Nesting Habitats of Lesser Adjutant Stork and their Environmental Challenges in Nagaon, Assam.

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Abstract

The Lesser Adjutant stork (*Leptoptilos javanicus*) is among the rarest stork categorized as Near Threatened according to the IUCN Red List of Threatened Species 2024, that is widely distributed throughout the Brahmaputra and Barak valleys of Assam. The present study evaluated nesting records and threat factors towards its survival and conservation in the Nagaon district of Assam. Five different nesting locations were studied and four different nesting trees were observed. The frequency of occurrence of nests in each tree species was calculated. Different threat factors were directly observed such as habitat destruction, human disturbance near nesting habitats, pollution in rivers and wetlands, application of harmful chemicals in agricultural practices, excess fishing practices in nearby wetlands, etc. This gradual increase in anthropogenic activities is affecting the stork population adversely. The current study will support future research by offering baseline data for analysis, enhancing conservation planning, and outlining the essential precautions for the Lesser Adjutant stork's protection.

Keywords: *Leptoptilos javanicus*, Habitat destruction, Anthropogenic activities, Nagaon, Kalong River, Conservation threats.

Introduction:

Birds are one of the incredibly most fascinating creatures on earth, they serve as vital indicators of environmental changes and reflect the overall health of their habitats. Their sensitivity to alterations in their surroundings has caught human interest in understanding their ecology and biology, aiming to preserve a healthy habitat and maintain balance in nature. The Indian subcontinent is home to approximately 2000 bird species, including migratory birds that visit during winter (Ali and Ripley, 1987). Numerous efforts have been made to study these species

in detail, aiming to develop conservation strategies according to their preferred habitats, which encompass a wide range of environments such as wetlands, oceans, riparian areas, grasslands, and woodlands.

The Lesser Adjutant stork is a Near threatened bird species which has an estimated population of 5000-15000 mature individuals around the world (IUCN). In Nepal and India mostly, the number of matured individuals has been estimated to be between 2000 and 5000 (Birdlife International 2023). The population is declining rapidly day by day. The stork is widely distributed throughout the Brahmaputra and Barak valleys of Assam. This species is known for its impressive size and distinctive appearance. It has a large population in districts such as Tinsukia, Barpeta, Dhubri, Nalbari, Kamrup, Nagaon, Darrang, Lakhimpur, Dibrugarh, and Jorhat (Dewan and Saikia, 2012). However, it is less abundant in the Barak Valley. Unfortunately, in the region of Nagaon, Assam, this awesome bird has been the subject of significant conservation efforts due to the numerous threats it faces in its natural habitat. The habitats of these bird species are under threat due to various factors including pollution, agricultural conversion, direct deforestation, hydrologic alteration, groundwater depletion, water quality degradation, rapid urbanization, global climate change, and various anthropogenic activities (Foote et al, 1996). This species was listed as globally threatened in the Red Data Book of Asia by BirdLife International in the year 2001.

The current study aims to provide a detailed analysis of the nesting records and recommends conservation threats along with measures to mitigate these threats to Lesser Adjutant stork in Nagaon, Assam, shedding light on the challenges and opportunities for the preservation of this bird species.

Study area

The study was conducted in the Nagaon district of Assam, located on the South bank of the Brahmaputra River which lies between 25°45” and 26°North latitudes and 91°50” and 93°20” East longitudes with average rainfall near about 1750 mm. The district is bounded by Karbi Anglong and Dima Hasao on the South, on the East by Golaghat, and on the West by Morigaon district which was originally a part of the erstwhile Nagaon district. The Kalong River is the major river that divides the town into two halves Haibargaon and Nagaon. The study area includes the bank of River Kalong across the town with all human habitation and the NH-37 in

Uriagaon, Nagaon, which includes the nesting trees of the Lesser Adjutant stork and paddy fields near the highways.

Methods of the Study

From October 2023 to March 2024, the selected sites were surveyed every month. Data collection occurred from sunrise to sunset and involved a combination of field observation and a Satellite Image Time Series to detect changes in the study area. Field observations were conducted using a Nikon Coolpix p900 camera, 10×50 Zenith binoculars and location were tracked by Garmin eTrex 10 GPS device. A distribution map of the study area was created using geographic information system (GIS) software (ArcGIS 10.5). [Fig.1]. Direct observation method was used to identify various threats and for spotting of storks. Different modes of transportation were utilized to reach study sites at various locations throughout the study period. Adults and immature (sub-adults) birds were distinguished based on their plumage (Allen, 1956; Johnson and Cezilly, 2007). Frequency of nest occurrence and storks on each nesting tree were calculated. All the statistical analysis were done on Microsoft Excel.

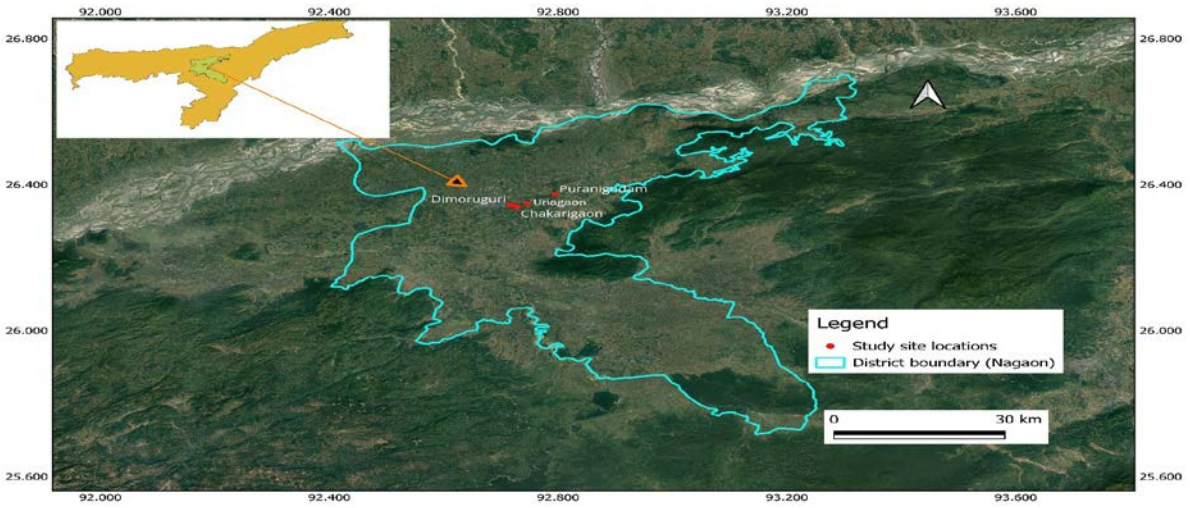

Figure 1: Map showing the study area.

Results:

Nesting Record

During the study period, 73 individual storks were counted in the nesting tree, together with juveniles (Table 1). In four separate tree species—*Bombax ceiba* (Simolu), *Alstonia scholaris* (Sotiyona), *Neolamarckia cadamba (*Kadam), *and Terminalia arjuna* (Arjun) - a total of twenty-one nests were found. [Fig.2]. The frequency of nest occurrence in *Bombax ceiba* and

Alstonia scholaris were recorded to be 33%, in *Neolamarckia cadamba* 24% and *Terminalia arjuna* to be 10%. [Fig.3]. Majority of the stork population was observed in *Alstonia scholaris* (33%) followed by *Bombax ceiba* (32%), *Neolamarckia cadamba* (25%) *and Terminalia arjuna* (11%). [Fig.4]. During October 2023, all the nests in each nesting tree were occupied and the hatching period was over. Local people in the study area have reported that the stork's nesting colonies have been there for over 5 to 6 years. However, from two locations – Chakarigaon and Uriagaon, it has been noted that the number of nests has been gradually declining from two to three years.

Conservation Threats

The major threats in the study area include habitat destruction, human disturbance, wetland degradation, pollution of Kalong River, nest destruction, and over-fishing in the nearby wetlands.

Residents have claimed that heavy rainfall and storms are one of the reasons for the destruction and falling out of eggs from the nests, leading to loss of habitat. Since all of the nesting trees in the study area were close to roadways, there have been reports of earlier tree removal for the construction of highways. This has greatly affected the nesting and roosting habitat of storks.

One of the main dangers to the stork species is the expansion of human settlements close to nesting habitats and the commercialization of the areas [Fig. 6]. Human settlements such as fuel stations, bamboo shacks, government schools, car garages, and other establishments were detected close to the nesting trees, which disturbs the stork population and also create hindrance in the selection of suitable trees for nesting.

For breeding habitat, storks primarily favour places like riverbanks and wetlands hence, the availability and good quality of water are crucial for the selection of nesting locations. The Kalong river in the study area, is observed to be overused and highly contaminated due to a variety of activities, including textile washing, the disposal of domestic trash and chemical waste, etc. Since agricultural fields are the primary foraging grounds, extensive usage of pesticides and fertilizers in agricultural operations may result in the biomagnification of stork populations. Since fish make up a large component of the diet of stork species, excessive fishing techniques, which involve deploying various traps and nets, for consumption and commercial purposes in neighbouring wetlands like Hahila beel, Samaguri beel, etc. may represent a serious threat to the species [Fig. 7].

The Lesser Adjutant stork was well known to the locals in the study area. The eggs and chicks from the *Terminalia arjuna* tree in Uria Gaon were seen falling onto the roads due to the intense storms. To report this problem, locals called the Nagaon Forest Office and the crew covered the nesting tree with bird safety netting to protect birds and eggs that fall from their nests and keep them safe [Fig. 6 (C)].

The results of our study showed that one of the locations – Chakarigaon is exposed to the majority of anthropogenic activities i.e. Highways, human settlements, tea stalls, and car garages followed by Nartum gaon with human settlements, highways, and shops. [Fig.5].

Table 1: Nesting trees with several nests of Lesser Adjutant stork in different locations of Nagaon, Assam.

Location	**Nesting Tree**	**Number of trees**	**Number of storks in each tree species**	**Number of nests in each tree species**
Dimaruguri	*Bombax ceiba*	1	10	3
Chakarigaon	*Alstonia scholaris*	2	24	7
Nartum Gaon	*Neolamarckia caramba*	1	18	5
Uria Gaon	*Terminalia arjuna*	1	8	2
Puranigudam	*Bombax ceiba*	1	13	4
	Total	6	73	21

A

B

C D

Figure 2: Four types of nesting trees (A - *Alstonia scholaris;* B- *Bombax ceiba;* C- *Neolamarckia cadamba;* D- *Terminalia arjuna*) were recorded in the study area.

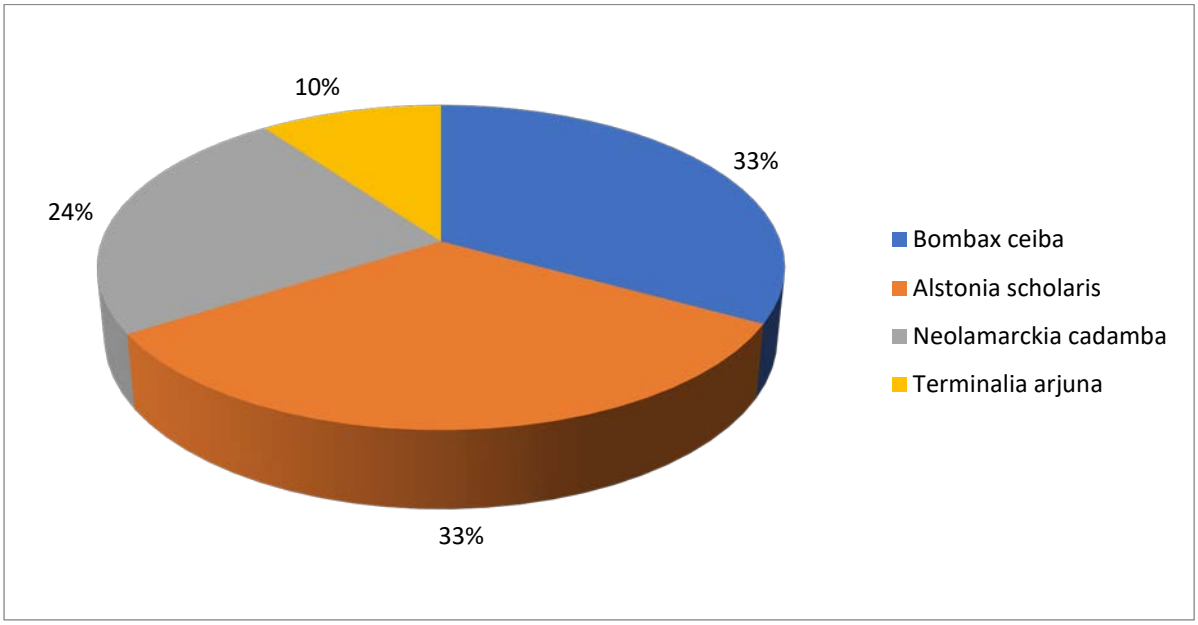

Figure 3: Frequency of nest occurrence in each nesting tree species in the study area.

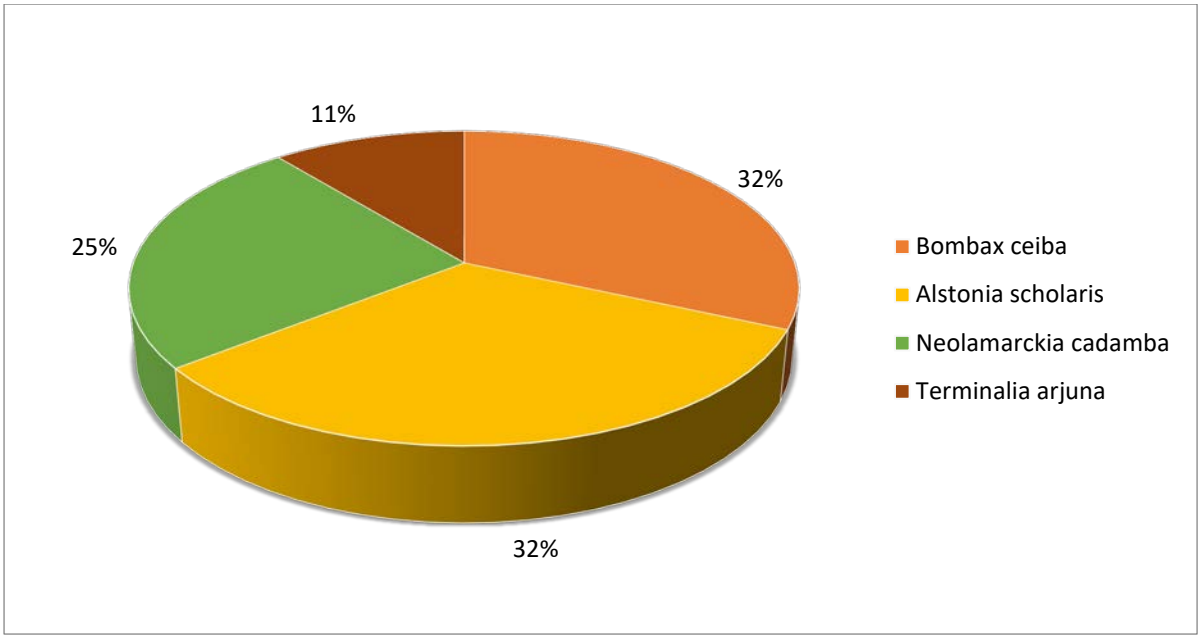

Figure 4: Frequency of stork observed in each nesting tree species in the study area.

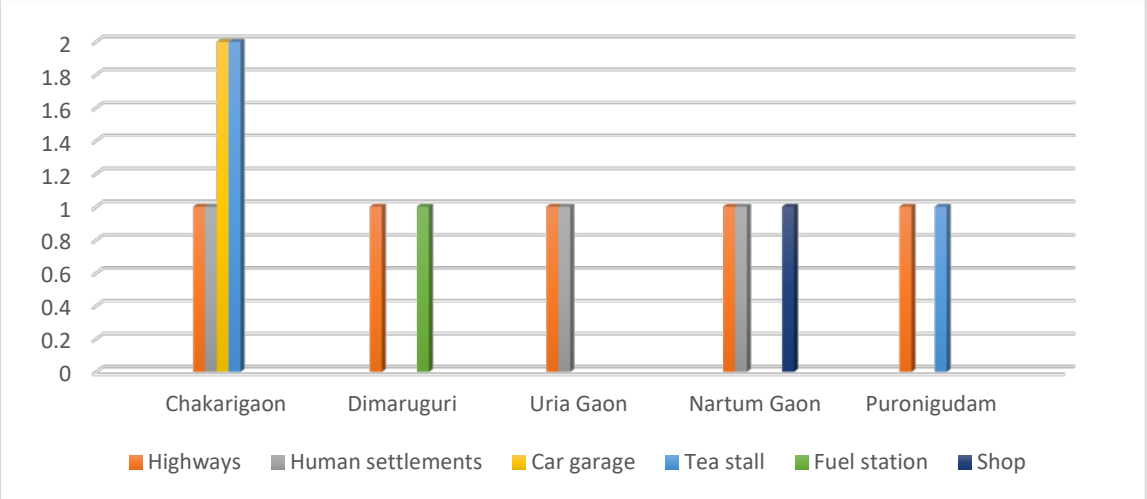

Figure 5: Frequency of threats observed near each nesting location.

(A)

(B)

(C)

(D)

(E)

Figure 6: Human disturbance - (A) & (B): Fuel station near *Bombax ceiba* at Dimoruguri; (C) National Highway near *Terminalia arjuna* at Uria gaon; (D) Tea shack near *Bombax ceiba* at Puronigudam; (E) Human settlements near *Alstonia scholaris* at Chakarigaon.

(A)

(B)

(C)

(D)

Figure 7: (A) & (B) Fishing practices using nets (Porngi jaal) in wetlands; (C) Pollution at Kalong river. (D): Storks foraging in agricultural fields.

Discussion:

Nesting Habitat

The Lesser Adjutant stork has a wide range of distribution across South and Southeast Asia. In India, the breeding of the stork has been recorded in Assam, West Bengal, Bihar, Odisha, Tamil Nadu, and Karnataka (Rahmani 2012). However, Assam holds the maximum reports of breeding (Barua and Sharma 2005; Choudhury 2000, 2006; Pawar and Birand 2002). Total count of Lesser Adjutant stork in Assam is reported to be 2000 (Choudhury 2000). However, our study has recorded 21 breeding pairs of the stork. The species was observed to use four separate tree species—*Bombax ceiba* (Simolu), *Alstonia scholaris* (Sotiyona), *Neolamarckia cadamba (*Kadam), *Terminalia arjuna* (Arjun) for nesting in the study area while in Nepal they were also found to use *Ficus racemose, Shorea robusta Terminalia alata, Adina cordifolia* (Bhattarai P. B. et al.,2021; Bajagain and Pradhan 2018), in Jharkhand *Ficus benghalensis, Tamarindus indicus* (Karki and Thapa 2013; Dwivedi et al., 2013) and in Sri Lanka only *Adina*

cordifolia was recorded (Silva N. T., et al., 2015). All the nesting habitats in this study area were located next to the Kalong river. This shows that the stork prefers locations close to water sources, as these areas provide food, foraging opportunities, and suitable nesting sites. While wetlands are ideal, they can also thrive near ponds, rivers, or any aquatic ecosystem that offers a favourable environment, with less competition. A similar finding was reported by Bhattarai P. B. et al.,2021 in Chitwan National Park, Nepal where the number of nests was negatively correlated with the distance to the nearest wetlands and foraging areas. This study also showed that Lesser Adjutant stork preferred *Bombax ceiba* trees in comparison with other trees which shows similarity with findings by Karki and Thapa 2013. This might be due preference of trees with safe height and large canopy for nesting. Similar results were found by Singha et al. 2002, Sundar et al. 2016, and Barman & Sharma 2020 for Greater Adjutant and Asian Openbill *Anastomus oscitans* (Sundar et al. 2016, Zainul-Abidin et al. 2017). However, the selection of a nesting site may also depend on factors like suitable mates, nesting materials, temperature, and rainfall (Tamang 2003).

Conservation Threats

Assam is the only state that has a stronghold for the conservation of nesting colonies of stork species especially Lesser Adjutant and Greater Adjutant. Hence there is an urgent need for the conservation of the species in Assam. Felling of trees and forest fragmentation are threats faced by all adjutant populations throughout Sri Lanka (Silva, T. N., et al.,2015). According to BirdLife International 2013, the felling of nesting trees, egg poaching, and hunting of chicks are threats that the species commonly faces throughout its global range. The results of our study showed that the major threat to the species is habitat destruction as a result of the cutting of trees, heavy rainfall, and storms, which is similar to the finding by Dewan and Saikia 2012 where, major threats include destruction of nesting trees, loss of potential wetlands and habitats, extensive tree cutting in rural areas, soil erosions and wetland eutrophication and extensive uses of pesticide around the wetland habitat. A study by Khan 2016 has also reported the destruction of nesting and roosting substrates due to systematic clear-cutting or selection logging operations by the Forest Department and other agencies. Human expansion and disturbance are other major threats to the LA stork in the study area. Studies by Bhattarai & Kindlmann 2012, and Bhattarai & Kindlmann 2013 reported that the highest number of trees were located in less disturbed areas such as people's presence and livestock grazing. However, our study shows the presence of nesting trees near human settlements in three locations. Despite the existence of human activities, the storks have chosen this area for nesting, this

might possibly be due to the presence of other essential factors like food availability, ideal nesting trees, surrounding water bodies, and foraging habitats. A study by Cheng et al. 2023 reported that nesting site selection of Oriental White storks shows flexible adaptive strategies. In safer environments, nests were lower and nearer to food sources allowing parent storks to devote more time and energy to the nestlings. While in a disturbing environment, nests were higher for the safety of nestlings. Pollution of the wetlands and rivers is another dangerous threat in the study area. As Kalong is the most polluted river in Assam and is one of the reasons behind the selection of nesting habitat, the survivability of the storks depends on the quality of water and availability of prey. From the findings of our study, the storks were seen to be foraging mostly in rice paddy fields. However, the application of various pesticides and agrochemicals in agricultural fields poses a severe threat to Lesser Adjutant storks since, rice paddy fields are the important feeding habitats of the storks (Pokharel 1998, Gyawali 2003). Contamination with toxic chemicals leads to biomagnification within the stork fat tissues. Similar findings have been reported by Oaks et al. (2004) where, diclofenac, was found to accumulate on the body tissues of vultures leading to fatal kidney failure. A study by Ohlendorf et al. 1978, reported that organochlorine residues from pesticides are known to cause eggshell thinning in storks and other birds with fish diets.

Conclusion:

The study on the nesting records and conservation threats of the Lesser Adjutant stork *(Leptoptilos javanicus*) in Nagaon, Assam provides valuable insights into the habitat preferences, nesting behaviours, threats faced by this species in the region and a better understanding of the Lesser Adjutant stork's ecology. In this study, a total of 4 types of nesting trees have been recorded in five locations. Two of nesting locations have been found to near human settlements and are exposed to different sort of anthropogenic activities. Here are few steps that could be taken by local community for conservation of the stork – Adopt sustainable agricultural practices to reduce habitat destruction, avoid cutting of tall trees near highways, avoid overfishing in wetlands, installation of nests in trees for preventing falling of chicks from nests, organize awareness campaigns in schools and communities to educate people about stork conservation. Further research and conservation initiatives are needed to ensure the long-term survival of this important bird species in the face of increasing human activities and habitat

degradation. The present study shall help providing baseline data for research and improvement of conservation planning and the necessary measures for the protection of Lesser Adjutant stork in the study area.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation, but for the advancement of knowledge.

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. All the authors contributed to the design of the study. Authors Baishali Das and Shatabdi Biswas wrote the first draft of the manuscript. Author Baishali Das analysed the data and author Jyotismita Das contributed to the management, and execution of the study and supervised the whole work. The collective efforts of all the authors have significantly enriched the quality and depth of this paper. All authors read and approved the final manuscript.

COMPETING INTERESTS:

All authors agree to this paper's publication and do not have any conflict of interest with any party or commercial identity. They have no involvement that might raise questions of bias in this reported work or its conclusions, implications, or opinions.

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