STRATEGY PAPER 8

Conservation Policies for Hilsa and Mahseer

NATIONAL ACADEMY OF AGRICULTURAL SCIENCES, NEW DELHI

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Conservation Policies for Hilsa and Mahseer

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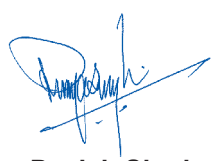
Preface

India is the second largest producer of fish in the world contributing to 5.68% of global fish production. We are also a major producer of fish through aquaculture and ranks second in the world after China. Fisheries sector occupies a very important place in socio-economic development of the country. The sector is a source of livelihood for over 14.49 million people engaged fully, partially or in subsidiary activities pertaining to the sector. The total fish production is estimated at 10.79 million metric tones (mmt) with a contribution of 7.21 mmt from inland sector and 3.58 mmt from marine sector, respectively. The overall growth in fish production in 2015-16 has been 5.9% , which has been mainly due to 7.3% growth in inland fish production. The major contribution to inland fish production has been primarily from aquaculture. The growth in marine fish production has been 3.7%.

However, in case of inland sector, the growth rates achieved are mainly through aquaculture and resultant economic benefits , has pushed the capture fisheries, which is strongly linked with ecosystem dynamics and properties, to the background. But to aim at ecologically sustainable growth, we need to find a balance between production based economic growth and ecosystem based sustainable growth.

It is amply clear that inland fishery is a potential contributor to national economy, supports livelihoods of lakhs of fishers directly or indirectly apart from fishery related activities and contributes to nutritional security and food basket of the country. While fish farming is receiving due attention but the open-water capture fisheries is getting neglected resulting in alarming decline in natural stocks of many important indigenous species. In this background the NAAS organized a strategy workshop on November 07, 2017 at NASC Complex, New Delhi to look at the capture fisheries issues relevant to effectiveness of existing fish conservation policies in respect of two important species viz., Hilsa and Mahseer, and examine the impediments / constraints in the implementations of policy regulations. The deliberations also looked at other national level policies related to water, environment, and wildlife protection and their impact on fishery policy with a focus on Hilsa and Mahseer.

This strategic workshop on “Conservation policies for Hilsa and Mahseer” was organized under the convenership of Dr K.K. Vass, Ex-Director, ICAR-DCFR and CIFRI and was attended by eminent scientists, ministry officials and experts in the relevant disciplines. The strategy paper is an outcome of the efforts of all concerned and I compliment the convener, and the editors of NAAS for bringing out this document. I am sure that it will be useful to all fellowship and stakeholders.



Panjab Singh
President

Conservation Policies for Hilsa and Mahseer

1. BACKGROUND

1.1 Fish in Indian economy

Fisheries and aquaculture remain important source of food, nutrition, income and livelihoods for a large section of society both directly and indirectly. Fisheries is a sunrise sector with vast and varied resources and unutilized and underutilized potential for development, engaging over 14.50 million people at the primary level and many more along the value chain. Transformation of the fisheries sector from traditional to technology driven commercial scale has led to an increase in fish production and export earnings fetching nearly Rs. 30,420 crores in 2015-16 (US $ 4.69 billion). While looking at the data from 2005-06, the GDP from fisheries alone has steadily increased from Rs 31,699 crores to Rs 96,824 crores in 2013-14 thus significantly contributing to overall economy of the country. The Sector contributes nearly 1% to the national GDP as shown in Table 1.

Table 1: Contribution of fisheries sector to GDP (at current prices) (Rs. in crores)

Year	Total GDP	GDP from agriculture, forestry & fishery	GDP from fisheries	% GDP of fisheries to total	% GDP from agriculture, forestry & fishery
2005-06	3390503	637772	31699	0.93	4.97
2006-07	3953276	722984	35182	0.89	4.87
2007-08	4582086	836518	38931	0.85	4.65
2008-09	5303567	943204	44073	0.83	4.67
2009-10	6108903	1083514	50370	0.82	4.65
2010-11	7266967	1306942	57369	0.79	4.39
2011-12	8353495	1465753	65541	0.78	4.47
2012-13	9252051	1668676	78053	0.83	4.75
2013-14	10477140	1881152	96824	0.92	5.58

Source: DAHD&F, GoI (2016)

1.2 Inland fishery resources

The major inland fishery resources include 19,5210 km stretch of rivers and canals, 29.07 lakh hectare reservoirs, 24.40 lakh hectare ponds and tanks, 7.98 lakh hectare of beels, derelict water bodies and 12.40 lakh hectare brackish water areas (Table 2). In inland sector, the technology based aquaculture in ponds and tanks, has paid rich dividends and increased fish production many folds. Similarly, fishery enhancement technologies in small reservoirs have improved their per unit production significantly and contributed to overall inland fish production.

Table 2: Inland fishery resources in the country

Resources	Area
Total inland water bodies (lakh ha)	73.85
Rivers and canals (Km)	19,5210
Reservoirs (lakh ha)	29.07
Tanks and ponds (lakh ha)	24.40
Flood plain lakes / derelict waters (lakh ha)	7.98
Brackish water (lakh ha)	12.40

Source: DAHD&F, GoI (2016)

1.3 Fish production trend

The historical scenario of Indian fisheries reveals a paradigm shift from marine dominated fisheries to a scenario where inland fisheries has emerged as a major contributor to overall fish production in the country. Presently, inland fisheries have a share of about 67% of total fish production of the country. Within inland fisheries, there is a shift from capture fisheries to aquaculture during the last two and half decades. Freshwater aquaculture with a share of 34% in inland fisheries in mid-1980s has increased to about 80 % in recent years. India is the second largest producer of fish in the world contributing to 5.68% of global fish production. India is also a major producer of fish through aquaculture and ranks second in the world after China (Table 3). Fisheries sector occupies a very important place in socio-economic development of the country and a source of livelihood for over 14.49 million people engaged fully, partially or in subsidiary activities pertaining to the sector (Table 6). The total fish production is estimated at 10.79 million metric tonnes (mmt) with a contribution of 7.21 mmt from inland sector and 3.58 mmt from marine sector, respectively. The overall growth in fish production in 2015-16 has been 5.9%, which has been mainly due to 7.3% growth in inland fish production (Table 4). The major contribution to inland fish production has been primarily from aquaculture.

Table 3: Top five countries contribution in global fish production for the year 2009 (in tonnes)

Country	Capture fishery	Culture fishery	Total production	% share
Total Global	8,89,18,040	5,56,80,738	14,45,98,778	
China	1,49,19,596	3,47,79.870	4,96,99,466	34.37
India	**40,83,241**	**38,84,760**	**79,45,161**	**5.68**
Peru	69,14,452	-	69,14,452	4.78
Indonesia	50,99,355	17,33,434	68,32,789	4.73
Vietnam	22,43,100	25,56,200	47,99,300	3.32

Source: Fisheries Profile of India. Annual Report DAC&FW, GoI (2016)

Table 4: Fish production in last twelve years

Year	Inland Fish Production		Marine Fish Production		Total Fish Production	
	Lakh tones	Growth rate (%)	Lakh tonnes	Growth rate (%)	Lakh tonnes	Growth rate (%)
2004-05	35.26	1.96	27.79	-5.53	63.05	-1.48
2005-06	37.56	6.52	28.16	1.33	65.72	4.23
2006-07	38.45	2.37	30.24	7.39	68.69	4.52
2007-08	42.07	9.41	29.20	-3.44	71.27	3.76
2008-09	46.38	10.24	29.78	1.99	76.16	6.87
2009-10	48.94	5.52	31.04	4.23	79.98	5.02
2010-11	49.81	1.78	32.50	4.70	82.31	2.91
2011-12	52.95	6.29	33.71	3.76	86.66	5.29
2012-13	57.20	8.03	33.20	-1.51	90.40	4.32
2013-14	61.36	7.28	34.43	3.68	95.79	5.96
2014-15	65.77	7.30	34.91	1.40	100.68	5.2
2015-16	72.13	7.31	35.83	2.63	107.96	5.9

Source : Fisheries Profile of India. Annual Report DAC&FW, GoI (2016)

If one looks at the trend of fish production during last four years among different states in the country (Table 5) it is observed that Andhra Pradesh and West Bengal have remained at the top followed by Gujarat, Kerala and Tamil Nadu. In these catches especially from West Bengal and Gujarat, Hilsa also contributes to some extent.

Table 5: Top five fish producing states (Production in '000 tonnes)

Year	Andhra Pradesh	West Bengal	Gujarat	Kerala	Tamil Nadu
2011-12	1603.17	1472.04	783.72	693.23	611.49
2012-13	1675.44	1490.01	848.79	677.78	620.40
2013-14	2018.42	1580.65	793.42	708.65	624.30
2014-15	1964.43	1617.31	809.93	632.26	697.61

Source: Fisheries Profile of India. Annual Report DAC&FW, GoI (2016)

This increased production in inland fishery has been triggered mainly by scientific management of stocks and ecosystem with policy support. These enhancement technologies are largely based on outside stocking of fish seed produced separately in hatcheries. This strategy for inland fishery development is registering satisfactory trajectory of growth in fish production through aquaculture and enhanced fishery, but in the process we seem to be overlooking the larger issue of inland capture fisheries. In marine sector the issues related to capture fisheries are being very seriously and effectively considered and supported through research, technology development, policy instruments and schemes. The higher growth rates in inland sector achieved mainly through aquaculture generating significant economic trade-offs, have pushed the capture fisheries to the background. Because its strong linkage with ecosystem dynamics and properties, it gives low production and economic returns. However, there is a need to find a balance between production based economic growth and ecosystem based ecologically sustainable growth.

Table 6: Fisher population (as per Livestock Census, 2003)

a)	Number of family members		
	i)	Males	4,696,158
	ii)	Females	4,033,963
	iii)	Children	5,755,233
	Total		**14,485,354**
b)	Engaged in fishing operations		
	i)	Full time	933,124
	ii)	Part time	1,072,079
	iii)	Engaged in fishing related activities other than actual fishing	
	i)	Marketing of fish	391,000
	ii)	Repair of fishing nets	245,100
	iii)	Processing of fish	46,200
	iv)	Other activities	334,700

Source : Fisheries Profile of India. Annual Report-DAC&FW, GoI (2016).

1.4 Fish diversity

Fish occupy an important position in the context of aquatic biodiversity. Blessed with rich and diverse natural water resources and ranking ninth in terms of mega-biodiversity (Mittermeier and Mittermeier, 1997), India harbours 2,508 finfishes, including 877 freshwater species, 113 brackishwater species and 1,518 marine species, besides 291 exotic species (NBFGR, 2012). In addition, 2,934 species of crustaceans (2,430 marine and 504 freshwater species), about 5,070 species of molluscs (3,370 marine and 1,700 freshwater) and 844 species of seaweeds also contribute to aquatic germplasm resources of the country.

Studies on fish diversity in the country started in the early nineteenth century (Hamilton-Buchanan, 1822), with notable contributions on distribution and taxonomic status of fishes in India in the last century (Hornell, 1924; Hora, 1938, 1939, 1940, 1941, 1943; Pillay, 1954; Jayaram, 1999; Talwar and Jhingran, 1991; Kowtal, 1976; Ponniah and Gopalakrishnan, 2000; Payne *et al*., 2004; Sarkar *et al*., 2012). The River Ganga harbours about 250 fish species, of which 150 are freshwater species. In a study carried out from 2007-09 in the river Ganga, 143 species were recorded, including 29 listed under threatened category (Sarkar *et al*., 2012). Rich species diversity has also been observed in several other important rivers, *viz*., Brahmaputra (167), Mahanadi (99), Cauvery (90), Narmada (95) and Tapti (57), however, a large number of species are common to different river systems. During a prolonged study period of survey carried out from 1987 to 2000 by CIFRI and NBFGR, rich fish biodiversity (151 species) was recorded from Brahmaputra river system in Assam. Viswanath *et al*. (2007) reported as many as 296 species belonging to 110 genera and 35 families from North-East, much higher than 172 species reported by Ghosh and Lipton (1982) and 266 species by Sen (2000). Information on fish biodiversity, endemism, threatened status of different species and the associated risk factors in all important water bodies has enabled habitat-specific conservation strategies. Consolidated lists of 287 freshwater fishes of the Western Ghats showed as many as 192 endemic species (67% endemicity), of which 47 species have aquaculture potential (Gopalakrishnan and Ponniah, 2000).

1.4.1 Biodiversity concerns

Freshwater ecosystems and their biodiversity remain among the most endangered and poorly protected resources on Earth (Millennium Ecosystem Assessment 2005, Dudgeon, 2011, Cooke *et al.*, 2012), with almost 1 to 3 freshwater species facing a high risk of extinction (Collen *et al.*, 2014). Of the 5785 species of freshwater fish assessed for their conservation status by the IUCN(2012), more than 36% are threatened, and over 60 species have gone extinct, (Carrizo *et al.*, 2013). Freshwater fishes are increasingly threatened by a range of factors, including habitat loss, over exploitation and biological invasion. Many countries, especially those in the tropics where much of the freshwater fish diversity is concerned, invest little time, funds and efforts on their conservation. For example, in

India, freshwater fishes, look to be “out of mind” of the policy makers and general public. This is in spite of the fact that the country harbours the greatest number of endemic fishes in continental Asia, many of which are threatened and some probably extinct (Dahanukar *et al.*, 2011; de Selva *et al.*, 2007; Vishwanath *et al.*, 2010; Raghavan and Ali, 2012 a, b).

These all issues concerning the fisheries have resulted from poor understanding and faulty management of our river systems. Whatever we divert and consume upstream of river is not available to downstream users. Upstream diversion policies made independently of downstream storage and flow conditions resulted in inefficiencies and inequities, however such policies are still not defined. Blockage of a river channel downstream reduces or restricts navigation / migration upstream for fish; case in point is that of Hilsa. Therefore, interdependence of sub-systems components of a river and impact of management decisions, strongly make a case for an integrated, holistic and sustainable system for deriving maximum benefits from them. In addition, decisions satisfying commercial objectives may not adequately meet environmental, long-term sustainability or social justice objectives.

It is amply clear that inland fishery is a potential contributor to national economy, supports livelihoods of lakhs of fishers directly or indirectly apart from fishery related activities and contributes to nutritional security and food basket of the country. While fish farming is receiving due attention but the open-water capture fisheries is getting neglected resulting in alarming decline in natural stocks of many important indigenous species. In this background the NAAS organized a strategy workshop on November 07, 2017 at NASC Complex, New Delhi to look at the capture fisheries issues relevant to effectiveness of existing fish conservation policies in respect of two important species viz., Hilsa and Mahseer, and examine the impediments / constraints in the implementations of policy regulations. The deliberations also looked at other National level policies related to Water, Environment, and Wildlife protection and their impact on Fishery policy with a focus on Hilsa and Mahseer.

2. CONCERNS OF HILSA AND MAHSEER

Both are long distance migratory species of India. Hilsa migrates from Sea mouth to Freshwater river systems via Estuaries for breeding and back to sea for rearing and growth to adulthood. The species has an unique physiology of adjusting to different salinity regimes. In comparison, Mahseer abodes purely in freshwaters in upland regions of Himalayan river-systems and its migration is triggered by water temperature and physiological needs for breeding and feeding. Both species reside in different ecologies have different attributes evolved in our aquatic system over a time scale and indigenous to our waters. Both the species have economic importance. While Hilsa has huge commercial

trade, considered delicacy and involving large number of stake holders, the Mahseer is considered as king of sport fishery all over the world supporting targeted strata of economy with a focus on angling and aqua-tourism. Both species are very critical elements of our fish biodiversity and their conservation has become a priority issue due to some inadequacies in standard and economically viable technology to culture these species under controlled conditions.

While development of culture technology and its refinement is an ongoing process, however, both the species have to be sustained at current level of stocks in their respective identified habitats through appropriate conservation strategies under enabling policy, regulation and governance regimes. We have in place a number of conservation regulations / policies for fishery in different States and at Centre level, but majority of them remain as pious statements without any tangible improvement on the ground in terms of fish stock improvement at the ground level.

2.1 Background

Hilsa

The Indian shad, *Tennualosa ilisha* (Hamilton) popularly known as Hilsa belongs to the sub-family Alosinae of family Clupeidae. Hilsa is an important and lucrative commercial fish of the Indo-Pacific region by virtue of its nutritional value and taste. The fish is considered a delicacy and provides livelihood to millions of fishers directly or indirectly along the coastal and riverine stretches along its range of distribution. It is most abundant in the Ganga-Brahmaputra-Magna drainage system of India and Bangladesh and Myanmar, forming one of the most important commercial fisheries in these countries. Recently as per reports (Timesofindia.com dated Aug 09, 2017) the fish has been accorded geographical identification (GI), which has tagged the fish as a Bangladesh product and is hailed as the “Queen of fishes” and is known for its unique aroma. However, India is also contesting about grant of GI status of Hilsa in favour of Bangladesh. Among five species under the Genus *Tenualosa only Tenualosa ilisha*; and to certain extent *T. toli*; are available in Indian waters. The most wide-spread and well studied species T.ilisha has been subjected to much research in the Indian-subcontinent (Banerji, 1955; Jones, 1957; Pillay, 1958; Gopalakrishnan, 1971; Bhanot, 1973; De, 2001). In India, Hilsa is distributed in rivers Narmada, Tapti, Purna, Ulhas, Kali and Vembanad lake on west coast of India and Brahmaputra, Ganges (Hooghly sector), Mahanadi, Godavari, Krishna, Cauvery and Chilka lake in the east coast and their near shore waters. The time scale changes during 1955 to 1967 in Hilsa catches from the river Yamuna were reported by Ghosh (1967). The life history and other biological traits of Hilsa from Narmada were reported by Kulkarni (1950). The Indian shad, *T. ilisha* is a high value fish, spends its adult life in the marine environment and migrates to riverine freshwater habitats for breeding. The young ones migrate back to marine environment for growth.

The normal habitat of the fish is the lower region of estuaries and the foreshore areas of the sea. Hilsa prefers to reside in the region having good sub-surface oxygen, relatively low salinity, strong tidal influence, high turbidity and siltation with rich growth of plankton. It is well known that Hilsa ascends the rivers for spawning and the spent fish as well their progeny migrates down the river towards lower estuaries and coastal areas. The species moves in shoals. The peak upstream migration of Hilsa in most of rivers of the country is generally with the advent of south-west monsoon i.e. July and August and continues up to October or November. While in Hooghly estuary the period of migration is reported to extend up to winter.

Over the years the hydrological alterations in the form of barrages and dams built across the major East and West Coast Rivers, especially along the Ganges and Narmada have blocked its migratory routes to breeding grounds in riverine areas, resulting in the collapse of its fishery in the rivers, (Nair, 1958). The impact of Farakka barrage on Hilsa fishery has been documented by De, Sinha and Ghosh (1994). As a result, Hilsa landing is now concentrated in estuarine part of the rivers. The lucrative commercial fisheries of the fish along the major estuaries, more particularly along the Hooghly estuary, have also drastically declined due to recruitment failure and indiscriminate exploitation of adults and juveniles, inviting management interventions for sustaining the fisheries. In this connection the present status of Hilsa fishery has been well documented by Suresh *et al.* (2017). It reports that juvenile catch forms about 38 t/year (Rs. 0.15 crores); causing annual loss of about Rs. 76.95 crores (at a value if they are allowed to grow one year to reach 250-300 g size) along Hooghly-Bhagarathi system. It is also reported that there is about 20% over-exploitation of stocks to the maximum sustainable yield level and serious over exploitation of spawning stock biomass. It is attributed to widespread use of small mesh gillnets (<60 mm mesh) leading to a large number of juveniles being caught, especially in riverine areas contributing to population decline

In India, the fishery of Hilsa is confined to the artisanal fishing sector in the riverine stretches, traditional non-mechanized sector in the coastal areas and small mechanized sector in the near shore waters of the Bay of Bengal and Arabian Sea; with major contribution from the Bay of Bengal along the coastline of West Bengal, particularly the Hooghly estuary and off Gujarat along the Narmada and Tapti estuaries. The marine distribution extends from Arabian Sea with Persian Gulf, Red Sea, and Bay of Bengal. Hilsa inhabits coastal areas in proximity of rivers, while it has been recorded 13-16 km offshore on Gujarat coast. Hilsa, mostly *T. ilisha*, contributes about 14.0% to the total fish catch of Ganga-Hooghly river system on East-coast and 23.2% along Narmada estuarine system on West-coast.

Recent studies conducted by CIFRI (Suresh *et al.*, 2017) indicate that natural resources of Hilsa are declining all along its fishing grounds; reflected in drastic reduction in catches, especially from Hooghly-Bhagarathi and Narmada estuaries. Mean size in catch has seriously declined (356 mm in 1960s to 260 mm in 2015-16) indicating serious overfishing. It may also be mentioned here that Bhaumik *et al.* (2012) reported the largest recorded

Hilsa fish (61.4 cm) from Tapti estuary in Gujarat but it appears to be an exceptional catch. But average sizes across the system have significantly declined.

On individual basis many workers have carried out research on different aspects of Hilsa fish and its fishery (De, 2001; Reuben *et al.*, 1992). The existing knowledge base gives us some insight into Hilsa fish but is sketchy on its fishery management protocols. The first holistic investigation in the country on "Stock characterization, captive breeding, seed production and culture of Hilsa (*Tennulosa ilisha*)" in a consortium mode was launched by ICAR under National Agricultural Science Fund (NASF) in 2012 and is being executed by CIFRI as lead institute with other ICAR-Fishery institutes and University of Shantineketan, West Bengal, in partnership mode. The project is in progress and will continue till the end of 2018. The project has given many important leads and findings. The outcome of this project will go a long way in developing science based conservation strategy for this important fish in future. The project is aiming to develop a feasible culture technology for this important species. However, previous attempts in this direction (Sen *et al.*,1990; De,1980, 1998, 2001; Malhotra *et al.*, 1969, 1970) could not be sustained and were only partially successful.

Mahseer

Mahseers are found in China, Afghanistan, Pakistan, India, Nepal, Sri Lanka and Southeast Asia as far as Malaysia. In India, the Mahseer inhabit the mountain and hill streams. Only *Tor putitora, Tor tor* and *T.progenies* inhabit the cold-waters, the rivers receiving snow-melt waters. Different species of Mahseer inhabit different ecosystems ranging from tropical waters where temperature in summer is as high as 35^{o}C to sub-Himalayan regions where winter water temperature drops to 10 ^{o}C. These species have been introduced in some lakes and reservoirs to get adapted to lacustrine environment. The distribution of Mahseer is governed by temperature (6-30 ^{o}C) as it influences the rate of development and growth, duration of life history stages, longevity as well as the size and form of individual. Temperature is critical to the survival of Himalayan Mahseer as is evident from its differential distribution and ecology of migration (Vass, 2006).

The Mahseer are rheophilic cyprinids globally acclaimed for their sport and table value. The Himalayan or the Golden Mahseer is the largest in both length and weight. The largest known size is 271 cm and weight 54 kg. This species has also witnessed reduction in size from the mid to end of the twentieth century registering sizes of 138-128 cm in length and 22-18 kg in weight and during 1994-95 in rivers. Large number of publications report declining trend in sizes of this species from various rivers and lakes holding Mahseer. The fish does not contribute significantly to the total catches in the Himalayan states (Table 7). In Kumaon lakes the catches have declined over the years while in Himachal reservoirs it constitutes 4-18% of total catch and in NE region the catches are still much less. The species apart from contributing to sustenance fishery in high altitudes also supports eco-tourism and is an important element of fish biodiversity. Raghvan *et al.* (2011) in case of *Tor khudree* used participatory approach in stock assessment of population in southern rivers.

Table 7: Trend of total Mahseer catch from different Central and NE Himalayan States

Year	Kumaon lakes	Himachal Reservoirs		Meghalaya	Arunachal Pradesh	Assam
	Catch in q	% total catch	Catch in t	% total catch	% total catch	Catch in kg
1982-83	8.92					
1983-84	6.35					
1984-85	5.03	8.9-18.0				
1985-86	-	8.2-17.8		2.69	2.50	
1986-87	4.33	13.8		-	2.20	774
1987-88	-	6.1-10.8		2.49	1.83	532
1988-89	-	4.1		1.99	1.58	300
1989-90	4.16					
2000-01			9.0			
2001-02			8.0			
2002-03			10.0-52			
2003-04			13.0-30			
2004-05			16.0-30			

Source : SOUVENIR-ICAR-DCFR-Sept 22-24, 2017

The population structure of Mahseer in a regulated river shows reduction or distorted proportions of the age groups. The Ganga River System stock is dominated by 0 age group (43.2%) and 0-3 group comprised equal share of male and female. Thus pre-reproductive age group (0-4) constituted 90% of the total population, indicating high fishing pressure on the prospective brooders. This situation leads to natural recruitment failure. Thus indiscriminate fishing and over exploitation, habitat degradation, and habitat fragmentation have been the major factors for depletion of natural Mahseer stocks in open waters in the country (Vass *et al.*, 2010). Much of damage has been caused by major water diversion projects such as hydro-power projects in the entire Himalayan water-shed resulting in various levels of threat to Mahseer.

Table 8: Different *Tor* fish species assessed for degree of threat by IUCN in India

Species	Status	Population trend
Tor putitora	Endangered A4	Decreasing
Tor tor	Near Threatened	Decreasing
Tor progenies	Near Threatened	Unknown
Tor khudree	Endangered A2	Decreasing

Source : NBFGR- Annual Report-2012

The Table-8 above indicates that *Tor putitora* is included in the Red List category as Endangered A4 but more data on its abundance need to be generated for continued placement in this category. *T.khudree* from the Western Ghats, listed as Endangered in 2007 and again in 2009, is now considered as Endangered A2 and *Tor tor* is considered as near threatened. Thus at the turn of century some Mahseer species are endangered, this calls for appropriate measures on priority. The ecological status and threat issues of Mahseer stocks have been elucidated by Jayaram (2005).

The issues concerning conservation, protection and management of Mahseer were in the recent past highlighted by WWF (2012) and reviewed in detail by Nautiyal (2014). But we need to formulate an actionable pathway to achieve the results. Further, technologies for seed production under controlled conditions of various species of Mahseer have been developed and pioneering efforts in this direction have been made by Kulkarni (1971), Tripathi (1977), Kulkarni and Ogle (1979), Joshi (1984, 1988), Ogle and Kulkarni (1987), Ogle (1999), Jan and Dogra (2001). The ICAR-Directorate of Coldwater Fisheries Research has done very good work and contributed immensely in developing technologies for seed production of Mahseer including hatchery support systems and feeds during last two decades, the technology still needs up-scaling and out-scaling for making it viable for farmers to produce table fish under controlled condition. The conservation route to restore/maintain natural stocks in natural waters assumes importance under the prevailing scenario. In this connection, some sincere and promising efforts are being made by Angler's Associations in North-east, Southern-India, Madhya Pradesh Forest Department and through collaborative projects by UK based Mahseer Trust and WWF, India.

3. CONSERVATION RELATED ISSUES

3.1 Political support

Looking at the political support to the conservation of these two important species, it ranges from nil to meager in case of Mahseer and Hilsa, respectively. Since Mahseer, restricted to Himalayan waters, is an internationally recognized best game fish associated mostly with national and international angler associations, does not attract any meaningful political agenda due to lack of its commercialization. Being a huge commercial fishery engaging lakhs of fishers with livelihood concern, the Hilsa has attracted political support in the eastern part of the country. However the political agenda here is mainly focused on welfare issues related to fishers and not targeted to fish and ecosystem that sustains fish stocks for fishers to fish. Therefore, political will on conservation issue seems to be absent.

3.2 Economic importance

In terms of economics, no evaluation for ecosystem or habitat is available but making an assessment of fishery economics, it is evident that Mahseer does not generate huge

economy but is restricted as sport fishery linked with anglers and to tourists in Himalayan region. However, the species may be having a direct and indirect impact on tourist economy of the concerned States. Here again the scale of economy being small and very low percent of fishers involved in angling profession. Mahseer does not attract any significant investment from government or private sector. It will be pertinent to note that the hill water resources receive tremendous investment for using the water as a commodity to produce power and water supply for local communities and urban cities living far away from the ecosystem. On the other hand, the Hilsa having huge economic and business potential is linked with catching, transportation, icing, trading, marketing and consumers. The direct economic value of Hilsa catch is about Rs. 16 billion / year . About 38.84% of annual family income of fishers' households along Hooghly-Bhagirathi system comes from Hilsa fishing (Suresh *et al.*, 2017). The Hilsa fishers are generally landless and also resource poor along riverine stretches, while rich trawl owners employ poor fish workers for operations in the marine sector. The catch and income from Hilsa fisheries has been highly fluctuating and have drastically declined over the years with consequential large scale loss of livelihood means and shifting of interest among Hilsa fishers to other activities.Therefore, there has been investment in the shape of government funding in view of sustained economic potential of Hilsa, mainly to support activities related to fisher's welfare, fishing operations and marketing. However, no funding support has been provided specifically for the conservation of stocks. In comparison, the private investment goes mainly towards procurement of fishing boats and gear.

3.3 Social concern

Examining the societal issue one finds that in respect of Mahseer it is the angler clubs and associations located in different Himalayan states who are concerned about the conservation and saving the natural stocks of this species but they lack any mechanism to implement any conservation strategies. While local communities along the Mahseer habitat would invariably indulge in destructive methods of fishing than conserve the stocks. For them the driving force is day to day immediate small economic benefit through the sale of fish in nearby market. He is not aware about the issue of conservation and sustainability. Even the regulatory authority is not much concerned as the fish does not command a significant commercial interest. Therefore, the civil society / littoral communities do not attach much importance to the issues related to conservation of Mahseer. The conflict of interest among various stake holders for Mahseer conservation strategy would be of low level as it does not constitute a major commercial fishery either onsite or offsite its habitat. This is very positive factor in implementing location specific conservation plan.

While examining this issue with regard to Hilsa, it is observed that common people of Bengal love to eat this fish of any size (from fingerling to table fish) and would pay any price to buy it. They are concerned about their declining catches and sizes from the river systems and their availability in the market. The civil society wants more fish at affordable

price but no public effort is visible to make Hilsa conservation an issue except being flagged in some newspapers every now and then. But no concrete action plan on ground through people's participation is projected. But the major issue in implementing any conservation plan for this species comes from conflict among fisher to fisher ; fisher-to fish trader, fisher to local department; fisher to NGO; fisher to law-enforcement agencies; apart from inter-departmental agencies which are directly or indirectly linked with Hilsa fishery / fishing. Resolution of conflict in itself makes a policy issue. Therefore, in case of Hilsa apart from civil society the fisher community involved in Hilsa fishing becomes a major challenge for getting them onboard to conservation action plan (Islam *et al.,* 2016).

3.4 Technology support

Looking at the technological issues with regard to these species, one finds that in case of Mahseer a lot of work has been carried out on its biological characterization, taxonomic status, migration and distribution, status of stocks and development of aquaculture protocol for some species. While we have fairly good basic knowledge on many aspects of this species but the total cycle of its suitability as candidate species for economically viable aquaculture practice is still desired. So to arrest the declining trend in natural stocks, we cannot depend on aquaculture, as we do for carps, appropriate conservation strategies have to be evolved, tested and implemented to maintain the stocks at reasonable level to sustain the fishery for future.

However, in case of Hilsa, research is much more challenging and demanding. Significant but patchy information is available on the basic fishery biology of this species from various Indian waters. The data on catch trends of Hilsa fishery overtime scale in Hooghly-Matlah estuary has been recorded and the impact of Farraka Barage on Hilsa fishery has been documented by many workers (CIFRI from 1980 onwards). But the detailed holistic work to understand its population structure in our estuarine waters and to assess the feasibility of controlled breeding and rearing for aquaculture was launched by ICAR in 2012 as a major initiative for Hilsa in the country. Significant leads for feasibility in seed production protocols have emerged, which is major achievement, but it is nowhere near to aquaculture, it may take many more years to standardize this technology. But at present the species need urgent conservation strategy to sustain the stocks at reasonable level. In this connection we need to undertake conservation research, test the conservation protocols and evaluate the ecosystem and population responses to those protocols.

The above discussion reveals that while political will and social responsibility are significant in adequately implementing conservation interventions but in case of Hilsa and Mahseer both are lacking but economic potential of these species and sustained technology backstopping can be suitably up-scaled to make appropriate strategies for an effective conservation interventions. Both these species require a strong conservation approach and action plan.

4. FISH CONSERVATION SCHEMES / INITIATIVES

4.1 ICAR initiatives

Realizing the importance of assessment of fish resources across the ecosystems in the country, a dedicated institute, National Bureau of Fish Genetic Resources (NBFGR) was established at Lucknow in 1983. At the institute we have a Division of Fish Conservation, where the work involves, and using modern biotechnology tools to characterize different fish stocks and explore different river basins including their tributaries to collect the fish accessions for taxonomic validation, stock identification and repository. After working on large number of projects the scientists of this institute and other fishery institutes, important generalized fish conservation suggestions have been made in these studies that include approaches on ecosystem restoration, reduction of anthropogenic stresses and increased efforts on *in situ* conservation. The *ex situ* conservation approaches are establishment of live gene banks, stock-specific ranching of threatened species and cryopreservation of gametes, and above all controlled breeding of regionally-important endemic species and bringing them into the fold of aquaculture. There would be practical and viable approaches towards management of the fish biodiversity that involve generating information on fish biodiversity, endemism, threatened status of different species and the associated risk factors in all important water bodies would also be required for drawing habitat-specific conservation strategies. This science based strategy makes sense provided the entire implementation pathway is controlled by fishery group alone especially the issue related with targets species viz., Hilsa and Mahseer. But the situation on the ground for effective conservation is very different.

4.2 Central sector schemes

The centrally sponsored schemes administered by Department of Animal Husbandry, Dairying and Fisheries are (DAHF&D-GoI, 2014)

- Development of Inland Fisheries and Aquaculture
- Development of Marine Fisheries Infrastructure and Post Harvest Operations.
- National Scheme of Welfare of Fishermen
- National Fisheries Development Board (NFDB) and
- Strengthening of Data base and Geographical Information System for Fisheries Sector.

After examining the quantum of financial support existing in the scheme listed above pertaining to inland fisheries, it is observed that the main objectives of the scheme envisages encouraging leasing of water area, expanding aquaculture by construction of ponds, popularizing fish/shrimp farming, utilizing vast brackish water areas for fish/shrimp

culture, utilizing saline / alkaline soil for raising commercial crop of fish, increase of fish production in capture as well as involving Fish Farmers Development Agencies (FFDAs) fully for development and delivery of sustainable aquaculture throughout the country. Since the inception of this scheme 8,69,661 hectares of fresh water bodies and 45,702 hectares of brackish water bodies have been developed till March 2014 benefiting 14,66,737 and 39,496 fishers, respectively. The conservation is not listed as an objective in the scheme therefore no provision exists for any funding support under the scheme for this purpose.

Table 9: Allocation of funds for fishery schemes during 2015-16

Name of Scheme	Total allocation (Rs in lakhs)
Development of Inland Fisheries & Aquaculture	3665.00
Development of Marine Fisheries, Infrastructure & Post-harvest Operations	7000.00
National Scheme of Welfare of Fisherman	4349.00
Strengthening of Database & Geographic Information System for Fisheries Sector	495.00
National Fisheries Development Board	15786.00

Source : Fisheries Profile, India- Annual Report, DAC&FW, GoI (2016)

From the objectives of the scheme and significant achievements made so far clearly indicates that it totally supports aquaculture including enhanced fishery in reservoirs and wetlands while conservation has hardly received any attention / funds in the scheme. From the Table 9 it is evident from the total allocation of Rs.3665 lakhs for Inland Fisheries, major share of funds goes to Aquaculture, so conservation hardly has any funds. We need to change this approach. Our main aim in the scheme seems to be increasing production. Therefore, it emerges that we make little investment in conservation activities / programme but at the same time we anticipate our natural fish stocks to improve and be sustainable in natural waters. This issue needs a serious consideration while under NFDB scheme one component on conservation is listed but the achievements under this component are not adequately documented.

4.3 Emerging questions on conservation

Many questions emerge which need answers, for any meaningful conservation road map (a) should fishery as a group of species, have a common conservation policy; (b) should the policy empower the line department to generate more revenue by regulating fishing or it should be targeted to protect a fish species; (c) if the line department has a policy / regulation for fishery but who has the policy for ecosystem, as fish and ecosystem can't be delinked; (d) the well being of fish is conditioned by the ecosystem health and its overall environment therefore, any policy elements/ regulations, in our water and environment

policy might positively / negatively impact the fish stocks ; (e) water in our policy is treated as an economic commodity but for fishery it is a biological resource including habitat with specific ecological identity, how the two economic values can be quantified and put in a policy frame work ; (f) many policy / regulations pertaining to fishery are focused on fisher's welfare with a basic premise that majority of them fish in inland open-waters for their livelihoods, but there are meager stocks to fish, should ecologically damaging practice be continued or extend help to inland fishers through other social welfare schemes without tagging it with fishery / fishing; (g) no reliable data has been generated to understand the impact of various regulations / policies on target fishery or specific fish species. (h) in hill streams the commercial fishery is non-existing but species are lost by putting engineering structures to divert water flows for other economic gains (i) but appropriate policy to regulate / compensate the biodiversity / ecosystem loss is not in place, all decision on this are adhoc.

5. EXISTING FISHERY POLICY INSTRUMENT

There is a Comprehensive Marine Fishing Policy 2004 that serves the marine fisheries both capture fisheries and mariculture and addresses issues related to this sector. Similarly The Coastal Aquaculture Authority Act, 2005 provides regulatory frame-work for promoting Brackish water aquaculture. But in case of Inland fisheries, especially on conservation, such enabling instruments are lacking. Now recently the Department of Animal Husbandry, Dairying and Fisheries, GoI have constituted an expert committee to prepare National Inland Fisheries and Aquaculture Policy, 2016-17, this is still under finalization. The committee developed a detailed questionnaire for getting feedback from different stakeholders and issued appropriate guidelines to States. While looking at the questionnaire and the guidelines it appears that many general statements focusing mainly on regulation of fishing and crafts have been made vis-a-vis conservation issue but many questions raised on conservation in the document, will perhaps remain un-answered. It is hoped that when the policy is finally released it might address some of the concerns expressed in the paper.

After examining the specific state policies with regard to these species, it is noted that in respect of Hilsa, West Bengal State has some directions for conservation in their policy. In the Kolkata Gazette, Extraordinary, April 9, 2013 specific notification has been issued for regulating the use of nets of specific mesh size for catching Hilsa (West Bengal Government, 2014). Also certain river stretches in different districts in the state have been declared as sanctuaries, catching of juveniles and banning of fishing within 5 km range of Farraka barrage. As a follow-up Gazette notification 2013 in the West Bengal Fisheries Policy, 2015, for Hilsa fishery conservation, a provision of setting up of an institutional mechanism has been made, accordingly the department has established "Hilsa Conservation and Research Centre". It looks to be step in right direction.

In respect of Mahseer, the policies of Uttrakhand and Himachal Pradesh states are available. The Himachal Pradesh has Fisheries Act of 1976 and Rules-1979 up to 8th

Amendment, after examining, it is noted that these are mostly regulatory in nature with prescribed penalties for any offense under the act. In the rules fishery waters have been categorized on fish species inhabiting those waters, and for Mahseer only size class of above 50 cm are permitted to fish. But no specific fish based conservation strategy has been listed. Similarly for the State of Uttrakhand, there is The Uttaranchal Fisheries Act, 2003 and Uttrakhand Fisheries Rules, 2013, in the act there is an intent to declare specific areas as sanctuaries for conservation of fish biodiversity not specific to any species . While in rules certain water areas having Mahseer stocks have been categorized and catching of Mahseer less than 400 g has been made as offense. These are state level policy instruments aiming at conservation. But it is a big question how to assess the response of these instruments at field level.

5.1 Other national policies that impinge on fishery

5.1.1 National Water Policy (2012)

It is recognized that Water is fundamental to life, livelihood, food security and sustainable development. India has only 4% of world's renewable water resources and further limits on utilizable quantities of water are owing to uneven distribution over time and space. In this context the objective of the National Water Policy (Ministry of Water Resources, GoI, 2012) is to take cognizance of existing situation, to propose a framework for creation of a system of laws and institutions and for a plan of action with a unified national perspective. Among large number of Preamble statements in policy, the statement (1.3,V) "Water is essential for sustenance of ecosystem, and therefore, minimum ecological needs should be given due consideration" is of importance to us. Under the water framework law, at 2.2 it mentions that, "Such a framework law must recognize water not only as a resource but also as a sustainer of life and ecology". Under uses of water, "it recognizes the water requirement for, domestic, agriculture, hydro-power, navigation, recreation etc." but does not mention Fisheries separately. However, under the same section at 3.3 it recognizes "Ecological needs of the river should be determined through scientific study. A portion of river flows should be kept aside to meet ecological needs ensuring that the low and high flow releases are proportional to the natural flow regime, including base flow contribution in the low flow season through regulated ground water use." Further under section 8, it mentions about "Conservation of river corridors, water bodies and infrastructure should be undertaken in a scientifically planned manner through community participation" and at 8.2 it states "Encroachments and diversion of water bodies (like rivers, lakes, ponds etc) and drainage channels must not be allowed, and wherever it has taken place, it should be restored to the extent possible and maintained properly". Under the important section 16 – Implementation of National Water Policy it has two important directives 16.1 "National Water Board should prepare a plan of action based on the National Water Policy, as approved by the National Water Resources Council, and to regularly monitor its implementation". 16.2 "The State Water Policies may need to be drafted / revised in accordance with this policy keeping in mind the basic concerns and principles as also a unified national perspective".

From some of the sections from National Water Policy (2012), mentioned above, indicates that some concerns on ecological issues are indirectly reflected in this new policy in comparison to previous National Water Policy (2002) and we must fine tune our fishery issues so that it gets embedded in water policy.

5.1.2 National Environment Policy (2006)

There are seven main objectives of the National Environment Policy, (MOEF, GoI, 2006) out of which objective –I "Conservation of Critical Environment Resources" is indirectly related to Fisheries. Elaborating this objective it states; To protect and conserve critical ecological systems and resources, and invaluable natural and manmade heritage, which are essential for life-support, livelihoods, economic growth, and a broad conception of human well-being. Under the section 5.2 "Enhancing and Conserving Environmental Resources" in sub-section 5.2.5 Freshwater Resources covers River-systems, Groundwater, Wetlands, Mountain ecosystems and Coastal Resources. Among the action plan suggested in the policy for each resource following points can be helpful in fish conservation approaches.

i)Promote integrated approaches to management of river basins by the concerned river authorities, considering upstream and downstream inflows and withdrawals by season; (ii) consider and mitigate the impacts on river and estuarine flora and fauna, and resulting change in the resource base for livelihoods, of multipurpose river valley projects, power plants and industries, (iii) adopt a comprehensive approach to Integrated Coastal Management by addressing linkages between coastal areas, wetlands, and river systems, in relevant policies, regulation, and programs. We can articulate fish conservation issues suitably in this broad policy statement.

5.1.3 The Indian Wildlife (Protection) Act 1972 (IWPA)

With regard to Mahseer fishery, this act is observed to pose a constraint. The act was enacted to provide the much needed legal protection to flora and fauna within areas set aside for protection (Protected Areas (PA)). According to Pinder and Raghvan (2013) this item of legislation seems to be in conflict with Hilsa conservation in river Cauvery. It is reported that little attention is afforded to freshwater fishes. The Act does not explicitly draw attention to fish under the definition of "wild animal", which is defined as including amphibians, birds, mammals and reptiles. The only specific reference to protected fish species is restricted to Part IIA of schedule I, which includes whale shark, shark and ray, sea horse and giant grouper. Further, under section 2(16a) of the IWPA, the Ministry of Environment and Forests (MOEF) has considered angling to be aligned with hunting; an activity which is prohibited within protected area so all angling activity within Protected Area has recently been prohibited. So monitoring the impact of conservation efforts in Protected Area becomes extremely difficult.

Based on the discussions in the workshop and suggestions given by different experts following recommendations are suggested.

6. RECOMMENDATIONS

- The wild inland fish stocks of Hilsa and Mahseer, which are not presently cultured, have great ecological and intrinsic value for the fishery sector. It merits required investment for an effective science led protection and conservation action plan, similar to conservation policy support provided to Tiger and Dolphin.

- During the discussion, it was clearly emphasized that inland fish conservation especially of these target species, should have multi-stakeholder approach. Therefore, it is imperative to bring in together Fisheries Department, State Forest Department including MoEF, Law Enforcement (police), Local Fishing Communities, Scientists and Researchers, NGO's and Angling Communities and involve them in a joint action plan for conservation.

- The existing inland fishery policy is more focused on fishery development while fish conservation especially of migratory stocks is not being addressed seriously. Therefore, any meaningful conservation policy may be developed by DAHF&D in consultation with MOEF, Ministry of Water Resources and Ministry of Power. A joint group may be constituted to undertake this exercise. Similar recommendation was made in 2012 in a WWF workshop on Mahseer to constitute a steering group comprising MOEF / WWF/DoF/MoA/MoWR/Line Departments and community representatives, to guide, coordinate and monitor efforts for Mahseer conservation.

- The inland fish species need to be included in the Indian Forest Protected Areas 1972 regulation so that Protected Area (PA) benefit can accrue to inland species as well. Further, the "hunting" and "angling" in the Protected Area (PA) regulation should not be treated at par. This prevents monitoring the impact of fish conservation strategy in Protected Area (PA) . Further, the definition of "wild animal" does not include the freshwater fish under this act. Therefore, it is suggested that efforts be made to get Mahseer and Hilsa included in the Act.

- A collaborative approach is required for Mahseer management outside the Protected Areas (PAs). At the same time, long-term monitoring of Mahseer population inside PAs will be essential for a broad and successful Mahseer conservation plan and to ensure better habitat health.

- A centrally sponsored comprehensive scheme may be launched exclusively for *in-situ* and *ex-situ* conservation of migratory stocks with a provision of alternative livelihood support for the fishers to stop fishing of threatened stocks either totally or partially.

- The support and improvement in fish production comes under the domain of Agriculture Ministry as per rules of business in the government. However, it is suggested that fish conservation may be made part of Environment Ministry in linkage with forest

conservation programme because many fish conservation sites fall under the jurisdiction of Forest Department. Accordingly, in case of Hilsa and Mahseer fishery the tradeoffs between socio-economic needs and conservations measures need to be evaluated and considered at various levels for policy support.

- It is noted that the success of any conservation initiative largely depends on the perception of problem among members of political class and civil society. However, the issues concerning inland fish conservation especially of Mahseer and Hilsa, do not receive any serious attention among the political class and civil society. Therefore, it is emphasized that appropriate steps may be taken for creating this awareness among this section of society.

- The Hilsa generates significant business starting from catching to entire marketing chain till the product reaches to the consumer. At each level a percent of profit is generated and shared among different individuals, at the cost of each fish traded, but nothing is ploughed back for the protection of Hilsa stock. It is suggested that a small percentage of cess (Payment for Ecosystem Services, PES) be levied for supporting approved conservation activity / ies. As Mahseer is directly linked with angling significantly supporting eco-tourism industry and not with any other major commercial fishing, it is suggested that part investment on its conservation including habitat improvement, should be the responsibility of concerned tourism department and the private sector who are the beneficiary of Mahseer / Hilsa centric tourism activity.

- It is recognized that research on developing aquaculture protocol for Hilsa and Mahseer is going on and has made reasonable headway. However, it is still at infancy in comparison to other cultivable fish species. It is strongly emphasized that ICAR and DAHF&D should encourage such institutional efforts and provide adequate funding support for improvement and extension of existing culture technologies.

- It is observed with concern that research on inland fish conservation especially of migratory stocks is totally lacking in the country. Therefore, research on migration, fish behavior, fish physiology in respect of migration, hydrology, upstream / downstream flow needs of different species, appropriate gear / sampling techniques, fish pass design, habitat requirements, and ranching need to be pursued on priority.

- In case of Mahseer, there is a need to develop science led angling protocol specific to each river stretch / type. It is suggested that research on stock restoration needs to be initiated, while some successful attempts have been made by Anglers Associations in Cauvery River but these models need to be given scientific basis. The restoration models should be trial tested on pilot scale, further, response of fish stocks and ecosystem to restoration interventions is documented for suggesting policy intervention.

- In the inland states it is observed that fish conservation is not given any attention, all efforts are made to improve the fish production, so conservation is sacrificed. It is

suggested that in these department/s a senior level officer may be made responsible for executing conservation activities in order to meet the conservation specified targets.

- The revised National Water Policy 2012, on one hand recognizes water also a sustainer of life and ecology, but does not list fisheries among the users of water requirements, however, for river system health it emphasizes the need of water for river ecology. Therefore, it is suggested that scientifically, ecological needs of water should be estimated for these river fishes for inclusion in inland fishery policy. The state policies could be revised accordingly.

- It is suggested that states require conservation policy specific to a particular fish species, as the state of West Bengal has made fish specific, by establishing Hilsa Conservation and Research Centre in 2013. The state has about 26,000 Hilsa fishers, with annual catches ranging between 980 -5530 tonnes in inland sector and 7699-54265 tonnes in marine sector. This example may be followed by other states as well for their specific species.

- Penal provisions in state fishery acts may be relooked. In case of Mahseer the Himachal Pradesh Government recently in their Act has made catching / killing of gravid fish during breeding season a cognizable non-billable offence inviting imprisonment of three years. Similarly catchable size has been increased from 300 mm to 500 mm in length or 1.2 kg in weight. Such measures would help in developing the required populations within the ecosystem.

- In case of Hilsa it is recommended that fishing of juveniles below 120 mm in length be totally banned. The ban on marine and off-shore fishing needs to be effectively implemented for adult / maturing stocks during 15 June to July 15. Fishing in identified breeding grounds to be effectively banned during last week of February to first week of March and also during last week of October to first week of November around nearest full moon period.

- There is a strong need to formulate science-led Environmental Impact Assessment (EIA) policy for migratory fish species likely to get impacted by big water diversion projects in entire Himalayan region. Presently each state has its own approach, some take monetary compensation for any anticipated loss in fish stocks while others follow some other mechanism, but all are ad-hoc approaches. Most of the EIA reports in the Detailed Project Report of majority of development projects are fragmentary and not much importance is given to fishery sector in EIA report or follow-up action plan. This approach may be dispensed with and a revised policy be put in place.

- In fish conservation strategy the conflict management would play a key role, in the sector there are four main conflicts viz., fishery jurisdiction, management mechanism, internal and external allocation within the sector, and fishery players and outsiders. This requires serious attention at various levels for developing proper guidelines.

7. PROPOSED STRATEGY / ACTION PLAN

7.1 General

Fishery persons / authorities need to realize that inland fish conservation especially of threatened/ vulnerable species, is a serious and priority issue in the country and all out efforts be made to flag it at appropriate levels so that seriousness of issue is registered and merits urgent action by the concerned authorities. **(State Departments / DAHF&D / ICAR/ NAAS)**

7.2 Research

Presently, the research work on inland capture fisheries is almost neglected. The research in this area is mainly focused on fisheries enhancement. Therefore, the problems related to fish conservation research on target species should be initiated on priorty, including generating long-term data sets both on fish population and the ecosystem. **(ICAR / SAUs)**

Research on Conservation Aquaculture should also be initiated on threatened and vulnerable species including pilot scale testing of eco-restoration of target population in affected stretches. This will enable us to develop suitable case studies for up-scaling and out-scaling. **(ICAR / SAU's / State Departments / NGOs)**

Population restoration, through ranching of target fish seed produced in hatcheries, in river stretches or impoundments, is strongly advocated and carried out in some systems with respect to Mahseer only as in respect of Hilsa artificial seed production is in infancy. Further, there are no scientifically validated guidelines / policies for taking up large scale ranching programmes. Therefore, research in this area should be taken-up on priority to provide validated inputs for policy formulation. **(ICAR / DAHF&D / Anglers Association / NGOs)**

7.3 Capacity building

Develop a course / training module on fish conservation for other stake holders viz, forest officers, water and power engineers who manage power projects and dams, whose activities impinge on conservation efforts. Even for fishery experts develop HRD in Fish Conservation programme implementation. **(ICAR / SAUs)**

Launch programme/s initiatives on fish conservation awareness among political class, civil society, fishers, traders and anglers. **(State Departments / ICAR / DAHF&D)**

7.4 Financial support

The Ministry of Agriculture and Ministry of Environment should either individually or jointly launch a centrally sponsored scheme for Fish Conservation Research and Population

Restoration for threatened and vulnerable inland species to be executed in a consortium mode among research institutes / competent universities / line departments / NGO's / Angler Associations. It could be included in Central Sector Scheme on Blue Revolution : Integrated Development and Management of Fisheries,launched in June, 2016. **(DAHF&D/ MOEF)**

Possibility of creating conservation fund may be examined to support the livelihoods of target fishers who volunteer for no-fishing in vulnerable stretches during fishing ban seasons. **(DAHF&D/ MOEF/ States)**

7.5 Policy re-looks

Make a working group with experts drawn from fisheries, water, environment, forest, engineer, legal and economist to critically examine other national level policy instruments on water, environment, forest, power generation and take advantage of some significant clauses in them, and suggest appropriate and effective changes in the existing inland fish conservation policy and action plan. **(ICAR / DAHF&D/ State Departments)**

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