Technical Assistance to IIU for Environmental and Social Safeguards
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Biodiversity Field Survey (BFS) Report

40 km Tappita to Toe Town Road Segment, RETRAP Project

TECHNICAL ASSISTANCE TO IIU FOR ENVIRONMENTAL AND SOCIAL SAFEGUARDS

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Abbreviation	Definitions
EPAL	Environmental Protection Agency of Liberia
EPML	Environmental Protection and Management Law of Liberia
ESIA	Environmental and Social Impact Assessment
ESMP	Environment and Social Management Plan
ESS	Environmental and Social Safeguards
FinnOC	Finnish Overseas Consultants Ltd
IDA	International Development Association
IIU	Infrastructure Implementation Unit
LIBRAMP	Liberia Road Asset Management Project
MPW	Ministry of Public Works
RETRAP	Rural Economic Transformation Project
SECRAMP	Southeastern Corridor Road Asset Management Project
STAT	Safeguards Technical Assistance Team
TOR	Terms of Reference
WB	World Bank
SDM	Species Distribution Models
HSM	Habitat Suitability Models
GIS	Geographic Information System
BFS	Biodiversity Field Survey
BMP	Biodiversity Management Plan
DEM	Digital Elevation Model
BIO	Bioclimatic Variable
AUC	Area under the curve

EXECUTIVE SUMMARY

The Rural Economic Transformation Project (RETRAP) aims to rehabilitate the 40 km Tappita to Toe Town Road in Liberia. It is a vital link for rural communities that has deteriorated since its establishment as a dirt track in the 1950s and was upgraded to laterite in the 1970s. Decades of minimal maintenance and Liberia's civil conflicts (1989–2003) have left it in poor condition, causing dust pollution, erosion, and limited market access for farmers, with 60% of rural Liberians lacking all-weather roads. The proposed bituminous surfaced carriageway will reduce transportation costs by 59%, improve livelihoods for over 1,500 households, and align with Liberia's Pro-Poor Agenda for Prosperity and Development (PAPD) and the Convention on Biological Diversity (CBD).

The Biodiversity Field Survey (BFS) was designed to generate validated, field-based data on the presence, abundance, and distribution of species along the 40 km road corridor and 1km buffer, as area of influence (AOI), with special focus on key threatened fauna such as the Western Chimpanzee (*Pan troglodytes verus*), African Forest Elephant (*Loxodonta cyclotis*), and Pygmy Hippopotamus (*Choeropsis liberiensis*). In addition, the survey aimed to identify and map critical habitats and wildlife movement corridors that may intersect with the road alignment, thereby guiding mitigation and conservation strategies to be incorporated into the BMP, as mandated by ESS6.

Methodology

The BFS utilized a robust, multifaceted approach to assess the area's biodiversity and socio-ecological context. This methodology integrated a suite of scientifically recognized field techniques—camera trapping, line transects, point counts, and botanical sampling—with advanced geospatial analysis and community consultations. Each method was carefully selected to capture specific ecological data, ensuring a comprehensive and holistic understanding of the ecosystem and its interactions with human communities.

1. **Camera Trapping**: This technique involved deploying motion-sensitive cameras in strategic locations to record elusive and nocturnal species that are challenging to observe directly. By capturing images and videos over extended periods, camera traps provided critical insights into species presence, behavior, and population trends, particularly for cryptic mammals like the Western Chimpanzee and Pygmy Hippopotamus.
2. **Line Transects**: Researchers conducted systematic walks along predetermined paths, recording sightings of wildlife to estimate population densities. This method was especially effective for assessing mammals and larger birds, offering quantitative data on abundance and distribution across various habitats within the project area.
3. **Point Counts**: Focused primarily on avian diversity, point counts entailed stationary observations at designated points, where surveyors recorded all bird species seen or heard within a fixed timeframe. This approach proved efficient for documenting bird populations and their habitat preferences, contributing to a broader understanding of faunal diversity.
4. **Botanical Sampling**: Through the establishment of sampling plots, botanists identified and cataloged plant species, assessing their distribution, abundance, and conservation status. This method was essential for documenting the area's floristic richness, including vulnerable and endangered plant species that underpin the ecosystem's health.

5. **Geospatial Analysis**: Using Geographic Information System (GIS) tools, the team mapped habitats, species distributions, and land-use patterns. This spatial analysis illuminated relationships between biodiversity and environmental factors, such as proximity to agricultural zones or human settlements, enhancing the ability to predict and manage conservation challenges.

6. **Community Consultations**: Engaging local stakeholders—hunters, farmers, and elders—provided a wealth of traditional ecological knowledge and socio-economic insights. These discussions revealed historical changes in the landscape, species behaviors, and human pressures on biodiversity, enriching the scientific data with a human dimension critical for effective conservation strategies.

Key Findings

The BFS revealed a wealth of information about the project area's biodiversity, ecological significance, and the challenges it faces. These findings underscore the area's global conservation value and the urgent need for protective measures. The Biodiversity Field Survey (BFS) conducted for the 40 km Tappita to Toe Town road corridor under the Rural Economic Transformation Project (RETRAP) aimed to assess the presence, abundance, and distribution of key threatened species, including the Western Chimpanzee, African Forest Elephant, and Pygmy Hippopotamus, within a 1 km buffer zone. The study employed scientifically robust methodologies such as camera trapping, line transect surveys, reconnaissance walks, and community consultations. Key findings include:

- **Species Presence**: No direct or indirect evidence (e.g., nests, dung, footprints) of Western Chimpanzees, African Forest Elephants, or Pygmy Hippopotamuses was found within the project's area of influence (AOI). Community interviews indicated rare historical sightings (last 5–20 years) but no recent activity. The survey documented over 100 plant species, including several classified as vulnerable or endangered by the IUCN Red List. This rich plant diversity supports a wide array of wildlife, providing food, shelter, and breeding grounds, and reflects a relatively healthy ecosystem capable of sustaining complex ecological interactions. The area hosts a remarkable diversity of mammals, birds, and reptiles. In addition to the flagship species listed above, the surveys recorded the Jentink's Duiker (Cephalophus jentinki, EN), a rare and endangered antelope, alongside other priority species. This faunal variety signals an intact ecosystem—a rarity in regions facing anthropogenic pressures—and emphasizes the area's ecological significance.
- **Habitat Assessment**: The AOI is predominantly degraded secondary forest, agricultural land (cocoa, rubber, mixed crops), and fragmented habitats, with no Key Biodiversity Areas (KBAs) or protected areas within 1 km. The figure below shows the degree of habitat modification in the study area, where tree cover loss and deforestation patterns from year 2000 to 2023 are visualized (color ramp from red – recent deforestation in 2023 to blue – deforestation in year 2000). The project area encompasses a mosaic of habitats, each contributing distinct ecological roles and supporting diverse species assemblages:
    - **Secondary Forests**: These regrowth forests, recovering from past disturbances, offer vital habitat for species adapted to dense vegetation, including mammals like the Western Chimpanzee. Despite their altered state, they remain biodiversity hotspots.
    - **Wetlands**: Essential for water regulation and flood control, wetlands harbor unique biodiversity, including amphibians, waterbirds, and aquatic plants, making them critical components of the ecosystem.

- **Agricultural Mosaics**: Comprising a blend of crops, fallows, and natural vegetation, these areas provide habitat and movement corridors for wildlife when managed sustainably, enhancing connectivity across the landscape.

Figure E1. Degree of habitat modification and tree cover loss in the target area.

- **Critical Habitat Criteria**: Only two species (Jentink's Duiker and white-bellied pangolin) met criteria 1 of the critical habitat assessment. The observations of these two threatened species were located beyond the 1km buffer of the project road.
- **Camera Trap Data**: The results from 23 camera traps showed no evidence of critical species such as chimpanzee, African forest elephant, pygmy hippopotamus. Only the presence of the white-bellied pangolin was confirmed through this method.
- **Landscape suitability Connectivity**: Species distribution models indicated low suitability for critical species in the project area, aligning with field observations.
- **Threats**:
  - **Existing Pressures**: The area is under significant strain from deforestation driven by slash-and-burn agriculture, logging, and unregulated hunting. These activities, often linked to poverty and limited alternative livelihoods, degrade habitats and reduce species populations, posing immediate risks to biodiversity.
  - **Project-Related Risks**: The proposed road rehabilitation introduces additional threats, notably **habitat fragmentation**, which can sever connectivity between populations, leading to reduced genetic diversity and increased extinction risk.

Furthermore, **increased human access** facilitated by the road may exacerbate poaching, illegal logging, and other destructive practices.

Impact Assessment

The project is anticipated to influence local biodiversity through various mechanisms categorized into direct, indirect, and cumulative impacts. A thorough impact assessment was essential to identify these effects, evaluate their significance, and inform the development of effective mitigation measures. This process ensures the project aligns with environmental standards and preserves the ecological integrity of the region.

Direct Impacts
Direct impacts arise immediately from the construction and operation of the road, affecting biodiversity within and adjacent to the road corridor.

- **Habitat Loss**: The construction process requires clearing vegetation along the road corridor, resulting in the direct loss of habitats. This can fragment ecosystems, isolating populations of plants and animals and reducing genetic diversity. For example, clearing trees and shrubs displaces species such as birds, small mammals, and insects that depend on these areas for nesting, foraging, and shelter. In extreme cases, this habitat loss could lead to local extinctions of species with limited ranges or specific habitat requirements.

- **Mortality from Construction Activities**: Construction activities pose a direct threat to wildlife through accidental mortality or injury. Heavy machinery increased human presence, and physical alterations to the landscape can harm or kill animals, particularly slow-moving or less mobile species like reptiles, amphibians, and small mammals. For instance, earth-moving equipment might crush burrowing animals or destroy nests, while construction noise and vibrations could drive away sensitive species, reducing their survival rates.

Indirect Impacts
Indirect impacts emerge as secondary consequences of the road rehabilitation, often extending beyond the immediate project area due to changes in human behavior and land use.

Increased Accessibility: The rehabilitated road will improve access to previously remote areas, potentially triggering a cascade of environmental changes. Enhanced accessibility can lead to further deforestation as land is cleared for agriculture, settlements, or logging. It may also increase poaching, as hunters gain easier entry to wildlife habitats. Additionally, the road could heighten human-wildlife conflict, with animals drawn to roadside resources (e.g., food waste) or displaced into human areas, leading to retaliatory killings. For instance, improved access might enable illegal logging of valuable timber species or overharvesting of wildlife, further degrading biodiversity.

Mitigation Strategy
To address these diverse impacts, the project employs a mitigation strategy grounded in the mitigation hierarchy: a structured approach that prioritizes avoiding impacts, minimizing unavoidable effects, restoring affected areas, and offsetting residual impacts. Community engagement is also a critical component, fostering local support and ensuring long-term sustainability.

1. **Avoidance**: Where possible, the road alignment should be adjusted to bypass ecologically sensitive areas, such as wetlands, old-growth forests, or known breeding sites of endangered species. For instance, rerouting the road to avoid a critical wetland could preserve its unique biodiversity and prevent hydrological disruptions. This step requires detailed environmental surveys to identify high-priority areas and collaboration with ecologists to optimize the route.
2. **Minimization**: Construction practices should be designed to reduce impacts on biodiversity. This includes timing construction to avoid sensitive periods, such as breeding or migration seasons, to limit disturbance to wildlife. Noise-reduction techniques, like using mufflers on machinery, and erosion control measures, such as silt fences, can prevent sedimentation in nearby water bodies. Installing wildlife crossings—underpasses for small animals or canopy bridges for arboreal species—maintains habitat connectivity, allowing safe passage across the road. For example, canopy bridges (rope bridges) could enable monkeys or squirrels to move between forest fragments without risking road crossings, subsequently leading to reduction of road mortality for these species. This can be established through engineering design in ladderlike or mesh designs, cleverly mimicking the natural vines and branches of trees. This should be recommended to all such area of the road especially between sections of the corridors between Bitterball and Mary Weah villages
3. **Restoration**: Areas disturbed by construction should be rehabilitated by replanting native vegetation, which

Monitoring and Adaptive Management
A robust monitoring program will track biodiversity indicators and the effectiveness of mitigation measures. The project will adopt an adaptive management approach, allowing for adjustments based on monitoring results and emerging scientific knowledge.

Conclusion on BMP Requirement

Based on the BFS findings Based on the BFS findings on critical species and the many detailed and specified mitigation measures recommended for both species and habitat, the need for a biodiversity offset and net gain plan is not expected for the following reasons

The result of detailed mitigation measures on critical habitat management specifically on Critically Endangered (CR) or Endangered (EN) species such as the Jentink's duiker and the White-bellied pangolin and the specific recommendation for such species protection justify concrete reasons on species protection and management, avoiding biodiversity offset. Moreover, there are clear mitigation measures for other activities such as flora management, fauna management and ancillary facilities which without, could affect the protection of these critical species. Additionally, the program for biodiversity field monitoring which earmarked institution and agency to conduct robust implementation plan in addressing mitigation actions has also been recommended, thereby strengthening no need for offset.
or the following reasons:

- **No Critical Habitat**: The Critical Habitat Assessment used 1km AOI to assess Project risks. Based on available information and additional biodiversity field surveys, the Project's Area of Analysis does not qualify as Critical Habitat. Even though, potential critical habitat was found to be relevant to two species only (Jentink's Duiker and White-Bellied pangolin) under criteria 1. Also, the study area has been heavily modified in the last decades (as seen from the recent tree cover loss throughout the 40km (about 24.85 mi), as well as the evidence from the ground on forest clearance activities and land-use change). While habitat classification may not excuse a project from developing biodiversity management plan, for this project, biodiversity risks are not significant as the twotarget species, presence has been confirmed beyond the 1km buffer AOI, , and there is no evidence of essential ecological function or viability for the species in this project's area. In this sense, the project area may not qualify as critical habitat, if it's determined that the site is not significant to the species' survival, based on the criteria above.

- **Significant reduction of Key Species**: Field surveys and community consultations confirmed no recent activity or viable populations of Western Chimpanzees, African Forest Elephants, or Pygmy Hippopotamuses. The target species to be managed in the mitigation plan are Jentink's duiker and the white-bellied pangolin and thoughthe project cannot make a definite statement on the complete absence of chimpanzees due to its rare presence; nevertheless, conclusion of a no net loss can be reached because of such species significant population decreased. **Precautionary Mitigation**: Mitigations measures will address residual risks (e.g., habitat fragmentation, noise)

Precautionary Mitigation Measures in ESIA/ESMP

To address potential indirect impacts, the following measures will be implemented:

1. **Habitat Connectivity**:
    - Install wildlife-friendly culverts (900 mm pipes for ephemeral streams, box culverts with natural substrates) at 5 km intervals.
    - Retain tree canopy connectivity (10 m gaps) where possible. In addition, roadside vegetation plans will include the management of a 10m buffer of planting native trees to increase canopy connectivity of wildlife.
2. **Construction Controls**:
    - Restrict clearing to designated areas; demarcate work zones to avoid unnecessary habitat disturbance.
    - Enforce "no hunting" and “no disturbance” policies for workers and contractors; conduct awareness programs.
3. **Traffic Management**:
    - Implement speed limits (40 km/h in rural areas) and install "wildlife crossing" signage on both sides of the road.
    - Prohibit night-time construction to reduce noise disturbance.
4. **Revegetation**:
    - Replant disturbed areas with native species to stabilize soils and restore green corridors.
5. **Monitoring**:
    - Conduct post-construction biodiversity monitoring to verify the effectiveness of mitigation measures.

Recommendation

The proposed road construction will not take place on virgin land or within a forested area. The project site has long served as an unpaved road, supporting various forms of transportation. Currently, this unmetalled road contributes to elevated sediment runoff, soil erosion, and dust pollution, negatively affecting air and water quality. The implementation of a metaled road is expected to mitigate these issues, leading to improved air quality in the area.

The Environmental and Social Management Plan (ESMP) will incorporate comprehensive mitigation measures to address residual risks, ensuring full compliance with Environmental and

Social Standard 6 (ESS6) and Liberia's environmental regulations. Should new data—such as findings from camera traps—reveal unforeseen impacts, an adaptive management approach will be employed to address them effectively.

1 INTRODUCTION

1.1 Project Overview

The Rural Economic Transformation Project (RETRAP), funded by the World Bank, is a transformative initiative designed to enhance rural connectivity, agricultural productivity, and economic resilience in Liberia. A key component of RETRAP is the rehabilitation and upgrading of a 125 km road corridor linking Ganta to Zwedru, with the 40 km Tappita to Toe Town segment serving as the initial phase of implementation. This segment, located in Nimba and Grand Gedeh counties, is part of an existing two-lane unpaved road that will be upgraded to a bituminous surfaced carriageway with a 20-year design life under an Output- and Performance-Based Road Contract (OPRC) model, executed through a Design, Build, and Transfer (DBT) arrangement. The project is managed by the Infrastructure Implementation Unit (IIU) of the Ministry of Public Works (MPW), with oversight from a Multi-stakeholder National Project Steering Committee (NPSC) chaired by the Ministry of Agriculture (MoA).

The 40 km Tappita to Toe Town segment traverses a diverse landscape, including degraded and secondary forests, swampy wetlands, riparian zones, and areas altered by anthropogenic activities, such as cocoa and rubber plantations. This region, part of Liberia's Upper Guinean Forest ecosystem, is recognized for its significant biodiversity, lying in proximity to Key Biodiversity Areas (KBAs) and the soon-to-be gazetted Kwa National Park, approximately 30 km east of the corridor. The road upgrade aims to improve market access for agricultural producers, reduce transportation costs, and stimulate rural economic growth. However, construction activities, including vegetation clearance, earthworks, and quarry operations, pose potential risks to biodiversity, such as habitat fragmentation, noise disturbance, and increased mortality of wildlife. These risks necessitate a Biodiversity Field Survey (BFS) to inform the Biodiversity Management Plan (BMP) and ensure compliance with the World Bank's Environmental and Social Standard 6 (ESS6) on Biodiversity Conservation and Sustainable Management of Living Natural Resources.

The RETRAP biodiversity safeguards work is embedded within Liberia's broader environmental and development framework, including the Pro-Poor Agenda for Prosperity and Development (PAPD), the National Biodiversity Strategy and Action Plan (NBSAP), and global commitments under the Convention on Biological Diversity (CBD). It specifically addresses the protection of species classified as Critically Endangered or Endangered by the IUCN Red List, such as the Western Chimpanzee (*Pan troglodytes verus*), African Forest Elephant (*Loxodonta cyclotis*), and Pygmy Hippopotamus (*Choeropsis liberiensis*).

1.2 BACKGROUND

The existing Tappita to Toe Town road, likely established as a dirt track in the 1950s and upgraded to a laterite road during the 1970s, has served as a critical lifeline for rural communities, connecting agricultural producers to markets in Nimba and Grand Gedeh. However, decades of minimal maintenance, compounded by the impacts of Liberia's civil conflicts (1989–2003), have left the road in severe degradation. The current unpaved surface generates significant dust during the dry season, contributing to air pollution that adversely affects community health, causing respiratory issues, and degrades roadside vegetation critical to local ecosystems. Poor drainage exacerbates erosion, leading to sedimentation in creeks and wetlands that support species like the Nimba Otter Shrew, while the road's rough condition increases vehicle noise and limits safe wildlife crossings, heightening risks of mortality for species such as duikers and primates. Socially, the road's unreliability restricts market access, perpetuating economic isolation for farmers and hindering the transport of goods, with 60% of rural Liberians lacking access to all-weather roads. These challenges underscore the urgent need for the RETRAP rehabilitation to address longstanding environmental degradation and socio-economic constraints.

Upgrading the Tappita to Toe Town road to a bituminous surfaced carriageway offers a compelling opportunity to mitigate these environmental and social challenges while advancing Liberia's development goals under the Pro-Poor Agenda for Prosperity and Development (PAPD) and global commitments under the Convention on Biological Diversity (CBD). Environmentally, the paved surface will eliminate dust generation, improve air quality for communities, and reduce stress on vegetation, thereby enhancing habitat quality for species reliant on roadside ecosystems. Enhanced drainage systems, including concrete side drains and strategically placed culverts, will control erosion and protect water quality in wetlands and creeks, safeguarding aquatic biodiversity. Socially, the rehabilitated road will provide reliable, all-weather access, reducing transportation costs by an estimated 59% and boosting agricultural market access, thereby enhancing livelihoods for over 1500 households in 16 communities along the corridor. Community engagement, through 16 Focus Group Discussions (FGDs) and a Grievance Redress Mechanism (GRM), ensures that local knowledge and concerns shape mitigation strategies, while training programs and conservation initiatives empower residents to protect biodiversity.

1.3 OBJECTIVES

The Biodiversity Field Survey (BFS) was designed to generate validated, field-based data on the presence, abundance, and distribution of species along the 40 km road corridor and 1km buffer, as area of influence (AOI), with special focus on key threatened fauna such as the Western Chimpanzee (*Pan troglodytes verus*), African Forest Elephant (*Loxodonta cyclotis*), and Pygmy Hippopotamus (*Choeropsis liberiensis*). In addition, the survey aimed to identify and map critical habitats and wildlife movement corridors that may intersect with the road alignment, thereby guiding mitigation and conservation strategies to be incorporated into the BMP, as mandated by ESS6. The specific objectives are:

- **Establish a Biodiversity Baseline**: Verify the presence or absence of critical habitat-qualifying species, including e.g. the Western Chimpanzee, African Forest Elephant, Pygmy Hippopotamus, Nimba Otter Shrew,
- **Assess Habitat Quality and Risks**: Quantify the extent and condition of habitats (e.g., closed forests, swamps, cocoa farms) and evaluate project-related risks, such as habitat fragmentation, noise disturbance, and water quality degradation, to inform the BMP's mitigation measures.
- **Address Data Gaps and World Bank Concerns**: Overcome deficiencies in previous BFS submissions (e.g., unverifiable species data, inadequate survey rigor) by employing scientifically robust methodologies (e.g., camera traps, reconnaissance (RECCE), and line transect surveys) and ensuring stakeholder validation.
- **Support ESS6 Compliance**: Validate the biodiversity risk classification for the 40 km segment, based on the absence of recent African Forest Elephant crossings and limited evidence of critical habitat, while identifying targeted mitigation measures to protect confirmed species, such as the Timneh Parrot.
- **Inform BMP Development**: Provide actionable data to refine the BMP's mitigation hierarchy, monitoring framework, and stakeholder engagement strategies, ensuring alignment with Liberian regulations and applicable World Bank Environmental and Social Standards (ESSs).

1.4 SCOPE

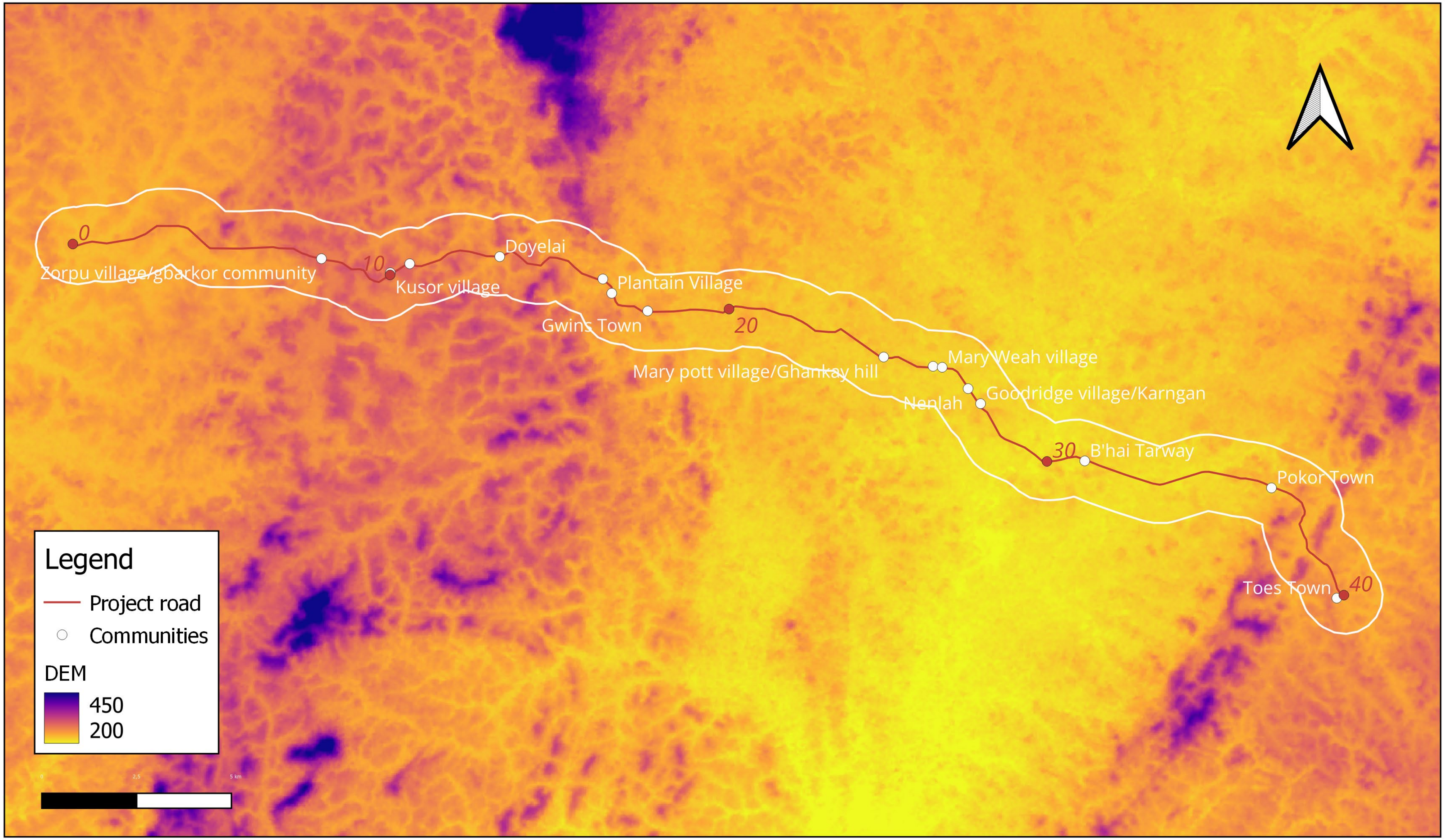
To achieve these objectives, the BFS applied a combination of scientifically recognized field methods—including camera trapping, reconnaissance (recce) walks, line transect surveys, and botanical plot sampling—complemented by geospatial analysis using GIS. A key component of the approach also involved participatory community consultations, through which local residents, including hunters and farmers, provided valuable ecological and cultural insights.

The BFS covered the 1 km AOI surrounding the 40 km Tappita–Toe Town road corridor, capturing all potential direct and indirect impacts from construction and operation activities. This includes the right-of-way (ROW), associated ancillary facilities (e.g., quarries, borrow pits), and areas of potential induced development (e.g., agricultural expansion). The survey area spans a range of habitat types, including closed canopy forests, secondary forests, swamps, riparian zones, and anthropogenically altered landscapes (e.g., cocoa farms), which may support critical habitat-qualifying species. The scope prioritizes 11 species selected for their conservation status under the International Union for Conservation of Nature (IUCN) Red List and their ecological significance.

The survey was conducted between April 15 and May 15, 2025, covering the late dry season (April 15–30) and early wet season (May 1–15) to capture seasonal variations in species behavior and habitat use. While the survey was conducted late dry and early wet, it is believed there would have not been any significant difference in the detection rate. Both fauna prone to rain and dry were detected throughout the survey. For instance, pangolins or duikers were encountered more than twice. All team also had a at least a hunter whose acquaintance with the forest and wild life status gave the team a solid sense of specific wildlife presence/absence. Their understanding of the biodiversity status informed the team of long distance covered by them during hunting. The BFS was led by a multi-disciplinary team of experts from four Liberian environmental NGOs: Fauna & Flora (FF), Wild Chimpanzee Foundation (WCF), Solimar International, and the Society for the Conservation of Nature in Liberia (SCNL), which served as the lead agency. Each organization contributed specialists in botany, mammalogy, primatology, and GIS.

Finnish Overseas Consultants (FinnOC) and Green Consultancy Group (GreenCons), contracted to provide Technical Assistance to the Infrastructure Implementation Unit (IIU)—the project's implementing agency—were responsible for logistical coordination and ensuring that the BFS was conducted in accordance with the project's Terms of Reference (ToR). A HEIS consultant was also involved to provide quality assurance of the survey methodology and final report. Additionally, key national regulatory stakeholders, including the Forestry Development Authority (FDA) and the Environmental Protection Agency (EPA), were engaged to ensure institutional alignment and compliance.

The results of the BFS will serve as the foundation for revising the BMP and strengthening safeguards compliance under RETRAP. **Figure 1** shows the location of the project road overlaid in a digital elevation model (lower elevations in yellow, higher elevations in purple), together with the 10km sectioning marked in red dots. Similarly, **Figure 2** shows the degree of habitat modification in the study area, where tree cover loss and deforestation patterns from year 2000 to 2023 are visualized (color ramp from red – recent deforestation in 2023 to blue – deforestation in year 2000).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10
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Zorpu village/gbarkor community
Kusor village
Doyelai
Plantain Village
Gwins Town
Mary pott village/Ghankay hill
Mary Weah village
Nenlah
Goodridge village/Karngan
B'hai Tarway
Pokor Town
Toes Town
Legend
Project road
Communities
DEM
450
200

Figure 1. Project road

Figure 2. Tree cover loss in the project road

1.5 ADAPTIVE MANAGEMENT PROCESS

The following figure shows the general framework followed for the environmental and social impact assessment. A clear context and purpose for the development project is needed to justify the investment. Each project type, in this case a 40km rehabilitation road, has different components (e.g. rehabilitation of the road sections, culverts, bridges, etc.), different phases (pre-construction, construction and operation phase) and different materials requirements (water, cement, gravel, sand, wood, etc.) and workforce requirements. Different alternatives should be considered at early stages (e.g. feasibility study stage) so that impacts can, first of all, be avoided. The preferred alternative and its technical characteristics will be in a defined geographic setting, therefore the need of having a clear picture of the environmental and social conditions of the study area (baseline) before the project is implemented. After defining the areas of influence, where impacts are expected, it is possible to identify and quantify the expected impacts of the development project on the environmental and social context. Specific management plans are therefore proposed in order to avoid, reduce, minimize, rehabilitate, and ultimately, compensate for negative impacts and enhance positive ones.

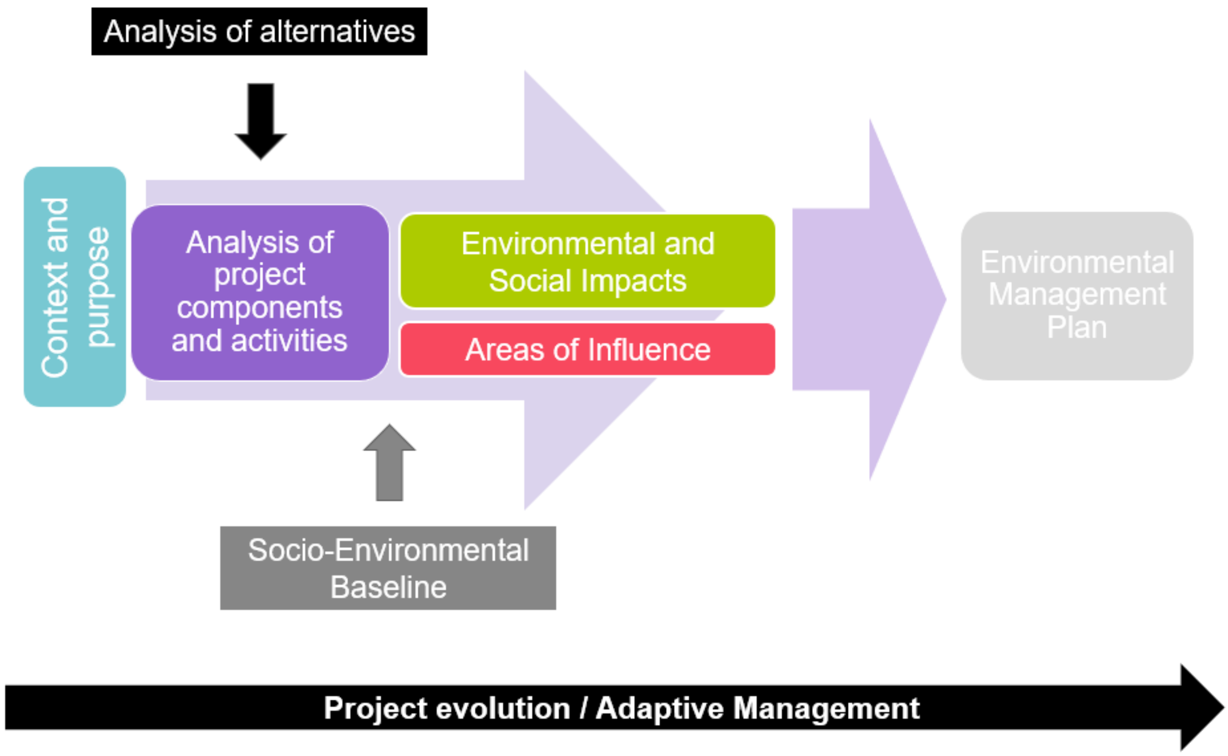

Figure 3. Environmental and Social Impact Assessment Process

An environmental adaptive management approach should be followed. Stakeholder consultations, adjustments between pre-feasibility, feasibility and detailed design project phases likely derive in changes in the project scope, components and alignment. Adaptive management, therefore, considers uncertainty and the consequences of actions.

2 PROJECT DESCRIPTION

2.1 DESCRIPTION

The corridor consists of the road section between Tappita and Toe Town (40 km) in Nimba and Grand Gedeh Counties, under RETRAP. The road section will be will be upgraded from a laterite road to international blacktop highway standards. The road routing and design will adhere to the existing right-of-way (RoW) established by the MPW. However, in urban areas, the road reserve will be reduced from 22.8 meters (75 feet) to 15.2 meters (50 feet) on either side of the road centreline to minimise impacts on assets within the standard 45.7-meter (150-foot) legal RoW. In rural areas, the RoW will remain at 22.8 meters (75 feet) on either side of the road centreline. Both rural and urban RoWs will include drainage and other roadside structures, and efforts will be made to minimise realignment. Major realignments are expected only when absolutely necessary.

To achieve the above design standards, substantial earthworks are required to form the embankment and ensure proper drainage, using material from borrow pits along the road. Bridges and numerous culverts will be constructed. Aggregates derived from quarried and crushed hard rock will be needed for concrete, road formation, and surfacing. A large amount of bitumen will also be needed for the asphalt.

For these major works in a remote rural area, the contractor will establish facilities such as camps, stores, workshops, offices, clinics, quarries, borrow pits, asphalt mixing plants, rock crushing and screening plants, and concrete batching plants. The main materials to be used for the project include, but are not limited to cement, steel, crushed rocks, sand, diesel, lubricants, bitumen or asphalt, wood and water.

2.2 CONCEPTUAL DESIGN

The conceptual design for the road is provided in a report by AURECON (2020), which is accompanied by drawings giving typical details, plans, profiles and cross-sections.

Along most of its length, in rural areas, the road will be as shown in the figure below: a two-lane highway with a 7.5-metre-wide asphalt carriageway and 1.5-metre shoulder on each side, also surfaced with asphalt. The design speed will be 80 km/h, reduced to 60 km/h in built-up areas. The economic modelling forecasts an additional traffic generation of 59 percent above current levels, largely through lower vehicle operating costs.

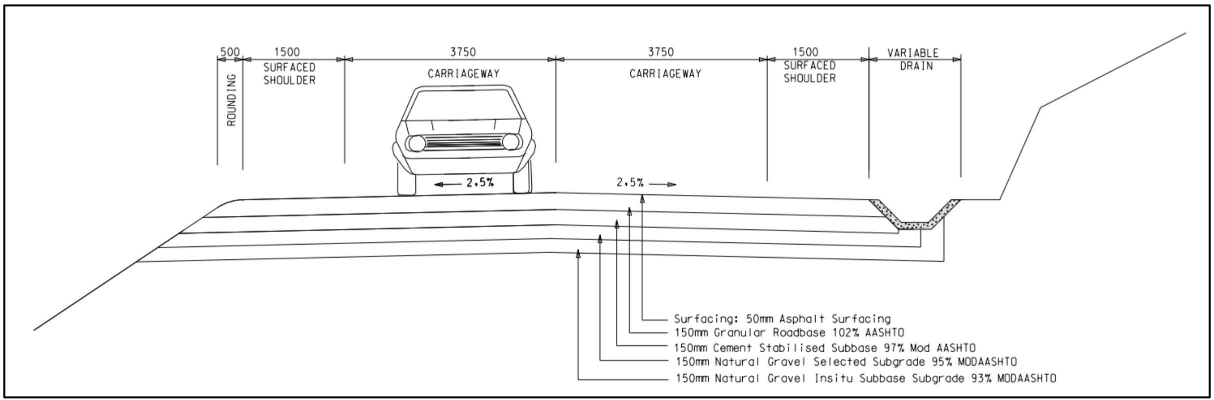

Figure 4. Proposed road cross-section in rural areas. Source: AURECON (2020).

The materials for the construction of the road are expected to be as follows, based on the road structure shown in the figure above

1. The proposed road layers will comprise of 50 mm asphaltic surfacing, 150 mm crushed stone base, 150 mm stabilised gravel upper subbase, 150 mm natural gravel lower subbase and 150 mm selected subgrade material.
2. The asphaltic surfacing material and the crushed stone base aggregates will be obtained from commercial sources or sources developed by the contractor.
3. The gravel for the subbase layers will be obtained from borrow pits in relatively close proximity of the project. (Haul distance of 10 km is assumed).
4. Gravel borrow pits of ± 2,5 hectares will be stripped of topsoil, gravel will be removed and the borrow pit area will be rehabilitated at the end of the project.
5. The material for the selected subgrade layer will be obtained from the excavation of existing pavement layers, which is suitable for use in the selected subgrade will be stockpiled after excavation and hauled to the point of use when required.
6. Topsoil will be stripped to a maximum depth of 250mm below the current natural ground level, stockpiled and spread over the embankments at the end of the project.
7. Aggregates for all concrete will be obtained from commercial sources, and hauled to the construction site for a maximum distance of 10 km.

This does not account for the earthworks required for cuttings and embankments. The Employer's Requirements (IIU, 2022) states that: "The Contractor is responsible for all embankment and cut slopes along the road's sections included in the contract. In particular he is responsible for ensuring they are stable, without deformations and erosions." The cross-sections show that the road will be raised on an embankment between about 0.5 and 2.0 metres, depending on the terrain and super-elevation. This will amount to approximately 0.5 million cubic metres of earthworks. The overall footprint of the road, embankments and drains will amount to about 70 hectares, assuming an average overall formation width of 17.5 metres.

The standard design for concrete side drains is given in the figure below. These are designed for safety reasons to be wide and shallow. It has the disadvantage of additional landtake, but the safety aspect, along with its ease of access for moving animals make it appropriate in the setting of the RETRAP roads.

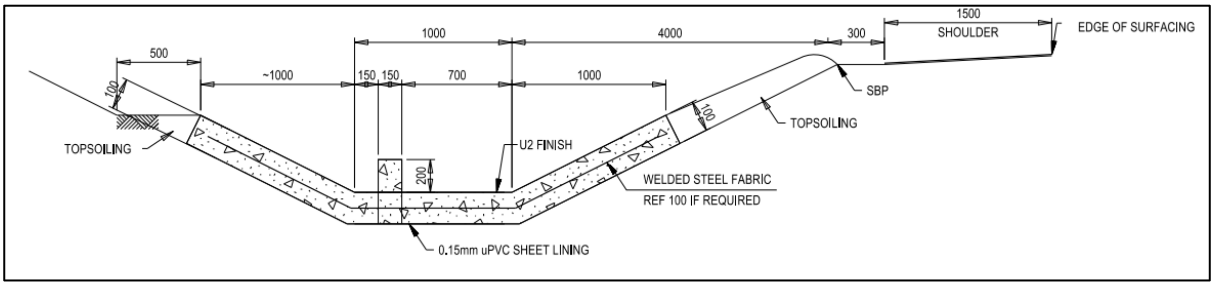

Figure 5. Proposed concrete side drain design. Source: AURECON (2020).

The standard designs for pipe and box culverts are shown in the following figures respectively. It is not specified in AURECON (2020) as to where each type should be used.

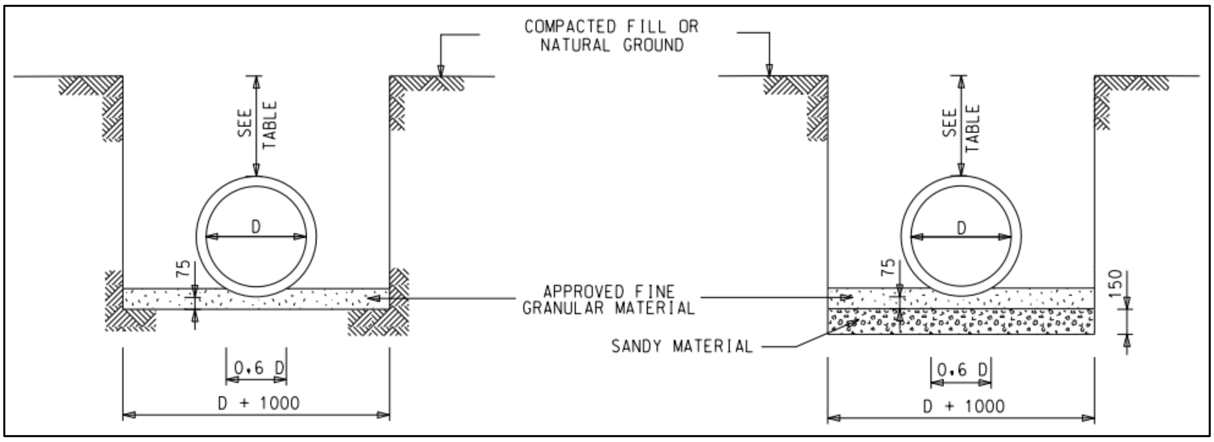

Figure 6. Proposed typical pipe culvert designs in hard material (left) and soft material (right). Source: AURECON (2020).

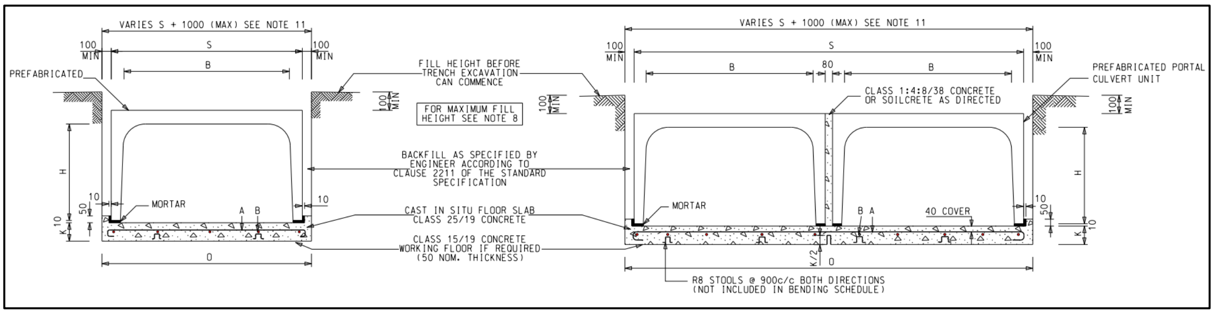

Figure 7. Proposed typical designs for single portal (left) and multiple portal (right) box culverts. Source: AURECON (2020).

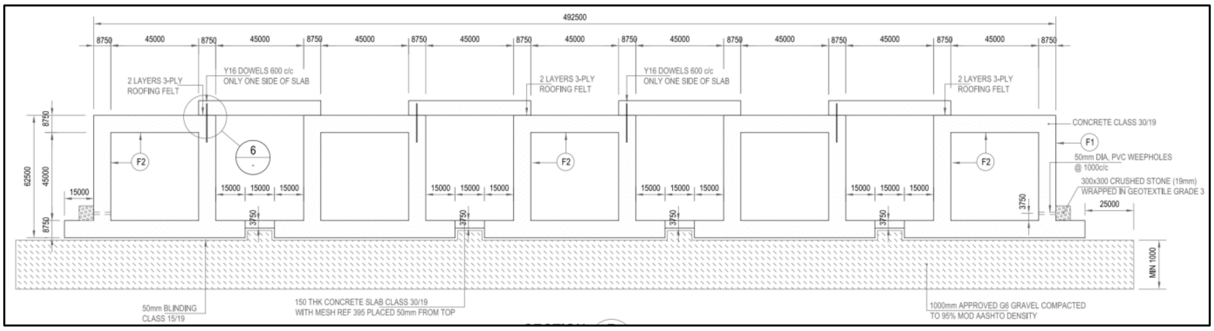

Figure 8. Proposed typical designs for large drainage structures. Source: AURECON (2020).

3 METHODOLOGY

3.1 Sampling Methods and Survey Design

3.1.1 Focus Group Discussions (FGDs) and community consultations

Approximately 16 Focus Group Discussions (FGDs) were conducted from April 19 to May 5, 2025, targeting communities along the 40 km Tappita-Toe Town section. Participants included farmers, miners, and community leaders, with a total of 126 participants across 16 documented communities. Discussions covered species sightings, environmental changes, and cultural practices.

The survey team chose FGDs over household surveys for the following reasons:

- FGDs enabled detailed, qualitative exploration of biodiversity and environmental issues, capturing nuanced community perspectives that broader methods might overlook.
- With 21 villages identified along the 40 km corridor, FGDs in 16 communities (excluding the other five communities, which are basically hamlets) offered a representative sample while optimizing time and resources.
- FGDs encouraged interactive dialogue, allowing participants to share collective knowledge and cultural insights vital for biodiversity management.
- Focusing on larger communities ensured robust participation and impactful data, avoiding the dilution of effort in smaller, less ecologically significant hamlets.

This FGD approach with the villages was not about surrounding vegetation but its balances effectively depth, representation, and practicality in a resource-limited context. Community members from hamlets were already represented, referring to their closest village as "big town." They were able to give their inputs into the discussion, contributing to the biodiversity understanding of the local culture.

Figure 9. Communities engaged in the field work

Local communities, including hunters and farmers, were consulted through focus group discussions (FGDs) and participatory approaches. Their knowledge helps identify species hotspots, seasonal movement patterns, and historical biodiversity changes. Integrating this information strengthens conservation strategies.

3.1.2 Line Transect Design

A systematic sampling design with a total effort of 46km was created using Distance 7.5 (Buckland *et al.*, 2001). Based on the shape effect of the road buffer, transects were placed at 45 ° with regular intervals of 1.5 meters. However, previous rapid surveys had insufficient data to gather information on rare species, making it difficult to determine the most effective survey efforts using the below formula. As the latter becomes an issue, the most applicable survey recommended is Systematic sampling. Transects were also placed based on existing raster files from IUCN mammal diversity (Junker *et al.*, 2015) and Chimpanzee density (Tweh *et al.*, 2014)

Determining expected precision

$$CV(\hat{D}) = CV(\hat{D}_0)\sqrt{\frac{K_0}{K}}$$

Planned effort (number of points)

Determining total effort (number of points)

$$K = \left(\frac{b}{\left[CV_t(\hat{D})\right]^2}\right)\left(\frac{K_0}{n_0}\right)$$

Dispersion parameter

Target CV

Inverse of encounter rate

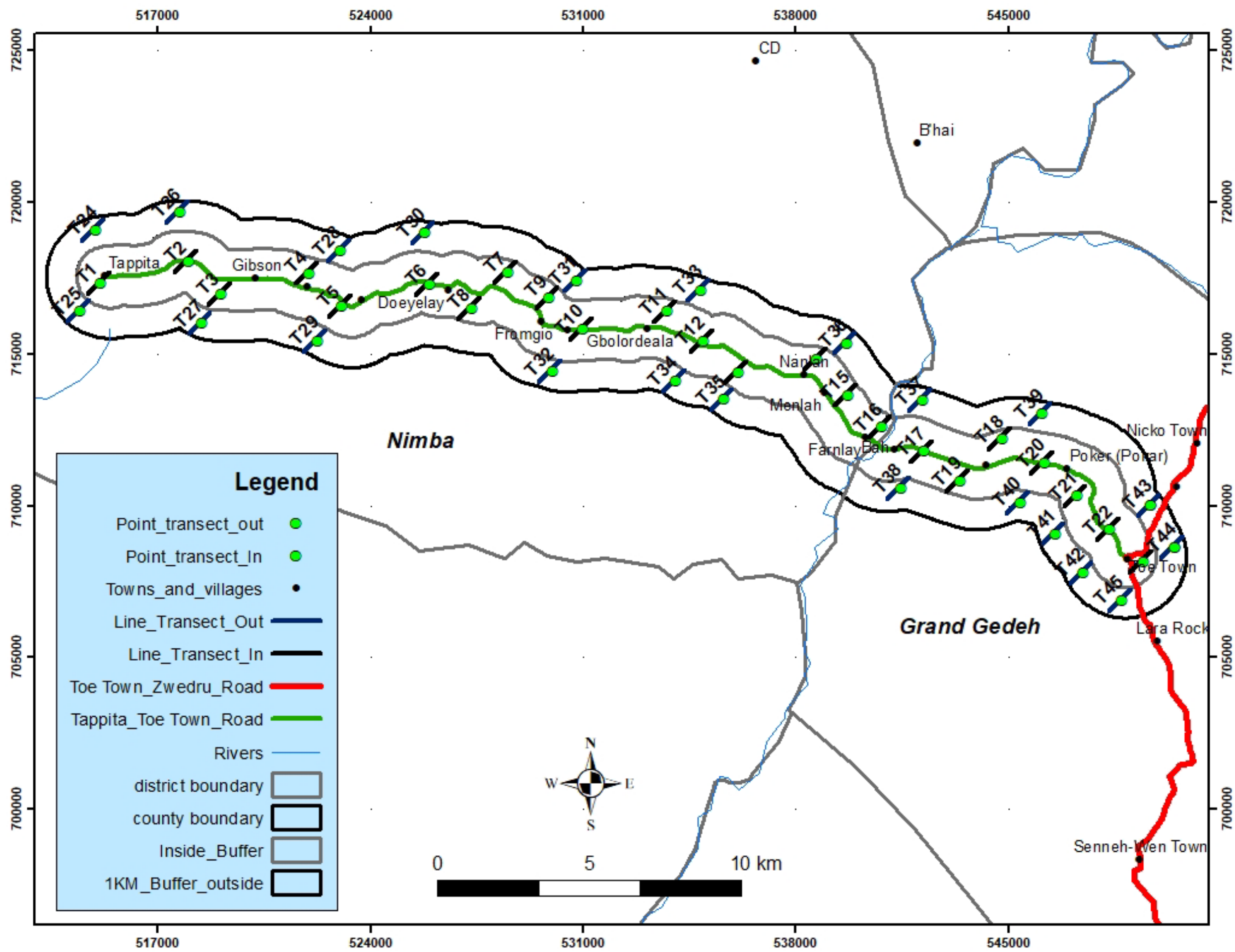

Figure 10. Line transects

3.1.3 Point transects

As recommended by Cappelle et al., 2018 Camera Trap Distance Sampling Technique in Tai National Park. Point transects were placed along the center (500m) of each line transect, moving 100m longitudinally from the center of the transect line. Cameras are placed northward at +-20o. Radius distances for the cameras will be recorded for possible analysis to determine species abundance based on independent videos. This survey was carried out from April 21st to May 5th, 2025 in at least fifteen (15) different communities representing forty- one (41) sampling plots:

3.1.4 Camara traps

Camera traps were placed in critical habitats of elusive and nocturnal species to monitor wildlife activity. These motion-activated cameras captured images and videos, providing data on species presence, population density, and habitat use. This method is essential for tracking threatened species like chimpanzees and other mammals that are difficult to observe directly. A total of twenty-three (23) camera traps were placed in the project's area of influence (as seen in **Error! Reference source not found.**).

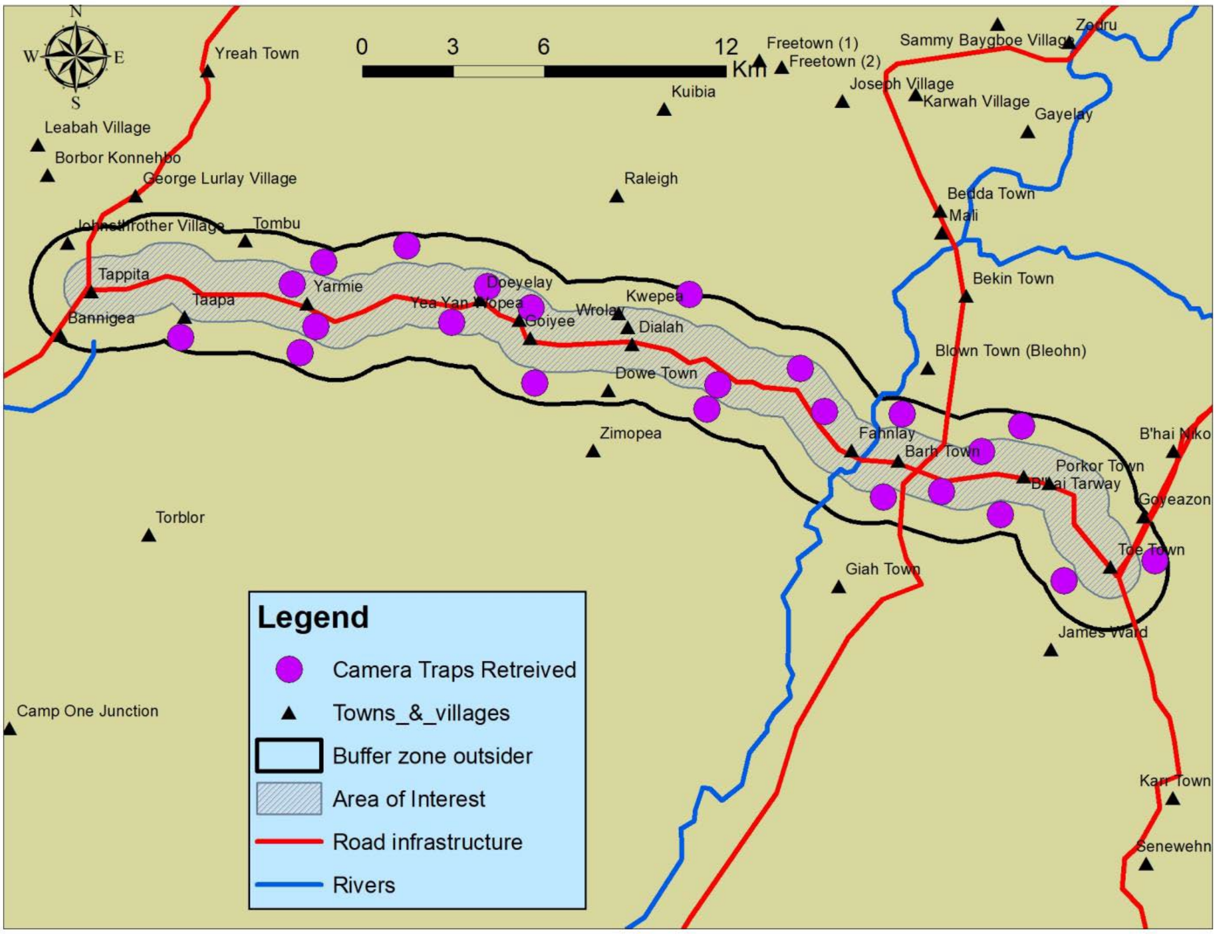

Figure 11. Location of installed camera traps

3.1.5 Recce surveys

Recce and line transect were used to document wildlife presence and habitat use. Recce surveys involve walking pre-determined paths to record signs like tracks, dung, nests, and feeding remains. Line transects require surveying along straight paths while systematically noting species' presence. These methods provide insights into population density, habitat preference, and movement corridors.

3.1.6 Botanical transects

Botanical surveys assess plant species diversity, distribution, and ecological roles. Researchers set up sampling plots to document tree species, canopy cover, and understory vegetation. This helps determine habitat quality for wildlife and identifies rare or plant species that need protection.

3.1.7 Spatial and data analyses

Geospatial analysis using GIS enabled mapping biodiversity hotspots, vegetation cover, and habitat connectivity. Data from camera traps, transects, and community input were combined to create spatial models showing species distribution (the geodatabase is presented in **Appendix 1**). More details about the data analysis are presented in **Chapter 3**.

3.2 TEAM COMPOSITION

The field validation team comprises highly skilled experts from key biodiversity stakeholders in Liberia. The IIU, through the MPW, has identified five key organizations, each providing two experts. The team composition includes:

- Botanists: For plant biodiversity assessment.
- Primatologists: Specialized in chimpanzee behavior and conservation.
- Large Mammal Experts: Focused on elephants, hippos, and other large mammals.
- Herpetologists: For reptile and amphibian biodiversity.
- GIS Specialists: For mapping and spatial analysis.

The team will include experts from frontline conservation organizations such as Fauna & Flora (FF), The Society for the Conservation of Nature in Liberia (SCNL), Wild Chimpanzee Foundation (WCF), Solimar International (SI), and while the Forestry Development Authority (FDA) responsible for wildlife in Liberia playing regulatory and observatory roles in collaboration with the IIU; notwithstanding, specialists will be responsible to play specific role. These specialists will be responsible for different aspects of biodiversity assessment, including botany, primatology, mammalogy, and GIS analysis. The overall responsibility of the document will be led by the Society for the Conservation of Nature in Liberia (SCNL).

Table 1. Technicians list and affiliating organization of the stirring committee

Category	Name	Affiliation	Role
Leadership	Jerry C. Garteh	Solimar International	General Team Lead
	Zoro Berenger	WCF	General Co-chair
	Webster Zieglar	FF	Specific Team Leader
Botanists	Armandu K. Daniels	Solimar International	Member
	Peter King	SCNL	Member
	Francis Korshe Cooper	FF	Specific Team Leader
	Emmanuel M. Loquah	SCNL	Member
	Zoro Berenger	WCF	Member
Primatologists	Anita Grant	WCF	Member
	Grace Kotee Zansi	Solimar	Member
	Deemie	SCNL	Member
Mammologists	Dickarmien A. Deemie	Solimar	Specific Team Leader

	Jerry Garteh	SCNL	Member
	Sam N. Newton	WCF	Member
GIS	Zoro Berenger	WCF	Team Leader
FDA	1 person	FDA	Member

4 BIODIVERSITY ASSESSMENT

4.1 LANDSCAPE ASSESSMENT

4.1.1 Integrated Biodiversity Assessment Tool

Based on the IBAT assessment, no Key Biodiversity Areas (KBAs)protected areas (PAs), nor Alliance for Zero Extinction (AZE) areas are within 1km of the area of influence of the project (**Figure 13**, **Figure 14**, **Figure 15**, **Figure 16**). Similarly, there are 18 potential species under threat based on the IBAT analysis withing a 50km buffer (**Figure 15**).

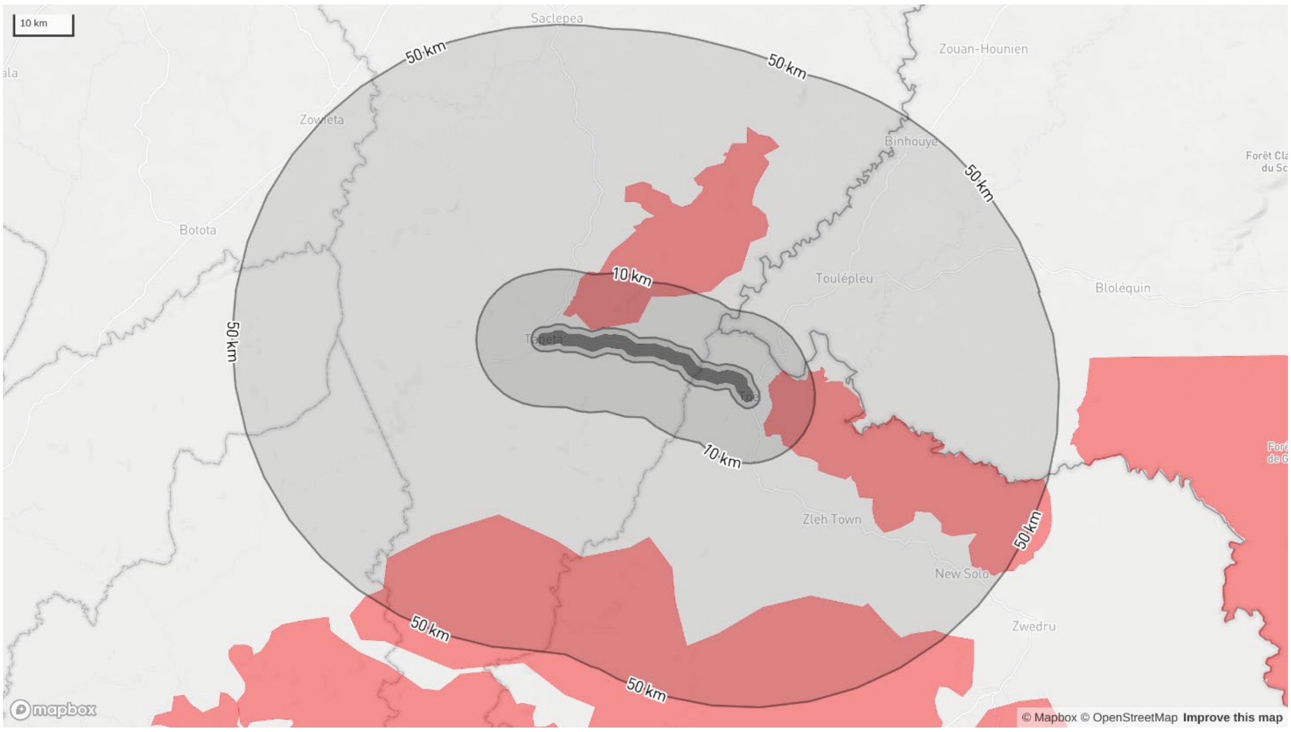

Figure 12. Key Biodiversity Areas (KBAs) in the area of influence of RETRAP project (IBAT, 2025)

There are no protected areas or internationally designated sites within the direct footprint or proximate zone (encompassing 1km around the corridor). Within 10 km of the road corridor there are two KBAs - the Gio National Forest and Zwedru Forest.

Gio National Forest KBA: The Gio National Forest was established in 1960 and covers an area of about 32,930 ha. It was designated a KBA in 2015 based on the presence of the Critically endangered West Chimpanzee and a range of threatened tree species. The Southern section of this forest may now be designated a Community Forest (CF)-for the Gblor Community. It is a hilly area and due to logging operations over the past decades, much of the original primary forest has been lost, although pockets remain in the more inaccessible areas. The remaining area would be described as mature secondary forests which is further degraded by farming activities and the presence of permanent villages. It is intersected by the Cestos River, the Boyee Creek and Sou Creek. The area south of Sou Creek is dominated by Raphia swamps. Fauna and Flora International (2012) undertook rapid biodiversity assessments of five forests in Liberia, which have been selected by the USAID PROSPER project for the development of community forestry. It stated that in addition to Western Chimpanzee, the Zebra Duiker Cephalophus zebra (VU), White-breasted Guineafowl Agelastes meleagrides (VU), African Dwarf Crocodile Osteolaemus tetraspis (VU), African Golden Cat Caracal aurata, White-bellied Pangolin Phataginus tricuspis (VU) and all six hornbill species were recorded in the Gio Forest. According to this report, the extremely rate and critically endangered Slender-snouted Crocodile Mecistops cataphractus was also present. Species such as the Diana Monkey Cercopithecus diana (EN), Pygmy Hippopotamus Choeropsis liberiensis (EN), and Western Red Colobus Piliocolobus badius (EN) had not been recently recorded, although thought to have been present in the past.

Zwedru forest KBA: The Zwedru Forest KBA and proposed protected area lies less than 10 km to the east of Toe Town, in Grand Gedeh County. This site was reassessed in 2018. The Cavalla River runs along the northern border of the forest, which also forms the border with Cote d'Ivoire. It is located west of the Cavally and Goin-Débé Forest Reserves KBA in Côte d'Ivoire. The site is subject to numerous threats including slash and burn agricultural activities and now includes fragmented forest blocks that are largely evergreen with some semi-deciduous elements. It was designated on the basis on the presence of a very diverse range species of birds, threatened mammals and trees. Species include the Western Chimpanzee, pygmy hippopotamus, White-breasted Guineafowl, the Timneh Parrot Psittacus timneh (EN), Gola Malimbe Malimbus ballmanni (NT), African Forest Elephant, Black and White Colobus, Colobus polykomos (EN), Western Red Colobus, Diana Monkey and several species of duikers including the Zebra Duiker. However, the recent expansion of the cocoa and pineapple farms has led to an increase in deforestation of the woody part of the Zwedru PPA with a loss of around 6.55 km² of forest between 2016 and 2020 (Burch 2021).

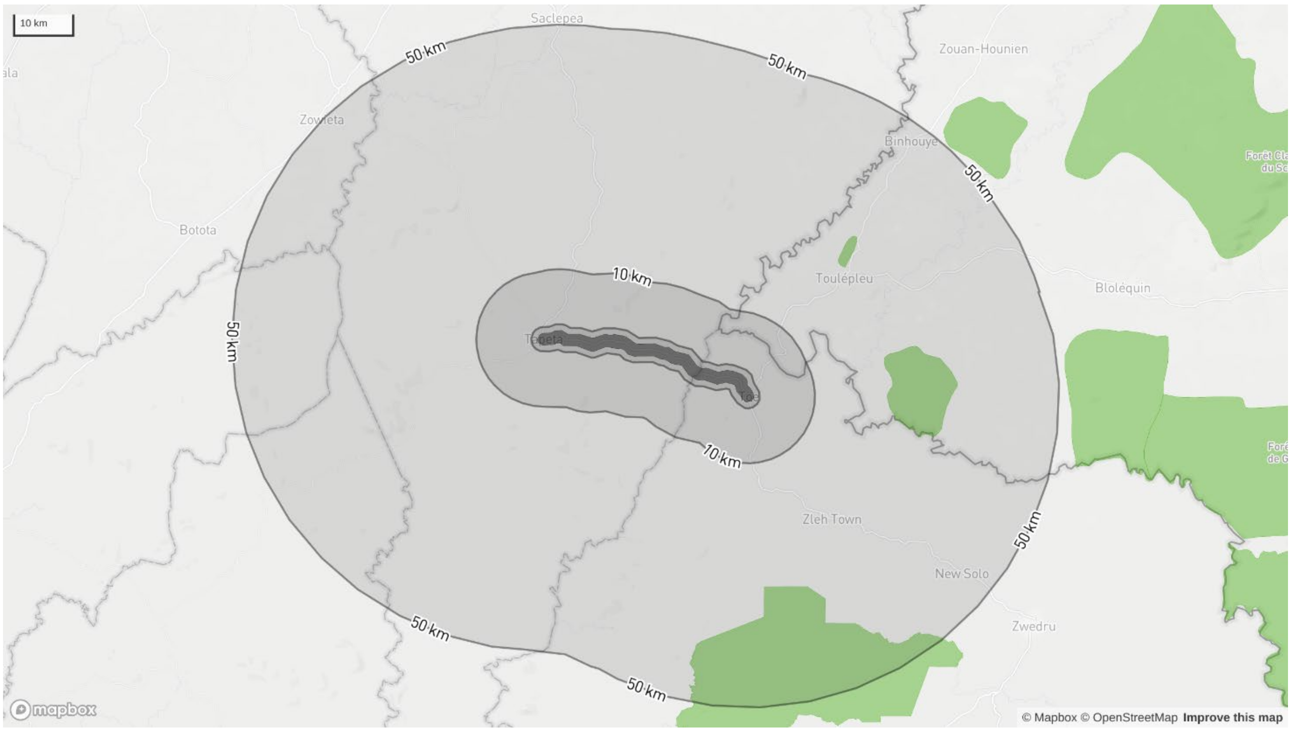

Figure 13. Protected areas in the area of influence of RETRAP project (IBAT, 2025)

Protected Areas	1 km: 0	10 km: 0	50 km: 3	3
World Heritage (WH)	1 km: 0	10 km: 0	50 km: 0	0
Key Biodiversity Areas	1 km: 0	10 km: 2	50 km: 1	3
Alliance for Zero Extinction (AZE)	1 km: 0	10 km: 0	50 km: 0	0
IUCN Red List				18
Critical Habitat				Likely

Figure 14. Summary results from the IBAT analysis of RETRAP project

Habitat of significant importance to priority species will trigger Critical Habitat status (See PS6: para 16). IBAT provides a preliminary list of priority species that could occur within the 50km buffer. This list is drawn from the IUCN Red List of Threatened Species (IUCN RL). This list should be used to guide any further assessment, with the aim of confirming know nor likely occurrence of these species within the project area. It is also possible that further assessment may confirm occurrence of additional priority species not listed here. It is strongly encouraged that any new species information collected by the project be shared with species experts and/or IUCN wherever possible in order to improve IUCN datasets. The following table shows the species under threat (Critically Endangered-CR, endangered-EN and vulnerable-VU, potentially found within 50km of the project area.

Table 2. IUCN species assessment within 50km of the project's area of influence

Class	Scientific name	IUCN	Trend	Movement	Restricted range	BFS* (2025)
REPTILIA	*Mecistops cataphractus*	CR	Decreasing	Not a Migrant	FALSE	
REPTILIA	*Kinixys homeana*	CR	Decreasing	FALSE		
MAGNOLIOPSIDA	*Vepris laurifolia*	CR	Decreasing		FALSE	
MAMMALIA	*Loxodonta cyclotis*	CR	Decreasing	Not a Migrant	FALSE	
MAMMALIA	*Cephalophus jentinki*	EN	Decreasing		FALSE	X
MAMMALIA	*Cercopithecus diana*	EN	Decreasing	Not a Migrant	FALSE	
MAMMALIA	*Colobus polykomos*	EN	Decreasing	Not a Migrant	FALSE	
MAMMALIA	*Choeropsis liberiensis*	EN	Decreasing	Not a Migrant	FALSE	
MAMMALIA	*Smutsia gigantea*	EN	Decreasing	Not a Migrant	FALSE	
MAMMALIA	*Phataginus tricuspis*	EN	Decreasing	Not a Migrant	FALSE	X
MAMMALIA	*Pan troglodytes*	EN	Decreasing	Not a Migrant	FALSE	
MAMMALIA	*Piliocolobus badius ssp. badius*	EN	Decreasing	Not a Migrant	FALSE	
MAMMALIA	*Cercopithecus nictitans ssp. stampflii*	EN	Decreasing		FALSE	
INSECTA	*Mesocnemis tisi*	EN	Unknown	FALSE		
AVES	*Psittacus timneh*	EN	Decreasing	Not a Migrant	FALSE	
MAGNOLIOPSIDA	*Okoubaka aubrevillei*	EN	Decreasing		FALSE	
MAGNOLIOPSIDA	*Croton dispar*	EN	Unknown		FALSE	
MAMMALIA	*Piliocolobus badius*	EN	Decreasing	Not a Migrant	FALSE	
MAMMALIA	*Cephalophus zebra*	VU	Decreasing		FALSE	
REPTILIA	*Cyclanorbis senegalensis*	VU	Decreasing	Unknown	FALSE	
MAMMALIA	*Hipposideros marisae*	VU	Decreasing		FALSE	
MAMMALIA	*Liberiictis kuhni*	VU	Decreasing		FALSE	
MAMMALIA	*Phataginus tetradactyla*	VU	Decreasing		FALSE	
REPTILIA	*Osteolaemus tetraspis*	VU			FALSE	
MAMMALIA	*Panthera pardus*	VU	Decreasing		FALSE	

MAMMALIA	*Procolobus verus*	VU	Decreasing	Not a Migrant	FALSE	
MAMMALIA	*Caracal aurata*	VU	Decreasing	Not a Migrant	FALSE	
MAGNOLIOPSIDA	*Milicia regia*	VU	Decreasing		FALSE	
MAGNOLIOPSIDA	*Neolemonniera clitandrifolia*	VU	Decreasing		FALSE	
MAMMALIA	*Poiana leightoni*	VU	Decreasing		FALSE	
REPTILIA	*Trionyx triunguis*	VU	Decreasing	Unknown	FALSE	
MAMMALIA	*Genetta bourloni*	VU	Decreasing		FALSE	
MAMMALIA	*Cercocebus atys*	VU	Decreasing	Not a Migrant	FALSE	
REPTILIA	*Bitis nasicornis*	VU	Decreasing	Not a Migrant	FALSE	
AVES	*Bycanistes cylindricus*	VU	Decreasing	Not a Migrant	FALSE	
AVES	*Ceratogymna elata*	VU	Decreasing	Not a Migrant	FALSE	
AVES	*Bubo shelleyi*	VU	Decreasing	Not a Migrant	FALSE	
AVES	*Scotopelia ussheri*	VU	Decreasing	Not a Migrant	FALSE	
AVES	*Calidris ferruginea*	VU	Decreasing	Full Migrant	FALSE	
AVES	*Pluvialis squatarola*	VU	Decreasing	Full Migrant	FALSE	
AVES	*Lobotos lobatus*	VU	Decreasing	Not a Migrant	FALSE	
AVES	*Picathartes gymnocephalus*	VU	Decreasing	Not a Migrant	FALSE	
AVES	*Melaenornis annamarulae*	VU	Decreasing	Not a Migrant	FALSE	
AVES	*Criniger olivaceus*	VU	Decreasing	Not a Migrant	FALSE	
MAGNOLIOPSIDA	*Psychotria samoritourei*	VU	Decreasing		FALSE	
AVES	*Phyllanthus atripennis*	VU	Decreasing	Not a Migrant	FALSE	
MAGNOLIOPSIDA	*Tricalysia faranahensis*	VU	Decreasing	FALSE		
MAGNOLIOPSIDA	*Memecylon ramosum*	VU	Decreasing		FALSE	
MAGNOLIOPSIDA	*Millettia liberica*	VU	Unknown		FALSE	
MAGNOLIOPSIDA	*Psychotria micheliae*	VU	Unknown		FALSE	

Note: (‘) species found during the biodiversity field survey (BFS) In May 2025

None of the species listed in the table above are restricted range species, and only two are full migrants (this is further analyzed in **Section 4.4**)

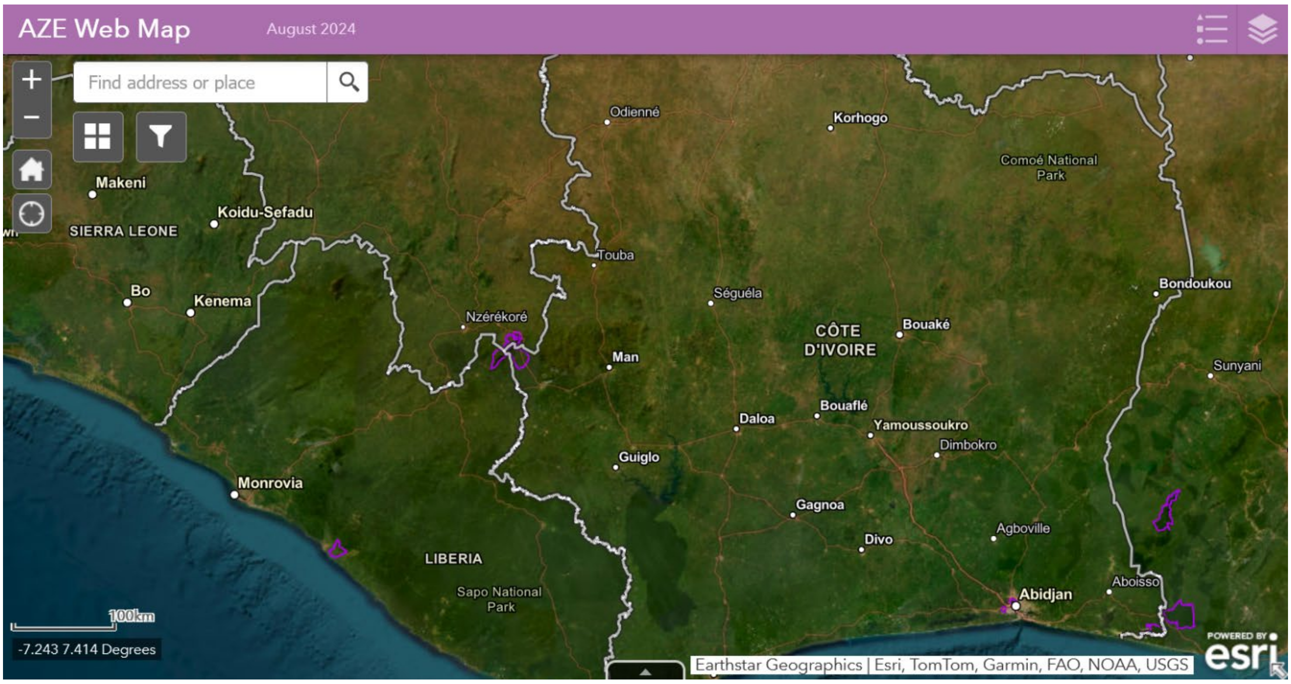

Figure 15. Alliance for Zero Extinction (AZE) areas in Liberia (AZE, 2024)

4.1.2 Habitat Distribution Model Approach

IUCN red list was explored to identify potential species to occur in the project area that are under threat categories (e.g. critically endangered-CR and endangered-EN). After identifying the species under threat, records of their location (occurrence data) were accessed and downloaded from the Global Biodiversity Information Facility (GBIF). Relevant environmental layers were also accessed and downloaded including bioclimatic variables (Fick & Hijmans, 2017; Karger et al., 2017), soil variables (Hengl et al., 2015, 2017), digital elevation models (Earth Resources Observation And Science (EROS) Center, 2017). Both occurrence and environmental data (bioclimatic variables) were used to model the distribution of all species with occurrence data with MaxEnt algorithm. **Figure 17** depicts a preliminary methodological framework for modelling the distribution of species within the study area.

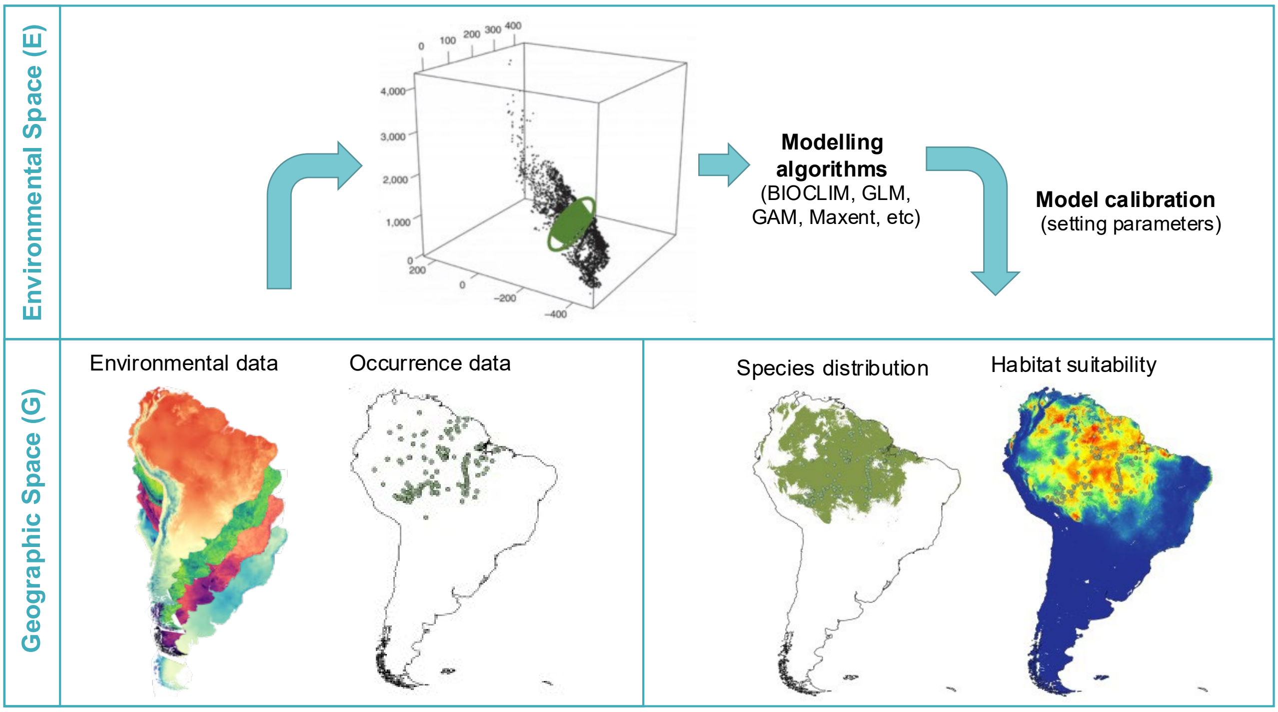

Figure 16. Example of methodological framework for modelling the distribution of species.

Table 3. Description of bioclimatic variables

Layer	Description
BIO01	Annual Mean Temperature
BIO02	Mean Diurnal Range (Mean of monthly (max temp - min temp))
BIO03	Isothermality (BIO2/BIO7) (×100)
BIO04	Temperature Seasonality (standard deviation ×100)
BIO05	Max Temperature of Warmest Month
BIO06	Min Temperature of Coldest Month
BIO07	Temperature Annual Range (BIO5-BIO6)
BIO08	Mean Temperature of Wettest Quarter
BIO09	Mean Temperature of Driest Quarter
BIO10	Mean Temperature of Warmest Quarter
BIO11	Mean Temperature of Coldest Quarter
BIO12	Annual Precipitation
BIO13	Precipitation of Wettest Month
BIO14	Precipitation of Driest Month
BIO15	Precipitation Seasonality (Coefficient of Variation)
BIO16	Precipitation of Wettest Quarter
BIO17	Precipitation of Driest Quarter
BIO18	Precipitation of Warmest Quarter
BIO19	Precipitation of Coldest Quarter

Bioclimatic variables were used as the main environmental layers to model the distribution of species in the project area. **Table 3** shows some the bioclimatic variables that will be used in the modelling process.

Species distribution models (SDM) characterize the environmental conditions that are suitable for a species and then identify where those suitable environmental conditions are distributed geographically (Guisan & Zimmermann, 2000; Guisan & Thuiller, 2005; Franklin, 2010; Peterson et al., 2011; Guisan et al., 2017). SDMs are used to deliver predictive maps of the species distributions, meaning predicting the likelihood of finding a species even in areas where field data are still unavailable (Franklin, 2010). SDMs have been widely used for different practical applications such as reserve design and conservation planning (Boitani et al., 2008; Rodríguez-Soto et al., 2011; Franklin, 2013; Guisan et al., 2013; Freeman et al., 2019), natural resources management (Chaves et al., 2018), invasive species assessments (Barbet-Massin et al., 2018; Chapman et al., 2019), as well as environmental impact assessments (Franklin, 2010).

Maxent algorithm (Phillips et al., 2017) was used as the main approach for modelling the distribution of species in the study area. MaxEnt is a machine learning algorithm that combines Bayesian methods, maximum entropy theory and statistical methods to model the distribution of species based of the presence of individuals and environmental background data. Maxent allows estimating the probability of presence of certain species through a linkage function between the probability density of the variables obtained from the presence records and the environment data. Maxent has performed equally well or better than other modelling algorithms (Elith* et al., 2006; Hernandez et al., 2006; Phillips et al., 2006; Wisz et al., 2008; Merckx et al., 2011), deriving consistent predictions (Giovanelli et al., 2010) and being less sensitive to parametrization (Hallgren et al., 2019).

4.1.2.1 Chimpanzee

The occurrence records were accessed and downloaded from the latest modelling approach done in Liberia (Frazier et al., 2021), which were collected in Liberia between January 2011 and May 2012 through line transect surveys. The modelling approached followed the framework described above.

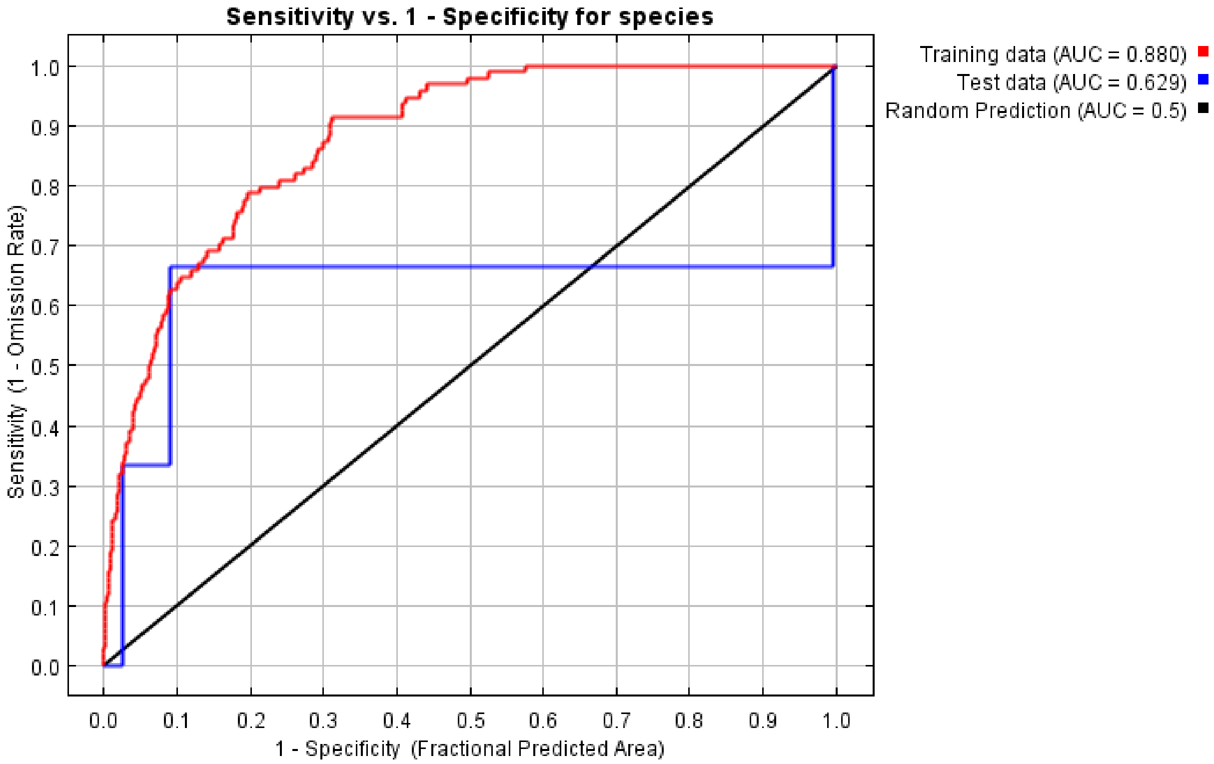

Figure 17. Evaluation results of the climatic habitat suitability of the Chimpanzees in Liberia (FinnOC, 2025)

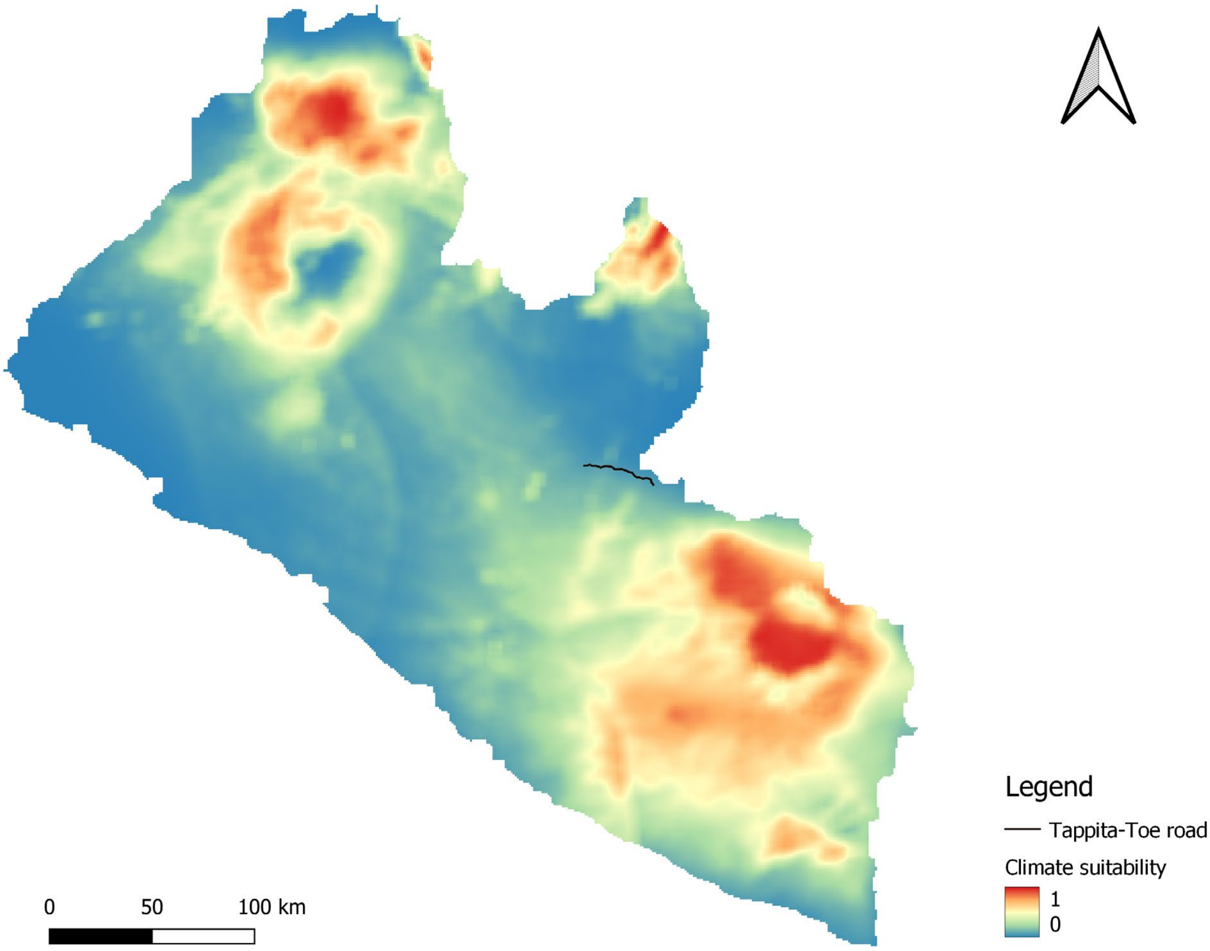

Figure 18. Predicted climatic suitability of Chimpanzees in Liberia (FinnOC, 2025)

The model outputs showed acceptable evaluation results (AUC > 0.8) as seen in **Figure 18**. **Figure 19**, shows locations where there is high climatic suitability of chimpanzee population in red colors, and low suitability areas in blue. This map shows that the project study area is located in a rather low suitability location for hosting Chimpanzee populations (the project road is marked in black in the figure).

4.1.2.2 Timneh Parrot

The occurrence records were accessed and downloaded from the Global Biodiversity Information Facility (GBIF) done in Liberia. The modelling approached followed the framework described above.

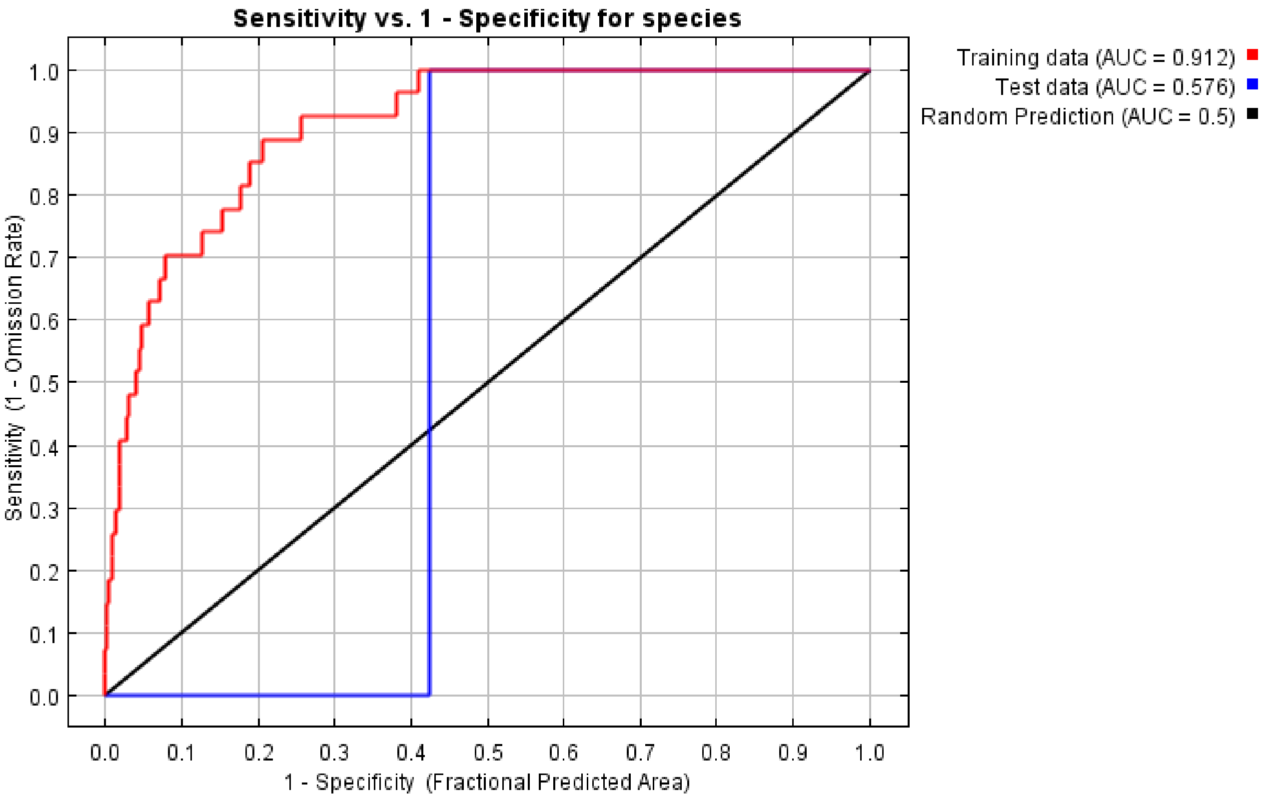

Figure 19. Evaluation results of the climatic habitat suitability of the Timnhed parrot in Liberia (FinnOC, 2025)

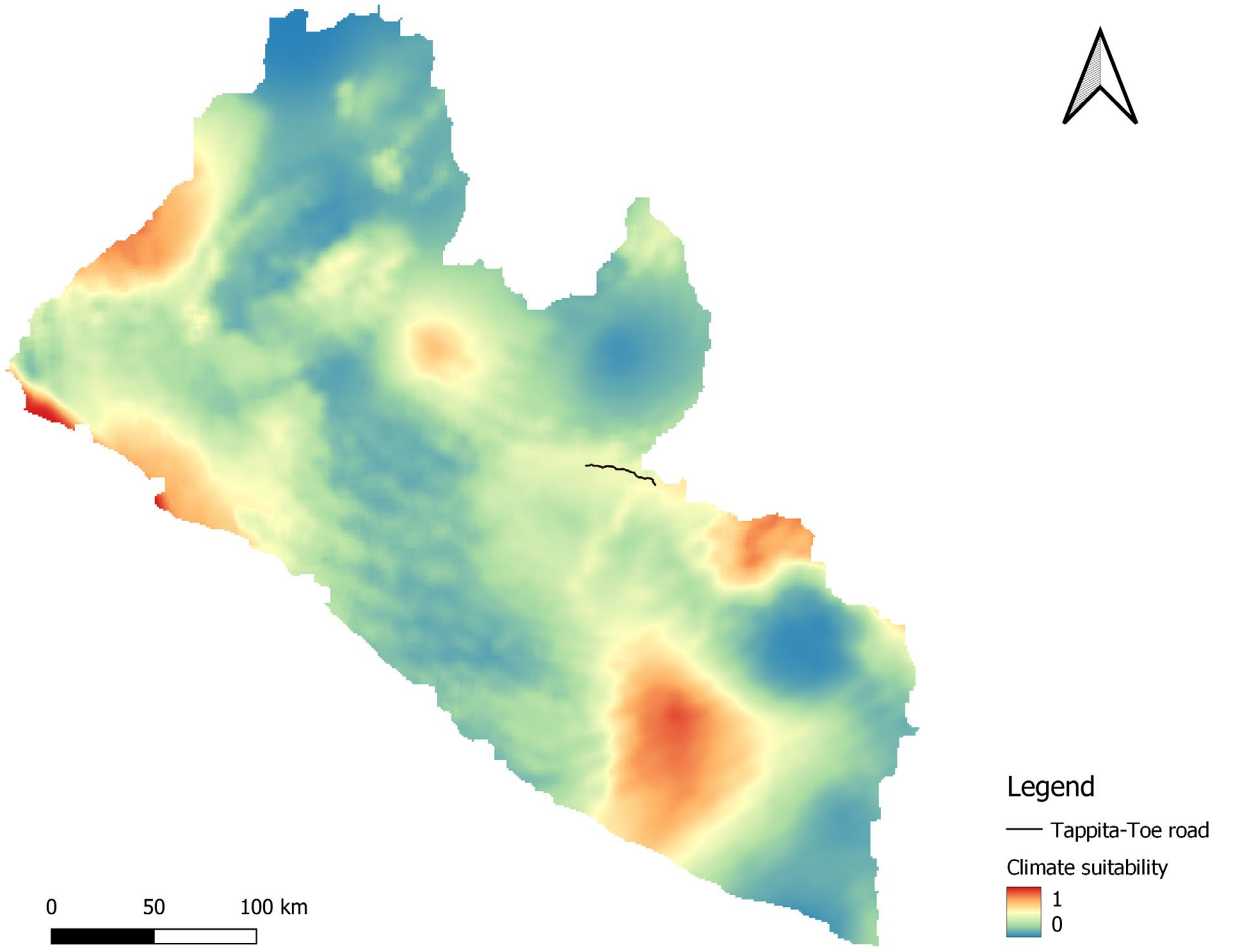

Figure 20. Predicted climatic suitability of Timnhed parrot in Liberia (FinnOC, 2025)

The model outputs showed acceptable evaluation results (AUC > 0.8) as seen in **Figure 20**. **Figure 21** shows locations where there is high climatic suitability of timnhed parrot population in red colors, and low suitability areas in blue. This map shows that the project study area is located in a rather low suitability location for hosting timnhed parrot populations (the project road is marked in black in the figure).

4.1.2.3 African Forest Elephant

The occurrence records were accessed and downloaded from the Global Biodiversity Information Facility (GBIF) done in Liberia. The modelling approached followed the framework described above.

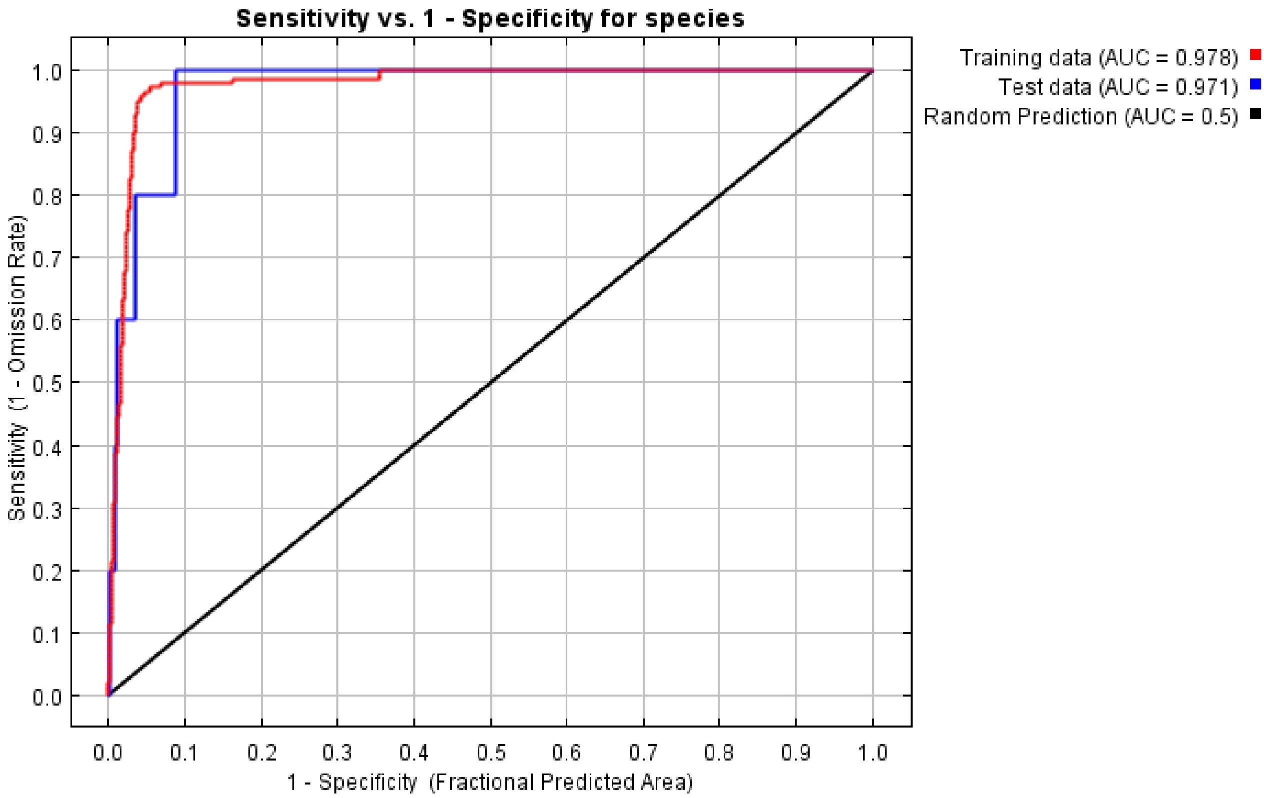

Figure 21. Evaluation results of the climatic habitat suitability of the African Forest Elephant in Liberia (FinnOC, 2025)

The model outputs showed acceptable evaluation results (AUC > 0.8) as seen in **Figure 20Figure 21** shows locations where there is high climatic suitability of the African Forest Elephant population in red colors, and low suitability areas in blue. This map shows that the project study area is located in a rather low suitability location for hosting African Forest Elephant populations (the project road is marked in black in the figure).

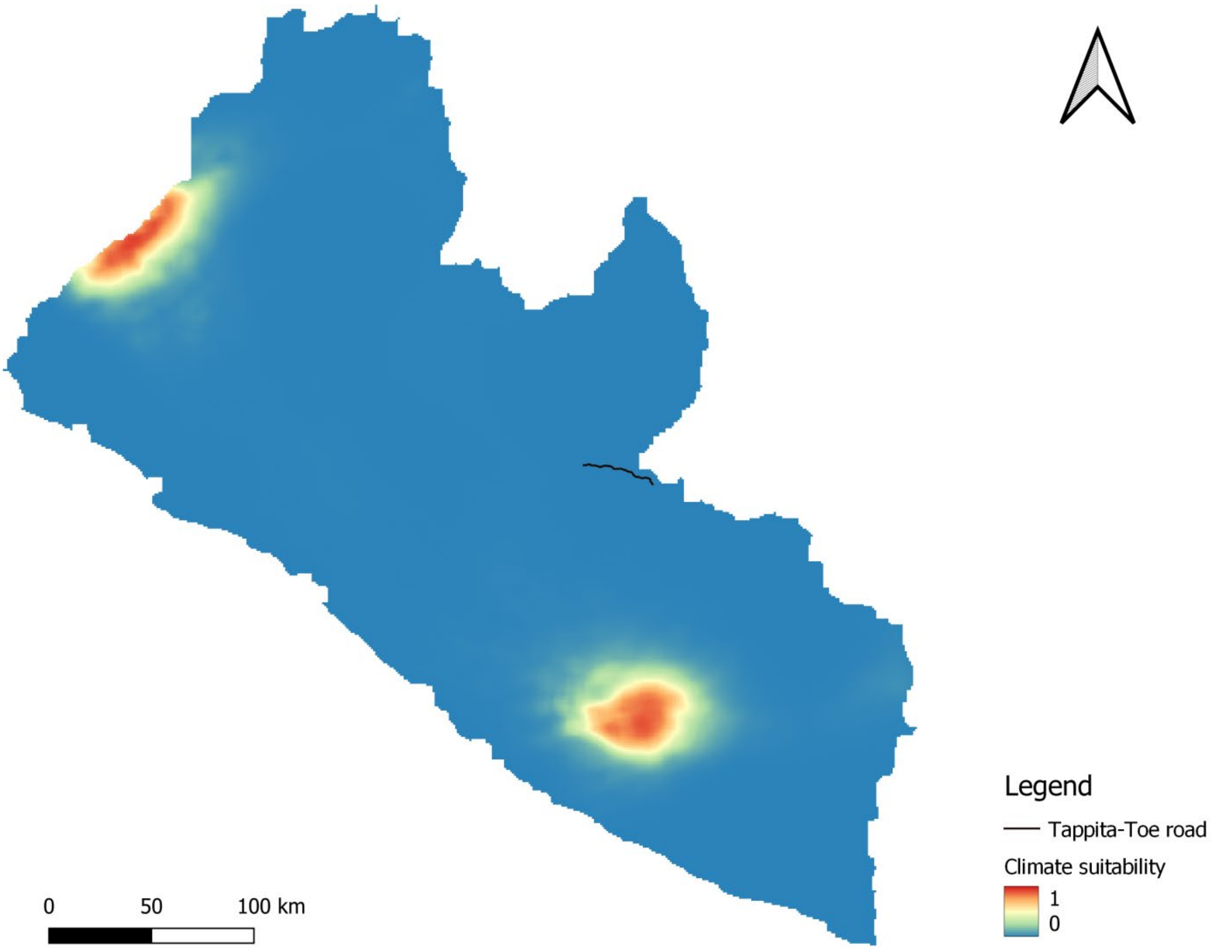

Figure 22. Predicted climatic suitability of the African Forest Elephant in Liberia (FinnOC, 2025)

4.1.2.4 Pygmy Hippopotamus

The occurrence records were accessed and downloaded from the Global Biodiversity Information Facility (GBIF) done in Liberia. The modelling approached followed the framework described above.

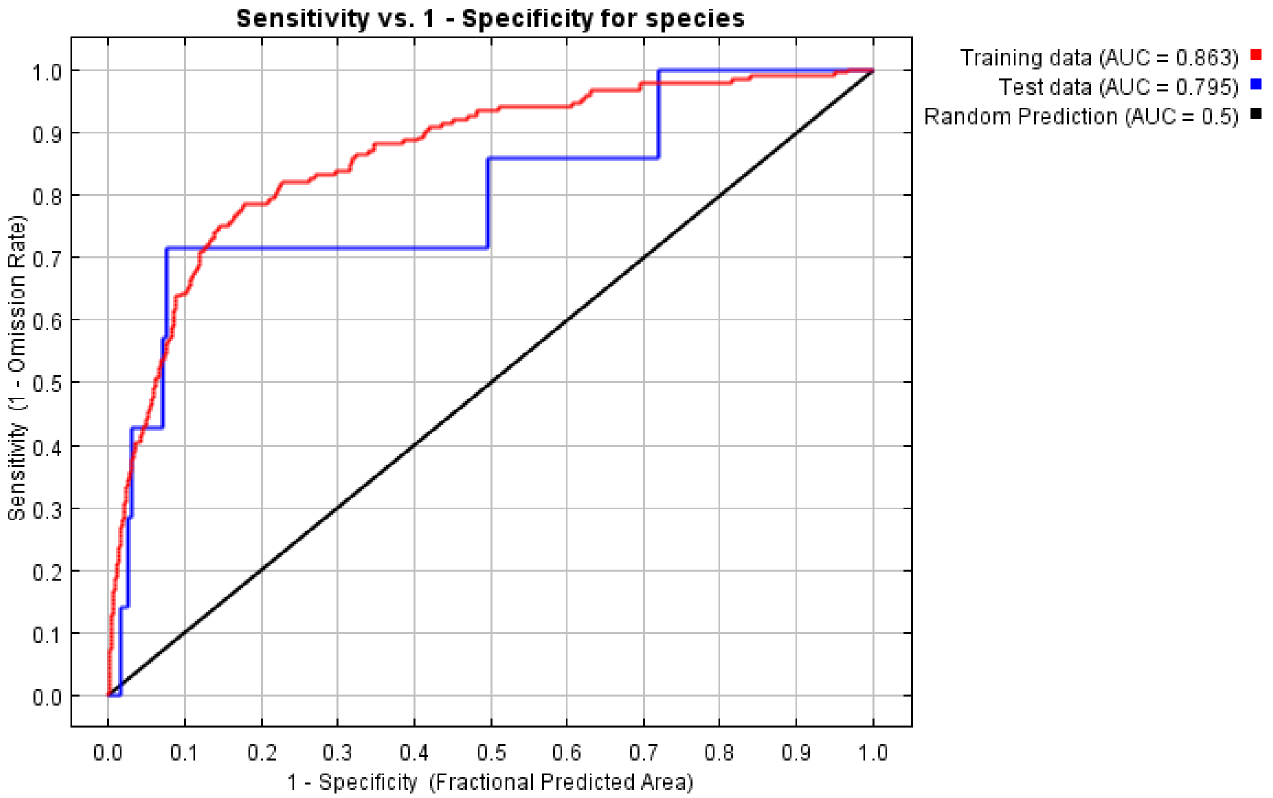

Figure 23. Evaluation results of the climatic habitat suitability of the Pygmy Hippopotamus in Liberia (FinnOC, 2025)

The model outputs showed acceptable evaluation results (AUC > 0.8) as seen in **Figure 24**. **Figure 25** shows locations where there is high climatic suitability of the Pygmy Hippopotamus population in red colors, and low suitability areas in blue. This map shows that the project area is located in a rather low suitability area for hosting Pygmy Hippopotamus populations (the project road is marked in black in the figure).

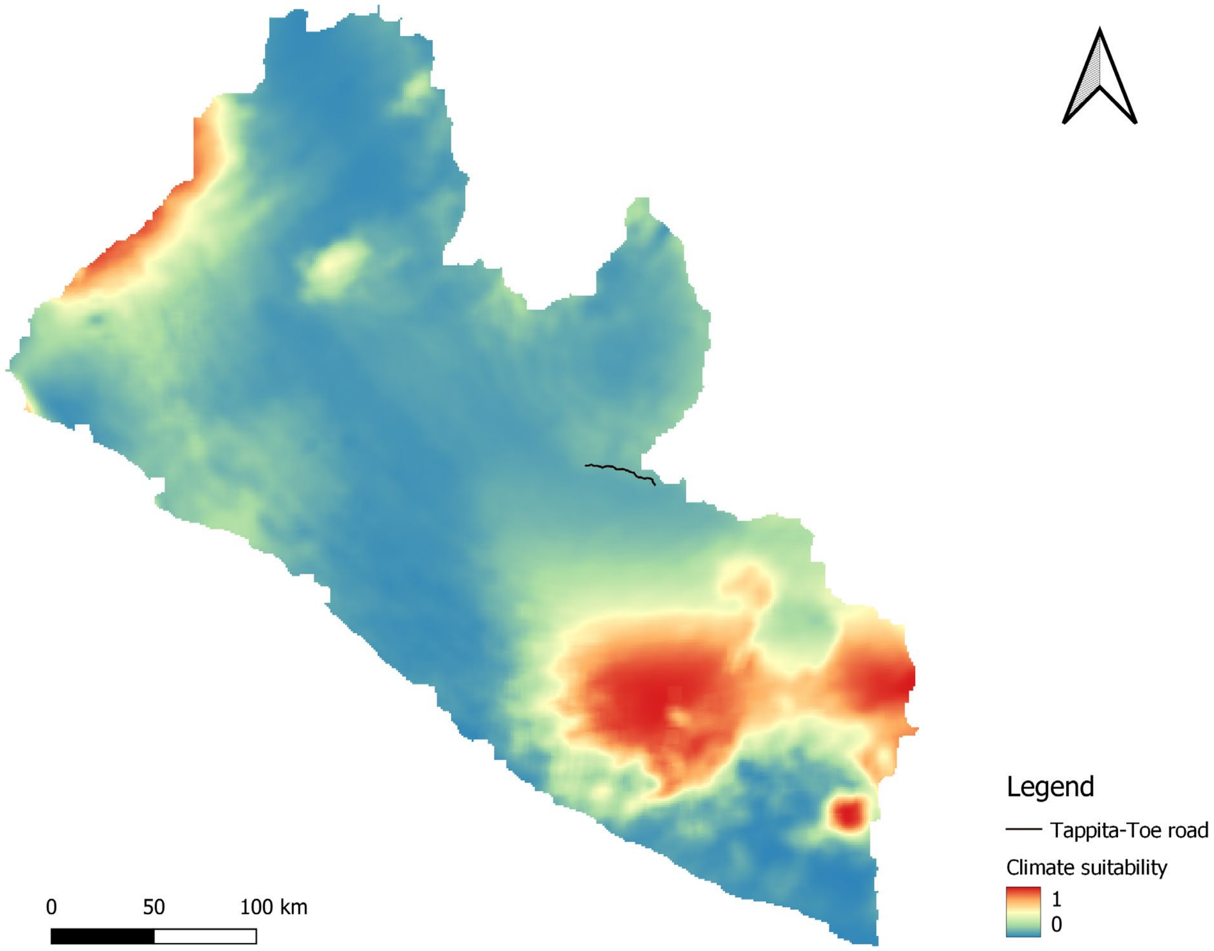

Figure 24. Predicted climatic suitability of the Pygmy Hippopotamus in Liberia (FinnOC, 2025)

4.1.2.5 Giant pangolin

The occurrence records were accessed and downloaded from the Global Biodiversity Information Facility (GBIF) done in Liberia. The modelling approached followed the framework described above.

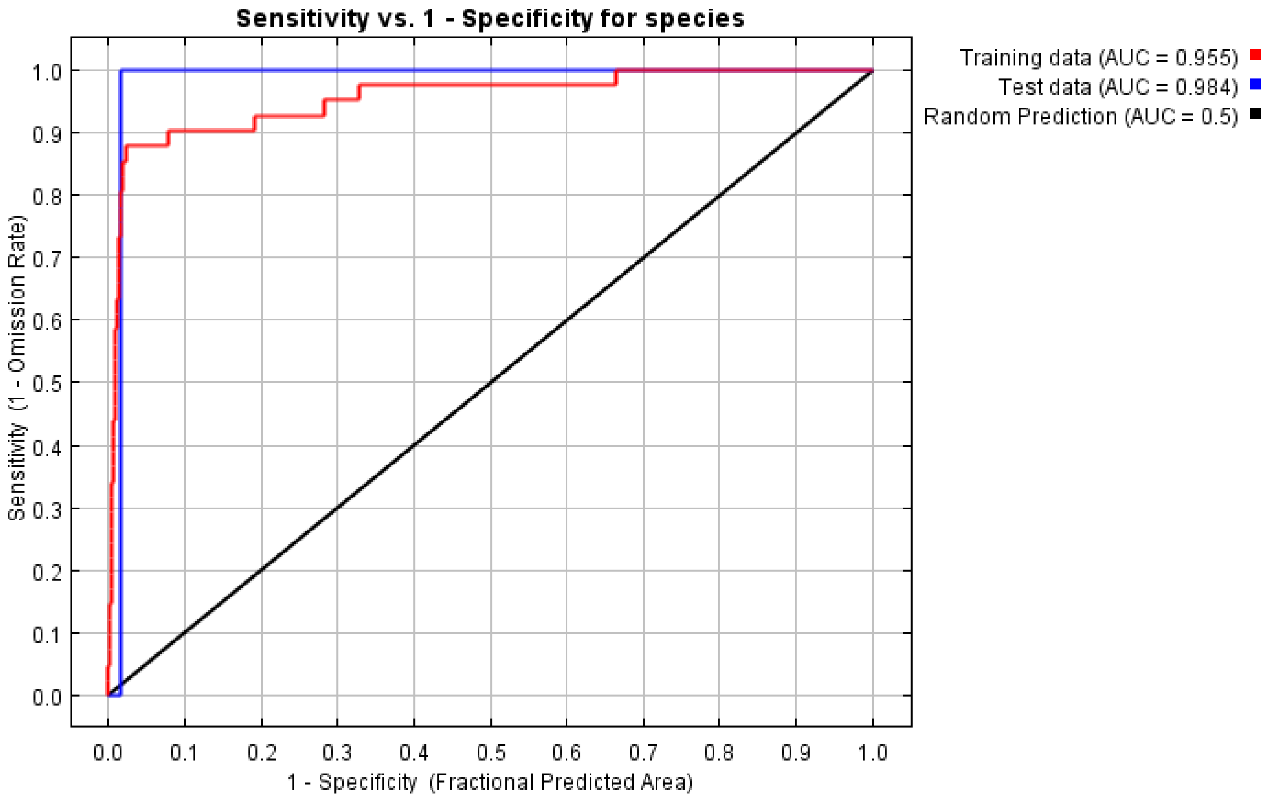

Figure 25. Evaluation results of the climatic habitat suitability of the Giant pangolin in Liberia (FinnOC, 2025)

The model outputs showed acceptable evaluation results (AUC > 0.8) as seen in **Figure 26**. **Figure 27** shows locations where there is high climatic suitability of the Giant pangolin population in red colors, and low suitability areas in blue. This map shows that the project study area is located in a rather low suitability area for hosting Giant pangolin populations (the project road is marked in black in the figure).

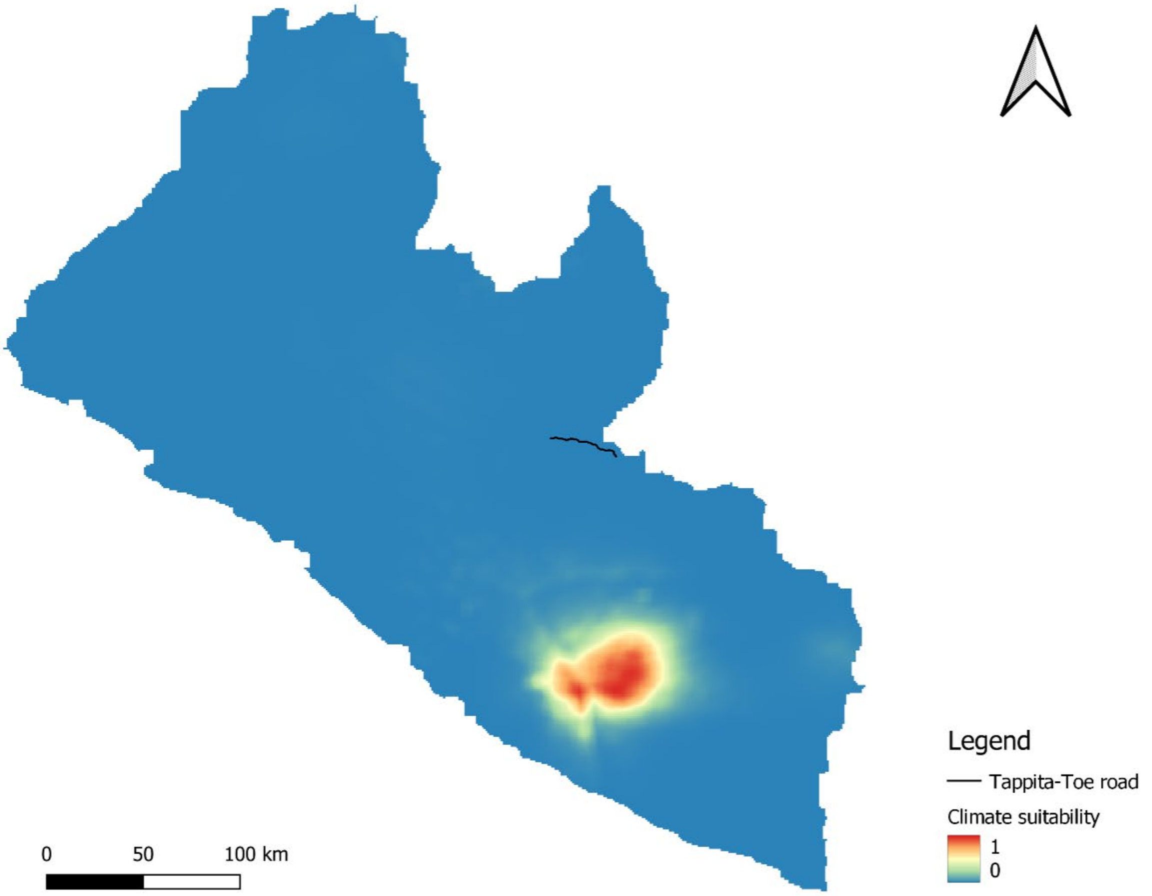

Figure 26. Predicted climatic suitability of the Giant pangolin in Liberia (FinnOC, 2025)

4.1.2.6 White-bellied pangolin

The occurrence records were accessed and downloaded from the Global Biodiversity Information Facility (GBIF) done in Liberia. The modelling approached followed the framework described above.

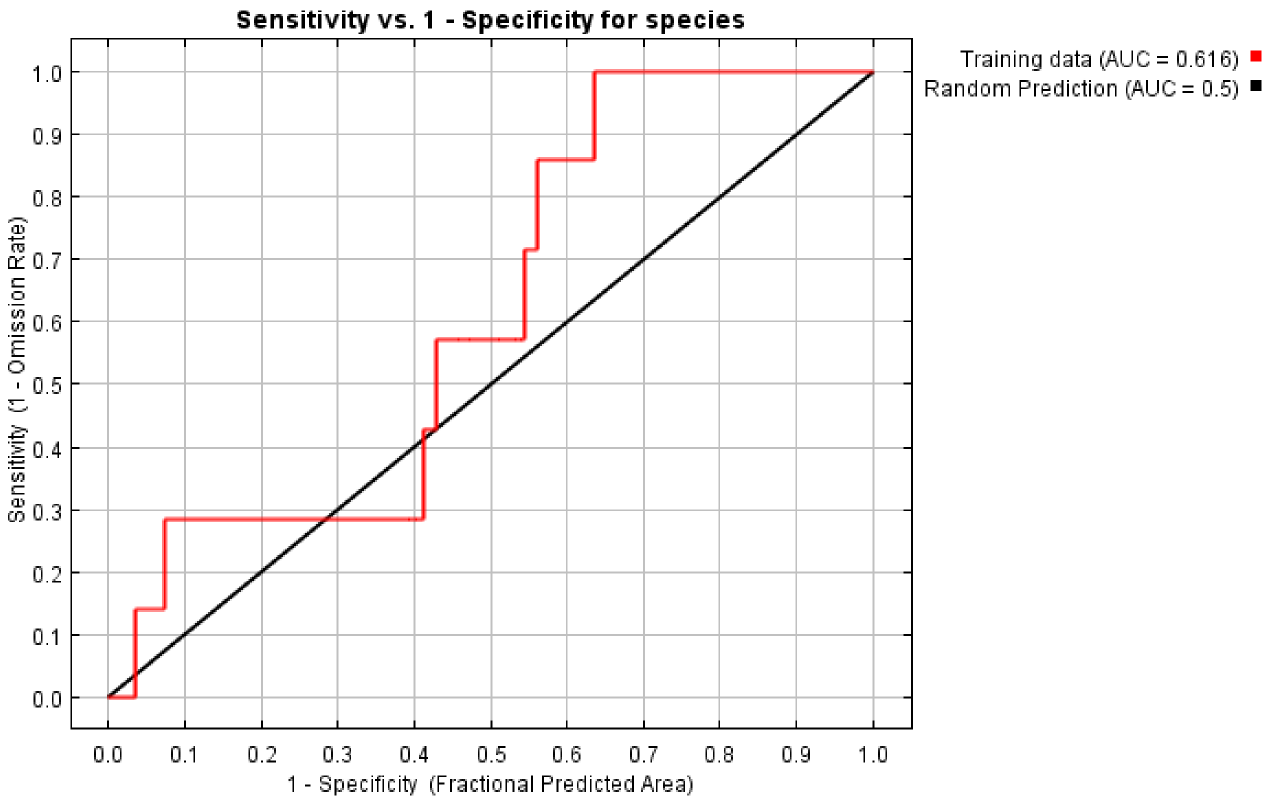

Figure 27. Evaluation results of the climatic habitat suitability of the White-bellied pangolin in Liberia (FinnOC, 2025)

The model outputs showed moderate evaluation results (0.6 < AUC < 0.7) as seen in **Figure 28**. **Figure 29** shows locations where there is high climatic suitability of the White-bellied pangolin population in red colors, and low suitability areas in blue. This map shows that the project is located in a moderate suitability area for hosting White-bellied pangolin populations (the project road is marked in black in the figure).

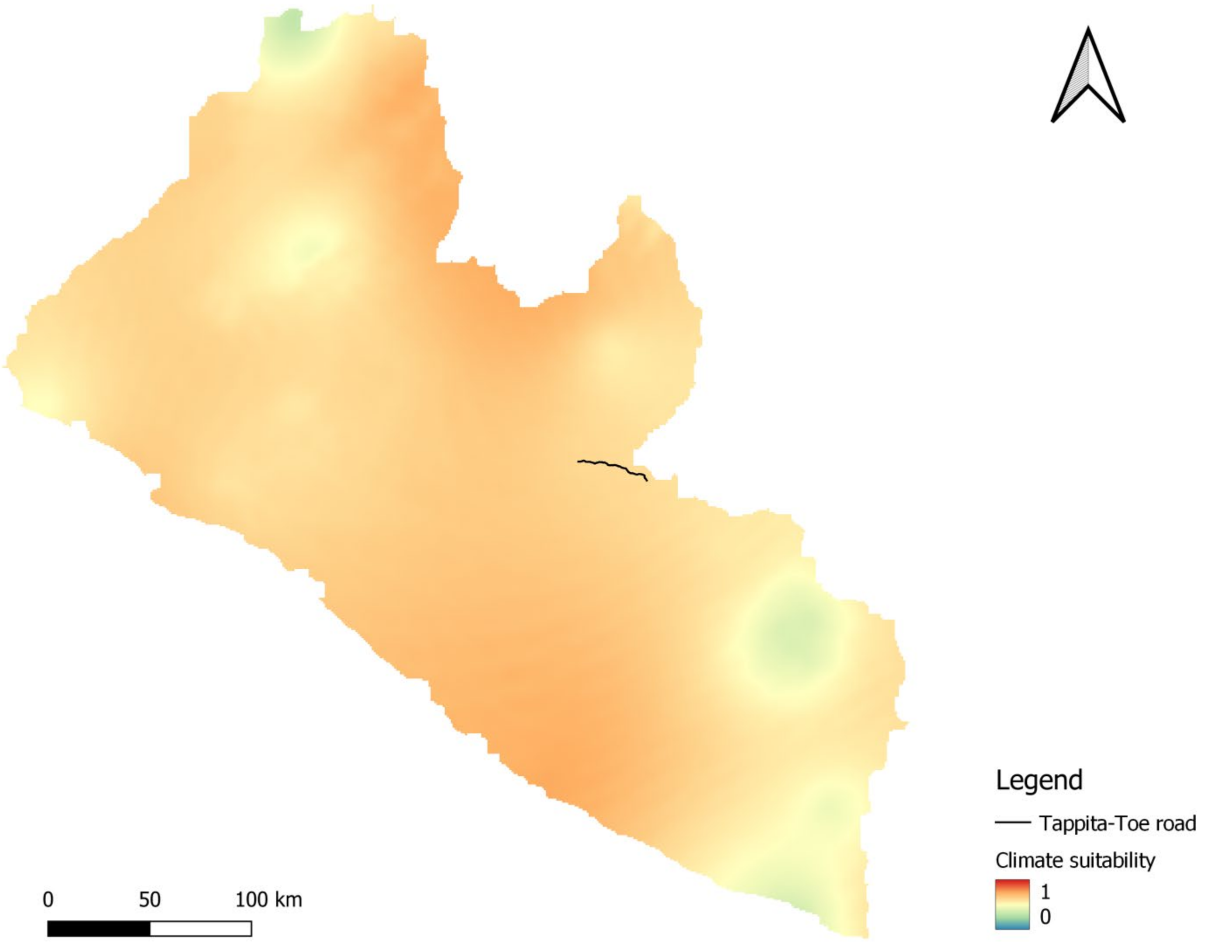

Figure 28. Predicted climatic suitability of the White-bellied pangolin in Liberia (FinnOC, 2025)

4.1.3 Predicted species richness

IUCN red list was explored to identify potential species to occur in the project area that are under threat categories (critically endangered-CR, endangered-EN, vulnerable-VU). After identifying the species under threat after the IBAT analysis (**Section 4.1.1**), records of their location (occurrence data) were accessed and downloaded from the Global Biodiversity Information Facility. All the species listed under **Table 2** were assessed. The same modelling approach described in **Section 4.1.2** was followed for all the remaining species (totaling in total 41 species). All the modelling results are presented in **Appendix 3**.

After modelling the distribution of species under threat in the project area, habitat suitability maps were transformed from numerical or continuous layers (that go because 0-low suitability to 1, high suitability), to binary maps (0, species is absent and 1, species is present). The method "maximum training sensitivity plus specificity threshold" was used for this, since it derives consistent results under different data and methods (Liu et al., 2016). After deriving presence/absence maps for all species, the SDM layers were aggregated and summed as a single layer, depicting the number of threated species (or species richness) with potential to occur in the project area. **Figure 30** shows an example of spatial prediction of the number of threatened species with potential to occur in the project area. In this figure, dark colors depict location with more threatened species whereas yellow colors, areas with a smaller number of threatened species. In this sense, the project road is located in areas with rather low number of threated species in comparison to other locations depicted in dark colors.

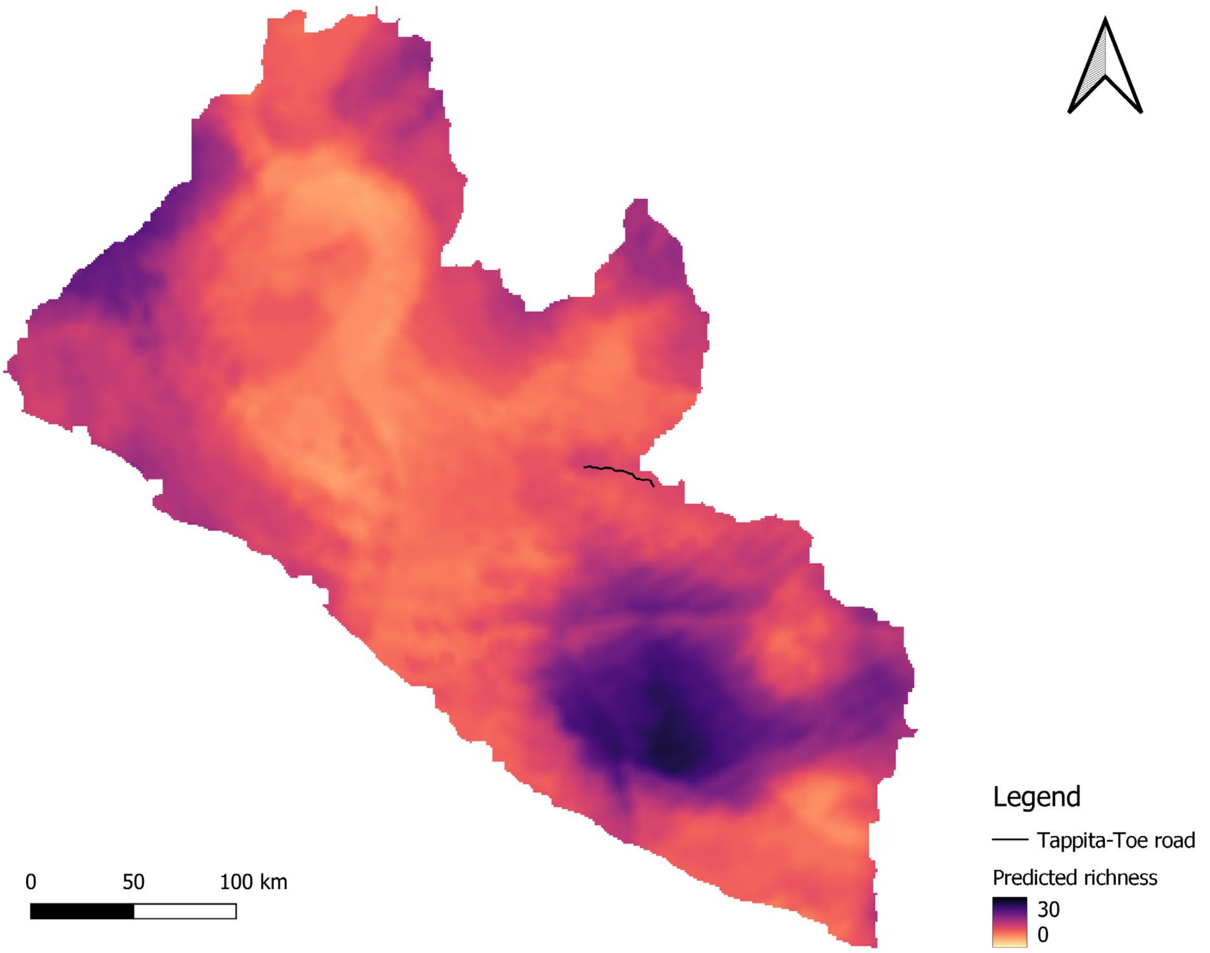

Figure 29. Predicted species richness in the target area in Liberia (FinnOC, 2025)

4.1.4 Existing Species Distribution Models, Connectivity and research for Chimpanzee

Frazier et al (2021) recently modeled the distribution and connectivity of Chimpanzees in Liberia. They modelled western chimpanzee habitat suitability, focusing on determining relevant environmental predictors and the most appropriate scale for modelling species–habitat relationships. Different models were built at six resolutions (30–960 m) to identify scale domains where relationships remain constant. Several habitat variables were included in the approach that have not been included in prior modelling efforts. The suitability maps were then used as the conductance input into a connectivity analysis using circuit-scape.

The results show the habitat suitability of Chimpanzees in the RETRAP study area is low, in agreement to the previous climatic modelling results done. In addition to climatic layers, this assessment also included forest cover and distance to forests as a predictor variable, which showed to be the most important one. This modelling approaches more to the potential distribution of the chimpanzee populations in Liberia. Similarly, the connectivity analysis shows limited conductance of populations near the study area. These results are shows in the figures below.

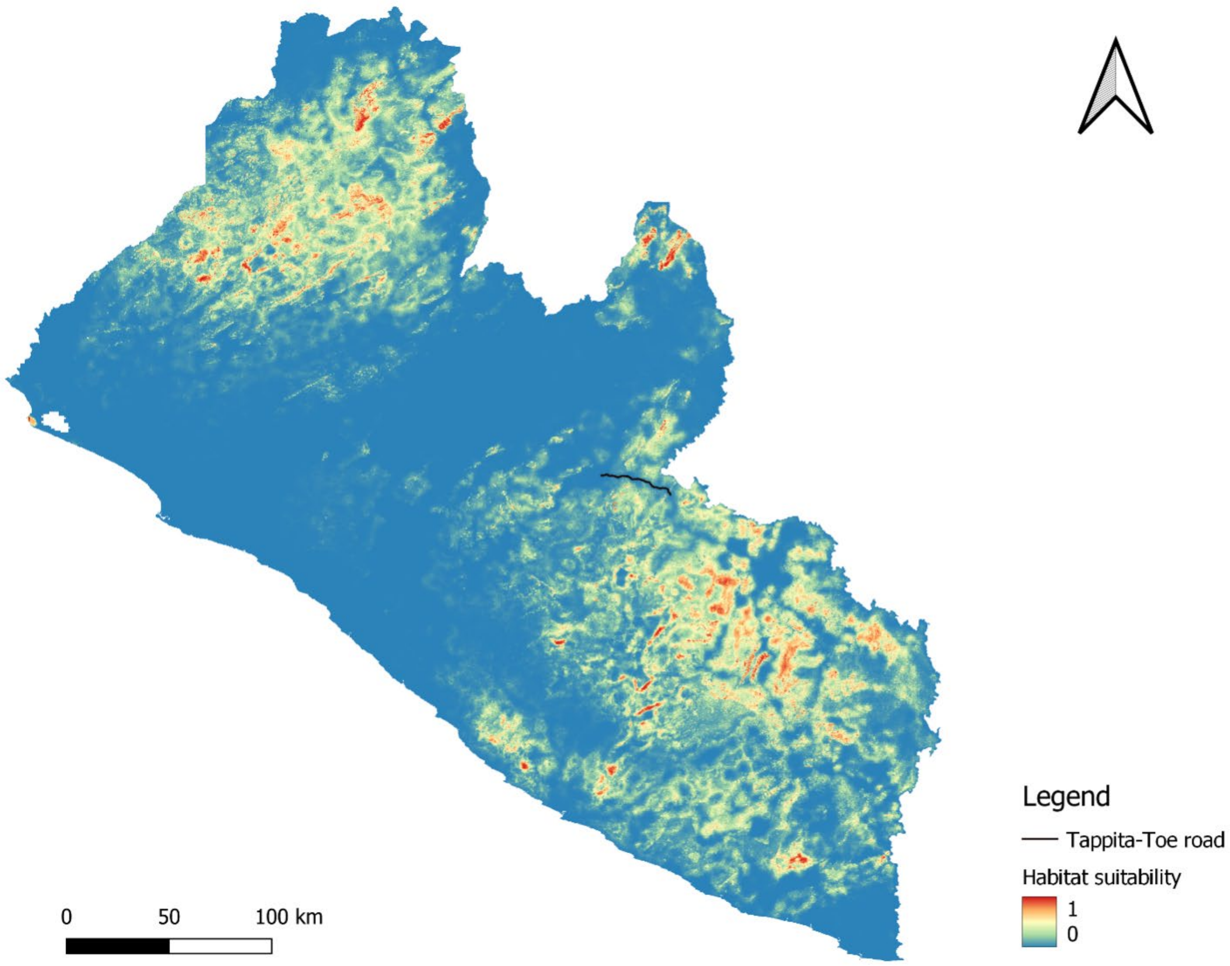

Figure 30. Potential distribution of chimpanzee populations in Liberia (Frazier et al, 2021)

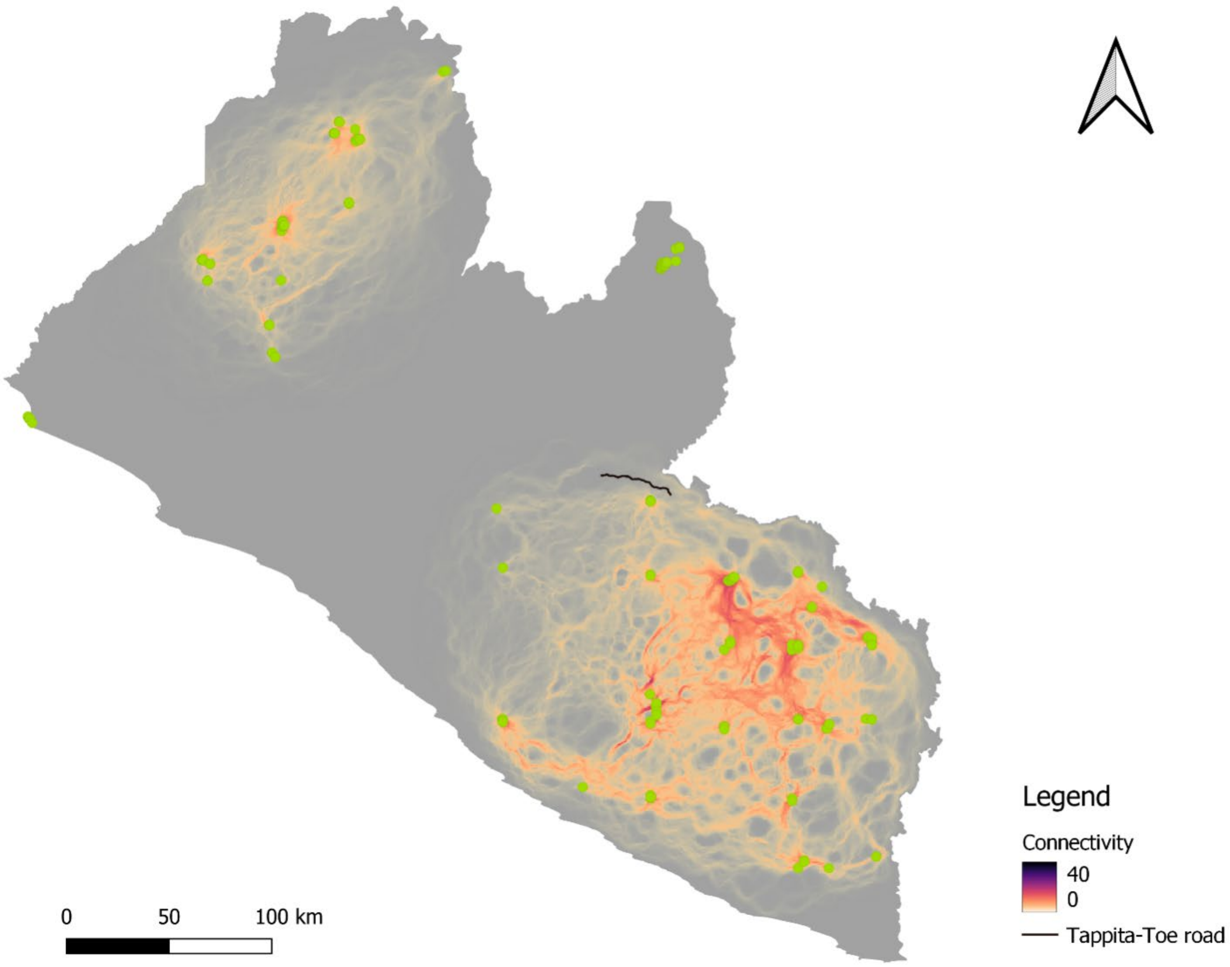

Figure 31. Connectivity analysis of chimpanzee populations in Liberia (Frazier et al, 2021). Green dots show the occurrence locations of chimpanzees in Liberia.

The ESIA Update for the project roads made a tentative estimate of the number of western chimpanzees that may be affected within the project's area of influence at around 465 individuals. This is uncertain for a number of reasons and a wide range – perhaps between about 50 and 1150 individuals – is possible. Estimating chimpanzee populations is extremely difficult, even with careful abundance studies. As seen in the figures below, the projects area of influence is partially out of range of chimpanzee communities and it is likely therefore to host very low density of chimpanzee's population.

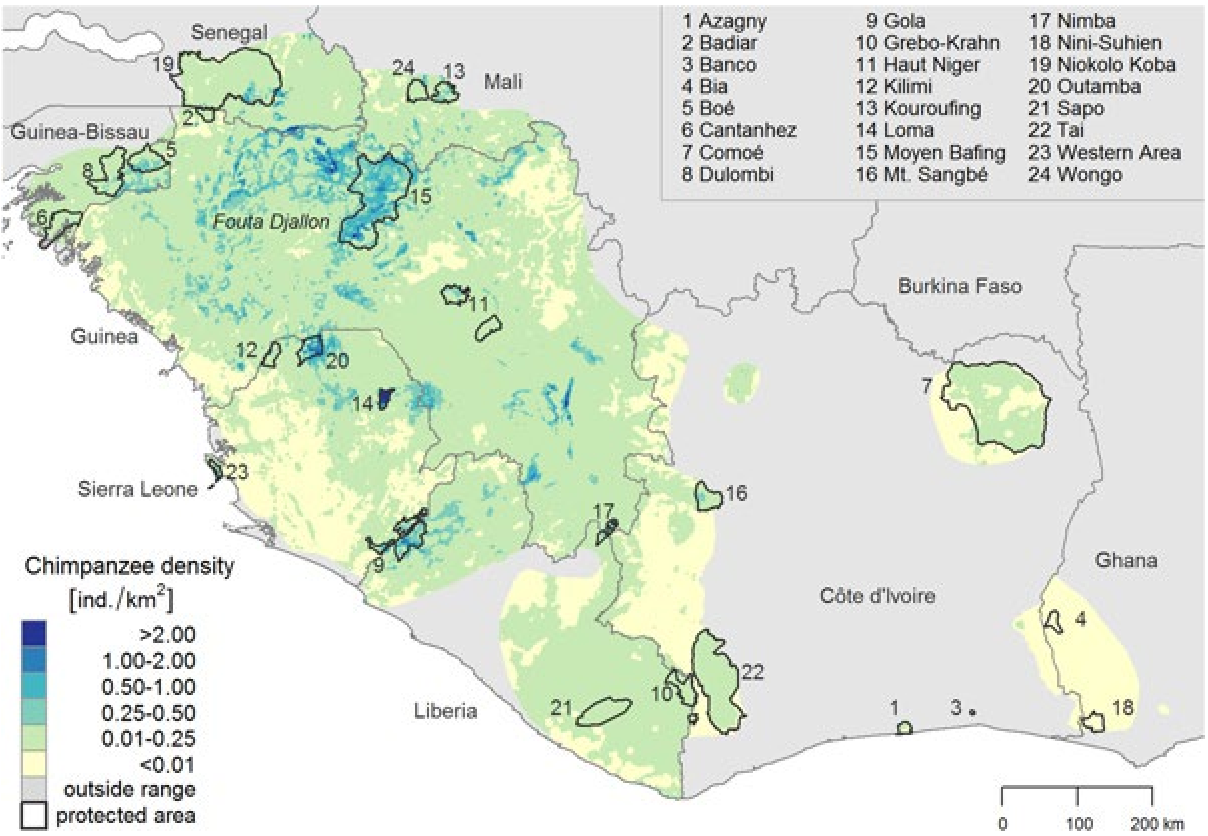

Figure 32. Modeled western chimpanzee density distribution (Heinicke et al., 2019)

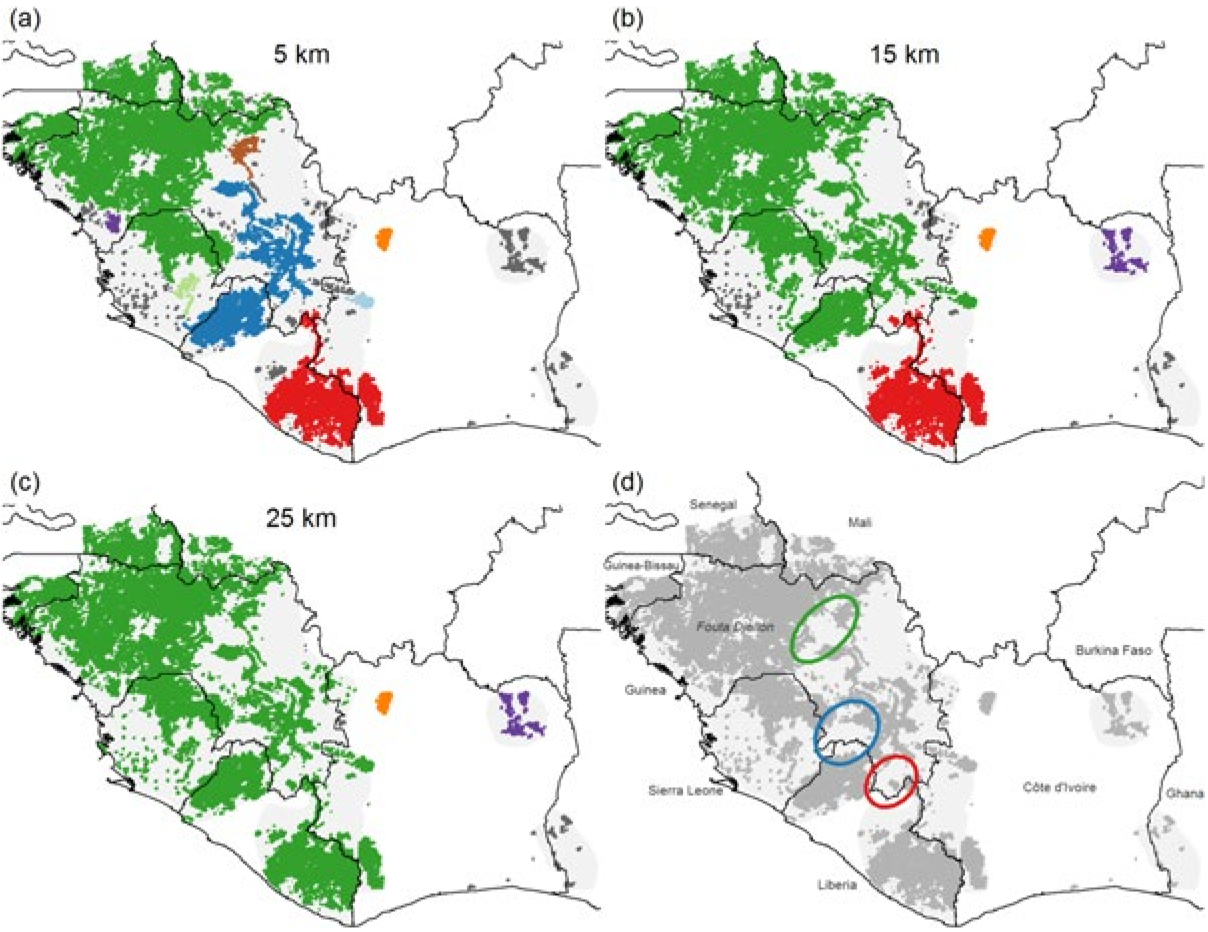

Figure 33. Scenarios for sub-populations based on three minimum distance thresholds(Heinicke et al., 2019)

Apart from the recce and transect assessment which identify no direct or indirect signs of chimpanzee, local Communities reported occasional chimps sighting but over the past 20 years and that no such sightings recorded in the last 5 years. However, most of the hunters who accompanied the team during the survey and community members disclosed that chimpanzees are only found in the mature secondary forest more than 3-5 hours from their village and mostly towards the proposed protected forest in the larger landscape. Two communities, Bitterball Village and Mary Weah Village reported chimpanzee sightings between 2017 and 2021 (indications that these animals still occur, however, rarely). Sightings were acknowledged at the north of Mary Weah Village where there is still some concentration of mature secondary forest (both south and north).

For further contextual information relevant for conservation planning, Heinicke et al (2019) estimated that 77.93% of western chimpanzees live in savanna-mosaic habitat, 16.38% in forest habitat, and 5.32% in cropland habitat. Also estimates show that 38.59% of chimpanzees live within 5 km and 67.43% within 10 km of settlements, while 59.25% live within 5 km and 88.11% within 10 km of road

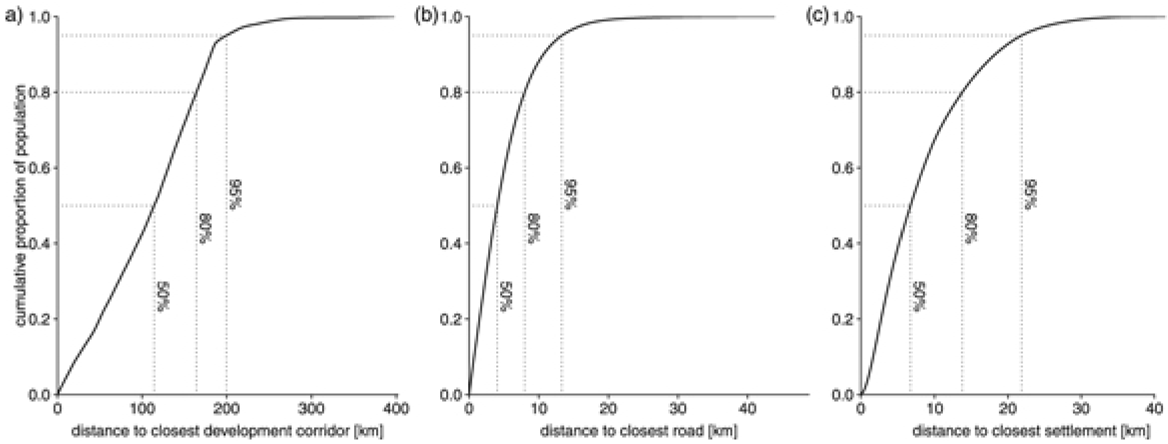

Figure 34. Cumulative proportion of western chimpanzees living within increasing distance to (a) 'development corridors', (b) roads, and (c) settlements. Plot (b) shows, for example, that 80% of western chimpanzees live less than 10 km from the nearest road (Heinicke et al., 2019)

4.2 VEGETATION MAPPING

4.2.1 Remote sensing

Vegetation mapping in the study area consisted on both remote sensing and ground-truth data approaches. The initial mapping used available cover data from the European Space Agency (ESA).

The European Space Agency (ESA) WorldCover 10 m 2021 product provides a global land cover map for 2021 at 10 m resolution based on Sentinel-1 and Sentinel-2 data. The WorldCover product comes with 11 land cover classes, aligned with UN-FAO's Land Cover Classification System, and has been generated in the framework of the ESA WorldCover project, part of the 5th Earth Observation Envelope Programme (EOEP-5) of the European Space Agency.

The ESA WorldCover 10m 2021 v200 product updates the existing ESA WorldCover 10m 2020 v100 product to 2021 but is produced using an improved algorithm version (v200) compared to the 2020 map. Consequently, since the WorldCover maps for 2020 and 2021 were generated with different algorithm versions (v100 and v200, respectively), changes between the maps should be treated with caution, as they include both real changes in land cover and changes due to the algorithms used.

The WorldCover 2021 v200 product is developed by a consortium led by VITO Remote Sensing together with partners Brockmann Consult, Gamma Remote Sensing AG, IIASA and Wageningen University. This cover data was accessed and cropped to the study area, as shown in **Figure 36** and **Table 4**.

Table 4. Vegetation cover in the study area (Zanaga et al., 2022)

Class	Description	Area (ha)
Secondary forests	tree canopy >70 %, almost all broadleaf trees remain green year-round. Forest cover has been disturbed and intervened by human activities.	7258.52
Shrubland	These are woody perennial plants with persistent and woody stems and without any defined main stem being less than 5 m tall. The shrub foliage can be either evergreen or deciduous	517.76
Grassland	Plants without persistent stem or shoots above ground and lacking definite firm structure. Tree and shrub cover is less than 10 %	154.56
Urban areas	Land covered by buildings and other man-made structures	169.59
Bare / sparse vegetation	Lands with exposed soil, sand, or rocks and never has more than 10 % vegetated cover during any time of the year	0.52
Water bodies	Fresh water bodies	12.76
Total		**8113.71**


Zorpu village/gbatkor community
Kusor village
Bitterball camp
Doyelai
Gwins Town
Mary
B'hai Tarway
Pokor
Legend
Project road
Communities
Land use classes
Secondary forest
Shrubland
Grassland
Cropland
Urban areas
Bare vegetation
Water bodies
Herbaceous wetland
Mangroves
0
2,5
5 km

Figure 35. Vegetation cover and land use in the study area (Zanaga et al., 2022)

4.2.2 Ground-truth vegetation cover

During the field work done in April/May 2025, different vegetation cover ground-truthing was done. The following figure shows the different vegetation cover existing throughout the project's area of influence. This data will be used to validate and calibrate the vegetation mapping presented in the previous section.

As presented in the previous section, the majority of the study area is covered by discontinuous patches of secondary forest. This finding was confirmed in the field, as seen in **Figure 37**. The vast majority of the assessed transects in the field were secondary forests. Furthermore, locations of swamp and wetland areas were also georeferenced in the field (**Figure 38**). These geotagged areas will be used to further calibrate the vegetation/habitat cover map presented in the section above. Only one location was classified as mature forest, whereas the rest was mainly secondary forest, followed by disturbed secondary forest.

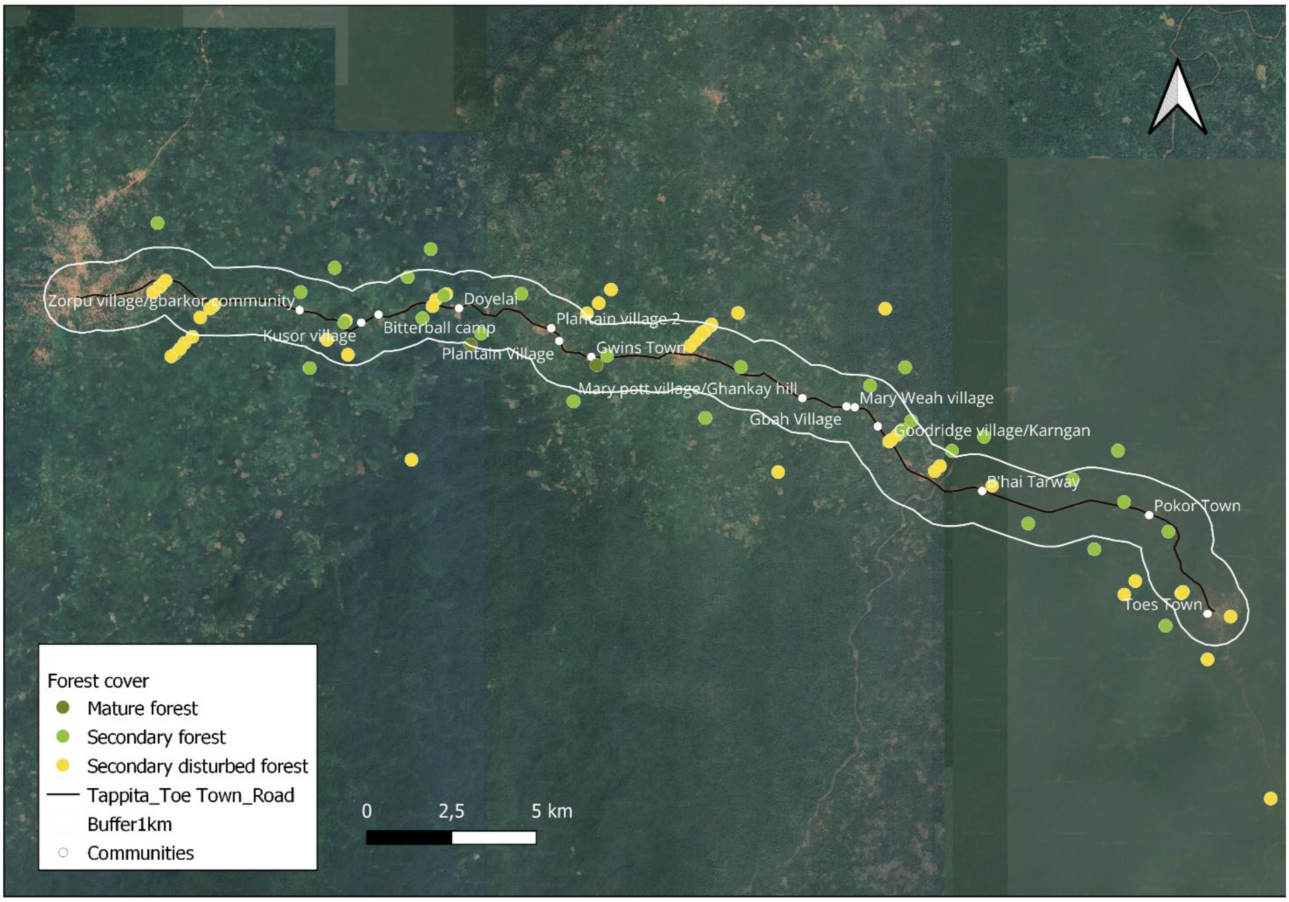

Figure 36. Tree vegetation cover in the study area

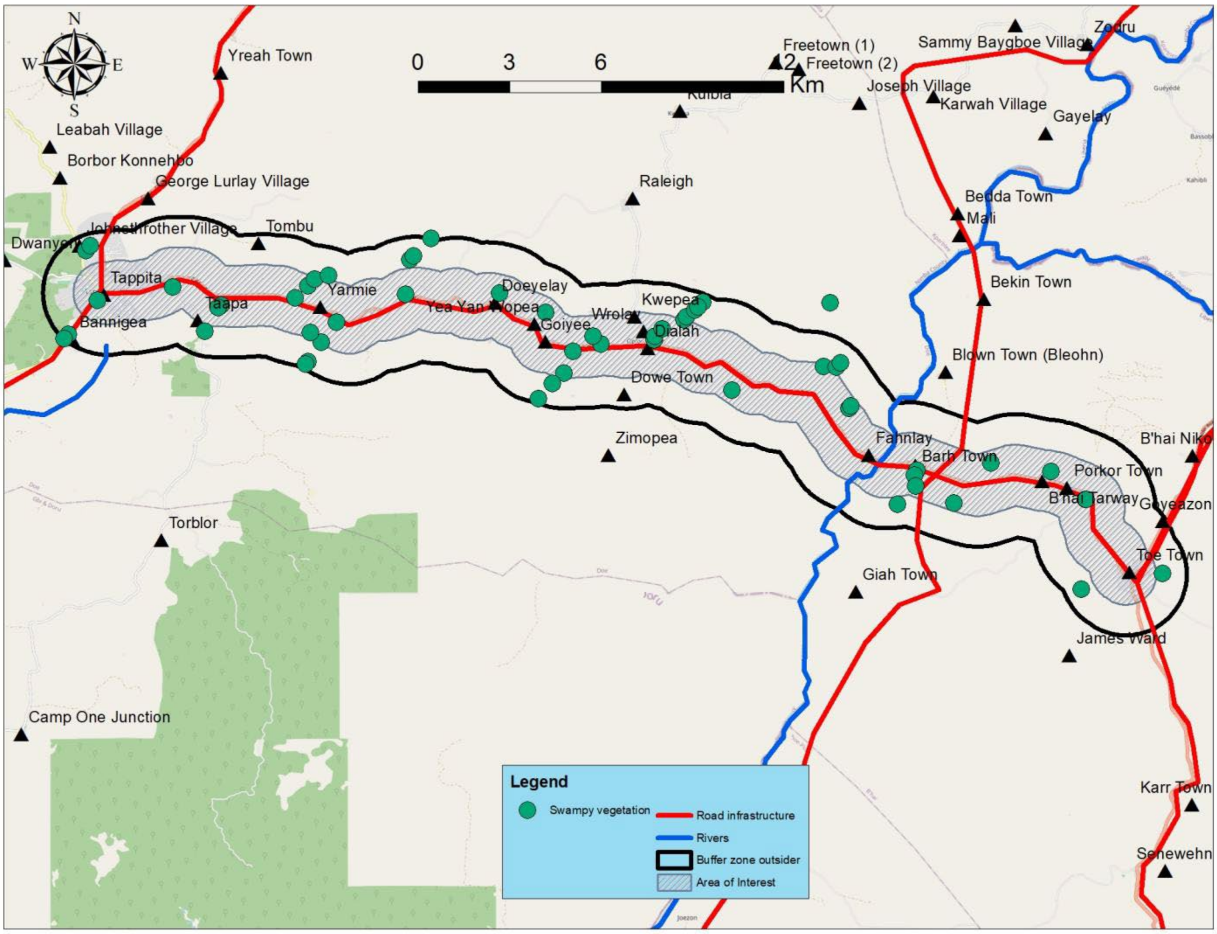

Figure 37. Wetland locations throughout the study area

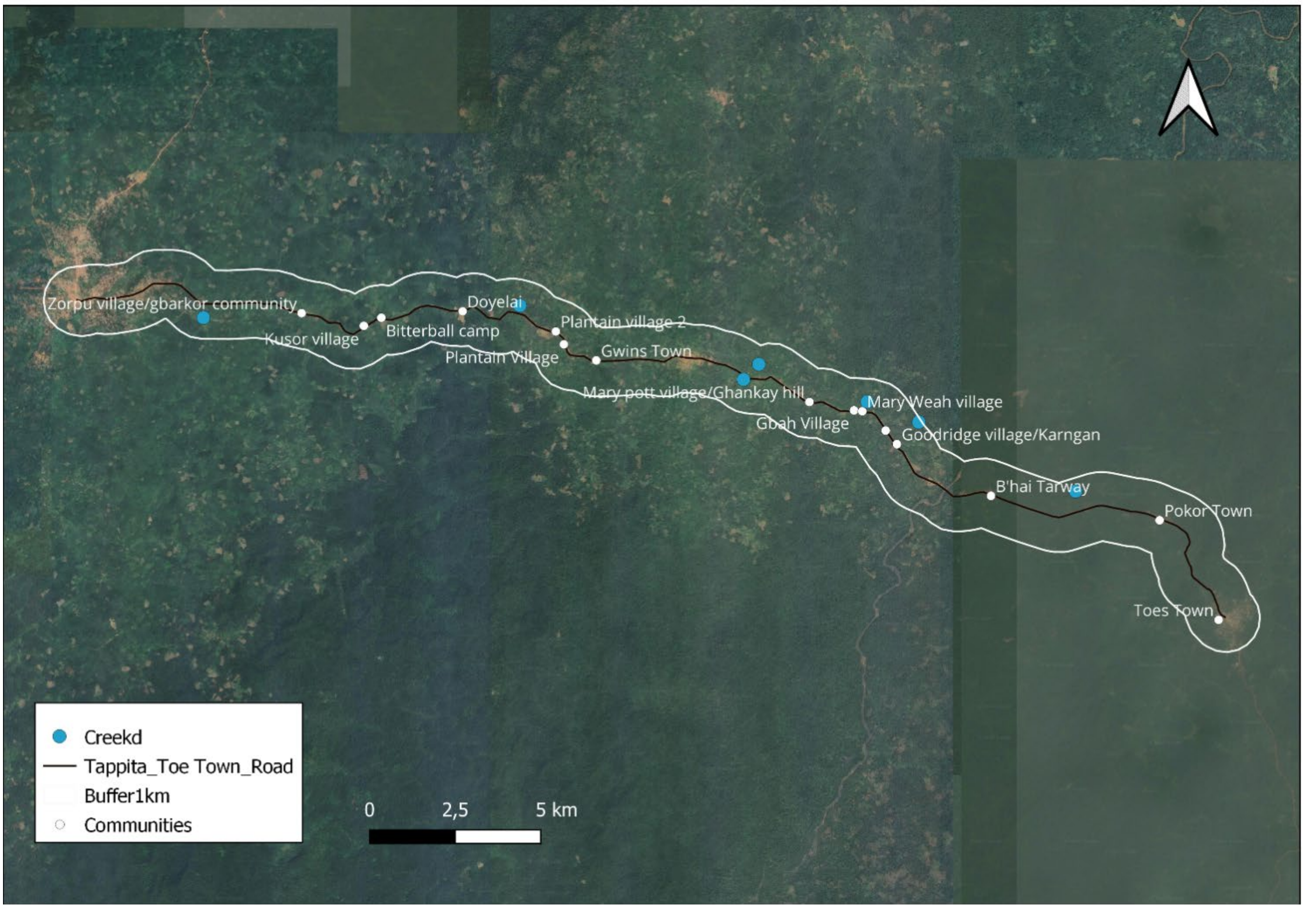

Figure 38. Location of creeks throughout the study area.

4.2.3 Anthropogenic activities in the study area

The field survey confirmed the presence of an extensive mosaic of anthropogenic activities, particularly farming. As seen in **Figure 40**, farming activities are present throughout the project area. A total of 225 human-influenced land use sites were recorded in the project area. Mixed farming was the most common activity, followed by rubber plantations, which together made up the largest share of these land uses. Other types of human activities were also observed but occurred less frequently. Cocoa farming is mainly present in the eastern section of the road project (the last 10km until Toe town from Cestos river). Rubber plantations are continuously present from chainage 0 until approximately chainage 32km. The rest of the crops are randomly distributed in the project area, being the most common, a mixed system. For a full list of these anthropogenic activities and their spatial distribution, see **Appendix 4**.

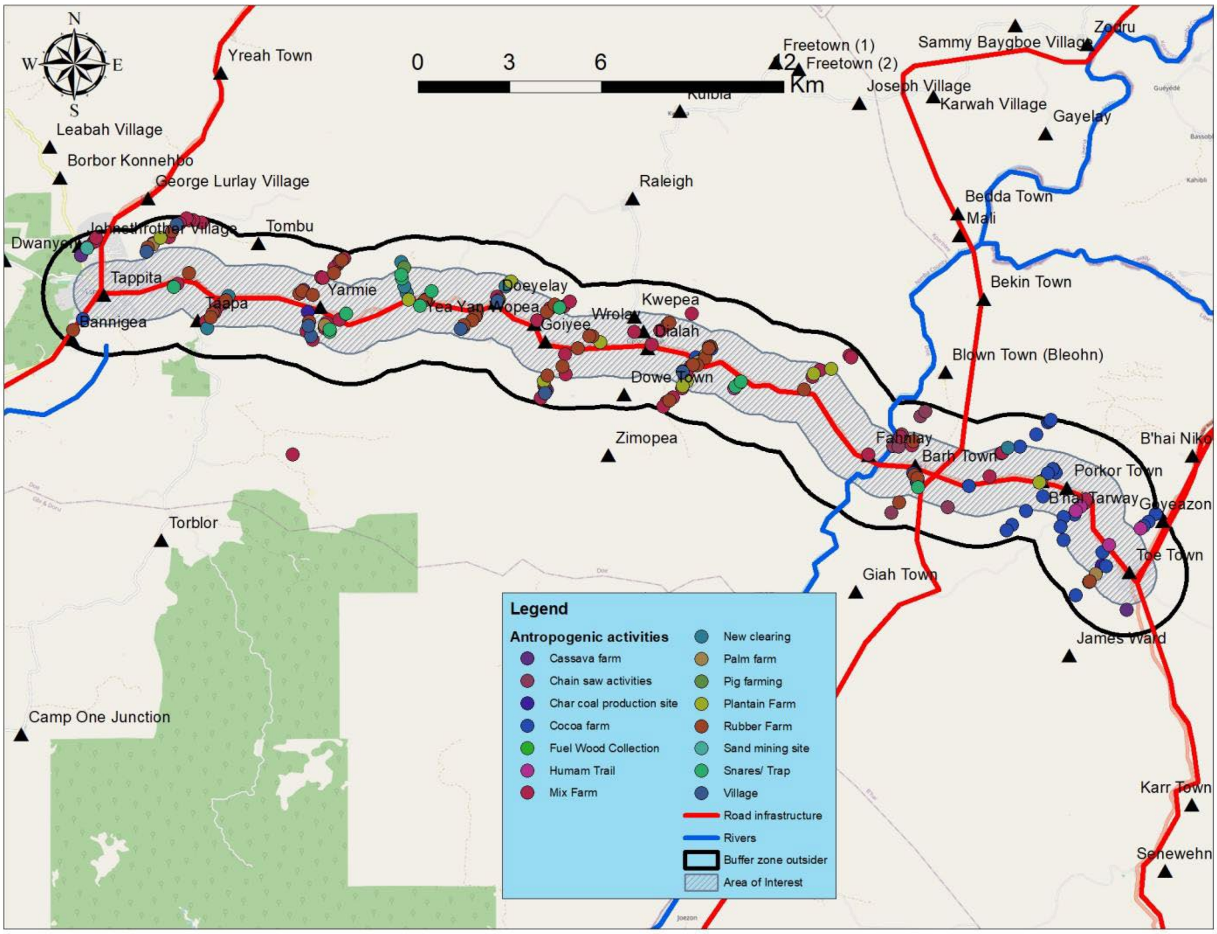

Figure 39. Anthropogenic mosaic throughout the study area.

4.3 Tree Cover Loss and Development Drivers

4.3.1 Development Drivers

The proposed road rehabilitation project is set within a landscape that is already undergoing rapid transformation driven by various sectoral and policy-led initiatives. These include agricultural expansion, land use intensification, and forestry-related developments that, when combined with improved accessibility from the road, are expected to generate significant cumulative effects across the region. **Appendix 4** shows the different anthropogenic activities and their spatial distribution.

Spatial analysis using Land Use Change Analysis (LUCA) and CTrees platforms further illustrate the pace of environmental change. Deforestation and forest degradation caused by roads, logging, and fire are particularly pronounced in Nimba and Grand Gedeh districts. Annual average forest disturbance ranges from 10,000 to over 17,500 hectares per district, with logging-related degradation rates exceeding 3,000 hectares per year in some areas. These patterns suggest that increased accessibility from the road project could act as a further catalyst for conversion of forested land to commercial and subsistence use. Improved accessibility is likely to encourage spontaneous settlement and migration.

These shifts in land use and economic activity are also expected to place pressure on customary land systems, water resources, and forest-based ecosystems, with downstream risks to biodiversity, aquatic health, and climate resilience. As communities adjust to market-driven development, the associated socio-ecological changes, such as settlement expansion, resource competition, and seasonal migration, may compound existing vulnerabilities, especially where governance capacity is limited.

Together, these trends show that the road project, although intended to improve access and boost economic opportunities, will inevitably interact with broader changes already taking place in the region. As such, the project's success will also depend on its ability to navigate and respond to these intersecting forces. As different developments come together along the project road, their combined impact on people, land, and ecosystems will need to be carefully managed alongside the road itself.

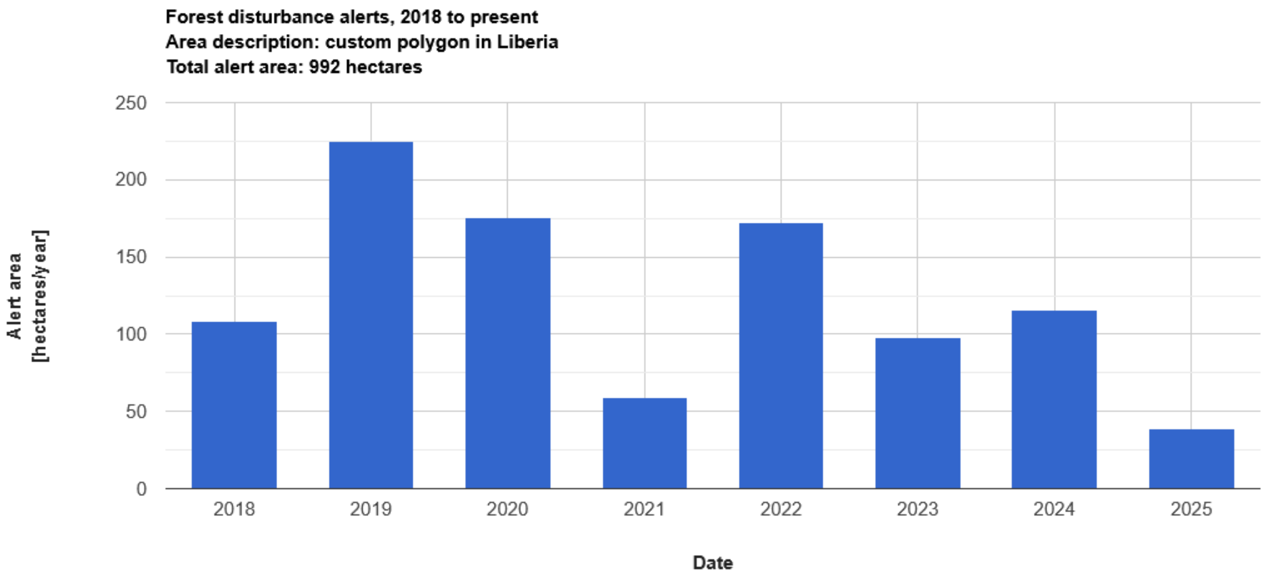

Figure 40. Forest disturbance (2018-2024) in the project area (Source: Ctrees)

Similarly, REDD+AI platform provides open access for visualization of CTrees' maps of stable forest cover, tree cover loss, and forest degradation, with attribution to logging, forest fire, and road construction. Data available cover the tropical moist forests biome at 4.77-meter resolution for 2016-2023. The platform offers summary statistics for all countries and their subnational jurisdictions where data are available. The data was retrieved and analyzed for the social area of influence (Nimba and Grand Gedeh Districts).

- Tree Cover Loss measures forested areas that have undergone a complete removal of trees. The model detects tree cover loss when classification of a pixel changes from tree cover to non-tree cover, and remains classified as non-tree cover. The Tree Cover Loss layer also displays stable forest cover, which are pixels classified as tree cover over the entire period covered by the Planet NICFI dataset (2016 to present).
- Degradation: Degradation in tropical rainforests consists of losses of tree cover and carbon storage, among other ecosystem services, which does not result in complete clearing of the forest. This tool measures degradation caused by logging, fire, and road construction.
- Degradation - Logging: The Degradation - Logging layer measures forest degradation due to logging. In the tropics, logging includes selective logging, where trees are removed inside forests without clear cutting, over logging cycles that can last decades. Logged forests are expected to regenerate over time without additional tree removal. The Degradation — Logging layer encompasses both legal and illegal logging. Logging can be legal in forest concessions where companies are required to follow rules of sustainable forest management. Illegal logging can result in severely increased levels of disturbance
- Degradation - Forest Fire: The Degradation — Forest Fire layer measures area of burned forests, where the forest has been partially lost or its ecosystem services diminished. Areas subject to forest fire degradation often experience increased tree mortality and reduced productivity that can last from years to decades.

- Degradation - Roads: The Degradation — Roads layer measures area degraded by construction of roads and trails inside forests, which can be used for transportation or for illegal activities. Roads are often connected to new deforestation and logging hotspots.
- Stable Forest (2016 - 23): The Stable Forest layer measures any area that remained forest during the 2016-current period analyzed by CTrees.
- Rate: The rate measures the total area of disturbance divided by the number of years selected by the user.

Table 5. Deforestation and degradation rates in the target districts (Source: cTrees)

District	**Deforestation**	**Degradation – Logging**	**Degradation - Roads**	**Degradation - Fires**
Tappita, Nimba	10,500 ha/yr	1,405 ha/yr	71 ha/yr	64 ha/yr
Grand Gedeh	17,568 ha/yr	3,472 ha/yr	103 ha/yr	741 ha/yr

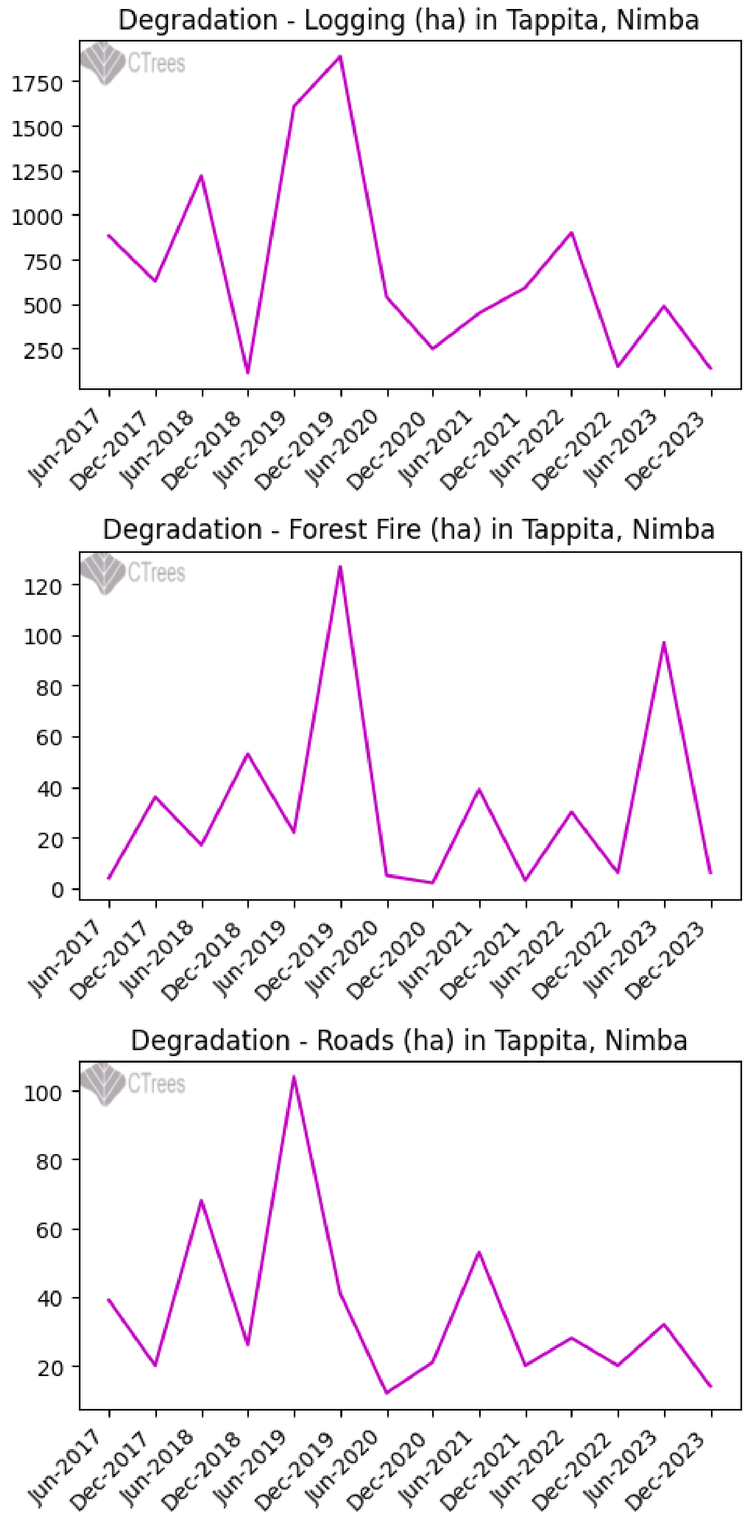

Figure 41. Deforestation and degradation in Nimba District (Source: REDD+ AI / Ctrees)

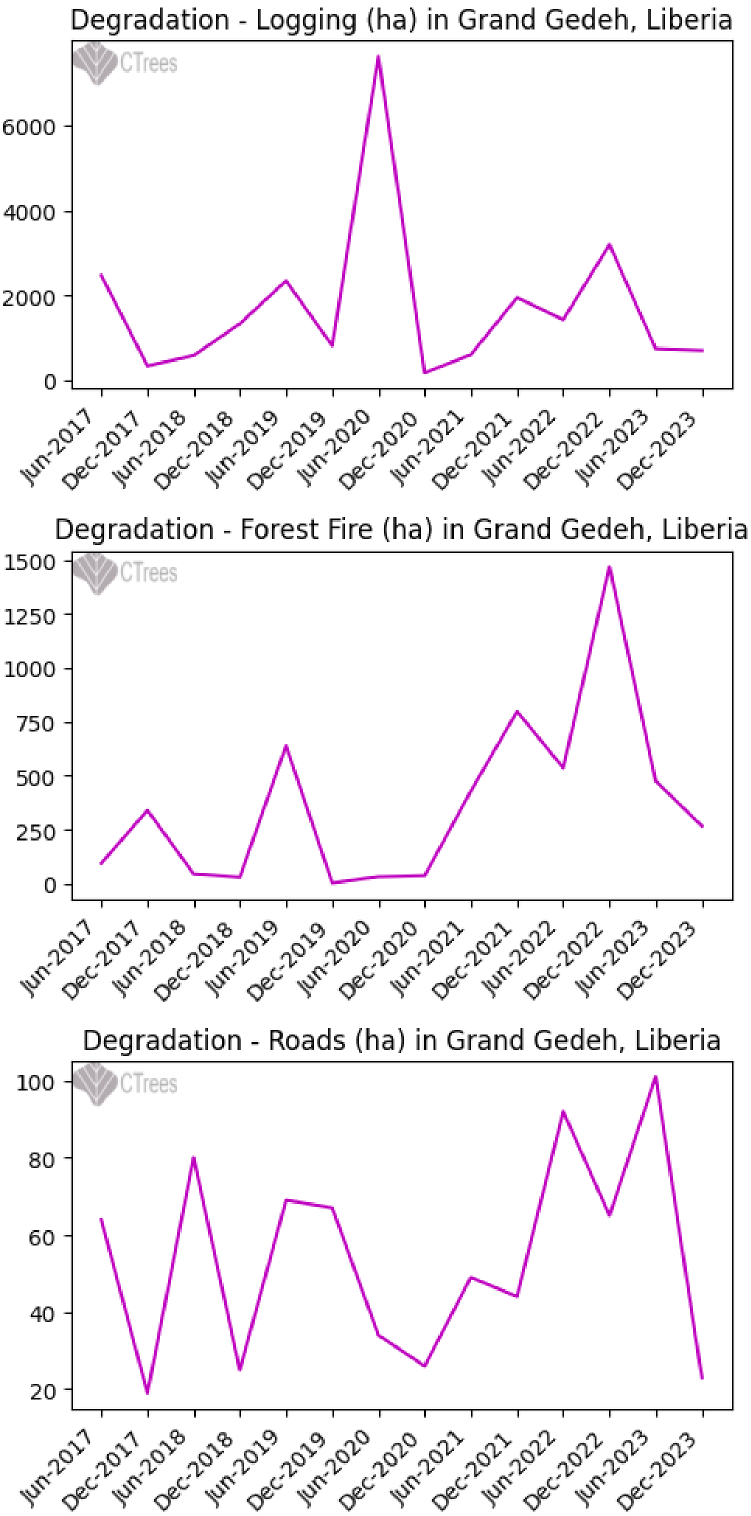

Figure 42. Deforestation and degradation in Grand Gedeh District (Source: REDD+ AI / Ctrees)

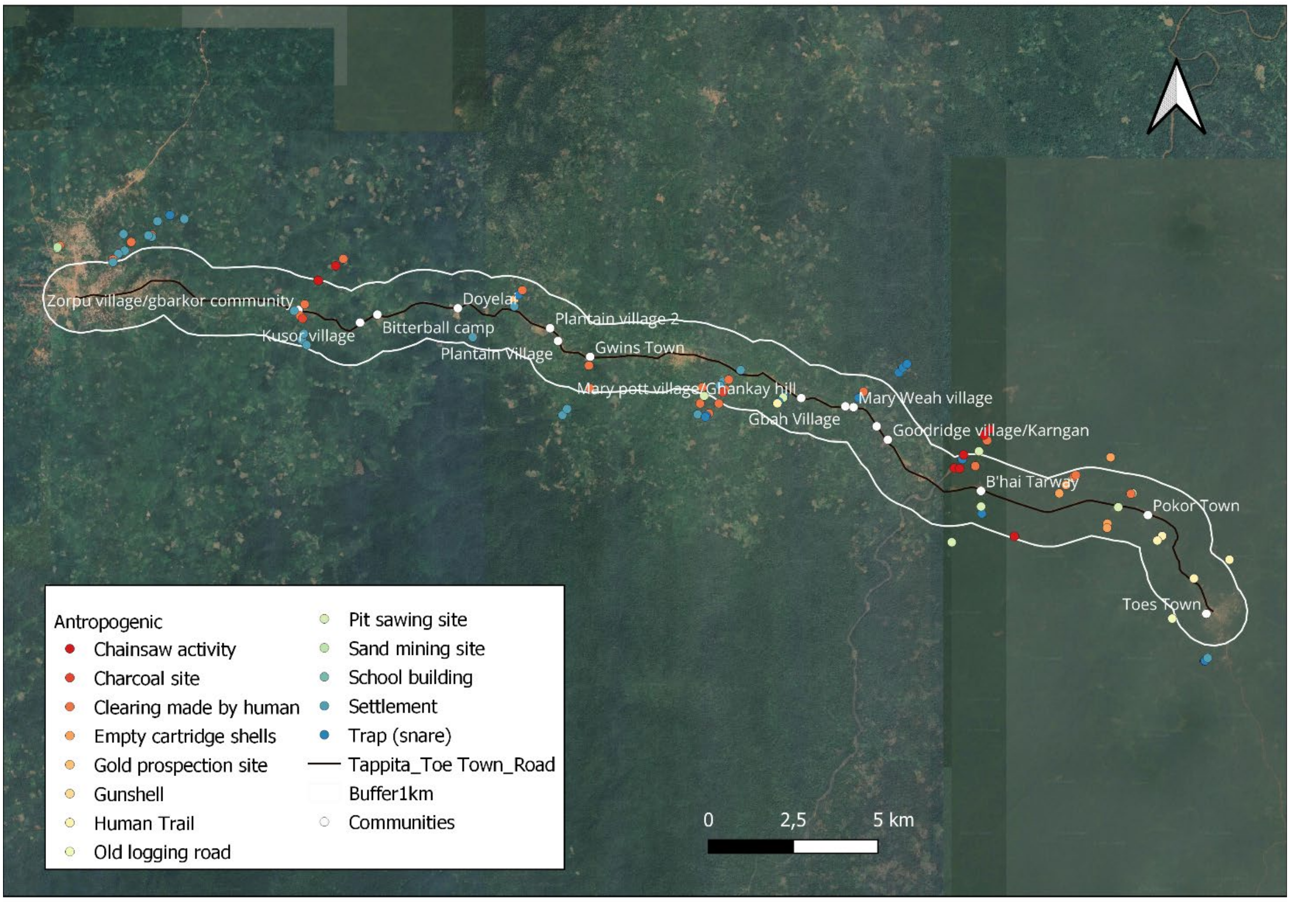

Figure 43. Anthropogenic activities in the study area

Based on the field surveys taken place in April/May 2025, different other anthropogenic activities were evidenced throughout the study area. These mainly included chainsaw activities, forest clearing and game traps (**Figure 44**), which confirms the highly modified vegetation cover throughout the study area.

4.3.2 Deforestation

The project's area of influence (AOI, 1km buffer along the 40km project road) has experienced significant loss of tree cover in the last two decades. The total AOI has approximately 8100 ha, and the average yearly tree cover loss has been 126.4 ha in the period 2000-2023 (**Figure 45** and **Figure 46**), with a total of 2907.3 ha (which represents approximately 36% of the study area, and more than 40% of the forest cover.

The data was accessed and retrieved from the Hansen Global Forest Change data (Hansen et al., 2013). This data tracks tree cover loss as a stand-replacement disturbance or a change from a forest to a non-forest state. It identifies tree cover loss, defined as vegetation exceeding 5 meters in height, between 2000 and 2023. The data represents this loss as a year of event, with values indicating the year of primary loss (e.g., 1-23 for 2001-2023, respectively). The technical details are summarized in the table below.

Table 6. Technical details of the Hansen Global Forest Change data

Concept	Description
Tree cover	The dataset defines tree cover as vegetation greater than 5 meters in height, encompassing both natural forests and plantations.
Loss	Tree cover loss is defined as a change from a forested area to a non-forested area, representing a stand-replacement disturbance.
Data encoding	Tree cover loss is defined as a change from a forested area to a non-forested area, representing a stand-replacement disturbance.
Temporal scope	The dataset provides data for the period from 2000 to 2023.
Data source	The Hansen Global Forest Change data is a product of time-series analysis of Landsat images

As seen in **Figure 46**, the study area has been heavily modified in the last two decades, in addition to the already existing anthropologic disturbance activities before the 2000s (e.g. Tappita and Toe locations). The vast majority of the study area is modified habitat. Even though there is still forest in the study area cover, this is mainly disturbed/secondary vegetation. This tree cover loss pattern was confirmed from ground-truth validation points of anthropogenic activities in the study area (**Appendix 4**)

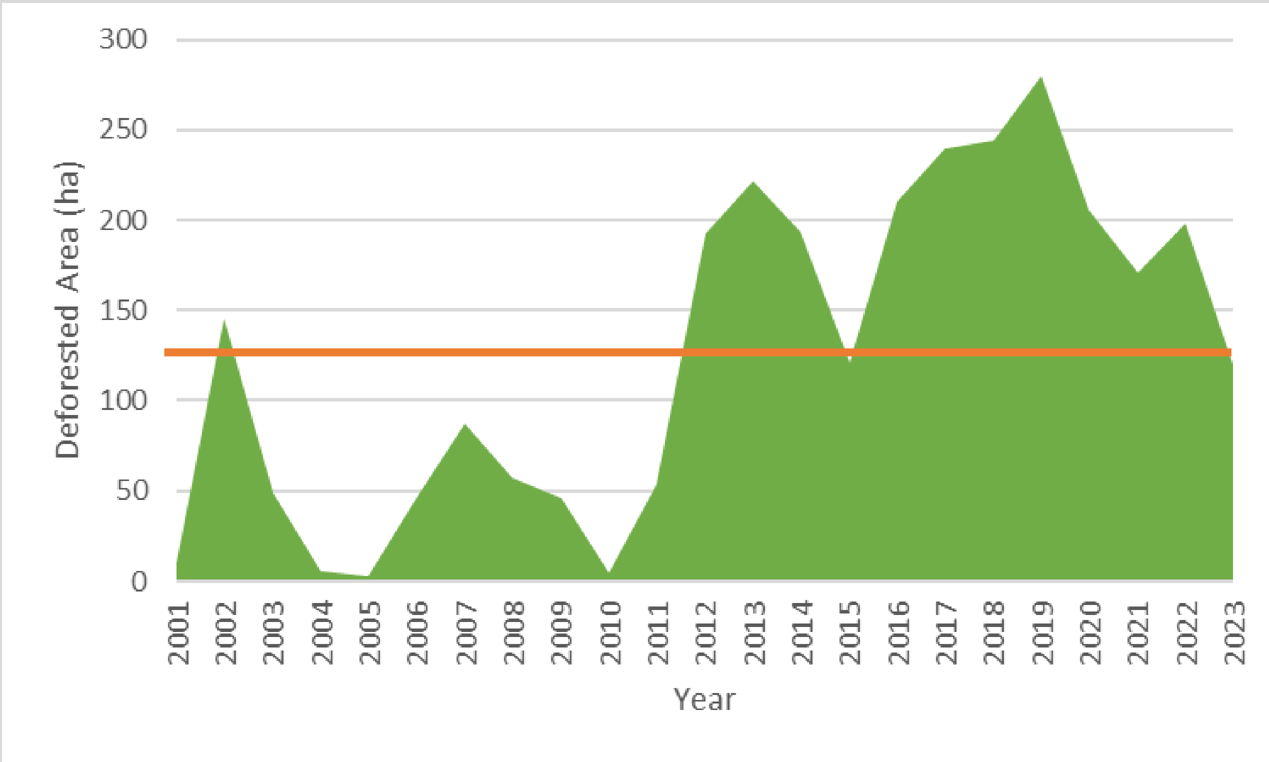

Figure 44. Deforestation and tree cover loss in the project's area of influence (AOI)


Zorpu village/gbarkor community
Kusor village
Bitterball camp
Doyelai
Plantain village 2
Plantain Village
Gwins Town
Mary pott village/Ghankay hill
Gbah Village
Mary Weah village
Goodridge village/Karngan
B'hai Tarway
Pokor Town
Toes Town
Legend
Deforestation
23
0
Project road
Communities
0
2,5
5 km

Figure 45. Spatial distribution of tree cover loss in the project's area of influence (Hansen et al., 2013)

The deforestation map depicted in **Figure 46**, shows the deforested areas between 2000 and 2023. Red colors show locations with recent forest loss events in year 2023 (marked as 23 in the legend), whereas blue colors, locations of forest loss events from 2000 (marked as 0 in the legend).

A number of physical observations were made as a result of the assessment through the 40km corridor, encompassing the AOI and its 1km buffer on either side of the existing unpaved road. Along the corridor beginning from Tappita, the corridor stretches from the establishment of complete settlement, to scattered settlements with young bushes lying in between as it reaches Toe Town, where the corridor ends. There is large fragmentation of the vegetation at the end of the AOI and mainly within the buffer. For instance, within the Nimba side of the AOI beginning from Tappita City to the Cestos Bridge, the areas of the 1km buffer have been impacted by large rubber farm and mixed farming to include plantain farm and large rice farm, pit sawing and sand mining, among other farms. The end of the 40km corridor, which begins from the Grand Gedeh side, commencing from the Cestor bridge to outside Toe Town is dominated with large forest fragmentation especially as a result of cocoa farming. All the validation ground-truth points of anthropogenic activities are presented in **Appendix 4**.

4.4 SPECIES PRESENCE AND ABUNDANCE

4.4.1 Flora and vegetation

The botanical survey was carried out from April 21st to May 5th, 2025 in at least fifteen (15) different communities. Access to all sites was by tracking through footpaths, hunting trails, cut paths and by vehicle. Besides additional observation data collected on the Recce, forty one sampling plot of 25 x 25 m were established at Mature forest, Secondary Forest, Secondary disturbed Forest, Farm bush/Agriculture degraded area, and Swamp or wetland. The project corridor was divided into two sections: the active corridor of 1km known as the Area of influence (AOI) and additional 1km buffer surrounding this section.

The RBS was based on Hawthorne and Abue-Juam 1995, Tchouto et al. 1995, Tchouto 2004 and Afrifa et al. 2013. The survey was qualitative to record all plant species in the different micro-habitats (Mature Forest, Secondary Forest, Secondary disturbed Forest, Farm bush/Agriculture degraded area, and Swamp or wetland). Plots of 25 x 25 m were established, and all trees >20 cm Diameter at Breast Height (DBH) were located by a field assistant and identified by a Botanist. Tree height was taken by visual estimation;

Observational data was carried out for species that were not recorded in the plots above. This was mostly carried out along the Recce process. A species list of this was developed and added to the RBS species list. A general species list of the study area was developed for a better understanding of species occurrences of the entire sample area.

All of the species were identified in the field by a botanist (consultant), the majority of the species recorded were snapped with at least two (2) pictures per specimens and species. Overall identification of specimens from pictures was carried out using the different volumes of the Flora of West Tropical Africa (FWTA), Trees of Nigeria, Voorhoeve 1965, Jansen 1974, Hawthorne and Jongkinds 2006, Marshall and Hawthorne 2013. Data entry and analysis were carried out using Microsoft Excel version 2013.

Star rating of species

Star rating was based on Hawthorne and Abue-Juam 1995 and adopted by Tchouto et al. 1995, Tchouto 2004, Afrifa 2013, Tseganu 2014, and Marshall et al. 2016 to define and classify conservation values of plant species recorded in a sample. Each species was assigned to a star rating category of its rarity in Liberia, Upper and Lower Guinea, and internationally.

Table 7 shows the descirption and weight summary of the star rating. Species with no spatial rarity value was rated green stars, but when heavily exploited, is classified as Scarlet, Red and Pink star species. This is classified in order of declining exploitation threats (Hawthorne 1996).

Rare and endemic species are scarce resources that are highly valued in star rating. Thus, any forest richer in highly valued species receives higher scores. However, species with complete monographs and filled per degree grid square distribution map have the following guideline for star rating:

- Black stars occupy about 1-3 squares
- Gold stars occupy about 4-14 squares
- Blue stars occupy about 15-30 squares
- Green stars occupy more than ca. 40 squares

Green star species are widespread species in the Coastal forest and mangrove swamps, and the Evergreen rainforest of Liberia and West Africa which are not under exploitation pressure. Calculation of the Genetic Heat Index (GHI) for green star species is rating with a weight of zero.Blue star species are moderately widespread and of global conservation concern, found in other African evergreen rainforests, coastal and mangrove forest or restricted to the Upper Guinea Forest. The calculation of Genetic Heat Index for blue star species is rating with a weight of 3.Gold star are range restricted species found only in Upper Guinea forest in ca. 6-degree squares and are of global conservation concern. The GHI for Gold Star is rating as nine (9). Black star are globally rare species, restricted to a small area and endemic to Liberia. The GHI calculation for black star is rated with a weight of 27.

Table 7. Star rating categories, GHI weighting and comments

Star	**Weight for GHI**	**Comment**
Black (BK)	27	Urgent conservation attention needed. Rare globally and not common in Liberia. Liberia must take particular attention to these species.
Gold (GD)	9	Fairly rare globally and locally. Liberia has some unavoidable responsibility for maintaining these species.
Blue (BU)	3	Widespread globally but rare in Liberia or rare globally but widespread in Liberia.
Scarlet (SC)	1	Common but under serious pressure from heavy exploitation. For usage to be sustainable, exploitation needs to be reduced and protection measures put in place.
Red (RD)	1	Common but under pressure of exploitation.
Pink (PK)	1	Common and moderately exploited.
Green (GN)	0	No particular conservation concern.

Occurrence and Floristic Composition

The study documented 494 plant stems across 32 families in the project area. The ten most common families included *Fabaceae* (102 stems), *Combretaceae* (63), *Apocynaceae* (39), *Moraceae* (37), *Maliaceae* (32), *Euphorbiaceae* (25), *Myristicaceae* (21), *Cecropiaceae* (21), *Annonaceae* (16), and Gentianaceae (15) (**Table 8**). Together, these families accounted for just over half of all recorded stems. A full list of species, organized by family, can be found in **Appendix 6**.

Table 8. List of flora species recorded from the project site per family (BFS, 2025)

Family	Total number of species recorded per family
Anacardiaceae	1
Annonaceae	16
Apocynaceace	39
Bombacaceae	14
Burseraceae	9
Cecropiaceae	21
Chrysobalanaceae	3
Clusiaceae	5
Combretaceae	63
Ebenaceae	3
Euphorbiaceae	25
Fabaceae	102
Gentianaceae	15
Guttiferae	3
Irvingiaceae	1
Lamiaceae	3
Lecythidaceae	9
Leguminosae	5
Maliaceae	32
Meliaceae	5
Moraceae	37
Myristicaceae	21
Ochnaceae	14
Pandaceae	1
Phyllanthaceae	15
Putranjivaceae	1
Rhizophoraceae	2
Rubiaceae	6
Rutaceae	10
Sapotaceae	1
Simaroubaceae	6
Violaceae	6

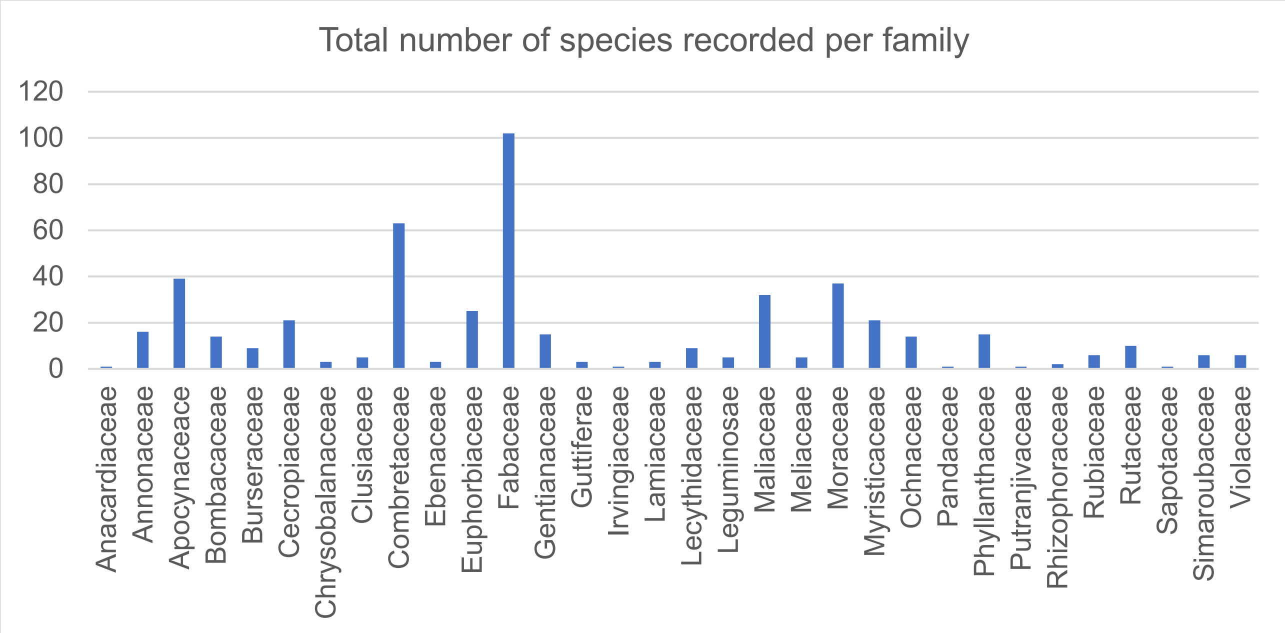

Figure 46. Graphical tabular presentation of the total number of flora species per family within the RETRAP Corridor 40 Km (Tappita-Toe Town).

Vegetation types of the project area

The project area contains five distinct vegetation types. Secondary Forest, characterized by older trees with some past logging or disturbance, covers the largest portion of the area. This is followed by Secondary Disturbed/Young Bush, which includes younger, regrowing vegetation. Mature Forest, the least common type, consists of undisturbed, fully developed tree stands. Other vegetation types, such as agricultural land and shrubland, were also observed. For a breakdown of each type's distribution and features, refer to **Table 9.**

Table 9. Vegetation types of the project area

Vegetation Type	**Percentage Vegetation Type of the RETRAP Corridor 40 Km (Tappita-Toe Town)**
Mature Forest	5
Secondary Forest	45
Secondary Disturb/ Young Bush	30
Degraded Swamp/Wetland	10
Farm bush/Agriculture degraded area	20

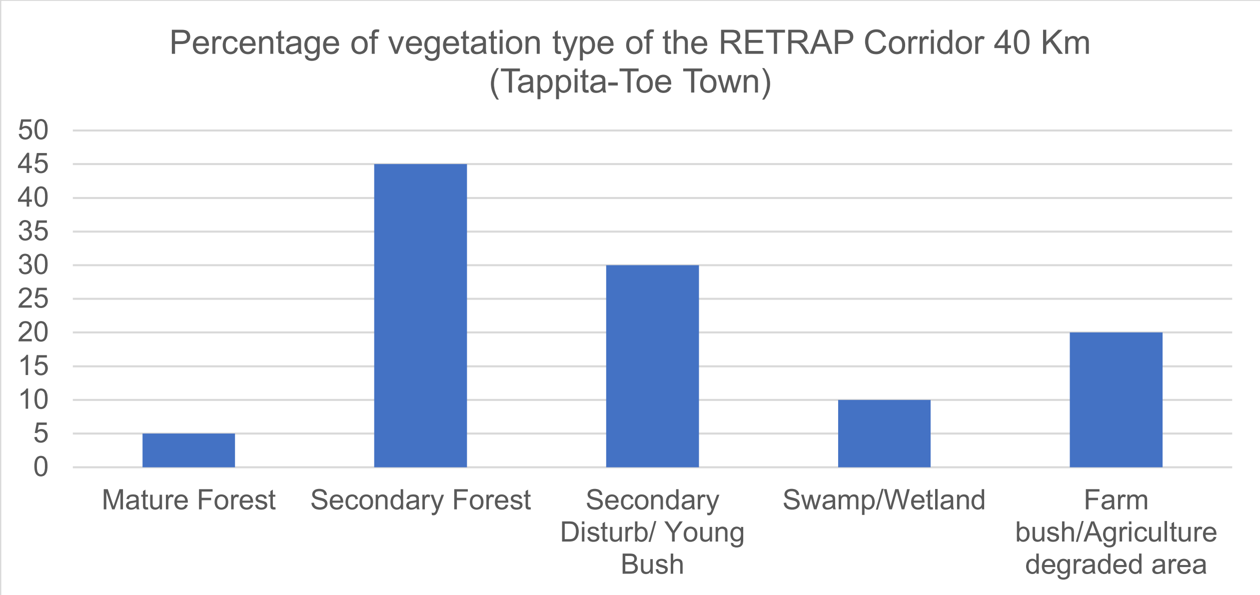

Figure 47. Percentage of vegetation type of the RETRAP Corridor 40 Km (Tappita-Toe Town).

A total of forty-one botanical plots were established out of the forty-five transect locations planned. As a result of unsuitable vegetation location for the plot establishment, such as farmland, open field and settlement, only forty-one botanical plots could be established. There were twenty-one (21) plots established with in the Area of Influence and a total of approximately 250 tree species were registered. The buffer of the AOI established twenty (20) plots with a total of at least 284 tree species. **Appendix 6** shows the statuses of the number of species found within each transect of the AOI and the buffer. One hundred twenty-three (123) species listed on the IUCN Red List were recorded across various sites in the project area. Of these, 6 species are classified as Endangered, 103 as Vulnerable, and 14 as Near Threatened.

List of species within the Area of influence (AOI)

A total of 71 species listed on the IUCN Red List were documented within the study area. Of these, one species was classified as Endangered (EN), sixty-three (63) as Vulnerable (VU), and seven (7) as Near Threatened (NT), with Vulnerable species making up the largest group. The findings show that nearly 90% of the IUCN-listed species in the area fall under the Vulnerable category.

Flora species recorded from the 1km buffer

A total of (52) plant species were recorded in the 1-kilometer buffer zone around the project area. Of these, (5) species are classified as Endangered, (14) as Vulnerable, and (6) as Near Threatened on the IUCN Red List. Vulnerable species made up the largest proportion of the documented flora, followed by Near Threatened and Endangered categories. These findings highlight the presence of conservation-priority species within the project's immediate surroundings. The full list of species and their conservation statuses for the different corridor sections are found in **Appendix 7**.

Table 10. Botany results

Area of Influence (AOI) 1km both sides of existing road			**Buffer 1km either side of the AOI**		
Transect Number	**# of tree species**	**IUCN Status**	**Transect Number**	**# of tree species**	**IUCN Status**
Transects 1-23	71	63 VU 7 NT 1 EN	Transects 24-45	52	14 VU 6 NT 5 EN

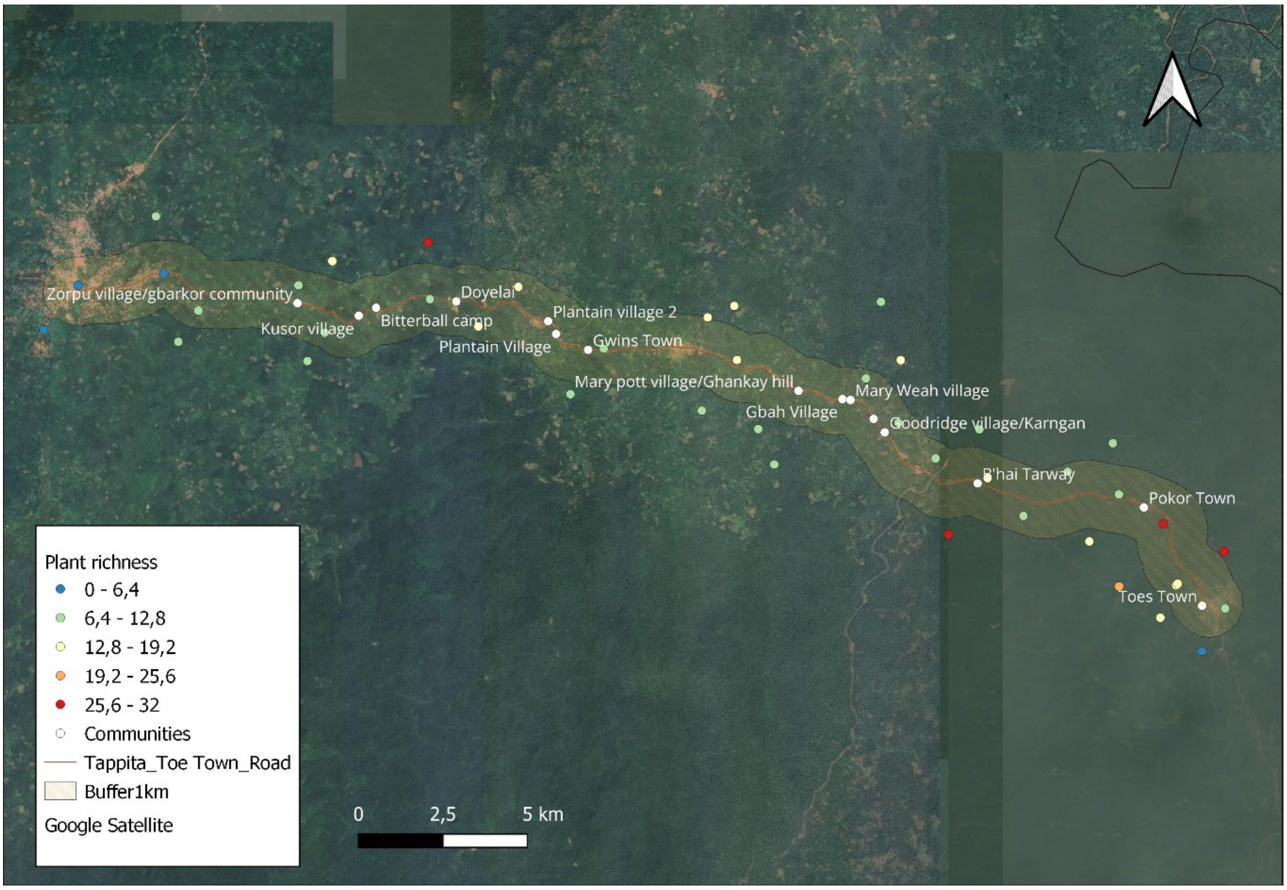

Figure 48. Plant species richness from the BFS (2025)

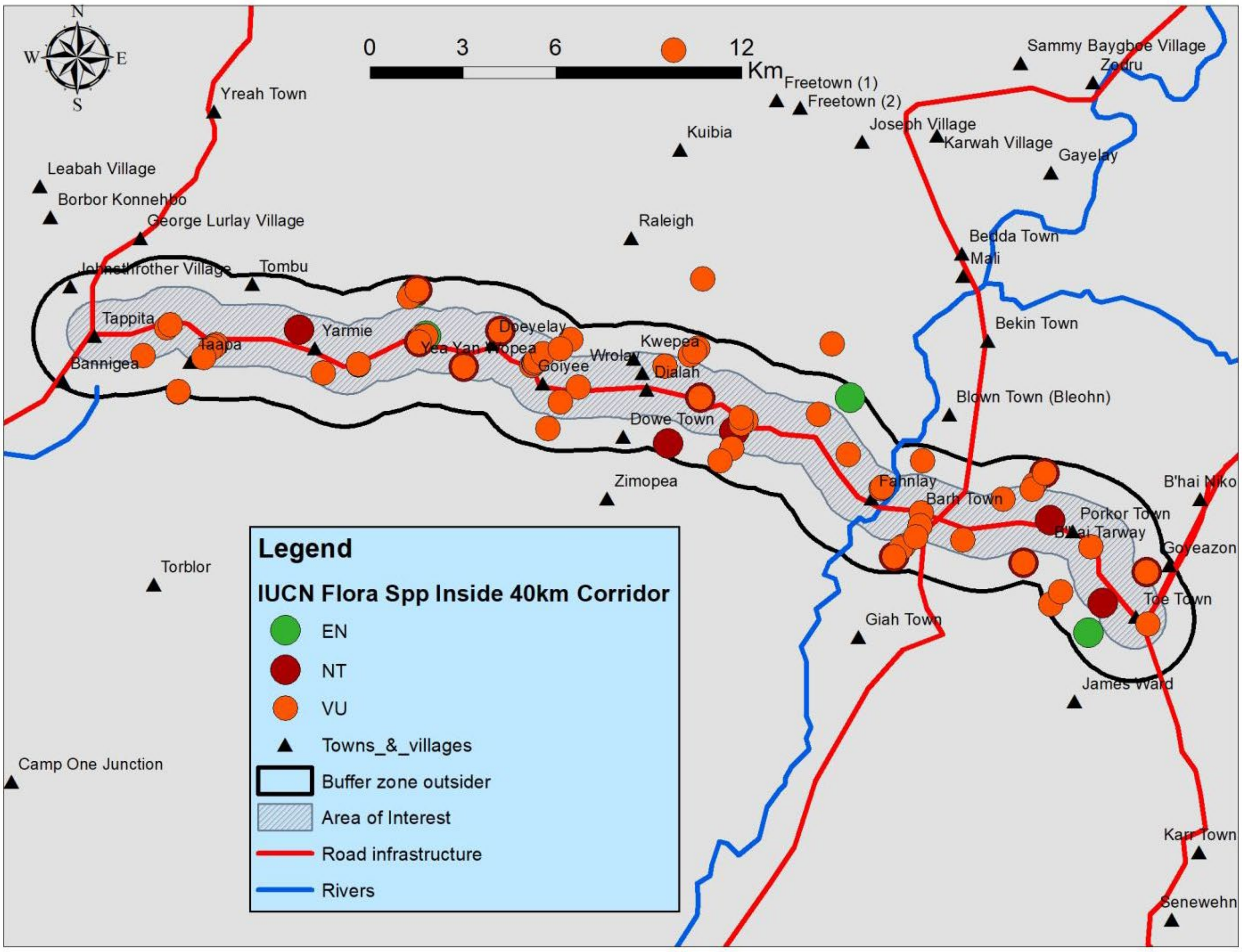

Figure 49. Presence of tree species in the road corridor

4.4.2 Wildlife

The recce or opportunistic surveys were conducted on the 40 km corridor from Tappita – Toe Town. The survey team followed pre-existing paths or trails of least resistance along the compass bearing to ensure minimal vegetation cutting. The team navigated to predetermined compass bearings – defined transect of 1 km distance within the AOI and another 1km buffer on either side of the transect. Prior to conducting both large mammals and primate survey on the pre-determined transects, recce was initiated through the forest towards to the transect. The reconnaissance survey involved the recording of all human activity signs like trails and activities like mining, farming, logging, and hunting. The hunting signs include gun shells, gunshots, hunting camps, snares/traps, footprints, etc. direct encounters with humans are also recorded. Large mammals' assessment included direct and indirect observation to include direct sighting or indirect such as dungs, prints, feeding sites, nests, etc.

A total of forty-five (45) transects were assessed and the mounting of twenty-three camera traps in critical habitats of elusive and nocturnal species to monitor wildlife activity. The critical habitat include valley, wetland/swamps, near flowing creeks, hills, etc.

Apart from the recce and transect assessment which identify no direct or indirect signs of chimpanzee, local Communities reported occasional chimps sighting but over the past 20 years and that no such sightings recorded in the last 5 years. However, most of the hunters who accompanied the team during the survey and community members disclosed that chimpanzees are only found in the mature secondary forest more than 3-5 hours from their village and mostly towards the proposed protected forest in the larger landscape. Two communities, Bitterball Village and Mary Weah Village reported chimpanzee sightings between 2017 and 2021 (indications that these animals still occur, however, rarely). Sightings were acknowledged at the north of Mary Weah Village where there is still some concentration of mature secondary forest (both south and north).

Notwithstanding, other primate apart from the chimps found were the babies of Campbell's monkey, Sooty mangabey and Lesser spot-nosed monkey all of which have been domesticated by the villagers and within individual homes as pets. The presence of these young primates suggest strong indication of hunting within the area. The survey noticed many indications of hunting including empty shell, snares, and hunters testimony. In fact, the team were informed that these babies were brought from the bushes by hunters. Over the years the Forestry Development Authority (FDA) has enforced the no hunting of wildlife leading to the burning of hundreds of bags of dry meat throughout the county; the FDA is aware of these massive hunting activities. Along these corridors.

The project is anticipation to support local conservation group to assist in spreading the massage of protection for these concern species. Contractor conservation policy such as support conservation effort by enforcing no hunting policy, no consumption of bush meat and no purchase or sale of live wildlife. Additionally, Residents mentioned no observation of Nimba otter shrew or Pygmy Hippopotamus in recent time but other mammals recorded included at least three different duiker species, pangolin, bushcow, and red river hog, among others.

The large mammals and primates survey recorded fifteen (15) different species. The table below shows the species and conservation status.

Table 11. Species-specific sign for recce survey data collection

Species	Signs Type	Protected Status National	Protected Status IUCN
African Civet	Dungs, prints	Protected	LC
Bay duiker	Dung		NT
Black duiker	Dung		LC
Brooke's duiker		Protected	VU
Bushbuck	Print, dung		LC
Forest buffalo	Foot print		NT
Jentink's Duiker	Dung, foot print	Protected	EN
Maxwell's duiker	Dung, foot print		LC
Red river hog	Foot print	Protected	LC
Pangoline	Direct observation	Protected	EN
Marsh mangoose	Feeding site		LC
Bushtail porcupine	Direct observation		LC
Primates			
Campbell's monkey	Direct observation		LC
sooty mangabey	Direct observation		LC
Lesser spot- nosed monkey	Direct observation		LC

The large settlement and fragmented vegetation are a clear indication that the proposed project is not a greenfield development. Large forest vegetation which would have been habitats of critical species have already been massively fragmented, and the majority of habitat impacts occurred years ago. Despite this, more and more forestland is being clear especially in the Toe Town belt, with communities expressing concerns over the level of clearance taking place. Anthropogenic activities such as large cocoa farming, pit sawing, rubber farm, cassava and plantain farm, including hunting has largely impacted the presence of any large mammals within the AOI. Hunters and community member alike have expressed frustration over the long distance they have to cover to see any of the large mammals like chimps.

Camera Traps

The camera trap survey teams were led by two teams from Wild Chimpanzee Foundation (WCF) and Fauna and Flora (FF), with support from team members from both the Society for the Conservation of Nature in Liberia (SCNL) and Solimar International. The aim of the camera trap survey was to build on the knowledge already gained from biodiversity transects and recce surveys. Given that there was no baseline conducted to identify critical spots within the 40km (about 24.85 mi) corridor, camera traps were placed in the elusive and nocturnal species' habitat to monitor wildlife. The selection of trap locations was based on areas of conservation priorities, chimpanzee densities and IUCN species diversity area across the project corridor. The trapping was an unbaited method since in fact the survey has already considered using the targeted species density map. While the baited trapping do influence the presence of species toward the camera trap, the unbaited method was selected to provide an unbiased species presence in their natural habitat and species natural and true behavior. Additionally, due to the small area covered and the high antropogenic activities, it was necessary to observe species behavior naturally. These were based on existing raster files from IUCN mammal diversity (Junker *et al.*, 2015) and Chimpanzee density (Tweh *et al.*, 2014).

(please see map below)

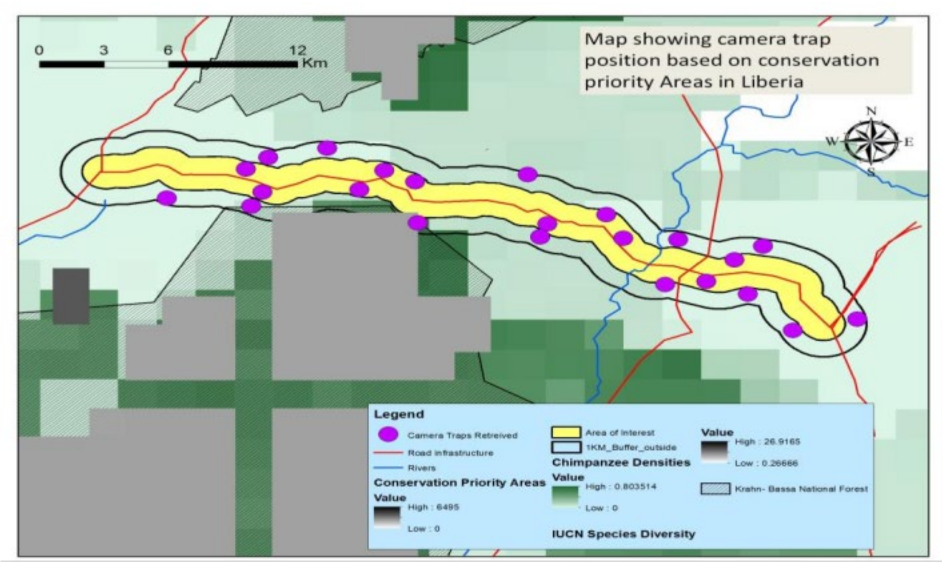

Figure 50: Camera Trap Locations

These areas were determined on the map and camera trap were placed within these locations.The survey was geared mostly in determining species presence, especially the targeted species of Western Chimpanzee, Forest Elephant, the hippo and the Nimba Otter Shrew. In regards to this animals presence based on feeding sites, prints, dung, habitat associated with and suitable for such mammals based on local hunters experience and knowledge were considered. Mammal diversity sites such as steep valley, different type of vegetation(dense, undergrowth, swamps, farms with crops were justified for placement of the camera traps. All of these was as a result of complete camera trap protocol set in place by the team. The protocol considered survey site, sensitization of communities on the camera trap so that it is not temper with, camera preparation(pre-survey, during set up-deployment, post set up-testing the camera, and retriever).

There were twenty-three(23) camera deployed and setup within the project study corridor. None of the camera was damaged, stolen or malfunctioned during the time of retriever, making all twenty-three(23) camera effective. The total trap night(day) was recorded by summing each of the camera trap days of the month and excluding the day of retriever. Each deployment date and retriever date has been calculated in numbers(using excel), with the maximum subtracting the minimum and minus one(representing the retriever day).This description give an overview of the total survey efforts.

Table 12: Camera Trap Night & Efforts

NO	Camera Trap Name	Date of deployment		Date of Collection		Trapping Days
1	WAB 29	04/22/2025	45,769.00	05/23/2025	45,800.00	30.00
2	BRTX 004	04/22/2025	45,769.00	05/23/2025	45,800.00	30.00
3	SCNL 19	04/25/2025	45,772.00	05/25/2025	45,802.00	29.00
4	SCNL 09	04/23/2025	45,770.00	05/23/2025	45,800.00	29.00
5	SCNL 04	04/24/2025	45,771.00	05/24/2025	45,801.00	29.00
6	WAB 08	04/27/2025	45,774.00	05/24/2025	45,801.00	26.00
7	WAB 33	04/27/2025	45,774.00	05/23/2025	45,800.00	25.00
8	WAB 15	04/26/2025	45,773.00	05/24/2025	45,801.00	27.00
9	WAB 16	04/26/2025	45,773.00	05/24/2025	45,801.00	27.00
10	WABERA 01	04/29/2025	45,776.00	05/25/2025	45,802.00	25.00
11	WAB 01	04/29/2025	45,776.00	05/25/2025	45,802.00	25.00
12	WAB 05	04/27/2025	45,774.00	05/25/2025	45,802.00	27.00
13	WAB 03	04/27/2025	45,774.00	05/25/2025	45,802.00	27.00
14	ELRECO 003	05/02/2025	45,779.00	05/25/2025	45,802.00	22.00
15	WAB 12	05/01/2025	45,778.00	05/25/2025	45,802.00	23.00
16	WAB 17	05/01/2025	45,778.00	05/25/2025	45,802.00	23.00
17	SCNL 07	04/25/2025	45,772.00	05/25/2025	45,802.00	29.00

18	WAB 02	04/24/2025	45,771.00	05/25/2025	45,802.00	30.00
19	ELRECO 004	05/03/2025	45,780.00	05/26/2025	45,803.00	22.00
20	SCNL 10	05/01/2025	45,778.00	05/25/2025	45,802.00	23.00
21	ELRECO 05	05/02/2025	45,779.00	05/26/2025	45,803.00	23.00
22	CTID 101	05/03/2025	45,780.00	05/26/2025	45,803.00	22.00
23	CTID 104	05/03/2025	45,780.00	05/26/2025	45,803.00	22.00

Given a total of 595 of all twenty-three(23) camera trapping days, the mean trapping days of the camera is 25.9 represents the number of trap nights.

Twenty-three camera traps were placed in 40km corridors in and around key areas identified as suitable for camera trapping. The details about the number of camera trap days, species counts, and examples of photos are expected to be shown in the form below.

The result of the camera traps is indicative of the survey information gathered from the transects and recce. It demonstrates the massive impacts of different anthropogenic activities within both the project AOI and its buffer. The dominate large mammals' species were the bay/black backed duiker, African civet and the Maxwell duiker. The number of species labeled in the table below is the number of different species within the total large mammals seen on the trap. It does not represent the total animal's photo (mammals, non-mammals and birds). Images captured from the trap also authenticate how hunter, slash and burn agricultural practices have impacted the forest, forcing large mammals to relocate into deeper forest. The large presence of Fire Footed Rope Squirrels and Gambian Pouched Rat in every photo of the different camera traps demonstrates how the degraded forest has impacted the presence of large mammals leaving mostly smaller rodents like species.

Figure 51. Retrieved camara traps

The most photo of the traps are those of humans. It explains why even at a 1km buffer, human activities are still prevalent and impacting. The continuous presence of human activities does not support the presence of large mammal species like the chimpanzee, elephant, and even the Pigmy hippopotamus. The results of the camera traps show both day and night activities of human presence. This dominance is followed by hours of no image both day and night. It explains how the area is so much disturbed by human activities making it less appealing to the presence of large mammals, but Fire Footed Rope Squirrels and Gambian Pouched Rat which easily strive in areas like these due to its many hideouts like holes, trees.

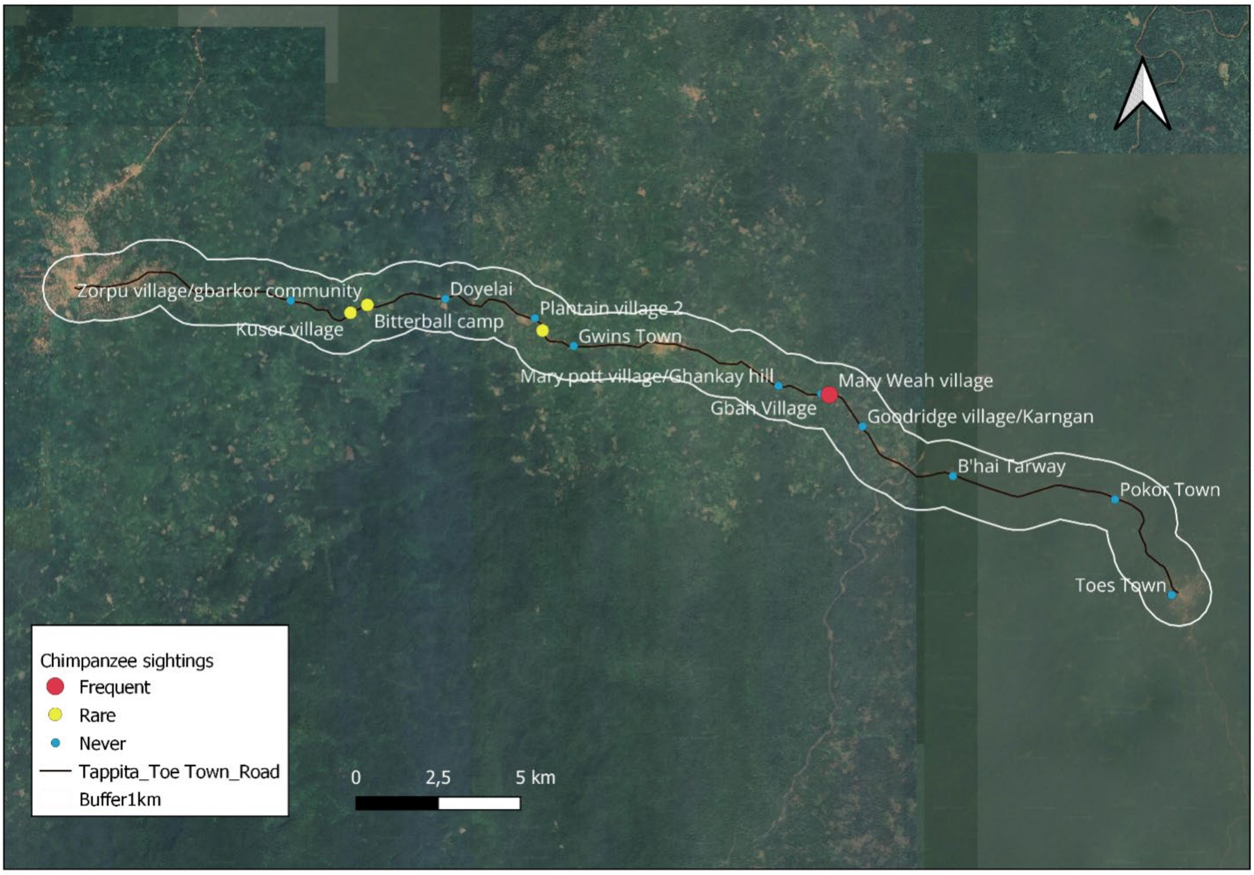

Figure 52. Community sightings of chimpanzee in the thick forest areas

Table 13. Camara trap results

No.	Transect	Coordinate		Vegetation	Number of photos	Number of human	Picture of all animals	Picture of mammals	Picture of birds	Others	Empty pictues	Number of species	Common name	Scientific name	IUCN Status
		X	Y												
1	T-13 WAB03	535995	714387	Young Secondar	510	237	45	35	10		228	5	African Civet African Palm Civet	*Civettictis civetta*	
2	T-15 WAB15	539512	713516	Farm bush	282	139	36	36	0	0	107	1	Fire Footed Rope Squirrel	*Funisciuru pyrropus*	LC
3	T-38 SCNL 19	541471	710697	Young Secondary	930	863	38	38	0	0	29	3	Gambian Pouched Rat Fire Footed Rope Squirrel	*Funisciuru pyrropus*	LC
4	T42 WAB 29	547420	707926	Youngbu sh	105	39		0	25	0	64				
5	T-40 SCNL 09	545316	710112	Secondary	553	449	90	2			14	4	Black backed duiker	*Cephalophus dorsalis*	NT
													Maxwell Duiker	*Philantomba maxwellii waxwellii*	LC

No.	Transect	Coordinate		Vegetation	Number of photos	Number of human	Picture of all	Picture of mammals	Picture of birds	Others	Empty pictures	Number of species	Common name	Scientific name	IUCN Status
		X	Y												
6	T-19 SCNL 04	543388	710877	Young secondary	870	855	11	10	1		4	2	Fire Footed Rope Squirrel	*Funisciuru pyrropus*	LC
													Maxwell Duiker	*Maxwellii waxwellii*	LC
7	T-37 WAB 16	542083	713430	Secondary	214	169	27	21	6	0	18		Fire Footed Rope Squirrel	*Funisciuru pyrropus*	LC
8	T-14 WAB 08	538719	714934	Degraded	275	170	38	22	13	0	67	2	Black backed duiker	*Cephalophus dorsalis*	NT
													Maxwell Duiker	*Philantomba maxwellii*	LC
9	T44 BRTX 004	550418	708595	Young Forest Secondary	366	51		6	2		170		Sooty Magabey	*Cercocebus atys*	VU
													African Civet	*Civettictis civetta*	LC
													Bay/Black Backed Duiker	*Cephalophus dorsali*	NT
													Gambian Pouched Rat	*Cricetomys gambianus*	LC
10	T-32	529956	714449	Young bush	606	267	283	256	27	0	56	2	African Civet	*Civettictis civetta*	NT
													Slender Mongoose	*Herpestes sanguinea*	LC

	WAB 33												Brush-Tailed Porcupine	*Atherurus macrourus*	--

No.	Transect	Coordinate		Vegetation	Number of photos	Number of human	Picture of all animals	Picture of mammals	Picture of birds	Others	Empty pictues	Number of species	Common name	Scientific name	IUCN Status
		X	Y												
11	T-35 WAB 05	535647	713581	Swamp	309	26	268	40	228		15	4	African Civet	*Civettictis civetta*	LC
12	T-05 ELRECO 003	550778	716587	Farm bush	9999	7	0	0	0	0	9992	0	--	--	--
13	T-33 WAB 01	535070	717367	Swamp	294	201	15	8	2	3	78	3	West African Monitor Lizard	*Varanus niloticus*	LC
14	T18 SCNL 07	544696	712194	Young bush	573	308	50	48	2	0		6	Bush Buck	*Tragelaphus sylvaticus*	LC
													Black Duiker	*Cephalophus dorsalis*	NT
													Maxwell Duiker	*Maxwellii waxwellii*	LC
15	T-39 WAB 02	546004	713023	Young bush	532	315	84	36	43		133	6	African Civet	*Civettictis civetta*	LC
													Bush Buck	*Tragelaphus sylvaticus*	LC

No.	Transect & Trap ID	Coordinate X	Coordinate Y	Vegetation	Number of photos	Number of human	Picture of all animals	Picture of mammals	Picture of birds	Others	Empty pictues	Number of species	Common name	Scientific name	IUCN Status
16	T-07 WAB 17	528405	717626	Mature secondary	105	18	50	45	5		37	7	Maxwell Duiker	*Maxwellii waxwellii*	LC
													African Civet	*Civettictis civetta*	LC
													Liberia Mongoose	*Liberiictis kuhni*	VU
17	T-30 SCNL 10	525747	718965	Young Secondar	360	62	114	12	102		184	9	White Bellied Pangolin	*Phataginus tricuspis*	EN
18	T-27 ELRECO 004	518285	715946	Farm bush	399	82	108	95	13		209	6	African Civet	*Civettictis civetta*	LC
19	T8 WAB 12	527228	716457	Young secondary	447	273	66	48	18	0	108	6	--		
20	T-29 ELRECO 05	522212	715455	Degraded	206	63	120	120	0	0	23	2	Black backed duiker	*Cephalophus dorsalis*	NT
													Maxwell Duiker	*Philantomba maxwellii waxwellii*	LC

No.	Transect & Trap ID	Coordinate		Vegetation	Number of photos	Number of human	Picture of all animals	Picture of mammals	Picture of birds	Others	Empty pictures	Number of species	Common name	Scientific name	IUCN Status
		X	Y												
21	T-04 CTIB 104	521960	717705	Young bush	13	2	0	0	0	0	11	0	Maxwell Duiker	*Philantomba maxwellii*	LC
22	T-28 CTIB 101	522995	718420	Young secondar	3	3	0	0	0	0		0	White Bellied Pangolin	*Phataginus tricuspis*	EN
23	T-09 WABER A 1	529833	716928	Farm bush	87	21	7	7	0	0	59	1	African Civet	*Civettictis civetta*	LC

T44 BRTX 004 Sooty Magabey
Y: 550418 X: 708595

T-40 SCNL 09 Black backed duiker
Y: 545316 X: 710112

T-32 WAB 33 African Civet
Y: 529956 X: 714449

T-32 WAB 33 Slender Mongoose
Y: 529956 X: 714449

T-39 WAB 02 Crested guineafowl
Y: 546004 X: 713023

T-07 WAB 17 Liberia Mongoose
Y:528405 X: 717626

Figure 53. Camara trap photo results from the biodiversity field surveys (2025)

	
T-35 WAB 05 African Civet Y:528405 X: 717626	T-19 SCNL 04 Maxwell Duiker Y:543388 X: 710877
	
T-29 ELRECO 05 Maxwell Duiker Y: 522212 X: 715455	T-29 ELRECO 05 Black backed duiker Y: 550778 X: 716587
	
T-19 SCNL 04 Maxwell Duiker Y:543388 X: 710877	T-30 SCNL 10 White Bellied Pangolin Y:**525747** X: 718965

Figure 54. Camara trap photo results from the biodiversity field surveys (2025)

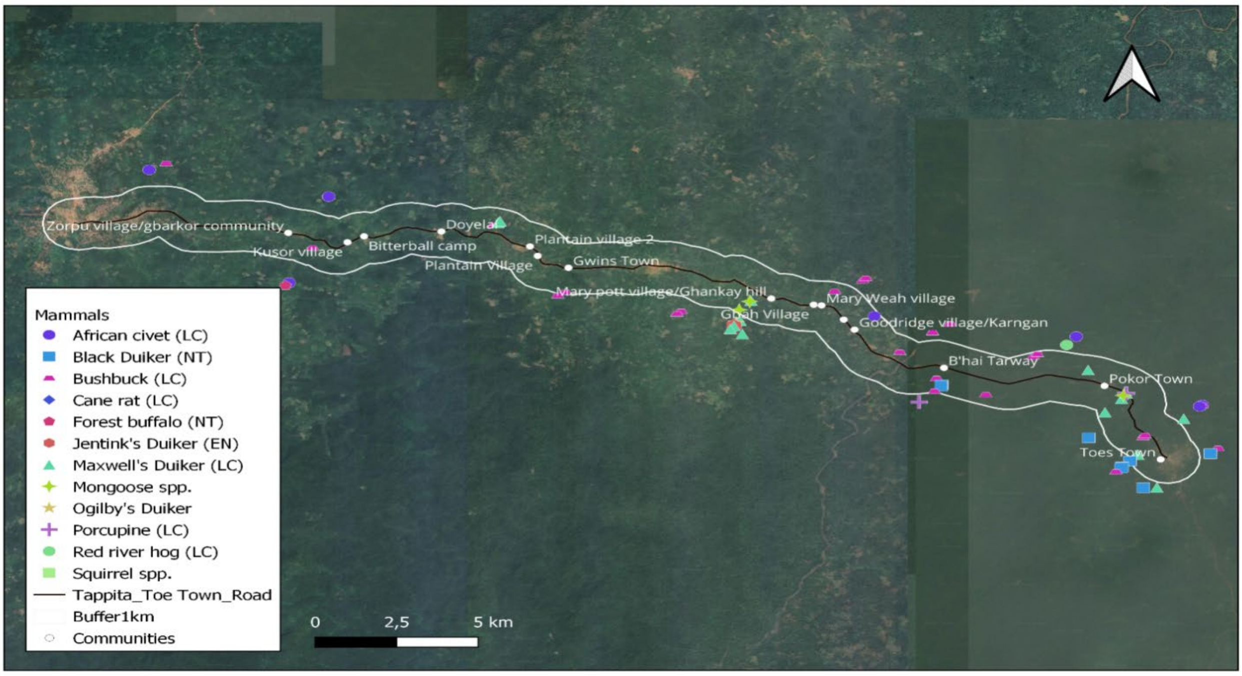

Figure 55. Indirect signs of mammals throughout the study area

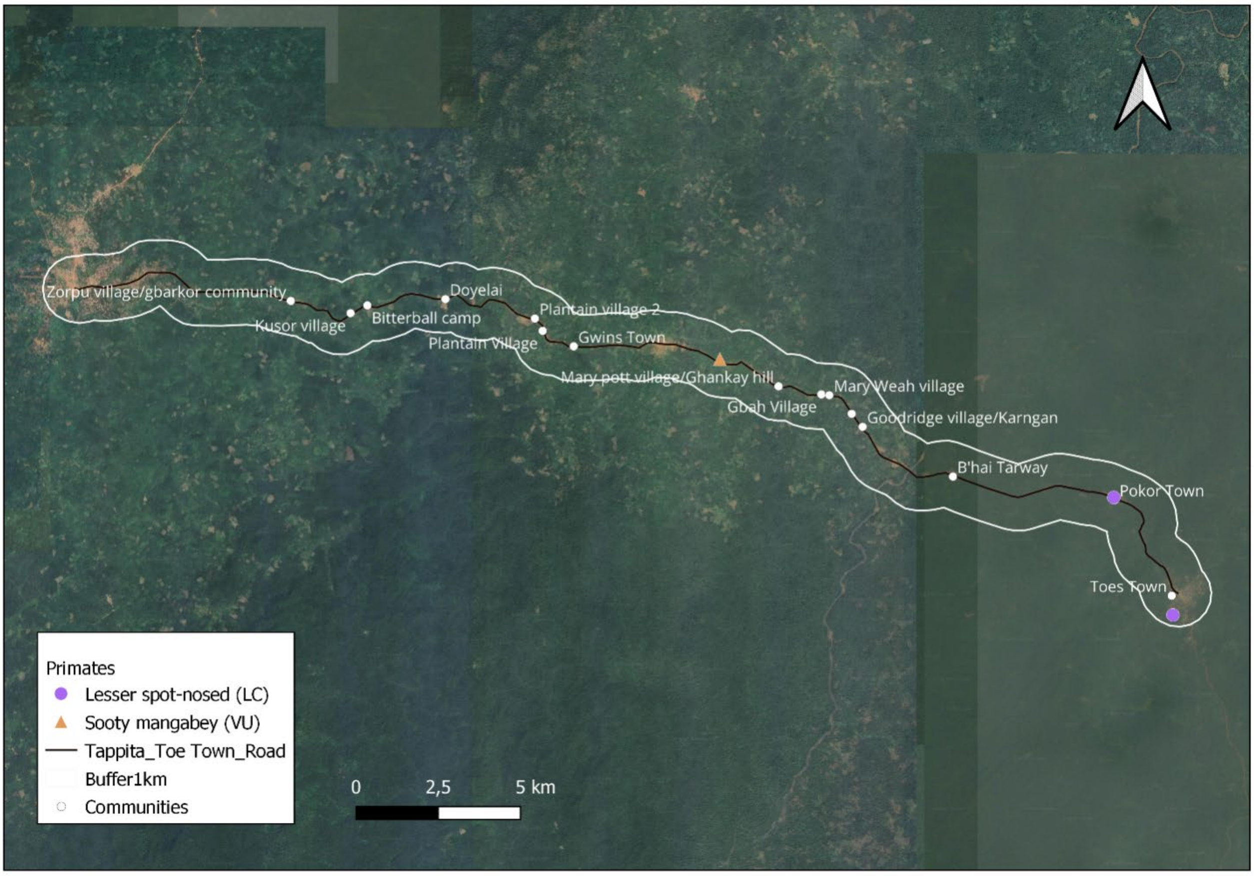

Figure 56. Indirect signs of primates in the study area

4.5 CRITICAL HABITAT ASSESSMENT

Critical Habitat and Natural Habitat assessment ideally takes place across sensible ecological or political units that are sufficiently large to encompass all direct and indirect impacts from the project. These ecologically-appropriate areas of analysis (AoAs) are thus often much broader than the direct project footprint. AoAs may be separate or combined, depending on the ecology of the biodiversity concerned.

The World Bank uses specific criteria to define and assess critical habitat, focusing on areas with high biodiversity value. These criteria include habitats supporting globally or nationally significant concentrations of Critically Endangered or Endangered species, endemic or restricted-range species, migratory or congregatory species, and unique or highly threatened ecosystems. Additionally, key evolutionary processes and ecological functions necessary for biodiversity viability are considered.

This Critical Habitat Assessment (CHA) follows the World Bank's Environmental and Social Framework (ESF), specifically Environmental and Social Standard 6 (ESS6). ESS6 requires a qualitative assessment of the importance of the habitat for species' persistence, rather than requiring strict thresholds or numerical criteria as under IFC Performance Standard 6 (PS6).

Under ESS6, Critical Habitat is defined as areas with high biodiversity value that are:

(a) Habitat of significant importance to Critically Endangered (CR) or Endangered (EN) species
- As listed in the IUCN Red List of threatened species or equivalent national approaches.
- "Significant importance" refers to a habitat's role in the survival or viability of these species (e.g., breeding, feeding, migration, seasonal refuge).

(b) Habitat of significant importance to endemic or restricted-range species
- Applies when a habitat supports species with limited distribution, making them vulnerable to habitat loss or fragmentation.
- A "restricted range" typically refers to species with a range less than 50,000 km² (for terrestrial species), but this is applied qualitatively, not as a fixed threshold.

(c) Habitat supporting globally or nationally significant concentrations of migratory or congregatory species
- Includes migratory corridors, staging areas, breeding grounds, etc.
- These may not support resident populations but are still critical for species survival during parts of the lifecycle.

(d) Highly threatened or unique ecosystems
- Ecosystems facing severe threats or those with distinct ecological characteristics, functions, or species assemblages not found elsewhere.
- Includes areas undergoing rapid degradation or fragmentation.

(e) Ecological functions or characteristics that are needed to maintain the viability of the biodiversity values described above in (C1) to (C4).
- Includes key ecological processes such as pollination, seed dispersal, predator-prey dynamics, or water regulation.
- Can also include ecosystem services that support biodiversity.

Following these criteria, modified or degraded habitats can still qualify as Critical Habitat if they provide essential ecological function or irreplaceable services to qualifying species.

For the Critical and Natural Habitat Assessment, a 1 km buffer on either side of the road was adopted as the primary AoA for assessing direct and indirect project-related biodiversity impacts. This includes impacts such as habitat loss, fragmentation, edge effects, pollution, and induced effects like increased access and hunting. This buffer distance is in line with international good practice for linear infrastructure assessments and is considered adequate to capture the likely spatial extent of such impacts.

For broader contextual understanding and cumulative impacts, a wider landscape perspective has been applied. For example, Key Biodiversity Areas (KBAs) such as the Gio National Forest and Zwedru Forest, located within 10 km of the road corridor, were included in the biodiversity screening exercise but are not considered part of the AoA for direct impact assessment. These KBAs are not physically intersected by the project corridor and are not expected to be directly affected. Therefore, the primary AoA for impact assessment remains defined as the 1 km buffer.

The rationale for this approach is to ensure that direct mitigation and monitoring efforts remain targeted and proportionate, while broader landscape considerations inform the cumulative impact assessment in later chapters. Although several species of conservation concern are present in the broader landscape, the CHA focused on evaluating whether the habitat within the AoA constitutes habitat of significant importance under ESS6, particularly for CR and EN species confirmed through fieldwork. This determination is based on qualitative factors such as population viability, habitat quality, irreplaceability, and fragmentation, as outlined in ESS6 Guidance Note GN14.1

4.5.1 (a) Habitat of significant importance to Critically Endangered and Endangered species

This section assesses whether habitat within the AoA provides significant habitat to support to CR and EN species, consistent with ESS6 Criterion (a). The evaluation is based on presence data (e.g., field surveys, camera traps), contextual literature, and qualitative assessment factors defined in GN14.1. This criterion ensures that any project located in or near critical habitats (i) Does not cause significant harm to the ecological integrity of the habitat, and (ii) Does not result in population declines or other measurable negative impacts on species for which the habitat is designated.

Each of the following sections considers candidate Critical Habitat-qualifying biodiversity identified within the Integrated Biodiversity Assessment Tool (IBAT: www.ibat-alliance.org), other literature or stakeholder consultations as actually or potentially present. In each case, reasons are identified for each biodiversity feature likely meeting or not meeting Critical Habitat thresholds within AoA.

Critically Endangered, Endangered and relevant subspecies were included in an initial screening if they were found during surveys, or there is indication of their presence near the Project from literature. Threat status is taken from the global IUCN Red List (IUCN 2025). Comparison with IUCN Red List Extent of Occurrence and other maps identified the potential for 4 Critically Endangered, and 13 Endangered species with potential to occur in the Project AoA. This total of 17 candidate species was reduced after a quick screen of IUCN distribution maps against quantitative thresholds for Critical Habitat (IFC 2019) based on the extremely limited extent of their global distribution known or likely to be within the AoA, it was implausible that these other species would meet these thresholds.

1. Home's Hinge-back Tortoise *Kinixys homeana* has most recently been assessed for The IUCN Red List of Threatened Species in 2019. *Kinixys homeana* is listed as Critically Endangered under criteria A2bcd+4bcd.
2. Slender-snouted Crocodile *Mecistops cataphractus* has most recently been assessed for The IUCN Red List of Threatened Species in 2013. *Mecistops cataphractus* is listed as Critically Endangered under criteria A2acde+3cde+4acde.
3. *Vepris laurifolia* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2016. *Vepris laurifolia* is listed as Critically Endangered under criteria C2a(i).
4. African Forest Elephant *Loxodonta cyclotis* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2020. *Loxodonta cyclotis* is listed as Critically Endangered under criteria A2abd.
5. Jentink's Duiker *Cephalophus jentinki* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2016. *Cephalophus jentinki* is listed as Endangered under criteria C1.

6. Diana Monkey *Cercopithecus diana* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2019. *Cercopithecus diana* is listed as Endangered under criteria A2cd.
7. King Colobus *Colobus polykomos* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2019. *Colobus polykomos* is listed as Endangered under criteria A2bcd.
8. Pygmy Hippopotamus *Choeropsis liberiensis* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2015. *Choeropsis liberiensis* is listed as Endangered under criteria C1.
9. Giant Ground Pangolin *Smutsia gigantea* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2019. *Smutsia gigantea* is listed as Endangered under criteria A2cd+4cd.
10. White-bellied Pangolin *Phataginus tricuspis* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2019. *Phataginus tricuspis* is listed as Endangered under criteria A2c+4cd.
11. Chimpanzee *Pan troglodytes* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2016. *Pan troglodytes* is listed as Endangered under criteria A4bcde.
12. Western Red Colobus *Piliocolobus badius* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2020. *Piliocolobus badius* is listed as Endangered under criteria A2bcd.
13. Putty-nosed Monkey *Cercopithecus nictitans* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2016. *Cercopithecus nictitans* is listed as Near Threatened under criteria A4cd.
14. Liberian Riverjack *Mesocnemis tisi* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2006. *Mesocnemis tisi* is listed as Endangered under criteria B1ab(ii,iii).
15. Timneh Parrot *Psittacus timneh* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2020. *Psittacus timneh* is listed as Endangered under criteria A2bcd+3bcd+4bcd.
16. Death Tree *Okoubaka aubrevillei* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2015. *Okoubaka aubrevillei* is listed as Endangered under criteria C2a(i).
17. *Croton dispar* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2020. *Croton dispar* is listed as Endangered under criteria B2ab(iii).

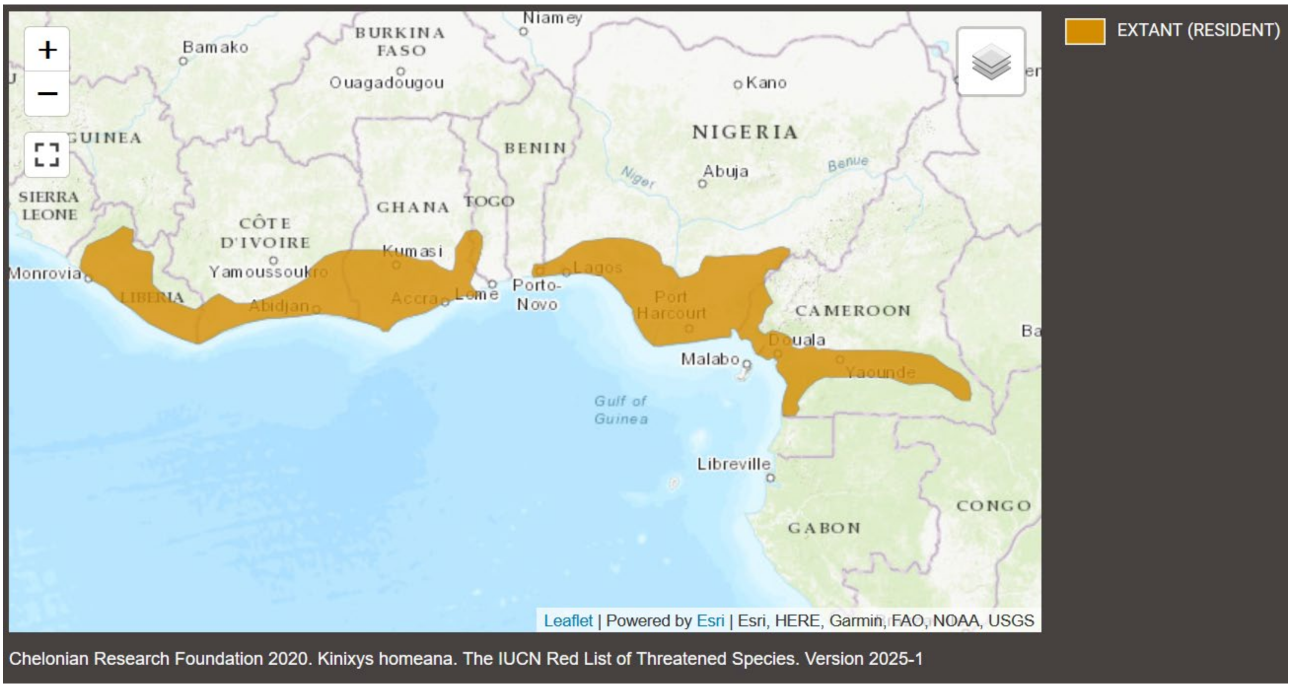

Figure 57. Range of *Kinixys homeana* (IUCN, 2025-I)

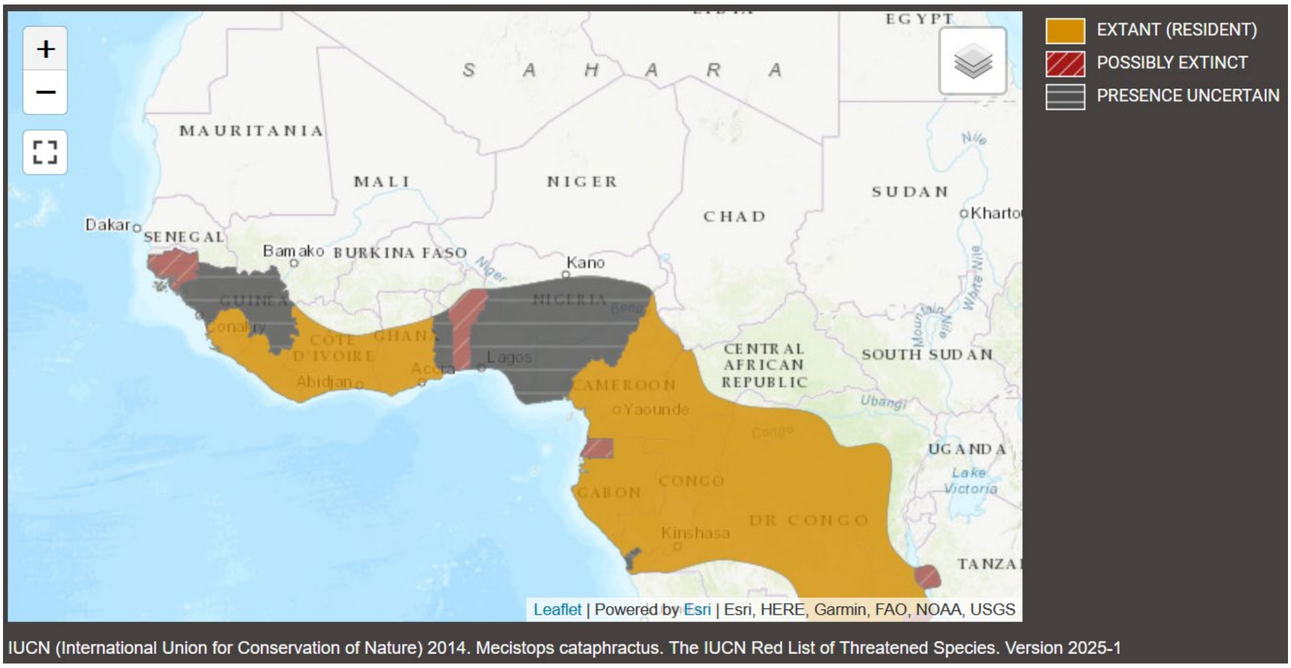

Figure 58. Range of *Mecistops cataphractus* (IUCN, 2025-I)

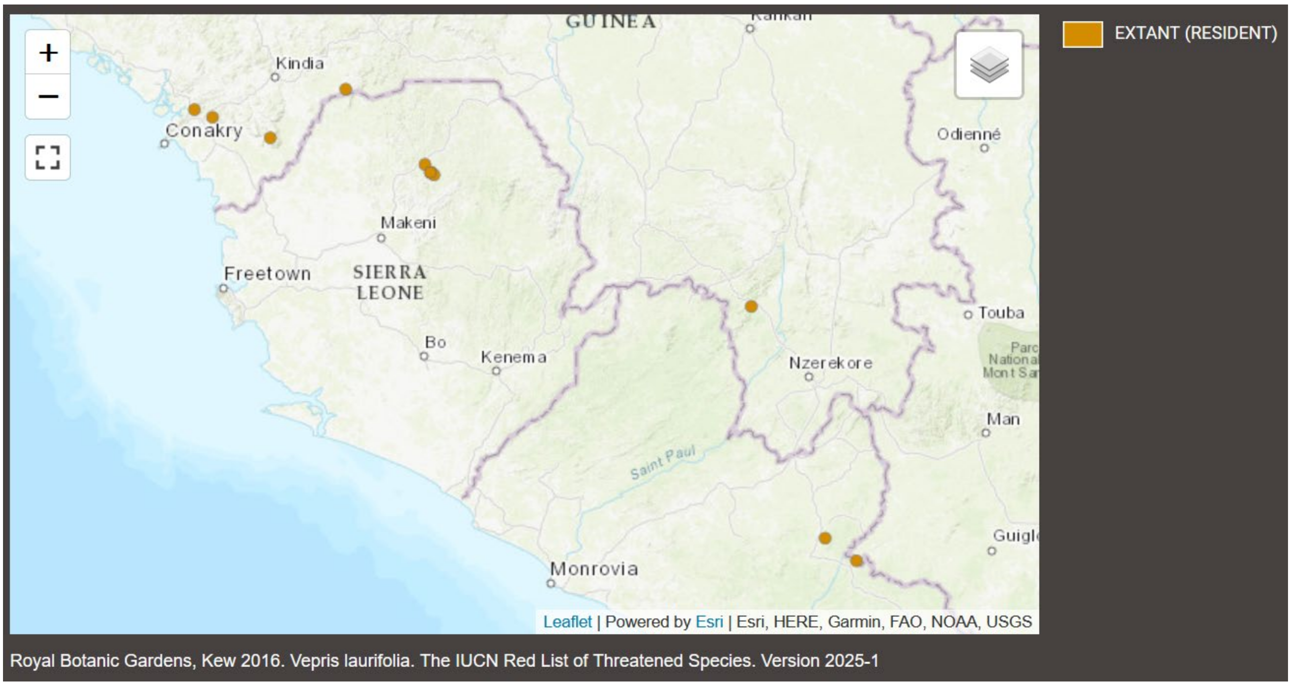

Figure 59. Range of *Vepris laurifolia* (IUCN, 2025-I)

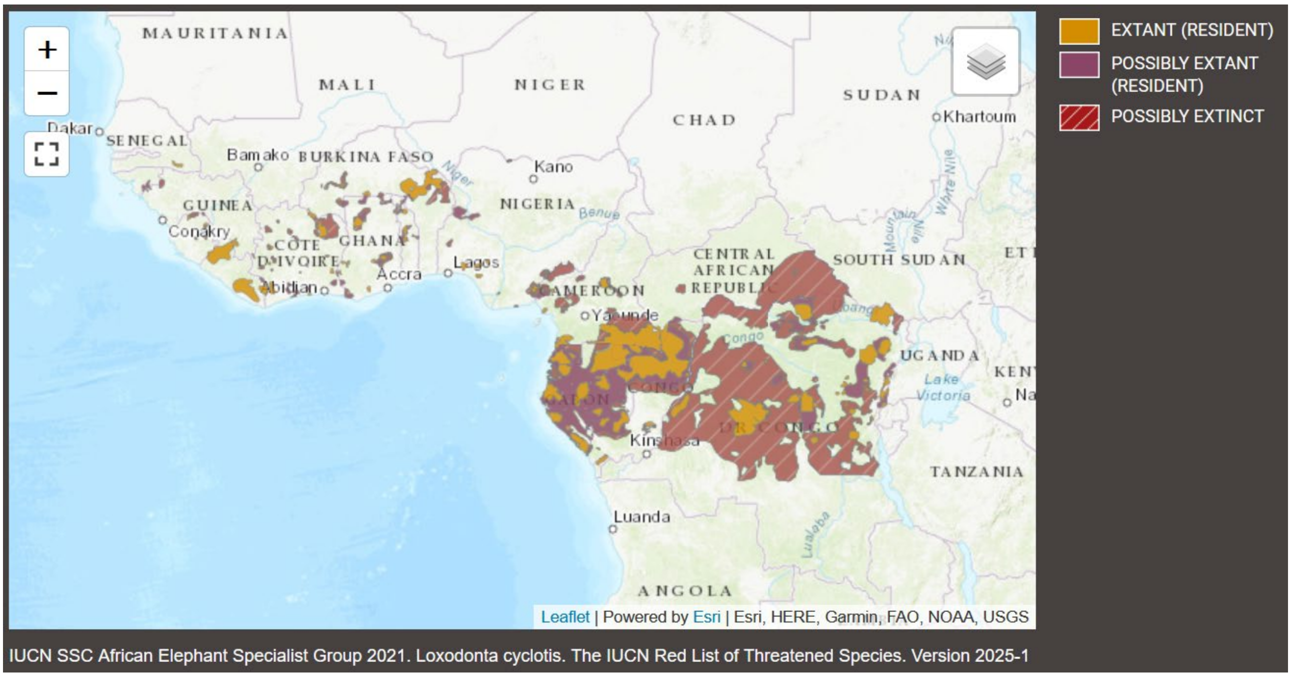

Figure 60. Range of *Loxodonta cyclotis* (IUCN, 2025-I)

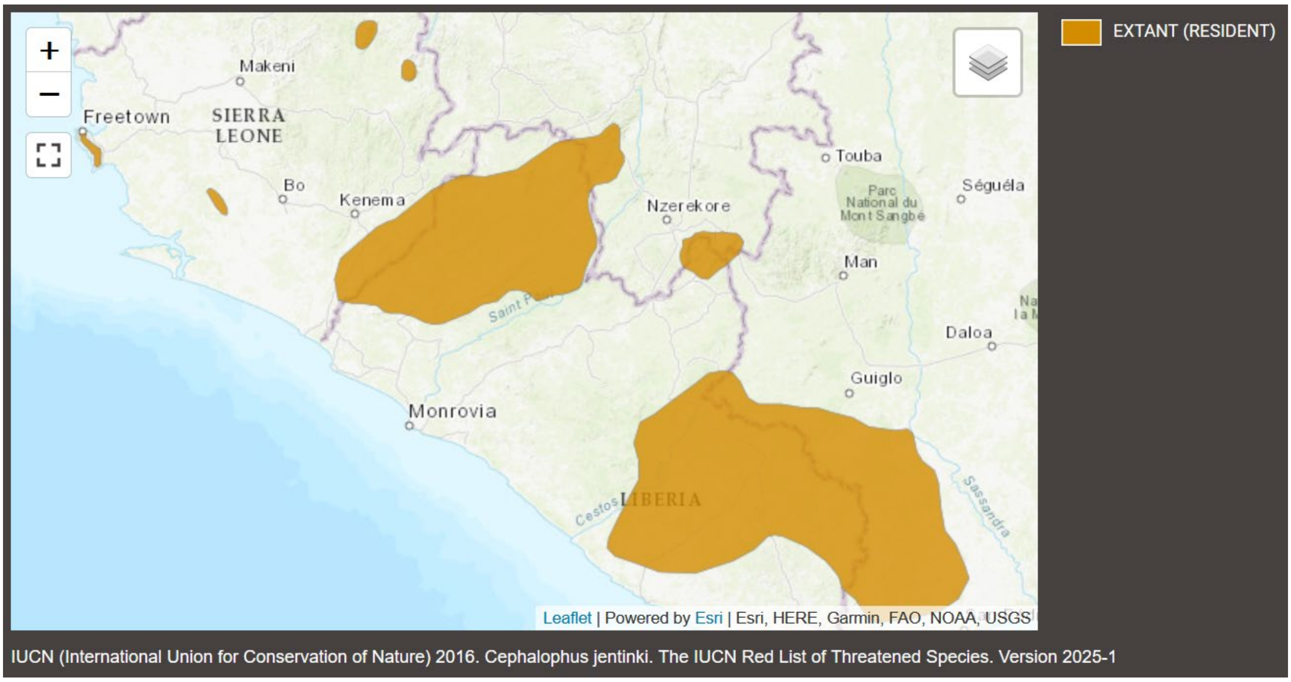

Figure 61. Range of *Cephalophys jentinki* (IUCN, 2025-I)

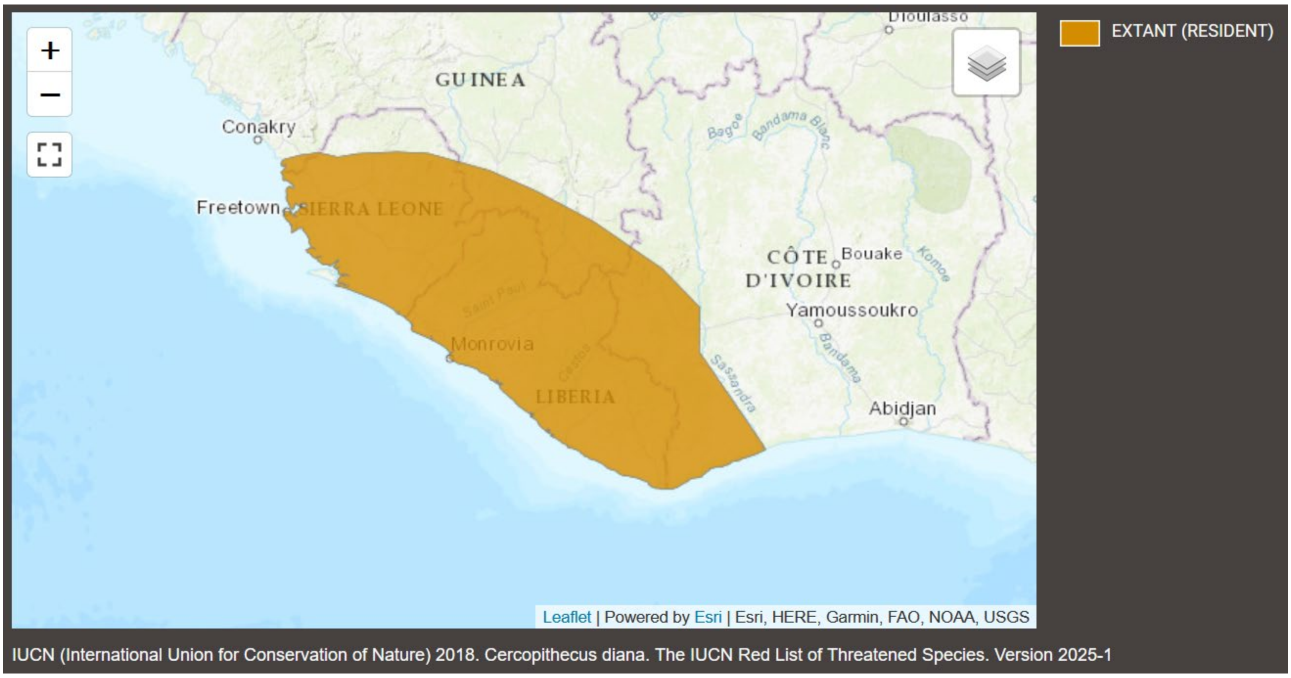

Figure 62. Range of *Cercopithecus diana* (IUCN, 2025-I)

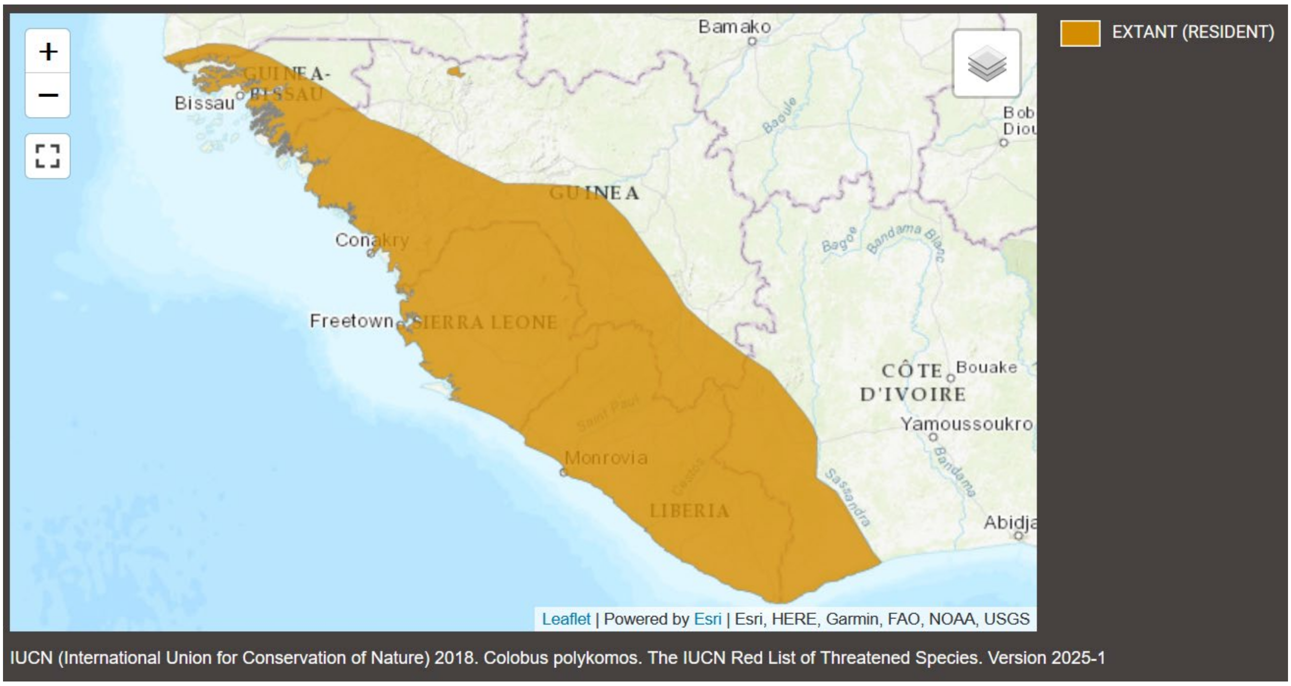

Figure 63. Range of *Colocus polykomos* (IUCN, 2025-I)

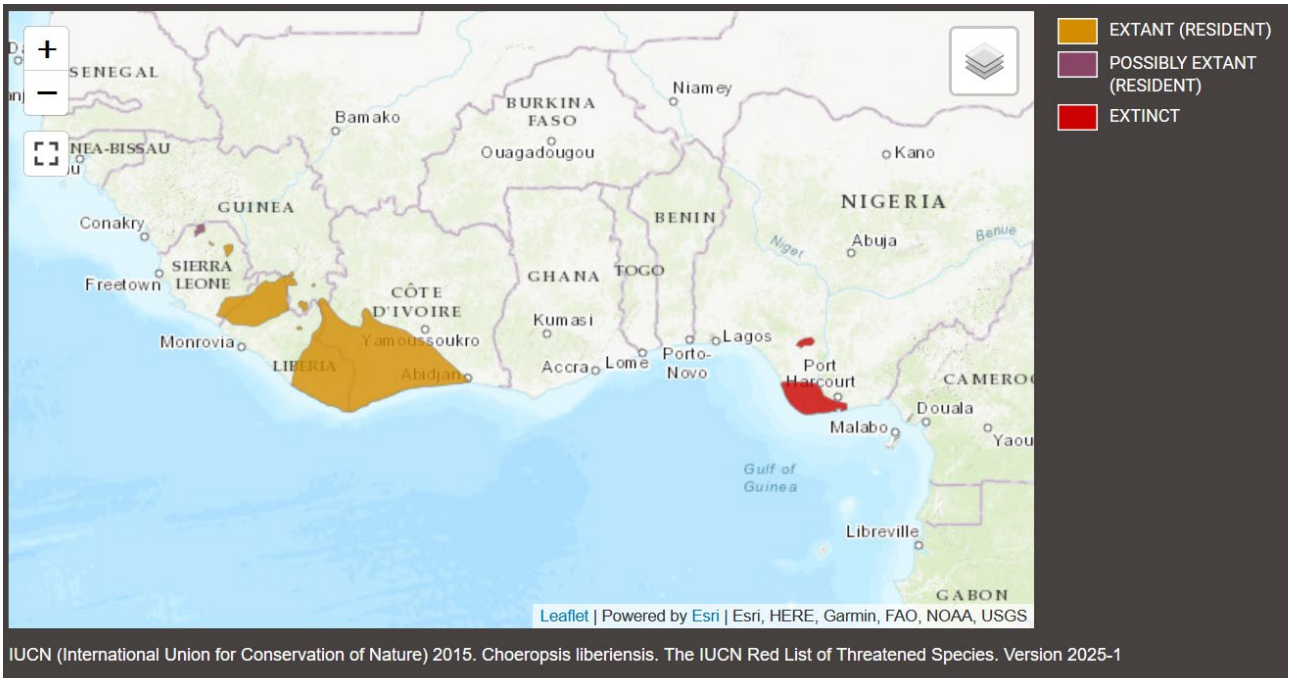

Figure 64. Range of *Choeropsis liberiensis* (IUCN, 2025-I)

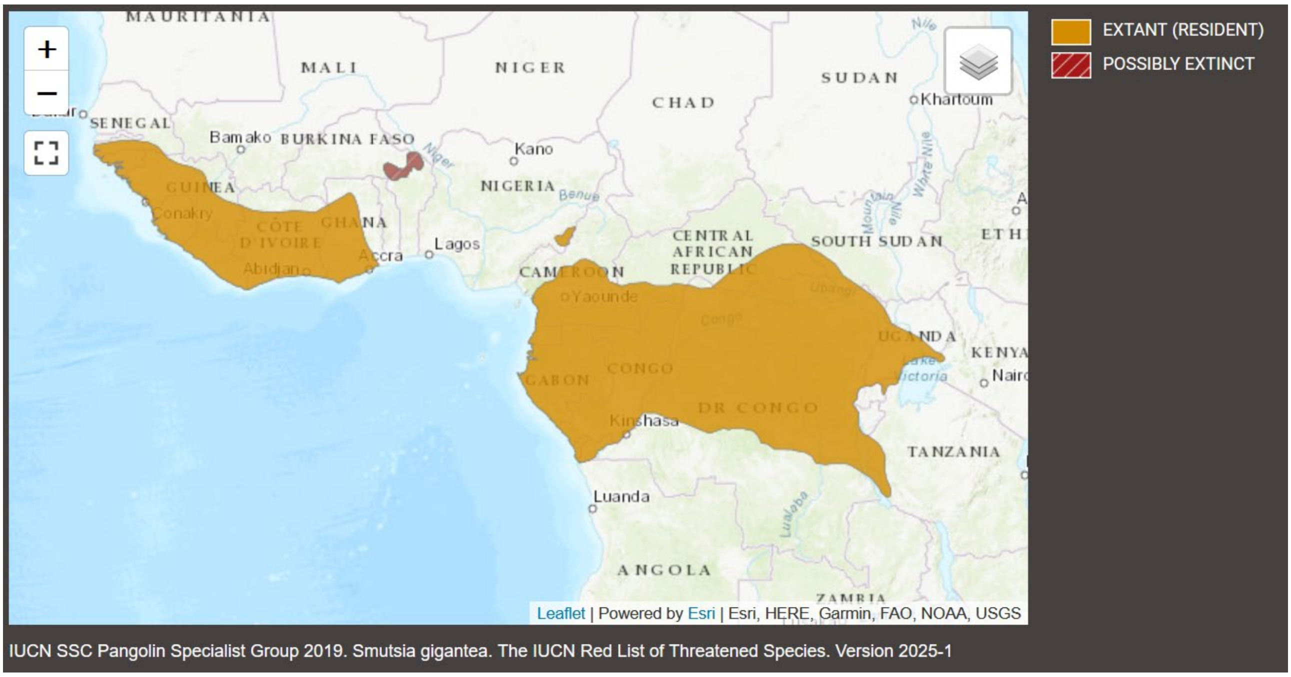

Figure 65. Range of *Smutsia gigantea* (IUCN, 2025-I)

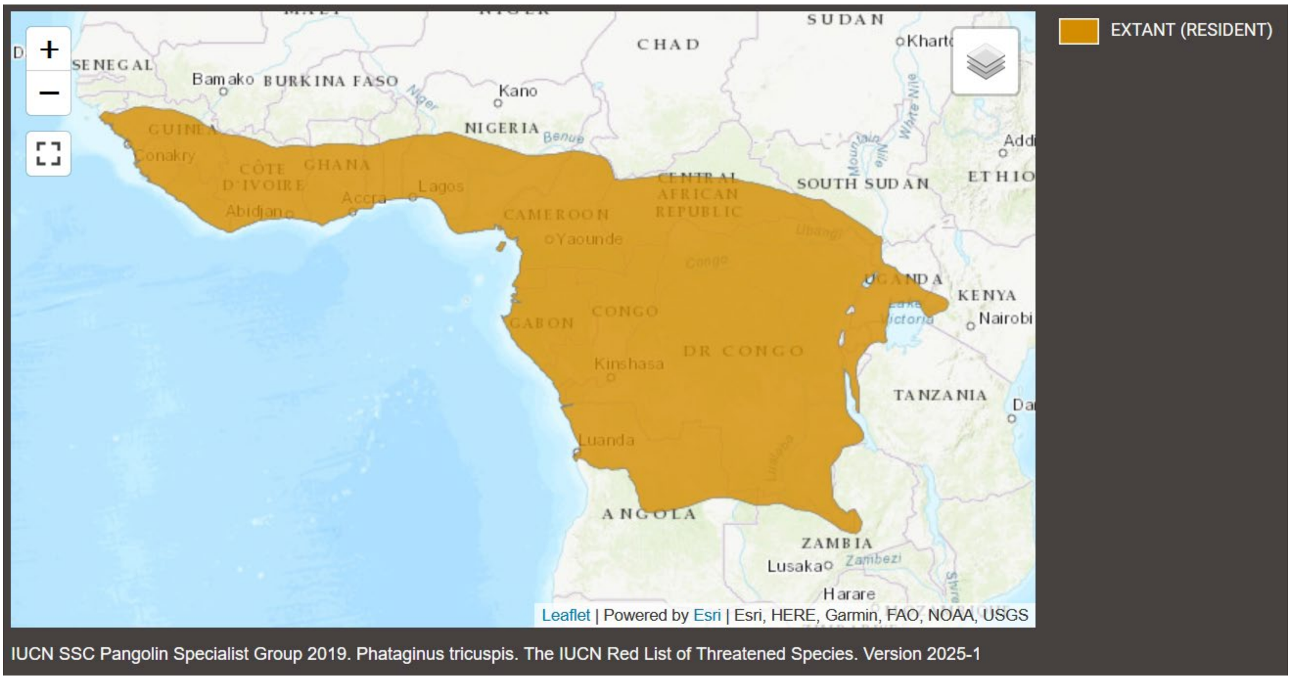

Figure 66. Range of *Phataginus tricuspis* (IUCN, 2025-I)

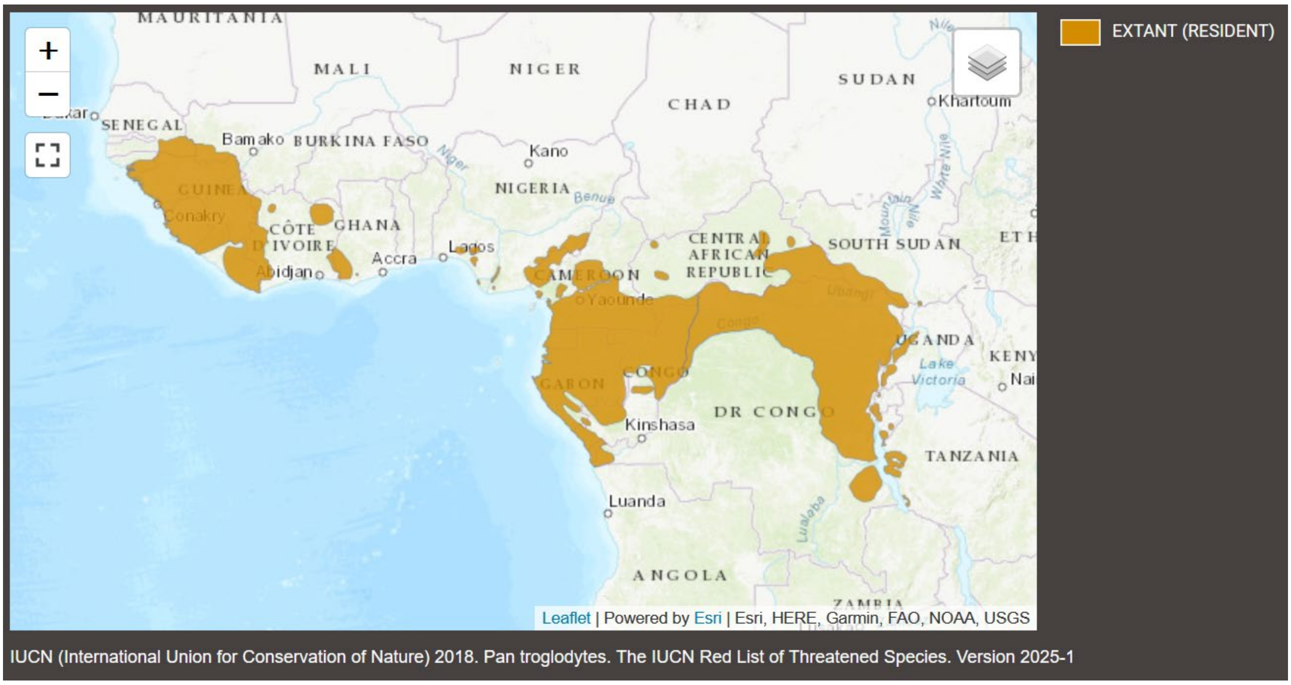

Figure 67. Range of *Pan troglodytes* (IUCN, 2025-I)

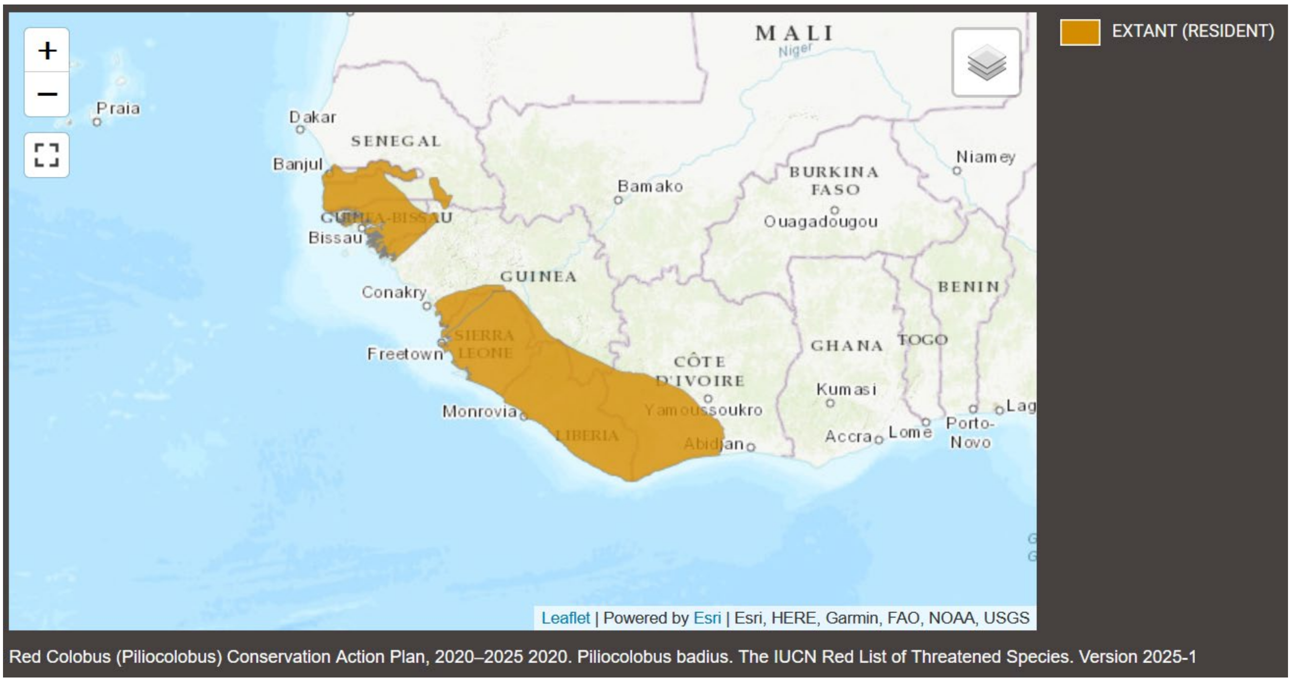

Figure 68. Range of *Pillocolobus badius* (IUCN, 2025-I)

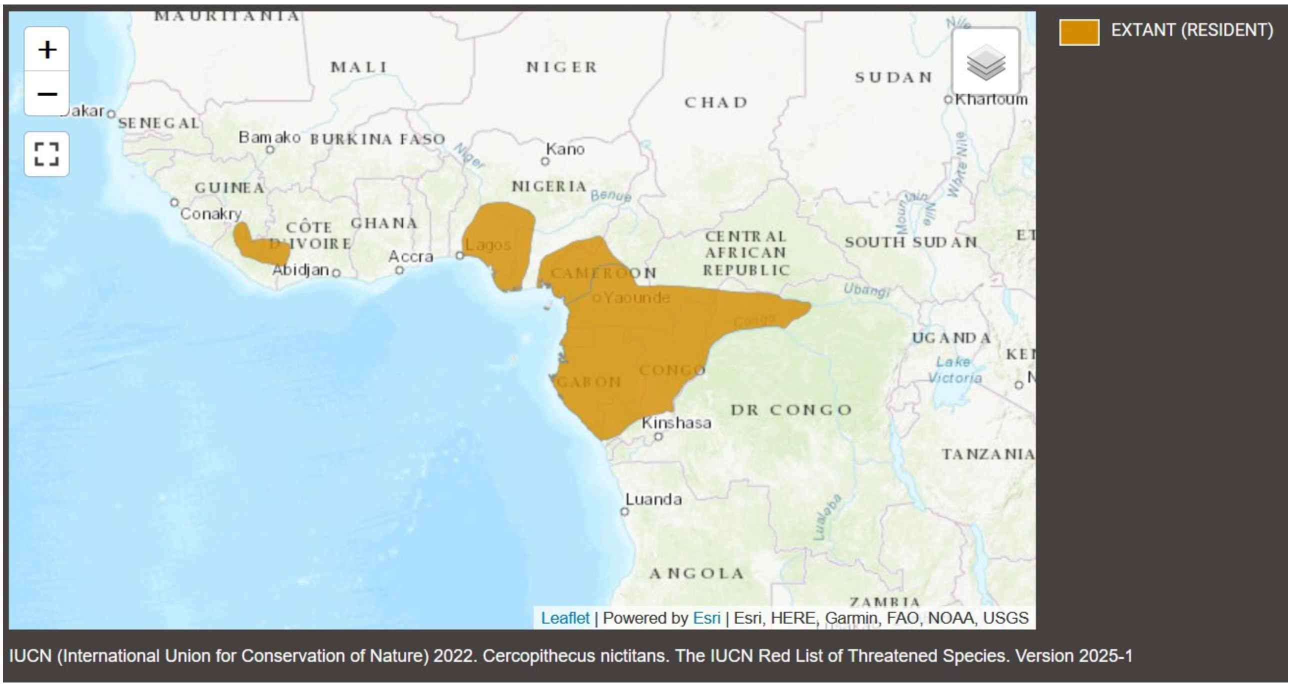

Figure 69. Range of *Cercipithecus nictitans* (IUCN, 2025-I)

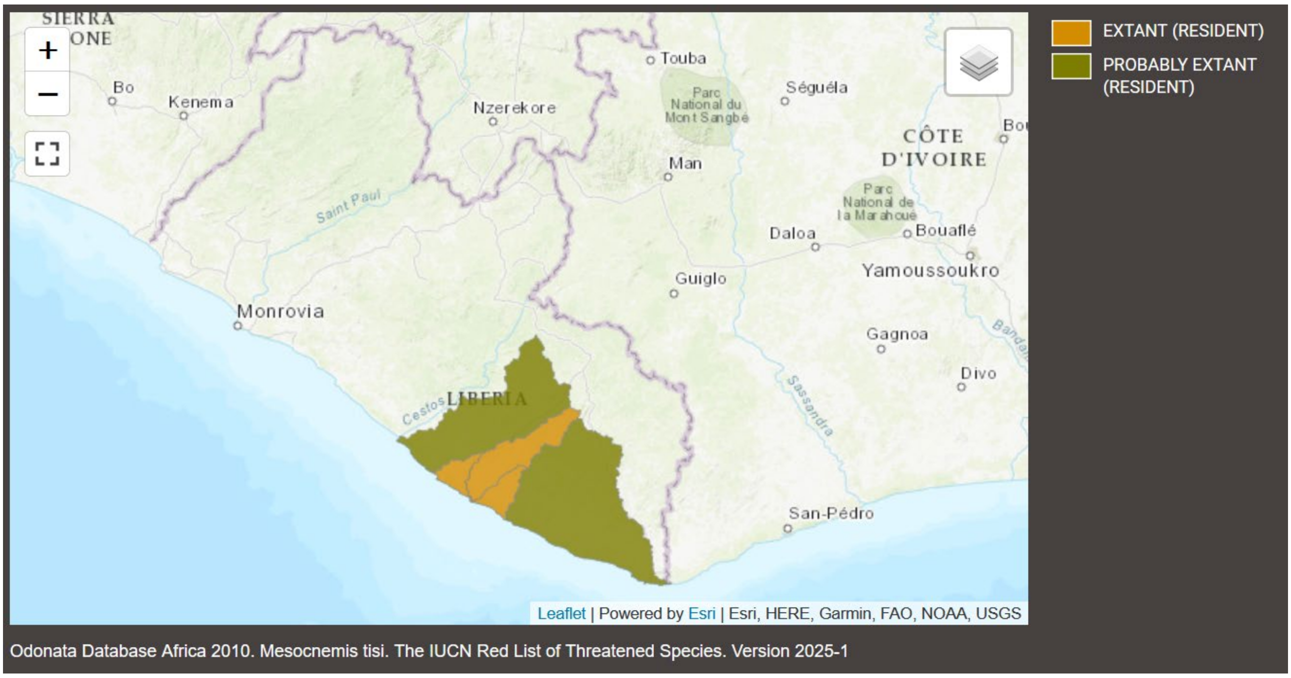

Figure 70. Range of *Mesocnemis tisi* (IUCN, 2025-I)

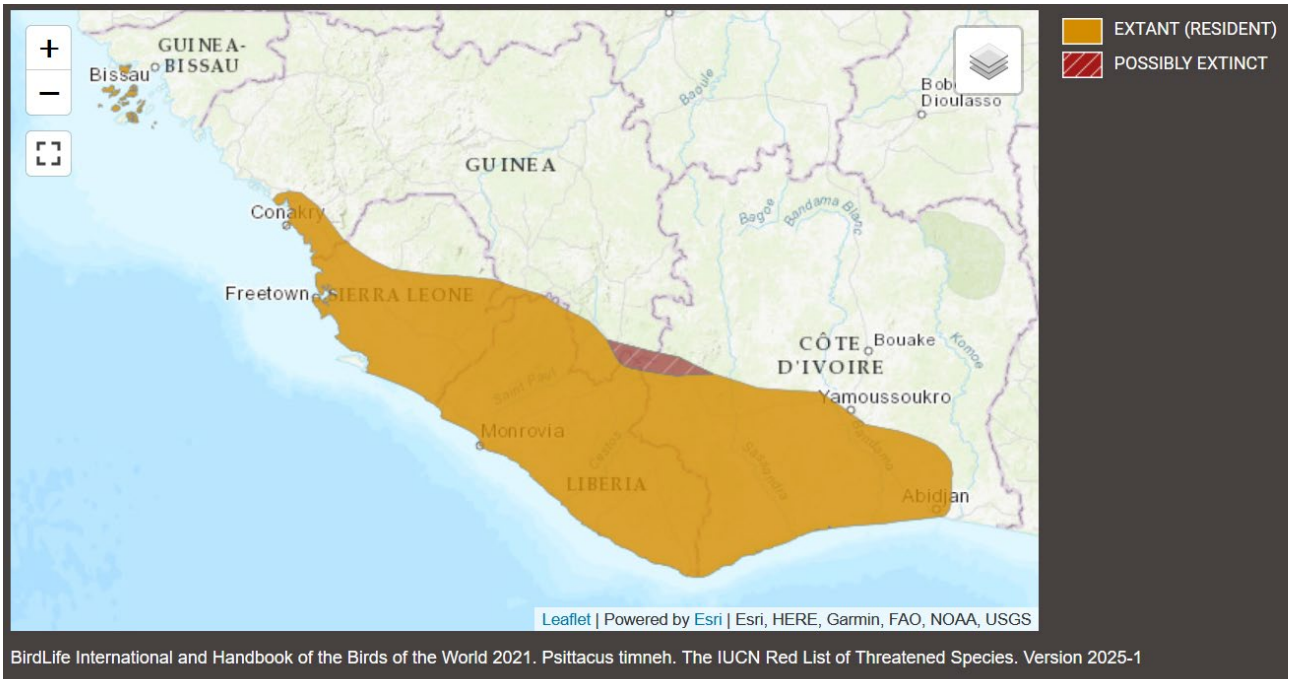

Figure 71. Range of *Psittacus timneh* (IUCN, 2025-I)

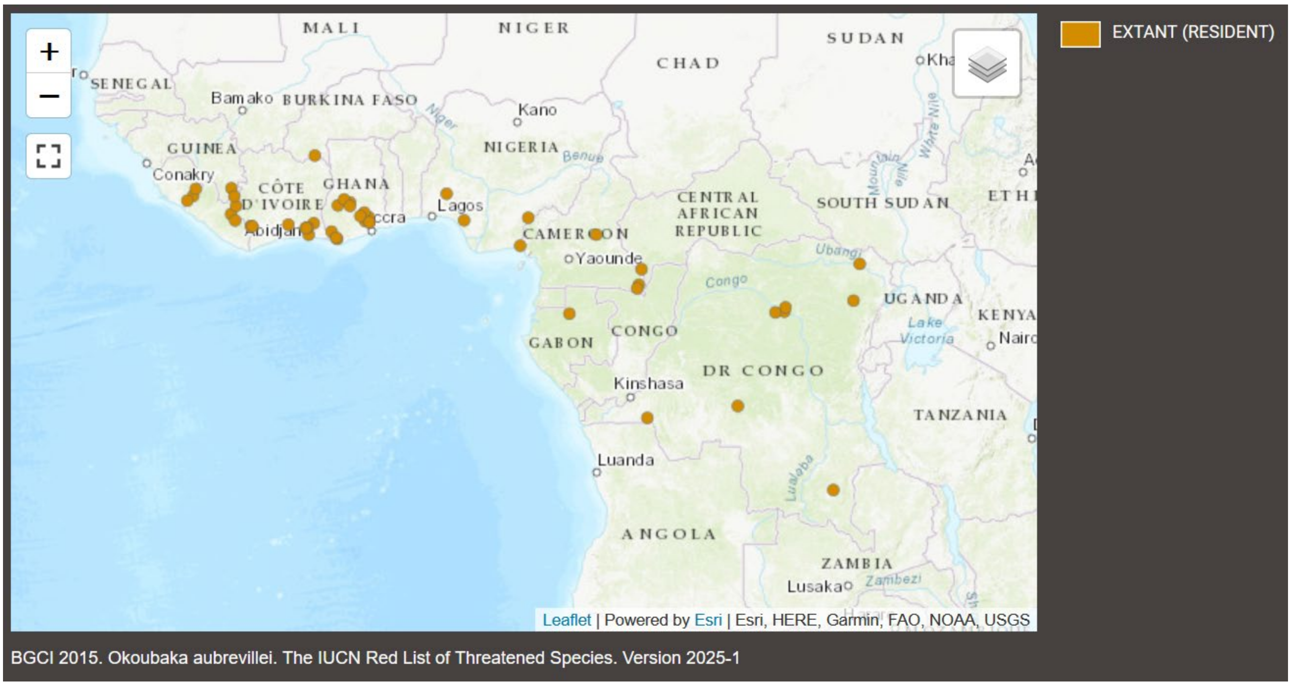

Figure 72. Range of *Okoubaka aubrivillei* (IUCN, 2025-I)

Figure 73. Range of *Croton dispar* (IUCN, 2025-I)

Table 14. Habitat of significant importance to critically endangered and endangered species

Scientific name	Common name	IUCN	BFS (2025)	Criterion (a)
Mecistops cataphractus	Slender-snouted Crocodile	CR	No	No
Kinixys homeana	Home's Hinge-back Tortoise	CR	No	No
Vepris laurifolia		CR	No	No
Loxodonta cyclotis	African Forest Elephant	CR	No	No
Cephalophus jentinki	Jentink's Duiker	EN	Yes[1]	Yes
Cercopithecus diana	Diana Monkey	EN	No	No
Colobus polykomos	King Colobus	EN	No	No
Choeropsis liberiensis	Pygmy Hippopotamus	EN	No	No
Smutsia gigantea	Giant Ground Pangolin	EN	No	No
Phataginus tricuspis	White-bellied Pangolin	EN	Yes[1]	Yes
Pan troglodytes	Chimpanzee	EN	No[2]	No
Piliocolobus badius ssp. badius	Bay Colobus	EN	No	No
Cercopithecus nictitans ssp. stampflii	Stampfli's Putty-nosed Monkey	EN	No	No
Mesocnemis tisi	Liberian Riverjack	EN	No	No
Psittacus timneh	Timneh Parrot	EN	No	No
Okoubaka aubrevillei	Death Tree	EN	No	No
Croton dispar		EN	No	No

(1) direct observations outside the 1km project buffer, (2) no direct observations, only sightings deep in the forest away from the road corridor and not within the area of influence.

Following a precautionary approach, both Jentink''s Duiker and White-bellied pangolin are highly sensitive species to disturbance and habitat modification. Even though the direct evidence of the species was found in areas beyond the 1km buffer, it is likely that the project will

4.5.2 (b) Habitat of significant importance to Endemic or restricted-range species

Following the WB ESS6, species were considered restricted-range when a habitat supports species with limited distribution, and its habitat range is less than 50,000 km^2 (for terrestrial species),

Considering all the caveats above, it should be clear that the list assessed here is therefore likely a minimum list of restricted-range species which may occur in Project AoA. A total of 3 species which might potentially qualify Project AoA as Critical Habitat are discussed in more detail below. On the basis of current knowledge, it is considered thatnone of these restricted-range species, including some also considered threatened (Section 3.4.1), qualify the Project's terrestrial AoA as Critical Habitat.

- Gola Malimbe *Malimbus ballmanni* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2021. *Malimbus ballmanni* is listed as Near Threatened under criteria A2c+3c+4c; C2a(i). This species is suspected to have a small population, and is experiencing continued habitat degradation. It is suspected to be undergoing moderately rapid declines. It has therefore been classified as Near Threatened, however new evidence about population size may result in a future change in Red List status.
- West African Scale Cricket *Arachnocephalus nigrifrons* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2019. *Arachnocephalus nigrifrons* is listed as Least Concern. The West African Scale Cricket (*Arachnocephalus nigrifrons*) is known from the islands Annobón and Sao Tomé as well as from Mt. Nimba (Guinea). Due to its wide distribution, the species is unlikely to meet the thresholds of an IUCN Red List criterion and is therefore assessed as Least Concern.
- Isabelline White-winged Serotine *Neoromicia isabella* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2016. *Neoromicia isabella* is listed as Data Deficient. This species is listed as Data Deficient because this species so far is only known from two specimens in the Simandou Range of Guinea, and one specimen from Mount Nimba, Liberia, both areas threatened by iron one mining. There is inadequate information to make an assessment of risk of extinction based on distribution or population status.

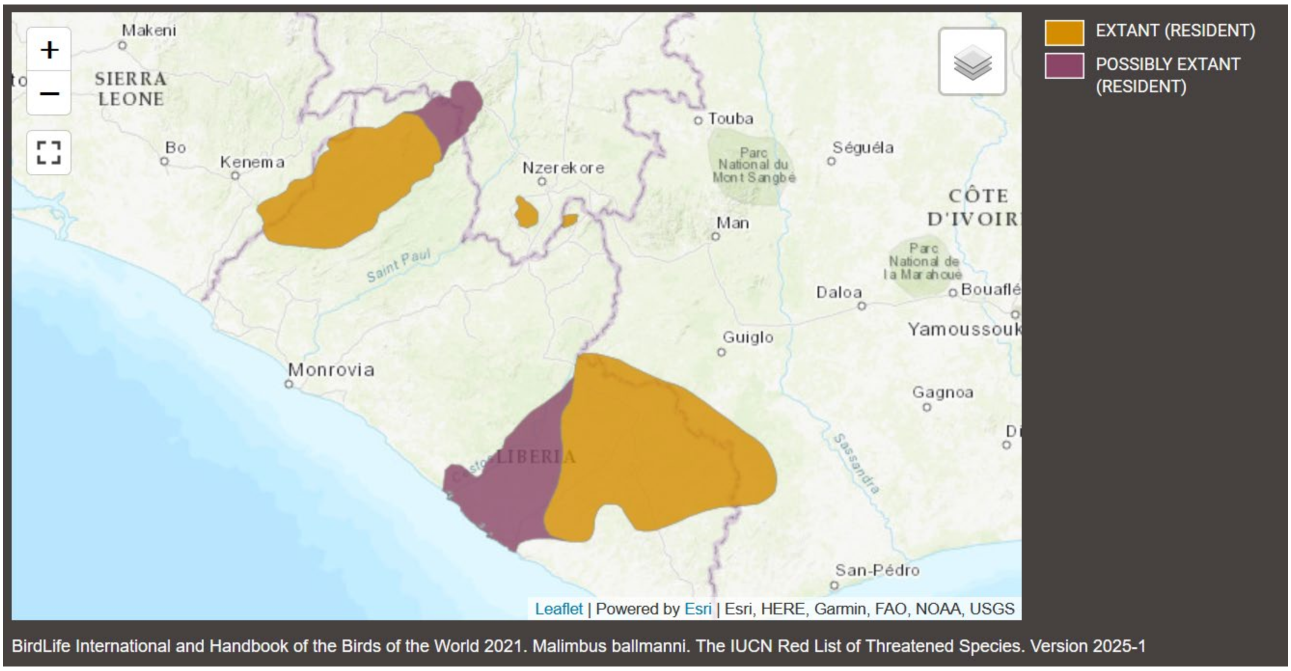

Figure 74. Range of *Malimbus ballmani* (IUCN, 2025-I)

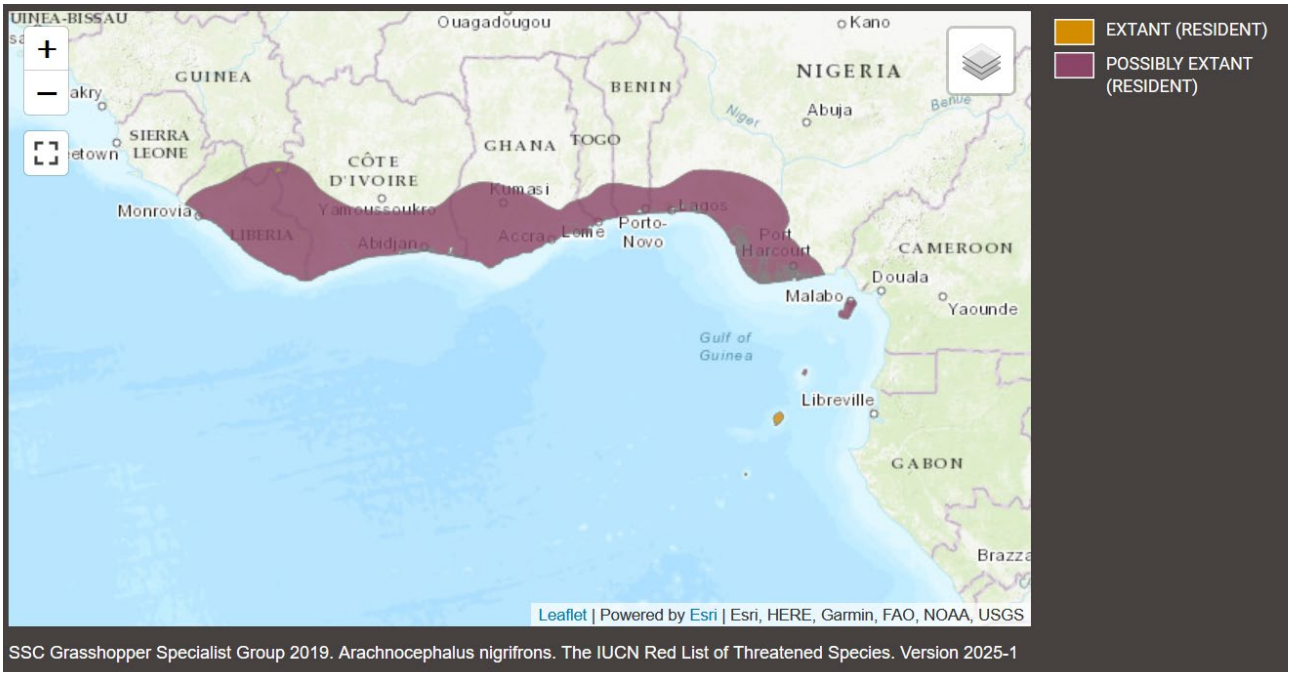

Figure 75. Range of *Arachnocephalus nigrifrons* (IUCN, 2025-I)

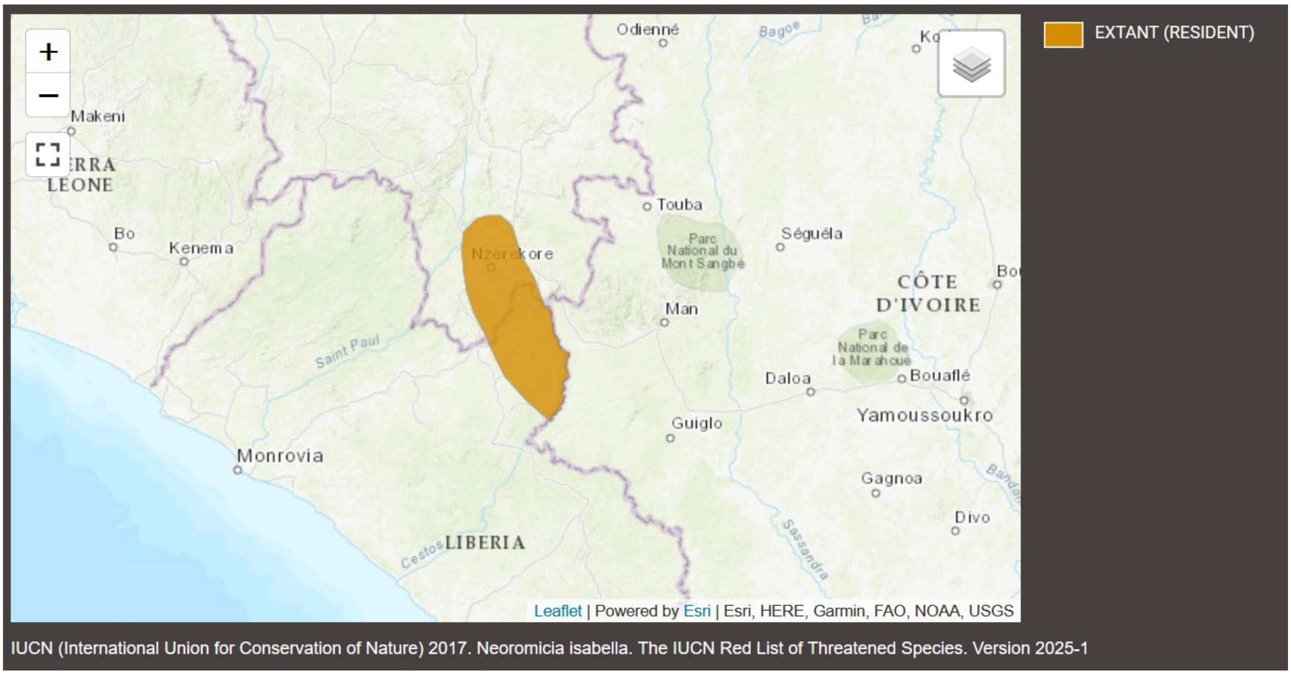

Figure 76. Range of *Neoromicia isabella* (IUCN, 2025-I)

Table 15. Criterion (b) assessment for critical habitat

Scientific name	Common name	IUCN	BFS (2025)	Criterion (b)
Malimbus ballmanni	Gola Malimbe	NT	No	No
Arachnocephalus nigrifrons	West African Scale Cricket	LC	No	No
Neoromicia isabella	Isabelline White-winged Serotine	DD	No	No

4.5.3 (c) Habitat of significant Migratory or congregatory species

Species which regularly migrate or congregate in large numbers were identified from literature and IBAT results. Nomadic species and purely altitudinal migrants were not included, as they are unlikely in this geographical context to fulfill the intent of this criterion.

- Curlew Sandpiper *Calidris ferruginea* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2024. *Calidris ferruginea* is listed as Vulnerable under criteria A2bcd+4bcd. Recent monitoring data have shown that this widely distributed species has probably declined by 30-49% over the past three generations (15 years). The exact causes of declines are unknown, but are likely to include habitat loss and degradation (particularly on stopover and wintering grounds) and climate change impacts (particularly affecting breeding productivity), as well as disturbance and hunting. Full migrant species.
- Grey Plover *Pluvialis squatarola* has most recently been assessed for *The IUCN Red List of Threatened Species* in 2024. *Pluvialis squatarola* is listed as Vulnerable under criteria A2bcd+4bcd. While Pluvialis squatarola remains a widespread and abundant species it is listed as Vulnerable in response to increasing evidence for rapid population declines over the past three generations (23 years), estimated to be more than 30%. The exact causes of these declines are unknown, but a myriad of plausible threats have been identified including habitat loss and degradation, disturbance and hunting. Full migrant species.

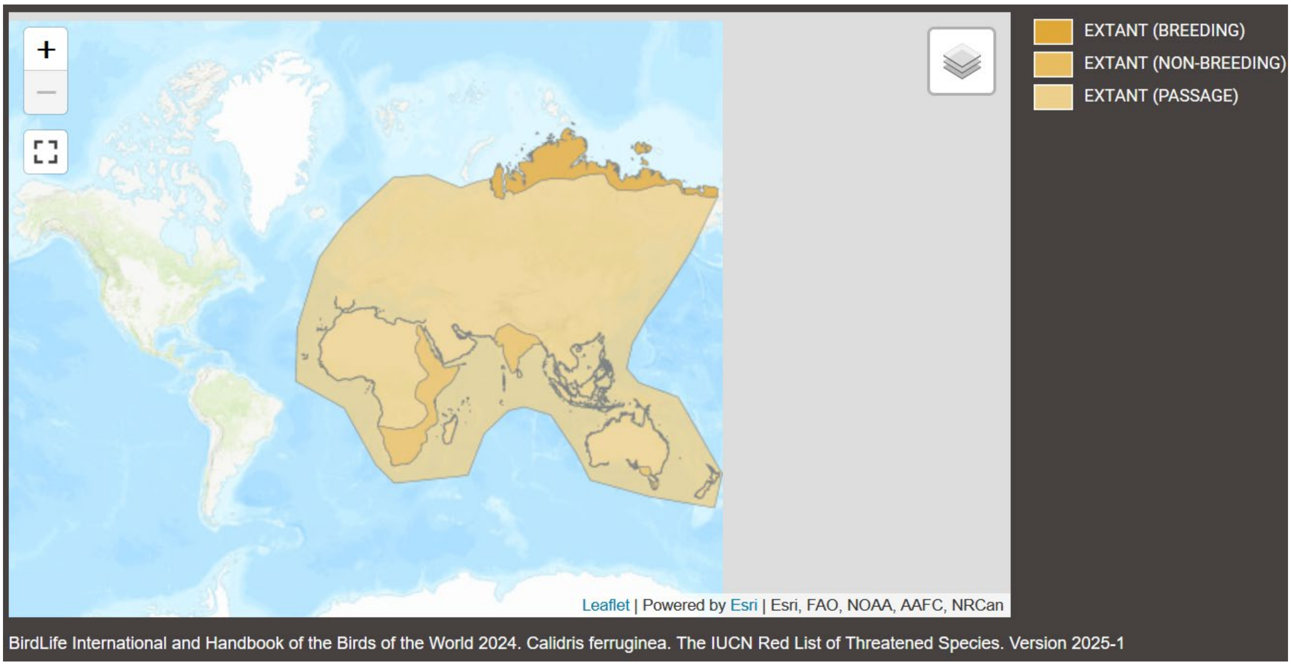

Figure 77. Range of *Calidris ferruginia* (IUCN, 2025-I)

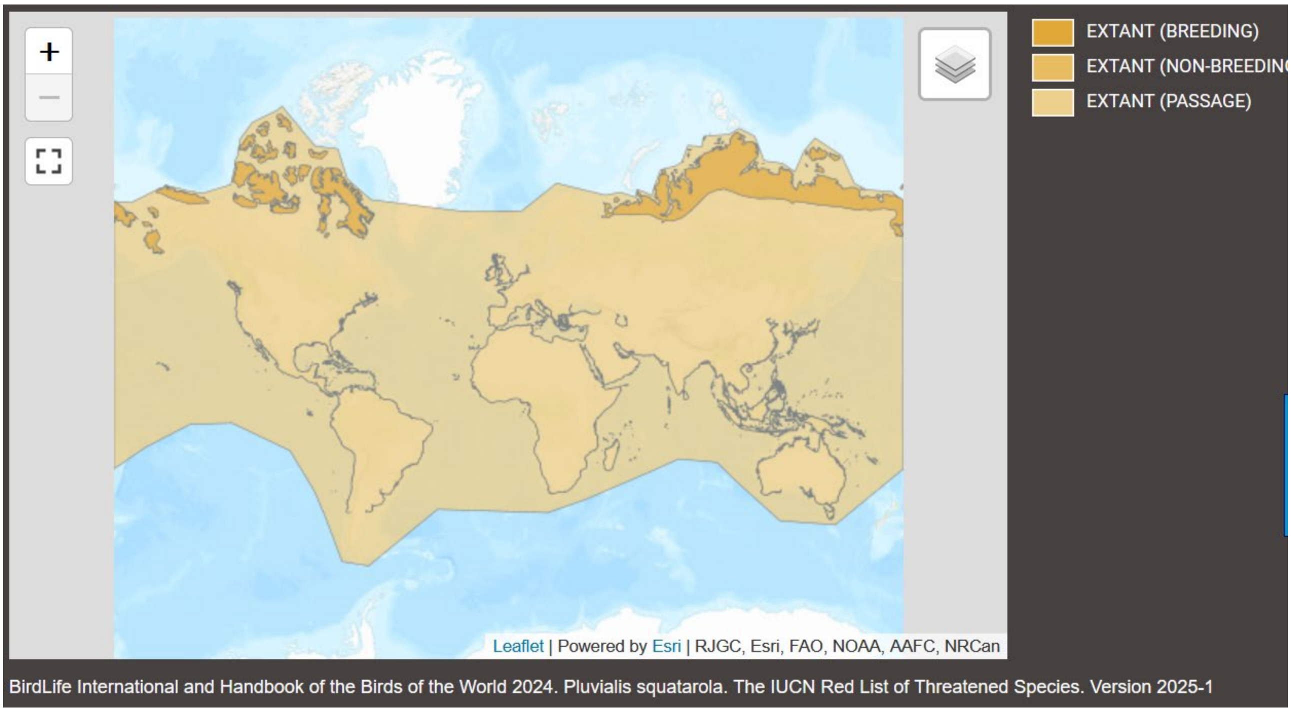

Figure 78. Range of *Pluvialos squatarola* (IUCN, 2025-I)

Table 16. Criterion 3 assessment for critical habitat

Scientific name	Common name	IUCN	BFS (2025)	Criterion 3
Calidris ferruginea	Curlew Sandpiper	VU	No	No
Pluvialos squatarola	Grey Plover	VU	No	No

4.5.4 (d) Highly threatened or unique ecosystems

In alignment with WB ESS6, this Criterion refers to e cosystems facing severe threats or those with distinct ecological characteristics, functions, or species assemblages not found elsewhere, including areas undergoing rapid degradation or fragmentation. As mentioned in Section 3.3, the Project is located in a highly modified habitat. Compared to other areas, terrestrial habitats in the Project area do not generally hold unusually unique ecosystems and thus do not qualify the AoA as Critical Habitat. Even though, there are some locations with potential wetlands and swamps, these areas are minor and have already been disturbed for development activities already (e.g. palm oil and other farming activities, see **Section 3.3.2**).

4.5.5 (e) Ecological functions or characteristics that are needed to maintain the vialibility of criteria a and e

In alignment with WB ESS6, this Criterion includes key ecological processes such as pollination, seed dispersal, predator-prey dynamics, or water regulation (including also ecosystem services that support biodiversity). Available information on local community dependency, and values of, natural resources in the Project area is currently far too coarse to assess the relative and absolute importance of related ecosystem services at a scale relevant to identifying Critical Habitat. It is beyond the scope of this rapid assessment to collect additional information on ecosystem services, and thus to assess which may qualify the project area as Critical Habitat.

4.5.6 Summary

The Critical Habitat Assessment (CHA) used a 1 km buffer on either side of the road corridor as the primary Area of Analysis (AoA) for evaluating direct and indirect biodiversity risks associated with the Project. Based on field surveys and a review of relevant secondary data, the presence of two Endangered species—Jentink's Duiker (Cephalophus jentinki) and White-bellied Pangolin (Phataginus tricuspis)—was confirmed, but outside the 1km buffer defined as the AoA. These findings triggered further evaluation under ESS6 Criterion (a), which considers whether a given area provides habitat of significant importance to Critically Endangered or Endangered species. Nevertheless, the study area has been heavily modified in the last decades (as seen from the recent tree cover loss throughout the 40km, as well as the evidence from the ground on forest clearance activities and land-use change), and the field records are located beyond the 1km buffer defined in the AoA.

In addition, two Key Biodiversity Areas (KBAs)—Gio National Forest and Zwedru Forest—were identified through IBAT screening within 10 km of the project corridor. Although not intersecting the 1 km AoA or the project footprint, these areas were reviewed in the contextual analysis of biodiversity risk. Gio National Forest is a mosaic of mature forest and regenerating areas, recognized for harboring primates and endemic species. Zwedru Forest includes significant forest cover and is known for high amphibian diversity. No direct project activities or infrastructure fall within these KBAs, and no significant edge or access effects are anticipated based on road alignment and buffer distance.

Table 17. Critical habitat assessment

Species/Habitats	Common name	IUCN	C1	C2	C3	C4	C5
Mecistops cataphractus	Slender-snouted Crocodile	CR	--	--	--		
Kinixys homeana	Home's Hinge-back Tortoise	CR	--	--	--		
Vepris laurifolia	--	CR	--	--	--		
Loxodonta cyclotis	African Forest Elephant	CR	--	--	--		
Cephalophus jentinki	Jentink's Duiker	EN	x	--	--		
Cercopithecus diana	Diana Monkey	EN	--	--	--		
Colobus polykomos	King Colobus	EN	--	--	--		
Choeropsis liberiensis	Pygmy Hippopotamus	EN	--	--	--		
Smutsia gigantea	Giant Ground Pangolin	EN	--	--	--		
Phataginus tricuspis	White-bellied Pangolin	EN	x	--	--		
Pan troglodytes	Chimpanzee	EN	--	--	--		
Piliocolobus badius ssp. badius	Bay Colobus	EN	--	--	--		
Cercopithecus nictitans ssp. stampflii	Stampfli's Putty-nosed Monkey	EN	--	--	--		
Mesocnemis tisi	Liberian Riverjack	EN	--	--	--		
Psittacus timneh	Timneh Parrot	EN	--	--	--		
Okoubaka aubrevillei	Death Tree	EN	--	--	--		
Croton dispar	--	EN	--	--	--		
Malimbus ballmanni	Gola Malimbe	NT	--	--	--		
Arachnocephalus nigrifrons	West African Scale Cricket	LC	--	--	--		
Calidris ferruginea	Curlew Sandpiper	VU	--	--	--		
Pluvialos squatarola	Grey Plover	VU	--	--	--		
Highly threatened or unique ecosystems						--	--
Ecological functions						--	--

While the Jentink's Duiker and White-bellied Pangolin were detected within the AoA, several key factors suggest that the project area may not qualify as Critical Habitat under ESS6. The AoA is characterized by heavily modified and fragmented secondary vegetation, the result of decades of agricultural expansion and other land use pressures (Section 4.3). Although viable local populations may persist, the habitat does not exhibit characteristics of irreplaceability or ecological integrity at a scale that would render it critical to the survival of the species in question.

ESS6 Guidance Note GN14.1 emphasizes that Critical Habitat designation is not automatic upon species presence. Instead, it requires a qualitative judgment as to whether the habitat supports key life cycle functions (e.g., breeding, feeding, or migration) at a level of significance. In this case, while direct observations of two species were made (including camera trap footage and signs), these occurred primarily in disturbed habitat types. There is no evidence to suggest that the project area provides irreplaceable, high-quality, or ecologically intact habitat essential for species recovery

While no direct or indirect evidence (e.g. dung, nests, tracks, camera trap records) of chimpanzees was observed during field surveys, community interviews referenced historical sightings, with some reports dated between 2017 and 2021 in Bitterball and Mary Weah Villages. Although these do not confirm the current presence, such reports suggest the possibility of rare or transient use of the broader area by chimpanzees. Based on the absence of physical evidence, degraded habitat conditions, and lack of signs of core ecological function (e.g., foraging or breeding areas), the AoA is not considered critical habitat for chimpanzees under ESS6 Criterion (a).

Table 18. Key Considerations to Determine Critical Habitat Status under Criterion a) Habitat of Significant Importance to CR/EN Species

Factor	Implication	Assessment
Population viability	Does the area support a viable local population of CR/EN species (e.g. breeding, foraging, or key life cycle functions)?	In the case of the duiker target species, several direct observations (both through camera traps and dung/footprints) were found during the additional biodiversity field surveys, but beyond the 1km AoA buffer. This is an important indication that the area, even disturbed, supports viable local population of the species. In the case of the white-bellied pangolin, direct observations were found from camera traps (locations 17 and 22) in young secondary forests (disturbed vegetation). Most of the study area is covered by this type of vegetation, therefore it is likely that the AOI supports viable local populations of this target species.
Irreplaceability	Is this habitat essential or irreplaceable for the species regionally/globally?	The AoA represents a degraded secondary forest with high anthropogenic pressure. While it provides habitat, it is not known to support irreplaceable populations or contain unique features necessary for the survival of the species.
Habitat quality	Is the habitat condition sufficiently intact to support species recovery or persistence?	The vegetation is largely disturbed secondary growth. While still used by target species, its quality is reduced. The habitat is likely of marginal importance compared to better quality habitat elsewhere in the species' range.
Degree of fragmentation	If too degraded or fragmented, the area may not be considered	The area is highly fragmented by human activity, which reduces its suitability for long-term persistence or connectivity.

	critical even if species are present.	However, the presence of species indicates some residual ecological value, warranting precautionary measures.

Nevertheless, the precautionary principle has been applied for all species, including those observed (i.e. Jentink's Duiker, White-bellied Pangolin) and those with indirect reports only (i.e. Chimpanzees), and biodiversity-related mitigation and monitoring measures—including species-specific management actions—have been integrated into the ESIA and ESMP (see Chapter 6 and Tables 32, 37, 38, and 40). These measures are designed to prevent, minimize, and monitor potential adverse impacts on these species and to ensure that the project contributes to achieving no net loss, in accordance with ESS6.[1]

[1] For chimpanzees, while no direct evidence was found, the precautionary principle also is applied through the insion of specific awareness and reporting measures in the ESMP, recognizing the potential for transient presence. As part of the broader biodiversity mitigation strategy, chimpanzee-specific measures—such as sighting protocols and community awareness campaigns—have been included in Tables 38 and 40. These do not imply confirmed presence but serve as precautionary safeguards aligned with good international practice.

5 IMPACT ASSESSMENT

5.1 PROJECT IMPACTS

5.1.1 Habitat loss and connectivity

Habitat fragmentation is an umbrella term describing the complete process by which habitat loss results in the division of large, continuous habitats into a greater number of smaller patches of lower total area, isolated from each other by a matrix of dissimilar habitats. Barrier Effect: The creation of gaps in habitat preventing or restricting the movement of wildlife due to roads. Habitat fragmentation is a landscape-level phenomenon. Fragmentation leads to decreased area of available habitat, increased isolation of organisms and ecosystem processes and the creation of habitat edges. Reduced fragment area and increased fragment isolation generally reduces abundance of birds, mammals, insects, and plants. The number of species drops significantly when more than 80 % of the original habitat is lost and as habitat remnants become isolated. Fragmentation of an animals' habitat (shaded areas) reduces the ability of individuals to move across the landscape. Some connectivity may be sustained through small habitat fragments or corridors. Roads impose additional movement barriers and strengthen the isolation effect caused by habitat fragmentation.

In general, species with limited mobility, large area requirements, or strong dependence on a certain type of habitat will be among the first to suffer the effects of habitat loss and isolation. Species that are abundant at a landscape scale, that utilize a variety of habitats and are more resilient to disturbance may not be affected so significantly. When the effect is below a critical threshold, populations may be sustained, but beyond this threshold, even small changes to the environment may cause unexpected and irreversible effects.

Traffic intensity and vehicle speed influence the barrier effect. Road width, verge characteristics, the animals' behavior and its sensitivity to habitat disturbances are also key factors. With increasing traffic density and higher vehicle speed, mortality rates usually increase until the deterrent effect of the traffic prevents more animals from getting killed.

The magnitude of impacts on biodiversity by road projects depend on:

- Road type: national road or secondary road often have differences in surface type, number of lanes and traffic flow. National or first order roads (e.g. highways) often represent a bigger barrier to wildlife, as well as more area/vegetation is needed to be intervened during the construction phase.
- Surface (paved or unpaved): traffic levels and speed limits are often higher in paved/asphalt roads compared to unpaved/gravel roads. Higher traffic and speed will have impacts of higher magnitude to fauna.
- Width of right of way: number of lanes: wider roads will represent a bigger barrier to species in terms of crossing.
- Fences and separators: if present, this will affect species movement and represent a barrier to movement.
- Traffic levels and vehicle classification: In general, higher traffic will have impacts of higher magnitude to wildlife (**Table 18**).
- Target species, expected impacts of road projects differ in type and magnitude in regards to different taxonomic groups (**Table 19**)

Table 19. Traffic intensity vs species permeability (Quintero, 2022)

Traffic Intensity	Permeability
<1000 vehicles/day	Permeable to most species
1000-4000 vehicles/day	Permeable to some species but avoided by most sensitive species
4000-10000 vehicles/day	Most species are scared away by barriers, traffic and noise; others may try crossing and might be run over
>10000 vehicles/day	Impermeable to most species

Latest traffic surveys show that the maximum traffic intensity (vehicles/day) reach around 3100, which means that generally the road project might be permeable to some species, but some sensitive species might avoid the project road (**Table 20**). Similarly, the vast majority of vehicles types are motor cycles (around 85%). Smaller vehicles will have less impact to different taxonomic groups due to size and average speed.

In general, species with limited mobility, large area requirements, or strong dependence on a certain type of habitat will be among the first to suffer the effects of habitat loss and isolation. Species that are abundant at a landscape scale, that utilize a variety of habitats and are more resilient to disturbance may not be affected so significantly. When the effect is below a critical threshold, populations may be sustained, but beyond this threshold, even small changes to the environment may cause unexpected and irreversible effects.

Traffic intensity and vehicle speed influence the barrier effect. Road width, verge characteristics, the animals' behaviour and its sensitivity to habitat disturbances are also key factors. With increasing traffic density and higher vehicle speed, mortality rates usually increase until the deterrent effect of the traffic prevents more animals from getting killed.

Table 20: General impacts of road projects to different taxonomic groups (Quintero, 2022)

Taxa	Major impacts from road projects				
	Habitat loss	**Habitat fragmentation**	**Disturbance-induced behavioral changes**	**Injury/Mortality**	**Impediment to movement**
Large mammals	Moderate	High	High	High	High
Medium/small mammals	High	High	High	High	High
Arboreal animals/gliders	High	High	High	High	High
Birds	Moderate	Moderate	--	High	Moderate
Reptiles	High	High	High	High	High
Amphibians	High	Moderate	--	High	High
Invertebrates	Moderate	Moderate	High	High	High

Table 21. Traffic intensity in the project road (Aurecon, 2017)

Table 3-2: Sections and Link traffic										
Ganta to Zwedru - Sections (Traffic Counts (6:00 to 18:00))										
Section	**Description**	**Motor cycles**	**Light Vehicles**	**Mini Busses**	**Medium Busses**	**Large Busses**	**2 Axle Trucks**	**3-4 Axle Trucks**	**5+ Axle Trucks**	**Total**
1-A	Ganta - Railway (North)	6,708	780	27	11	8	24	10	5	7,570
1-B	Ganta - Railway (South)	3,637	429	16	8	3	21	9	6	4,127
2	Railway - Tappita	2,188	288	10	7	1	38	19	8	2,558
3-A	Tappita - Toe Town (West)	2,765	299	9	6	1	57	28	8	3,174
3-B	Tappita - Toe Town (East)	1,450	204	10	2	1	41	21	6	1,735
4	Toe Town - Zwedru	657	125	7	1	1	28	11	4	833
5	Toe Town - Côte d'Ivoire	260	19	-	-	-	3	-	-	281

Landscape ecology provides a theoretical framework for local landscape study. Landscape is understood as an area of heterogeneous terrain composed of a set of interacting ecosystems that is similarly repeated (Forman et al., 1986). Landscape dynamics depend on the relationships between societies and their environment, creating changing structures in space and time. The resulting spatio-temporal heterogeneity controls numerous movements and flows of organisms, matter and energy. Therefore, in order to understand the mechanisms for the maintenance of species and the permanence of water flow or nutrients, it is essential to take into account the determinants of heterogeneity origin in the environment. In this sense, landscape ecology integrates the object of study (landscape), its determinants (the environment and society) and its effects on ecological processes (Burel & Baudry, 2003)

Habitat fragmentation can be defined as the process by which habitat loss results in large and continuous division into smaller, isolated remnants (Didham, 2010). The following figure shows an example on how fragmentation modifies the geometric configuration of landscapes. Fragmented landscapes differ in the size and shape of the patches, spatial configuration and the floristic composition that they harbour. Most landscape fragmentation studies have been carried out at the level of fragments, where they individually are the unit of study (Bennett & Saunders, 2010).

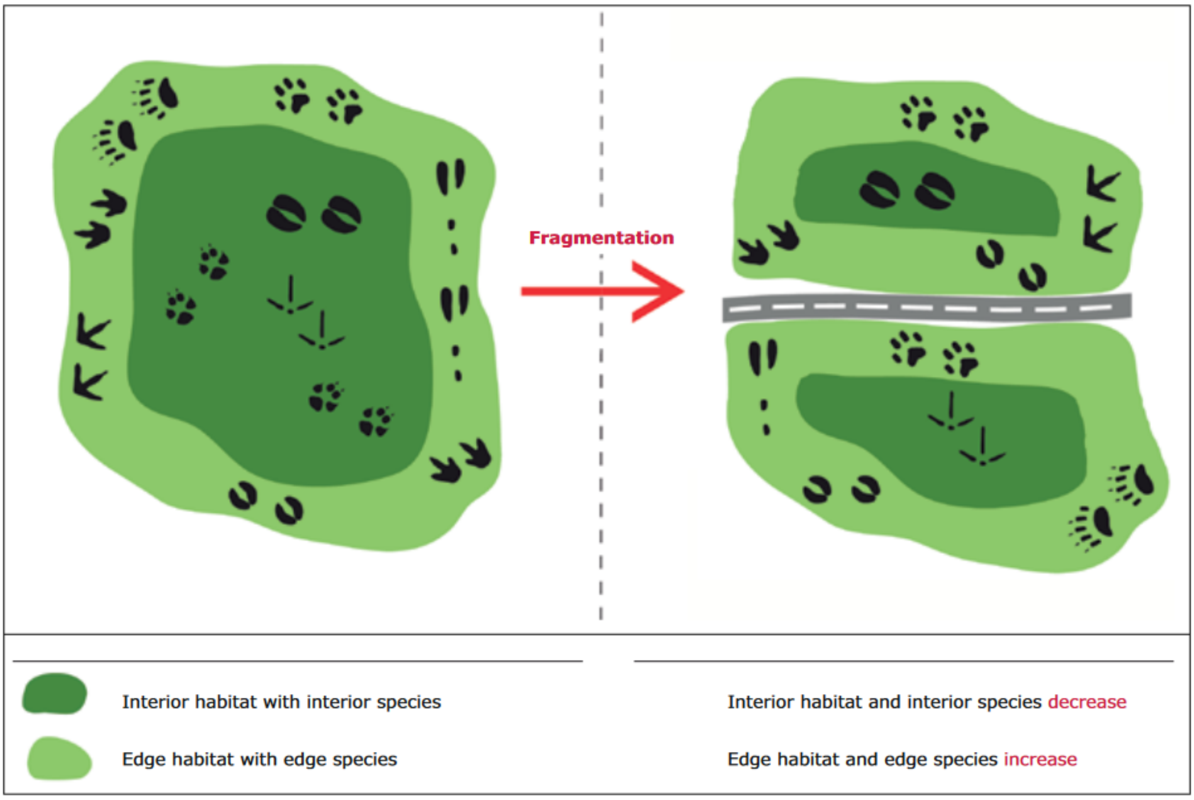

Figure 79. Illustration of the loss of core habitat (or interior habitat) caused by road construction cutting through a patch of habitat (European Environment Agency & Swiss Federal Office for the Environment (FOEN), 2011)

5.2 IMPACT IDENTIFICATION AND EVALUATION FRAMEWORK

This impact methodology seeks to adapt both to the reality of this project and to current national regulations through a series of concatenated logical tasks that allow the process of reflection on the chain of events that lead, with comfort and order, to be conducted from the project to the environment.

5.2.1 Impact identification

The present assessment methodology identifies, first, the impacts and risks according to two parallel lines: one that analyses the project and leads to the identification of activities that are likely to produce impacts, and another that analyses the environment, to identify the environmental factors that are presumably affected by those activities.

For the identification of the activities the following three levels will be considered:

- First level: *Stages*. It refers to those that form the vertical structure of the project, which come to be the construction, operation and abandonment.
- Second level: *Elements*. It can identify homogeneous parts of the project or processes such as traffic that occurs at the stage of construction of an access road. The element refers to the second level of disaggregation of the project.
- Third level: *Activities*. It refers to concrete actions or activities. An action refers to a simple, concrete, direct, well defined, and localized cause of impact, such as: earth moving, emission of a certain gas by the traffic of a road, civil works, emission of noise by machinery, among others, for example, for the construction stage.

On the other hand, in order to define the socio-environmental factors, the following levels would have to be defined:

- First level: *subsystems*, which refers to the environment, constituted by the elements and processes of the natural environment as they are at present, and to the socioeconomic, e.g. their activities, attributes, life forms, patterns of behaviour, system of inhabited nuclei, equipment, infrastructure, among others.
- Second level: *means*, the subsequent division to the proposed subsystems, such as physical means, biotic medium, medium of human interest, among others.
- Third level: *factors* that basically correspond to those described in the current national regulations, such as water, air, flora, fauna, archaeological, among others.
- Fourth level: *sub-factors* or division of factors into concepts of very clear definition and very concrete (air quality, endangered species, employment, housing, social acceptance of the project, among others).

It is important to mention that both the activities and socio-environmental factors and sub-factors should have the following characteristics:

- *Relevant*: they must conform to the reality of the project and be able to trigger notable effects.
- *Exclusive / independent*: to avoid overlaps that may lead to duplications in impact accounting.
- *Localizable*: attributable to a specific area or point of the space in which the project is located.
- *Quantifiable*: to the extent possible, they must be measurable in physical quantities.

Then, both lines - activities and environment - converge in a task destined specifically to the identification of effects by the search of cause-and-effect relationships between activities and factors.

These relationships are expressed in a double entry verification matrix for both the construction stage and the operation stage. For example, the corresponding matrix contains one of its inputs to each environmental and socio-economic factor while in the other entry the project activities are mentioned. Thus, in this matrix the "-" sign has a negative impact and the "+" sign has a positive impact.

5.2.2 Impact Assessment

The estimation of impacts as relevant or negligible, or as beneficial or harmful is the subject of this section. After the ordering and identification of impacts, the Rapid Impact Assessment Matrix (RIAM) method will be applied as a tool that organizes, analyses and presents the integrated results of the impact assessment. The RIAM methodology (Pastakia & Jensen 1998) integrates the impacts of the activities evaluating them on the different factors to consider (physicochemical, biological, social / cultural, and economic). For each factor, a total value is determined, using the criteria listed below, which provides a measure of the expected impact for each factor.

This methodology is a scoring system within a matrix that has been designed to allow subjective judgments based on the knowledge of the socio-environmental reality, the characteristics of the project and the experience of the evaluators, to become quantitative values or registers, thus providing both the assessment of the significance of the impacts and the obtaining of a record of impacts that can be re-evaluated in the future. RIAM methodology follows different criteria including (i) importance of condition, (ii) magnitude of change/effect, (iii) permanence, (iv) reversibility and (v) cumulative. Following table summarizes the criteria:

5.2.2.1 Importance of condition (A1)

It expresses the degree of importance of a certain component in relation to its environment, represented in terms of spatial limits or human interest. The rating of this relevance is determined quantitatively in a range of values where the minimum score is 0 and the maximum score is 4. The condition of the component can be qualified as not important (0), of only local importance (1), important for areas immediately outside the local condition (2), important to regional or national interests (3) or important to national or international interests (4). It is necessary to indicate that the assessment of the importance of the component is carried out prior to any impact assessment, that is, it is independent of any project or activity planned to be executed in the area, which is why it does not represent an assessment of the environmental impact.

5.2.2.2 *Magnitude of change/effect (A2)*

Magnitude is defined as the measure of the scale of benefit or harm of a certain impact. The magnitude rating is preceded by the nature of the impact, which can be positive (+), if the change generates beneficial effects for the environmental component, or negative (-), if the change causes harmful effects for the environmental component. The rating of the magnitude of the impact is given by a quantitative assessment (from -3 to +3). It is rated as (-3) if a major damage or change is foreseeable, (-2) if it is a significant damage or negative change, (-1) if a negative change of the current state is generated, (0) if a significant negative change does not occur. change in the current state, (+1) if an improvement in the current state is generated, (+2) if it is a significant improvement in the current state and (+3) if a greater positive benefit is foreseeable.

5.2.2.3 *Permanence (B1)*

Permanence defines whether the condition is temporary or permanent and is used only as a measure of the temporary state of the condition. The condition rating varies between 1 and 3, being (1) when there is no change or not applicable, (2) when the change is temporary, and (3) when the change is permanent. It is important to indicate that although an impact may be reversible, it has been conservatively classified as permanent if it occurs throughout the useful life of the project. Subsequent closure measures will be focused on managing these impacts.

5.2.2.4 *Reversibility (B2)*

Reversibility is the ability of a component to return to its original characteristics or similar to the original ones, after being affected by a certain impact caused by some activity. Depending on the nature of the impact, the effects that they may cause in the environment can be classified as (1) when there is no change or it is not applicable, (2) when the change is reversible and (3) when the change is irreversible.

5.2.2.5 *Cumulativeness (B3)*

The degree of cumulativeness is a measure that considers whether the effect will have a simple direct impact or whether there will be a cumulative effect over time, or a synergistic effect with other conditions. According to this parameter, an impact is qualified as (1) when there is no change or not applicable, (2) when it is a simple or non-cumulative impact, and (3) when the impact is cumulative or synergistic. A more detailed discussion of potential cumulative and synergistic impacts is presented in Chapter 6.4 (Cumulative Impact Assessment).

5.2.2.6 *Final evaluation (ES)*

The calculation of the total impact is carried out using the RIAM matrix formula (Pastakia, C.M.R., 1998) presented in summary below. The final evaluation was carried out using the results of two main groups of elements:

- Group (A): Formed by the importance of the condition (A1) and magnitude of the change/effect (A2).
- Group (B): Formed by permanence (B1), reversibility (B2) and cumulativeness (B3).

The scoring system requires multiplication of the scores given for each of the criteria in group (A). The use of the multiplier for group (A) is important because it ensures that the weighting of each score is expressed, considering that a simple sum of the scores could provide identical results for different conditions.

The scores for the criterion value in group (B) are added together to provide a simple sum. This ensures that individual score values cannot influence the total score, but that the collective importance of all values in group (B) are fully considered.

Table 22. Impact assessment criteria

Group	Criteria	Scales
Group A	Importance of condition (A1)	4 = important to national/international interests
		3 = important to regional/national interests
		2 = important to areas immediately outside the local condition
		1 = important only to the local condition
		0 = no importance
	Magnitude of change/effect (A2)	+ 3 = major positive benefit
		+ 2 = significant improvement in status quo
		+ 1 = improvement in status quo
		0 = no change/status quo
		- 1 = negative change to status quo
		- 2 = significant negative dis-benefit or change
		- 3 = major dis-benefit or change.
Group B	Permanence (B1)	1 = no change/not applicable
		2 = temporary
		3 = permanent
	Reversibility (B2)	1 = no change/not applicable
		2 = reversible
		3 = irreversible
	Cumulative (B3)	1 = no change/not applicable
		2 = non-cumulative/single

		3 = cumulative/synergistic

The scoring system requires simple multiplication of the scores given to each of the criteria in group (A). The use of multiplier for group (A) is important for it immediately ensures that the weight of each score is expressed, whereas simple summation of scores could provide identical results for different conditions. Scores for the value criteria group (B) are added together to provide a single sum. The sum of the group (B) scores is then multiplied by the result of the group (A) scores to provide a final assessment score (ES) for the condition. The process can be expressed:

(a1) x (a2) = aT

(b1) + (b2) + (b3) = bT

(aT) x (bT) = ES

The environmental scores, final assessment score and ranges used in the RIAM methodology are presented in table below.

Table 23. Range values for the impact assessment

RIAM Environmental Score (RS)	Range Value (RV) alphabetical	Range Value (RV) numerical	Description of range band
72 to108	E	5	Major positive impact
36 to 71	D	4	Significant positive impact
19 to 35	C	3	Moderate positive impact
10 to 18	B	2	Positive impact
1 to 9	A	1	Slight positive impact
0	N	0	No change
-1 to -9	-A	-1	Slight negative impact
-10 to -18	-B	-2	Negative impact
-19 to -35	-C	-3	Moderate negative impact
-36 to -71	-D	-4	Significant negative impact
-72 a-108	-E	-5	Major negative impact

The RIAM is suited to Environmental and Social Impact Assessments (ESIAs) where a multi-disciplinary team approach is used, as it allows for data from different sectors to be analyzed against common important criteria within a common matrix, thus providing a clear assessment of the major impacts.

5.3 IMPACT IDENTIFICATION AND EVALUATION RESULTS

5.3.1 Impact identification

First, the impacts and risks were identified through the following tasks:

- Know the project, its stages, elements and specific activities.
- Know the environment in which it will develop, that is, its environment.
- Determine the interactions (reciprocal relationships) between both.

The activities and environmental factors identified must be relevant, independent, traceable, and quantifiable. In **Table 23**, the activities of this project, in the construction stage, that are likely to produce impacts on biodiversity have been determined. Similarly, in Table 24, the biological factors that may be affected by the execution of the project (pre-construction, construction and operation) are presented.

Table 24. Activities for each project's phase

Phase	Elements	Activities
Pre-construction	Previous activities	Acquisition of land and rights of easement and agreements
		Recruitment and presence of staff
		Clearing of the areas to be intervened
Construction	Earth movements	Excavation, Cutting and Filling
		Disposal of surplus material
	Infrastructure construction	Construction of embankments
		Placement of aggregates
		Road rehabilitation
		Bridge/culvert construction/rehabilitation
	Logistics	Transport of materials and machinery
		Transport of personnel
Operation	Flow	Transit and circulation on the road
	Inspection and maintenance	Infrastructure inspection
		Infrastructure maintenance
	Logistics	Transport of equipment and personnel for inspection and maintenance

Table 25. Biological components and factors

Component	Factor	Sub-factor
Biological	Vegetation	Vegetation cover
		Important/threatened plant species
	Wildlife	Wildlife habitat
		Important/threatened fauna species

Table 26. Risk and impact identification matrix on the biological component

Phases		**Pre-construction**		**Construction**									**Operation**		
Elements		Previous activities		Earth movements		Infrastructure construction				Logistics		Flow	Inspection and maintenance		Logistics
Factor	**Sub-factors / Activities**	Acquisition of land and rights of easement and agreements	Recruitment and presence of staff	Excavation, Cutting and Filling	Disposal of surplus material	Construction of embankments	Placement of aggregates	Road rehabilitation	Bridge/culvert construction/rehabilitation	Transport of materials and machinery	Transport of personnel	Transit and circulation on the road	Infrastructure inspection	Infrastructure maintenance	Transport of equipment and staff
Noise	Noise levels			-	-	-	-	-	-	-	-	-	-	-	-
Vegetation	Vegetation cover			-		-		-							
	Important/threatened plant species			-		-		-							
Wildlife	Wildlife habitat			-	-	-		-	-						
	Important/threated fauna species			-	-	-	-	-	-	-	-	-	-	-	-

Note:
(-) negative impacts
(+) positive impacts

5.3.2 Impact assessment

This section quantifies the impacts of the project on biodiversity for the pre-construction, construction, and operation phases according to the methodology detailed in **Section 5.2**. **Table 24** lists the factors and sub-factors to be evaluated. The tables below present the impact assessment results.

Table 27. Impact assessment for the project's pre-construction and construction phase

Factor	Subfactor	Impact Description	Importance of condition (A1)	Magnitude of change/effect (A2)	Permanence (B1)	Reversibility (B2)	Cumulative (B3)	Final Score	Impact
Noise	Noise level	Increase in noise levels	Important only to the local condition	Negative change to status quo	Temporary	Reversible	Non-cumulative/single	-6	Slight negative impact
Vegetation	Vegetation cover	Loss of vegetation cover	Important only to the local condition	Negative change to status quo	Temporary	Reversible	Non-cumulative/single	-6	Slight negative impact
	Important plant species	Impact on threatened/important plant species	Important to national/international interests	Negative change to status quo	Temporary	Reversible	Non-cumulative/single	-12	Negative impact
Wildlife	Wildlife habitat	Loss of wildlife habitat	Important to national/international interests	Negative change to status quo	Temporary	Reversible	Non-cumulative/single	-12	Negative impact
		Wildlife habitat fragmentation	Important to national/international interests	Negative change to status quo	Temporary	Reversible	Non-cumulative/single	-12	Negative impact
	Threatened/ Important	Disturbance-induced behavioral changes	Important to regional/national interests	Negative change to status quo	Temporary	Reversible	Non-cumulative/single	-12	Negative impact

	animal species	Injury/Mortality	Important only to the local condition	Negative change to status quo	Temporary	Reversible	Non-cumulative/single	-6	Slight negative impact
		Impediment to movement	Important to regional/national interests	Negative change to status quo	Permanent	Reversible	Non-cumulative/single	-12	Negative impact

Legend

Major positive impact	Slight negative impact
Significant positive impact	Negative impact
Moderate positive impact	Moderate negative impact
Positive impact	Significant negative impact
Slight positive impact	Major negative impact

Table 28. Impact assessment for the project's operation phase

Factor	Subfactor	Impact Description	Importance of condition (A1)	Magnitude of change/effect (A2)	Permanence (B1)	Reversibility (B2)	Cumulative (B3)	Final Score	Impact
Noise	Noise level	Increase in noise levels	Important only to the local condition	Negative change to status quo	Temporary	Reversible	cumulative/single	-6	Slight negative impact
Vegetation	Vegetation cover	Loss of vegetation cover	Important only to the local condition	No change	Permanent	Reversible	Non-cumulative/single	0	No changes
	Important plant species	Impact on threatened/important plant species	Important to national/international interests	No change	Permanent	Reversible	Non-cumulative/single	0	No changes
Wildlife	Wildlife habitat	Loss of wildlife habitat	Important to national/international interests	No change	Permanent	Reversible	cumulative/single	0	No changes
		Wildlife habitat fragmentation	Important to national/international interests	No change	Permanent	Reversible	cumulative/single	0	No changes
	Threatened/ Important animal species	Disturbance-induced behavioral changes	Important to regional/national interests	Negative change to status quo	Temporary	Reversible	cumulative/single	-12	Negative impact
		Injury/Mortality	Important to national/international interests	Negative change to status quo	Temporary	Reversible	cumulative/single	-12	Negative impact

		Impediment to movement	Important to regional/national interests	Negative change to status quo	Permanent	Reversible	cumulative/single	-12	Negative impact

Legend

Major positive impact	Slight negative impact
Significant positive impact	Negative impact
Moderate positive impact	Moderate negative impact
Positive impact	Significant negative impact
Slight positive impact	Major negative impact

5.4 CUMULATIVE IMPACTS

5.4.1 Introduction

This section presents the Cumulative Impact Assessment (CIA) for the Project. CIA refers to the analysis of combined environmental and social effects arising from the Project in conjunction with other past, present, and reasonably foreseeable future developments within the Project's Area of Influence (AoI). Unlike a standard project-level impact assessment, a CIA evaluates how multiple overlapping impacts may interact and intensify over time.

The methodology follows the guidance provided in the International Finance Corporation's Good Practice Handbook on Cumulative Impact Assessment and Management (IFC, 2013)[1] and the Asian Development Bank's Safeguard Policy Statement (ADB, 2009), both of which emphasize early identification and management of cumulative risks. The assessment considers both environmental and social valued components (VECs) relevant to the AoI.

A cumulative impact assessment refers to an analysis that examines the combined environmental and social effects of the proposed road project when added to existing roads, planned developments, and other ongoing activities in the area, considering how these combined impacts could potentially worsen issues like traffic congestion, air pollution, noise levels, and land use changes over time, rather than just assessing the project in isolation.

Roads can significantly impact land use by directly consuming land for construction, and indirectly by influencing development patterns, often leading to increased urbanization, suburban sprawl, and changes in agricultural practices, particularly around areas with improved accessibility due to new road construction; essentially, the presence of a road can determine how land is used and developed in a region.

Roads can make previously remote areas more accessible, leading to increased development like residential subdivisions, commercial areas, and industrial facilities along the road corridor. By facilitating easier travel to outlying areas, roads can encourage suburban development, spreading urban areas further from city centers. Similarly, improved road access can lead to shifts in agricultural practices, potentially encouraging more intensive farming in areas previously used for extensive grazing.

The road project will consist of rehabilitating/widening/improving around 40km of existing road between Tappita and Toe. Stakeholder consultations and historical satellite imagery reveal that the project area is already undergoing significant transformation. The region's main economic activities include farming (cocoa, plantain, palm, mixed crops) and forestry — sectors that are closely tied to road access and land availability.

Based on experiences from similar road and resource projects, it is clear that improved access to remote areas often leads to rapid changes in land use, population movement, and resource exploitation. These kinds of induced and cumulative effects are considered foreseeable in the context

[1] IFC (2013) Good Practice Handbook: Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets. Washington, DC. Available at: https://www.ifc.org/content/dam/ifc/doc/mgrt/ifc-goodpracticehandbook-cumulativeimpactassessment.pdf

of the project. This assessment recognizes them as part of the broader development landscape and addresses them through the Cumulative Impact Assessment and the accompanying Cumulative Impact Management Plan (CIMP).

5.4.2 Valued Environmental and Social Components

To assess cumulative impacts in a way that is meaningful to affected communities, the following Valued Environmental and Social Components (VECs) have been identified. These were selected based on the project environmental and social context and observed development trends in the area of influence. The table below outlines each VEC and the rationale for its inclusion.

Table 29. Key Valued Environmental and Social Components (VECs) and Their Rationale

VEC	Rationale
Land use and forest cover	Highly sensitive to conversion from subsistence to cash crops (e.g., palm oil, cocoa), logging access roads, and settlement expansion.
Biodiversity and habitats	At risk from habitat loss due to road access, clearing, and encroachment into forest areas.
Water resources	Vulnerable to contamination and overuse as a result of agricultural intensification, forest loss, and growing settlements.
Local livelihoods	Smallholders and informal producers are affected by land pressure, commodity shifts, and market integration driven by improved access.
Community health and safety	Health risks from air quality, dust, traffic, communicable diseases, and gender-based violence during construction and operation.
Public services and infrastructure	Schools, clinics, and local administrations may struggle to meet demand as population inflows and settlements grow.
Population dynamics	Road development may attract in-migration, increasing service demand, resource pressure, and land tenure conflict.
Climate vulnerability	The project area is prone to flooding, and extreme weather — risks likely to increase with vegetation loss.

A summary of cumulative impacts across identified Valued Environmental and Social Components (VECs) is presented below. The table synthesizes key concerns, expected interactions with regional development, and the assessed overall significance of each cumulative effect.

Table 30. Summary of Cumulative Impacts on Valued Environmental and Social Components (VECs)

VEC	Sensitivity	Cumulative Impact Summary	Impact Significance
Land use and forest cover	High	Accelerated land conversion driven by palm oil, cocoa expansion, and logging due to improved access. Satellite data indicates sustained degradation across the project area of influence.	High
Local livelihoods	Medium	Road enhances market connectivity for smallholders, but land competition and shifts in crop patterns may lead to inequality and displacement of traditional farming.	Medium
Biodiversity and natural habitats	Medium	Habitats lossdue to logging and agricultural expansion compounded by improved road access.	Medium
Community health and safety	Medium	Cumulative health risks include increased traffic injuries, construction emissions, GBV, and pressure on health services.	Medium
Population influx and settlement	Medium	Improved connectivity is likely to encourage in-migration, spontaneous settlements, and strain on local planning systems.	Medium
Water resources	Medium	Cumulative stress from increased domestic and agro-industrial use could lead to seasonal water shortages and competition.	Medium
Public services capacity	Low–Medium	Rising demand for education, health, and administrative services may exceed provincial resource capacity.	Medium

5.4.3 Summary

The cumulative impact assessment reveals that the road project is situated in a development landscape already shaped by active and emerging economic sectors, including cocoa and palm oil expansion, ongoing logging activities, and population movement. The interaction between these drivers and the proposed infrastructure works may intensify existing land use pressures, accelerate deforestation and forest degradation, and place additional strain on natural resources, community safety, and public service delivery. **Vulnerable groups, including rural smallholders, women**, and customary landowners, may be particularly exposed to risks associated with increased land competition, in-migration, and environmental change. Special attention should be given to ensuring these groups are meaningfully **engaged in mitigation planning** and benefit-sharing mechanisms.

To address these risks, it is recommended that a **Cumulative Impact Management Plan (CIMP)** be implemented in parallel with the project's Environmental and Social Management Plan (ESMP). This plan should support cross-sectoral coordination between government, civil society, and local leaders. Strengthening participatory monitoring mechanisms will be essential to ensuring that communities have a role in identifying emerging pressures, adapting mitigation responses, and promoting equitable access to project benefits.

5.4.4 Cumulative Impact Management Plan

5.4.4.1 Objective

The Cumulative Impact Management Plan (CIMP) provides a strategic framework to manage the overlapping environmental and social effects likely to emerge from the interaction between the road project and other development activities in the region. Its purpose is to anticipate and respond to indirect and long-term risks that go beyond the project footprint. These include pressures on natural ecosystems, tenure systems, and the social fabric of communities along the corridor.

Rather than addressing each impact in isolation, the CIMP emphasizes integrated and collaborative approaches. It highlights the importance of coordination across sectors and institutions, ensuring that cumulative risks are addressed holistically and inclusively. It also recognizes the need for flexible, adaptive management informed by ongoing dialogue with affected communities and grounded in evidence generated through local monitoring systems.

5.4.4.2 VEC-based management measures

Managing cumulative impacts requires proactive engagement across the VECs identified in the assessment. In the case of land use and forest cover, it is essential to work closely with customary landowners and local authorities to support zoning decisions and monitor forest degradation. Promoting agroforestry and reforestation activities through Incorporated Land Groups (ILGs) can help relieve pressure from expanding agricultural frontiers. Clear land tenure mapping and inclusive land-use planning processes should be prioritized to reduce disputes and ensure equitable access to land.

For local livelihoods, particularly those dependent on cocoa and palm oil, interventions should focus on training and capacity-building to ensure fair access to inputs, markets, and technical support. Strengthening partnerships with agricultural cooperatives and extension services will enhance sustainability and reduce exposure to commodity price fluctuations. Targeted support should also address youth employment and financial inclusion, especially for women-headed households and informal producers.

Biodiversity conservation will require focused measures in and around key biodiversity areas where development should be carefully controlled or excluded altogether. Establishing buffer zones and enforcing no-go areas in ecologically sensitive landscapes will be crucial. Close collaboration with EPA and conservation NGOs can strengthen ecological monitoring and protection.

To promote community health and safety, the plan should include outreach and education on road safety, sanitation, and prevention of gender-based violence. Strengthening local clinics and training frontline workers will be key, alongside community-based awareness programs. Engaging peer educators and local volunteers will help ensure outreach reaches vulnerable groups, including women, youth, and persons with disabilities.

In areas with cultural heritage or Indigenous land, early and respectful engagement with elders and traditional custodians is vital. Cultural mapping should be undertaken in close collaboration with local communities and integrated into project planning. Culturally appropriate protocols and accessible grievance mechanisms should be established to safeguard heritage values and maintain social cohesion.

Managing population influx will require coordinated planning with provincial and district governments to prepare for spontaneous settlement growth. This includes developing integrated spatial plans, exploring affordable housing options, and guiding basic service expansion through regular demographic monitoring and public consultation.

Water resource management should address increased demand from households, farming, and industry. Monitoring systems need to track availability and quality, and communities should be supported with improved access points and awareness on conservation. Schools and local water committees can play a role in fostering responsible use, particularly in areas affected by floods or droughts.

Finally, strengthening education, healthcare, and administrative services is essential to maintain resilience as development accelerates. Coordination between project timelines and government service planning will help reduce institutional strain. Support for training teachers, nurses, and mobile outreach teams should also be considered to bridge service gaps in remote or underserved areas.

5.4.4.3 Institutional coordination

Effective management of cumulative impacts cannot rest solely with the project proponent. It requires a shared commitment from national agencies such as PIU, EPA, as well as from provincial administrations and civil society. These actors should establish a coordination platform or taskforce to share data, align strategies, and collectively monitor outcomes.

Coordination should be structured around regular reviews and feedback loops. Local development committees can serve as key points of contact and communication between formal agencies and affected communities. Designated focal points within government bodies and among implementing contractors should be assigned responsibility for addressing cumulative impacts within their respective sectors. Their roles should be integrated into the Environmental and Social Management Plan (ESMP) and reflected in the contractors' Construction Environmental and Social Management Plans (CESMPs).

5.4.4.4 Monitoring and reporting

Monitoring must go beyond compliance to support learning and adaptation. The CIMP should be accompanied by a dedicated monitoring framework that tracks key environmental and social indicators over time, including those related to deforestation, community health, household incomes, settlement growth, and biodiversity conditions.

This monitoring should be participatory wherever possible, involving communities in data collection and interpretation. Communities, and school or health staff can act as local informants, creating early warning systems and fostering transparency.

Annual summary reports should be compiled and made available to stakeholders. These reports should present cumulative risks observed, management responses undertaken, and lessons learned to inform future action. Adaptive responses should be incorporated into project operations and communicated openly to maintain trust with communities and partners.

The success of the CIMP depends not only on technical measures but on building relationships, trust, and shared responsibility among all actors involved in shaping the development future of the project.

6 MITIGATION STRATEGY

6.1 MITIGATION HIERARCHY

The Environmental and Social Management Plan (ESMP) will follow the mitigation hierarchy, which is defined by a set of hierarchical set of actions and steps that enable avoiding, minimizing, restore and offsetting unfavorable impacts (Ekstrom et al., 2015). Hence, it is a set of prioritized, sequential measures aimed at achieving no net loss of biodiversity, and where feasible, net gain, particularly for natural and critical habitats. The steps of the mitigation hierarchy are as follows:

- ***Step 1. Avoidance***: Measures taken to avoid creating direct, indirect and cumulative impacts, such as careful spatial or temporal placement of elements of infrastructure, in order to completely avoid impacts on certain components of biodiversity. The avoidance of ecological impacts by not developing the proposed infrastructure may be the only solution to avoid fragmentation of vulnerable habitats. Avoidance of habitat fragmentation should become the first principle applied throughout the Project cycle
- ***Step 2. Minimization***: Measures taken to reduce the duration, intensity and/or extent of direct, indirect and cumulative impacts that cannot be completely avoided, as far as is practically feasible. The barrier effect can be mitigated by good engineering techniques such as fauna passages over and underpasses aimed at maintaining landscape permeability.
- ***Step 3. Restoration***: Measures taken to rehabilitate and restore affected habitats to their original condition or ecological function after disturbance.
- **Step 4. Offsett**: As a last resort, implementing biodiversity offsets to compensate for significant residual impacts that remain after avoidance, minimization, and restoration measures have been applied.

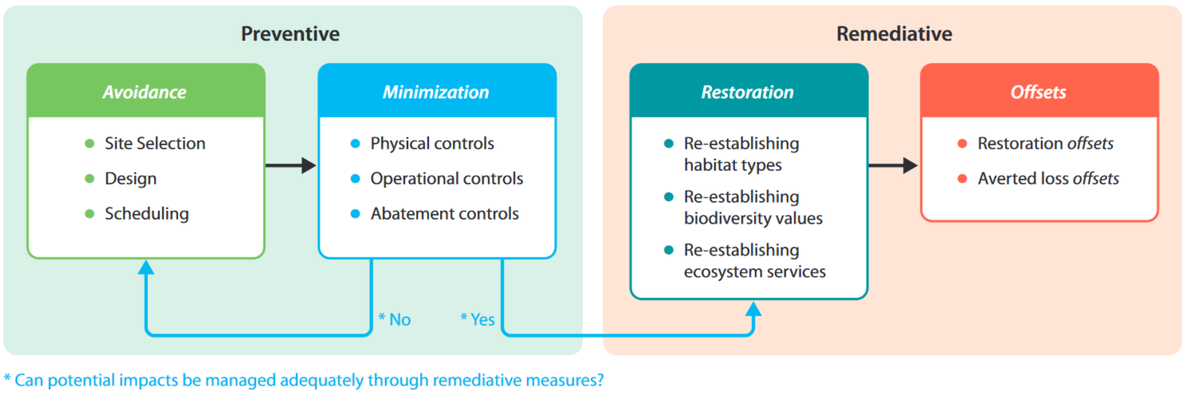

Figure 80. Schematic diagram showing the implementation of the mitigation hierarchy (Ekstrom et al., 2015)

Avoidance (site selection, design, scheduling) and minimization (physical controls, operational controls and abatement controls) are preventive measures whereas restoration (re-establishment of habitats, biodiversity and ecosystem services) and offsets are remediated measures (**Figure 80** and **Figure 81**)

6.2 Mitigation Priorities

6.2.1 Mitigation options

The following figure shows mitigation options by (i) providing links to fauna, and (ii) reducing mortality in a project road area.

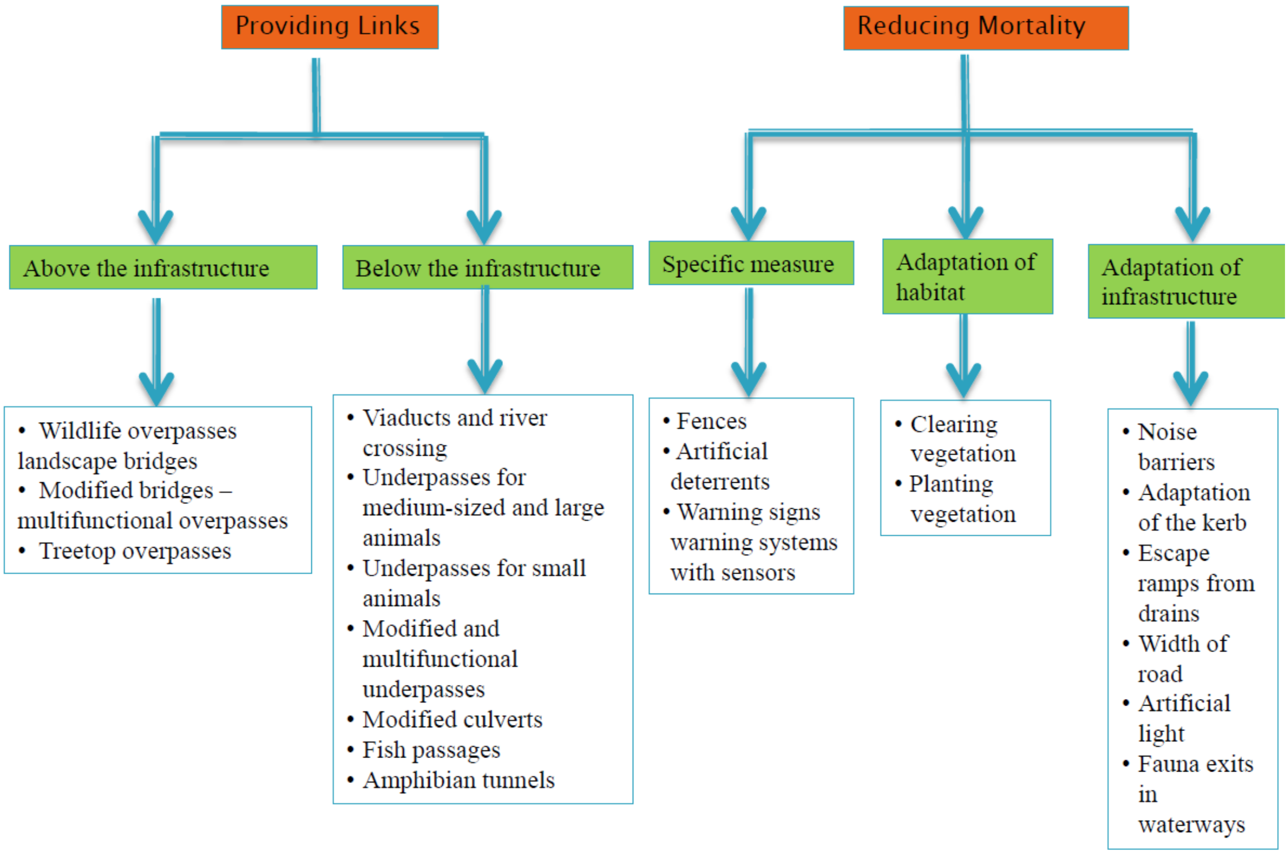

Figure 81. Specific mitigation solutions (Iuell, B., Bekker, G.J. et al., 2003)

Table 31. Mitigation recommendations per functional group (Quintero, 2022)

Mitigation measures	**Functional groups**						
	Large carnivores	**Large herbivores**	**Medium-sized mammals**	**Small mammals**	**Amphibians**	**Reptiles**	**Birds**
Roadside forest habitat management							
Maintain natural habitat							
Minimize human activity							
Maintain canopy connectivity							
Establish and maintain vegetation along the roadway							
Structure type							
Pipe culvert							
Box culvert							
Canopy bridges/ glider poles							
Bridge underpass							
Overpass							

	Best
	Adequate

	Minimum requirement

6.2.2 Structural options

- Bridges/Over pass and Underpass: Primarily for the passage of large animals but used by a wide variety of small and medium animals.
- *For arboreal species such as Campbell's monkey, recommendation of rope bridge to enable road crossing.*

- Culverts: Mostly used by smaller animals, including both aquatic (amphibians) and terrestrial (small mammals, snakes, lizards, tortoises) species, but are also used by a variety of larger species like deer and bear

- Fences: Useful for diverse groups including amphibians, reptiles, deer, and elk.

All arboreal species will make use of the rope bridges which will be constructed at different locations of the corridor. As mentioned earlier, the engineering design should mimicking the natural vines and branches of trees. While there are no specific crossing locations, this is recommended for all earmarked locations.
A combination of structures can be used. E.g. fences work well in combination with fauna passages to compensate for their barrier effect and channel fauna towards the passage. The measure may need to be tailored according to species and location. E.g overpass may be suitable for ungulates like deer while underpass may be more suitable for large animals or predators that do not prefer to be exposed such as jaguars. Inclusion of such structures does not automatically mean that all effects will be been mitigated and the project should proceed.

Small mammals utilize a mixture of small pipes, box culverts, or pipe culverts. Smaller structures should be placed with a frequency that corresponds to the spatial scale over which targeted species move. Riparian amphibians and reptiles tend to prefer small pipes, as well as box or pipe culverts with natural substrates while upland amphibians and reptiles prefer box culverts.

6.2.2.1 Signals

Signals serve as a warning, alerting people with the intention to reduce speed while passing areas with wildlife activity. The signs should be placed in locations where they can be clearly seen and provide motorists time to react particularly in areas where fauna crossings occur. Methods to enhance the effectiveness of fauna signs include:

- Adding a speed limit,
- Adding flashing lights,
- Using fiber optics to display speed limits or flashing lights when triggered by an animal,
- Making signs physically larger,
- Adding diamond reflecting material,
- Using portable rather than permanent signs

6.2.2.2 *Culverts*

Openness ratio: size of culvert is defined by the size of animals that wil use the structure and the width of the road above the culvert. For example, if the length of the culvert increases, the cross section are of the culvert must also increase.

Openness Ratio: (Height x Width)/Length

Example: minimum open ratio for large mammals is 0.75, preferably 0.9. For medium sized mammals, 0.4

Some box culvert considerations for wildlife:

- Suitable Habitat (suitable habitat should occur at both ends and, where feasible, within the culvert)
- Appropriate Size
- Placement Near or Within Natural Movement Corridors (if known)
- Minimal Human Activity
- Funneling/Fencing
- Wildlife Accessibility
- Ongoing Maintenance and Monitoring
- Natural Substrate
- Lighting (e.g. installing grates or skylights at medians)

Internal habitat in the culvert:

- Preferably natural substrate
- Humidity and shelters
- Humidity not same as stagnant waters: drainage is important
- Replicating natural environments facilitates crossing of reptiles and amphibians

6.2.3 Cost-effectiveness

Table 32. Cost-effectiveness of mitigation options (Quintero, 2022)

Measure	Effectiveness	Costs
Vegetative protection fence	Medium protection, excellent integration into the landscape	Low cost, requires maintenance
Artificial fence	Good protection of animals and drivers, but can inhibit animal movements. Should be used to guide animals to passages.	Comparable to vegetation fence
Animal overpass	Effective where warranted	Expensive; same as normal overpass
Animal underpass	Effective for many species, and more common for smaller species for cost reasons	Same as a culvert
Speed reducing devices	Effective if well enforced	Relatively low cost
Developing of forest borders, planting	Complements the above devices, preferably, using local species	Low cost for relatively good results

6.3 GENERAL MITIGATION MEASURES

General management measures are presented below, which apply to different environmental factors, including biodiversity. It is important to indicate that these measures are scopes or guidelines and in each independent program the specific measures are presented depending on the environmental component or factor:

- All construction activities must be planned in such a way that the areas to be intervened are reduced. The prior signage and identification of the areas where the facilities will be located will prevent other areas from being unnecessarily affected. Prior recognition of the areas and in situ demarcation of the land to be intervened will be necessary in each work front. There are several demarcation methods (use of milestones, flags) that will allow the unnecessary intervention of land that is outside the footprint of the project.
- Differentiated speed limits will be respected according to traffic zones. National speed limits established by state regulations will be respected.
- Preventive and periodic maintenance will be carried out on the machinery, equipment and vehicles to be used during the project stages, in order to guarantee their good condition, reducing the probability of spills and the generation of noise. This measure applies to both company vehicles and its contractors.
- Any untreated liquid or solid discharge into riverbeds, streams and nearby areas will be strictly prohibited. Likewise, input handling activities near surface water bodies will be avoided. The handling of inputs will be carried out at a minimum distance of 20 m from waterbodies.
- The oil or grease residues that will be used for the maintenance of vehicles, machinery or equipment will be stored in special compartments and in the event of a spill, they will be collected with special equipment, to be finally disposed of properly.
- The personnel involved in the construction of the project will receive training on the activities to be carried out, safety, environment and social management before the start of the activities. This training will include safety regulations and restrictions related to means of transportation, vehicle handling, protection of flora and fauna species, importance of the preservation of cultural heritage and codes of conduct.

Any road project should include a set of general/standard mitigation measures relevant to potential Project impacts on biodiversity, including:

- Influx management planning, including through hiring and procurement plans which discourage temporary settlements near construction camps/areas;
- siting of flexible facilities (e.g., borrow pits, laydown areas, construction camps) away from Natural Habitat and a minimum distance from the coast and watercourses;
- minimization of structures within watercourses (e.g., siting of bridge piers on land where possible) and retention of natural flows at water-crossings;
- construction of bridges and culverts only in the dry season, and ensuring the entire span of streams or rivers is not blocked at any time (i.e., there are never any dry stretches in permanent watercourses);
- minimizing the width of clearance corridors and marking of work areas prior to clearance to minimize unnecessary clearance of Natural Habitat;

- careful use of slope stabilization, ditches and silt fences to prevent impacts from landslides and erosion (Alamgir et al. 2019);
- good practice handling of waste and hazardous materials, particularly near freshwater areas;
- prevention of hunting, collection, trade or possession of wild animals and plants – including firewood – by workers; minimization of noise; speed limits and avoidance of night driving to minimize accidental mortality of wildlife;
- minimization of lights at night, with use of shaded, downward-facing low-UV lights where necessary;
- a range of measures to best achieve rehabilitation and/or restoration of temporarily disturbed habitats; and
- ensuring contractor/sub-contractor contracts have sufficient penalties that environmental mitigation measures are taken seriously.

6.4 General mitigation measures of flora and fauna

This section outlines the general measures to be applied to flora and fauna. These measures have been extracted, adapted and proposed based on the project's area of influence, project type and existing environmental studies. It is important to note that many of these measures are applicable to all components, since each taxonomic group of interest has specific measures based on its natural history, degree of vulnerability, project impacts, or threats from various sources. Where relevant, it has been indicated whether a given measure is only applicable to a particular taxonomic group. Furthermore, since impact management revolves around the application of the mitigation hierarchy, the implementation of the sequential steps for its application is necessary.

The following are the general management measures that will be applied to flora and fauna during project activities.

6.4.1 General management measures of flora

The mitigation measures to be applied to potential impacts on the vegetation cover and flora specimens will depend on the type of vegetation formation identified in the project area. On this basis the following measures will be applied:

- Unnecessary clearing of vegetation outside the areas of the main facilities, auxiliary facilities, access roads and other components of the project will be avoided. This will be achieved through adequate pre-construction signage for each work front. It is important to indicate that the non-unnecessary intervention of vegetation will also be beneficial for the operation of the project, since by avoiding exposing the soil of unused areas, the risk of erosion and movement of masses that constitute a threat to safety and normality is reduced. development of the works.
- The areas to be worked on as part of the project components will be marked on the ground in advance, so that the areas to be cleared are easy to identify in the field. Likewise, clearing personnel will be trained in recognizing the pre-established boundaries of the layout or polygons of the project components, ensuring that areas located outside the predetermined area are not cleared.
- During the construction stage of the project, the existing access roads will be used, minimizing the impact generated by soil compaction and impact on the vegetation cover.

The incursion towards the work fronts will be carried out exclusively through the existing access roads. Each of the incursion towards the work fronts will be previously planned in the office to avoid alterations

- Revegetation activities will be carried out at the end of the construction stage. The details of the revegetation at the end of the construction stage are presented in **Section 7.7.**
- Burning of vegetation will be prohibited by the construction personnel, since these lead to a series of environmental consequences that include, among others, the impoverishment of the soil and the impact of biodiversity. Likewise, the fire generated could affect areas in which it is not desired to clear.
- The proponent's staff and its contractors will be trained on the importance of preserving wild flora species, and the collection or commercialization of wild flora species by workers will be prohibited.

The management measures for impacts on flora and vegetation derived from the operation stage of the project are presented below.

- Talks will be given to workers about the importance of caring for the surrounding flora and vegetation.
- If necessary, the guidelines stipulated in the specific management measures of the construction stage will be taken into account, solely related to the maintenance activities of the electrical system.

6.4.2 General management measures of fauna

Below are the management measures related to impacts or risks on fauna during the construction phase:

- In areas close to rivers and stream bottoms, mainly (areas with the greatest wildlife activity), an inspection will be carried out before starting construction activities to verify the absence of individuals (chicks, nests) that could be directly affected by the activities to
- All project workers and contractors will be prohibited from hunting wild animals or marketing (buying and selling) products derived from wild animals such as meat, skins, eggs, etc. Likewise, the capture of young or chicks of wild species on work fronts will be strictly prohibited.
- The activities of the construction stage will be limited strictly to the project site area, minimizing the impacts on the habitat of the fauna species in the study area. This will be achieved through adequate pre-construction signage for each work front.
- Project contractors will be trained on the importance of preserving wildlife species, especially those that fall under a national or international protection category. These training sessions will be conducted periodically through talks, using audiovisual media and informational brochures detailing the main characteristics of the aforementioned species.

- Entry of outsiders into work areas will be restricted to avoid increasing human presence in undisturbed habitats.
- Periodic maintenance will be performed on heavy equipment, generator sets, pumping equipment, and general vehicles used in construction and operation activities to reduce noise and gas emissions. The condition of the mufflers on the machinery used will also be frequently checked.
- Vehicle speed will be controlled in accordance with the project's internal safety regulations. Vehicle handling will not only take into account all precautions to avoid accidents, but also the importance of not disturbing wildlife, and all regulations or guidelines regarding driving speed and noise emission (e.g., sirens, horns, etc.) must be observed. Informational signs will be posted indicating the maximum speed limit, as well as signs prohibiting noise generation and wildlife disturbance.
- Work personnel and its contractors will be prohibited from hunting or possessing wild animals in the project area, as well as from purchasing products derived from them: meat, hides, leather, eggs, and others.
- Signs will be installed stating "no hunting of wildlife" and providing information on the legal consequences of poaching. They also indicate that the target species are protected (e.g. chimpanzee, African forest elephant, duikers, etc). These signs will be located at various key points along the access roads to the water supply area.
- The presence of poachers could increase due to the construction and improvement of the project road. Considering this, a surveillance plan will be established with daily patrols along the access routes-
-

Below are the management measures related to impacts or risks on fauna during the operation phase:

- The policy of prohibiting hunting activities and transactions linked to products obtained from wildlife will continue, which will be aimed at all project workers, both direct and contractors.
- Training will be carried out for maintenance workers on the preservation of local fauna.

Below are the measures applicable to contact with wildlife during project activities:

Vehicle collision with wildlife species

Considering the increase of traffic flow during the operation phase, there is the possibility of collision with individuals of larger fauna. Among the species with the greatest susceptibility to colliding with vehicles, due to their behavior and distribution in the project area, are:

- Domestic animals
- Cattle
- Wildlife

The response measures against vehicle collisions are presented below:

- If the roadkill animal is still alive, the first measure is to immediately notify the environmental personnel of the construction company.
- Do not try to approach the animal because it can be risky for the safety of inexperienced personnel in this type of case.
- The environmental office staff will be responsible for handling the injured animal.
- The animal will be immobilized using instruments designed for this purpose, such as immobilizing sticks, ties, hoods and splints.
- Once the animal is immobilized and out of reach of bites or kicks, the damage will be evaluated by observation and palpation.
- Once the recognition has been carried out, and if the animal has curable damage, it will be transported to the evaluation point by a specialist, who will be the one to determine the appropriate treatment, or failing that, the sacrifice. of the animal.
- After healing, the animal will be returned to the wild, outside the scope of the project activities. If it is domestic, it will be returned to the owner through the collaboration of the staff of the Community Relations department of the company that owns the project.
- If the roadkill animal dies and is wild, the pertinent authorities will be notified and it will form part of the project's environmental management statistics.
- If the roadkill animal dies and is domestic, the Community Relations department of the company will be notified, who will be in charge of identifying and communicating the owners, as well as defining the corresponding type of compensation.

Entry of fauna to work fronts

If fauna enters the work fronts that will be part of the construction stage of the project (enabling areas for foundations of the towers), the following measures will be taken:

- If a specimen enters (falls) into an excavation or pit, the environmental team will be immediately alerted.
- The specialist will proceed to immobilize the animal and, if necessary (larger fauna), apply tranquilizers, which will be ready to be used by trained personnel.
- Based on on-site observations, the specialist will determine if it is possible to immobilize the animal without the use of tranquilizers. This can be achieved mainly for smaller animals and through the use of restraint loops and cloth bags.
- The specialist will carry out an evaluation of the individual's condition and, if there is no damage, they will be rescued and transferred to the release area, outside the scope of the work front activities.
- If there is damage, it will be released, rescued and disposed of in a safe place for the respective veterinary evaluation.
- If it is minor fauna, the individual will be captured using Sherman or National type traps, depending on its size, and then released in places far from the work fronts.

6.5 WILDLIFE AND HABITAT MANAGEMENT PLAN

Wildlife and habitat management is vital to the protection of key IUCN threatened species. Assessment indicates that these habitats are threatened with continuous pressure from deforestation caused by slash and burn agriculture for large farms, unregulated pit sawing for commercial purposes and hunting. The management of Jentink's duiker and White-bellied pangolin is due to threats such as Heavy hunting pressure for bushmeat and habitat degradation from logging, agriculture, and road development, and often captured in snare traps. The White-bellied pangolin is especially hunted as it is believed to be a major traditional medicine and with it scales highly valued and therefore poaching for international trafficking. The management table below describes specific recommended actions for the protection of these species.

The main threats to Jentink's duiker population include: (i) hunting for bushmeat, (ii) snare trapping and shotgun hunting in both protected and unprotected areas, (iii) habitat loss due to logging and agricultural expansion. Additionally, the impact on reptiles and amphibians is largely as a result of vegetation alteration.
The table below presents a summary of the proposed wildlife mitigation plans in the project's area of influence and the proceeding chapters detailed the impact and risk of the projects on these species and vegetation

Table 33. Summary of proposed mitigation plans on biodiversity

Management Plan	Main objective	Specific programs/actions
Duiker Management Plan	Conserve the current population status of this species and its habitat, and to the extent possible promote population recovery	Monitoring Program
		Sign installation/Traffic management
		Roadside vegetation management
		Awareness and training program for residents and staff
White-bellied pangolin	Conserve the current population status of this species and its habitat, and to the extent possible promote population recovery	Monitoring Program
		Sign installation/Traffic management
		Roadside vegetation management
		Awareness and training program for residents and staff
		Adaptation of culverts as crossings
Amphibian and Reptile Management Plan	Conserve the current population status of sensitive herpetofauna in the study area	Rescue and relocation
		Adaptation of culverts as crossings
Revegetation Plan	Restore the current use of the land affected by the temporary works associated with the construction of the project's infrastructure	Program for the rescue, relocation, and propagation of flora species of interest.

6.5.1 Ecology and distribution of the target species

6.5.1.1 White-bellied pangolin

The white-bellied pangolin is widely distributed across Liberia's lowland tropical forests and is considered one of the more commonly encountered pangolin species in West and Central Africa. In Liberia, its range includes protected areas such as the Sapo National Park, Gola Forest Transboundary Peace Park and Grebo-Krahn National Park. Similarly, it is often found both in primary and secondary forest areas, including unprotected community forests and forest-agriculture mosaics (such as the project AOI). Despite being considered widespread, its actual population density in Liberia is poorly known due to its secretive, nocturnal nature and the difficulty of conducting surveys.

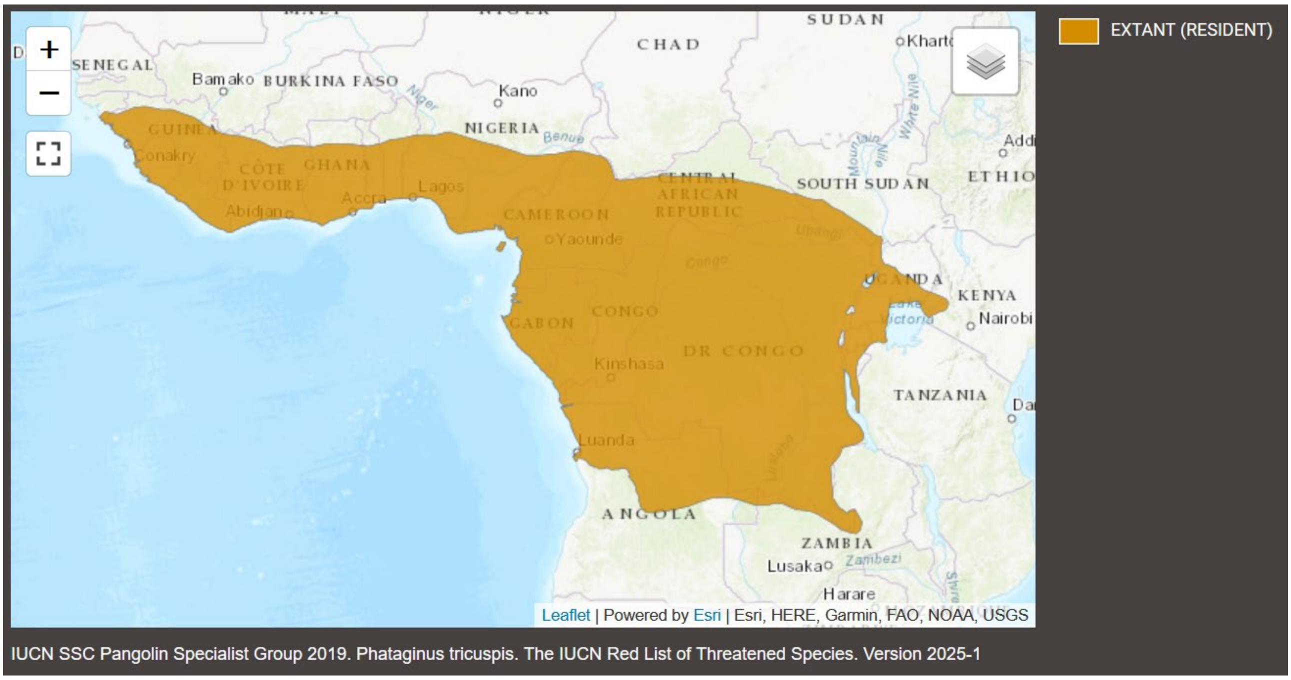

Figure 82. Range of *Phataginus tricuspis* (IUCN, 2025-I)

In Liberia, the white-bellied pangolin typically inhabits tropical moist lowland forest, swamp forest, riparian zones, and gallery forests, degraded forests and secondary growth (showing some tolerance to habitat disturbance), and occasionally enters agroforestry systems and fallow lands. However, they show strong preference for tree-rich environments that support abundant ant and termite populations. Key habitat features include canopy cover for climbing and shelter, termite mounds and ant nests, and hollow trees and burrows for daytime rest.

The white-bellied pangolin is insectivorous, feeding almost exclusively on ants and termites. Regarding their feeding features, they use a long, sticky tongue (up to 40 cm) to extract insects from nests. They have no teeth; relies on a muscular stomach and ingested pebbles to grind food, and they may forage both on the ground and in trees, accessing arboreal nests. They consume large numbers of social insects, which makes them important for controlling termite populations, contributing to forest ecosystem balance. The following table shows their main ecology and behavior.

Table 34. Ecology of while-bellied pangolin

Factor	Description
Activity pattern	Nocturnal and secretive, usually emerging from burrows or tree hollows at night to forage
Diet	Mainly ants and termites; it uses its long, sticky tongue to extract them from nests and tunnels.
Locomotion	White-bellied pangolins are adept climbers and semi-arboreal, but they also spend considerable time on the ground. Primarily arboreal but also forages on the ground; uses prehensile tail for balance
Predators	Natural predators include large birds of prey, big cats, and pythons. However, humans are the greatest threat due to hunting and trafficking
Shelter	Rests in tree hollows or burrows during the day
Reproduction	Little data from Liberia; elsewhere females usually give birth to a single offspring per year. Females typically give birth to a single offspring after a gestation period of about 140 days. The young ride on the mother’s tail and are cared for several months.
Territory	Likely to maintain individual home ranges, though data is limited. Their exact home range is not well documented, but it's believed they occupy fairly large territories for their size due to their need to find sufficient food

The main threats to this species include: (i) Heavy hunting pressure for bushmeat and traditional medicine, (ii) Poaching for international trafficking (scales highly valued), (iii) Habitat degradation from logging, agriculture, and road development, and (iv) Often captured in snare traps set for other wildlife.

As seen in the picture below, the only observations of the white-bellied pangolin occurred through two camera traps located beyond the 1km AOI buffer of the project area. Even though, their potential presence includes locations of disturbed vegetation, the only direct records were found beyond the project’s AOI.

Figure 83. Observations of white-bellied pangolin in the project area

6.5.1.2 *Jentink's duiker*

Liberia represents the core of the global range of Jentink's duiker, and it is the most important stronghold for this elusive and rare antelope. Confirmed records include the Sapo National Park (key population stronghold), Grebo-Krahn National Park, Gola Forest National Park (Liberian portion), and Reports from parts of Lofa, Nimba, and Grand Gedeh counties. However, its distribution is highly patchy, and it occurs at low densities even in suitable habitats due to its sensitivity to disturbance and hunting.

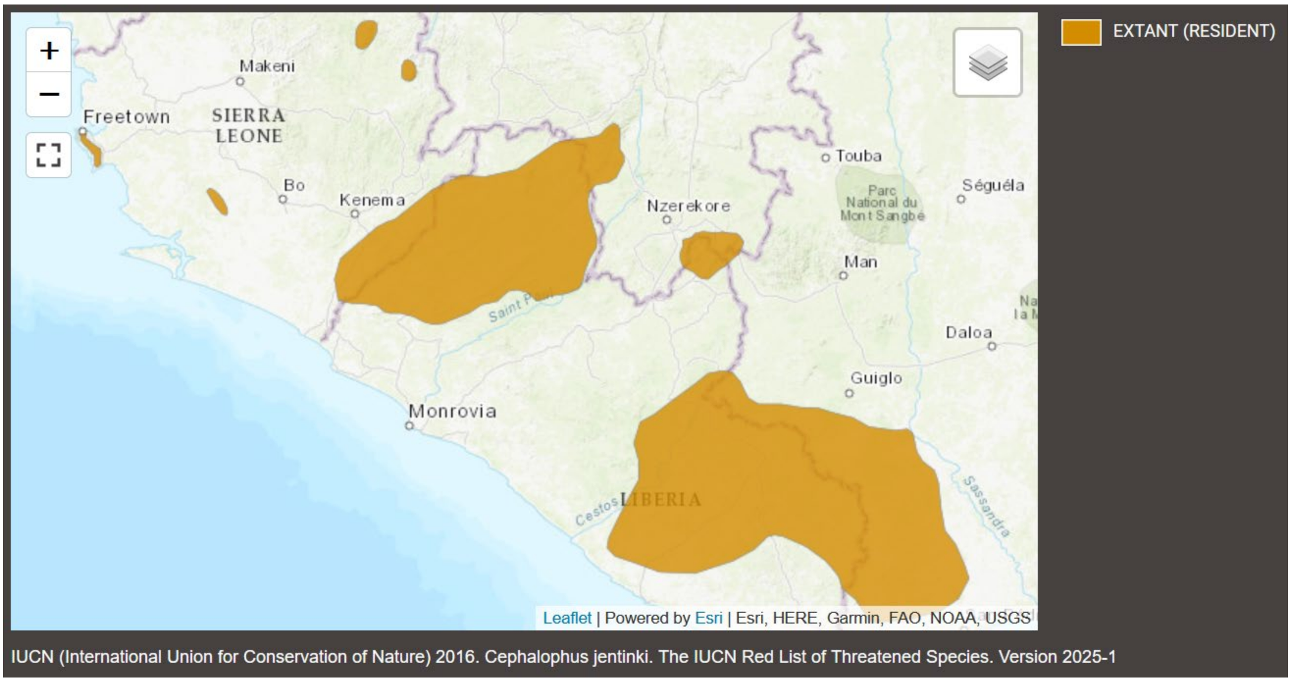

Figure 84. Range of *Cephalophys jentinki* (IUCN, 2025-I)

Jentink's duiker is a strict forest specialist, preferring undisturbed lowland evergreen rainforest, Dense interior of mature forests, areas with closed canopy, thick understory, and minimal human presence. This species is extremely sensitive to habitat degradation, and will abandon disturbed areas, even if tree cover remains. Therefore, there would rather avoid heavily logged, fragmented, or secondary forest, edge habitats and open farmland as well as wetland/swamp forests (unlike other duikers)

Jentink's duiker is primarily frugivorous, feeding on fallen forest fruits (main dietary component), seeds, leaves, young shoots, and buds, and occasionally feeds on mushrooms or small invertebrates. Its feeding is mostly ground-based, relying on seasonal fruiting trees and diverse forest structure to sustain its diet. It plays a key ecological role as a seed disperser, aiding forest regeneration. The following table shows their main ecology and behavior.

Table 35. Ecology of Jentink's duiker

Factor	Description
Activity pattern	Mostly diurnal, with peaks in early morning and late afternoon. Jentink's duikers are herbivorous, solitary, and forest-dependent antelopes. Their ecological role includes seed dispersal and understorey foraging
Diet	Primarily frugivorous, feeding on fallen fruits, leaves, shoots, and some fungi. They are known to consume overripe and fermented fruits, which may aid digestion
Locomotion	Generally solitary or found in pairs (especially breeding pairs). Quiet, cautious movement through dense forest undergrowth. They use well-worn paths and tend to freeze or dash suddenly if threatened
Shelter	Rests in dense thickets or forest hollows during midday
Reproduction	Little is known, but believed to have low reproductive rates, possibly producing 1 calf per year after gestation of approximately 7 months. Very secretive, making breeding behavior hard to observe.
Territory	Defends well-defined territories; uses scent-marking

The main threats to Jentink's duiker population include: (i) hunting for bushmeat, (ii) snare trapping and shotgun hunting in both protected and unprotected areas, (iii) habitat loss due to logging and agricultural expansion.

As seen in the picture below, the only observations of the Jentink's duiker pangolin occurred indirect dung observations on recce transects, which was encountered beyond the 1km AOI buffer of the project area. This confirms their presence in rather undisturbed forest areas.

Figure 85. Observations of duikers in the project area

6.5.2 Amphibian and Reptile Species Management Plan

6.5.2.1 Generalities

Amphibians play a fundamental role in the ecosystem as secondary consumers (from herbivores to omnivores) in many food chains. Their unique developmental stages allow them to occupy different trophic niches; as tadpoles, they have a significant impact on the nutritional cycle, while as adults, they are the best biological pest controllers. Due to these functional roles in the ecosystem as both prey and predator, population declines have a significant impact on other organisms.

Furthermore, at an ecological level, they are considered good indicators of the environmental quality of ecosystems, the impact of pesticides, and various anthropogenic activities, due to their high degree of sensitivity at their different developmental stages (adult and tadpole), responding to slight changes in the environment. Such responses have been used to indicate habitat fragmentation and ecosystem stress; they are characterized by their habitation in specific locations.

Regarding the biological importance of reptiles, these animals are part of the upper food chain as predators, preventing overpopulation of mainly rodents and invertebrates, and simultaneously providing food for larger predators such as birds of prey.

Considering their functional importance in the ecosystem, it has been considered pertinent to include an Amphibian and Reptile Management Plan, focused on the rescue and relocation of species categorized under a conservation status according to the Red List of the International Union for Conservation of Nature. With these criteria, the present management plan includes six species of reptiles as presented in the table below.

Table 36. Target reptiles in the project area

Class	Scientific name	IUCN
REPTILIA	*Mecistops cataphractus*	CR
REPTILIA	*Kinixys homeana*	CR
REPTILIA	*Cyclanorbis senegalensis*	VU
REPTILIA	*Osteolaemus tetraspis*	VU
REPTILIA	*Trionyx triunguis*	VU
REPTILIA	*Bitis nasicornis*	VU

6.5.2.2 Effects of the Project on the local population of amphibians and reptiles

- Habitat loss associated with the alteration of vegetation cover or waterways due to the location of project facilities.
- Displacement of populations due to noise and physical disturbances
- Habitat fragmentation of amphibian and reptile species

6.5.2.3 *Objective*

The main objective of this Amphibian and Reptile Management Plan is to conserve the current population status of sensitive herpetofauna in the study area.

6.5.2.4 *Specific management actions*

Due to the low mobility and natural escape capacity of amphibian and reptile species in response to habitat changes, they are less likely to move in response to disturbances generated by project activities, increasing the risk of impact. To reduce and prevent this impact, the rescue and relocation of the species described above is proposed.

6.5.2.4.1 *Rescue*

Wildlife rescue involves the extraction of an individual found in a situation that could threaten its safety, well-being, and survival. To rescue amphibians and reptiles, intensive searches will be conducted in habitats commonly used by these organisms (bushes, rocks, shelters, etc.). Individuals will be captured manually, and morphological data will be collected after capture.

In general, amphibians are nocturnal animals because they cannot tolerate high temperatures. Among reptiles, lizards are diurnal species. For this reason, intensive searches for individuals should be carried out in the early morning hours, ideally between 6:30 and 10:30, and in the evening/night, between 6:00 and 10:00 pm.

All captured specimens must be tagged for subsequent identification during monitoring. Reptiles will be tagged and classified using electronic chips, and small individuals will be tagged using small incisions or perforations in their scales. However, the phalangeal clipping method can also be used for this group, using the same coding for post-relocation tracking. Amphibians will be tagged using the phalangeal clipping method, following the standard enumeration method. In this case, a coding is assigned to each phalanx, and only the tips are clipped, so that the individual's locomotion is not affected.

It is important to mention that for each individual the data on species, location, date, time of capture, type of vegetation, microhabitat, tag number, weight, sex and biometric data will be recorded according to the species. If the species of the individual cannot be determined exactly, it will be photographed, showing its morphological characteristics of taxonomic importance for a more specific determination.

Regarding transportation, all reptile species will be placed in sturdy, yet porous, cloth bags; while amphibians will be placed in Ziploc-type plastic bags with a little moist substrate to prevent desiccation, as these individuals depend on high humidity for their survival. Tadpoles should be transported in jars filled with water taken from the same place where they were captured.

6.5.2.4.2 Relocation

Before release, the health and physical condition of each animal must be ensured. Due to the diurnal habits of lizards, they must be released during the day, never at night. To do so, untie the knot of the woven bag at ground level and gently shake it to encourage the animal to emerge on its own. For amphibians, release them in the late afternoon when temperatures are cooler.

The areas designated for relocation will be selected based on factors such as vegetation, water availability, altitude, conservation status, and safety for the individual, among others. These factors must have ecological conditions similar to those of the original site, so that the stress to which the animal is exposed is minimal. Furthermore, overcrowding of the ecosystem, i.e., the release of many individuals in a single area, must be avoided. Furthermore, efforts will be made to relocate individuals to locations close to the capture site, with the intention of avoiding long periods of confinement and reducing the stress resulting from handling the individual.

After release, the species must be monitored, considering parameters such as: survival, impacts on other species, reproductive success, etc.

6.5.3 Revegetation plan and roadside vegetation management

This plan sets out the practices that the project owner/contractor will carry out in order to adequately manage the loss of vegetation cover along the project, due to the installation of the different components of the project, which will allow the land to be given optimal conditions of vegetation cover compatible with that of the surroundings, to the extent possible and where this has been pre-existing.

The main objective of the Revegetation Plan is to develop the bases and guidelines to implement revegetation in a sustainable manner and adequately manage the impacts of the projects on the vegetation cover.

The impacts to be controlled through the Revegetation Plan are mentioned below:

- Loss of vegetation cover due to clearing activities during the construction stage of the project.

This plan sets out the practices that the project owner/contractor will carry out in order to adequately manage the loss of vegetation cover due to the installation of the different components of the road project.

The program includes the scope, objectives and guidelines that will guide the strategies to be implemented; as well as the stages that will be carried out in the program design and management process, which has been prepared in such a way that the benefits, effects and positive impacts thereof are allowed to exceed the useful life of the program's execution.

The purpose of this revegetation plan is to reduce the impacts related to the loss of vegetation cover and the quality of the landscape, and to minimize the risk of erosive processes, so the following guidelines are presented below in order to minimize these impacts and risks:

- General revegetation guidelines
- Revegetation techniques
- Propagative material

6.5.3.1 *General revegetation guidelines*

The activities to consider prior to revegetation activities are described below. The existing roadside vegetation along the corridor varies including secondary vegetation, smallholder agriculture (coconut, plantain, cocoa, etc), palm oil plantations and rural and urban vegetation close to populated areas. It is important to mention that the project works are not expected to affect primary vegetation, but rather rehabilitate the existing alignment in areas where there is mainly secondary vegetation.

Determination of soil characteristics

In the most sensitive areas, the agronomic characteristics of the soils to be revegetated will be determined, according to the baseline results in order to ensure appropriate compatibility with the species to be used in the revegetation work. The existing information on the main edaphic characteristics such as pH, electrical conductivity, textural classes, edaphic profile, among others, will be taken into account.

Profiling and restoration

All areas will be restored through profiling and stabilization activities with the aim of returning the area to a condition as close to the original as possible.

Soil conditioning

The recompositing process leaves the soils permeable, stable and not excessively compacted. The soil will be decompressed, returning its initial physical and mechanical characteristics. Before starting planting, earth borders (or rows of stones) will be built transverse to the slope of the land, in order to contain rainwater runoff and protect the areas from the washing of seeds and topsoil.

6.5.3.2 *Proposed revegetation techniques*

Triangle planting

This plantation consists of alternating lines forming a network of triangles. It is used to cover large areas and allows the best distribution and coverage with a smaller number of plants, being used for trees, shrubs or herbaceous plants.

In the case of bagged seedlings (eventually bare root seedlings will be used), these will be planted in holes 30 cm deep by 30 cm in diameter, enriching the mineral substrate with organic matter and leaf litter (mulch) collected from the zone. The proposed spacing for tree species is 5 m x 5 m, which makes a total of 400 seedlings per hectare.

In the case of seed planting, direct sowing "at once" is proposed, that is, seeds placed directly in superficial holes (5 cm), at a rate of 2 to 3 per hole, then covered with available topsoil. Sowing seeds requires prior soaking for 12 to 24 hours, depending on their size and hardness. Subsequently, specific management guidelines for potential revegetation species on the project fronts are presented.

Block of grasses and/or shrubs

Blocks are understood to mean bands of variable width with high plant density, installed in contour (transverse direction to the slope). These constitute at the same time a block of coverage, against rain and exposure, at the same time a “brush” type vegetation filter to control drag at surface level.

The blocks of grasses and shrubs will be propagated by broadcast sowing of the previously soaked seed. After sowing, the seeds are protected by spreading a superficial layer of mulch or topsoil. When this is present on the surface, the use of rakes is enough to bury the seeds superficially. For broadcast sowing of grass or shrub seeds, the use of backpack sprayers should be considered, which implies considerable seed savings due to their uniform distribution.

If you have local grasses, you can resort to planting runners or cuttings, planted in 5 cm manual dimples, spaced 30 cm apart in a staggered manner. Although labor intensive, this technique allows dense coverage of large areas to be achieved in a short time.

Table 37. Planting techniques proposed by scenario

Scenario	Object	Technique	Distribution	Density
Excavation in soil and rock with moderate slope in terrain with moderate slope	Superficial stabilization	Planting in lines, trees, shrubs, grasses	Contour grooves	2 x 2 m
Protection areas	Stabilization, Runoff Reduction	Triangle plantation + Blocks of trees, grasses/shrubs	Homogeneous	30/2 kg/ha
				20 trees/50 m
Stepped areas	Runway runoff reduction	Triangle plantation + Blocks of grasses/shrubs	Parallel to structures	2 x 2 m
				5 kg/ha
Areas of material removed	Deep stabilization	Triangle plantation + Blocks of shrubs	Homogeneous	3 x 3 m
				2 kg/ha

Leading edges	Deep stabilization	Triangle plantation	Sides of crosses	2 x 2 m

Propagative material should include native tree species and other rapid growing vegetation species such as bamboo.

6.5.4 Proposed mitigation measures

For a 40km road rehabilitation project, upgrading from gravel to asphalt, the most cost-effective mitigation measures for managing the impacts on White-bellied Pangolins (*Phataginus tricuspis*) and Jentink's Duiker (*Cephalophus jentinki*) must account for their ecological characteristics (e.g. nocturnal vs diurnal, sensitivity to disturbance, forest-affinity, etc), as well as common threats to the target species (e.g. poaching, road kills, habitat loss, etc). Similarly, the measures should manage the surrounding habitat, including vegetation.

6.5.4.1 Wildlife crossings

- The main objective of these crossings is to enable safe movement of Jentink's duikers and pangolins across road, reducing roadkill and maintaining habitat connectivity. The current project design already considers the incorporation of 41 box and pipe culverts along the road corridor (**Appendix 8**). It is recommended that most of the proposed drainage infrastructure along the road corridor are box culverts, which would enable a more permeable passage for the target species in comparison to pipe culverts. This last proposed infrastructure is more effective for other taxonomic groups such as amphibians and reptiles (see **Section 6.6**). Unit costs of concrete box culverts may range between USD 30,000 – USD 50,000 pending of the size and type, and specific modifications for wildlife (such as camouflage and ramps) could cost up to USD 10,000-15,000 per unit. The adaptation/modifications of these proposed culverts could should be done in areas where the proposed culverts are with surrounding thicker roadside vegetation. These proposed adaptations are recommended to take place approximately every 5-10km (in total approximately 4 culvert modifications). Wildlife crossing will also consider canopy bridges for arboreal species—maintains habitat connectivity, allowing safe passage across the road. This will enable monkeys or squirrels to move between forest fragments without risking road crossings, subsequently leading to reduction of road mortality for these species.

As mentioned in the previous sections, the main target species part of the mitigation measures are the white-bellied pangolin and the Jentink's duiker. Generally, the design of wildlife crossings requires details regarding the species' ecology, behavior, and habitat preferences. Below are technical recommendations tailored to each species with design considerations to maximize effectiveness and species-specific use.

White-bellied pangolin

The preferred crossing types for the white-bellied pangolin are arboreal and forest underpasses. The main technical characteristics are described below:

- Type: Rope bridges, canopy bridges, or natural log bridges suspended between trees or poles. Tunnel-style underpasses in forested areas.

- Height: At least 6–10 meters above ground to match canopy use.
- Width: Minimum 0.5–1 meter for bridge stability; wider if traffic volume below is high.
- Surface: Rough, natural materials like bark, rope mesh, or wooden slats for gripping. Avoid metal or slick surfaces.
- Anchoring: Must be securely anchored to stable trees or artificial poles, with flexibility to sway naturally.
- Location: Place near known pangolin habitat or movement corridors in intact forest canopy.
- Fencing: Use fine mesh vertical fencing (~1.5–2 m high) along roads to guide animals to crossing points.
- Lightning: No artificial lighting – pangolins are nocturnal and avoid well-lit areas.
- Monitoring: Camera traps and motion sensors to assess usage.

Jentink''s duiker

The preferred crossing types for the Jentink's duiker is forest underpasses such as culverts or tunnels. The main technical characteristics are described below:

- Dimensions: Height: ≥2.5 m, Width: ≥5–7 m to reduce tunnel effect and allow light entry.
- Length: Keep as short as feasible to encourage use – duikers are shy and avoid long dark corridors.
- Vegetation: Dense native vegetation at entrances and on green bridges to mimic natural cover.
- Surface: Natural soil or leaf-litter flooring to simulate forest floor; avoid concrete where possible.
- Fencing: Duiker-proof fencing (2–2.5 m high, durable and opaque) at least **500 m** from each side of the crossing.
- Lighting: Natural light at entrances (e.g., skylights or grated sections); avoid artificial lighting.
- Monitoring: Camera traps and motion sensors to assess usage.

The assessment did not identify specific areas for wildlife crossing; nevertheless, the installation of these different pipe culverts, box-culverts and concrete side-drains automatically addresses the issue of suitable wildlife crossing once encountered. As indicated, these are standard designs for concrete side drains, pipe and box culverts. These are designed for safety reasons to be wide and shallow, up to 10feet in height for box culvert. It has the disadvantage of additional land-take, but the safety aspect, along with its ease of access for moving animals make it appropriate in the setting of the RETRAP roads.

6.5.4.2 *Speed Control and Signage*

The main objective of this mitigation measure if to reduce wildlife mortality due to collisions, especially during dusk/dawn when species are active. Specific measures include the installation of reflective wildlife warning signs at 2km intervals, and building of speed bumps near areas with higher forest cover and village road crossings. It is recommended to include around 40 signs every 1km on both road directions and 5-10 speed bumps along the 40km road corridor. Unit prices of signs may range between USD 100 – 200, and speed bumps, USD 10000 - 20000.

6.5.4.3 *Poaching prevention and community engagement/awareness*

The main objective of this mitigation measure is to reduce poaching risk, which increases due to easier access via asphalt roads, as well as reducing human pressure on the target species habitats and improve local support for conservation. The mitigation plan should include (i) education of communities about the target species conservation, (iii) driver awareness raising, and (iv) developing alternative income sources to reduce hunting and habitat destruction. Specific actions include the development of community workshops on the conservation of the target species, avoidance of hunting and mainstreaming proposed alternative activities for local population. These events/workshops could cost approximately USD 4000-6000 per event.

6.5.4.4 *Roadside vegetation management and habitat restoration*

This activity aims at reducing habitat degradation and edge effects by restoring native vegetation near road shoulders. Specific actions include replanting tree species along shoulders and disturbed areas, as well as avoiding introducing invasive species during roadside stabilization. Tree planting prices might range between USD 5-10/unit, and maintenance/ha during the first year around USD 500-1000. It is recommended to manage and rehabilitate 10m buffer along the road corridor, which could reach between 5-8ha throughout the 40km. On average, one hectare of managed tree vegetation and planting include 1000 individuals (3x3m). The total pricing of this could reach between USD 50000 – 75000 including tree establishment and maintenance during the first year. More details are provided in **Section 6.7**.

6.5.4.5 *Monitoring and evaluation*

The main objective of this plan is to track mitigation effectiveness and adapt actions if needed. Specific actions should incorporate camera traps surveys during construction and reporting compliance with environmental safeguards (e.g. adapted ESIA report). The total monitoring cost during construction could reach between USD 30000 - 50000.

6.5.4.6 Amphibian/reptiles management plan

As presented already in Section 6.5.2, in case the target species are found/encountered in the project area, it is recommended that these are rescued/relocated in suitable areas for the species (preferably beyond the project's area of influence. This activity typically involves a biodiversity expert, and the cost ranges between USD 500-1,000 per encounter event.

Table 38. Mitigation costs

Mitigation plan	**Unit cost (SD)**	**Unit**	**Cost (USD)**	**Potential funding source**			
				Civil works (contractor)	**Community sensitization**	**Monitoring**	**Other mitigation**
Adaptation/modification of culverts as wildlife crossings	10,000 -15,000	5 culverts	50,000 – 75,000	50,000 – 75,000			
Rope bridge for arboreal species	500-5,000	3 sections	1,500-15,000	500-5,000	500-2,500		
Wildlife reflective signs	100-200	40 signs	4,000 – 8,000	4,000 – 8,000			
Traffic/speed signs	100-200	80 signs	8,000 -16,000	8,000 -16,000			
Speed bumps	10,000 -20,000	5 bumps	50,000 – 100,000	50,000 – 100,000			
Community engagement/awareness	4,000 – 5,000	5 events	20,000 – 25,000		20,000 – 25,000		
Roadside vegetation management plus management (1 year)	7,500 – 10,000	8 ha	60,000 – 80,000				60,000 – 80,000
Amphibian/reptile management	500 – 1,000	Event	--			--	

Monitoring during construction	10,000 – 15,000	2 events	20,000 – 30,000			20,000 – 30,000	
Cost range (USD)			212,000 – 334,000	112,500 – 204,000	20,500 – 27,500	20,000 – 30,000	60,000 – 80,000

6.6 CRITICAL HABITAT MANAGEMENT IN PROJECT AREA OF ANALYSIS AOI WITHIN THE 40KM CORRIDOR

The following table summarizes the main costs associated with the habitat management and wildlife management plan developed under Section 6.5. As presented in the previous section, the total costs for managing the habitat and wildlife range between USD 210,000 – 320,000, including both structural, vegetation management (see **Figure 82**) and monitoring activities, which would provide links to fauna and reduce mortality in the project's area (see **Figure 82**)

Table 39. Critical habitat management costs

Description	Current issue and challenges	Recommendation	Supervising institution	Cost
Critically Endangered (CR) or Endangered (EN) species	Potential critical habitat was found to be relevant to two species: 1. Jentink's Duiker indirect observation 2. White-bellied pangolin, during camera trap observations Over-exploitation of the Forest led to the loss and degradation of the habitats.	**Species Protection:** 1. Establish awareness campaigns for the target species including protection/avoidance program 2. Ensure machinery along this corridor are fitted with silencers to reduce surrounding sound during construction; 3. Establish proactive communication channel/protocol contact for roadway sighting of chimps. 4. Educate drivers and communities on and position speed limit signs and animal	CE & MC IIU FinnOC FDA	US$ 250,000.00(*)

		crossing/caution signs along this stretch of the corridor 5. Stop work, avoid contact, completely cutting off all engines to avoid loud sounds/noise upon encounters of the species 6. Limit work activities to diurnal times, since both target species are mainly more active during night time. **Training:** 7. Biodiversity management training of the monitoring consultant and contractor; 8. Encourage and Support(training) community conservation group to spread message on conservation law. **Monitoring Program** 9. Ensure effective monthly monitoring program to access effectiveness of efforts put to species protection 10. Enforce a "no hunting and bush meat consumption policy for all workers of the CE, including the purchase or sales of wildlife as pet		
Endemic or restricted-range species	Current knowledge and applying a precautionary approach put some species within the wilder landscape	Any additional documentation from the project AOI of these range species should be reported to the FDA		$US0.00

	of the project AoA, however, the **AOI or its buffer does not qualify**			
Migratory or congregatory species	Two of the species which could be earmarked Calidris ferruginea and Pluvialos squatarola Were not recorded, this might be due to the massive clearance of the forest area for farming . **AOI or its buffer does not qualify**	NA	NA	$US0.00
Unique assemblages of species that are associated with key evolutionary processes	The Project is located in a highly modified habitat. Compared to other areas, terrestrial habitats in the Project area do not generally hold unusually unique assemblages of species a**nd thus do not qualify the AoA as Critical Habitat.** Already, potential wetlands and swamps have been disturbed for development activities	NA	NA	$US0.00
Areas having biodiversity of significant social,	This was not applicable to the scope of the study and could not obtain the necessary data.	This could be taken on by the FDA to understand the important ecosystem services which could be avoided to the local communities. The result could	NA	$US0.00

economic, or cultural importance to local communities (including ecosystem services)		develop program which could alleviate pressure from large forest clearance.		
Legally protected areas and internationally-recognized areas	There are no protected areas nor key biodiversity areas in the project's area of influence(AOI) and buffer and thus **AOI or its buffer does not qualify for this critical habitat**; notwithstanding, such can be found outside, within the wilder landscape of the project ares of influence.	NA	NA	$US0.00

Table 40. Other mitigation measures

description	Current issue and challenges	Recommendation	Supervising institution	Cost
Ancillary Facilities				
Quarry	Condition surrounding the quarry include 1. proposed quarry is set to covered 50acres, 2. surrounded by some farms and secondary forest 3. Habitat around include flowing streams without no detail assessment	1. Implement an initial environmental evaluation (IEE)/EMP prior to the commencement of work 2. Conduct an ARAP for communities in the vicinity of the quarry(around 500m least) prior to the commencement of the quarry 3. Replace community drinking water by installation of water facilities if location being occupied by quarry	CE MC IIU & FinnOC	17,000.00
Quarry operation	Studies have shown that without proper blasting technique, people and homes nearby get affected; loud blasting noise affects large mammals and confuses them, making them aggressive and at the same time	Blasting operation should consider the following 1. Blasting methods and protocols must be reviewed and cleared before operation; 2. Procure and install suitable vibration meters that can measure vibration ≤ 0.015m/s^2 for building occupants 3. Procure and install particulate matter meter to measure the baseline and post-blasting of quarry operation	CE MC IIU & FinnOC	5,000.00

	vulnerable to human			
Borrow pits & Spoil pits	In addition to the borrow pits currently used by government contractor to maintain road during the rainy seasons, Contractors are expected to locate additional borrow pits, sand mining locations, etc.	In order to avoid land conflicts; damage to local people drinking water and unnecessary clearance of vegetation including large forest tree species, all borrow pits earmarked will have to be independently accessed and approved prior to usage of such site, this also apply to spoil pit.	CE MC FinnOC IIU MPW Legal	6,000.00
Camp site	The proposed camp site is a previous established site with no forest within and no expansion expected	Ensure the following is set within the existing camp site to be used 1. The surrounding of specific sites such as the workshop(machine/heavy and light duty; fuel/gasoline storage site, asphalt plant must be of impervious surface surrounded by drainage collection system 2. The site will need to be fenced to prevent intruder getting into dangers	CE MC IIU & FinnOC	US$50,000.00 (should be capture within the contract cost)
Post quarry, borrow pits, spoil pit and camp site operation s	All sites are void of any foreign materials except for vegetation	4. Restore and decommission, leading to complete clean up of all sites(quarry, borrow pits, spoil pit and camp site) prior to project closure phase 5. Inspection by the Bank, IIU and the regulatory agencies	CE MC IIU & FinnOC	75,000.00
Road Design	Would be culverts locations may	For the safety and free unhindered movement of wildlife	CE MC	This should already be captured in the

	not be suitable to allow the free movement of wildlife and as such, wildlife moves across the existing unpaved road to get to the other side of the forest. Some of these wildlife have gotten knocked down by moving vehicle particularly at night.	1. Use 900 mm pipe culverts for ephemeral streams and box culverts with natural streambeds for perennial watercourses to support small mammals and aquatic species (e.g., Nimba Otter Shrew). 2. Depending on the terrain, install at 5km intervals; coordinate with Monitoring Consultant Engineers and ensure natural substrate in culverts.		cost under the contract
	Tree Canopy Connectivity along the existing road is visible to most sections, the widening of the road to at least 10m will affect most canopies connectivity.	1. Where possible retain tree canopy over the road at confirmed Timneh Parrot roosting/foraging sites to reduce fragmentation. 2. Maintain 10 m canopy gaps at 3–5 sites ; no felling of trees >200 mm diameter	CE MC IIU & FinnOC	
Flora management				
Road side Vegetation loss during construction	Vegetation along current road side composed of young secondary forest, shrubs, twig and scattered flora species.	Revegetation. 1. Assessment of land area cleared along the road(Soil suitability assessment evaluation) 2. Establish revegetation technique, for instance bagged seedlings to be planted 3. Maintain natural habitat by establishing and maintaining	CE (through third party, for instance local environmental NGO) in collaboration with the FDA IIU & FinnOC	US$25,000.00

		native and foreign fast growing flora species like the Terminalia superba, and planting of local fast growing grasses along the road way, with focus measures in and around concerned biodiversity area (CBA) based on precautionary principle (corridor between Bitterball Village through Mary Weah Village) covering a distance of approximate 14.24km(75,187ft) and a width of 40ft.		
Vegetation and soil protection		Vegetation protection and soil free pollution through the project corridor can be done 1. Preventive and periodic maintenance on vehicles/machinery, light & heavy duty vehicles so as to reduce possibility of oil or fuel spill, noise, smoke; 2. Adequate control and storage of waste oil to avoid accidental release in the environment or water bodies 3. Contact EPA Certified Waste Disposal firm to collect and disposal	CE IIU/FINNOC	US$6,000.00
Increase in mining, hunting and pitsawing	The cumulative impact assessment reveals that the road project is situated in a development landscape already shaped by active and emerging economic sectors, including cocoa and palm oil	The interaction between these drivers and the proposed infrastructure works may intensify existing land use pressures and put additional strains on natural resources. 1. Liaise with the FDA and EPA including local authorities in strengthening regulatory compliance and enforcement on pit sawing regulations, wildlife hunting and bushmeat trade and forest degradation 2. Document the number of the compliance over time due to	CE MC IIU/FINNOC	US$5,000.00

	expansion, ongoing pitsawing activities, and population movement. The interaction between these drivers and the proposed infrastructure works may intensify existing land use pressures, accelerate deforestation and forest degradation	enforcement versus the number of non-compliance and periodically report on the changes quarterly.		
Fauna management				
Rescue of wildlife species	Domestication of primate species (different species of monkey) and other wildlife is common within the corridor	Measure must be taken to discourage the selling and domestication of wildlife 1. Provide training in One Health Initiative/education on wildlife importance to the health and protection our environment & diseases which affect human due to contact with wildlife). For instance rabies,ebola and avian influenza, lyme disease, etc. 1. Coordinate and engage with the requisite regulatory/institutional bodies like the FDA, EPA, so as to rescue captured wildlife for protection prior to releasing into the wild.	CE MC FDA FinnOC/IIU	US$8,000.00
		TTota l Management Cost		US$297,000.00

6.6.1 Biodiversity Field Survey Monitoring Action Program

Monitoring is a key aspect to determining the successful implementation of the management program and for informing adaptive adjustments, ensuring that the overall benefits of the Plan are maximized and any negative impacts are appropriately mitigated. Periodic monitoring shall address the Management Programs outlined. The tables below present outcome-oriented matrices of what successful implementation of the Plan would look like. The matrices define program objectives and indicators of success and lead the agency responsible for the implementation of each Management Program.

The table below addresses the mitigation actions within the BFS for effective monitoring and implementation through the project design, construction and closure phases.

Table 41. Monitoring activities

No.	Action	Responsibility	Commencement Timeframe
1.	Immediate actions – within three months		
1.1	Adopt the BFS for the 40km and make adherence to it a contractual requirement of all project service providers.	IIU	Week 2 June 2025
1.2	Incorporate BFS mitigation measures into design phase of the 40 km contract and ensure Contract abide by it by signing onto these measures	Contracting Entity (CE) IIU & FinnOC	Week 2 June 2025
1.3	Implement effective monitoring and management program commencing from the design phase to the construction phase through a monthly report indicating different areas targeted for the month to avoid any lapses in the project's biodiversity monitoring and management programs.	IIU FinnOC	Week 2 June 2025
2.	Actions throughout the design phase		
2.1	Manage close coordination with both CE and MC through physical presence	IIU CE	June-December 2025

No.	Action	Responsibility	Commencement Timeframe
	on site to help determine items such as areas where clearing is to be avoided location of quarries, camps, borrow pits and spoil pits; access roads, water-crossing design, the design of Concern Wildlife Areas and the necessary National regulatory compliance issues, Bank's safeguard issues, etc. to be addressed prior to construction	MC FinnOC	
2.2	Undertake detailed inventories of the large forest trees within the AOI ROW once the contractors have finalized the land required for (a) road construction and (b) ancillary infrastructure, and these plans have been approved by the IIU. A detailed report showing the categories of inventory done	CE & MC IIU FinnOC	June-December 2025
2.3	Complete Concern Wildlife Area(CWA) evaluation for re-vegetation with the involvement of local biodiversity group: this must be achieved through collaboration with the FDA and local communities. Demonstrate meetings with LBG and coolaboration with the FDA.	CE & MC With Technical support from FinnOC	June-December 2025
2.4	Based on BFS assessment and the adopted management and action plan, provide full monitoring and mitigation guidance for the construction phase by requesting the CE for design and construction plan and advising appropriately on different chainages to be worked on.	FinnOC	June 2025-2027
3.	Actions for the construction phase – one to five years		
	Design Phase		
3.1	Conduct awareness for chimpanzee and elephant protection/avoidance program between Bitterball village through Mary Weah village; other villages along the corridor for the CE, MC and workers.	IIU/ FinnOC CE & MC	October - December 2025

No.	Action	Responsibility	Commencement Timeframe
	The awarenesss will consider Stop safety procedure in case workers get in contact with or see elephant or chimpanzee. The result of such undertaking should demonstrate increase percentage of knowledge and actions from commencement till the end. Result will be based on baseline knowledge 0-5%, to progressing knowledge 10%-75%		
3.2	Ensure heavy machinery are fitted with silencers to reduce surrounding sound during construction by evaluating the percentage of heavy machinery and how many heavy are fitted with silencers	CE MC IIU/Finnoc	During construction phase
3.3	Educate vehicle drivers and community members on road signs; position speed limit signs and " animal crossing/caution signs…wild crossing" along this stretch of the corridor. Random sampling monthly to evaluate the knowledge of drivers and community members to the different road signs; evaluation based on level of compliance/non-compliance.	FinnOC & IIU	During construction phase
3.4	Support training in biodiversity management and in One Health Initiative with CE and MC including local community conservation group with coordination with FDA, EPA, Liberia Chimp Rescue Protection and Libassa Wildlife Sanctuary(LiWiSa). Knowledge of the training should demonstrate percentage of unknown knowledge to such training to known knowledge. Result will center on baseline knowledge 0-5%, to progressing knowledge 10%-75%	FinnOC	August 2025- onwards and during design phase

No.	Action	Responsibility	Commencement Timeframe
3.5	Establish record of periodic maintenance of light & heavy duty vehicles to avoid vehicle malfunction leading to possibility of oil or fuel spill, noise, smoke; polluting the environment. Quarterly percentage of vehicle maintenance log will be evaluated and corrective action initiated.	IIU with Technical Support from FinnOC	August 2025-onwards and during design phase
3.6	Engaged and hire a hazardous waste disposal firm responsible for all domestic and hazardous waste produce by the project by demonstrating through contract the hiring of such firm with proactive ToR.	CE & MC	October 2025-onwards before the construction phase
3.7	Establish early coordination with the FDA, local environmental organization or environmental institution, for instance the Liberia Forestry Training Institute(LFTI) for the planting of native fast growing tree and grass species. Demonstrate such williness through the number of meetings/communications and technical site meetings/assessment	CE & MC	August 2025-onwards before the construction phase
4	Construction Phase-Camp Site		
4.1	Immediately construct impervious surface surrounded by drainage collection system on specific sites such as the workshop(machine/heavy and light duty; fuel/gasoline storage site, asphalt plant during the establishment of these sites. Listing of the different sites and a physical demonstration of the construction.	CE & MC	October - January 2026
4.2	Complete fencing of CE camp site to prevent intruders.	CE & MC	December 2025-January 2026
4.3	Independently access all borrow pits/spoil pits sites to ensure it suitability-void of secondary forest, surrounding water bodies, etc. And it legal status. Assessment report on all	FinnOC & IIU	June -August 2025

No.	Action	Responsibility	Commencement Timeframe
	borrow pits with results showing the status of each prior to acquiring such land.		
5	Quarry Operation		
5.1	Prepare an initial environmental evaluation(IEE)/EMP prior to the commencement of work on the quarry Conduct an ARAP for communities in the vicinity of the quarry(around at least 500m) prior to the commencement of the quarry exploitation. Submission of EMP and ARAP reports; the complete valuation and payment of affected structures or farms/trees or persons to be affected by the quarry operation .	CE through Third party EPA Certified Environmental Firm with Technical Support from FinnOC & IIU	June -October 2025
5.2	Prepare and submit blasting methodology and protocol to the IIU & Ministry of Mines Procure and install suitable vibration meters that can measure vibration ≤ $0.015m/s^2$ Procure and install particulate matter meter to measure the baseline and post-blasting of quarry operation. Submission and approval of the blasting protocol and availablity of monitoring equipments prior to blasting operation	CE & MC With Technical support from FinnOC, IIU and Ministry of Mines(MM)	June -October 2025
5.3	Replace community drinking water by installation of water facilities if found in close vicinity of the quarry by negotiating with local community on where and the number of water faciltiies to be contructed.	CE & MC with support from the IIU	By February 2026
6	Pre-Closure, Restoration and Decommission Plan		
6.1	Develop pre-closure plan and submit to the IIU. The plan shall commit the CE to the successful restoration and decommission(including clean up) of all	CE & MC With Technical support from FinnOC	Three(3) month prior to the contract ending date 2027

No.	Action	Responsibility	Commencement Timeframe
	sites(quarry, borrow pits, spoil pit and camp site) used by the Contracting Entity Submitted report within the given time period on the outline of all items to be closed and decomissioned. Site assessement, report evaluation and approval.		
6.2	Hire third party environmental and hazadous waste and disposal firms respectively for the preparation of Environmental Restoration and Decommission Plan and Waste Disposal Plan, immediately upon submission of the re-closure plan to the IIU by alerting the CE of its compliance to local regulatory bodies, assisting the CE in the process of ensuring a third party is contracted and reviewing the submitted report of the third party.	CE & MC	Three(3) month prior to the contract ending date 2027
7	Closure Restoration and Decommission Plan		
7.1	preparation of Environmental Restoration and Decommission Plan and Waste Disposal Plan, immediately upon submission of the pre-closure plan to the IIU. This will be initiated by alerting the CE & MC of its responsibility in reference to local regulation and the Bank's safeguard measures.	CE through Third party EPA Certified Environmental Firm with Technical Support from FinnOC & IIU	Three(3) month prior to the contract ending date 2027
7.2	Ensure the implementation of the restoration and decommission plan by presenting environmental, social and biodiversity(ES&B) corrective action to the CE & MC	CE & MC With Technical support from FinnOC & IIU	Three(3) month prior to the contract ending date 2027

7 CONCLUSIONS AND RECOMMENDATIONS

The Biodiversity Field Survey (BFS) conducted for the 40 km Tappita to Toe Town road corridor under the Rural Economic Transformation Project (RETRAP) aimed to assess the presence, abundance, and distribution of key threatened species, including the Western Chimpanzee, African Forest Elephant, and Pygmy Hippopotamus, within a 1 km buffer zone. The study employed scientifically robust methodologies such as camera trapping, line transect surveys, reconnaissance walks, and community consultations. Key findings include:

- **Species Presence**: No direct or indirect evidence (e.g., nests, dung, footprints) of Western Chimpanzees, African Forest Elephants, or Pygmy Hippopotamuses was found within the project's area of influence (AOI). Community interviews indicated rare historical sightings (last 5–20 years) but no recent activity.
- **Habitat Assessment**: The AOI is predominantly degraded secondary forest, agricultural land (cocoa, rubber, mixed crops), and fragmented habitats, with no Key Biodiversity Areas (KBAs) or protected areas within 1 km.
- **Critical Habitat Criteria**: Only two species (Jentink's Duiker and white-bellied pangolin) met criteria 1 of the critical habitat assessment. The observations of these two threatened species were located beyond the 1km buffer of the project road. Eve
- **Camera Trap Data**: The results from 23 camera traps showed no evidence of critical species such as chimpanzee, African forest elephant, pygmy hippopotamus. Only presence of the white-bellied pangolin was confirmed.
- **Landscape Connectivity**: Species distribution models indicated low suitability for critical species in the project area, aligning with field observations,

Conclusion on BMP Requirement

Based on the BFS findings on critical species and the many detailed and specified mitigation measures recommended for both species and habitat, the need for a biodiversity offset and net gain plan is not expected for the following reasons:

- **No Critical Habitat**: The Critical Habitat Assessment used 1km AOI to assess Project risks. Based on available information and additional biodiversity field surveys, the Project's Area of Analysis does not qualify as Critical Habitat. Even though, potential critical habitat was found to be relevant to two species only (Jentink's Duiker and White-Bellied pangolin) under criteria 1. Also, the study area has been heavily modified in the last decades (as seen from the recent tree cover loss throughout the 40km (about 24.85 mi), as well as the evidence from the ground on forest clearance activities and land-use change). While habitat classification may not excuse a project from developing biodiversity management plan, for this project, biodiversity risks are not significant as the two target species, presence has been confirmed beyond the 1km buffer AOI, , and there is no evidence of essential ecological function or viability for the species in this project's area. In this sense, the project area may not qualify as critical habitat, if it's determined that the site is not significant to the species' survival, based on the criteria above.

- Significant reduction of Key Species: Field surveys and community consultations confirmed no recent activity or viable populations of Western Chimpanzees. African Forest Elephants, or Pygmy hippopotamuses. The target species to be managed in the mitigation plan are Jentink's duiker and the White-bellied pangolin and though the project cannot make a definite statement on the complete absence of chimpanzees due to its rare presence; nevertheless, conclusions of a no net loss can be reached because of these species significant populations decreased.
- Precautionary Mitigation measures will address residual risks (e.g., habitat fragmentation and noise) .
-

Precautionary Mitigation Measures in ESIA/ESMP

To address potential indirect impacts, the following measures will be implemented:

6. **Habitat Connectivity**:
   - Install wildlife-friendly culverts (900 mm pipes for ephemeral streams, box culverts with natural substrates) at 5 km intervals.
   - Retain tree canopy connectivity (10 m gaps) where possible. In addition roadside vegetation plans will include the management of a 10m buffer of planting native trees to increase canopy connectivity of wildlife.
7. **Construction Controls**:
   - Restrict clearing to designated areas; demarcate work zones to avoid unnecessary habitat disturbance.
   - Enforce "no hunting" and "no disturbance" policies for workers and contractors; conduct awareness programs.
8. **Traffic Management**:

- Implement speed limits (40 km/h in rural areas) and install "wildlife crossing" signage on both side of the road.
- Prohibit night-time construction to reduce noise disturbance.

9. **Revegetation**:
    - Replant disturbed areas with native species to stabilize soils and restore green corridors.
10. **Monitoring**:
    - Conduct post-construction biodiversity monitoring to verify the effectiveness of mitigation measures.

List of Mitigation Measures as Precautions

- **Avoidance**: Minimize vegetation clearance; use existing access roads.
- **Minimization**: Silencers on machinery; seasonal restrictions (e.g., no bridge work during wet season).
- **Restoration**: Revegetate borrow pits/quarries; stabilize slopes with erosion controls.
- **Offset**: Not required due to absence of critical habitat but may support landscape-level conservation initiatives.

Recommendation

The proposed road construction will not take place on virgin land or within a forested area. The project site has long served as an unpaved road, supporting various forms of transportation. Currently, this unmetalled road contributes to elevated sediment runoff, soil erosion, and dust pollution, negatively affecting air and water quality. The implementation of a metaled road is expected to mitigate these issues, leading to improved air quality in the area.

The Environmental and Social Management Plan (ESMP) will incorporate comprehensive mitigation measures to address residual risks, ensuring full compliance with Environmental and Social Standard 6 (ESS6) and Liberia's environmental regulations. Should new data—such as findings from camera traps—reveal unforeseen impacts, an adaptive management approach will be employed to address them effectively.

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APPENDICES