



# Fisheries of Indian rivers and their role in establishing E-flows: Case study

**Amiya Sahoo, Ph.D**

**Sr. Scientist**

**Member, EAC for river valley projects,  
Ministry of Environment and Climate Change**

**[Amiya.sahoo@icar.gov.in/](mailto:Amiya.sahoo@icar.gov.in/)**

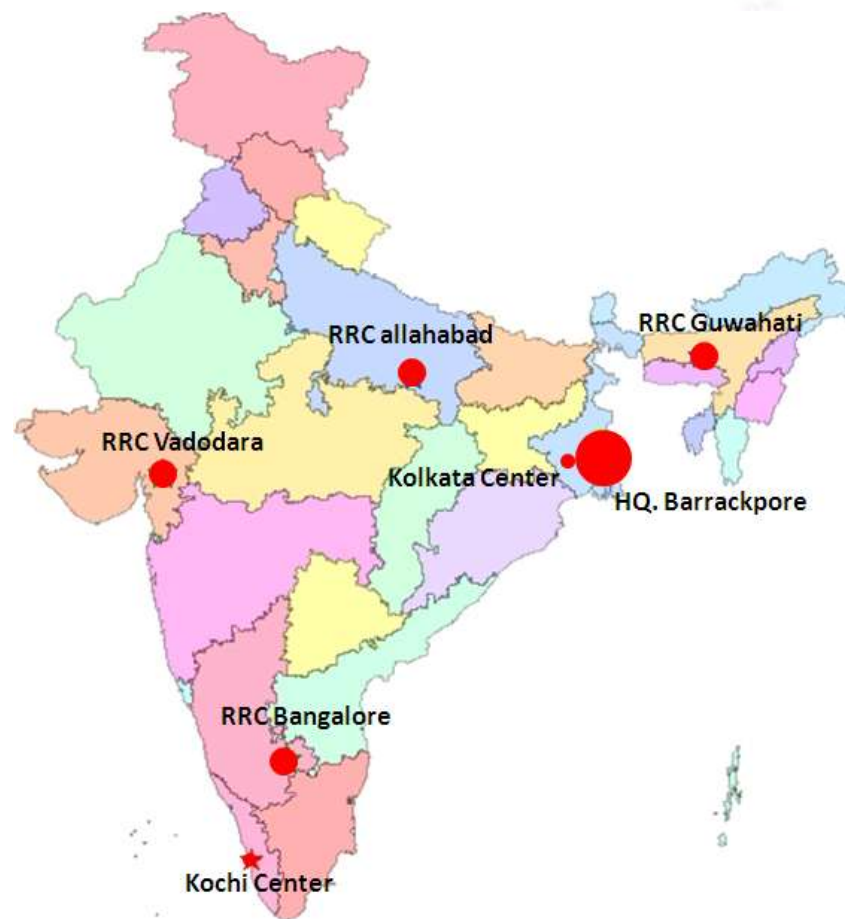
**[amiya7@gmail.com](mailto:amiya7@gmail.com)**





## *CIFRI at a glance:*

- CIFRI was established during 1947 under the Govt. of India
- Major focus on fisheries sustainability (Ecology, Fisheries, Water budgeting and Climate change) in Inland open waters



# Ecosystem diversity-Home of fish -Fish diversity

<b>Coast line</b>	<b>8,118 kms (3,600 fishing villages)</b>
<b>EEZ</b>	<b>2.03 million sq. km</b>
<b>Continental Shelf</b>	<b>0.506 million sq. km</b>
<b>Rivers &amp; Canals</b>	<b>1,91,024 km</b>
<b>Reservoirs</b>	<b>3.15 million ha</b>
<b>Ponds and Tanks</b>	<b>2.36 million ha</b>
<b>Oxbow lakes &amp; derelict waters</b>	<b>1.3 million ha</b>
<b>Brackishwater</b>	<b>1.2 million ha</b>





# Four-dimensional nature of river ecosystem

## 4. TEMPORAL DIMENSION

behavioural response - evolutionary

Streams



Medium size rivers



Large rivers

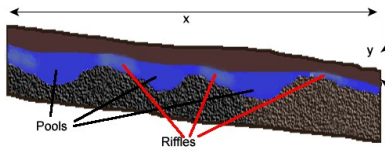


## 2. LATERAL DIMENSION

channel - riparian/floodplain

### Longitudinal Profile

Water Surface Slope =  $\Delta y / \Delta x$  (Measured at water Surface)



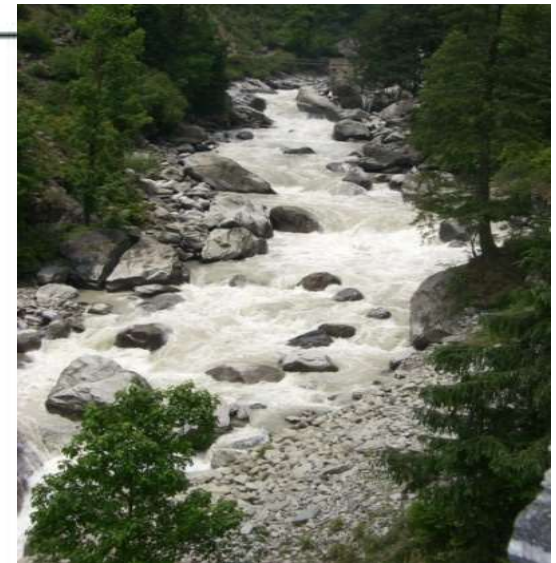
## 1. LONGITUDINAL DIMENSION

channel - channel

## 3. VERTICAL DIMENSION

channel - aquifer

(Ward 1979)







**Obstruction/Abstraction**



**Pollution**



**Siltation**  
©ICAR-CIFRI



**Climate change**





# Main issues confronting us



## A :Conservation

- *What to conserve ?* ( *Fishery alone –no* )
  - Ecosystem
  - Stocks
  - Sustainable management of both

## B. Enhancement

Harnessing productivity ( Technology )

- Improving production
- Species improvement
- Appropriate combination of indigenous and outside stocks

## C. Is Fishery sector responsible for any loss?

i) Direct ii) Indirect iii) Other sector impinging

## D. Other sectors are impinging FISH in a big way

## E. So the concept of IWRM ?







# River management objectives



- **Extractive objectives :**
- food fishery, recreational fishery, ornamental fishery, bait fishery, fry fishery, others.
- **Ecological objectives :**
- sustainability, conservation,
- **Social objectives :**
- income to fishers, equity/benefit distribution, conflict reduction, revenue to government, contribution to GDP, export income





# Relation of River fish and water



- A group of fishes move large distances within river channels between feeding and breeding habitats.
- A group of fishes that move locally from floodplain water bodies to surrounding plains during floods and return to impoundment later
- A group of fishes that are intermediate between the floodplain resident and long distance migrants.
- Each group respond differently to changing conditions in river system.
- A relationship exists between the greater biomass catch of fish with intensity of flooding in river.

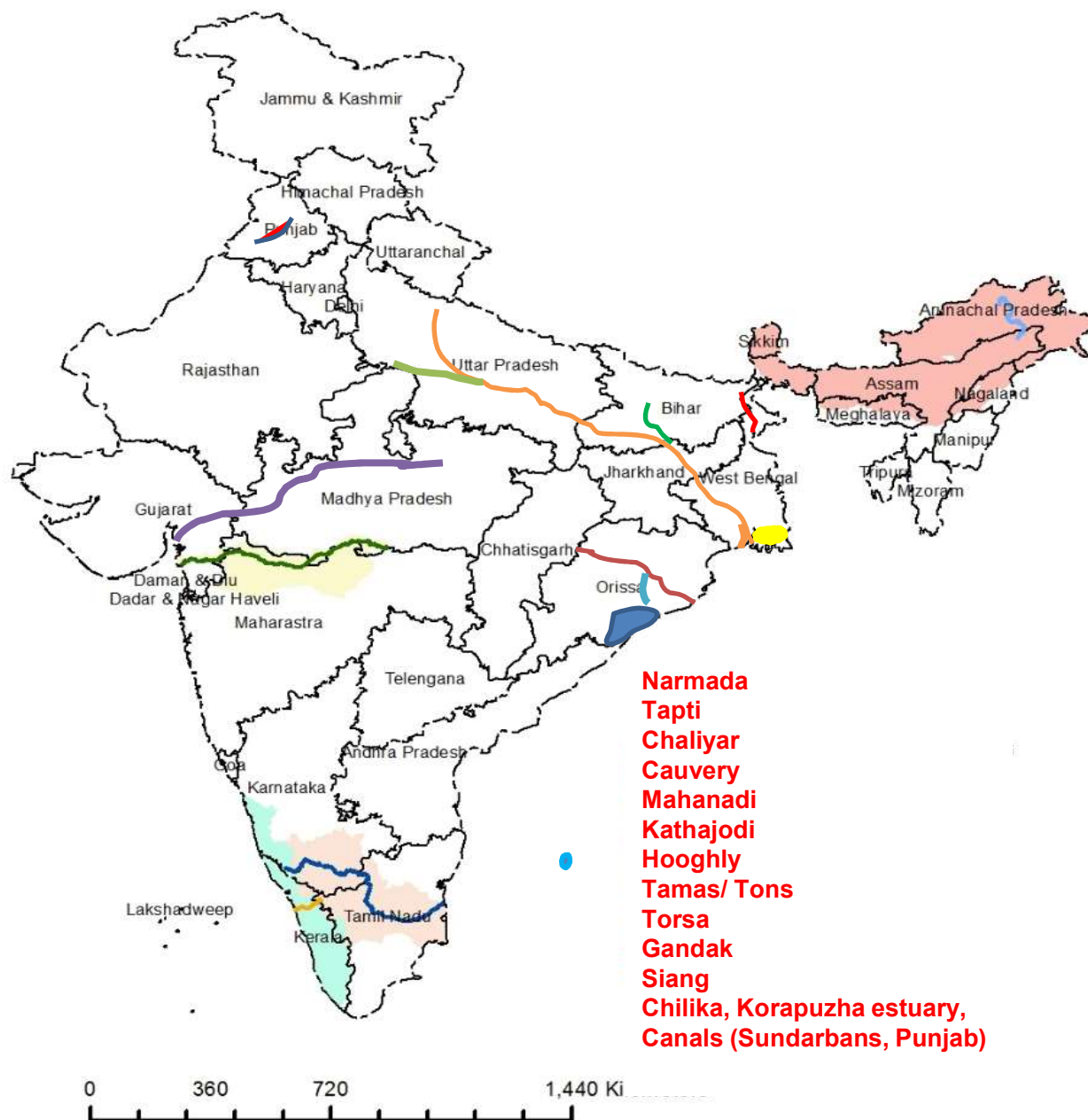
**Any drastic changes in river flows does impact all above, results in loss in fish habitat and economies at different levels.**







# Recent ongoing CIFRI'S REACH



1. Arunachal Pradesh
2. Gujarat
3. Kerala
4. Karnataka
5. Maharashtra
6. Madhya Pradesh
7. Uttar Pradesh
8. Bihar
9. Odisha
10. Punjab
11. Tamil Nadu
12. West Bengal



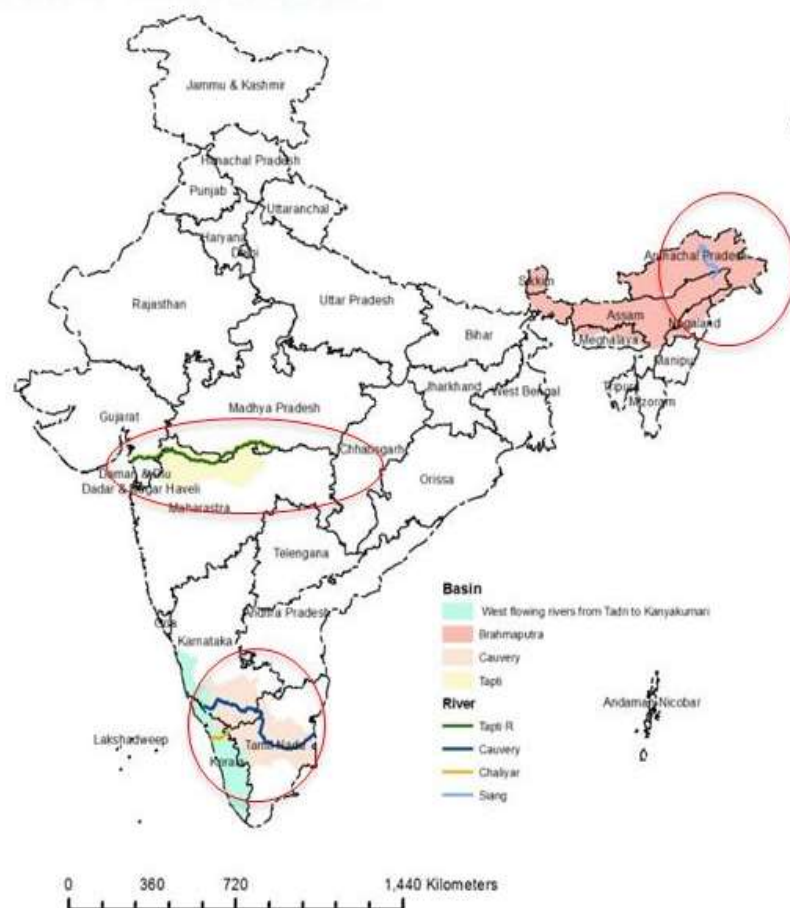


# FISHERIES AND SOCIOECONOMICS OF RIVERS

## Mahanadi, Cauvery, Tapti, Siang AND Chaliyar

### OBJECTIVES

- Characterization of different habitat types based on quantitative and qualitative attributes
- Assessment of fisheries, population structure and fish production
- Assessment of socio-economic status of fishers

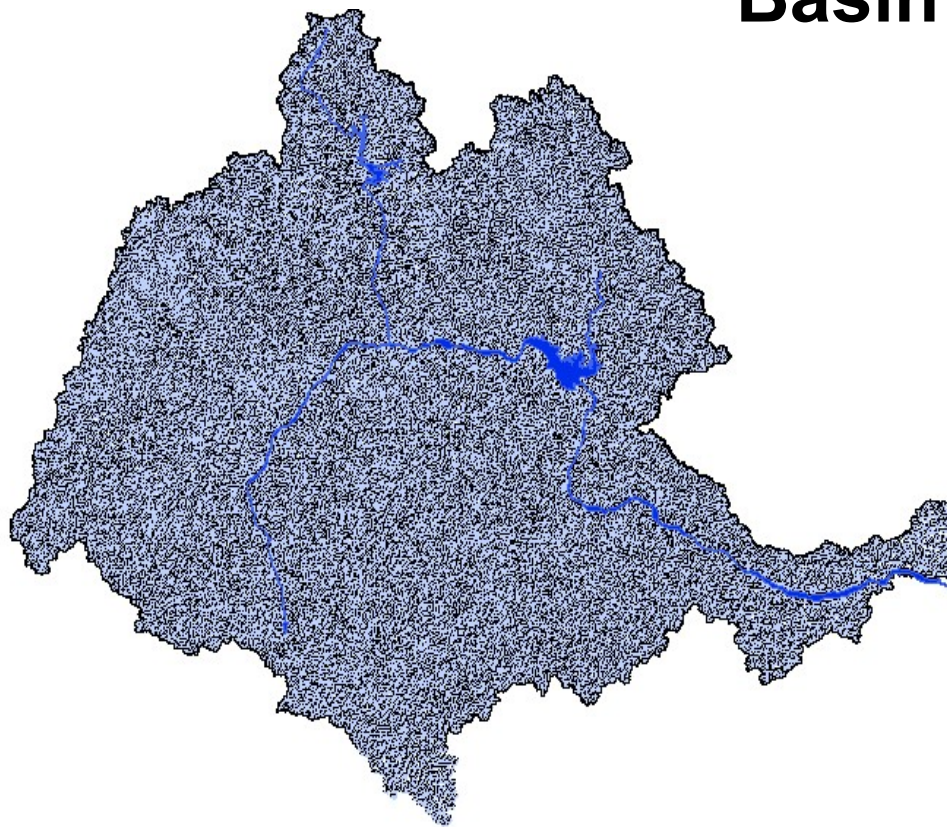


©ICAR-CIFRI





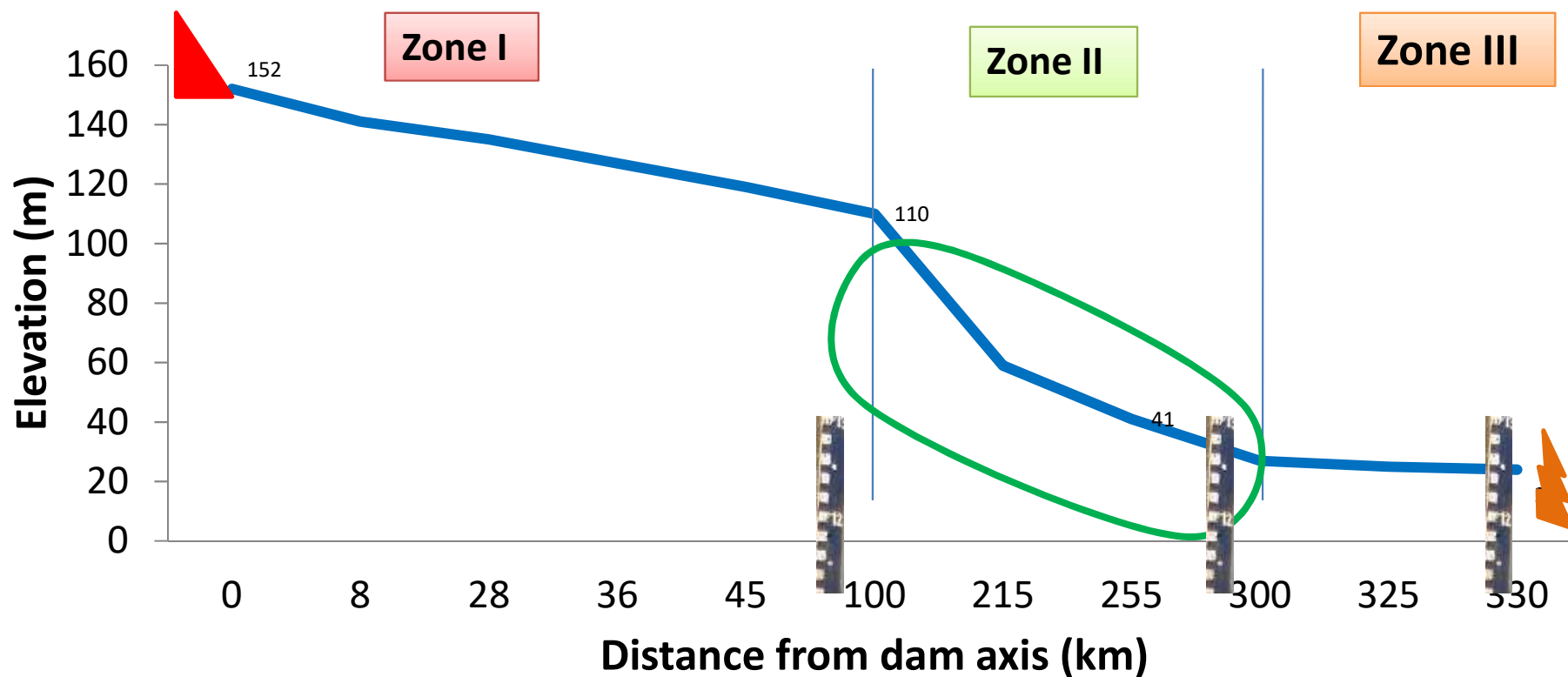
# Mahanadi Basin



Mahanadi river: Basin  
area of 1,41,589 km<sup>2</sup>,  
nearly 4.3% of the total  
geographical area of the  
country  
Length: 845 km









## Significant Records:

- Ecological asset were identified (**Ansupa floodplain wetland and Satkosia wild life sanctuary** and 38 deep pools serving are shelter sites for fish during lean season).
- Livelihood mapping showed **fisheries is the top income** source for the people. Hence, underlines the importance of river water connectivity with river for fish catch.



©ICAR-CIFRI



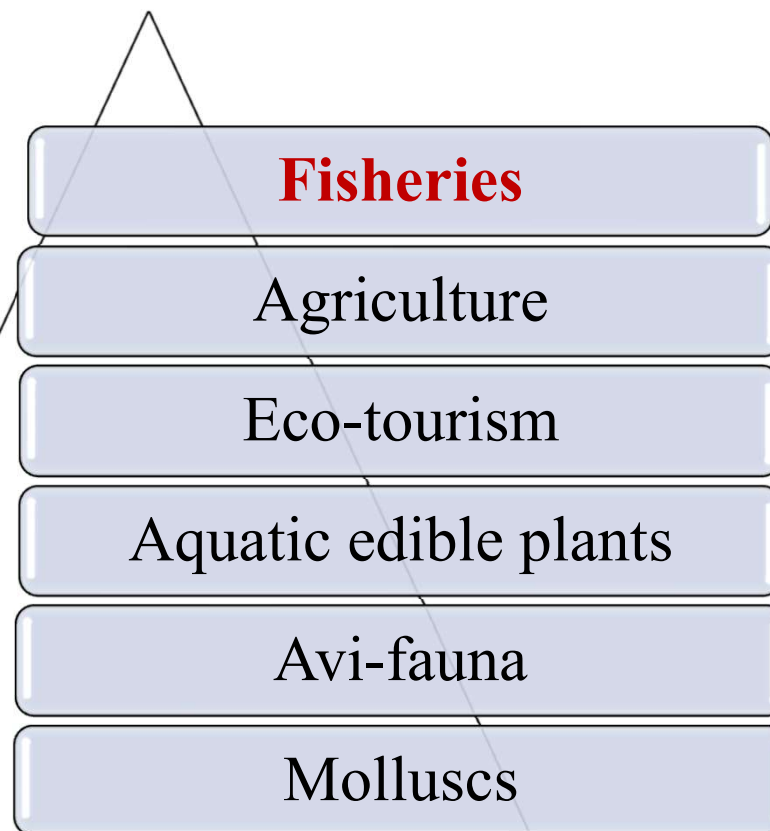
## ANSUPA WETLAND





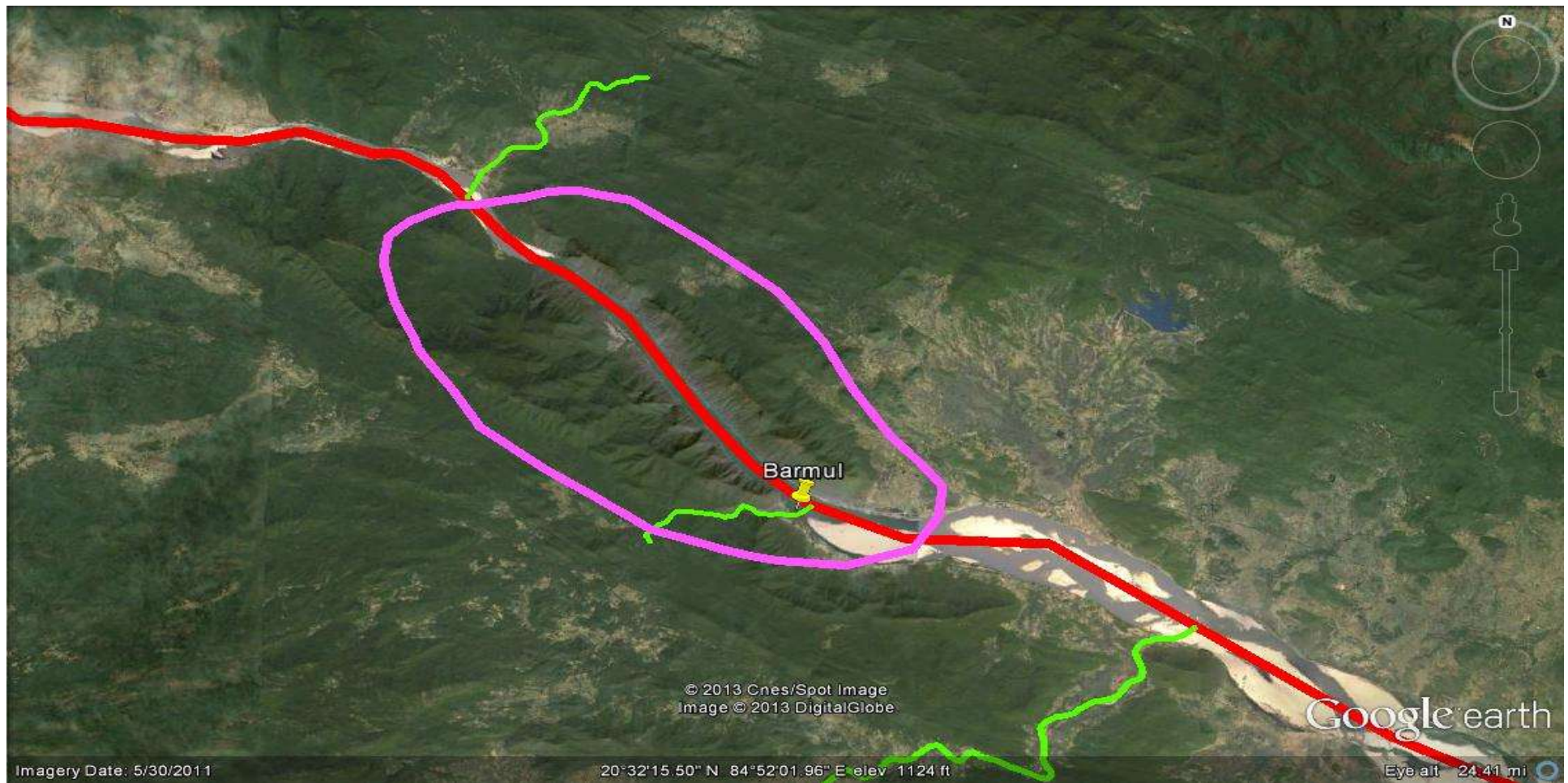


**Fish** species of SIF (Nutrient rich) and ornamental fish importance are major focus for future studies such as conservation and exploitation.



## Direct livelihood opportunities provided by Ansupa





## SATKOSIA GORGE (wild life sanctuary and home for large bodied carps and catfishes)









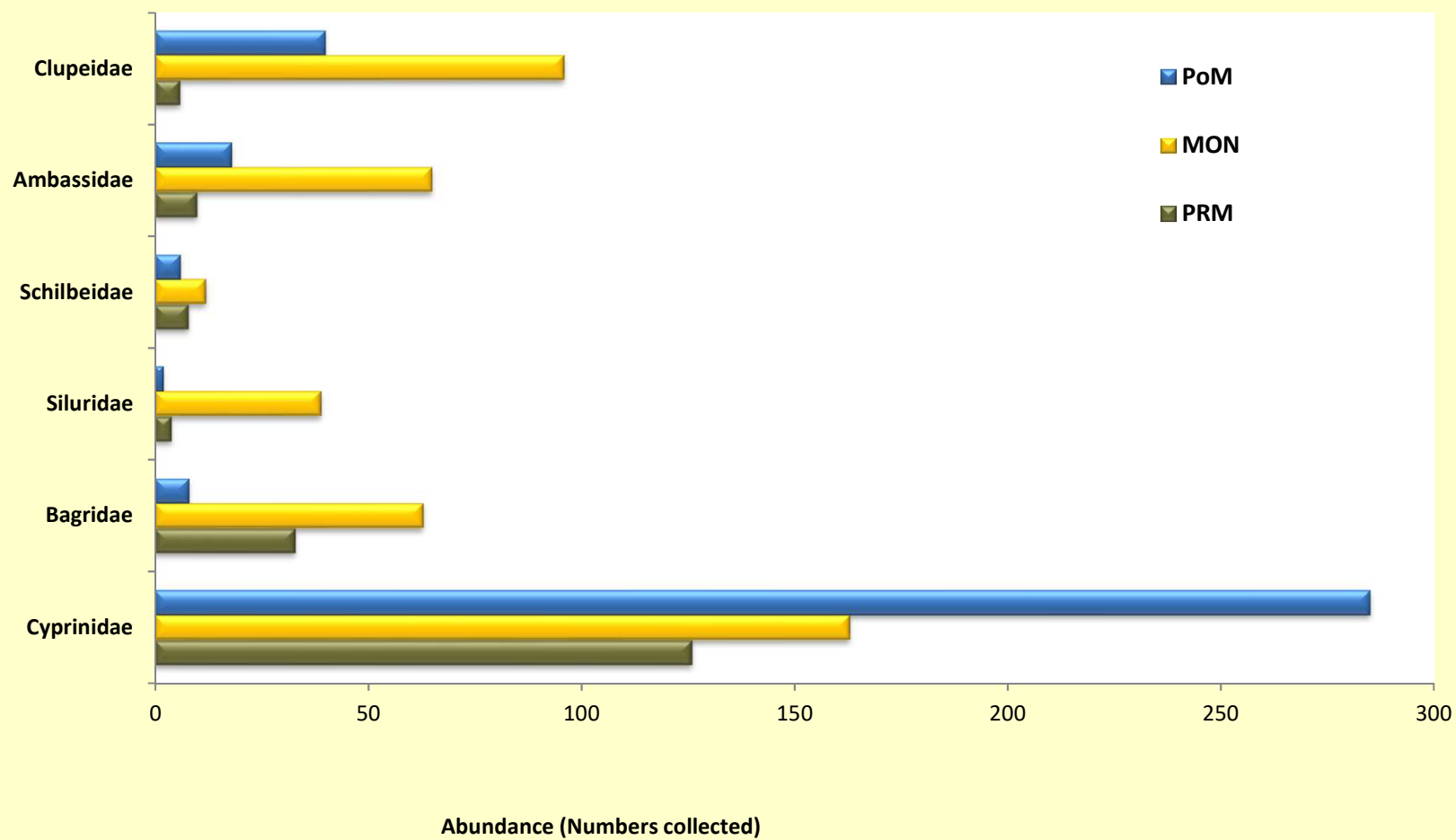


# Fishes of river Mahanadi

A total of **113 (76+37) species** belonging to **44 (20+24) families** was reported in the Mahanadi river. While **Day (1869)** has recorded **146** species of which several were collected from the Cuttack region. **Job (1955)** work covering a stretch of 104 km of the main Mahanadi presents a record of **86 species**.

*First record of the Burmese river gizzard shad, **Gonialosa modesta** (Day, 1870)*







# Endangered Fish (IUCN Red List 2012.2)

## State fish of ODISHA



*Tor mahanadicus*







NT (IUCN)



Generalised linear model (GLM) analysis observed **that depth ( $P < 0.01$ )** and **water temperature ( $P < 0.05$ )** are significantly correlated with ***C. chitala*** and ***Tor tor mahanadicus*** distribution. Study underlined that a depth of 18 to 30 feet should be maintained in the river course as deep pools as habitat preference of ***Chitala chitala* during lean season.**





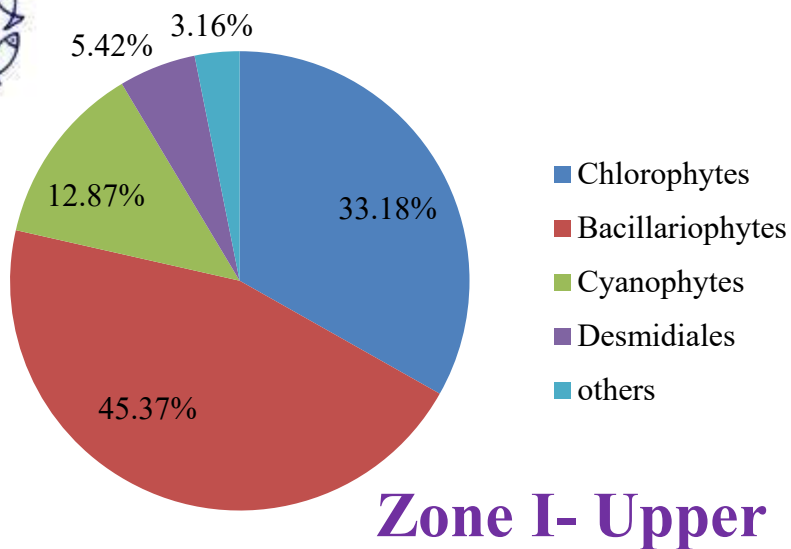
## Breeding stage water requirement

*Tor mahanadicus* breeds during post monsoon season with a river discharge more than 60000 cusec with water temperature  $24.0 \pm 0.5$  °C, pH 7.5 and DO 7.4 ppm

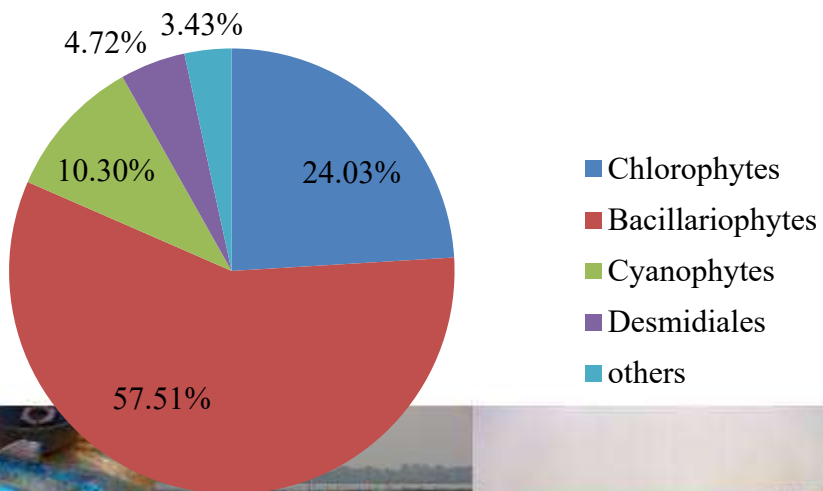
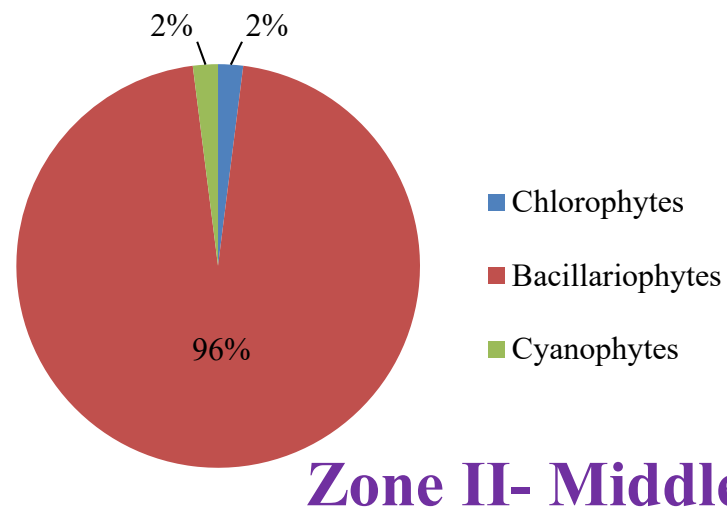
*Sahoo A.K. and Sahoo B., (2015) Environmental flow estimation under climate change. **Current Science**.109 (9): 1522*

*Sahoo A.K. Sharma A.P. and Suresh V.R., (2016) Managing rivers: Ecohydrology an effective tool under climate change. **National Academy Science Letters**. DOI 10.1007/s40009-016-0454-0*





## Percentage of Phytoplankton composition in different stretches of river Mahanadi







## Plankton species suitability water requirement

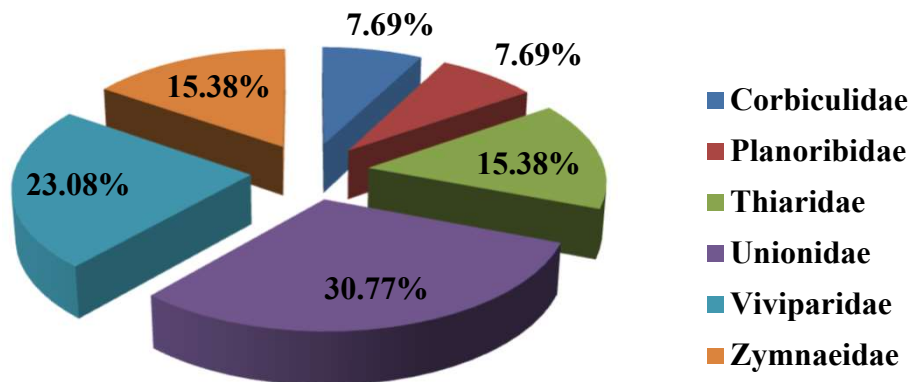


- Association between habitat variables (Flow, Dissolve oxygen, BOD, transparency, specific conductivity, nitrate, phosphate and magnesium) with phytoplankton abundance showed that **Fragilariophytes and Cyanophytes** are more influenced by Phosphate and Specific conductivity during Low flow (8000 to 15,000 cusec) than high flow (>90,000 cusec).

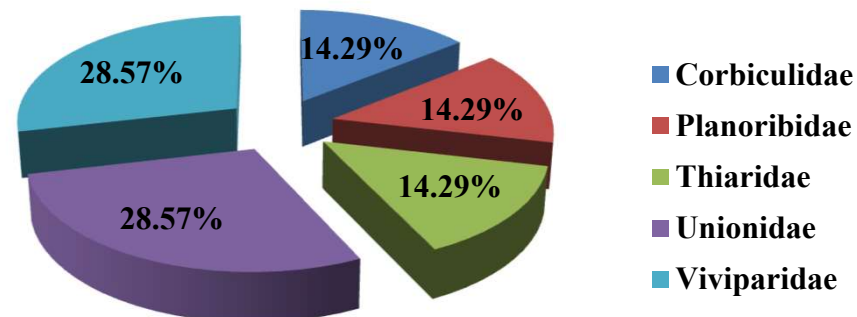




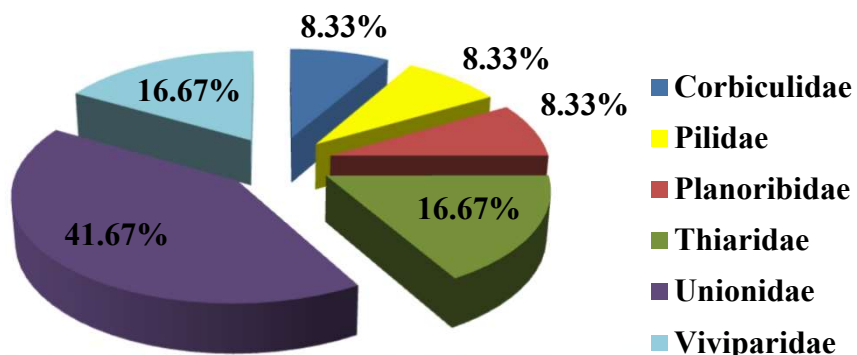
## Macrobenthos composition in different stretches of river Mahanadi



Zone I- Upper



Zone II- Middle



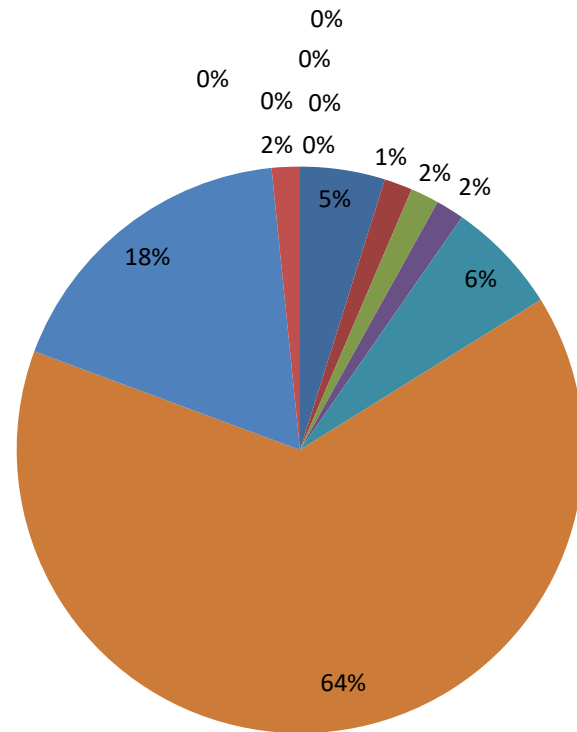
Zone III- Lower



©ICAR-CIFRI



## Fresh water zone



- *Bellamya bengalensis*
- *Corbicula striatella*
- *Parreysia (R) lima*
- *Parreysia occata*
- *Thiara sp.*
- *Thiara(T) lineata*
- *Thiara (m) tuberculata*
- *Thiara scabra*
- *Tellina opalina*
- *Mactra turgida*
- *Mactra mera*
- *Nerita articulata*
- *Polychaeta*
- *Nematoda*



©ICAR-CIFRI

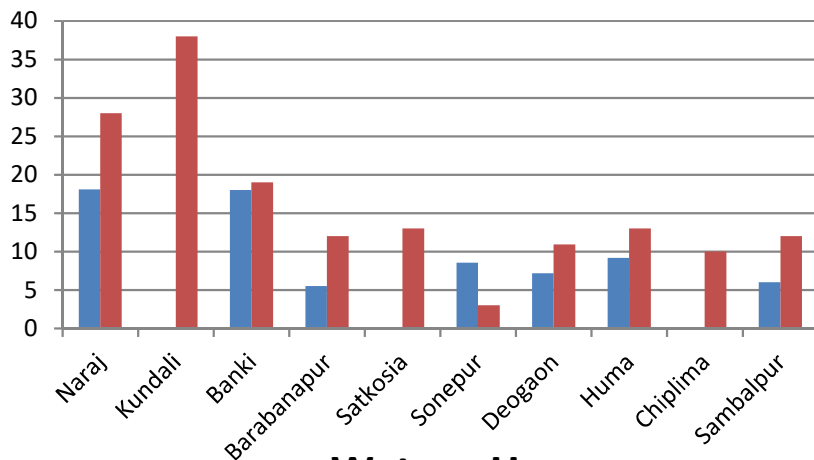




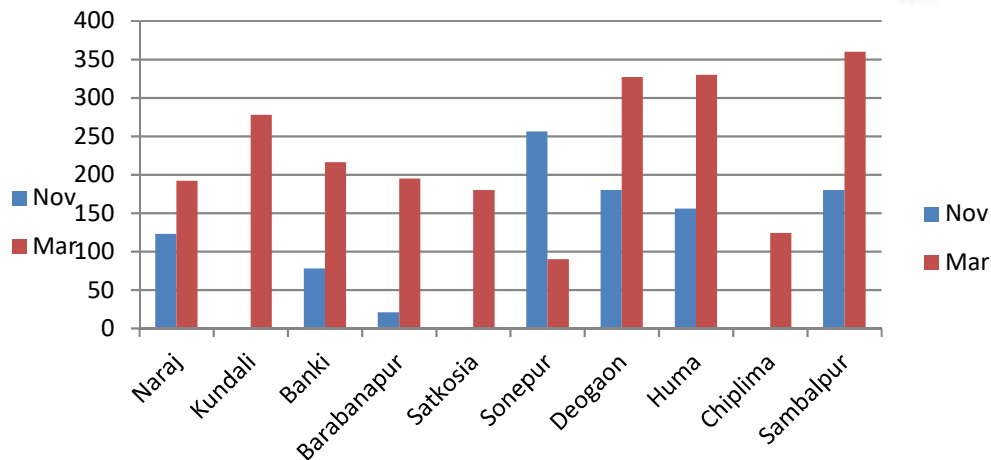
# Physico-chemical parameters:



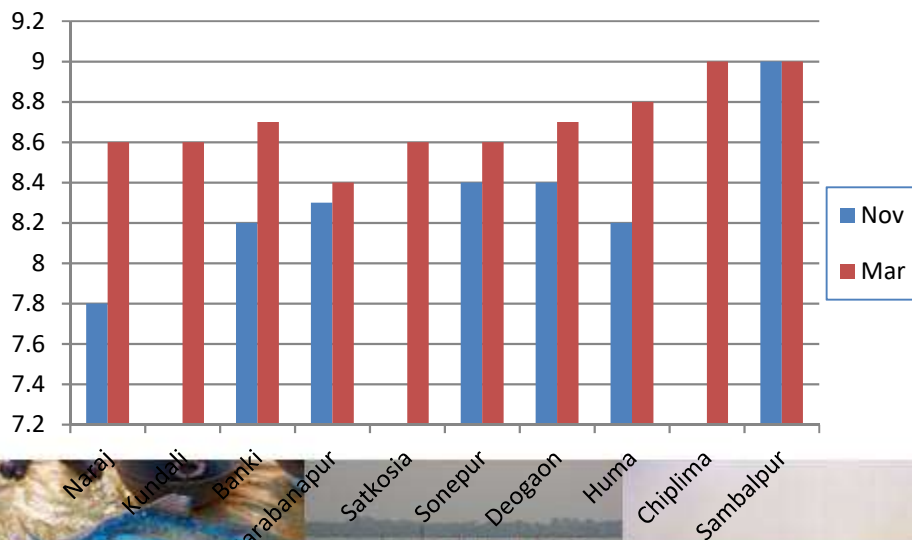
Water depth (ft)



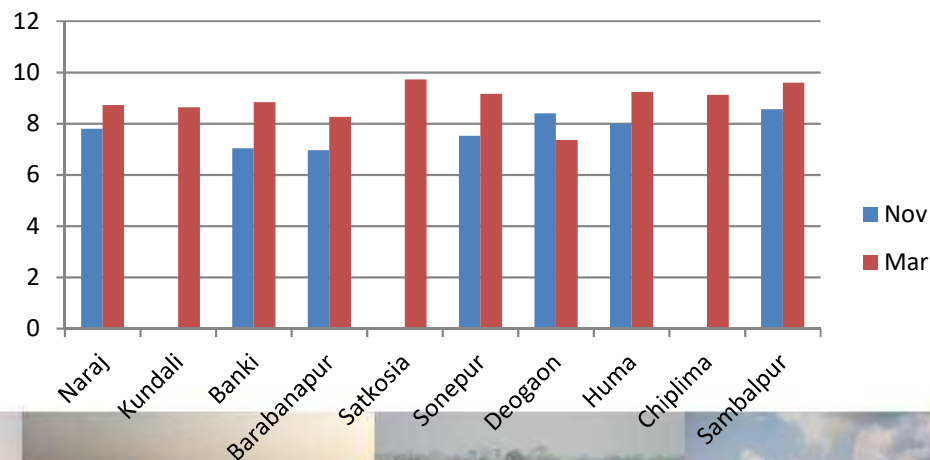
Transparency (cm)



Water pH



Dis. oxygen (mg/l)





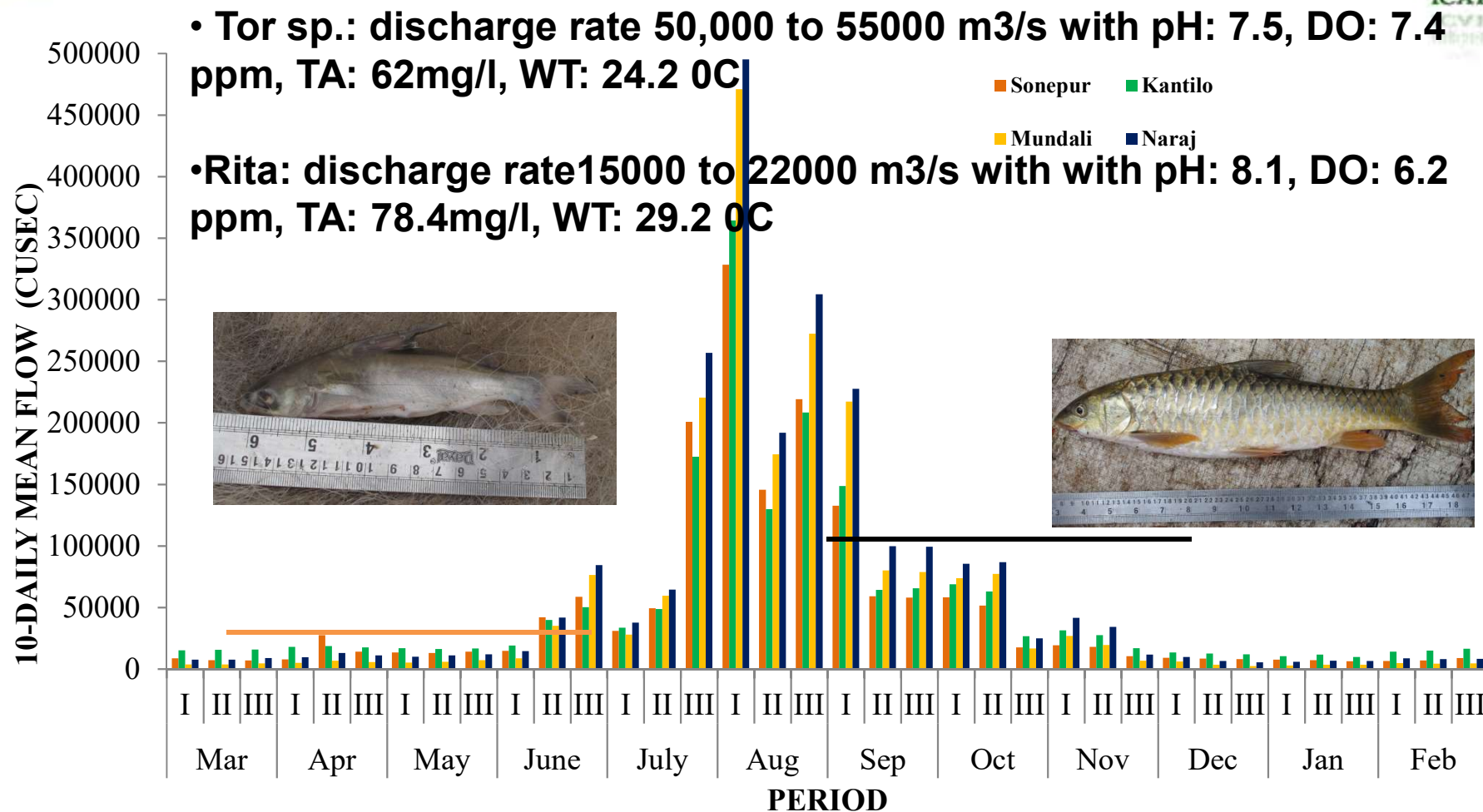
- Redundancy analysis (RDA) was preferred over canonical correspondence analysis (CCA) because of unimodal response of biotic community to the gradient of water quality. **Biotic parameters such as fish, benthos and plankton diversity were associated with the water quality parameters such as velocity, dissolve oxygen, silicate and TDS and observed that fish community is inclined more towards TDS and periphyton is more inclined to higher Silicate value and benthic community is more inclined towards the water velocity. It was noticed that higher the velocity ( $>0.8\text{m/s}$ ) the lesser diversity of *Thiara lineate***







## Water requirement for fish species:



©ICAR-CIFRI



## Awareness on Mahanadi fish conservation through e-flows:



**Staff of State Fishery  
Dept. Odisha**



**State Fishery Department, Village  
panchayat, and NGO, Utsharga,  
Jagatsinghpur, Odisha**



**Fishermen of Boudh  
Dist.**



©ICAR-CIFRI





# Assessment of fish and fisheries of the Ganga river system for developing suitable conservation and restoration plan



*Sponsored by -*  
**NMCG, Ministry of Jal Sakti**  
**Govt. of India**



©ICAR-CIFRI



# FINDINGS



- ❖ An all total of **190 fish species** belonging to 133 genera, 60 families and 17 orders were recorded from 18 selected sampling stations so far under the project.
- ❖ Maximum number of species were recorded from **Bijnour (N=99)** and **Narora (N=91)** in Uttar Pradesh
- ❖ Out of 190 fish species recorded, total of **12 Near threatened (NT)**, **03 Endangered (EN)** and **04 Vulnerable (VU)** have been recorded as per IUCN Red list category ver. 3.1 from the entire stretch of the river Ganga.



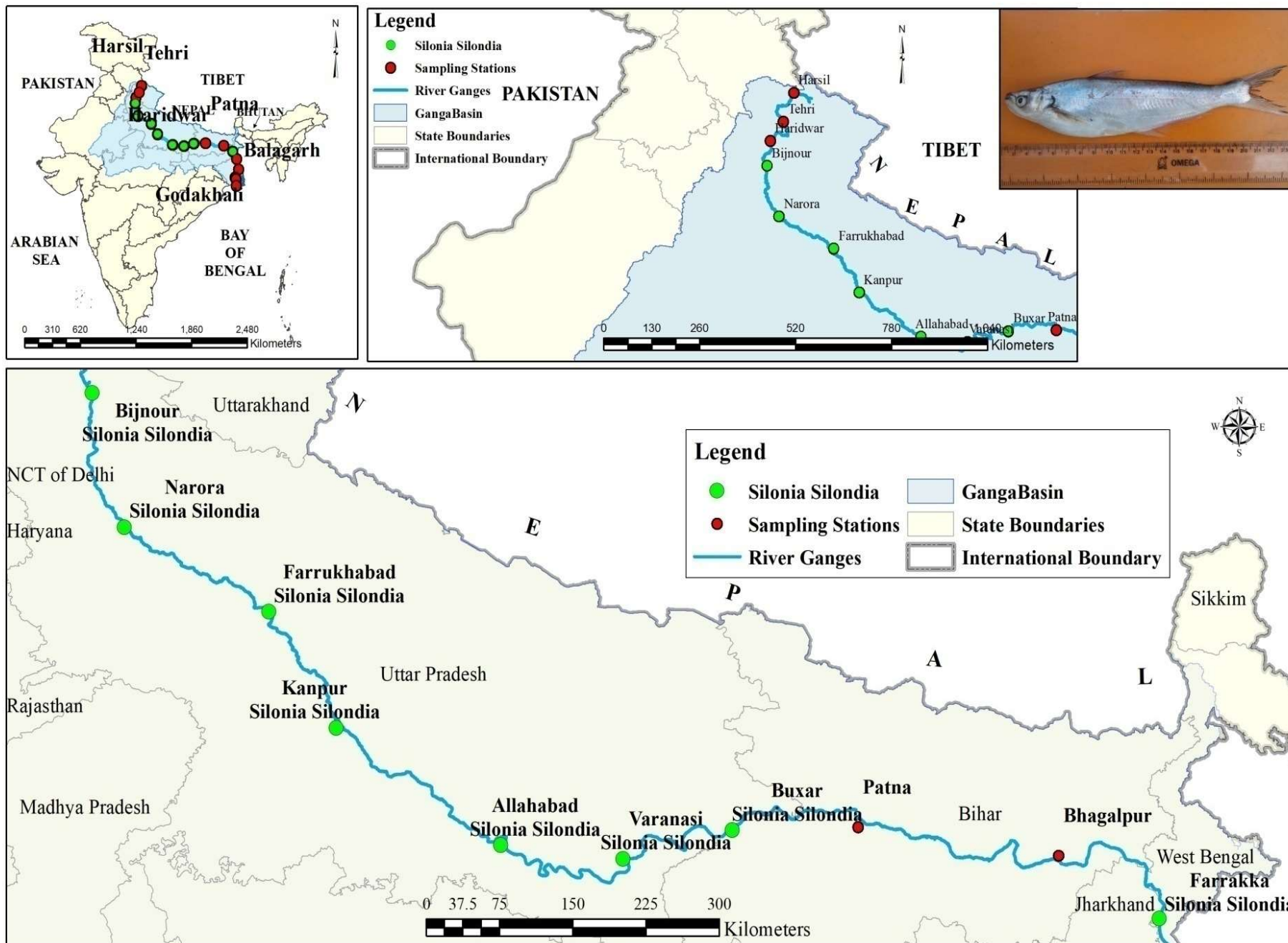
Threat status (IUCN)	Number of species enlisted
Near threatened (NT)	12
Endangered (EN)	03
Vulnerable (VU)	04
Least concern (LC)	120
Not evaluated (NE)	45
Data deficient (DD)	06



©ICAR-CIFRI



## LOCATION OF SAMPLING STATIONS WITH SILONIA SILONDIA ON RIVER GANGES







## River ranching of depleted fish stock and awareness programme



2019/2/8 13:44







**भारत का राजपत्र**  
The Gazette of India

असाधारण  
EXTRAORDINARY

भाग II—खण्ड 3—उप-खण्ड (ii)  
PART II—Section 3—Sub-section (ii)

प्राधिकार से प्रकाशित  
PUBLISHED BY AUTHORITY

सं. 4009] नई दिल्ली, बुधवार, अश्विण 18, 2018/आश्विन 18, 1940  
No. 4009] NEW DELHI, WEDNESDAY, OCTOBER 10, 2018/ASVINA 18, 1940

जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय

(राष्ट्रीय स्वच्छ गंगा मिशन)  
अदेश

ਸ੍ਰੀ ਸਿੰਘੀ 9 ਅਗਸਤ 2018

**क.अ. 5195(क)**—समाजवादी जनताधिकार पत्रिका और हम देश के लोगों द्वारा स्थापित पुस्तकीय है तथा संकाय सत्री बेसिन जवन राष्ट्रीय क्षेत्र के नियंत्रणमुक्त बाजार में प्रसारण सत्री बेसिन है, जिसमें साप्ताहिक देश की दृष्टीय प्रतिष्ठित भूमि सम्मिलित है तथा जो तथाकथ प्रकाश करने प्रत्यक्षता के लिए प्रोत्साहित है।

और समासदी विशेष गुणों विविधताओं तथा मूल्य के रूप में वर्गीकृत है जिसका महत्वपूर्ण नैतिक और स्थानिक प्रभाव विद्यता के साथ अन्य विज्ञान या वास्तुविज्ञान ऐतिहासिक सामाजिक मानविक और वर्तमान कारण है

और समा नदी को राष्ट्रीय नदी का दर्जा दिया गया है तथा नदी दफ्तरी में मिलाई, धरेनु, बाधार्थिक और अन्य प्रयोजनों के लिए बेसिन में सर्वेय पानी की बहाई काम के साथ धरेनु, बाधार्थिक और बाधार्थिक बाधार्थिक मजिद विभिन्न क्षेत्रों में प्रदूषण प्रवेश कर रहा है, जो नदी के स्वास्थ्य को लंबे समय में प्रभावित कर रहा है।

जीर बागल सरकर समुक्ति पयोकरण प्रबल तथा साथ ही नदी में प्रदूषण के प्रवेक के नियंत्रण को सुनिश्चित करने के लिए नदियों की गोदिका की बराली करने और उसे बराला स्थले के लिए बरामबल है।

और यह सुनिश्चित करना आवश्यक है कि सभा सत्री में इन समय सत्री के निर्बाध प्रवाह को पूरी तरह से बनाए रखा जाए, जिसमें सौमरी निष्पत्ति को बढ़ाते बिना सत्री में प्रवाह की निरंतरता सुनिश्चित हो सके।

देशीय मत्स्यजाल ने पर्यावरण (संस्था) अधिनियम, 1986 (1986 का 29) के अर्धीन अधिसूचना का.आ. 3187 (नं.) मार्च 7, अनुसार, 2016 द्वारा समाप्ती प्रलेख के संरक्षण, संरक्षा और प्रबंधन का निम्न लिखित उपोद्देशों के लिए एक वार्षिकताएं अधीन राष्ट्रीय स्तर पर समाप्ती का सफल किया का अधीन:

(न) साना नदी और उसकी सहायक नदियों के जल की शुद्धता और पर्यावरणीय बहालीय संरक्षण, संरक्षा और प्रबंध को सुनिश्चित करने के लक्ष्य में सर्वेय विभिन्न क्षेत्रों में विभिन्न विद्वानों पर बनाया स्थान के लिए अंशित रासायनिक नदी और उसकी सहायक नदियों में पर्यावरणिक।

MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT AND GANGA REJUVENATION  
(NATIONAL MISSION FOR CLEAN GANGA)

## ORDER

New Delhi, the 9th October, 2018

S.O.5195(E).—Whereas, the River Ganga is the most sacred and deeply revered by the people of this country and the Ganga river basin is the largest river basin in India in terms of catchment area, constituting twenty six per cent of the country's land mass and supporting about half a billion population;

And whereas, River Ganga is unique as having special properties, features and importance, holding reasons that are hydrological, geomorphological, historical, socio-cultural and economical with significant temporal and spatial flow variation:

And whereas, River Ganga has been given status of a National river and the ever increasing demand for water in the basin for irrigation, domestic, industrial and other purposes coupled with pollution ingress from different sources including domestic waste, industrial waste, into river system is affecting the health of the said river for long;

And whereas, the Central Government is committed to restore and maintain the wholesomeness of the rivers ensuring appropriate environment flows and simultaneously preventing the pollution ingress into the said river;

And whereas, it is considered necessary to ensure that uninterrupted flows of water are maintained throughout its length at all times in River Ganga to ensure continuity of flows in the river without altering the seasonal variations;

And whereas the Central Government vide notification S.O. 3187(E), dated the 7<sup>th</sup> October, 2016 under the Environment (Protection) Act, 1986 (29 of 1986) has constituted an authority, namely, the National Mission for Clean Ganga for Revivification, Protection and Management of River Ganga basin for the following purposes, namely:-

- (a) to determine the magnitude of ecological flow in the River Ganga and its tributaries required to be maintained at different points in different areas at all times with the aim of ensuring water quality and environmental

[ Part II - Order 3(ii) ] भाग का प्रस्ताव : असाधारण 5

- (iii) the project which is at different stages of construction, where physical progress on ground has been initiated and made and reported to appropriate authority shall also make necessary provisions to maintain the stipulated environmental flow before and after commissioning of the project;
- (iv) the mini and micro projects which do not alter the flow characteristics of the river or stream significantly are exempted from the set environmental flows;
- (v) to ensure the release of desired quantities of water to maintain environmental flows, flow conditions in these river reaches shall be monitored at hourly intervals from time to time;
- (vi) the Central Water Commission shall be the designated authority and the custodian of the data and shall be responsible for supervision, monitoring, regulation of flows and reporting of necessary information to the appropriate authority as and when required and also authorised to take emergent decisions about the water storage norms in case of any emergency. The Central Water Commission shall submit flow monitoring-cum-compliance report on quarterly basis to National Mission for Clean Ganga;
- (vii) the concerned project developers or authorities shall install automatic data acquisition and data transmission facilities or required necessary infrastructure at project sites at appropriate locations specified by the Central Water Commission within six months from the date of this order. The installation, calibration, maintenance of flow monitoring facility shall be the responsibility of the project developers or authorities and they shall submit the data to the Central Water Commission from time to time;
- (viii) the Central Government through National Mission for Clean Ganga may direct release of additional water in the River Ganga to meet special demand as and when required.

IV. The concerned Central and State authorities shall implement demand side management plans to reduce water withdrawal from River Ganga by adopting good and scientific practices such as efficient method of irrigation, reuse and recycle of water including monitoring and regulation of ground water withdrawals for various purposes.

3. This Order shall come into force on the date of its publication in the Official Gazette.
4. This Order shall apply to the upper Ganga River Basin starting from originating glaciers and through respective confluences of its head tributaries finally meeting at Devprayag up to Haridwar and the main stem of River Ganga up to Unnao district of Uttar Pradesh.

[FE No.-E-01/2016-17/111/NMCG/Vol.III]

**RAJIV KISHORE**, Executive Director (Admin)



# Maintaining Longitudinal connectivity in rivers

***Ecological flows***

**+**

***Fish Pass***



©ICAR-CIFRI







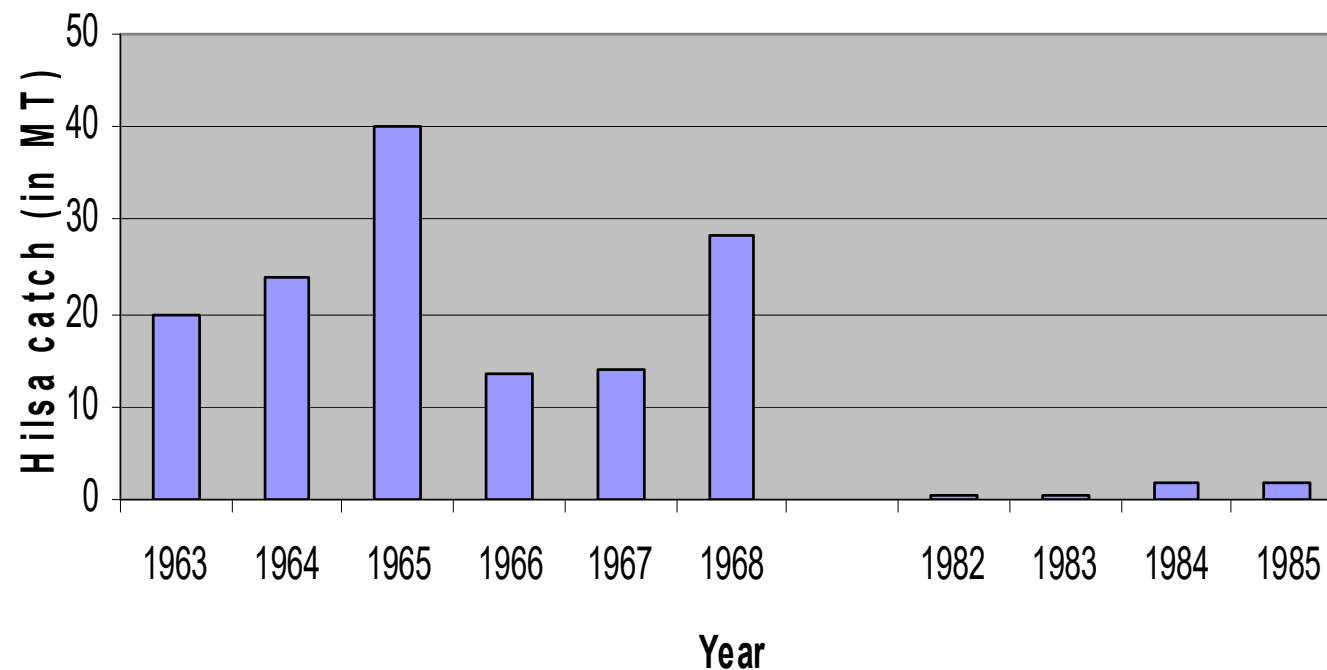
# Hilsa fisheries improvement in middle stretches of river Ganga





Upstream Farakka  
Barrage

## Hilsa Catch at Allahabad



Trend of hilsa catch at Allahabad



©ICAR-CIFRI







CWC, NMCG, IWAI & CIFRI



Hilsa ranching station, Farakka



©ICAR-CIFRI



Hilsa tagging to understand the migration of hilsa in the middle stretch of river Ganga





## GUIDELINES FOR MAINTAINING LONGITUDINAL CONNECTIVITY THROUGH DAMS



CENTRAL WATER COMMISSION

SEPTEMBER 2017

### 3.3.3 Guidelines for maintaining longitudinal connectivity for fish migration

1. Optimum ecological/environmental flows must be estimated taking into account of fish migration, and recruitment.
2. Bypass channel is recommended in the middle and lower stretches of the river for maintaining the fish habitat and migration.
3. Detailed behavioral study on fish migration and habitat requirement of the targeted fish species must be carried out before designing of fish pass/bypass.
4. Design of fish pass in barrages must be site and species specific and should be installed in a straight way with optimum continuous flows and natural slope of the river.
5. In dams with wide gorge or relatively flat topography at abutments, provision of fish passes in the form of fish ladder/ bypass channel should be explored. In other dams, provisions of fish lift shall be explored.
6. In dams, where fish ladder/bypass channel/lift etc. is not suitable due to technical constraint of height and site topography, other conservation measures such as creation of fish hatchery/ fish farm may be considered
7. For planning and design of fish pass in a particular dam and river reach, CIFRI or any other specialized agency shall be consulted.
8. Environmental flow may be used for fish pass water requirement.



©ICAR-CIFRI





# *Present/Future work on environmental flows:*



## GIZ-CIFRI-E-flows Mahanadi delta



©ICAR-CIFRI





***Ohh...Water....***

***You are not something  
that is needed for life;  
you are life itself.***



***Thank You***

