



Session 1

FRESHWATER ECOSYSTEMS AND BIODIVERSITY

INTRODUCTION

- Aquatic biodiversity is the variety of life and the ecosystems that make up the
 - freshwater
 - tidal and
 - marine regions of the world and their interactions.
- It encompasses both freshwater and marine ecosystems.

Freshwater ecosystem

- Freshwater ecosystems -drinkable water or water of almost no salt content (<.0.5 ppt).
- They are created by water that enters the terrestrial environment as **precipitation**, and flows both above and below ground towards the sea.
- Encompass a wide range of habitats- **rivers, lakes, and wetlands** and zones associated with them.

- Their boundaries are constantly changing with the **seasonality of the hydrological cycle**.
- Their environmental benefits and costs are distributed widely across **time and space**, through the **complex interactions between climate, surface and groundwater, and coastal marine areas**.

- The freshwater ecosystem can be divided into
 - **lentic ecosystems** (still water) and
 - **lotic ecosystems** (flowing water).
- Freshwater resources include
 - **lakes and ponds**
 - **rivers and streams**
 - **reservoirs**
 - **wetlands**
 - **estuaries** and
 - **backwaters**



- Freshwater ecosystem provide
 - **drinking water resources**
 - **water resources for agriculture**
 - **industry**
 - **sanitation**
 - **food including fish and shellfish**
 - **recreational opportunities**
 - **means of transportation**
 - **home to numerous organisms** (e.g., fish, amphibians, aquatic plants, and invertebrates).

- **vertebrate fauna** in freshwaters accounts for nearly **25 %** of the global vertebrate diversity, but these also happen to be among the world's most **threatened ecosystems**
- The world's smallest known vertebrate is a fish, ***Paedocypris progenetica*** (7.9 mm) while the largest aquatic a vertebrate too is a whale shark, ***Rhincodon typus*** which is a giant and the heaviest fish.



Biodiversity in freshwater systems is **distributed** in a fundamentally **different** pattern from that in **marine systems**

- **Freshwater habitats are relatively discontinuous**, and many freshwater species do not disperse easily across the land barriers that separate river drainages into discrete units.

This has three **important consequences**:

1. **Freshwater species must survive climatic and ecological changes in place**
2. **Freshwater biodiversity is usually highly localized, and even small lake or stream systems often harbour unique, locally evolved forms of life**
3. **Freshwater species diversity is high even in regions where the number of species at any given site is low, since species differ between one site and the next.**

Global freshwater fish biodiversity

- Nelson (2006) estimated **27,977** species
 - 4,494 genera
 - 515 families
 - 62 orders in the world

11952 species are exclusively freshwater in origin

One third of the fish families have, at a minimum, **one species** with members spending at least **part of their life in freshwater.**

Freshwater fish diversity is therefore **large** compared to other systems since freshwater lakes and rivers account for **only 1% of the earth's surface**



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- The **largest number of species occurs in the tropics and the diversity of fishes**, in general, increases from the poles to the tropics. **For example in many Arctic lakes there is only one species, the Arctic char, *Salvelinus alpinus* (Johnson, 1983) compared to Lake Malawi which has at least 500 species of Cichlidae alone (Craig, 1992). The Palearctic region is species-poor.**
- Southeast Asia, South America and Africa have the most freshwater fishes although many have not been described. **For example the Amazon Basin has about 2,000 species, the Mekong Basin about 1,200 species and the Zaire system about 900 species.**

- However, only about 100 fish species, or species groups, are listed in **FAO statistics** as making up inland capture.
- In this regard, the quantification of the importance of individual species and of species groups as inland fishery resources is severely handicapped by the lack of reporting at these levels.
- Overall, some 45 percent of inland catch is aggregated as "freshwater fish ***not elsewhere included***" (*nei*), 7 percent "freshwater molluscs nei" and 6 percent is "crustaceans nei".

Freshwater fish biodiversity in India

- India is blessed with the vast and varied fish germplasm resources distributed widely in vivid aquatic ecosystems.
- The Indian fish fauna is divided into two classes, viz., **Chondrichthyes** and **Osteichthyes**.
- The Chondrichthyes are represented by 131 species under 67 genera, 28 families and 10 orders in the Indian region.
- The Indian Osteichthyes are represented by 2,415 species belonging to 902 genera, 226 families and 30 orders.

- The Indian fish population represents
 - **11.72% of species**
 - **23.96% of genera**
 - **57% of families**

- About 400 species are commercially important which include cultured, cultivable and wild caught species. These fishes have a quite a wide variety of forms and habits which have been reflected in their adaptation to live in markedly varying biotypes, ranging from cold torrential mountain streams to the dark abyssal depth of the seas.

- The approximate ecosystem-wise distribution of fish germplasm resources of India are: **coldwater** (73; 3.32%), **warm waters of plain** (544; 24.73%), **coastal brackishwater** (143; 6.50%) and **marine** (1440; 65.45%).

The major groups of freshwater fishes

- cyprinids (family: cyprinidae),
- Live fish (family: Anabantidae, Clariidae, Channidae, Heteropneustidae),
- Cat fish (family: Bagridae, Siluridae, Schilbeidae),
- Clupeids (family: Clupeidae),
- Mulletts (family: Mugilidae),
- Featherbacks (family: Notopteridae),
- Loaches (family: Cobitidae),
- Eels (family: Mastacembelidae),
- Glass fishes (family: Chandidae) and gobies (family: Gobiidae).
- Cyprinidae is one of the largest families and is well represented in India with species ranging from few millimeters in length (minnows) to more than a metre (major carps).

Coldwater fish biodiversity

- The aquatic resources located 914 m above MSL in Himalayas, sub-Himalayan zone and mountains of the Deccan are known as coldwaters.
- The temperature varies between **0 - 20°C** with an optimal range between **10 - 12°C**. The coldwater lakes and streams of high altitude are characterized by high transparency and dissolved oxygen and sparse biota.
- Most of the fishes are small-sized showing a **distribution pattern** depending upon the **rate of flow of water, nature of substrata** and **food availability**.
- Some fishes living in **turbulent streams** have developed **special organs for attachment**.

- The major coldwater resources – upper stretches of **Indus, Ganga, Brahmaputra rivers and their tributaries**, coldwater lakes and reservoirs of Himalayan and Deccan plateau harbour fishes belonging to six different families
 - **Cyprinidae**
 - **Cobitiidae**
 - **Salmonidae**
 - **Sisoridae**
 - **Psilorhynchidae and**
 - **Homalopteridae**

- Some commercially important species are ***Tor tor***, *T. putitora*, *T. mosal*, *T. khudree*, *T. mussullah*, *Neolissochielus hexagonolepis*, *Schizothorax richrdsonii*, *Schizothoraichthys progastus*, *Barilius bendelisis*, *Labeo dero*. *L. dyocheilus* and *Garra gotyla*.

Fish biodiversity in warm waters

- The freshwater of inland resources **below coldwater zone** are known as **warm waters**.
- Coming to the plains, the rivers become wider, the slope is slight and the current is moderate to slow. The warm water aquatic resources harbour abundant fish species.
- In India, fourteen major river systems share about 83% of the drainage. The important rivers are: **Ganga** river system, having a stretch of 1600 km from Hardwar (Uttar Pradesh) to Lalgolaghat (West Bengal), **Brahmaputra**, **Indus**, **Mahanadi**, **Godavari**, **Krishna**, **Cauvery**, **Narmada** and **Tapti**.

- The river Ganga harbours 382 species, Brahmaputra 126, Mahanadi 99, Cauvery 80, Narmada 95 and Tapti 57 fish species of warm water origin.
- However, many species are common to different river systems. There are about 450 families of freshwater fishes globally. Roughly **40 families are represented in India** (warm freshwater species).
- About 25 of these families contain commercially important species. Among 544 endemic warm freshwater fish species in India, **Cyprinidae accounts for nearly 24.12%** of them.

- Some commercially important carps include ***Labeo catla***, ***Labeo rohita***, ***Cirrhinus mrigala***, *L. calbasu*, *L. goni*, *L. bata*, *L. fimbriatus*, *L. kontius*, *Cirrhinus cirrhosa* and *C. reba*.
- Cat fishes are important groups contributing significantly to the riverine catches and include ***Aorichthys aor***, ***A. seenghala***, ***Wallago attu***, ***Pangasius pangasius***, *Silonia silondia*, *Bagarius bagarius*, *Rita rita* and *Eutropiichthys vacha*.
- Finfishes adapted to swampy areas owing to their accessory respiratory organs are known as air breathing fishes. Murrels and other important species of the group are ***Channa striatus***, ***C. marulius***, ***C. punctatus***, ***Clarias batrachus***, ***Heteropneustes fossilis***, ***Anabas testudineus***, ***Notopterus notopterus*** and ***N. chitala***.



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Fish biodiversity in Brackishwater

- The brackishwater i.e., estuarine regions are considered as transition zone between freshwater of the rivers and saline water of seas.
- The salinity of brackishwater ranges from **0.5 ppt to 30 ppt**.
- The major estuarine systems of India are **Hooghly-Matlah estuary**, Mahanadi estuary, **Godavari estuary**, Krishna estuary, Cauvery estuary and other estuaries of east and west coasts, **Chilka Lake, Pulicat Lake** and **Kerala backwaters**.

- The important species contributing significantly to the brackishwater fisheries are ***Mugil cephalus*, *Liza macrolepis*, *L. tade*, *L. parsia*, *Rhinomugil corsula*, *Hilsa ilisha* (*Tenuالosa ilisha*), *Chanos chanos*, *Etroplus suratensis* and *Lates calcarifer*.**
- The brackishwater also harbour lucrative shellfish species like ***Penaeus monodon*, *Fenneropenaeus indicus*, *Metapenaeus monoceros*, *M. dobsoni*, *M. affinis* and *M. brevicornis*.**

Exotic fishes in inland ecosystems

- Some exotic fishes have been introduced in the Indian waters for sport, food, vector control and ornamental purposes.
- A few important exotic species are ***Salmo trutta fario***, ***Salmo gairdneri gairdneri*** (*Oncorhynchus mykiss*), ***Cyprinus carpio*** var. *specularis*, *C. carpio* var. *communis*, *C. carpio* var. *nudus*, *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix*, ***Oreochromis mossambicus***, ***Clarias gariepinus***, ***Gambusia affinis***, *Lebestes reticulatus*, *Betta splendens*, *Xiphophorus hellerii* and ***Carassius auratus***.



- While the trouts (*Salmo* spp.) have filled in a vacant niche in upland coldwaters, the grass carp (*Ctenpharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*) and common carp (*Cyprinus carpio* var. *communis*) have helped **in enhancing the aquaculture production in India,**
- But a few others like **tilapia (*Oreochromis mossambicus*), *Gambusia affinis*** and even common carp in some natural waters created competition with native species with adverse influences.

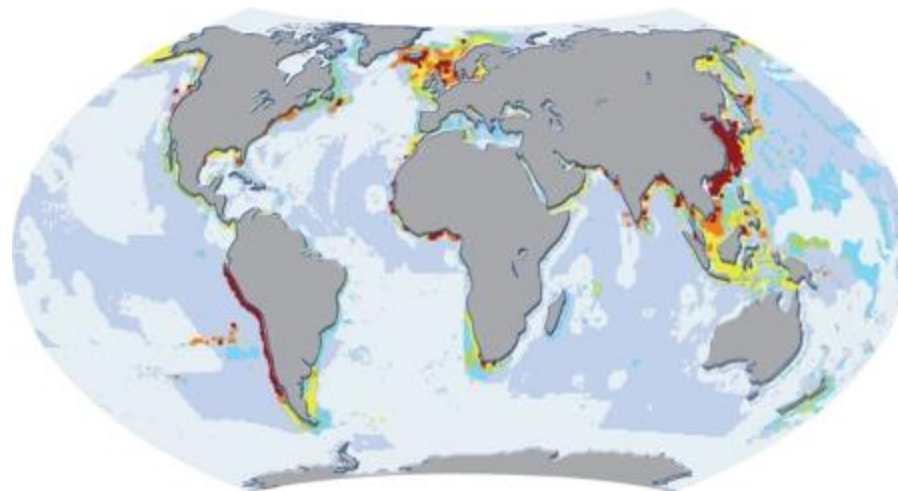


WORLD FISHERIES AND AQUACULTURE

- Capture- **90.9 MT**
 - ▣ Inland- 11.6 MT
 - ▣ Marine- 79.3 MT

- Aquaculture- **80.0 MT**
 - ▣ Inland- 51.4 MT
 - ▣ Marine- 28.7 MT

- Utilization
 - ▣ Human Consumption- **151.2 MT**
 - ▣ Non-food uses- **19.7 MT**
 - ▣ Population (billions)- **7.4**
 - ▣ Per capita consumption (kg)- **20.3**



Total- 170.9 MT

INDIAN FISHERIES

- **Global position-**
 - 2nd – 3rd** in Fisheries Production
 - 2nd** in Aquaculture
 - 7th** in Marine Capture
 - 2nd** in Inland Capture

- Indian fisheries and aquaculture is an important sector of food production providing nutritional security, besides
 - **livelihood** support and
 - gainful employment to more than **14 million** people
 - contributing to agricultural **exports**

RESOURCES

Inland

- Area under Reservoirs - 3.15 million ha
- Area under Ponds & Tanks - 2.36 million ha
- Area under Brackish water - 1.24 million ha
- Length of Rivers & Canals - 0.19 million ha

Marine

- Length of the Coast Line - 8,118 km
- Exclusive Economic Zone - 2.02 million Sq.km
- Continental Shelf - 0.53 million Sq.km
- Number of Fish landing Centers - 1537
- Number of Fishing Villages - 3432

INDIAN FISH EXPORTS

- More than **50** different types of fish and shellfish products are being exported to **75** countries around the world
- Fish and fish products have presently emerged as the largest group in agricultural exports from India, with **13.77 lakh tonnes** in terms of quantity and **Rs. 45,106.89 crore** in value (2018)
- Accounts for around **10%** of the total exports and nearly **20%** of the agricultural exports, and contribute to about **0.91%** of the **GDP** and **5.23%** to the **Ag – GDP** of the country