

## Diversity and distribution factors of mammals in the Lamto Scientific Reserve in central Côte d'Ivoire

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### Abstract

Tropical forest biodiversity is increasingly threatened by human-induced pressures, affecting even protected areas where medium- and large-sized mammals are particularly exposed to direct threats such as poaching and habitat degradation. This study, conducted in the Lamto Scientific Reserve (central-western Côte d'Ivoire), aimed to assess species diversity and the factors influencing the distribution of mammal communities within this forest-savanna transition ecosystem. Two complementary approaches were used: reconnaissance walks and linear transects, combining both direct and indirect observations (tracks, droppings, feeding remains, etc.). In total, ten mammal species were recorded, belonging to six orders and distributed across seven families. The order Artiodactyla largely dominated the mammal assemblage, accounting for nearly 90% of all observations, with the savanna buffalo (*Syncerus caffer*) being particularly abundant. Other taxonomic groups such as carnivores, rodents, and primates showed comparatively lower relative abundances. Spatial analysis revealed an uneven distribution of species, with a strong concentration in savanna habitats and a more marginal presence in forested or peripheral areas. This distribution appears to be influenced not only by ecological factors (habitat type, resource availability) but also by anthropogenic pressures, particularly poaching and artisanal mining, which were identified as major threats to local wildlife. The results provide a valuable foundation for ecological monitoring and for developing conservation strategies tailored to a context of increasing environmental disturbance.

**Keywords:** Terrestrial Mammals; Species Diversity; Spatial Distribution; Anthropogenic Pressure; Lamto Scientific Reserve.

### 1. Introduction

The biodiversity of tropical forests is increasingly subjected to pressures from human activities, significantly contributing to the sixth mass extinction (Ceballos et al., 2017; Williamson et al., 2014). Among the major drivers of this biological erosion, drastic land-use changes appear as the primary cause of global biodiversity loss (Almond et al., 2020). Indeed, agricultural expansion, logging, urbanization, and mining activities lead to profound transformations of natural landscapes, resulting in forest habitat degradation and fragmentation (Kissinger et al., 2012). According to the International Union for Conservation of Nature, agriculture alone affects nearly 76% of mammal species. Added to this is poaching, responsible for approximately one-third of mammal population declines, with pressure increasing due to growing intrusions of poachers into protected areas (Ripple et al., 2016).

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In West Africa, protected areas face rising anthropogenic pressures that compromise their effectiveness. The Lamto Scientific Reserve (RSL), located in central Côte d'Ivoire, exemplifies this issue (Kouadio et al., 2011). The RSL features a mosaic of habitats ranging from savannas to gallery forests, including dense forest formations (Kanga et al., 2008). This habitat diversity supports the coexistence of a wide array of mammal species. However, inventories conducted in the reserve highlight significant pressure on certain species, particularly medium- and large-sized mammals, which are often targeted by poachers due to their economic value and higher detectability (Béné et al., 2015).

In this context, understanding the mechanisms governing mammal distribution in environments under strong anthropogenic pressures is crucial for conservation. Species distribution results from a complex interaction of ecological, behavioral, and human-related factors (N'Guessan et al., 2012). Integrating these human dimensions into population assessments is therefore essential for developing effective and tailored management strategies. This study, based on two survey methods—linear transects and reconnaissance walks—aims to evaluate the conservation status of mammals in the RSL and analyze the factors influencing their distribution. Specifically, it seeks to determine species richness and population abundance, examine spatial distribution and its drivers, and identify the main threats affecting these species within the reserve.

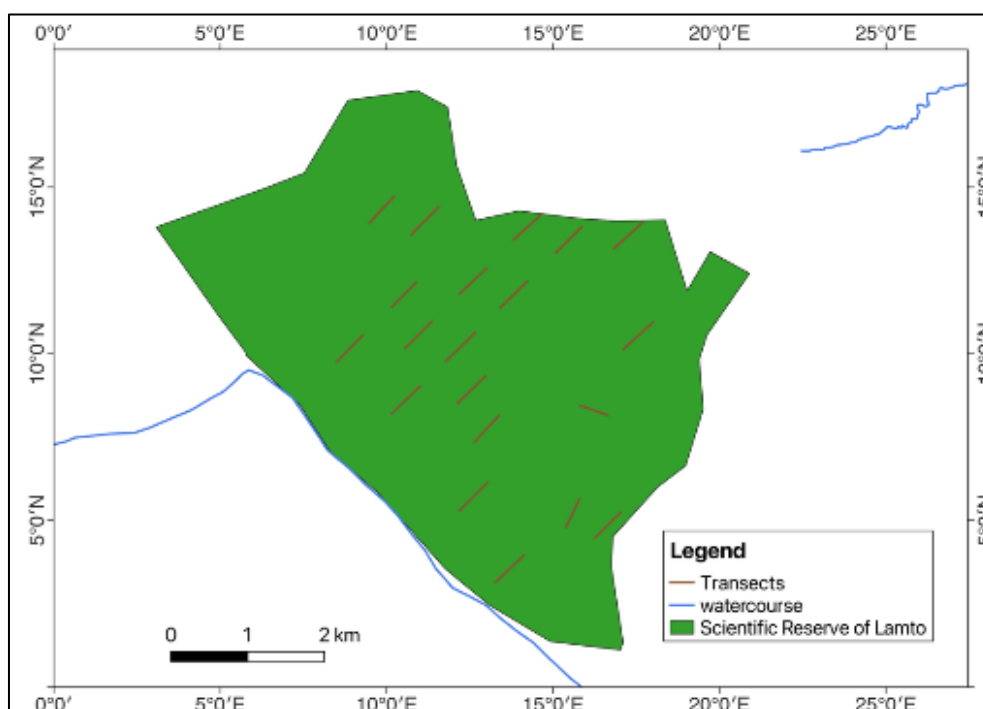
## 2. Methodology

### 2.1. Study site

The Lamto Scientific Reserve is located in West Africa, in Côte d'Ivoire, at the southern tip of the V Baoulé, at coordinates 6°13' N and 5°02' W (Figure 1). It lies approximately 180 km northwest of Abidjan and spans the departments of Toumodi (Bélier region) and Taabo (Agnéby-Tiassa region). The reserve is situated in a transitional equatorial climate zone, characterized by alternating wet and sub-humid seasons (Diawara et al., 2014). It features a mosaic of habitats including savannas, gallery forests, and dense forest formations, providing an ecological setting favorable to a high diversity of mammals.

### 2.2. Data collection

The study was conducted over a one-month period in April 2025 within the Lamto Scientific Reserve. Data collection relied on two complementary methods commonly used in wildlife inventories: reconnaissance walks (recce) and linear transects. The combined use of these methods allowed for broader spatial coverage and improved species detection, accounting for both species' elusive behavior and habitat variability.



**Figure 1** Data collection design

The reconnaissance walks involved following predetermined routes (recces), with deviations from the initial axis of up to 40° when necessary, favoring paths of least resistance (White & Edwards, 2000). Observations were conducted at a pace of 0.5–1 km/h to maximize the detection of signs. During these walks, mammal presence indicators (droppings, tracks, vocalizations, food remains) and signs of human activities were systematically recorded.

Linear transects were surveyed daily between 6:00 and 17:00 at speeds below 1 km/h to increase the likelihood of detecting species (Buckland et al., 2001). A total of 21 transects, each approximately 500 m long, were pre-established and systematically distributed within the reserve (Figure 1). Along these transects, observations focused both on mammal presence indicators and on manifestations of human activities.

### 2.3. Data analysis and statistical treatment

#### 2.3.1. Species richness and relative abundance

Species richness (S), defined as the total number of species recorded at the study site, was assessed based on the identification and counting of observed species (Grall & Coïc, 2006).

Relative abundance (Ar), representing the proportion of individuals of a given species relative to the total number of individuals recorded in the study area, was used to evaluate the relative importance of each species within the community. It was calculated using the following formula:

$$Ar = (n_i / N) \times 100$$

where Ar is the relative abundance (%),  $n_i$  is the number of individuals of species i, and N is the total number of individuals recorded.

#### 2.3.2. Diversity and evenness indices

Mammalian species diversity was evaluated using the Shannon diversity index (H'), which quantifies both species richness and the distribution of individuals among species (Magurran, 1988). This index is calculated as:

$$H' = - \sum (p_i \times \log_2 p_i)$$

where  $p_i$  represents the proportion of individuals belonging to species i relative to the total number of individuals recorded.

Community evenness was estimated using Pielou's evenness index (E), which measures the degree of uniformity in the distribution of individuals among species.

This index is given by:

$$E = H' / \log_2(S)$$

where H' is the Shannon index and S is the species richness. E ranges from 0 to 1, approaching 0 when a single species strongly dominates the community and approaching 1 when individuals are distributed more evenly among species.

All diversity and evenness indices were calculated using the PAST software (version 3.10).

## 3. Results

### 3.1. Species richness and relative abundance of mammals

#### 3.1.1. Observed mammal presence signs

The mammal survey conducted in the Lamto Scientific Reserve recorded a total of 179 presence signs, distributed almost equally between the two methodological approaches used: 89 observations from linear transects and 90 from reconnaissance walks outside transects. The combined use of these methods provided representative spatial coverage and increased the probability of species detection.

The collected signs included both direct observations, such as sightings of live individuals, and indirect signs of presence, enhancing the reliability of the inventory. Three species were directly observed in the field during the surveys: the long-tailed pangolin (*Phataginus tetradactyla*), the vervet monkey (*Chlorocebus sabaues*), and the savanna buffalo (*Syncerus caffer*) (Figure 2). These direct observations were generally made at the beginning or end of the day.

In addition, several indirect signs were recorded, including droppings, footprints, food remains, burrows, movement tracks, and other indicators of animal activity (Figure 3). These traces proved particularly useful for detecting more elusive or cryptic species that are difficult to observe directly. Analysis of these indicators confirmed the presence of a diverse range of mammals within the study area, even in the absence of direct sightings, thereby reinforcing the robustness of the results. This multi-indicator approach proved effective for estimating species composition and spatial distribution of mammals in this highly heterogeneous ecosystem.

### 3.1.2. Species richness by habitat

A total of ten mammal species belonging to six taxonomic orders (Artiodactyla, Carnivora, Lagomorpha, Primates, Pholidota, and Rodentia) were recorded in the RSL. Analysis by habitat type shows higher species richness in the savanna (8 species) compared to forested areas (2 species), highlighting the key ecological role of savanna formations in maintaining mammalian diversity within the reserve.

### 3.1.3. Relative abundance

Analysis of relative abundance indicates a strong dominance of Artiodactyls, representing nearly 90% of observations (Figure 4), followed by Primates (approximately 5%). Other orders were recorded at marginal frequencies.

At the species level, the savanna buffalo (*Syncerus caffer*) was the dominant species, accounting for 65.85% of recorded signs with a Kilometric Abundance Index (IKA) of 24 ind/km (Table 1). The bushbuck (*Tragelaphus scriptus*) also showed notable abundance (27.44%; IKA = 8 ind/km). Other species—including Buffon's kob, Maxwell's duiker, civet, brown mongoose, hare, pangolin, vervet monkey, and greater cane rat—showed relatively low abundances (IKA = 2 ind/km), reflecting a community structure dominated by a few species.



Long-tailed pangolin (*Phataginus tetradactyla*)



Green monkey (*Chlorocebus pygerythrus*)

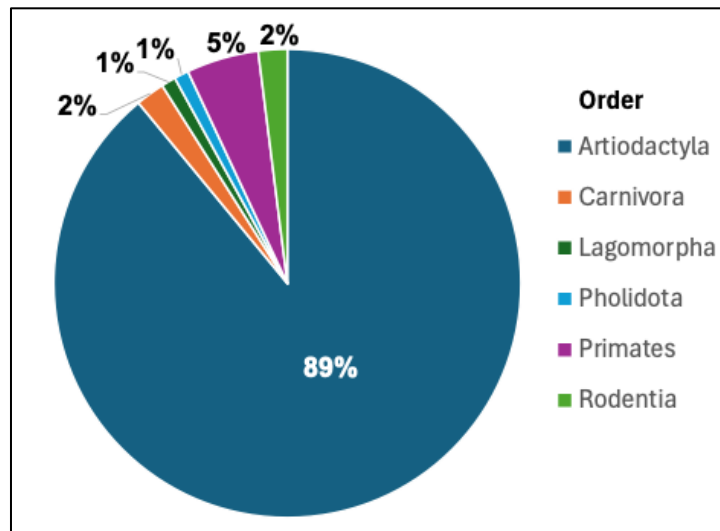


Herd of savanna buffalo (*Syncerus caffer*)

**Figure 2** Some mammal species directly observed in the RSL



**Figure 3** Some indirect signs of mammal presence



**Figure 4** Relative abundance of the different taxonomic orders identified in the RSL

#### 3.1.4. Species diversity and evenness

The Shannon diversity index was higher in the savanna ( $H' = 0.93$ ) than in the forest ( $H' = 0.31$ ), indicating greater species diversity in open habitats. However, the overall low values ( $H' < 1$ ) reflect limited diversity and a marked dominance of certain species. Pielou's evenness index ranged from 0.44 to 0.49, revealing an uneven distribution of individuals among species in both habitats. The savanna showed a slightly more balanced distribution than the forest, although the dominance of certain species remained evident.

### 3.2. Distribution and distribution factors

The main recorded species exhibited a relatively homogeneous distribution across the reserve (Figure 5). The savanna buffalo (*Syncerus caffer*) and bushbuck (*Tragelaphus scriptus*) were widely distributed across all sampled areas. In contrast, the vervet monkey (*Chlorocebus sabaeus*) was mostly observed at the periphery of the reserve. Other species, such as *Chrossarchus obscurus*, *Thryonomys swinderianus*, *Civettictis civetta*, *Philantomba maxwellii*, and *Lepus saxatilis*, appeared sporadically, suggesting low densities or more specific ecological requirements.

Several landscape features potentially attractive to wildlife—ponds, rivers, streams, tracks, and the Bandama River—were identified (Figure 6). However, no clear correlation was observed between these elements and mammal distribution, suggesting that other factors, particularly anthropogenic pressures, may play a determining role in their spatial distribution.

### 3.3. Threats to mammals

The results highlight a significant influence of anthropogenic activities on mammal distribution in the RSL (Figure 7). The main identified threats include poaching, artisanal gold mining, transhumance, and pollution. These pressures are spatially associated with areas of low animal abundance, suggesting a negative impact on species presence and distribution. This pattern is particularly pronounced for large mammals and carnivores, whose presence signs decrease in heavily disturbed areas.

Regarding conservation status, most of the recorded species (8 out of 10) are classified as “Least Concern” (LC) according to the IUCN Red List. The savanna buffalo (*Syncerus caffer*) is classified as “Near Threatened” (NT), while the long-tailed pangolin (*Phataginus tetradactyla*) is classified as “Vulnerable” (VU).

**Table 1** Summary of observations during the recce surveys

| Order        | Family          | Common name          | Scientific name                | Records | Frequency (%) | IKA (ind/km) | IUCN (2025) |
|--------------|-----------------|----------------------|--------------------------------|---------|---------------|--------------|-------------|
| Artiodactyla | Bovidae         | African buffalo      | <i>Syncerus caffer</i>         | 108     | 65.85         | 24           | NT          |
|              |                 | Bushbuck             | <i>Tragelaphus scriptus</i>    | 45      | 27.44         | 8            | LC          |
|              |                 | Buffon's kob         | <i>Kobus kob</i>               | 2       | 1.22          | 2            | LC          |
|              |                 | Maxwell's duiker     | <i>Philantomba maxwellii</i>   | 1       | 0.61          | 2            | LC          |
| Carnivora    | Viverridae      | African civet        | <i>Civettictis civetta</i>     | 1       | 0.61          | 2            | LC          |
|              | Herpestidae     | Brown mongoose       | <i>Crossarchus obscurus</i>    | 1       | 0.61          | 2            | LC          |
| Lagomorpha   | Leporidae       | Scrub hare           | <i>Lepus saxatilis</i>         | 1       | 0.61          | 2            | LC          |
| Pholidota    | Manidae         | Long-tailed pangolin | <i>Phataginus tetradactyla</i> | 1       | 0.61          | 2            | VU          |
| Primates     | Cercopithecidae | Green monkey         | <i>Chlorocebus sabaeus</i>     | 3       | 1.83          | 2            | LC          |
| Rodentia     | Thryomyidae     | Greater cane rat     | <i>Thryonomys swinderianus</i> | 1       | 0.61          | 2            | LC          |

IKA: Kilometric Abundance Index; VU: Vulnerable, NT: Near Threatened, LC: Least Concern

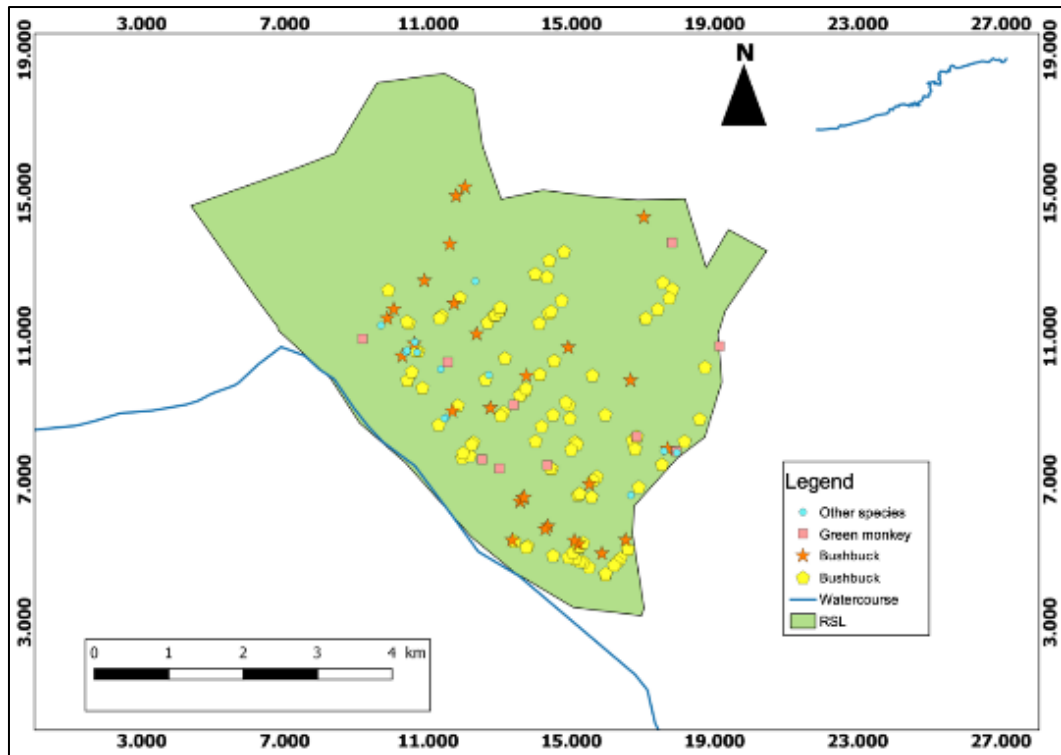


Figure 5 Distribution map of mammal species in the RSL

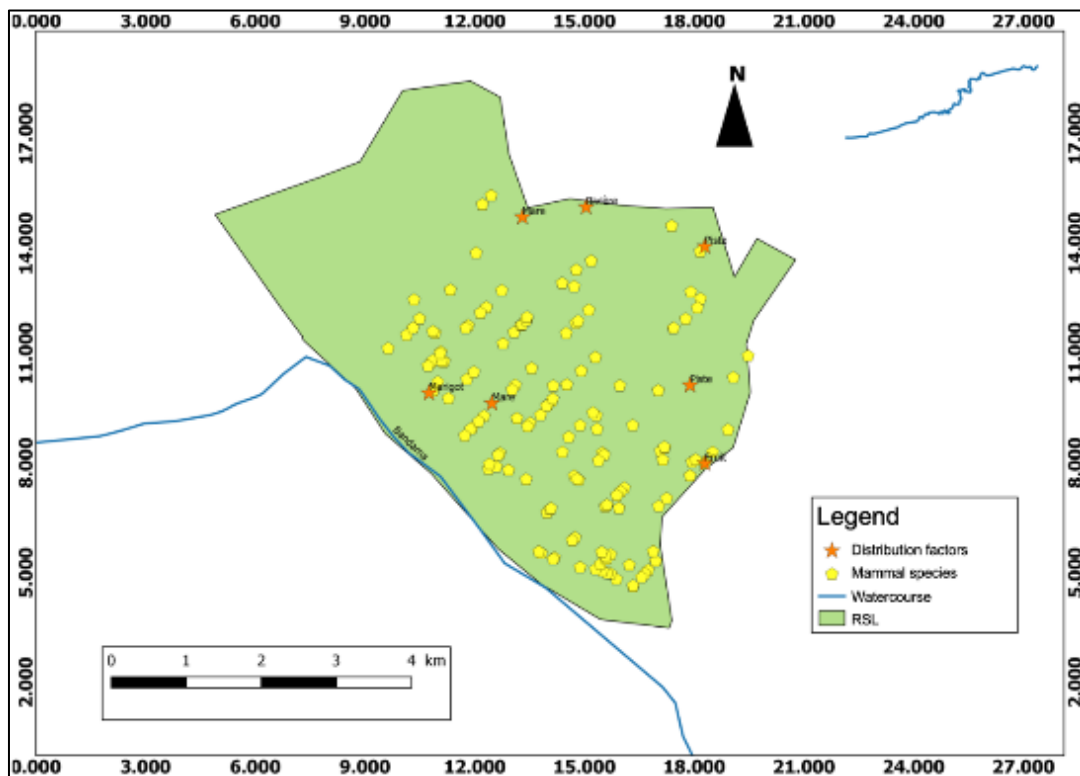
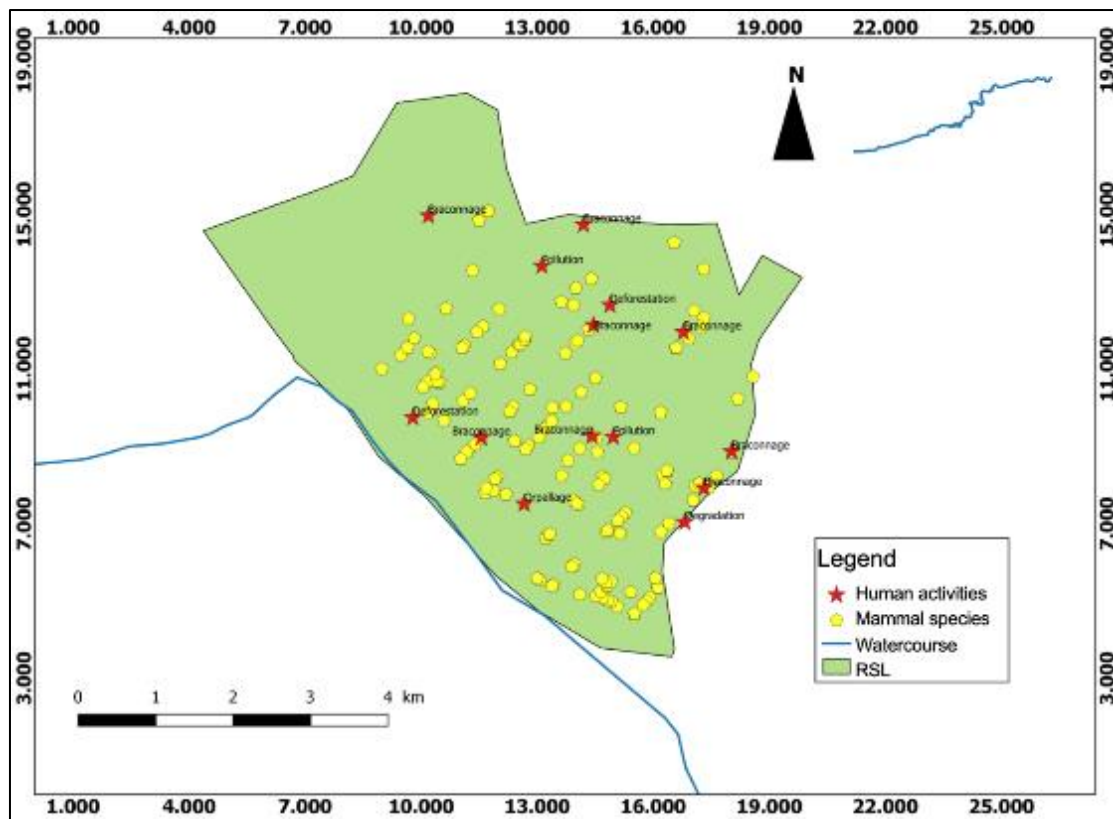


Figure 6 Distribution map of factors influencing mammal distribution



**Figure 7** Distribution map of signs of human activity in the RSL

#### 4. Discussion

The study conducted in the Lamto Scientific Reserve revealed a relatively low-diversity mammal community composed of ten species, strongly dominated by the savanna buffalo (*Syncerus caffer*), followed by the bushbuck (*Tragelaphus scriptus*), and to a lesser extent, the vervet monkey (*Chlorocebus sabaeus*). This community structure, characterized by the dominance of a few species, reflects ecological dynamics typical of mosaic ecosystems under anthropogenic pressures.

The observed species richness remains moderate but aligns with previous studies in the RSL (Bakayoko, 2020; Kone et al., 2018), which also report a strong representation of large herbivores in savanna habitats. The higher richness recorded in savanna compared to forested areas confirms the central role of these open habitats in maintaining local mammalian biodiversity. However, the overall low diversity ( $H' < 1$ ) and low evenness values indicate an unbalanced community structure dominated by a small number of species. Studies reporting higher richness (12–15 species) in the RSL suggest that such variations may be related to methodological differences, sampling effort intensity, or seasonal fluctuations (Kouassi et al., 2019).

The uneven distribution of IKA values between the buffalo and other mammal species in the RSL can be explained by a combination of ecological and behavioral factors. Large herbivores benefit from wide resource availability and ecological plasticity, allowing them to exploit diverse habitats. Conversely, elusive or nocturnal species, such as civets and pangolins, are likely under-detected, potentially biasing estimates of their true abundance. In addition, solitary or naturally low-density species, as well as those with specific ecological requirements, are generally more sensitive to environmental and anthropogenic disturbances.

Spatial distribution patterns indicate widespread occupancy of the reserve by buffalo and bushbuck, reflecting their high adaptability to various habitats in the RSL, including savannas and gallery forests. In contrast, the peripheral distribution of the vervet monkey may result from a strategy to avoid high-competition zones or from a preference for habitats offering specific food resources, as observed in other West African forest ecosystems (Fischer et al., 2020). Other species, occurring sporadically, appear to rely on narrower ecological niches and may be particularly vulnerable to habitat fragmentation, a phenomenon widely documented in the region (N'Goran et al., 2017).

Identified anthropogenic pressures—particularly poaching, artisanal gold mining, deforestation, and pollution—emerge as major factors influencing mammal distribution and abundance in the RSL. These threats, similar to those documented in other protected areas in West Africa (Benítez-López et al., 2019), contribute to habitat degradation and declining animal populations. Illegal gold mining, in particular, represents a growing threat due to its multiple impacts, including habitat destruction and water contamination (Arhinful et al., 2021). Likewise, deforestation, although less documented locally, is recognized as a major factor in mammal population declines across the region (FAO, 2020; Fischer et al., 2021).

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## 5. Conclusion

This study highlights a moderate mammal diversity in the Lamto Scientific Reserve, characterized by the dominance of a few species, notably the savanna buffalo (*Syncerus caffer*) and the bushbuck (*Tragelaphus scriptus*). Mammal distribution appears to be influenced both by the ecological characteristics of habitats and by anthropogenic pressures. Savannas play a key role in maintaining biodiversity, while other habitats host more specialized and potentially more vulnerable fauna.

The results also emphasize the impact of human activities such as poaching, artisanal gold mining, and habitat degradation, which contribute to population declines and alterations in spatial distribution.

In this context, strengthening conservation measures—including enhanced monitoring, sustainable resource management, and mitigation of anthropogenic pressures—is essential to preserve the diversity and functionality of mammal communities in the RSL. Furthermore, complementary studies incorporating long-term approaches and more refined ecological monitoring methods would improve understanding of population dynamics and guide effective conservation actions.

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## Compliance with ethical standards

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### *Disclosure of conflict of interest*

All authors of this manuscript confirm that they have no conflicts of interest or competing interests related to the publication.

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