

**Insights into the population status, distribution, feeding ecology
and breeding biology of painted stork (*Mycteria leucocephala*)
in India: a comprehensive review**

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Abstract

Painted Stork (*Mycteria leucocephala*) is a striking wader species found in freshwater wetland habitats across the Indian subcontinent and Southeast Asia. Recognizable by its mix of pink, white and black plumage, yellow facial patches, and long, downward-curved bill, the Painted Stork inhabits marshes, ponds, and lakes in regions such as India, Sri Lanka, Nepal, Bangladesh, Thailand and Myanmar. While the species' population varies regionally, it faces threats from habitat loss, pollution, and human disturbances. Primarily piscivorous, the Painted Stork feeds on fish by probing shallow waters with its specialized bill, though it also consumes crustaceans, amphibians, and small reptiles. These opportunistic feeding habits help the storks adapt to seasonal changes in food availability. During breeding, Painted Storks form large colonies, nesting in trees near water. Both males and females collaboratively build nests made of twigs, lined with leaves and grass. As a species dependent on healthy wetland ecosystems for food and reproduction, the Painted Stork's survival is closely linked to the preservation of these habitats. Effective conservation efforts are critical to safeguard the species, particularly as anthropogenic pressures continue to threaten their natural environments.

Key words : Painted stork, Breeding, Conservation efforts, Feeding, Habitat, Human disturbance.

Painted storks (*Mycteria leucocephala*) belong to the genus *Mycteria* within the family *Ciconiidae*, which comprises 19 species globally, with 11 species found in Asia. India is home to eight reported species of storks^{2,3}. Their distribution were in South Asia, South-East Asia and southern part of East Asia including India, Sri Lanka, Nepal, Myanmar, Cambodia and Vietnam^{14,18,49}. They are not migratory species; instead, they exhibit limited, short-distance movements in certain regions, primarily in reaction to fluctuations in food availability and for reproduction purposes²⁹. These birds are restricted to freshwater and they are commonly found in large colonies at swamps, ponds, lakes, river banks and wetlands⁶⁷. Like other waterbirds, the painted stork is characterized by long legs, an elongated neck and a long, heavy and slightly curved bill^{2,3} and a predominantly white body with a distinctive black stripe across the chest and wings. Additionally, it features a pink mark on the scapula, which is the hallmark feature giving it the name “painted stork”⁴⁹. The downy chicks of the Painted Storks are primarily whitish, with grey bills and dark facial skin. In contrast, juveniles display brownish plumage as they mature²⁹. This bird stands at a height ranging from 93 cm to 102 cm, with a wingspan measuring between 150 cm and 160 cm, and it typically weighs between 2 kg and 3.5 kg⁶⁹. In addition, this species is considered a flagship species, and due to its exclusive piscivorous nature²³, its nesting behavior is closely linked to monsoon patterns. The productivity of local rivers and wetlands, essential for fish production, is highly dependent on the monsoon cycle⁶³. Both environmental and biological factors, such as climatic conditions (*e.g.*,

temperature and precipitation), vegetation types, aquatic organisms (*e.g.*, fishes, amphibians and small reptiles), and water quality, are key determinants influencing the species diversity and population density of birds in wetland habitats⁵⁶. Painted Storks exhibits sexual monomorphism in plumage, meaning there is no noticeable difference in coloration or pattern between males and females. However, the species demonstrates sexual size dimorphism, with males generally being larger than females, as previously documented in studies of this species^{18,69}.

According to BirdLife International⁷, the global population size of the painted stork ranges between 20,000 to 60,000 mature individuals, with an increasing trend. This species lives in colonies and nests in large groups of up to 200 individuals⁵³. They are observed foraging in groups ranging from 1 to 18 individuals²³. Recently, these birds are classified as “least concerned” in Red Data list of avifauna of the World by International Union for Conservation of Nature (IUCN)⁶, previously they were in the category of “Near Threatened”⁵⁵ due to various factors including hunting, wetland drainage, and population decline. Waterbirds are excellent biological markers for their surrounding environments, providing insights into issues like habitat loss and the effects of climate change^{26,47,74}. According to Urfi *et al.*,⁷¹ the Painted Stork (*Mycteria leucocephala*) faces several significant threats, including the degradation of feeding habitats, overfishing in key wetlands and deforestation that impacts the availability of nest-building trees. Additional pressures include poaching of both adults and juveniles, reduced egg hatching success, malnutrition of

developing chicks, and increased egg depredation^{47,51,55,57}. These combined factors contribute to the species' vulnerability and underscore the need for targeted conservation efforts. For safeguarding bird species, particularly Nomadic shorebirds, documenting and protecting both feeding sites and roosting sites, in addition to breeding sites, are critical steps⁵⁶. In the current review paper, the focus revolves around the current population status, geographical distribution, feeding habits, nesting and breeding behaviours, and the conservation challenges faced by the painted storks.

I. *Population status and distribution of Painted Stork :*

Painted Stork is not confined to a specific area in India; instead, it is a resident breeder with a global distribution spanning approximately 8,700,000 square kilometre⁶. According to BirdLife International⁷, this species inhabits a vast range spanning from South Asia to South-East Asia, where its population trend shows signs of growth. This positive trend, particularly notable in South-East Asia, is attributed to focused conservation efforts and the safeguarding of breeding colonies. These birds are primarily restricted to freshwater habitats, commonly forming large colonies in swamps, ponds, lakes, riverbanks, and wetlands across urban, suburban, and rural areas⁶⁷. Painted storks exhibit a remarkable adaptation to urban environments, utilizing a variety of waterbodies effectively. Their colonial behavior, coupled with their larger size compared to other waterbird species, enhances their ability to adapt and colonize new areas successfully. The Painted Stork has an extensive distribution across

wetlands, ranging from the Indo-Gangetic plains to Southeast Asia⁷. In India, the species is known to breed in at minimum 25 locations, with key breeding colonies, roosting sites, and foraging habitats primarily located in the southern states of Andhra Pradesh, Tamil Nadu, and Karnataka^{50,67}. Among the significant sites in Andhra Pradesh, Uppalapadu in Guntur district and Telineelapuram in Srikakulam district are particularly important for supporting large numbers of Painted Storks, facilitating essential activities such as breeding, roosting, and foraging^{40,41}. Additionally, Bhat *et al.*,⁴ conducted a study on the nesting and feeding behavior of the Painted Stork at Veerapuram Village in Anantapur District, Andhra Pradesh. Painted storks are known for their colonial breeding behavior, and there is considerable variation in the size and type of colonies across India. These colonies can consist of single species or be mixed with other heron species like Indian Cormorant (*Phalacrocorax fuscicollis*), Cattle Egret (*Bubulcus ibis*), Black-crowned Night Heron (*Nycticorax nycticorax*), Black-headed Ibis (*Threskiornis melanocephalus*) and Asian Openbill (*Anastomus oscitans*)⁷⁰, reflecting a common occurrence. The Grey Heron (*Ardea cinerea*), Little Cormorant (*Microcarbo niger*) and Great Egret (*Ardea alba*) have also been observed nesting in close proximity to Painted Stork heronries⁵⁹. While many colonies are typically found on trees such as *Acacia*, *Prosopis*, *Ficus* and *Tamarindus* growing on islands, there are also instances where colonies are established in villages and agricultural lands⁶². Additionally, colonies of these Storks are present within protected areas like Delhi Zoo, Sultanpur National Park in Haryana⁷¹ and Keoladeo Ghana National Park in Bharatpur^{20,29,35}.

Ranganathittu Bird Sanctuary in Karnataka, Harike Lake Bird Sanctuary in Punjab, Koonthankulam Bird Sanctuary in Tamilnadu³⁴ and Wild Ass Wildlife Sanctuary in Kutch, Gujarat, are among the Important Bird Areas (IBAs) identified for significant populations of painted storks⁶⁷. Breeding colonies are also reported near human settlements in Kanpur and Lucknow cities in Uttar Pradesh^{27,29}. Population dynamics and feeding behavior of painted storks were studied at three isolated ponds within the Godavari river basin in the Nanded region of Marathwada, Maharashtra State¹⁰. Their presence and distribution is also reported in Rajasthan^{25,44}. Kokkare Bellur village, commonly referred to as the 'Stork Village,' is located approximately 80 km from Bengaluru, in the Mandya district of Karnataka³⁹.

II. Food and foraging behaviour of Painted Stork :

In the context of avian reproduction, a consistent and reliable food supply is essential for the successful breeding and rearing of offspring. In India, the monsoon season serves as a crucial period for sustaining biodiversity across various ecosystems⁶⁸. Foraging studies are vital for developing conservation strategies for storks, as their breeding success frequently depends on changes in food distribution⁶⁷. In foraging, the bill plays a crucial role. An adult Painted Stork has a large bill, over 24 cm in length, which is waxy yellow and curved at the tip⁶⁷. This pincer-like adaptation allows the stork to grasp and hold onto prey effectively, preventing it from slipping. Despite the powerful jerks of fish⁸, once captured by the Painted Stork, the prey is unlikely to escape unless it is dropped.

Painted Stork, exhibit a distinctive pattern of tactile foraging³². The individual typically forages by inserting its partially open bill into the water while keeping its eyes above the surface. This movement is often accompanied by a lateral motion of the bill and foot-stirring—behaviours also noted in egrets. These actions, along with wing-flashing, are likely employed to startle hidden fish. In particular, the Painted Stork demonstrates a unique foraging technique characterized by 'active tactolocation'⁶⁸. The Painted Stork is confined to the littoral zone, where it forages in shallow waters that are generally less than 25 cm in depth⁶⁷. Painted Storks forage in groups, with the size of these groups varying by season. During the breeding season, foraging groups tend to be smaller compared to the non-breeding season. This is primarily due to the drying of wetlands in summer, which forces the storks to concentrate their foraging efforts on the limited remaining water bodies⁶⁸. In India feeding ecology and nesting ecology was studied by Desai¹³. While primarily classified as piscivorous, the Painted stork exhibits a diverse diet that includes insects, crustaceans, and amphibians^{23,54, 67}. Notably, there are documented instances of the bird consuming snakes and hatchling Mugger crocodiles^{48,61}. A Painted Stork was also observed foraging on carrion from a plastic bag, attempting to extract a piece of meat, which appeared to be goat offal, from within the bag³⁶. During the early morning hours, when dissolved oxygen levels in aquatic environments are typically lower, fish may exhibit behaviours such as moving to shallow areas, surfacing more frequently, or making periodic trips to the surface to gulp air. These behaviours increase their vulnerability to

capture²⁸. At various times during the day, fish tend to retreat to deeper, less accessible regions, reducing their exposure to predators, such as storks²³. Nocturnal foraging activity of Painted stork were also observed^{24,38}. An alternative foraging strategy employed by carnivorous birds, including storks and herons, is kleptoparasitism or food theft¹⁵. Although various bird species are commonly found in the same foraging habitats as Painted Storks, only the Grey Heron and Great Egret—both of similar size and fish-eating habits—are capable of being targeted by Painted Storks for prey theft. Additionally, Mahendiran and Urfi³¹ documented instances of Painted Storks stealing fish from Little Cormorants.

III. Nesting and breeding behaviour of Painted Stork :

Painted storks (*Mycteria leucocephala*) are colonial breeders. Outside of the breeding season, they are widely dispersed across a variety of habitats, including wetlands, agricultural fields, and shallow coastal areas other suitable urban and rural areas, in search of food⁶⁸. The breeding season of the Painted Stork is influenced by monsoon conditions. Typically, the breeding season occurs from August to October in northern India, and from November to March in southern India^{2,3}. In India, particularly in the southern states of Andhra Pradesh, Tamil Nadu, and Karnataka, several sites are recognized as key breeding, roosting, and foraging habitats for Painted Storks^{41,50,67}. Additionally, breeding colonies have been documented in northern India, across states such as Delhi, Uttar Pradesh, Haryana, Gujarat⁵⁵ and Rajasthan^{16,58}. Temperature and rainfall exhibit a positive

correlation with the nesting density of Painted Storks^{21,41,57,75}, whereas reduced rainfall and diminished food availability have been shown to negatively impact their reproductive success³⁰. Painted Storks are known for their strong fidelity to specific breeding sites, often selecting trees within villages where human habitation is present^{42,60}. The preferred tree species for nesting include Ashoka (*Saraca asoca*), Semal (*Bombax ceiba*), Babul (*Acacia nilotica*), Banyan (*Ficus benghalensis*). Several other tree species frequently used for nesting, including *Ficus religiosa*, *Tamarindus indica*, *Azadirachta indica*, *Ziziphus jujubo*, *Prosopis juliflora*, *Leucaena leucocephala*, *Acacia negev* and *Tectona grandis*⁴². According to Ramamohana and Rao⁴¹ painted storks also establish their colonies on *Bambusa arundinacea*, *Sapindus emarginatus*, and *Melia azadirachta* trees. *Euphorbia*, the shortest nesting tree, was recorded at Man Marodi, an island off the coast of the Gulf of Kutch⁶⁴. Painted stork is a monogamous species; both male and female Painted Storks participate actively in nest building. They build their nests using twigs and fresh leaves, primarily from Eucalyptus trees, and regularly maintain and repair them throughout the breeding season^{27,44}. The optimal nesting sites for Painted Storks are located at the tops of trees with sparse foliage, and these locations are highly competitive. The male selects the nest site, which he actively defends against intruders. To attract a mate, the male engages in a series of display behaviors, preening himself including up-and-down head movements, vocalizations and bill clattering^{13,22,27}. After the pair bond formation between them they do mating. During copulation, the male produces a sound by clashing his mandibles against the

female's bill^{13, 27}. Different studies have reported variation in the clutch sizes of the Painted Stork, with factors such as the age of the bird and the stage of the reproductive season potentially influencing clutch size⁴¹. At the Thol Bird Sanctuary, Gujarat, Pathak³⁷ noted a typical clutch size range from three to four eggs, while other studies have documented clutches with as many as five eggs^{17,51}. The average clutch size of Painted Storks is believed to range between 2.2 and 2.8 eggs^{33,54}. Both male and female Painted Storks equally contribute to egg incubation, with the Incubation duration of about one month before the eggs hatch^{11,19,41,51} while the fledging period is nearly 3 months^{27,41}. Painted storks show excellent bi-parental care until the fledglings will be able to stand on their own and take up the flights^{27,41,74}.

IV. Threat and conservation issues of Painted Stork :

Painted storks are fish eating water wading birds. The decline in their populations can be attributed to several interconnected factors, primarily habitat loss and degradation. Destruction of wetlands, a critical habitat for these species^{65,66,67}, has been a significant driver of population decline. Pollution, both from industrial and agricultural sources, further exacerbates the problem by contaminating water bodies and disrupting the food chain. Pesticides and insecticides applied in agricultural fields can enter the food chain of carnivorous species like the Painted Stork. As these birds prey on organisms that have accumulated pesticides, bioaccumulation and biomagnification processes may lead to harmful physiological effects. In particular, exposure

to pesticides has been linked to negative outcomes such as the thinning of eggshells, which can significantly impact reproductive success. Additionally, the spread of invasive aquatic plants, such as *Water Hyacinth* (*Pontederia crassipes*), contributes to the degradation of foraging habitats by altering water quality, reducing biodiversity, and obstructing access to prey. These combined pressures have led to a marked reduction in suitable feeding and nesting environments, posing a considerable threat to the survival of fish-eating bird species^{27,68}. The rapid and often unplanned expansion of urbanization and industrialization, coupled with the encroachment on natural habitats, has led to significant challenges for Painted Stork⁴¹. These birds are experiencing regional population declines, primarily due to increasing pressure from agricultural expansion and housing development²⁷. The most pressing threats to their survival are the loss and degradation of critical habitats, as well as the diminishing availability of suitable nesting sites. As urban sprawl encroaches on wetlands and other essential ecosystems, Painted Storks face increasing difficulties in finding both food sources and safe breeding grounds, further compounding the challenges to their long-term survival⁵¹. In regions such as Assam and Nagaland, hunting of Painted Storks (*Mycteria leucocephala*) for food and other purposes remains a concern²⁷. The practice of hunting is exacerbated by environmental factors such as low rainfall, which leads to food scarcity, and cold weather conditions that contribute to nest desertion, reduced breeding success, and ultimately lower fledgling survival rates. Additionally, various predators pose a threat to the population of Painted Storks. Known predators in India include tigers (*Panthera*

tigris), leopards (*Panthera pardus*), jungle cats (*Felis chaus*), hyenas (*Hyaena hyaena*) and crocodiles (*Crocodylus* spp.). Egg predation by Black Kites (*Milvus migrans*) and house crow (*Corvus splendens*) has also been documented, further exacerbating the species' vulnerability^{27,41}. Predation of fledgling by Spotted Eagle was also reported in Sultanpur National Park, Haryana⁵². Furthermore, a lack of awareness and conservation education among local communities contributes to the ongoing threats faced by this species²⁷. Urbanization significantly alters the natural habitats in which species have evolved¹. Factors such as high human population density, increased artificial lighting, chemical pollution, and elevated noise levels further exacerbate these challenges. Man-made disturbances, including proximity to high-rise buildings, cell phone towers, noisy motorways, light pollution from street and tower lights, vehicular emissions, waste discharge, and direct human interference with nesting sites, create additional stressors that make heronries particularly vulnerable⁹. These anthropogenic factors disrupt breeding success and pose significant threats to Painted stork¹⁶. Invasive, non-native fish species may have entered Indian waters accidentally, pose a significant threat to the integrity of local food webs, particularly within wetland ecosystems. A notable example is the African Catfish (*Clarias gariepinus*), an aggressive and rapidly proliferating species known for its large size. The proliferation of this invasive fish has led to the displacement of numerous native fish species, many of which are integral to the diet of fish-eating birds like painted stork⁶⁸. To comprehensively assess the population dynamics and reproductive success of the Painted Stork, it is essential to conduct in-depth

genetic studies, monitor breeding outcomes, and implement long-term population surveys. Such investigations would provide valuable insights into the species' genetic diversity, breeding patterns, and overall population health, contributing to more effective conservation strategies and Sustained resilience of the population.

Painted Stork is a sizable waterbird found in shallow habitats. These birds are primarily restricted to freshwater habitats, commonly forming large colonies in swamps, ponds, lakes, riverbanks, and wetlands across urban, suburban, and rural areas. They are colonial breeder and breeding season for Painted Stork occurs from August to October in northern India and from November to March in southern India. It has beautiful appearance with a distinctive black stripe across the chest and wings and has pinkish feathers on lower back. During foraging time they use active tacto-location technique to catch the prey (mainly fishes) in water. The optimal nesting sites for Painted Storks are typically found at the uppermost branches of trees with sparse foliage. Large-scale ecosystem changes, including urban development, habitat loss, industrialization and deforestation, may act as significant limiting factors for the availability of suitable nesting sites and prey population for Painted Storks, potentially impacting their reproductive success and overall population stability. To establish an effective long-term conservation monitoring program for nesting heronry birds like Painted Stork, it is essential to integrate volunteer participation at the community level. This can be achieved by developing comprehensive nature education initiatives aimed at raising awareness and fostering local engagement in conservation

efforts. Additionally, it is crucial to address key ecological stressors that threaten the health of these habitats, including pollution, siltation, and the escalating encroachments on riverbanks, wetlands and floodplains. Implementing targeted mitigation strategies to reduce these pressures will be critical for the sustainability of heronry populations and the preservation of the broader ecosystem.

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