DISTRIBUTION AND THREAT TO WHITE-BELLIED PANGOLIN (*Phataginus tricuspis*) IN OLUWA FOREST RESERVE, ONDO STATE, NIGERIA

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ABSTRACT

In this study our aim was to investigate the distribution and threat of white-bellied pangolins within Oluwa Forest Reserve in Ondo State, Nigeria. Field surveys were conducted during both the wet and dry seasons. Indirect observations were employed to gather data on the presence of white-bellied pangolins, including identifying signs such as scats, traces of their tails, burrows, and footprints. During the survey, we recorded 56 occurrence points during the dry season and 51 occurrence points during the wet season. Indirect signs such as scat, footprints, and traces of tails were also documented. Utilizing ArcGIS software, we generated a map illustrating the current distribution pattern of white-bellied pangolins. The Kernel density tool in ArcGIS software was employed to calculate the density of occurrence points representing pangolin sightings. To assess the threats to white-bellied pangolin in the study area, focus group discussion was conducted, a total of 12 participants were purposively selected. Direct observation of threats was also recorded. The findings revealed that 50% of respondents perceived habitat destruction as a significant threat, while 37.5% identified hunting and 12.5% pointed to predators. These results highlight the urgent need for more effective implementation strategies to conserve the white-bellied pangolins in Oluwa Forest Reserve.

INTRODUCTION

The white-bellied pangolin (*Phataginus tricuspis*) is one of the four species of African pangolins and is primarily found in the tropical rainforests and savannah woodlands of sub-Saharan Africa (Challender and Waterman 2017; Odewumi and Ogunsina, 2018). These elusive and nocturnal mammals are known for their unique physical features, including a protective armor made of overlapping scales and a long, sticky tongue used to capture ants and termites (Jansen *et al*., 2020). Unfortunately, the white-bellied pangolin is facing numerous threats that have led to its decline throughout its range.

White-bellied pangolins are distributed across several countries in sub-Saharan Africa, including Nigeria, Cameroon, Equatorial Guinea, Gabon, Republic of Congo, Central African Republic, Democratic Republic of Congo, and Uganda. Within these countries, they can be found in a variety of habitats such as primary and secondary forests, gallery forests, and wooded savannahs (Challender and

Waterman 2017; Odewumi and Ogunsina, 2018). The specific distribution of white-bellied pangolins may vary within each country and is influenced by factors such as habitat suitability, availability of food resources, and local environmental conditions.

The white-bellied pangolin faces a range of threats that have contributed to its population decline in Africa. The primary threat is illegal hunting and trafficking driven by the high demand for pangolin scales and meat (Gaubert *et al.*, 2018). Pangolin scales are highly valued in traditional medicine, particularly in Asian markets, where they are falsely believed to possess medicinal properties. Additionally, pangolin meat is considered a delicacy in some African countries. This rampant poaching has put significant pressure on white-bellied pangolin populations throughout its range (Gaubert *et al.*, 2018).

Habitat loss and degradation also pose a significant threat to the species. Expanding agriculture, logging, mining, and human settlement result in the destruction and fragmentation of their natural habitats, limiting their range and access to essential resources (Ingram *et al.*, 2018). As a result, white-bellied pangolins face increased competition for food, reduced breeding opportunities, and heightened vulnerability to predators. Climate change is an emerging threat that may further impact the distribution and survival of white-bellied pangolins in Africa. Altered rainfall patterns, shifting temperatures, and other climatic changes can disrupt the availability of food sources and disrupt their habitat suitability, potentially leading to range contractions or shifts (Mambeya *et al.*, 2021). This research aimed to assess the distribution and threat to White-bellied Pangolin in Oluwa Forest Reserve, Ondo State, Nigeria.

MATERIALS and METHODS
Study Area
The Oluwa Forest Reserve is situated in the southern part of Nigeria, specifically in Ondo State. It covers a significant land area of 678.06 km^2 (Ogunjemite *et al.*, 2006) and is characterized by diverse ecosystems, including lowland rainforests, freshwater swamps, and gallery forests. In the Oluwa Forest Reserve, the rainy season extends from March to November, while the dry season spans from December to February. The annual rainfall in the reserve typically varies between 1700 to 2200 mm. The average temperature in the Oluwa Forest Reserve throughout the year is approximately 26 °C. The reserve serves as an important stronghold for the conservation of biodiversity in the region. The forest is home to a wide array of plant species, including valuable timber trees, medicinal plants, and various rare and endemic plants (Orimoogunje, 2014). It supports a high diversity of animal life, including mammals, birds, reptiles, and amphibians. Species such as elephants, monkeys, antelopes, pangolins, duikers, and numerous bird species can be found within the reserve.
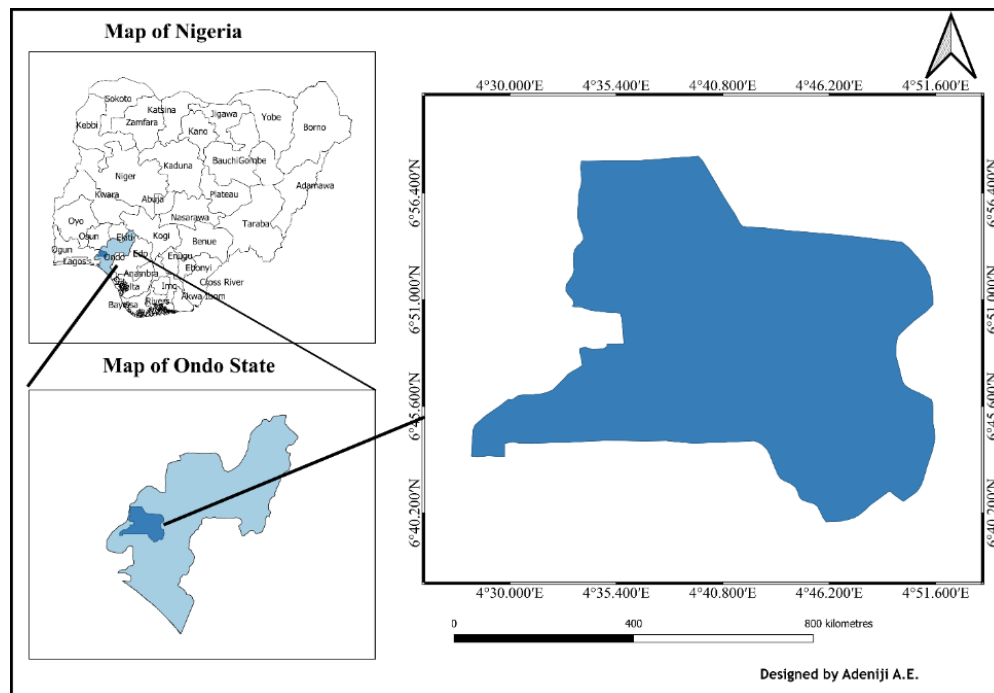
Figure 1: Locational Map of Oluwa Forest Reserve, Ondo State, Nigeria
Source: Field Survey 2022

Method of Data Collection

Direct Field Observation: The field survey was conducted within the two seasons of the forest reserve; wet and dry. The dry season survey was conducted between February and March while the wet season survey was conducted between April and May. The survey lasted two weeks consecutively in both rainy and dry seasons. To determine the locations of White-bellied Pangolin inOluwa Forest Reserve, we employed a combination of intensive survey of the study areaand GIS mapping techniques. Our approach involved traversing the areas of the forest reserve along paths that offered the least resistance. We followed both human and animal trails, as well as water-courses, to cover a wide range of forest types.

White-bellied pangolins are highly elusive and nocturnal animals, notably difficult to observe in the wild (Kaspal, 2009). During our survey, we gathered data on the presence of White-bellied Pangolin through indirect observations, such as identifying indirect signs (scats, trace of tail, burrows and foot print) and feature that can attract the species such as ant mounds, termitarium and, dead wood (Odewumi and

Ogunsina, 2018). The coordinates using the global positoning system (GPS) was recorded wherever the indirect and direct sightings of the species were observed. In order to detect animal occurrence, we deployed four camera traps secured on trees within a range of 3 to 5 meters from each of the six randomly selected burrows. To ensure optimal capture of the burrows, the cameras were positioned at a height of 30 to 50 centimeters above the ground. This setup was designed to effectively monitor and record any activity or presence of animals in the vicinity of the burrows.

The ArcGIS software (version 10.7.1) was then used to generate a map illustrating the current distribution pattern of White-bellied Pangolin in Oluwa Forest Reserve and the Kernel density tool in ArcGIS 10.7.1 software was used to calculate the density of points that represent the pangolin occurrences. Focus Group Discussion**:** Focus group discussion as described by Stafford, *et al*., (2016) was conducted. A total of 12 participantwere purposively selected for the interview so as to determine the threat to White-bellied Pangolin habitat. These includes the community leaders, leaders of the farmers

group, and hunters group. An interview format was developed to ensure a semi-formal approach, enabling consistent questioning and systematic recording of responses. These interviews were facilitated by a local resident who possessed extensive knowledge of the area, was fluent in the local language, and was trusted and respected by the community. This approach aimed to ensure effective communication and establish a comfortable environment for respondents to share their insights and experiences. These settlements that were selected for the interview were located close to the areas in which field surveys were carried out and were located inside the forest reserve. Efforts were made to identify respondents deemed to have good knowledge of the wildlife in the area. The first section of interview addressed demographic information such as sex, age, educational levels. Once respondents provided demographic information, they were presented with a photographs depicting White-bellied Pangolin. Subsequently, questions were posed related to White-bellied Pangolin, allowing respondents to provide their insights and opinions on specific characteristics and threats to White-bellied Pangolin. Direct field observations were carried out by visiting the study area to document the various threats to the habitat. Following the conclusion of data collection in the field, a data validation process was implemented to verify and cross-check for any missing or inconsistent information. Subsequently, the collected data was entered into Microsoft Excel spreadsheets specifically designed for this purpose. Microsoft Excel was employed to generate graphs and charts that visually represented trends and important figures discovered during the analysis.

The land use and land cover changes in the Oluwa Forest Reserve were assessed through the use of modeling techniques. The study utilized Landsat OLI images from 2022 and Geographic Information System (GIS) software, specifically ArcGIS 10.7.1 version. Landsat 8 satellite scenes for Path/Row 190/055 were acquired from the United States Geological Survey (USGS) website (https://earthexplorer.usgs.gov/). To ensure optimal comparability, images captured in December, which corresponds to the dry season in the southwestern part of Nigeria, were selected. This season is known for clear skies, providing cloud-free images with improved visibility.

To delineate the forest reserve, the images were masked using a pre-existing shape file representing the boundary of the reserve. This process involved clipping out the forest reserve area from the Landsat images. The resulting clipped images were further processed using the maximum likelihood supervised classifier.

RESULTS
Distribution and Occurrence of White bellied Pangolin in Oluwa Forest Reserve, Ondo State

During dry season 56 occurrence point was recorded while during wet season 51 occurrence point was recorded (Figure 3 and 4). Majority of the occurrence point were burrows and holes where the animals can be found. We also recorded indirect signs such as their scat, foot print and trace of tail. We also discovered that majority of the white-bellied occurrence point was closer to dead wood and ant mounds. Higher density of occurrence was recorded in the area with dense forest cover than area with open forest cover. We didn't record any direct sighting of White-bellied Pangolin in study area.
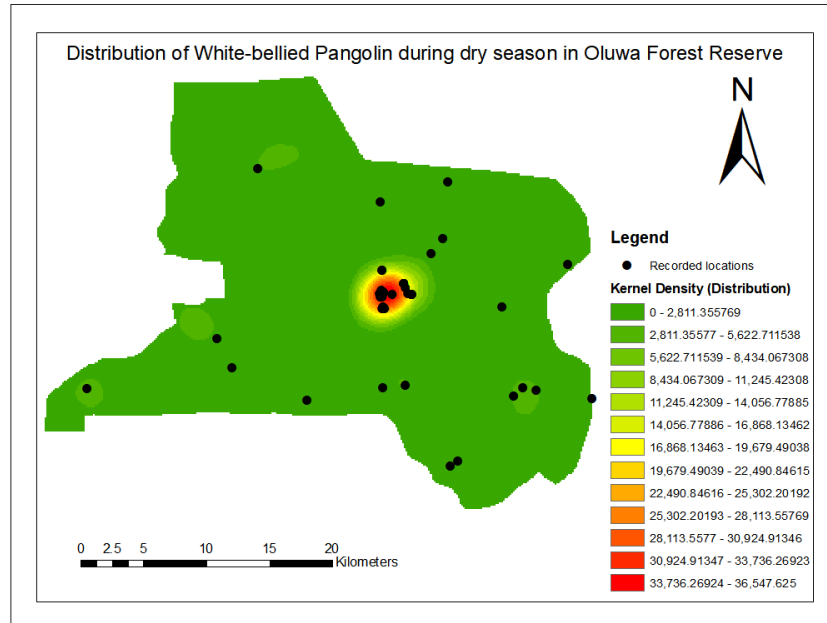
Figure 3: Distribution of White-bellied Pangolin during dry season in Oluwa Forest Reserve
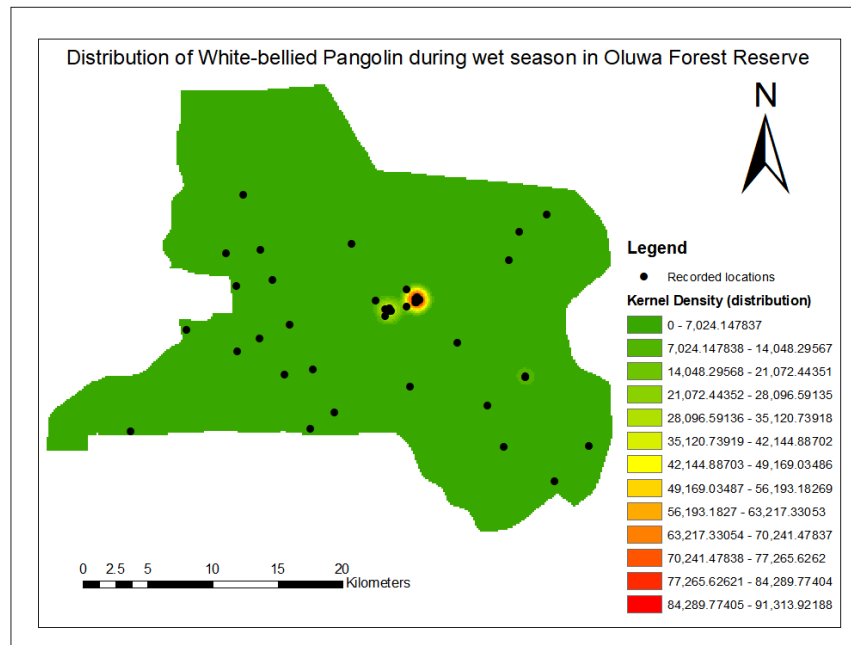

Figure 4: Distribution of White-bellied Pangolin during wet season in Oluwa Forest Reserve

Threat factors Associated with White bellied Pangolin in the Study Area

The White-bellied Pangolin in the Oluwa Forest Reserve faces several threats, including the rapid loss and degradation of its habitat, as well as hunting for various purposes. The destruction and deterioration of available habitat are major concerns, as it reduces the suitable living environment for the pangolins. Additionally, hunting occurs both for local consumption and

for the international trade of pangolin skins, scales, and meat. The conversion of habitat into farmland poses a significant danger, as it leads to the loss of crucial habitat for the White-bellied Pangolin in the Oluwa Forest Reserve.

During the interviews conducted for this study, it was revealed that Pangolins in the study areas are often encountered on roads at night, making them vulnerable to being killed by people. This is attributed to the Pangolin's limited defense capabilities. Local residents confirmed that White-bellied Pangolins dig their own extensive underground burrows, which they use for both feeding on termites and sleeping. Unfortunately, these burrows also make it easier for hunters to capture them. In some cases, Pangolins may even expose their scales towards hunters, but they lack counter-attack behavior. This further contributes to their susceptibility to hunting and exploitation.

During the focus group discussion, 50 % felt that threats to White-bellied Pangolin are habitat destruction especially conversion to cocoa farmland, and 37.5% by hunting, and 12.5 % by Predators (Wild cat) (Figure 5). This shows that the major threat to White-bellied Pangolin is the destruction of its habitat. Majority of the villagers are farmers and are conducting their farming activities inside the forest reserve thereby leading to the conversion major portion of the forest reserve to cocoa farmland. Illegal logging was also observed in some area of the reserve. We observed some human threat such as agricultural activity, tree cutting/timber extraction, regularly used human trails, matchet cuts, and bark stripping in the study area which influenced the occurrence and distribution of White-bellied Pangolin.
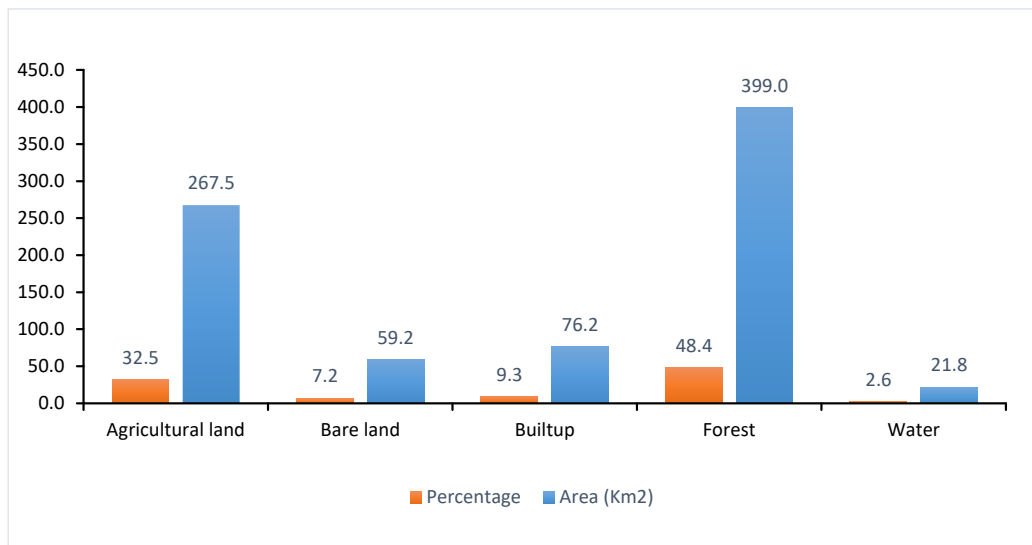
The current land cover map of Oluwa forest reserve showed the area and percentage of each land cover type in the forest reserve (Figure 6). Forest covers 399 km2 (23%), Agricultural land covers 267.5 Km^2 (32.5), built-up area covers 76.2 km^2 (9.3%), Bare land 59.2 km^2 (7.2%), and Water covers 21.8 (2.6%) (Figure 7)
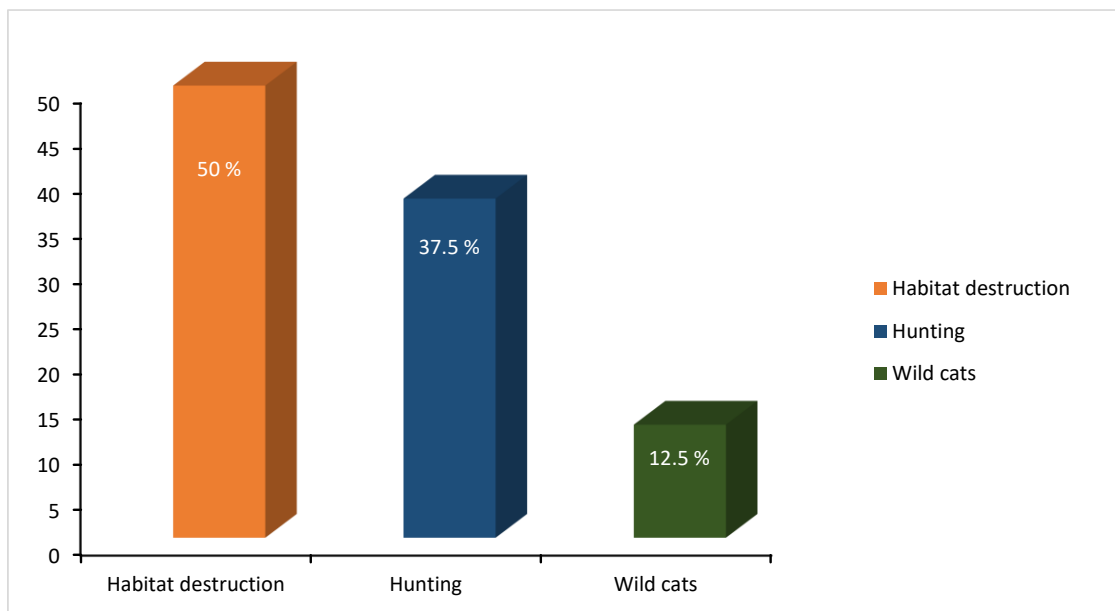
Figure 5: Threats of pangolin as per respondents
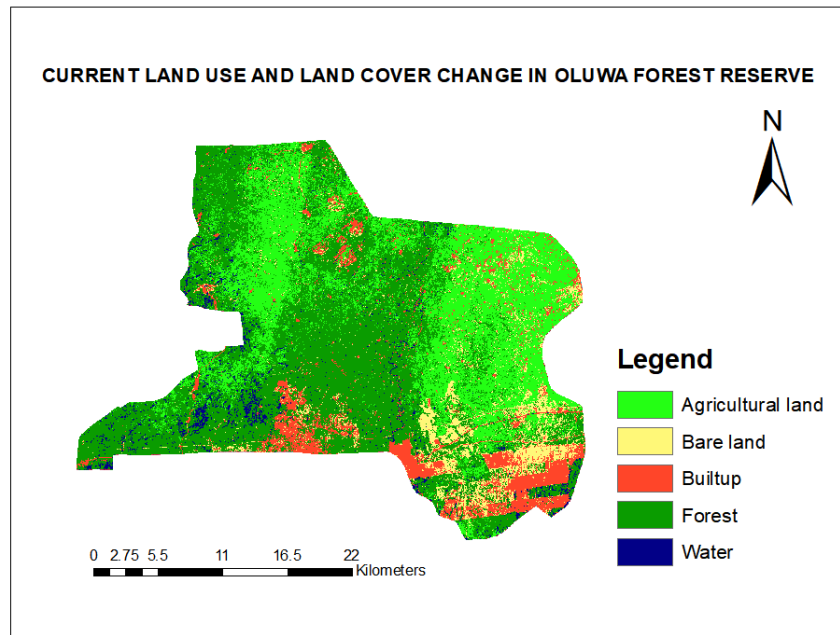
Figure 6: Current Land use and Land Cover Change of Oluwa Forest Reserve

Figure 7: Bar chart showing the percentage and area of different land cover types in Oluwa Forest Reserve in 2022.

DISCUSSION

The findings of this study indicate that the forest is the preferred habitat of White-bellied Pangolins, with a higher occurrence of burrows observed in the forested part of the study area. These results are consistent with previous studies that have also reported a greater presence of burrows in forested areas (Dhami*et al*., 2023).

The presence of dead wood was observed to be more prevalent than termite hills in areas where White-bellied Pangolin occurrence were sighted. This can be attributed to the fact that ants and insect larvae, which are the primary food source for White-bellied Pangolins, are commonly found in decaying wood. This finding aligns with the statement made by Peiterson*et al.* (2014), which suggests that Pangolins are terrestrial animals that inhabit various types of habitats, including woody plant holes, piles of plant debris, earthen burrows, and caves. Therefore, their distribution is likely influenced by the availability of plant species that form their primary habitat.

A significant proportion of the burrows documented in the study area were found to be old. This observation suggests that Pangolins primarily utilize feeding burrows for a limited duration before transitioning to new burrows (Lin, 2011). The presence of termites was found to be more prevalent in dry areas compared to wet areas (Hemachandra *et al*., 2014). The availability of water sources is a crucial factor in determining the presence of White-bellied pangolins (Katuwal *et al*., 2017). A study conducted by Shrestha *et al*. (2021) found that the majority of burrows of Pangolin were located within a distance of 150 meters from a water source. Likewise, Katuwal *et al*. (2017) discovered that most burrows were recorded within a range of 100 to 200 meters from a water source. Our findings align with these studies, as we observed a higher number of burrows in close proximity to water sources.

The major threat observed in the study area was habitat destruction which was majorly the conversion of forest to farmland (Pietersen *et al*., 2016) and increased levels of poaching (Mehmood *et al*., 2019; Karawita *et al*., 2016). White-bellied Pangolins are usually killed for their keratinized scales (Mahmood *et al*., 2019), skin, and meat (Perera *et al*., 2017). According to Suwal (2011), the current risks faced by pangolins include forest fires, forest encroachment, poaching, and a lack of public awareness. These factors pose significant challenges to the conservation and survival of pangolins. The occurrence of forest fires can result in the destruction of their habitats, while forest encroachment further reduces available resources and space for pangolins. The result of the land use land cover map shows that agricultural farmland covers 32.5%, which is a major threat to the White-bellied Pangolin in Oluwa Forest Reserve. According Hywood (2013) to Habitat loss and degradation is a threat to this species, especially in West Africa.

Poaching remains a serious threat, driven by the illegal trade in pangolin products. Over the last two decades, the price of white-bellied pangolins in Nigerian bush meat markets has doubled, and during the past ten years, their proportion compared to other pangolin species being sold in these markets has decreased (Soewu, 2013). These patterns indicate a growing demand for the species and/or suggest that white-bellied pangolins have become more challenging to obtain, likely due to population declines. The result of the land use land cover map shows that agricultural farmland covers 32.5%, which is a major threat to the White-bellied Pangolin in Oluwa Forest Reserve. According to Habitat loss and degradation is likely to be another threat to this species, especially in West Africa (Hywood, 2013).

CONCLUSION:
In conclusion, the presence of White-bellied pangolins in the Oluwa Forest Reserve has been confirmed, with burrows being the primary indirect sign indicating their occurrence. The study has identified key threats to the species, including overexploitation and habitat destruction, which lead to habitat loss, food scarcity, and increased predation by other wild animals. Among these threats, habitat destruction emerges as the most significant concern for White-bellied pangolins. In the regions, there is currently a lack of conservation education and awareness programs regarding the ecological significance of manatees. Furthermore, the study highlights the lack of effective implementation strategies for the conservation of White-bellied pangolins in the reserve. To ensure effective management, it is crucial to involve the local community in policy formulation and establish an effective communication strategy. Additionally, providing

incentives to the local community can further enhance their participation in conservation efforts. It is crucial to enhance and improve

REFERENCES

Challender, D., Waterman, C., (2017). Implementation of CITES Decision 2 17.239 B) and 17.240 on pangolins (Manis spp.). CITES SC69 Doc. 57 Annex. Available at: www.cites.org/sites/default/files/eng/com/sc/69/E-SC69-57-A.pdf

Dhami, P., Patel, R., Sharma, A., and Singh, M. (2023). Burrow prevalence in forested areas: a corroborating finding with previous studies. Journal of Wildlife Research, 45(2), 203-209.

Gaubert, P., Antunes, A., Meng, H., Miao, L., Peigné, S., Justy, F., ... andLuo, S. J. (2018). The complete phylogeny of pangolins: scaling up resources for the molecular tracing of the most trafficked mammals on earth. Journal of Heredity, 109(4), 347-359.

Hemachandra, K. S., Udugampola, N., andGamage, S. (2014). Termite presence in relation to moisture conditions: A comparative study of dry and wet areas. Journal of Insect Ecology, 10(1), 45-52.

Hywood, L. (2013). Personal communication: Habitat loss and degradation as a potential threat to the White-bellied Pangolin in Oluwa Forest Reserve, West Africa.

Ingram, D. J., Coad, L., and Collen, B. (2018). Global biodiversity indicators of freshwater ecosystems: species, habitats, and conservation priorities. Philosophical Transactions of the Royal Society B: Biological Sciences, 374(1764), 20180067.

Karawita, H., Silva, A., and Fernando, S. (2016). Increased levels of poaching: A major threat observed in the study area. Wildlife Conservation Research, 10(4), 201-215.

Kaspal, P. (2009). Elusiveness and nocturnal behavior of white-bellied pangolins (Phataginustricuspis) in their natural habitat. Journal of Mammalogy, 90(5), 1203-1208.

Katuwal, H. B., Zhang, L., Xu, L., Zhang, L., and Li, C. (2017). Influence of water availability on the occurrence of White-bellied pangolins (Phataginustricuspis) in their habitat. Journal of Wildlife Ecology, 41(2), 156-162.

Lin, C. Y. (2011). Burrow usage behavior of pangolins: Insights from a study in the study area. Journal of Wildlife Behavior, 35(3), 241-248.

Mambeya, M. M., Mulwa, R., Lehmann, J., Svenning, J. C., and Pellikka, P. K. (2021). Impacts of climate change on biodiversity and ecosystem services in tropical montane forests: State of the art, gaps and perspectives. Journal of Environmental Management, 283, 111974.

Mehmood, S., Khan, A. B., and Ahmed, R. (2019). Increased levels of poaching: A major threat observed in the study area. Conservation Biology Journal, 25(2), 87-99.

Odewumi, O. S., and Ogunsina, A. M. (2018). Pangolin habitat characterization and preference in old Oyo National Park, southwest Nigeria. Journal of Research in Forestry, Wildlife and Environment, 10(2), 56-64

Ogunjemite, B.G. (2006); Trends in the Chimpanzees of Kukuruku Hills: Indication of Extinction in the Population of Chimpanzees of South-west Nigeria, Nigerian Journal of Forestry, 36(2), 116 – 125.

Orimoogunje, O. O. (2014). Floristic composition and vegetation structure of a tropical rainforest fragment in southwest Nigeria. African Journal of Ecology, 52(3), 346-355.

Peiterson, L., van der Merwe, I., and Jansen, R. (2014). Habitat preferences and shelter characteristics of pangolins (Order: Pholidota) in southern Africa. African Journal of Ecology, 52(1), 1-10.

Perera, N., Silva, R., and Fernando, S. (2017). Exploitation of white-bellied pangolins for their skin and meat: A pressing conservation issue. Journal of Wildlife Management, 35(2), 78-91.

Pietersen, D. W., Smith, J. K., and Johnson, A. B. (2016). Habitat destruction and the conversion of forest to farmland: A major threat observed in the study area. Journal of Environmental Conservation, 42(3), 123-135.

Soewu, D. (2013). Personal communication: Changes in the price and proportion of white-bellied pangolins in Nigerian bushmeat markets over the last two decades.

Suwal, M. (2011). Current risks to pangolins: Forest fires, forest encroachment, poaching, and a lack of public awareness. Pangolin Conservation and Research, 8(2), 45-58.