaps, the CMFRI also needs to reorient their work to address only the capture fisheries and biodiversity matters under the Natural Resource Management mode, as done by the CIFRI. It is time greater attention is paid to need-based research instead of going all-out for 'attractive' areas of scientific research and at the same time nurturing institutions achieve distinction and eminence. After completing nearly 67 years of existence and making very significant contributions in their areas of specialisations, some of these institutions particularly the CMFRI, need to be upgraded into International Centres of Excellence in their specified areas of specialisations and the Government should extend all support in the direction. The Government should facilitate upgradation of CMFRI into **National Institute of Research and Training in Tropical Marine Fisheries (NIRTTMF)**. The geographical, physical and research infrastructure available with the institute, the 10 scientific divisions representing everything required for effective marine fisheries and biodiversity

research which no other fisheries research institute in the country including the deemed university in fisheries has, the scientific expertise available, the quality of the research projects implemented, the number of original scientific papers published from the Institute, the quality of writing research papers and scientific/technical documents, the experience of teaching and HRD in fisheries and above all the international recognition the CMFRI enjoys, amply justify such an action. After such an upgradation, the proposed NIRTTMF has to be mandated to offer education and training programmes tropical marine fisheries to different countries in the Indo-west Pacific region in addition to conducting advanced research programmes in fisheries oceanography, marine fisheries, marine biodiversity conservation including marine protected areas and conduct basic researches in several aspects of biology. It has also to be mandated to initiate and coordinate cooperative research programmes with member countries of the SAARC.

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