REPORT:

The first survey of waterbird nesting colonies on the Barotse Floodplain, Zambia

July 2023

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Summary
Over two days in July 2023 I flew an aerial survey of the Barotse Floodplain covering more than 2,500 km² with pilot Neil McGreevy. We located three waterbird nesting colonies that were each dominated by African Openbills. Based on aerial photos taken during the flights, an estimated 68,092 Openbill nests were present in all three colonies. African Spoonbills were only found in one colony, where 546 nests were counted. Less than 2,000 egret nests were estimated in all three colonies. One colony located on the central floodplain represents the largest known breeding site for Openbills and spoonbills on the continent, and it is also one of the largest waterbird nesting sites in the world. No cranes or Saddlebill Storks were observed during the survey.

Introduction
The Barotse Floodplain of the Zambezi River in western Zambia is one of the most important wetlands in the Upper Zambezi Basin, supporting scores of wildlife and communities in the region. The Barotse is over 5,500 km² and has a highly seasonal hydrology because of the region’s marked wet-dry seasons. During the wet season (November–April), the Zambezi and its tributaries flood the surrounding landscape, creating a pulse of nutrients in the vast wetland system. As water levels recede throughout the dry season, aquatic animals become increasingly concentrated in ephemeral pans and floodplain tributaries. This dynamic hydrology entirely drives the ecology of the region’s wildlife and human communities.

The entirety of the Barotse likely supports a population of hundreds of thousands of people, around 90% of which are involved in agriculture. Herding and fishing are integral parts of the floodplain lifestyle, which means subsistence activities are closely tied to the flooding cycles of the Barotse. Changes in rainfall patterns driven by climate change pose a threat to floodplain communities that may be forced to put greater pressure on the floodplain environment in times of drought. Such pressure may take the form of overfishing or changes in subsistence practices, such as poaching waterbird nestlings for food, which has become a threat to the African Openbill population in the past two decades.

The Barotse Floodplain is both a Ramsar Wetland and an Important Bird Area because of the large numbers of waterbirds that the vast wetland system supports, yet it is not protected as a national park nor reserve. Like the human inhabitants, the life cycles of waterbirds on the floodplain are closely linked with the highly seasonal hydrology. The Barotse supports significant numbers of egrets, herons, storks, ibis, spoonbills, cormorants, and pelicans, most of which probably nest on the floodplain. In the early dry season, mixed-species nesting colonies form on the floodplain (pers. obs.), likely timing the fledging of young with water levels that will maximise chances of survival (i.e., low water levels with concentrated prey).

The importance of the Barotse for regional breeding populations of most waterbird species remains unknown. Sporadic records from over forty years ago indicate the presence of at least several large nesting colonies on the floodplain, generally dominated by African Openbills but also including lower numbers of other species. While African Openbills certainly still nest in colonies numbering in the thousands, colonies also contain small numbers of Reed Cormorants,
Little Egrets, and African Spoonbills (pers. obs.). It is, therefore, likely that the latter species also nest in their own colonies, although no such sites have been recorded in recent decades. Other species that have been recorded nesting on the floodplain historically include African Darter, Pink-backed Pelican, Yellow-billed Egret, Great Egret, Goliath Heron, Marabou Stork, Sacred Ibis, and Glossy Ibis (Dowsett et al. 2008). Most other long-legged wading birds probably nest on the floodplain but have gone undetected.

The immense size of Openbill colonies on the floodplain has made them the easiest breeding species to detect. However, the overall data deficiency on other species is largely driven by the inaccessibility of most of the floodplain on the ground and the smaller size of their nesting colonies, making them more difficult to locate. The Barotse is an extremely flat landscape, so most nesting occurs in reedbeds or remote, isolated trees. Therefore, the only way to thoroughly assess waterbird breeding on the floodplain is from an aircraft.

Methods
On 10 and 11 July 2023 I conducted an aerial transect survey of the Barotse Floodplain between Kalabo and Senanga (Figure 1). Additionally, we flew a reconnaissance loop up the Zambezi to near Lukulu, across to the middle Luambimba River and down the western edge of the floodplain. The north-south transects averaged ~4 km apart. The pilot, Neil McGreevy, and I searched for swarming groups of birds that might indicate nesting colonies as well as for Wattled Cranes, Grey Crowned Cranes, and Saddlebill Storks. Upon locating a nesting colony, we circled overhead to allow for aerial photography so that nests could later be counted. Colonies were too large to estimate nest abundance with any reasonable accuracy from the air. Species composition of colonies were also later determined from photos.

Series of aerial photos were used to visually piece together nesting areas within each colony. The subsections of each colony could be distinguished easily due to segregation of nests into distinct reedbed patches, which could be identified using their shape and other features in the colony, such as bare pieces of ground, pools, or, in one case, a pair of hippos standing in the colony that served as a useful static reference point during a flyover. In the case of the largest colony (called Central Colony), nesting occurred in a patchwork of separate reedbeds that could be delineated on Google Earth imagery (dated from 5 August 2023) and corroborated with aerial photos (Figure 1b-c), which actually allowed for the approximate area of the colony’s ‘footprint’ to be measured. Counts of nests were made from photos of each distinct reedbed patch in QGIS 3.18 by placing a point feature over each nest and then summing the total number of points created in the vector. However, in the northernmost colony (called North Colony), photos were of insufficient resolution to allow a manual count of the second nesting area subsection, but its extent in wider angle photos was approximated as the same as the counted subsection. The total colony count was conservatively estimated as double the number in the manually-counted subsection.

In Central Colony, the extent of the largest reedbed patch was too large to capture in one photo and all other patches were not photographed sufficiently to allow for a complete manual count of each individually. Therefore, subsections with sufficient photos were sample counted and then nest density (per m²) was extrapolated from these to the entire colony ‘footprint’ using
measured areas of the distinct, delineated reedbed patches on Google Earth (and corroborated from aerial photos). In this way, five subsections of the overall colony were manually sample counted and nest density estimates from these were extrapolated to the entire colony area. We consider these extrapolations and the manual counts of nests in all colonies to be highly conservative because (1) nests are often placed vertically in the ‘topography’ of trampled *Phragmites* stalks so that many are immediately below those at higher levels (pers. observ.) and likely undetectable in many aerial photos; (2) nests in aerial photos could only be identified and counted if a clear, unobstructed nest platform was visible or if a stork was on the nest; and (3) in North Colony, nestlings formed creches that often stood on multiple nests, which meant that distinct clusters of nestlings had to be conservatively counted as one nest in the aerial photos. Nests of unidentifiable white egrets and African Spoonbills (*Platalea alba*) were also counted where present.

Figure 1. (a) Map of aerial survey of the Barotse Floodplain and locations of recorded waterbird nesting colonies. (b) Google Earth imagery of Central Colony showing the ‘footprint’ of the total nesting area. (c) Aerial photo of part of Central Colony, which was partially used to corroborate the colony subsections in (b).

**Results**

We located three waterbird nesting colonies, which were each evenly spaced across the floodplain. Colonies were found in *Phragmites* reedbeds along the main channel of the Zambezi River and were dominated by African Openbills. North Colony, which was located north of the
Lubosi Imwiko II Bridge over the Zambezi, was estimated to have at least 3,866 Openbill nests and 177 white egret (likely Little Egrets based on size and ground-truthing) nests. Nest density extrapolations for Central Colony (Figure 2), the biggest nest site, averaged 57,844 Openbill nests (range: 42,251–73,940). African Spoonbills were only found nesting in Central Colony, with 546 nests counted in a centralized cluster within the colony. Nest density extrapolations for white egrets produced an estimate of 1,479 nests for the whole colony. In South Colony (Figure 3), 6,342 Openbill and 167 white egret nests were counted in the whole colony. Cumulatively, at least 68,092 Openbill nests and less than 2,000 egret nests were present across all three colonies.

We observed no Wattled Crane, Grey Crowned Crane, or Saddlebill Storks on the floodplain. White egrets were observed in abundance throughout the floodplain, and only two small groups of Great White Pelicans were observed. In the southern floodplain, large flocks of Black Herons—as many as 100–were observed.

Discussion
The Barotse Floodplain is clearly one of the most important wetlands for Openbills on the continent. Indeed, Central Colony is the largest nesting colony ever recorded for the species and is one of the largest known waterbird nesting colonies in the world. To my knowledge, it is also the largest known colony of African Spoonbills. Only on several occasions have colonies of Straw-necked Ibis in Australia and American White Ibis in Florida, USA, surpassed the nest abundance we found in Central Colony. It is likely that the high productivity of the floodplain is what allows waterbirds, especially Openbills, to occur in such abundances. In particular, the main prey source of Openbills, aquatic snails, must occur in super abundances to support such a breeding population.

We did not anticipate finding as much human activity on the floodplain as we did, so unfortunately we were not prepared to record such observations. However, the pilot, Neil McGreevy, observed that the number of villages on the floodplain has grown exponentially since he last flew over it 25 years ago. Although we did not record herds of cattle, we also observed thousands of cattle across the survey area. Immediately adjacent to each nesting colony on the riverbank was located a temporary fishing village (Figure 4). Local fishermen have reported to us that harvesting nestlings for food is a common practice. While this is generally for subsistence purposes, I have been informed that some people sell dead nestlings in Mongu for ~15 Zambian Kwacha each.

Nestling harvesting would seem like a threat to these few nesting sites, but the super abundance of nestlings probably buffers the impact of harvest. However, a critical next step is to investigate breeding success to estimate how many young Openbills are recruited into the population each season. Nestling survival is likely more influenced by foraging conditions for provisioning parents, which may be tied to hydrology over the breeding season. Understanding these ecological dimensions in conjunction with the impact of human activities like nestling harvesting is an important follow-up to this aerial survey that we will begin to investigate.

It remains unclear why Openbills cluster in just three sites (that we know of) for nesting on the floodplain. Whether these sites are used year after year is also an open question and seems unlikely given the destruction to the reedbeds that can happen after several years. Therefore, next season we will visit these sites to determine site fidelity and to begin to
understand colony dynamics. Additionally, we have begun a nestling colour-ringing project in which we started by accessing North Colony by boat to fit nestlings with alpha-numeric colour rings that will allow researchers and birders to resight individuals after they disperse. To date, we have fitted 181 Openbills with colour rings. Before this season, only 13 Openbills had ever been ringed. Ultimately, locating these colony sites through the aerial survey has opened up a range of research possibilities as we begin to investigate the ecology of Openbills and other waterbirds that nest alongside them.

Acknowledgements
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Financial summary

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Figure 2. Aerial photo of Central Colony. Note the concentration of African Spoonbills nesting in the center.
Figure 3. Aerial photo of South Colony.

Figure 4. A temporary fishing village located adjacent to Central Colony.