

Beels and Oxbow Lakes of India: Fishery Resources, Ecological Importance and Sustainable Management

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Floodplain wetlands are among India's important inland aquatic ecosystems, linking the dynamics of rivers, seasonal flooding, sediments, aquatic vegetation and fish communities. Beels and oxbow lakes are characteristic floodplain water bodies, especially across the Ganga, Brahmaputra and Barak river basins. They support capture fisheries, culture-based fisheries, aquatic biodiversity, food and nutritional security, and the livelihoods of fishing communities. The presentation on beels and oxbow lake fishery resources describes these wetlands as natural, river-borne systems with high production potential and important flora and fauna, including food and ornamental fishes, crustaceans, aquatic vegetables and flowers, and feeding and breeding habitats for fish and other aquatic organisms. Floodplain lakes are locally known by different names in different parts of India. The terminology reflects regional traditions: they are called tal or jeel in Uttar Pradesh, maun in Bihar, baor in West Bengal and beel in Assam and several neighbouring northeastern states. Although these names may describe somewhat different wetland forms, the common feature is their close relationship with floodplain geomorphology and river processes. These wetlands are therefore not isolated ponds; their ecological character is strongly influenced by the river systems from which they originate or with which they remain connected (Datta, 2011).



A representative floodplain wetland or beel landscape

How Do Oxbow Lakes and Beels Form?

The formation of an oxbow lake begins with the behaviour of a meandering river. A drainage basin is the area drained by a single river system, while a river together with its tributaries forms a river system. When a slight sinuosity develops in a river channel, water moves with greater turbulence along the concave bank. This enhances erosion on the concave side, while slower flow on the convex side encourages sediment deposition. Progressive erosion and deposition make the bend increasingly pronounced. When a river bend becomes highly sinuous and approaches or exceeds about 180 degrees, it is described as a meander. Continued differential erosion can bring the two limbs of the bend close together. During a subsequent high-flow event, the river may cut through the narrow neck, leaving the former meander isolated from the main channel. The abandoned channel gradually assumes a characteristic curved or horseshoe-shaped form and becomes an oxbow lake.

Distribution of Floodplain Wetlands in India

Floodplain wetlands are particularly concentrated in the eastern and northeastern parts of India. The source material identifies important distributions in Arunachal Pradesh, Assam, Bihar, Manipur, Meghalaya, Tripura and West Bengal. The reported wetland forms include beels, mauns, chaur and baors. The largest areas listed in the presentation occur in West Bengal and Bihar, followed by Manipur and Assam, although the exact extent of individual wetland categories varies with definitions, season and survey methods. In Assam, the Brahmaputra and Barak valleys contain extensive beel systems. In Bihar, floodplain wetlands occur particularly in the Gandak and Kosi basins. West Bengal contains numerous wetlands associated with river systems such as the Hooghly, Ichhamati and Bhagirathi. The northeastern states add further floodplain habitats associated with the Brahmaputra and Barak drainage systems. These geographical patterns explain why beel fisheries are especially important to inland fisheries and rural livelihoods in eastern and northeastern India (Datta, 2011). The presentation reports approximately 10,000 ha of beel wetlands for Assam, 40,000 ha of floodplain wetlands for Bihar, 16,500 ha for Manipur, 42,500 ha for West Bengal, and smaller reported areas for Arunachal Pradesh, Meghalaya and Tripura. These figures should be understood as source-reported estimates for the categories presented and may differ from newer inventories because wetland boundaries, hydrological conditions and classification methods vary.

State	Local wetland name(s)	Area reported in source (ha)
Arunachal Pradesh	Beel	2,500
Assam	Beel	10,000
Bihar	Maun, Chaur, Dhar	40,000
Manipur	Pat	16,500
Meghalaya	Beel	213
Tripura	Beel	500
West Bengal	Beel, Charha, Baor	42,500

What Makes a Beel Ecologically Special?

Beels and oxbow lakes are generally shallow, lentic, elongated, semi-circular or horseshoe-shaped water bodies with irregular shorelines. The presentation notes that their areas may range from about 2 ha to more than 1,000 ha. Their hydrodynamics are controlled by river-water incursion, the quality of inflowing catchment water and precipitation. Because these factors change seasonally, the same wetland can experience major shifts in water depth, connectivity, nutrient availability, aquatic vegetation and fish distribution. The river connection is particularly important. Himalayan rivers are characterized by meandering, high sediment loads and shifting channels. Earthquake-related tilting and repeated flooding can also influence channel migration. Once a channel becomes separated from its parent river, its hydrodynamics and ecological characteristics can gradually change from lotic, or flowing-water conditions, toward lentic, or standing-water conditions. The associated biological community may also shift from relatively nutrient-poor conditions toward more productive and eutrophic states as sediments and organic matter accumulate.

Open and Closed Beels: Why Connectivity Matters

The presentation classifies oxbow lakes according to water-renewal patterns as open-type and closed-type systems. Open-type wetlands retain a connection with the parent river through channels or sluice structures and receive riverine water, particularly during the flood season. Such inflow renews water, changes nutrient balance and influences hydrological and productivity characteristics. Floodwater can also transport brood fish, juveniles and shellfish into the wetland, helping maintain recruitment and fishery productivity. Closed-type wetlands are permanently disconnected from the parent river because of bunds, embankments or other barriers. According to the source material, these barriers can negatively affect hydrology, nutrient dynamics, abundance of aquatic communities, recruitment and production potential.

Closed wetlands may depend largely on monsoon rainfall and can experience accelerated eutrophication and shallowing. The contrast illustrates why maintaining appropriate hydrological connectivity is a central consideration in floodplain-wetland management.

A Rich Habitat for Fish and Aquatic Life

Beels provide feeding, breeding and refuge habitats for diverse aquatic organisms. The presentation lists small cyprinids, minor and major carps, loaches, small and large catfishes, air-breathing fishes, perches and perchlets, mullets, spiny eels, featherbacks and mud eels among the ichthyofaunal groups occurring in oxbow lakes. It also identifies snakeheads, herrings, gobies, needlefishes, mud eels, pufferfishes and prawns as important components or potential fishery resources. The diversity of fish is closely associated with habitat heterogeneity. Shallow vegetated zones provide shelter for juveniles, while open-water areas and deeper pockets may serve different feeding and growth functions. Seasonal river connection can further enhance recruitment by allowing fish to move between the river and wetland. Thus, the productivity of a beel should not be judged only by its standing fish stock at a particular time; it is also shaped by seasonal connectivity, habitat quality and the life cycles of resident and migratory organisms.



A small cyprinid representative of the fish diversity associated with floodplain wetlands

Aquatic Vegetation: Useful Habitat but a Management Challenge

Macrophytes are common in beels and include floating, submerged and rooted aquatic plants. The source presentation illustrates aquatic vegetation such as Eichhornia, Hydrilla, Nymphaea and Typha. Aquatic plants can provide shelter, feeding surfaces, spawning substrates and refuge for juvenile fishes and invertebrates. Vegetated margins can therefore contribute to the biological productivity and structural complexity of a wetland. At the same time, excessive macrophyte infestation can become a major constraint on fisheries. The presentation reports that infestation density in some portions of certain wetlands may exceed 16.5–31 kg/m², hindering aquaculture and fisheries operations. Dense vegetation can obstruct fishing gears and boat movement, alter oxygen dynamics and reduce the accessible water area. Management therefore needs to distinguish between ecologically useful vegetation and excessive infestation rather than attempting indiscriminate removal.

Fish Production Potential of Oxbow Lakes

The source presentation reports a wide range of fish yields from oxbow lakes, approximately 0.6 to 1,600 kg/ha/year. Productivity varies greatly among wetlands because waterbody morphology, connectivity, nutrient status, macrophyte coverage, fishing pressure, stocking, management and local environmental conditions differ. Regional values listed in the presentation include approximately 140–145 kg/ha/year for Uttar Pradesh, 45–105 kg/ha/year for Bihar, 137–1,300 kg/ha/year for West Bengal and 71–215 kg/ha/year for Assam. These ranges highlight the high variability of floodplain fisheries rather than a single expected production level. In suitable systems, management interventions can improve fish production. ICAR-CIFRI has documented the use of culture-based fisheries, supplementary stocking and

pen culture in beels and floodplain wetlands. For example, a 2021 ICAR-CIFRI demonstration in Bamuni Beel, Assam, combined supplementary stocking and pen culture with community participation and reported an increase in fish production and fisher household income (ICAR, 2021).

Beel Fisheries and Livelihood Security

For communities living around floodplains, beels are more than fish-producing water bodies. The presentation describes them as sources of livelihood for fisherfolk and aquaculturists and as providers of food, nutritional and livelihood security. Wetlands can also support recreation and water-based activities. Fish and other aquatic foods harvested from these ecosystems contribute directly to household nutrition and local markets, while fishing and associated activities generate employment and income. Assam provides a particularly important example. The presentation states that beels contribute about 25% of fish production in Assam and notes the state's extensive water resources. Contemporary ICAR-CIFRI programmes continue to treat beel fisheries as an important livelihood sector. In 2026, ICAR-CIFRI entered an agreement to provide technical support for sustainable beel fisheries management in Assam, including water-quality monitoring, productivity enhancement, conservation of small indigenous fishes and biodiversity monitoring across 100 beels.

Fisheries Management Approaches

Beel fisheries can be managed through capture fisheries, stock enhancement, species enhancement, management enhancement and culture-based fisheries. Capture fisheries are particularly important in open-type beels where river connectivity supports natural recruitment. In closed or weakly connected wetlands, supplementary stocking and culture-based fisheries can be used where ecological conditions and management institutions permit. Pen culture is another approach described in the presentation. Pens provide controlled enclosures within the wetland in which selected fish can be stocked, fed and grown before harvest or release into the wider water body. The presentation reports estimated pen-culture production ranging from about 0.65 to 4 tonnes/ha, while ICAR-CIFRI has documented practical demonstrations in Assam and other floodplain wetlands. Such interventions work best when they are combined with water-quality monitoring, suitable species selection, stocking strategies, feed management, disease prevention and community participation (ICAR, 2021; ICAR, 2026). ICAR-CIFRI's experience in Bamuni Beel demonstrates how culture-based fisheries and pen culture can be integrated with community participation. The 16-ha closed beel was stocked with advanced fingerlings and a pen was used for table-fish production. ICAR reported that fish harvest increased from approximately 6.29 tonnes in 2019–20 to 13.52 tonnes in 2021–22, while the reported annual net income of participating fisher families also increased. These results are from a specific demonstration and should not be treated as a universal production expectation for all beels.

Major Challenges to Sustainable Beel Fisheries

Despite their production potential, floodplain wetlands face multiple pressures. The presentation identifies excessive infestation by floating, submerged and rooted aquatic weeds as a major management problem. Domestic and agricultural runoff can degrade water quality, while reclamation, conflicting land-use practices, multiple ownership and large numbers of resource users complicate management. In closed wetlands, embankments and bunds may disrupt natural water exchange and fish recruitment. Fishing pressure and habitat modification can also reduce the resilience of wetland fisheries. A sustainable approach therefore requires management of both the fish stock and the wetland ecosystem that supports it. The objective should be to maintain adequate water exchange, protect breeding and nursery habitats, control excessive vegetation, reduce pollution and coordinate access among different users. Current wetland-fisheries programmes increasingly emphasize ecosystem-based and community-based approaches. ICAR-CIFRI has demonstrated participatory management, fish stock enhancement and pen culture in several wetlands. In Borkona Beel,

Assam, supplementary stocking was undertaken with the participation of local fishers to improve fish stocks and livelihood support.

Towards Climate-Resilient Beel Fisheries

Floodplain wetlands naturally experience strong seasonal changes, making climate variability an important management consideration. Changes in rainfall, flood timing, drought periods and extreme events can alter the duration of river connectivity, water depth, dissolved oxygen, nutrient cycling and fish recruitment. Management measures should therefore retain flexibility rather than relying on a single production strategy. ICAR-CIFRI has described pen culture as a climate-resilient technology for wetland fishers and has demonstrated it alongside stocking of indigenous carps and small indigenous fishes. Such approaches can provide an additional layer of livelihood security when natural capture fisheries are affected by climatic variability or other disturbances.

Conserving Beels While Improving Fish Production

The future of beel fisheries depends on balancing production with ecological function. Maintaining river–wetland connectivity where appropriate, protecting shallow breeding areas, managing macrophytes carefully, controlling pollution and preventing excessive reclamation can help preserve the ecological foundation of fish production. Stock enhancement should be based on the carrying capacity and ecological characteristics of individual wetlands rather than simply maximizing stocking density. Community participation is equally important. Fishers possess detailed knowledge of seasonal water levels, fishing grounds, breeding periods and local species. Their participation can improve compliance with management measures and help align conservation objectives with livelihood needs. Cooperative societies, fisheries departments, research institutions and local communities can jointly develop wetland-specific management plans. The experience of ICAR-CIFRI also shows the value of combining scientific monitoring with practical interventions. Recent programmes include water-quality assessment, biodiversity monitoring, conservation of small indigenous fishes and productivity tracking. These components are important because fish yield alone cannot fully describe the health of a floodplain wetland.

Why Beels Matter Beyond Fisheries

The ecological importance of beels extends beyond fish production. They provide habitats for aquatic plants, invertebrates, amphibians, birds and other wildlife; retain water during periods of high flow; and act as dynamic interfaces between terrestrial and aquatic environments. Migratory birds also use many floodplain wetlands during winter. The presentation highlights their role as feeding and breeding grounds for fish, amphibians, insects and crustaceans, demonstrating that fishery production is only one part of their wider ecological value. Healthy floodplain wetlands also preserve biological diversity and maintain natural ecological processes. Their connection to rivers means that changes in the river system can rapidly influence the wetland, while changes within the wetland can affect downstream ecological and fisheries processes. Protecting beels is therefore closely linked to maintaining the integrity of river–floodplain ecosystems.

Beels of India: A Shared Responsibility

Beels and oxbow lakes represent a valuable natural resource at the intersection of fisheries, biodiversity, food security and rural livelihoods. Their productivity is strongly influenced by hydrological connectivity, seasonal flooding, habitat structure, aquatic vegetation and the intensity of human use. Sustainable fisheries development should therefore integrate capture fisheries management, culture-based enhancement, habitat conservation and community participation. The message from the beel fisheries resource base is clear: production enhancement and conservation should proceed together. Where river connectivity is retained, natural recruitment can support productive capture fisheries; where connectivity has been reduced, carefully planned stock enhancement and pen culture may provide opportunities for improvement. At the same time, pollution, excessive macrophyte infestation, reclamation and

unmanaged fishing pressure must be addressed. With science-based management and active participation of fisher communities, beels can continue to support fish production, aquatic biodiversity and nutritional and livelihood security. Protecting these wetlands is not simply about conserving individual water bodies—it is about maintaining the ecological and social functions of India's floodplain landscapes.

Conclusion

Beels and oxbow lakes are distinctive floodplain wetlands formed and shaped by river processes. Their shallow, productive waters support diverse fish communities, aquatic vegetation and other organisms while providing important fisheries and livelihood opportunities. The presentation highlights their distribution across eastern and northeastern India, their open and closed hydrological types, their substantial production potential and the major challenges affecting their development. Sustainable management requires a balance between fish production and ecosystem health. Capture fisheries, stock enhancement, culture-based fisheries and pen culture can all contribute when matched to the ecological characteristics of individual wetlands. Long-term success will depend on maintaining suitable hydrological conditions, improving water quality, managing aquatic vegetation, protecting biodiversity and involving local communities in decision-making. Beels are therefore both fisheries resources and living floodplain ecosystems whose conservation is essential for resilient inland fisheries in India.

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