

ECOLOGY, HYDROLOGY AND CONSERVATION OF THE INDUS RIVER DOLPHIN: A MULTIDISCIPLINARY REVIEW

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Abstract

Indus River Dolphin (*Platanista minor*) is one of the few obligate freshwater cetaceans in the world which is an endemic and endangered species of Indus River system. This review combines hydrological, physiological, behavioral, and conservation viewpoints to synthesize current knowledge based on ecology and needs of Indus River Dolphin. Following a review of the taxonomic status, evolutionary history, and biogeographic distribution, we analyze a significant amount of data related to reproductive biology, food ecology, habitat use, population dynamics, and sensory adaptations. Particularly, the link between river hydrology and dolphin ecology is studied, and how flow management, sediment load, and channel architecture affect habitat distribution and availability. Climate driven threats that could change river conditions in the future are assessed alongside anthropogenic pressures, including pollution, fishing by-catch, vessel disturbance, habitat fragmentation from barrages, and water abstraction. To evaluate successful conservation strategies and lingering issues, conservation measures, management plans, and policy frameworks are evaluated. In order to direct future multidisciplinary research and evidence-based conservation planning, important research gaps and priority directions are finally highlighted. This review offers a scientific basis for preserving the integrity of riverine ecosystems throughout South Asia and safeguarding this endangered freshwater cetacean by fusing ecological theory with data specific to a given region.

INTRODUCTION

The Indus River dolphin lives in freshwater systems of the Indus River in Pakistan. Although it once covered a huge historical range of more than 3,400 km (Reeves & Chaudhry, 1998), about 80% of its natural habitat has been lost (IUCN Red List of Threatened Species, 2018). The construction of irrigation dams along with other factors (Nabi et al., 2021) has caused their population to drop (Braulik et al., 2015), leaving only approximately 2,000 individuals, primarily in Sindh province, despite their recent recognition as a distinct species

Platanista minor from Ganges river dolphins (Braulik et al., 2015; Braulik et al., 2021).

Due to their near-complete blindness (Anderson, 1878), Indus River dolphins hunt and navigate using echolocation (Hamilton et al., 2001). Different feeding patterns, such as grasp-suction and rotational eating, have been discovered in recent research, suggesting adaptations for their riverine habitat (Anderson, 1878; Reeves & Chaudhry, 1998).

The species life history traits are similar to those of the Ganges River dolphin. The dolphins have a long,

narrow rostrum, are functionally blind, and swim in a distinctive sideways manner (Herald et al., 1969). Births peak between March and May (Anderson, 1878), and they attain sexual maturity around the age of ten. Since hunting has been prohibited, conservation initiatives have contributed to a considerable recovery despite their past abundance (Braulik et al., 2017).

It is mainly located in three isolated groups along roughly 690 km of the Indus River in Pakistan. Entrapment in fishing gear, pollution, and additional habitat deterioration anticipated over the next 20–40 years (Braulik et al., 2021; Aisha et al., 2021) are the main risks (Turvey et al., 2007).

According to conservation studies, the dolphin's dwindling population and fragmented habitat make it eligible for endangered status (Turvey et al., 2007), requiring actions to ensure its survival and possible inclusion as a subpopulation on the IUCN Red List (Braulik et al., 2017).

Since habitat downstream of the Sukkur Barrage has been destroyed owing to water diversion, Indus River Dolphins predominantly live in deep river channels (Braulik et al., 2021; Aisha et al., 2021), becoming more and more concentrated in the remaining deep sections during the low-water season, which runs from October to April (Braulik et al., 2023).

They prefer habitats with narrow widths, lesser degrees of braiding, and larger mean and maximum depths (Braulik, 2006; Braulik et al., 2012). Canal entrapments, bycatch from fisheries, traditional hunting methods, and pollution from farming and industry are additional dangers. The sustainability of the Indus River Dolphin population in its natural habitat is seriously threatened by the combined effects of these factors (Braulik et al., 2012).

The Wildlife Act of Sindh protected Indus River Dolphins in 1972, and a dolphin reserve between Sukkur and Guddu Barrages was created in 1974. Deliberate dolphin killing was outlawed by the Punjab Wildlife Protection Act of 1974, and more dolphin reserves were established in 1983 and 1984 (Braulik, 2006; Reeves et al., 1991).

Their international significance is increased by the fact that these places are Ramsar wetlands and Important Bird Areas, which are designated as Key Biodiversity Areas (Braulik, Noureen, et al., 2015;

Kelkar, 2008). With the help of a rescue operation that has averaged seven dolphin rescues per year for more than 20 years, the implementation of anti-hunting laws has stopped the decline in dolphin numbers (Braulik et al., 2012).

In order to increase awareness and generate revenue for the local fishing communities through small-scale dolphin watching activities, WWF-Pakistan and the Sindh Wildlife Department have also established educational centers (Braulik et al., 2021).

1. Taxonomy and systematic status

Due to the difficulty in accessing species in large, isolated regions, the studies tackle important issues in cetacean taxonomy, indicating that many species and subspecies are still unknown (Taylor et al., 2017). New cetacean species have recently been described with the use of molecular data (Braulik et al., 2021).

Because of their endangered status, the Platanistidae family; in particular, the Indus (*Platanista minor*) and Ganges river dolphins (*Platanista gangetica*) are emphasized as taxonomic research priorities (Reeves et al., 2004; Taylor et al., 2017).

The two subspecies; the Ganges river dolphin and the Indus river dolphin, both of them are geographically remote and also highly endangered. The possibility of interbreeding is now barely possible due to additional research studies confirming the fact of geographic separation of the Indus and Ganges systems over a long period of time (Braulik et al., 2015; Braulik et al., 2012).

Ultimately, the Indus river dolphin (*Platanista minor*) and Ganges river dolphin (*Platanista gangetica*) are regarded as two distinct species of river dolphins located in South Asia, according to Braulik's researches (illustrated in Table 01). The evidence includes morphological differences, isolation caused by long-separated river systems, genetic divergence, and a lack of contemporary gene flow (Braulik et al., 2021). Long standing taxonomic doubt has been resolved by the strong support of DNA and morphological evidence for the species level distinction.

Table 01. Species differentiation of Indus river dolphin and Ganges river dolphin

Evidence type	Key Finding	Interpretation	Citation
Genetic divergence	Distinct genetic differences detected	Supports species separation	(Braulik et al., 2021)
Morphological traits	Skull structure variation	Diagnostic morphological distinction	(Braulik et al., 2024)
Geographic isolation	Long-term river system separation	Prevented interbreeding	(Braulik et al., 2015)
Gene flow	Absent between populations	Confirms reproductive isolation	(Braulik et al., 2012)

2. Evolutionary history and biogeography

Geographic isolation is important when evaluating the taxonomic theories, particularly under the light of the Biological Species Concept (BSC), which maintains that barriers prevent species from interbreeding. The study focuses on the Indus and Ganges river dolphins, highlighting how their geographical isolation for over 550,000 years has prevented interbreeding. Certain skull traits and variations in DNA are used to identify the Indus river dolphin (Braulik et al., 2024; Braulik et al., 2021).

Due to habitat fragmentation brought on by human activity, their range has historically dramatically decreased, and today, populations are concentrated within 690 kilometers of the Indus mainstream (Braulik et al., 2015). Phylogenetic analyses reveal that South Asian river dolphins show one of the earliest diverging lineages of toothed whales, suggests marine ancestors transition to fresh water environments.

3. Physiological and hydrological ecology of Indus River Dolphin

According to estimates from 2017, there were up to 2000 Indus river dolphins, most of which lived in Sindh between the Guddu and Sukkur barrages, with lesser numbers in Punjab and KPK (Aisha, 2017). Consistent dolphin counts over the last 50 years show a notable rise in population, which has

been ascribed to successful conservation initiatives and the ban on hunting (Braulik et al., 2015).

Entanglement in fishing nets, habitat fragmentation from water infrastructure like dams and barrages, and pollution that jeopardizes river health are some of the species' main concerns (Braulik & Barnett, et al., 2015). Due to these environmental issues, dolphin populations are isolated, migratory fish access is impeded, and habitat quality is decreased (Aisha, 2017; Braulik et al., 2015).

Female Indus river dolphins are somewhat bigger than males, and they typically weigh between 150 and 200 pounds and measure 7 to 8.5 feet in length (Braulik et al., 2021). Their distinctive features include a prominent 'melon' for collecting sound, a short triangular dorsal fin, and a rounded body. Sound is the primary means of communication and navigation, and although they are usually observed alone or in pairs, they may form groups of up to 10 (Braulik et al., 2012).

As they search for clams, fish, and shrimp along riverbeds, they may hold their breath for over one minute. In the past, the Indus River dolphin's range included the river's tributaries and stretched from the Indus River delta to the Himalayas (Herald et al., 1969). Favoring freshwater environments, Usually, found in shallow, muddy waters, Indus river dolphins live for roughly 30 years (Braulik et al., 2012), achieve sexual maturity at age 9, and breed all

year long while nursing a single child for nearly a year (Anderson, 1878).

These dolphins prefer deeper waters, yet they may adapt to shallower ones. Since there is little information on how long they live in captivity (Lindgren et al., 2011), their small eyes and extended beaks suggest that they have limited vision, and poor water quality may shorten their lifetime. Although they could follow rivers, it is uncertain where they are native. They consume around one kilogram on average which may vary depending upon body mass of different bottom-dwelling species per day while in captivity, and they have few natural predators outside humans (Bricklin, R. 2004).

Because of their limited habitat, Indus River dolphins are particularly at risk during low-water seasons. These dolphins favor deeper locations with larger cross-sectional areas, shorter widths, and less braiding, according to research that used generalized linear models (Braulik et al., 2012).

They are more frequently found in river constrictions and confluences, and the most important factor affecting their existence is the cross-sectional area of the channel (Bricklin Rachel, 2004). Due to the possibility of entrapment and fewer feeding chances, channels with an area smaller than 700 m² are avoided. The study found that habitat preferences vary by size and that channel geometry has a greater impact on habitat selection than river geomorphology (Braulik et al., 2012).

4. Habitat ecology

Table 02 shows the findings of habitat ecology of the Indus River dolphin that lives in freshwater in the river and its tributaries (Braulik et al., 2015). The deepest river channel is where they typically occur,

while secondary or side channels and minor braids are less prevalent (Bhatti and Pilleri 1982, Braulik 2006). The dolphin favors rivers segments that are between 2.4 and 5.1 meters deep and lengths of 0.5 to 2.0 kilometers (Akbar et al., 2004).

Since barrages redirect a significant portion of the river's flow during the low-water season (October to April), dolphin habitat downstream of Sukkur Barrage and in the majority of its tributaries has been destroyed. Dolphins congregate in the remaining deep regions as the water levels decrease throughout the winter. According to a study on the selection of dry-season habitats across the range, animals chose advantageous riverine areas (Braulik et al., 2012)

Additionally, dolphins steer clear of channels with a cross-sectional area smaller than 700 m² and favor regions with less braiding (Braulik et al., 2012). Confluence locations with counter-current eddies are preferred by dolphins (Khan and Niazi 1989; Braulik et al., 2012). Dolphins can more easily capture fish when they are "trapped" by these circular currents (Kreb et al., 2004).

Additionally, it has been proposed that these circular current areas might serve as resting grounds for dolphins, as they eliminate the need for them to exert themselves by swimming against the downriver current (Smith and Reeves 2012). Although single animals are the most commonly observed group size, Indus River Dolphins typically surface alone and appear to occur in loose aggregations of up to 25 individuals in some regions (Braulik et al., 2006). Collectively, these studies indicate that hydraulic variables exert stronger influence than geographic factors, suggesting that flow regulation may be the primary determinant of habitat suitability

Table 02. Comparison of habitat selection for Indus river dolphin; findings across different studies

Variable examined	Finding	Interpretation	References
Depth	Prefer deep channels	Depth is primary habitat driver	(Braulik et al., 2012)
Channel geometry	Cross-section area most important	Channel shape more influential than geomorphology	(Braulik et al., 2012)
River location	Prefer confluences	Feeding efficiency driver	(Khan & Niazi, 1989)

Current structure	Prefer eddy zones	Prey trapping advantage	(Kreb, 2004)
Depth range	2.4-5.1 m optimal	Narrow ecological tolerance	(Akbar et al., 2004)

5. Behavior ecology

Similar to Ganges river dolphins, Indus river dolphins have evolved a distinctive side-swimming technique that aids in their ability to maneuvers through shallow waters (Herald et al., 1969). While the dolphins are mostly solitary, they have been observed in individuals of up to 30 people on occasion. After spending just one second at the surface, people dive for a little more than a minute. Indus river dolphins use echolocation to navigate, just like other dolphin species, but they also make continuous acoustic signals, which reflects the intricacy of the river environment. These species are typically timid toward people (Braulik et al., 2012).

6. Feeding ecology

The Indus river dolphin consumes a wide range of food, such as carp, catfish, and river prawns (Anderson et al., 1879). Although it seems to vary depending on the area and/or time of year, Indus River Dolphins often eat a wide range of mid-water and bottom-dwelling species (Butt 1977; Pilleri and Zbinden 1973-74).

Dolphins of the Indus River are essentially blind and utilize echolocation to locate prey in the murky rivers where they reside. There is limited information available on the behavior of creature in the wild due to this turbidity and the challenges of watching them (Braulik 2006; Braulik 2012; Braulik et al., 2015).

7. Reproduction ecology

Growth and reproduction

Around the age of ten is when Indus River dolphins reach sexual maturity (Brownell et al., 1984). Although mating takes place all year round, the number of newborns seems to peak between March and May (Anderson et al., 1879). A single calf, typically around 70 cm long, is born during an 8-9 months of gestation period and feeds on the

mother's milk (Brownell et al., 1984). They can reach a maximum length of 2.5 meters and a maximum weight of 70-110 kg (Table 03).

Basic and practical understanding regarding the reproductive biology of wild animals is crucial for their conservation and management, as increasing anthropogenic activities are the primary cause of animal extinction (Comizzoli and Holt, 2019). Regretfully, little is known about the reproductive biology of the majority of wild endangered species, including IRDs (Frankham, 2008; Comizzoli and Holt, 2019).

IRDs can reproduce at any time of year, unlike YFPs, who have a set breeding season (Dolphins-World, 2017). However, more research is necessary given the IRD's low reproduction rate (Khan at al., 2016). Despite the challenges of tracking, capturing, and managing cetaceans, there are a number of logistical, moral, and physiological concerns (Nabi et al., 2018). The IRDs in the irrigation canals and during the rescue efforts, however, might offer a chance to observe them for a time (e.g., interaction between mother and calf, nursing, parental care, and sexual behavior). These chances might also assist us in documenting anthropometric measurements and the sex ratio. Samples of milk, blood, and blowholes can be utilized to test different reproductive factors. A unique chance to comprehend the fundamental reproductive biology of the IRDs may also be presented by examining the fresh carcasses (Xiao et al., 2018; Ji et al., 2019).

At Wuhan, China's Baiji Dolphinarium, the first YFP was born in captivity in 2005 (Wang et al., 2005). The birth of this first freshwater cetacean in captivity not only shows that the natural breeding program is working, but it also gives other freshwater cetaceans that might be able to reproduce normally in captive hope (Zeng et al., 2017-2019; Hao et al., 2019).

Table 03. Traits of the Indus River dolphin

Trait	Value	Source
Body length	7-8.5 ft	(Braulik et al., 2021)
Body mass	150-200 lb	(Braulik et al., 2021)
Sexual maturity	~9-10 years	(Anderson, 1878), (Brownell et al., 1984)
Gestation period	8-9 months	(Brownell et al., 1984)
Calves per birth	One	(Brownell et al., 1984)
Maximum lifespan	39 years	(Braulik et al., in press)

Population ecology and distribution patterns

Based on the latest population estimates, there are still 1800 and 2000 individuals in the wild, most of them are confined to the Sindh Province’s main stem of the Indus River (Braulik et al., 2021). Due to in large part to reduced direct killing and improved conservation awareness, recent population estimates using standardized survey techniques have shown a steady but observable population growth in the protected river section (IUCN, 2023).

The species is now restricted to isolated river segments between barrages, with the greatest population density recorded between the Guddu and Sukkur barrages. Sub-populations in the upper stretches are more scattered and smaller, but are at risk of localized extinction because of habitat deterioration and gene flow (WWF-Pakistan, 2022).

Methods for population monitoring and surveys

The best way to monitor the Indus river dolphin population is through visual surveys made from boats along fixed river transects. In order to maximize detection, these surveys are usually scheduled to take advantage of lower water periods when dolphins congregate in deeper river channels. Direct counts or statistical adjustments are used to estimate abundance (for inaccurate detection). Then it is being observed and recorded who is visible, how many individuals of dolphins are in the group, and when and where they are active (WWF-Pakistan, 2020).

Acoustic monitoring

Since the Indus River dolphin lives in highly turbid river waters and only comes up above the surface of water for very short periods of time, sound monitoring has become an important additional tool. Dolphins produce high-frequency sounds with echolocation (Hamilton et al., 2001) for orientation and prey location, which are detectable by hydrophones or passive acoustic monitoring (PAM) devices (Khan et al., 2022).

This is particularly useful for acoustic monitoring in deep or occluded areas where visual detection is not feasible. Because PAM does not require the sustained presence of field staff, it allows for long-term monitoring of dolphin occurrence, habitat use and activity patterns over time (WWF-Pakistan; Thomas et al., 2021).

Limitations of monitoring methods

The low detection likelihood is explained by the underestimation of the true population size due to dolphins' fleeting above-water sightings. Light, turbidity, river breadth, and observer fatigue all further reduce survey accuracy. Those individuals who are hidden or submerged down in water may not be detected and visible in only visual surveys (Thomas et al., 2021).

When using acoustic techniques, data processing calls for certain equipment and expertise. Signal detection may be hampered by fishing activities, boat traffic, and ocean currents (Braulik et al., 2021).

Additionally, the frequency of the auditory data reflects the presence of the species rather than its actual population size unless it is analyzed in statistical or graphical models. (Thomas et al., 2021; IUCN, 2023). According to these results, integrated monitoring strategies that include visual and acoustic methods are necessary for precise population estimation.

Anthropogenic effects on dolphin ecology

The Indus River dolphin is facing problems because of human activities. Pollution changes habitat quality while anthropogenic disturbances are negatively affecting the ecology of dolphins. In the Indus River dams and barrages have broken up the dolphin's

home. Separated its groups. This has stopped the dolphins from moving and mixing with each other. The river's also getting polluted from farm waste, dirty sewage and industrial waste. This pollution is damaging the dolphins home. Some studies have found micro plastics in the dolphin's stomach (Table 04). This is a threat to the dolphin's survival and health. The World Wildlife Fund in Pakistan has been studying this issue (WWF-Pakistan 2020; Ali et al., 2025). In some distant river sections, the lack of enforcement, despite being protected by law, remains a problem despite recent efforts (WWF-Pakistan, 2022).

Table 04. Integrated ecological constraints affecting Indus river dolphin's survival

Ecological driver	Mechanism	Population effect	Supporting source
Low river discharge	Reduced habitat depth	Population fragmentation	(IPCC, 2023)
Flow regulation	Altered hydrology	Habitat loss	(Paudel et al., 2020)
Habitat isolation	Barrages	Genetic risks	(WWF-Pakistan, 2022)

Climate change and future ecological threats

Climate change-related variations in South Asia's monsoon intensity, glacial melting, and seasonal rainfall have increased the Indus River's discharge unpredictability, posing serious ecological risks to its inhabitants, especially the Indus River dolphin. Extreme flood events may force dolphins to abandon their preferred deep-water habitats, kill newborn dolphins, and change the distribution of prey, even though extended periods of low discharge reduce water depth and the connectivity of river sections, fragmenting dolphin populations (IPCC, 2023).

Indus river dolphin and conservation ecology

The main goal of the scientific field of conservation ecology is to understand and conserve ecological processes, species survival, and biodiversity under the influence of environmental change and human

activities (Fig. 01). It combines ecological knowledge with effective approaches to conserve species, ecosystems, and ecological processes (Paudel et al., 2020).

Identifying sensitive species and the ecological threshold such as flow values below which species are unable to survive that show when ecosystems are approaching the point of very rapid decline is a basic assumption (Paudel et al., 2020; WWF-Pakistan, 2025).

Because the health, abundance, and survival of the Indus River dolphin are representative of the status of the river ecosystem as a whole, it is considered a key indicator species. A decline in the dolphin population in freshwater habitats may suggest habitat fragmentation, water quality, or flow changes that could also threaten other species (WWF-Pakistan, 2025).

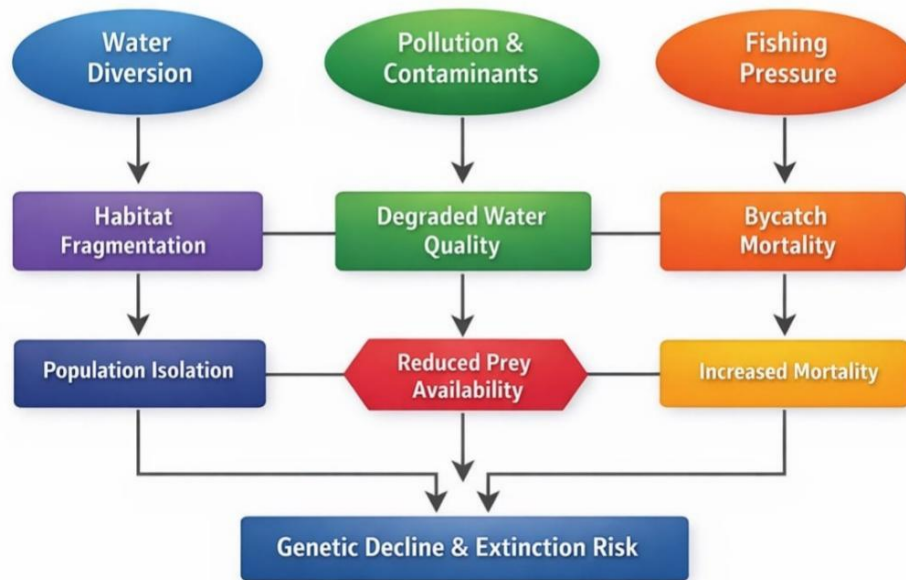


Figure 01. Factors affecting survival of the Indus River dolphin

The points at which small changes to the environment (such as river flow) lead to a substantial reduction in the viability of a species are called ecological thresholds. The points at which small changes in the environment (such as river flow) lead to a substantial reduction in the viability of a species are called ecological thresholds (WWF-Pakistan, 2025). River dolphins and other aquatic megafauna have specific habitat and flow requirements; flows below thresholds may limit access to vital deep-water pools, impact foraging, and cause strandings (Paudel et al., 2020).

Management and action for conservation

To conserve this critical dolphin habitat, the Indus Dolphin Reserve in Sindh, Pakistan, between Guddu and Sukkur Barrages, has been declared a Ramsar protected wetland. By maintaining habitats with appropriate water depth, prey density, and lower human presence than in other areas, core area protection, which helps in the survival of the species, is ensured (Indus Dolphin Reserve, n.d.). To improve the chances of survival and reduce mortality rates, WWF and Sindh Department jointly

worked in the early 1990s to return safely dolphins stranded in irrigation canals to the main river (Braulik, 2006; Reeves et al., 1991). These efforts are essential as water diversion and barrage construction often result in dolphins being stranded in canal systems (WWF-Pakistan, 2025).

Environmental flow management helps in ensuring that river flows are managed for ecological needs and not just human needs. Dolphins require deep-water habitats; therefore, maintaining river flows during dry periods and preventing abrupt drawdowns can help in preventing habitat destruction and preventing “ecological stress.” Although there are no studies available specifically related to the Indus, studies worldwide have suggested that flow management plans should be developed around the biological threshold of the species of interest (Paudel et al., 2020).

Sustainable fishing, awareness campaigns, and the use of ecotourism by local communities are all factors that contribute to the success of conservation efforts. Sensitizing fishermen and local communities about dolphin ecology could help minimize the use of destructive fishing nets, encourage diversification of livelihoods that do not overburden river resources,

and increase the reporting of stranded animals (WWF-Pakistan, 2025).

Future research directions and knowledge gaps

Overall, current literature (Table 05) suggests that habitat fragmentation represents the central limiting factor governing long-term persistence of the species. The ecology and survival of the Indus River dolphin

(*Platanista minor*) are still not well understood, despite increased conservation efforts. It is largely because of scattered and uneven conservation efforts that there is still a lack of good ecological information on habitat use, reach-specific population trends, and flow-ecology relationships (Thomas et al., 2021).

Table 05. Major knowledge gaps identified in current literature

Research area	Current knowledge	Limitation
Reproduction	Basic data available	Few wild observations
Population trends	Estimates exist	Detection bias
Genetics	Species distinction confirmed	Low diversity data
Behavior	Observational reports	Lack of long-term study

There are concerns about viability and genetic isolation due to the fact that the Indus River dolphin is becoming increasingly confined to isolated river stretches between barrages, despite recent estimates of a population of about 2000 individuals (Aisha et al., 2025).

In order to improve the uncertainty of abundance estimation and more precisely detect population trends, passive acoustic monitoring and statistical analysis advancements (occupancy and state space population models) are essential (Arshad et al., 2022).

Conclusion

The Indus river dolphin being endemic specie of Indus river system depends on its ecological stability for survival. Studies reviewed in this paper reveals the fact that many factors including fragmentation, pollution, fishing pressure are changing its behavior and population size. Although research has improved

for understanding the biology and conservation needs, but still major threats are there including many human activities. Many strategies and management are required for conservation for this specie. Continued monitoring and coordinated conservation efforts are needed to prevent further population decline.

REFERENCES

Aisha, H. B. G. K. U. (2017). Indus river dolphin (*Platanista gangetica minor*) an update on the current population assessment and conservation challenges.

Aisha, H., Khan, U., Arshad, M., Noureen, U., Akram, U., Mahar, J., Farooque, M., Usman, M., Brohi, M., & Braulik, G. (2025). Abundance of the endangered Indus dolphin *Platanista minor*. *Endangered Species Research*, 58, 315-329.

Ali, A., Khan, J., & Hussain, M. (2025). First characterization and risk assessment of microplastics in endangered Indus River dolphin (*Platanista minor*): Implications for conservation strategies

Anderson, J. (1878). *Anatomical and zoological researches: comprising an account of the zoological results of the two expeditions to western Yunnan in 1868 and 1875; and a monograph of the two cetacean genera, Platanista.* B. Quaritch,. <https://doi.org/10.5962/bhl.title.50434>

Arshad, M., Noureen, U., Khan, U., & Braulik, G. T. (2022). Evaluating survey methods for monitoring river dolphins in regulated rivers. *Aquatic conservation: Marine and Freshwater Ecosystem*, 32(6), 987-1001.

- Bhatti, M. U. and Pilleri, G. 1982. Status of the Indus Dolphin population (*Platanista indi* Blyth 1859) between Sukkur and Guddu Barrages in 1979-1980. *Investigations on Cetacea* 13: 245-52.
- Braulik, G. 2006. Status assessment of the Indus River dolphin, *Platanista gangetica minor*, March-April 2001. *Biological Conservation* 129: 579-590.
- Akbar, M., A.A. Chaudhry, and M.J. Arshed. 2004. Effect of Water Depth and River Width on Indus Dolphin Population. *Pakistan Journal of Life and Social Sciences* 2(1):33-35.
- Braulik, G. T. (2006). Status assessment of the Indus River dolphin, *Platanista gangetica minor*, March-April 2001. *Biological Conservation*, 129(4), 579-590. <https://doi.org/10.1016/j.biocon.2005.11.026>
- Braulik, G. T., Archer, F., Khan, U., Imran, M., Sinha, R. K., Jefferson, T. A., Graves, J.A. (in press). Taxonomic revision of the South Asian River dolphins (*Platanista*): Indus and Ganges River dolphins are separate species. *Marine Mammal Science*.
- Braulik, G. T., Barnett, R., Odon, V., Islas-Villanueva, V., Hoelzel, A. R., & Graves, J. A. (2015a). One Species or Two? Vicariance, Lineage Divergence and Low mtDNA Diversity in Geographically Isolated Populations of South Asian River Dolphin. *Journal of Mammalian Evolution*, 22(1), 111-120. <https://doi.org/10.1007/s10914-014-9265-6>
- Braulik, G. T., Barnett, R., Odon, V., Islas-Villanueva, V., Hoelzel, A. R., & Graves, J. A. (2015b). One Species or Two? Vicariance, Lineage Divergence and Low mtDNA Diversity in Geographically Isolated Populations of South Asian River Dolphin. *Journal of Mammalian Evolution*, 22(1), 111-120. <https://doi.org/10.1007/s10914-014-9265-6>
- Braulik, G. T., I. Archer, F., Khan, U., Imran, M., Sinha, R. K., Jefferson, T. A., Donovan, C., & Graves, J. A. (2021a). Taxonomic revision of the South Asian River dolphins (*Platanista*): Indus and Ganges River dolphins are separate species. *Marine Mammal Science*, 37(3), 1022-1059. <https://doi.org/10.1111/mms.12801>
- Braulik, G. T., I. Archer, F., Khan, U., Imran, M., Sinha, R. K., Jefferson, T. A., Donovan, C., & Graves, J. A. (2021b). Taxonomic revision of the South Asian River dolphins (*Platanista*): Indus and Ganges River dolphins are separate species. *Marine Mammal Science*, 37(3), 1022-1059. <https://doi.org/10.1111/mms.12801>
- Braulik, G. T., I. Archer, F., Khan, U., Imran, M., Sinha, R. K., Jefferson, T. A., Donovan, C., & Graves, J. A. (2021c). Taxonomic revision of the South Asian River dolphins (*Platanista*): Indus and Ganges River dolphins are separate species. *Marine Mammal Science*, 37(3), 1022-1059. <https://doi.org/10.1111/mms.12801>
- Braulik, G. T., Noureen, U., Arshad, M., & Reeves, R. R. (2015). Review of status, threats, and conservation management options for the endangered Indus River blind dolphin. *Biological Conservation*, 192, 30-41. <https://doi.org/10.1016/j.biocon.2015.09.008>
- Braulik, G. T., Reichert, A. P., Ehsan, T., Khan, S., Northridge, S. P., Alexander, J. S., & Garstang, R. (2012a). Habitat use by a freshwater dolphin in the low-water season. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 22(4), 533-546. <https://doi.org/10.1002/aqc.2246>
- Braulik, G. T., Reichert, A. P., Ehsan, T., Khan, S., Northridge, S. P., Alexander, J. S., & Garstang, R. (2012b). Habitat use by a freshwater dolphin in the low-water season. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 22(4), 533-546. <https://doi.org/10.1002/aqc.2246>
- Braulik, G. T., Taylor, B. L., Minton, G., Notarbartolo di Sciara, G., Collins, T., Rojas-Bracho, L., Crespo, E. A., Ponnampalam, L. S., Double, M. C., & Reeves, R. R. (2023). Red-list status and extinction risk of the world's whales, dolphins, and porpoises. *Conservation Biology*, 37(5). <https://doi.org/10.1111/cobi.14090>

- Braulik, G., Kanwar, G., Nawab, A., Khan, M. S., Behera, S. K., & Rajkumar, B. (2024). A review of the status, threats and management priorities of a remnant population of Indus River dolphins in the Beas River, India. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 34(2). <https://doi.org/10.1002/aqc.4087>
- Braulik, G.T. U. Noureen, M. Arshad, and R.R. Reeves. 2015b. Review of status, threats, and conservation management options for the endangered Indus River blind dolphin. *Biological Conservation* 192:30-41
- Brownell, R. L. (1984). Review of reproduction in Platanistid dolphins. Report of the International Whaling Commission (Special Issue 6), 149-158.
- Butt, J. A. 1977. Food of the freshwater dolphin (*Platanista minor* Owen) from the River Indus, Deralsmail Khan, Pakistan. *Biologia* 23(1): 91-94.
- Comizzoli, P., and Holt, W. V. (2019). Breakthroughs and new horizons in reproductive biology of rare and endangered animal species. *Biol. Reprod.* 101,514-525. doi: 10.1093/biolre/iox031
- Dolphins-World (2017). Indus River dolphin (*Platanista gangetica minor*). Available online at: <http://www.dolphins-world.com/indus-river-dolphin/> (accessed May 2, 2017).
- Frankham, R. (2008). Genetic adaptation to captivity. *Mol. Ecol.* 17, 325-333. doi: 10.1111/j.1365-294X.2007.03399.
- Hamilton, H., Caballero, S., Collins, A. G., & Brownell, R. L. (2001). Evolution of river dolphins. *Proceedings of the Royal Society of London. Series B: Biological Sciences*, 268(1466), 549-556. <https://doi.org/10.1098/rspb.2000.1385>
- Herald, E. S., Brownell, R. L., Frye, F. L., Morris, E. J., Evans, W. E., & Scott, A. B. (1969). Blind River Dolphin: First Side-Swimming Cetacean. *Science*, 166(3911), 1408-1410. <https://doi.org/10.1126/science.166.3911.1408>
- IPPC. (2023). Climate change 2023: Impacts, adaptation and vulnerability. Intergovernmental Panel on Climate Change.
- IUCN red list of threatened species. (2018).
- IUCN. (2023). Guidelines for monitoring freshwater cetacean populations. International Union for Conservation of Nature.
- Ji, J., Nabi, G., Zeng, X., Hao, Y., and Wang, D. (2019). Histological variation of blubber morphology in the endangered east Asian finless porpoise (*Neophocaena asiaeorientalis sunameri*) with ontogeny and reproductive states. *Zool. Stud.* 58:42. doi: 10.6620/ZS.2019.58-42
- Kahn, K.M. and M.S. Niazi. 1989. Distribution and population status of the Indus dolphin, *Platanista minor*. Pages 77-80. In: W.F. Perrin, R.L. Brownell Jr, K. Zhou & J. Liu (editors) *Biology and conservation of the river dolphins*. Occasional paper of the IUCN Species Survival Commission, 3, IUCN, Gland, Switzerland.
- Kelkar, N. (2008). Patterns of habitat use and distribution of Ganges river dolphins *Platanista gangetica gangetica* in a human-dominated riverscape in Bihar, India Post-Graduate Programme in Wildlife Biology & Conservation. In *Wildlife Biology & Conservation*.
- Khan, M. S. (2016). Factors affecting the survival of Indus River dolphin and species tolerance towards anthropogenic pressures. *Mar. Freshw. Res.* 68, 1245-1250. doi: 10.1071/MF16001
- Khan, M.S., Suleman, M., & Nawaz, R. (2022). Applications of passive acoustic monitoring for river dolphins in South Asia. *Journal of Cetacean Research and Management*, 23, 45-56.
- Kreb D (2004) Facultative river dolphins: conservation and social ecology of freshwater and coastal Irrawaddy dolphins in Indonesia. PhD thesis. University of Amsterdam, the Netherlands.

- Lindgren, J., Uvdal, P., Engdahl, A., Lee, A. H., Alwmark, C., Bergquist, K.-E., Nilsson, E., Ekström, P., Rasmussen, M., Douglas, D. A., Polcyn, M. J., & Jacobs, L. L. (2011). Microspectroscopic Evidence of Cretaceous Bone Proteins. *PLoS ONE*, 6(4), e19445. <https://doi.org/10.1371/journal.pone.0019445>
- Mar. Mam. Sci. 33, 803–816. doi: 10.1111/mms.12398
- Hao, Y., Nabi, G., Deng, X. J., and Wang, D. (2019). Non-invasive fecal steroid measurements for monitoring the reproductive status of a critically endangered yangtze finless porpoises (*Neophocaena asiaeorientalis asiaeorientalis*). *Front. Endocrinol* 10:606. doi: 10.3389/fendo.2019.00606
- Nabi, G., Ahmad, S., McLaughlin, R. W., Hao, Y., Khan, S., Ahmad, N., Ahmad, S., Kiani, M. S., Wu, Y., & Li, D. (2021). Deteriorating Habitats and Conservation Strategies to Repopulate the Endangered Indus River Dolphin (*Platanista gangetica minor*); a Lesson Learned from the Conservation Practices of the Yangtze Finless Porpoise (*Neophocaena asiaeorientalis*). In *Frontiers in Marine Science* (Vol. 8). <https://doi.org/10.3389/fmars.2021.561905>
- Nabi, G., Hao, Y., McLaughlin, R. W., and Wang, D. (2018a). The possible effects of high vessel traffic on the physiological parameters of the critically endangered Yangtze Finless Porpoise (*Neophocaena asiaeorientalis ssp. asiaeorientalis*). *Front. Physiol.* 9:1665. doi: 10.3389/fphys.2018.01665
- Paudel, S., Korowski, J. L., Thakuri, U., Sigdel, R., & Gautam, R. C. (2020). Ecological responses to flow variation inform river dolphin conservation. *Scientific Reports*, 10, 22348.
- Pilleri, G. and Zbinden, K. 1973–74. Size and ecology of the dolphin population (*Platanista indi*) between the Sukkur and Guddu Barrages, Indus River. *Investigations on Cetacea* 5: 59-69.
- Platanista gangetica*: Braulik, G.T. & Smith, B.D. (2017). In *IUCN Red List of Threatened Species*. <https://doi.org/10.2305/IUCN.UK.2017-3.RLTS.T41758A50383612.en>
- Platanista minor*: Braulik, G.T., Khan, U., Malik, M. & Aisha, H. (2021a). In *IUCN Red List of Threatened Species*. <https://doi.org/10.2305/IUCN.UK.2022-1.RLTS.T41757A243168232.en>
- Platanista minor*: Braulik, G.T., Khan, U., Malik, M. & Aisha, H. (2021b). In *IUCN Red List of Threatened Species*. <https://doi.org/10.2305/IUCN.UK.2022-1.RLTS.T41757A243168232.en>
- Reeves R.R, Baker, C. S., Taylor, B. L., & Perrin, W. F. (2004). Reeves et al. <https://iucn-csg.org/wp-content/uploads/2010/03/Reevesetal2004.pdf>
- Reeves, R. R., & Chaudhry, A. A. (1998a). Status of the Indus River dolphin *Platanista minor*. *Oryx*, 32(1), 35–44. <https://doi.org/10.1046/j.1365-3008.1998.00016.x>
- Reeves, R. R., & Chaudhry, A. A. (1998b). Status of the Indus River dolphin *Platanista minor*. *Oryx*, 32(1), 35–44. <https://doi.org/10.1046/j.1365-3008.1998.00016.x>
- Reeves, R. R., Chaudhry, A. A., & Khalid, U. (1991). Competing for Water on the Indus Plain: Is There a Future for Pakistan's River Dolphins? *Environmental Conservation*, 18(4), 341–350. <https://doi.org/10.1017/S0376892900022591>
- Smith BD, Reeves RR (2012) River cetaceans and habitat change: generalist resilience or specialist vulnerability? *Journal of Marine Biology* 2012: art. 718935.

- Taylor, B. L., Archer, F. I., Martien, K. K., Rosel, P. E., Hancock-Hanser, B. L., Lang, A. R., Leslie, M. S., Mesnick, S. L., Morin, P. A., Pease, V. L., Perrin, W. F., Robertson, K. M., Parsons, K. M., Viricel, A., Vollmer, N. L., Cipriano, F., Reeves, R. R., Krützen, M., & Baker, C. S. (2017). Guidelines and quantitative standards to improve consistency in cetacean subspecies and species delimitation relying on molecular genetic data. *Marine Mammal Science*, 33(S1), 132-155.
<https://doi.org/10.1111/mms.12411>
- Thomas, L. Marques, T.A., & Keller, O. (2021). Design and analysis of wildlife population surveys using distance and acoustic sampling. *Ecological Indicators*, 125, 107456.
- Turvey, S. T., Pitman, R. L., Taylor, B. L., Barlow, J., Akamatsu, T., Barrett, L. A., Zhao, X., Reeves, R. R., Stewart, B. S., Wang, K., Wei, Z., Zhang, X., Pusser, L. T., Richlen, M., Brandon, J. R., & Wang, D. (2007). First human-caused extinction of a cetacean species? *Biology Letters*, 3(5), 537-540.
<https://doi.org/10.1098/rsbl.2007.0292>
- Wang, D., Yujiang, H., Kexiong, W., Qingzhong, Z., Daoquang, C., Zhuo, W., et al. (2005). The first Yangtze finless porpoise successfully born in captivity. *Environ. Sci. Pollut. Res.* 5, 247-250. doi: 10.1065/espr2005.08.284
- WWF-Pakistan. (2020). Indus River dolphin population monitoring and conservation status report.
- WWF-Pakistan. (2022). Indus River dolphin conservation and monitoring report. World wide Fund for Nature-Pakistan.
- WWF-Pakistan. (2022). Status and conservation of the Indus River dolphin World Wide Fund for Nature Pakistan.
- WWF-Pakistan. (2025). Indus River dolphin conservation overview.
- Xiao, Y., Nabi, G., Yang, J., Hao, Y., and Wang, D. (2018). Hormonal regulation of testicular development in the finless Porpoise *Neophocaena asiaorientalis sunameri*: preliminary evidence from testicular histology and immunohistochemistry. *Zool. Stud.* 57:41. doi: 10.6620/ZS.2018.57-41
- Zeng, X., Huang, S. L., Hao, Y., Wang, D., Ji, J., Deng, X., et al. (2018). Ultrasonography of mammary glands in finless porpoises (*Neophocaena asiaorientalis*) at different reproductive stages. *Mar. Mam. Sci.* 34, 529-540. doi: 10.1111/mms.12453
- Zeng, X., Huang, S. L., Qian, Z., Hao, Y., Wang, D., Ji, J., et al. (2017). Characterization of milk composition in narrow-ridged finless porpoises (*Neophocaena asiaorientalis*) at different lactation stages.