


# Conservation of the River Gang Biodiversity

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# What is Biological Diversity?

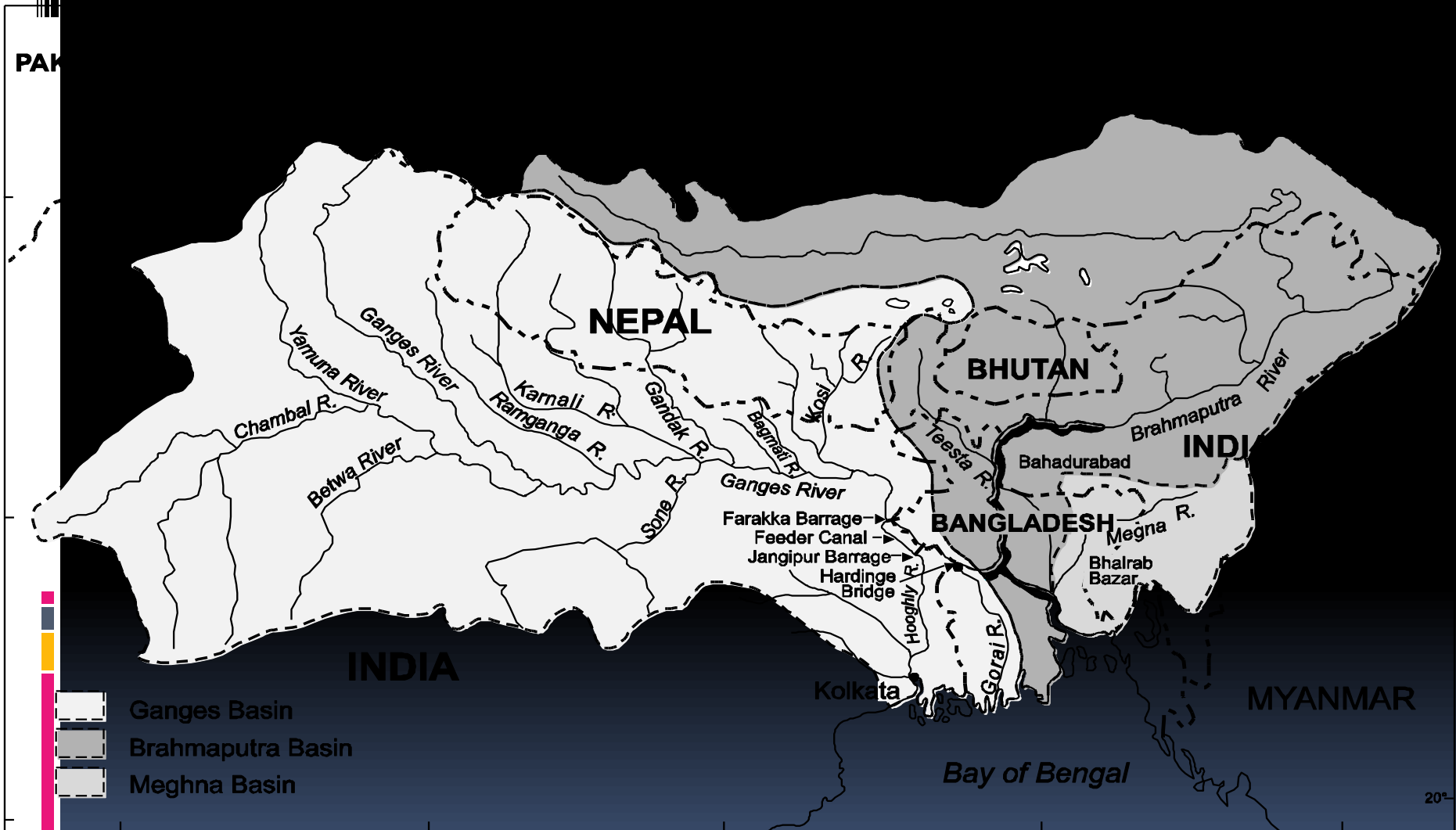
- **Biodiversity is diversity within species, between species and of ecosystems.**
  - **Biodiversity is extremely complex, dynamic and varied like no other feature of the Earth. At the same time, no other feature of the Earth has been so dramatically influenced by man's activities as that of biodiversity.**
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The Ganga basin harbours a rich biota including wide variety of relict species, like the Ganges river dolphin (*Platanista gangetica gangetica*), the Ganges river shark (*Glyphis gangeticus*), Ganges soft-shell turtle (*Nilssonina gangetica*), gharials (*Gavialis gangeticus*) and several species of endemic freshwater crabs. The Ganga is home to 265 fish species.

Increasing population growth, industrial development, urbanization, deforestation, construction of dams and barrages as well as embankments have adverse impacts on ecological health of the river including its biodiversity. A steady decline in populations of prized carp and *Tenualosa ilisha* (hilsa) fishes, as well as minnows has been observed after commissioning of the Farakka Barrage in 1975. The Farakka Barrage has a significant impact on fisheries as far up as Allahabad, about 1000 km upstream Farakka. Catches are reported to have declined from an average of 19.2 ton hilsa/year to 0.9 ton hilsa/year. The yield of the major carps has been reduced from 26.62 kg/ha/yr in 1958–1961 to a dismal low of 2.55 kg/ha/yr in 1995



# GANGA BASIN



The Basin Area in India 861000 km<sup>2</sup>

Annual Mean Discharge  $18.7 \times 10^3 \text{ m}^3 \text{ sec}^{-1}$

Ganga-Brahmaputra-Meghna basin is 0.12% of Earth's surface where 10% of world's Population reside

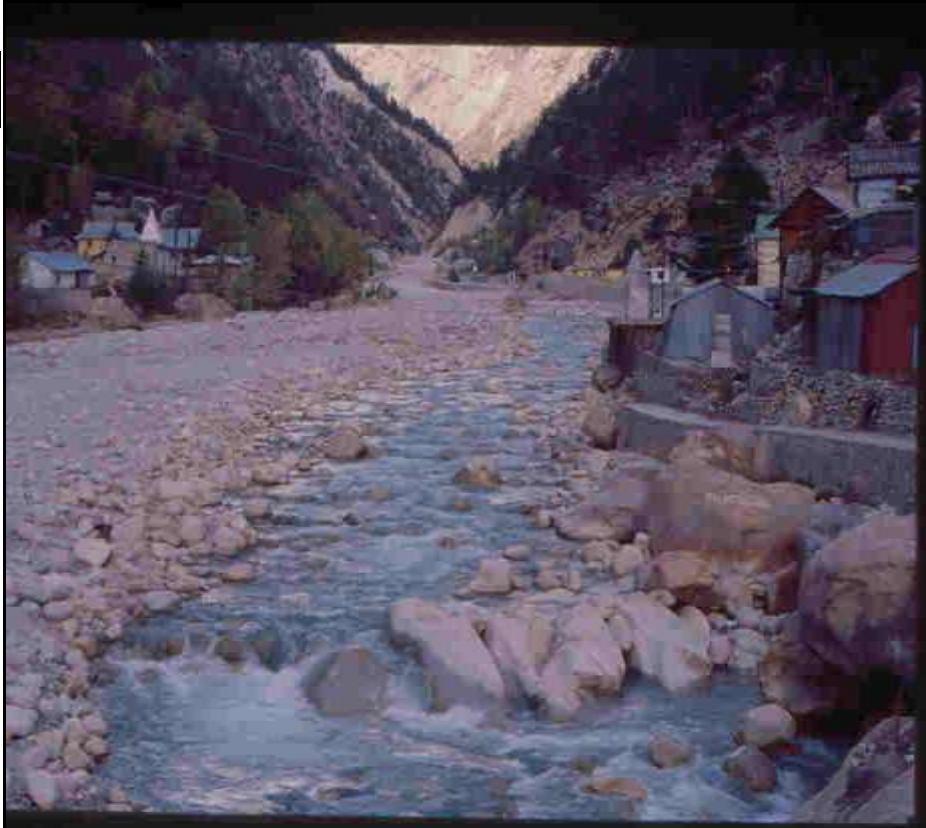
## Gomukh, the origin point of the Ganga ( $4100\text{ m asl}$ , $30^{\circ}55'\text{ N}$ , $79^{\circ}07'\text{ E}$ )



The River Ganga originates under the name of River Bhagirathi from Gangotri Glacier system ( $30^{\circ}43' - 31^{\circ}01'\text{N}$  and  $79^{\circ}00' - 79^{\circ}17'\text{E}$ ) at Gomukh ( $30^{\circ}55'\text{N}$ ,  $79^{\circ}07'\text{E}$ ) cave at an altitude of  $4100\text{ m ASL}$  in Garhwal Himalaya.

The Gangotri Glacier system is a cluster of many glaciers comprising the main Gangotri Glacier (length:  $30.20\text{ km}$ ; width:  $0.20 - 2.35\text{ km}$ ; area:  $86.32\text{ km}^2$ ).





Ganga at Gangotri



# Natural Flow of Ganga in the Himalaya





# Natural and Regulated Flow in the Ganges in the Himalayas



## Effects of Dams



**Ganga at Dharasu, 45 km  
upstream of  
Tehri Dam**





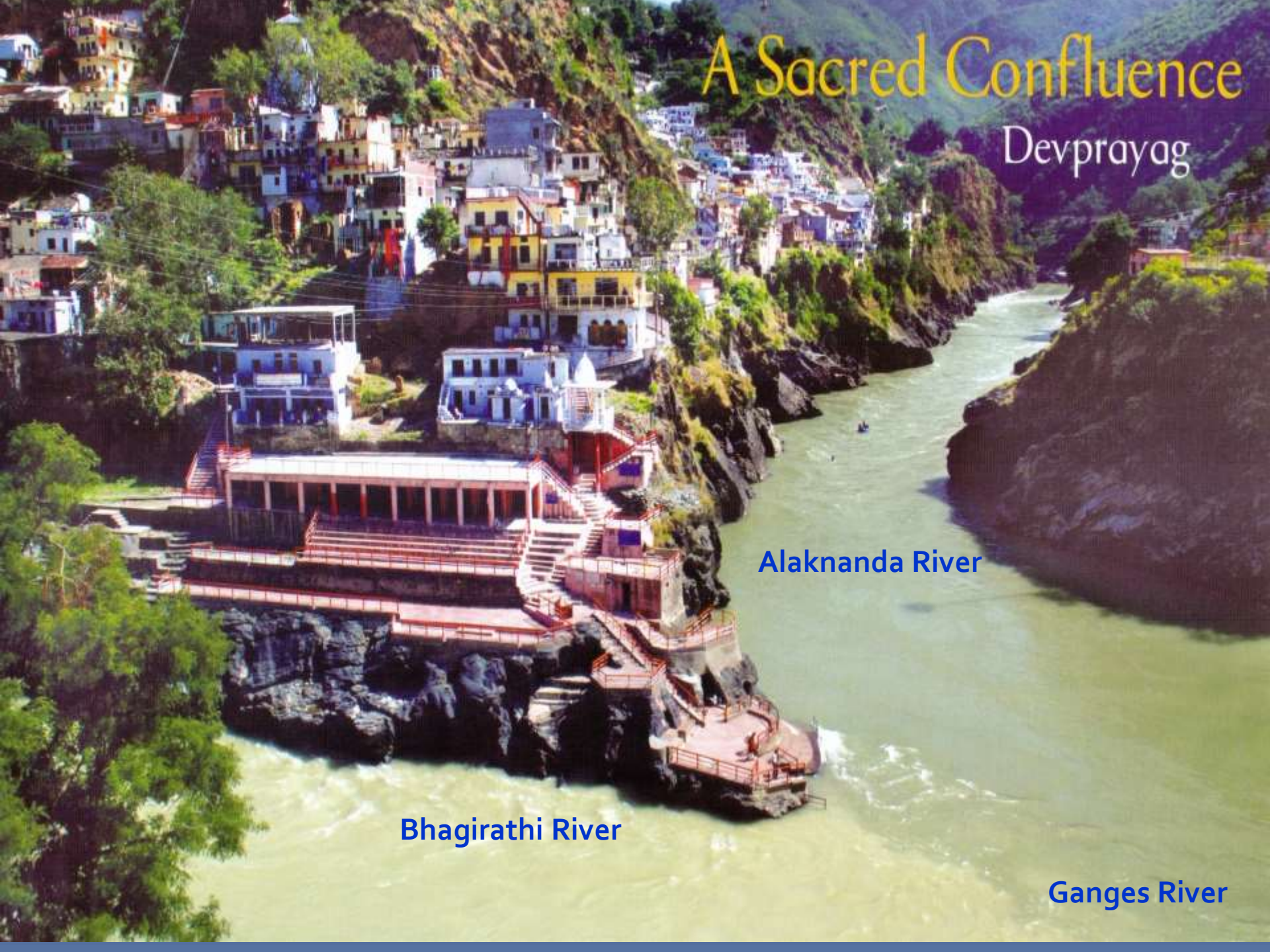
# A Sacred Confluence

## Devprayag

Alaknanda River

Bhagirathi River

Ganges River







# RIVER ECOSYSTEM

**Rivers are not linear channels.**

**Rivers are  
three-dimensional  
dynamic systems  
dependent on  
*longitudinal, lateral and  
vertical transfers of  
material, energy & biota***



**We talk of**

**Landscapes**





But not the



**Riverscape**



and ....

invade the Riverscape





Braided Ganga at Kanpur with wild meanderings



River Sarda at Sardanagar  
Barrage



## Ganga at Patna in August showing lateral connectivity



Average annual suspended load Ganga: 1451 million tonnes; 1518 tonnes/km<sup>2</sup>

Kosi: 172 million tonnes; 2774 tonnes/km<sup>2</sup>    Huang: 1887 million tonnes; 2804 tonnes/km<sup>2</sup>



The Ganga created a vast fertile plains, which attracted settlements of people over time. 10% of world's population are residing in 0.12% of world's land mass in Ganga- Brahmaputra- Meghna river basin in Indian subcontinent.

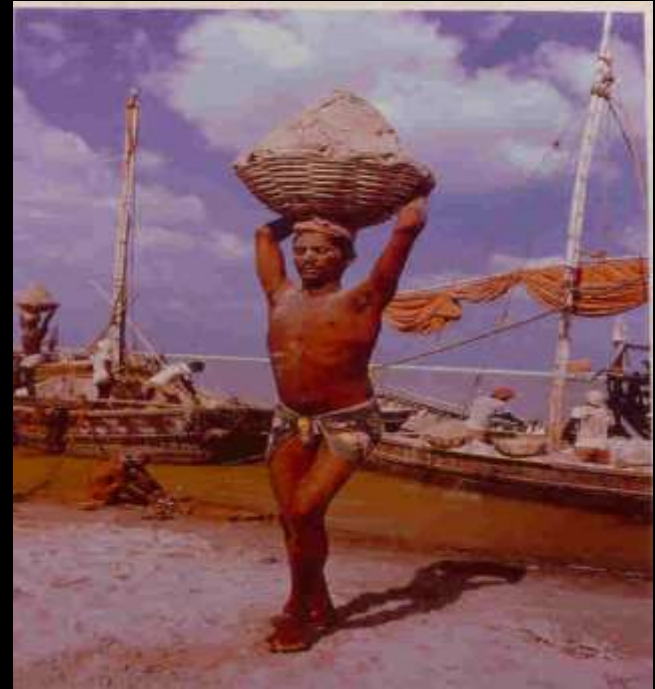


**Crops in floodplains**



**Over 1000 big Sand mining boats operate only at Doriganj, Chhapra, in Bihar**





Livelihoods from the Ganga floodplains





**Ganga behind Farakka Barrage in 1991**



**Farakka Feeder Canal**



**Ganga below Farakka Barrage**

# Ganga behind Farakka Barrage in 2004



Almost 3 km long and 300 m wide sand bar emerged in the pondage area at Farakka



Searching the Dolphins and other biota in Ganga





Survey team at Howrah Bridge



Survey team arrived at Ganga Sagar



Crabs at Ganga Sagar Island, mouth of Ganga



# Species diversity of the Ganges

## Fungi

- In water : 51 species
- In sediment : 54 species
- Dominant genera. : *Aspergillus* (11 sps.)

## Algae

- Chlorophyceae : 264 species
- Cyanophyceae : 237 species
- Bacillariophyceae : 240 species

Macrophytes : 79 species

## Invertebrates

- Protozoa: 28 species
- Rotifera: 104 species
- Oligochaetes: 37 species
- Polychaetes: 11 species
- Hirudinea: 14 species
- Cladocera: 36 species
- Bivalves: 36 species
- Gastropods: 40 species

## New records

39 aquatic Annelids

- 27 Oligochaeta
- 10 Hirudinea
- 2 Polychaeta

Fish: 265 (375) species

Amphibians: 11 species

Reptiles: 27 species

Aves: 177 species

Mammals: 11 species

## Biodiversity in the Himalayan Ganges

- In the Himalayan segment from Gaumukh to Haridwar (294 km), the river flows in gorges and on steep gradient of 1 in 67.
- The river bed is composed mostly of rocks, boulders intermingled with pebbles and sand, carries cold water, has less pollution sources, and is highly sensitive and has fragile ecosystem and biodiversity.
- The Himalayan Ganges supports a distinct biodiversity with rich habitat diversity in terms of rapids, runs, riffles, and pools. Biodiversity in the stretch are represented by plant diversity (periphyton and phytoplankton), animal diversity (zooplankton, zoobenthos, fish and other vertebrates) and microbes (bacteria, fungi, actinomycetes). Macrozoobenthos are extremely diverse group of animals dwelling in this part of the Ganges.



## Biodiversity in the Himalayan Ganges

- Macrozoobenthos are represented by nymphs and larvae of Ephemeroptera (15 species), Plecoptera (5 species), Trichoptera (4 species), Hemiptera (3 species), Diptera (7 species), Coleoptera (8 species), Odonata (5 species), Mollusca (4 genera), and Annelida (2 genera).
- As the river flows down through the plains the diversity gets richer.

# Fish in the Himalayan Ganga

- The uppermost stretch of the River Ganga is devoid of fish and is called "No fish Zone" as the fish cannot survive under the extreme environmental conditions of very low temperature and turbulent water current. The metarhithronic zone is known as "Snow Trout Zone" which provides conducive habitat for the species of *Schizothorax*.
- Hyporhithrone is characterized by "Mahseer Zone" dominated by pools and few runs and rapids. This zone has a high volume of water and sufficient food to sustain big fish like Mahseer.
- **Sixty fish species belonging to 27 genera and 12 families** are represented in the Ganges. Cyprinidae is the biggest family with 35 fish species

## Upper reaches (Foothill downwards)

- 40 species of zooplankton, 4 crustaceans, 15 molluscs, 51 insects, 83 fishes, 12 turtles, 2 crocodiles (Gharial and Crocodile), 48 aquatic birds and two mammals (Ganges River dolphin and Soft-coated otter) have been documented from the upper reaches of the Ganges between Rishikesh and Kanpur (over 850 km)



## Ganga from foothill to Varanasi

- In the segment, Haridwar to Varanasi (1081 km), the river flows in plains, meandering on bed of fine sand, has wide river bed and floodplains, and has been modified by construction of dams and barrages for diversion of water mainly for irrigation purposes.
- Due to Diversion of over 80% of river water to the irrigation canals, and discharge of industrial and domestic effluents, besides non-point sources of pollution mainly from agriculture sector, the segment downstream Narora Barrage to Allahabad (600 km), especially in and around Kanpur, is grossly polluted.
- The river gradient is 1 in 5000 in this segment.
- Declining river flow and polluted river water are matter of serious concern in this segment.

## Ganga-----

- Besides encroachments of river bed, gravel and sand mining, farming in river bed in dry season, etc are some other concerns.
- Several large and mega religious conglomerations are part of socio-cultural dimensions of the riverine systems at places like Haridwar, Allahabad, and Varanasi.
- Twelve species of turtles has been documented in this stretch.



## Mahakumbh at Haridwar

Ganges water diverted in canal  
at Haridwar





## Lower Ganga

- Lower Segment of the Ganges from Varanasi to Ganga Sagar (1383 km) receives water from glacier-fed large rivers like Ghaghara (Karnali river + Mahakali river), Gandak, Kosi; rain-fed and groundwater and spring-fed rivers originating in lower Himalayas or foothill of the Himalayas like Gomati, Rapti, Bagmati, Burhi Gandak, Mechi etc.
- The third category of rivers originate in the central India and are rain-fed. The gradient of the Ganges from Varanasi to Farakka is 1 in 13000 and from Farakka to Ganga Sagar is 1 in 24000.
- Thus in this segment the river is almost flat and has created vast floodplains on its both banks. Annual flood is a common feature in this segment.
- Very few industries are located in this stretch except near Kolkata. There is only one Farakka Barrage in this segment on the main stem of the Ganges.
- The main source of pollution is urban domestic effluents from towns and cities besides non-point sources in Agriculture sectors

## Lower Ganges

- This segment offers unique biodiversity with many important wetland systems.
- The Ganges river stretch in Bihar (over 500 km) and its tributaries sustains highest number (approximately 1500) of Ganges River dolphin.
- The River Gandak harbors a population of over 50 Gavialis (fish eating crocodile) population.
- Few families of the soft-coated otter, *Lutrogale perspicillata*, have been encountered in the rivers and wetlands in the segment.
- Good population of soft-shell turtles, *Nilssonia gangetica* and *Lyssemis punctata*, thrived in this segment but due to rampant poaching their number is declining very fast.
- After construction of Farakka Barrage in 1975, anadromous fishes like hilsa and catadromous fishes like eels, freshwater prawn etc. have been affected very badly.
- Some euryhaline species like polychaetes are found in this zone.



*Gaviialis gangeticus*, a fish eating crocodile



*Chitra indica*, Indian narrow headed soft-shell turtle



Turtle poachers



*Nilssonina hurum*, Peacock soft-shell turtle





Pelicans and Spoon Bill in the Ganges in Bihar



Indian skimmers in the River Sarda



Open-billed storks along the bank of Ganga



An otter feeding on a fish



Otters in Ganges near Bhagalpur



Ganges dolphins surfacing and leaping in Ganga

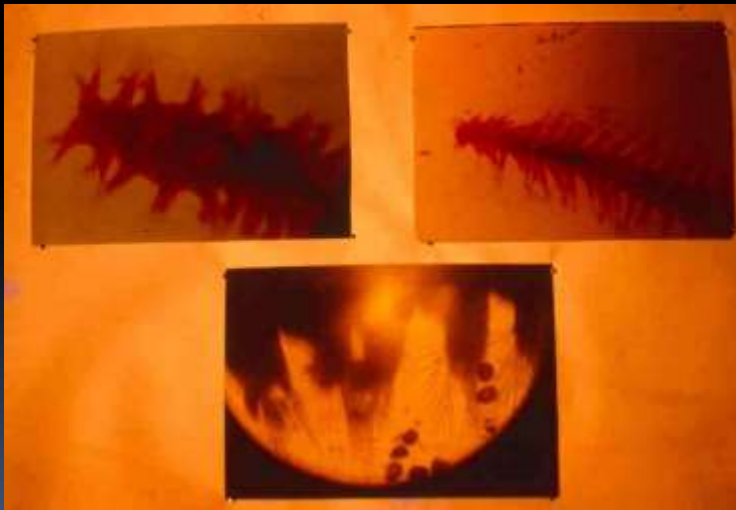
# Some interesting invertebrates



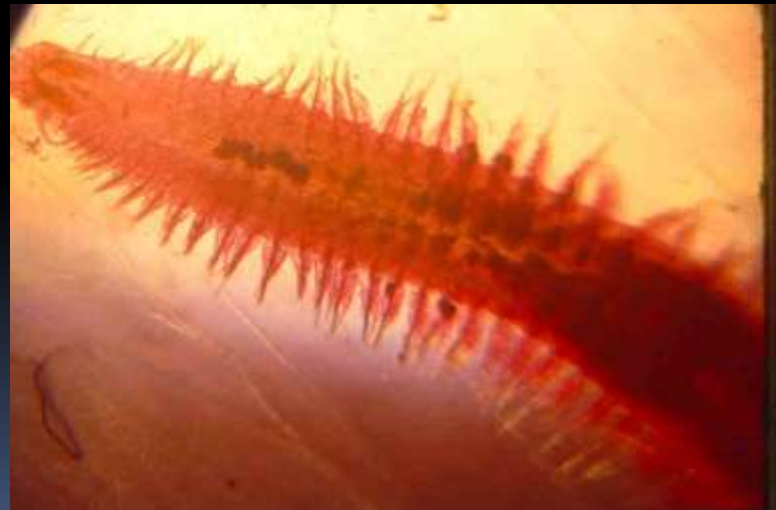
Mayfly nymphs in the Ganges, an indicator species of organically unpolluted water



Mayfly nymphs



*Nephthys polybranchia*, another marine element In the Ganges



*Namalycastic indica*, a marine element in the Ganges



## New species from the Lower Ganges

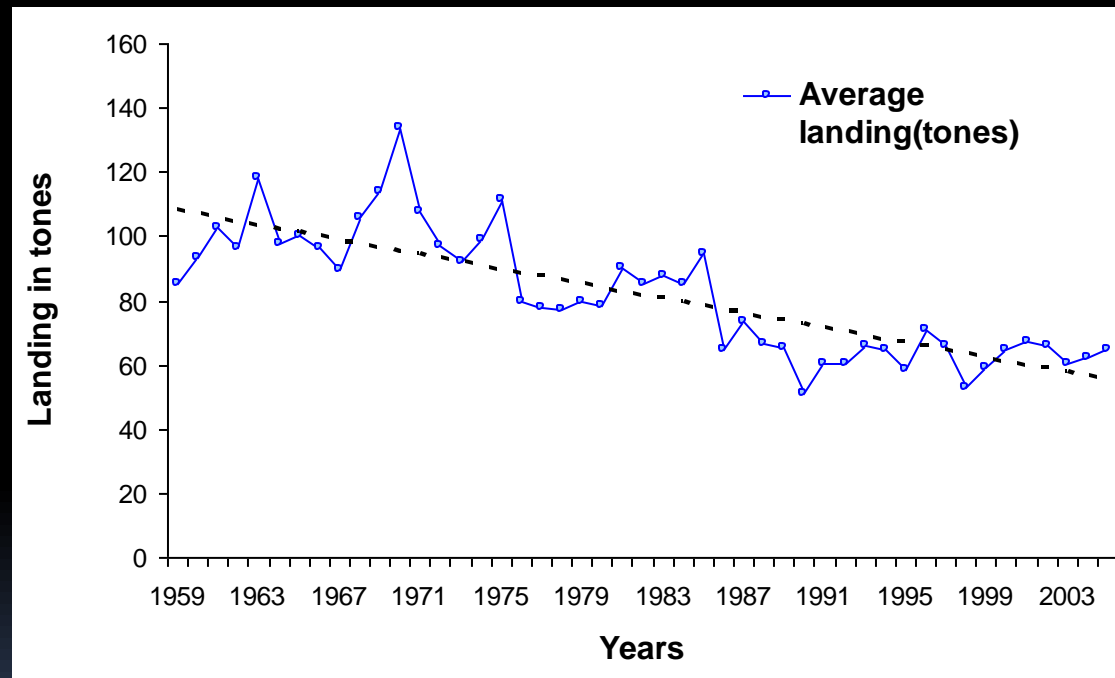
- New records of thirty-nine aquatic annelids (27 Oligochaeta, 10 Hirudinea and 2 Polychaeta) from the Ganga and adjacent water bodies at Patna.
- Two naidids- *Nais bretscheri* and *Pristina acuminata* were reported for the first time from the Indian sub-continent.
- One leech species, *Salifa biharensis* is new to science.
- Three species of bivalvia from the Ganga (*Scaphula celox*, *S. deltae*, *Novaculina gangetica*) are marine relicts of the families Arcidae and Solecurtidae

## Economically important fishes in the Ganges

- The **major carp** yield at Allahabad has decreased from **44.5% in 1958-66 to 8.3% in 1996-97** and *Tenualosa ilisha* (hilsa) from 9.7% to 4.2 in the same period, while large catfishes yield increased slightly from 22.7% to 24.1%.
- The miscellaneous fishes (*Setipinna phasa*, *Chela spp.*, *Mastacembelus spp.*, *Puntius spp.*, *Eutropiichthys vacha*, *Clupisoma garua*, *Notopterus spp.*, *Rita rita*, *Mystus vittatus*, *Ailia coila*, *Nandus nandus* etc) yield increased from 23.1% to 63.4% at the same centre and duration.

# Total average fish landing in Ganga (Kanpur-Bhagalpur) during 1959-2004

The total average Fish landings in the Ganga River systems Declined from 85.21 Tones during 1959 to 62.48 tones during 2004





## Increase in fish catch in Estuarine zone

- The average annual yield of prawn and fish from the estuary increased from 9481.5 tons in pre-Farakka barrage period (1966-67 to 1974-75) to 61032 ton during 1997-2000. This is due to increased influx of freshwater in the Hooghly after commissioning of the Farakka Barrage in 1975.
- Hilsa fishery increased more than five times in Hooghly from 1457.1 tons in 1975 to 9576.9 tons in 1997-2000. Freshwater species like *Eutropiichthys vacha*, *Clupisoma garua*, *Rita rita*, *Aorichthys seenghala*, *A. aor*, *Catla catla* and *Labeo bata* have made their appearance in the upper zone of estuary not reported prior to construction of Farakka Barrage.

# Threats to the River Biodiversity of the Ganga

## Receding glaciers: climate change and declining flow in the Ganga:

- Undoubtedly, the glaciers are retreating, but not at a catastrophic rate and they are not going to disappear in the near future .
- Assuming the recession rate of Gangotri glacier to be 40 m/yr, simple computations show that a glacier of 30 km length will take about 700 years to completely melt away. Further, there will be years of heavy snow fall in between which will extend the life of the glaciers.
- As different glaciers in the same climatological set-up respond differently to the changing climate, long-term studies on glacier mass balance and glacier dynamics are needed to understand the impact of climate change on Himalayan glaciers.
- Since global warming will have effect on other variables like precipitation intensity and quantity, cloud cover, wind etc. besides temperature change, a detailed measurement and modelling study needs to be conducted to derive useful inferences.

## Habitat Alteration

- The major causes of habitat alteration are **construction of dams and barrages, embankments, drainage channels, sedimentation**, etc. Three dams being constructed in Tibet region is likely to affect flow in Brahmaputra. Similarly HEPs in Garhwal Himalayas in India will adversely affect flow in the Ganges.
- The Western Ganga Canal diverts more than 60% of the annual flow, and almost 100% of dry seasons flow at Haridwar.
- The Lower Ganga Canal at Narora, about 264 km downstream of Haridwar, diverts even more water.
- The **dams and barrages act as physical barrier** for migratory aquatic species and block the downstream transport of particulate matter, which replenish a delta and is an important source of nutrients and food for aquatic biota.
- The Farakka Barrage traps the silt from the Ganges water and the "silt free" water is diverted through the Farakka Feeder Canal (38 km) to the Bhagirathi-Hooghly river system. The 'silt free' water has destroyed the hydro-geomorphological complexities, essential for biodiversity in the River



## Embankments as flood control measure

- Construction of 3500 km embankments as flood control measures, increased the flood affected areas 3 times in Bihar

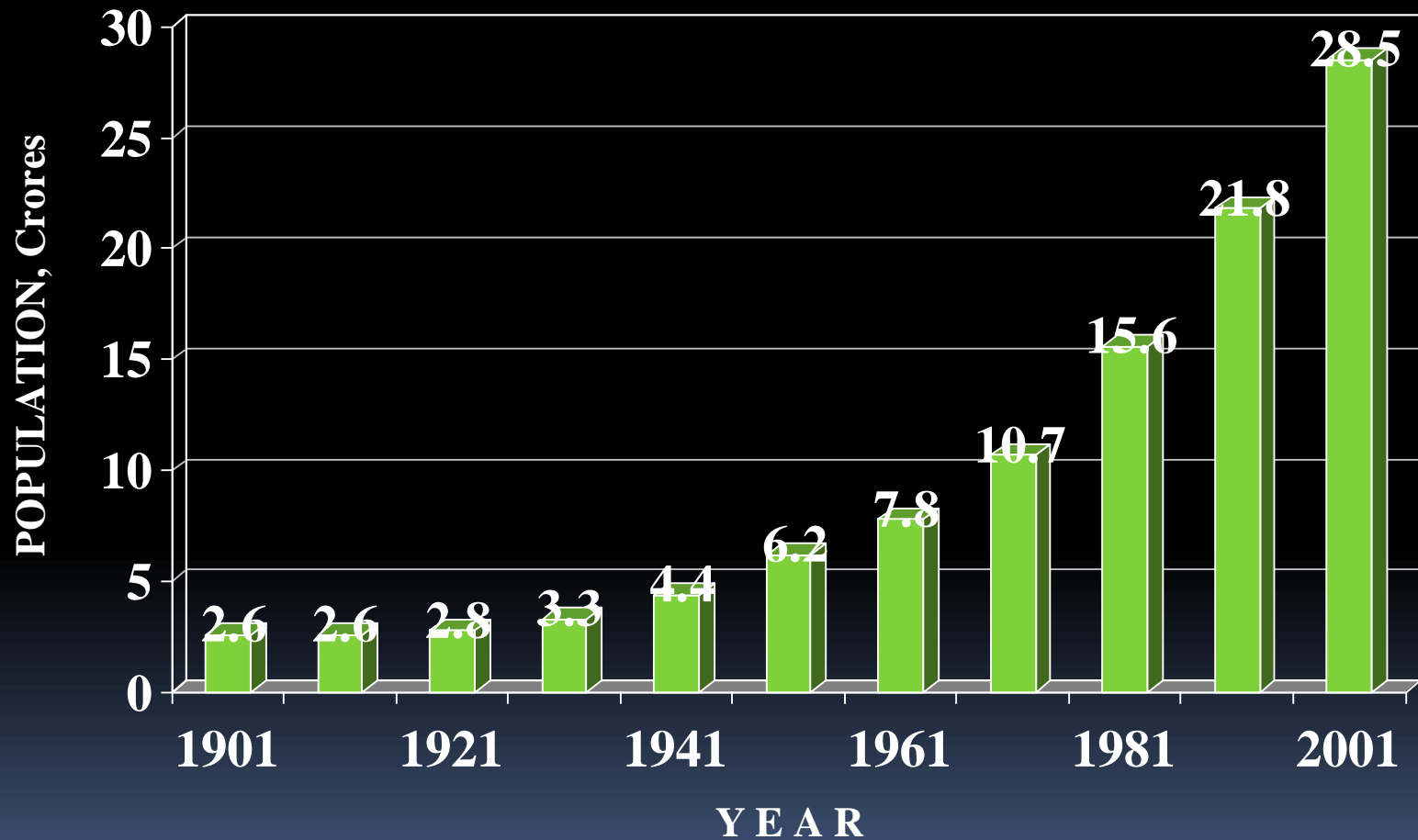
## Wetland destruction

- Wetlands are vanishing in the Ganga basin due to excessive siltation, channelization and construction of embankments
- Wetlands help in maintaining water quality, recharge groundwater, provide habitat for various species and their life history stages.

## Pollution

- As per National Mission for Clean Ganga total sewage discharged in the Ganga basin is 13000 MLD; treatment capacity is only for 4000 MLD.
- From 29 Class – I and 23 Class – II cities total sewage discharged along the Ganga main stem is 2600 MLD and treatment capacity is only for 997 MLD.
- Delhi alone discharges 3300 MLD sewage in the Yamuna.
- The agriculture sector drains about 134.8 million m<sup>3</sup> wastes into the Ganga basin. Fertilizers used in agriculture activities in basin released about 887133 tons of Nitrogen; 137445 tons PO<sub>4</sub> and 91247 tons Potassium.
- Similarly 2573 tons pesticides, mainly DDT and BHC-Y are applied annually for pest control.
- In addition, hundreds of human corpses are released to the river each day for spiritual rebirth. Besides, thousands of animal carcasses are also dumped in the river.

# Increase in Urban Population in Ganga Basin







Different sources of organic pollution in Ganga

## Use of organochlorines in the floodplains of the Ganges



Tissues	DDTs	HCHs	CHLs	PCBs
Blubber	41800	1400	160	4000
Liver	1200	117	3	285
Milk	480	400	33	620

Concentrations in ng/g wet wt.

# Exotic species in Ganga Basin

- Thai Mangur (*Clarias gariepinus*)
- Chinese grass carp (*Ctenopharyngodon idella*)
- Common carp (*Cyprinus carpio*)
- Tilapia
- South American ornamental aquarium cat fish (*Pterygoplichthys anisitsi*)
- *Physa* (Haitia) *mexicana*, a snail
- *Eichhornia crassipes*, Water Hyacinth from Latin America
- Parthenium, a North American grass

# Over-exploitation of bio-resources

## FISH

- Fish production decreased by 22% at Allahabad and 75% at Buxar during 1958 to 1984.
- During 1961 – 69 to 1980 – 86 fish production declined by 42% at Patna.
- Collectively Indian Major Carps accounted for 40% in 1958 – 61; declined to 32.41% in 1972 – 79 and 22.3% in 1995.
- At Patna IMC constituted 31.4% in 1958 – 61 and declined to 6.5% in 1993 – 95.

## Reptiles

- Soft – shell turtles (*Nilssonina gangetica*), an endemic species has reduced to scarce.
- > 5000 such turtles confiscated during 2006 – 08 in Bihar being smuggled to West Bengal from Uttar Pradesh state.
- Gavialis and crocodiles are almost extinct

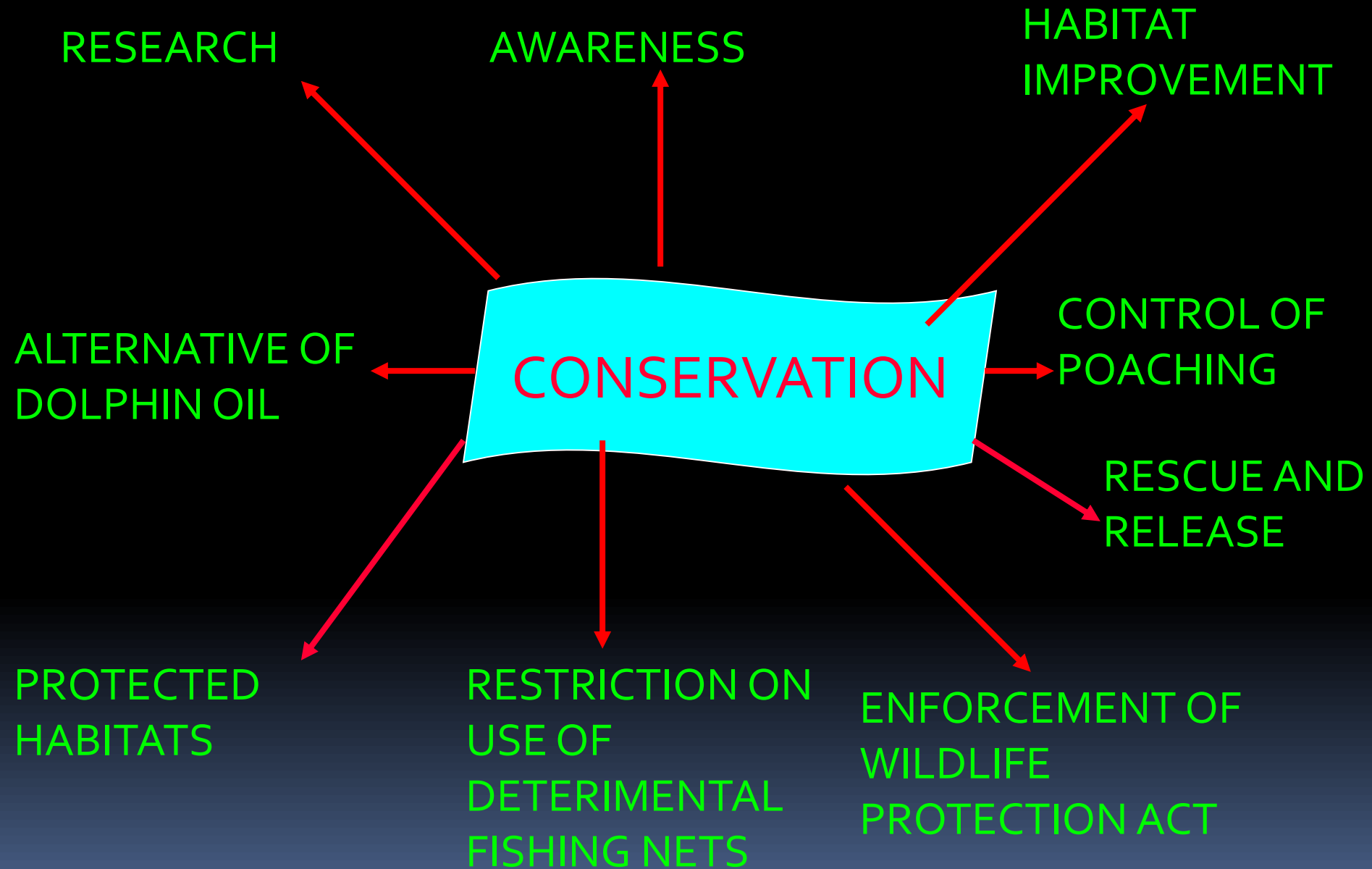
## Mammal

- Gangetic dolphin reduced to about 3000 in the Ganga and its tributaries including Brahmaputra
- Smooth coated otter population has also declined to critical level



## Intense Fishing in Sundarbans where dolphins also live





# HOW TO CONSERVE RIVER BIODIVERSITY?

- We must address the different threats the rivers are facing.
- Conservation of riverine biodiversity requires adequate understanding of the structure and functioning of particular river system.
- Rivers are three-dimensional systems involving longitudinal, lateral and vertical transfers of material, energy and biota.
- The flow regimes of a river play the most critical role in conservation of river biodiversity.
- In India, there has been considerable emphasis on the treatment of domestic and industrial wastewaters for “restoring” the water quality while the flows issues continued to be neglected.
- Rivers have been perceived only as channels which could be modified at human will.

- The Conservation of river biodiversity must address the issues of climate change as increased variability in precipitation is projected for all the river basins in our country, the variability is expected to be much higher in the Himalayan region.

- The flow data in the Ganga basin are highly classified and their non-accessibility is in itself a major stumbling block in biodiversity conservation.



## HOW TO CONSERVE RIVER BIODIVERSITY?

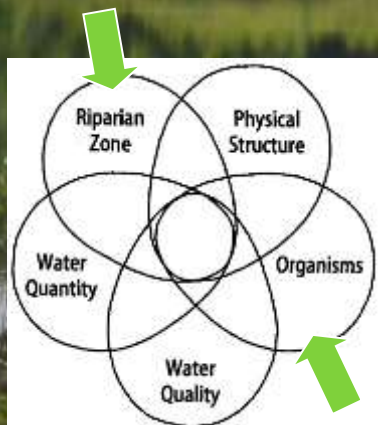
- The floodplains have been eliminated and, in most cases, the riparian vegetation completely lost. It may be emphasised that floodplain is an integral part of rivers.
- **Much of the riverine biodiversity cannot be conserved without their floodplain habitats which are also allowed to interact with the river channels.**
- Also, the impacts of catchment degradation cannot be overlooked.
- Conservation of riverine biodiversity cannot rely upon the ex-situ and protected area approaches. Fish nurseries, induced breeding and river ranching may be appropriate for a couple of endangered species but cannot substitute for the loss of populations in their natural habitats.
- Rivers must be allowed to have uninterrupted quality flow.

**Floodplains are as important to rivers as bark is to trees.**

**Most of the processes that drive life in rivers happen around their edges. Just as the sap flows through the outermost ring of a tree, not through its centre, the life blood of a river ebbs and flows on its floodplain.**

**The vegetation growing there isn't mere decoration; it is a river's roots and leaves.**

*from: Living on Floodplains*





THANKS