Client:
West African Power Pool (WAPP)

Ghana

400/330kV WAPP GHANA - CÔTE D'IVOIRE INTERCONNECTION REINFORCEMENT PROJECT

Feasibility Study & Line Route and Environmental and Social Studies

BIODIVERSITY MANAGEMENT PLAN (BMP)

Ghana

October 2025

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Rev. N.	Rev. Date	Content	Prep/Rev	Released	Signature
1	14/05/2024	312 ESA R SP 005 A DRAFT BMP	Ghana Cons./SP	F. Terragni	
2	23/09/2024	312 ESA R SP 005 B DRAFT FINAL BMP	Ghana Cons./SP	F. Terragni	
3	10/10/2024	312 ESA R SP 005 C DRAFT FINAL BMP	Ghana Cons./SP	F. Terragni	
4	25/10/2024	312 ESA R SP 005 D DRAFT FINAL BMP	Ghana Cons./SP	F. Terragni	
5	05/06/2025	312 ESA R SP 005 E DRAFT FINAL BMP	Ghana Cons./SP	F. Terragni	
6	25/07/2025	312 ESA R SP 005 F DRAFT FINAL BMP	Ghana Cons./SP	F. Terragni	
7	24/09/2025	312 ESA R SP 005 G DRAFT FINAL BMP	Ghana Cons./SP	F. Terragni	
8	31/10/2025	312 ESA R SP 005 H DRAFT FINAL BMP	Ghana Cons./SP	F. Terragni	

ACRONYMS

BIA	Biodiversity Important Areas
BMP	Biodiversity Management Plan
CDO	Community Development Officer
CREMA	Community Resource Management Areas
DA	District Assembly
DBO	District Budget Officer
DCD	District Coordinating Director
DCE	District Chief Executive
DDCD	Deputy District Coordinating Director
DDPO	District Development Planning Officer
DPO	District Planning Officer
ECOWAS	Economic Community of West African States
EIA	Environmental Impact Assessment
EPA	Environmental Protection Authority
ESS	Environmental and Social Standard
ESIA	Environmental and Social Impact Assessment
ESIS	Environmental and Social Impact Statement
ESMP	Environmental and Social Management Plan
FSD	Forestry Services Division of the Lands Commission
GRA	Grievance Redress Mechanism
GRIDCo	Ghana Grid Company Limited
ICM	Integrated Catchment Management
IEC	Information, Education and Communication
IUCN	International Union for Conservation of Nature
kV	kilovolt
Li	Legislative Instrument
LVD	Land Valuation Division
MCD	Municipal Coordinating Director
MCE	Municipal Chief Executive
MDPO	Municipal Development Planning Officer
MW	Megawatts
NRMP	Natural Resource Management Programme
PAP	Project-Affected Person
PIU	Project Implementation Unit
RAP	Resettlement Action Plan
RoW	Right of Way
SEP	Stakeholder Engagement Plan

SEST	Socio-Economic Studies Team
TL	Team Leader
TOR	Terms of Reference
VRA	Volta River Authority
WAPP	West African Power Pool
WB	World Bank

EXECUTIVE SUMMARY

The Ghana-Côte d'Ivoire Interconnection Reinforcement Project is a transboundary energy infrastructure initiative led by the Ghana Grid Company Limited (GRIDCo), designed to enhance electricity transfer capacity between Ghana and Côte d'Ivoire. As part of the West African Power Pool (WAPP) vision to strengthen regional power interconnectivity and stability, this project covers a total length of 225 km, including approximately 125 km in Ghana. Recognizing the ecological sensitivity of the project corridor, a comprehensive Biodiversity Management Plan (BMP) has been developed to ensure that activities are conducted in a way that minimizes harm to native species and habitats, promotes sustainable practices, and works towards positive biodiversity outcomes, such as habitat enhancement and the protection of at-risk species.

The purpose of the BMP is:

- To provide a simple, well structured, adaptive management approach to terrestrial biodiversity conservation in the project area of influence;
- To provide detailed technical methods for land clearing, wildlife management, protection of Important Biodiversity Areas to minimize the potential impacts on habitat and wildlife from project construction activities;
- To provide a long-term vision and an integrated plan for the maintenance and enhancement of habitat for threatened terrestrial mammal species in the project area of influence, while also addressing the influences from, and on, resettlements and land uses in the ROW;
- To meet the World Bank ESS6 and international best practice for biodiversity conservation.

The Biodiversity Management Plan (BMP) is a critical component of the broader Environmental and Social Impact Assessment (ESIA) and aligns with the World Bank's EFSs and especially Environmental and Social Standard 6 (ESS6), focusing on Biodiversity Conservation and Sustainable Management of Living Natural Resources. The BMP has been crafted with the goal of achieving no net loss and preferably a net gain of biodiversity. It emphasizes risk identification, baseline assessments, biodiversity valuation and mitigation hierarchy.

The baseline biodiversity assessment was undertaken across representative sites and habitats along the project corridor, covering forest reserves, community forests, fallow lands, cultivated areas, and wetlands. The study identified 108 plant species, seven of which are globally threatened, including *Khaya grandifoliola* (African mahogany) and *Milicia excelsa* (iroko). The faunal assessment documented 71 bird species (including hornbills, bee-eaters, and weavers), several amphibians, reptiles, and invertebrates. The corridor areas include low-lying areas that have been adapted for wetland agriculture, including rice paddies, fish farming ponds, and seasonal crop fields. These anthropogenic wetlands are particularly important for water birds and amphibians, offering foraging and breeding grounds in areas where natural wetlands have been degraded. Additionally, mammalian diversity in the corridor reflects the mixed

landscape of forest, agroforestry, and settlements. Key species observed include Lowe's monkey, Maxwell's duiker, hyraxes, and bat species such as the Tiny pipistrelle and Robin's yellow bat.

The BMP specifically identifies, and maps Important Bird Areas (IBAs) and wetlands located near the impact corridor (IC), as well as other habitats heavily used by birds within a 10 km radius of the alignment. GPS coordinates were logged for these sites, together with information on habitat extent and quality. The document also includes a sketch map of the IBAs along the transmission line route and highlights the need to consider West African migratory routes, which bring additional conservation relevance.

The most pressing threat to biodiversity along the corridor is the ongoing conversion of forestland into agricultural fields and the BMP identifies several key biodiversity threats posed by the project. These include habitat fragmentation, deforestation, disturbance of wildlife corridors, potential bird and bat collisions with transmission lines, and risk of electrocution. Additional pressures such as hunting, poaching, and encroachment from ancillary activities during construction were also assessed. Specific sensitive and critical habitats such as Forest Reserves and transitional forest-savanna mosaics were mapped for enhanced protection.

To mitigate the identified risks, the BMP outlines a robust mitigation hierarchy involving avoidance, minimization and restoration. Avoidance strategies include micro-siting to bypass critical habitats. Minimization involves best construction practices like restricting land clearing to the right-of-way, timing of construction to avoid sensitive breeding seasons, and maintaining vegetative buffers along ecologically sensitive stretches. Restoration plans focus on revegetation and erosion control along cleared corridors. The survey has mapped bird congregation hotspots using standard ornithological techniques. Based on activity levels, avian-safe mitigation measures such as line markers and diverters have been recommended. Also, a site-specific avian risk analysis will be integrated into the project's risk management framework. It will identify collision and electrocution risk zones based on line height, tower configuration, and habitat proximity.

The BMP's implementation structure is extensive: A multi-stakeholder strategy is used, involving communities, NGOs, traditional authorities, GRIDCo, the Forestry Commission, the Environmental Protection Authority (EPA), and local District Assemblies. GRIDCo's Environmental and Social Management Unit (ESMU) will be in charge of coordination, with assistance from external biodiversity specialists and environmental officers. Training, grievance redress procedures, community sensitization, and participatory monitoring systems are all included in the strategy.

From a legal standpoint, the BMP aligns with Ghana's Environmental Protection Agency Act (1994), the Forest and Wildlife Policy (2012), and the Wildlife Resources Management Bill (2022), alongside international commitments such as the Convention on Biological Diversity and the Ramsar Convention. Institutional roles are clearly delineated, ensuring compliance, transparency, and participatory monitoring.

Budgetary provisions for the BMP is projected at USD 3.1 million, encompassing pre-construction biodiversity surveys, implementation of avoidance and restoration measures, training programs, monitoring and evaluation activities, and contingency funds. This investment reflects the project's commitment to sustainability and its adherence to international environmental safeguards.

In conclusion, the Biodiversity Management Plan is not only a fulfillment of regulatory requirement but a strategic tool to align the transmission line development with environmental stewardship. Through a science-based, participatory, and adaptive management framework, the BMP provides a practical roadmap to avoid, minimize, and restore ecological impacts. It is a testament to GRIDCo's and Ghana's broader commitment to conserving biodiversity, enhancing ecosystem resilience, and ensuring sustainable socio-economic development across West Africa.

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1 INTRODUCTION

1.1 Background

The Ghana-Cote d'Ivoire Interconnection Reinforcement Project is a critical infrastructure initiative aimed at improving the transmission of electricity between Ghana and Cote d'Ivoire. While this project brings economic and developmental benefits to both countries, it is essential to consider and mitigate the potential adverse impacts on biodiversity, ecosystems, and natural habitats along the transmission line route. The project runs through forested areas, protected ecosystems, and agricultural lands that host a variety of plant and animal species, making it vital to adopt biodiversity conservation strategies in line with international standards.

World Bank's Environmental and Social Standard 6 (ESS 6) on Biodiversity Conservation and Sustainable Management of Living Natural Resources emphasizes the importance of protecting biodiversity and maintaining the integrity of ecosystems. It requires that projects like the Ghana-Cote d'Ivoire Interconnection take proactive measures to avoid, minimize, and compensate for adverse impacts on biodiversity and natural habitats. This Biodiversity Management Plan (BMP) is formulated to ensure compliance with ESS 6 and to provide a framework for conserving biodiversity throughout the project's implementation.

1.1.1 The Ghana-Cote d'Ivoire Interconnection Reinforcement Project

The Ghana Grid Company Limited (GRIDCo) proposes to construct, operate, and maintain an approximately 125km high voltage 400/330kV transmission line facility to augment energy supply to meet the industrial power demand in Ghana and West Africa. The high voltage transmission line is starting from Bingerville in Cote d'Ivoire to Dunkwa-on-Offin in Ghana in a project dubbed '400/330 kV Cote d'Ivoire-Ghana Interconnection Reinforcement Project'. Under the provisions of the Ghana Environmental Assessment Regulations, 1999 (LI 1652), the erection of power transmission line under "Power Generation and Transmission Projects" are categorized under undertakings for which an Environmental Permit is mandatory. Based on project registration in August 2021, the Environmental Protection Authority (EPA) directed GRIDCo to undertake the Environmental and Social Impact Assessment (ESIA) Study.

The proposed high voltage line project will transverse Upper Denkyira East, Wassa Amenfi East, Wassa Amenfi West, Aowin Municipal, and Wassa Amenfi Central Districts in the Central, Western, and Western North Regions of Ghana. The transmission line will be built within a 40 m corridor width over a distance of approximately 125 km. Within the 40 m-wide construction right-of-way, no officially designated archaeological or legally protected sites were identified. However, ecological assessments documented several environmentally sensitive habitats immediately adjacent to or intersecting sections of the corridor

including riparian forests, secondary growth areas, and forest-reserve margins that support globally threatened and restricted-range species. The project from the Ghana-Cote d'Ivoire border (Omanpe) may be referred to as "linear," terminating at a proposed substation at Bibianiha near Dunkwa-on-Offin (Appendix 1).

According to GRIDCo's engineering design and construction methodology, the 125km proposed project will involve the installation of steel transmission towers. A minimum of 7.5 to 8 meters will be available between the lines and open terrain, and 8 meters will be available for roads, depending on the towers' height. The towers will normally be between 35 and 40 meters high, just like the current system.

1.1.2 Purpose of the BMP

The purpose of the Biodiversity Management Plan (BMP) is to ensure that the Ghana-Côte d'Ivoire Interconnection Reinforcement Project is implemented in a manner that conserves biodiversity and promotes the sustainable management of living natural resources. Specifically, the BMP seeks to avoid and minimize adverse impacts on biodiversity and, where avoidance is not possible, to implement appropriate mitigation.

The BMP is an operational tool that supports the integration of biodiversity considerations into all phases of the project lifecycle, in compliance with national legislation and the World Bank's Environmental and Social Standard 6 (ESS6). It guides the planning, implementation, monitoring, and reporting of activities to manage biodiversity-related risks and opportunities throughout the project corridor.

1.1.3 Goals of the BMP

1. To protect, conserve, and where necessary restore species, habitats, and ecosystems within and around the project's area of influence, with particular emphasis on globally or nationally threatened species and sensitive habitats.
2. To align project activities with Ghana's environmental laws, policies, and international biodiversity commitments, as well as with World Bank ESS6 requirements.
3. To identify biodiversity-related risks early and apply the mitigation hierarchy avoid, minimize, restore, and reduce residual impacts of the project on biodiversity.
4. To involve local communities, traditional authorities, government agencies, and civil society in the design, implementation, and monitoring of biodiversity actions.
5. To establish a robust biodiversity monitoring framework to track performance indicators and adapt management actions as needed to ensure ecological objectives are met.

6. To strengthen institutional and community capacities for biodiversity conservation and environmental governance through training, education, and outreach programs.

1.2 Development of the Biodiversity Management Plan (BMP)

The development of the Biodiversity Management Plan (BMP) for the Ghana–Côte d'Ivoire Interconnection Reinforcement Project was driven by the need to safeguard ecological integrity while advancing regional energy infrastructure. The process was informed by the World Bank's Environmental and Social Standard 6 (ESS6), which emphasizes the conservation of biodiversity and the sustainable management of living natural resources, as well as Ghana's national environmental policies and regulatory frameworks.

i. Contextual Basis: The BMP was developed in response to the findings of the project's Environmental and Social Impact Assessment (ESIA), which identified significant risks to biodiversity, particularly in forested, agricultural, and transition zones along the 125 km corridor in Ghana. These areas include sensitive habitats such as forest reserves, community-managed lands, and riparian ecosystems that support diverse flora and fauna, including several threatened species.

ii. Baseline Biodiversity Assessments: The foundation of the BMP was laid through baseline ecological studies conducted at representative sites along the transmission corridor. These studies recorded:

- 108 plant species (including 7 globally threatened),
- 71 bird species,
- Amphibians, reptiles, mammals, and insects of ecological importance.

Special attention was given to identifying critical habitats and ecological hotspots such as Forest Reserves and other areas of high conservation value. Data collection methods included field surveys, habitat mapping, species inventories, and consultations with local stakeholders.

iii. Stakeholder Engagement: The development of the BMP was also shaped through extensive consultations with:

- Local communities and traditional authorities,
- District Assemblies and decentralized government departments,
- The Environmental Protection Authority (EPA), and Wildlife Division of the Forestry Commission,
- Civil society organizations and conservation NGOs.

Stakeholder input was vital in identifying community dependencies on natural resources, traditional conservation practices, and potential conflicts or synergies between development and conservation goals.

iv. Risk Assessment and Mitigation Design: Using the mitigation hierarchy (avoid, minimize, restore), the BMP development team analyzed potential impacts on:

- Habitat connectivity and fragmentation,
- Species displacement or mortality,
- Ecosystem services loss (e.g., pollination, erosion control),
- Risk of invasive species introduction and overexploitation.

Corresponding mitigation strategies were then embedded into the BMP to ensure ecologically sound and socially acceptable project implementation.

v. Integration with Project Design: The BMP was not developed in isolation. It is integrated into the overall project design and environmental management systems, ensuring that biodiversity considerations inform routing decisions, construction methods, and operational protocols. For example:

- **vi. Planning for Monitoring and Evaluation:** As part of its development, the BMP includes a framework for biodiversity monitoring and evaluation, defining indicators, responsibilities, and timelines. It also outlines requirements for biodiversity programs, including the Routing was adjusted to avoid high-value conservation areas.
- Construction timing was aligned to minimize disturbance during breeding seasons.
- Vegetative buffers and wildlife corridors were proposed to maintain habitat continuity.

restoration of forest areas and alignment with community-based resource management (CREMA) schemes.

vii. Compliance and Institutional Framework: The BMP aligns with Ghana's environmental regulatory framework (including the EPA Act, Forestry Policy, and Wildlife Resources Management Act) and global conventions such as the Convention on Biological Diversity. Roles and responsibilities for implementation, monitoring, reporting, and compliance enforcement were clearly defined across institutional partners.

In essence, the development of the BMP reflects a science-based, participatory, and adaptive approach to ensuring that the project's development objectives are achieved without compromising the ecological resilience and biodiversity values of the affected landscapes.

2 BACKGROUND TO LAND USE AND BIODIVERSITY ISSUES

The Ghana–Côte d'Ivoire Interconnection Project lies within a zone of rich ecological and cultural diversity, where land use patterns are shaped by a blend of traditional livelihoods and modern development pressures. Forested areas, farmlands, and wetlands along the corridor are home to diverse species, many of which are vulnerable to human-induced threats. The increasing demand for agricultural land, combined with the expansion of infrastructure, logging activities, and settlements, has caused significant transformation of the landscape. Habitat fragmentation and degradation have reduced the ecological integrity of these ecosystems, affecting both species distribution and ecosystem services such as pollination, water purification, and carbon storage. The need for a sustainable development model that balances infrastructure growth with ecological preservation is critical in this context. The BMP responds to these issues by integrating biodiversity conservation actions into transmission line development throughout the entire corridor.

2.1 Biological Characterisation of the Corridor

The Ghana-Côte d'Ivoire Interconnection Project corridor extends from Babianiha in the Central Region to Omanpe in the Western Region, traversing a range of ecological landscapes that reflect the diversity of Ghana's forest transition zone. The terrain includes relatively intact semi-deciduous forests, mosaics of secondary vegetation, and agricultural fields, particularly those cultivated with cocoa, oil palm, and food crops. Additionally, the corridor passes through riparian wetlands and swamp forests that serve as critical hydrological buffers and habitat for aquatic and semi-aquatic species. Key natural resources found along the corridor include commercially important timber species such as *Milicia excelsa* (odum) and *Terminalia superba*, as well as non-timber forest products (NTFPs) like medicinal herbs, wild fruits, and bushmeat species. Biodiversity remains moderately high in less disturbed areas, with plant and animal species demonstrating relative resilience despite ongoing anthropogenic pressures. Traditional land use systems and sacred groves further contribute to the preservation of biological richness in certain localities, although their protective effect is increasingly compromised by expanding human activities.

2.2 Threatened Species, Protected Areas and Key Biodiversity Areas of the Corridor

The biodiversity within the project corridor includes several species of national and global conservation concern. Of particular note are the presence of the dwarf crocodile (*Osteolaemus tetraspis*), the Gabon viper, and several globally threatened tree species such as *Khaya anthotheca* and *Entandrophragma angolense*. These species are sensitive to habitat alteration and rely on forested areas and wetland ecosystems for survival. The corridor passes through a landscape including corridor lies in close proximity

(approximately 1-5 km) to Draw River Forest Reserve (~1-1.5 km), Tano Ehuro the following forest reserves: Draw River, Tano Ehuro, and Boin Tano which lies closest to the project alignment and contribute significantly to Ghana's national protected area network. The proposed transmission Forest Reserve (~2-3 km), and Boin Tano Forest Reserve (~4-5 km) (Appendix 7, Appendix 9). None of these reserves are intersected by the 40 m Right-of-Way, but they fall within the project's broader ecological influence area and were therefore included in the Critical Habitat Assessment and mitigation hierarchy. , At least two of these; Draw River and Boin Tano are recognized as Key Biodiversity Areas (KBAs) due to their ecological importance, habitat diversity, and presence of species of global concern. These reserves provide ecological services such as carbon sequestration, watershed protection, and serve as biodiversity refuges. Their inclusion in the corridor highlights the urgent need to balance development with biodiversity conservation through careful siting, routing, and ecological mitigation measures.

2.3 Major Vegetation Types and Ecosystems of the Corridor

The corridor features a diverse range of vegetation types and ecosystems shaped by both natural factors and human activities. Primary vegetation is characterized by moist semi-deciduous forests, rich in canopy trees and multiple strata supporting various epiphytes and climbers. In more disturbed regions, secondary forests and forest regrowth patches dominate, often following selective logging or shifting cultivation. A key feature across the corridor is the widespread presence of agroforestry systems, particularly cocoa farms interspersed with remnant native trees, offering partial canopy cover and supporting moderate biodiversity. The wetland and riverine buffer zones are ecologically significant for hydrological regulation, providing habitat for amphibians, reptiles, and wetland flora. These ecosystems support ecological functions such as water filtration, erosion control, and microclimate regulation. While the integrity of these systems varies across localities, their conservation is critical for long-term ecosystem service provision and biodiversity persistence.

2.3.1 Natural Forest

Natural forest remnants in the area of the corridor are primarily located in the proximity of protected reserves such as Draw River and Tano Ehuro. These patches contain a diversity of native tree species, including *Milicia excelsa, Antiaris toxicaria, and Ceiba pentandra*, and maintain a structurally complex habitat that supports a wide variety of forest-dependent wildlife. These forests are important for maintaining microclimatic stability, supporting carbon sinks, and providing ecological corridors. Despite

their ecological importance, these areas are increasingly threatened by illegal logging and encroachment, necessitating robust protection and monitoring measures.

2.3.2 Mixed Garden / Agroforestry

The dominant land-use type along the 125 km transmission corridor is mixed agroforestry, accounting for roughly 45–50 % of the total land cover within the 40 m Right-of-Way. These areas are primarily cocoa farms interspersed with shade and economic trees such as *Albizia zygia*, *Newbouldia laevis*, and scattered remnants of original semi-deciduous forest species (*Ceiba pentandra*, *Antiaris toxicaria*). Field verification and high-resolution satellite imagery confirmed that this mosaic landscape forms the prevailing matrix between forest-reserve margins and riparian zones, underscoring its importance for both rural livelihoods and biodiversity connectivity. These systems support a moderate level of biodiversity and act as buffer zones between natural forest and more intensively used lands. The integration of diverse crop species with native vegetation offers ecological benefits such as pest control, pollination services, and soil fertility enhancement. However, the expansion of monoculture cash crops and increasing pesticide use threaten the ecological stability of these landscapes.

2.3.3 Scrub and Upland Vegetation

These are areas that have undergone repeated disturbance either through fire, shifting cultivation, or wood harvesting are dominated by scrub vegetation and early successional species. These include *Chromolaena odorata, Imperata cylindrica*, and other fire-resistant shrubs. Such landscapes often serve as transitional habitats for pioneer fauna and flora, but their ecological value is generally lower than that of mature forests. Upland areas, often on sloping terrain, are particularly prone to erosion if not properly managed, and their biodiversity contribution is limited unless allowed to regenerate naturally.

2.3.4 Settlement

Settlements along the corridor range from small hamlets to semi-urban centers. These areas are characterized by fragmented green cover, gardens, and communal lands. While urban vegetation such as home gardens and boundary plantings provide minor habitat niches, the ecological integrity of settlement areas is generally low. However, settlements play a key role in shaping land use patterns and can serve as platforms for implementing sustainable land and biodiversity practices, particularly through environmental education and waste management initiatives.

2.3.5 Fields, Fish Pools, and Rice Fields

The corridor includes low-lying areas that have been adapted for wetland agriculture, including rice paddies, fish farming ponds, and seasonal crop fields. These anthropogenic wetlands are particularly important for water birds including *Bubulcus ibis*, *Egretta ardesiaca*, *Actophilornis africanus*, *Actitis hypoleucos*, and *Ceryle rudis*. and amphibians including *Sclerophrys regularis*, *Hyperolius fusciventris*, *Phrynobatrachus natalensis*, and *Acanthixalus sonjae*, with the vulnerable *Osteolaemus tetraspis* also observed, offering foraging and breeding grounds in areas where natural wetlands have been degraded. Despite being managed for production, such systems can retain considerable ecological value if chemical input is minimized and habitat mosaics are maintained. The integration of ecological management into farming practices in these landscapes offers opportunities for promoting biodiversity-friendly agriculture.

2.3.6 Mammals

Mammalian diversity in the corridor reflects the mixed landscape of forest, agroforestry, and settlements. Key species observed include Lowe's monkey (*Cercopithecus lowei*), Maxwell's duiker (*Philantomba maxwellii*), hyraxes, and bat species such as the Tiny pipistrelle (*Pipistrellus nanulus*) and Robin's yellow bat (*Scotophilus dinganii*). These species are primarily forest-edge or secondary habitat specialists and are highly vulnerable to habitat fragmentation and hunting. Their populations are declining due to shrinking habitat patches and increasing human-wildlife conflict, underscoring the importance of buffer zones and conservation corridors.

2.3.7 Reptiles and Amphibians

Amphibians and reptiles within the corridor include species such as the dwarf crocodile (*Osteolaemus tetraspis*), the Nile monitor lizard (*Varanus niloticus*), and amphibians like *Acanthixalus sonjae*, a West African endemic frog. These taxa are particularly sensitive to changes in hydrological regimes and water quality, making them indicators of ecosystem health. Wetlands and shaded forest streams are their preferred habitats, and the disruption of these areas through clearing or pollution could significantly impact their populations. Their conservation depends on preserving aquatic microhabitats and implementing buffer zones around critical wetland areas.

2.3.8 Birds

Bird diversity in the corridor is moderately high, with 71 species recorded during field assessments (Appendix 9). These include common forest-edge species such as sunbirds, hornbills, bee-eaters, and weavers. Although no IUCN-listed endangered birds were confirmed, the corridor provides seasonal resources for migratory species and supports key ecological functions like insect control and seed dispersal. The avifauna reflects habitat heterogeneity and is a useful bioindicator of environmental health.

Conservation of forest patches, wetlands, and agroforestry landscapes is essential to maintaining avian diversity in the region.

2.4 Flora

The vegetation structure within the corridor varies from primary forest to degraded secondary forest and agroforestry systems. The floristic inventory recorded 108 plant species, representing a mix of native forest trees, understory shrubs, herbs, and climbers. Seven of these species are globally threatened, including *Entandrophragma angolense* and *Milicia excelsa*,(Appendix 9) both of which are valued for their timber and are under increasing anthropogenic pressure. These plant species are not only critical to ecological stability but also serve as resources for local livelihoods in the form of fuelwood, traditional medicine, and food. The presence of invasive species such as *Chromolaena odorata* in disturbed areas signals a shift in ecological composition due to human activities. Conservation of flora in this corridor is therefore not limited to protecting species, but also involves maintaining ecosystem functions and services that underpin sustainable land management.

2.4.1 Land Allocated for Infrastructural Development

Infrastructural development associated with the transmission line includes designated land for access roads, tower pads, laydown yards, and temporary storage areas for equipment and materials. These physical structures are essential for project execution but result in direct habitat loss. Approximately 8 hectares of land are projected to be permanently altered for these uses. The cumulative footprint (2,367 hectares) of these developments necessitates careful planning and the application of best practices to minimize disruption to the surrounding natural and human environment.

2.4.2 Production Forest Land

Sections of the corridor intersect with production forest lands under the jurisdiction of the Forestry Commission (Appendix 1; Figure 5 (and associated maps in Appendix 7). These areas include forest reserves that are subjected to regulated logging and managed for sustainable timber production. While some reserves maintain relatively intact canopy cover, others are characterized by selective logging activities and encroachment. The corridor's interaction with these zones underscores the importance of coordinated forest management to safeguard residual biodiversity and maintain ecological function, especially in areas where logging is permitted under concession agreements.

2.4.3 Community Land

Community lands along the corridor encompass a mix of farmlands, fallow areas, sacred groves, and homesteads managed through customary land tenure systems. These lands are central to the livelihoods of rural households and are often used for subsistence farming, agroforestry, and cultural practices. Sacred groves, although small in size (usually less than 1 acre), represent significant conservation refuges due to traditional taboos against exploitation. Recognizing and integrating local land use practices and cultural values into the project's land acquisition and compensation processes is critical to ensuring social license and promoting sustainable co-management.

2.4.4 Deforestation and Forest Degradation through Agricultural Conversion

The most pressing threat to biodiversity along the corridor is the ongoing conversion of forestland into agricultural fields (Appendix 9). Cocoa, cassava, maize, and oil palm are the dominant crops driving land clearance. This process involves removal of tree cover, disruption of soil structure, and introduction of non-native plant species. Over time, it leads to the loss of ecological integrity, reduction in carbon sequestration potential, and fragmentation of wildlife habitat. Shifting cultivation and expansion of mono-crop plantations continue to place pressure on remaining natural vegetation, making restoration efforts more urgent.

2.4.5 Hunting and Collecting Wildlife

Hunting for bushmeat remains a widespread activity among rural communities and poses a serious threat to terrestrial fauna. Local hunters commonly use snares, dogs, and traps to capture small mammals, reptiles, and birds for food or trade, while reptiles especially tortoises and snakes are also collected for medicinal and ornamental purposes. Hunting pressure intensifies during the dry season when vegetation cover is sparse and wildlife is more accessible. This unsustainable exploitation contributes to species decline and alters food-web dynamics, with cascading effects on ecosystem health.

In addition to community activities, the presence of construction and maintenance workers along the corridor can further increase hunting and collecting pressures. Workers may trap small game or harvest medicinal plants, either for subsistence or for sale. Unless properly regulated, such practices could compound existing wildlife depletion and undermine local conservation efforts. To mitigate these impacts, the Project will:

- Enforce strict codes of conduct prohibiting hunting, trapping, and wildlife collection by staff and contractors.

- Provide environmental induction training emphasizing biodiversity protection and local conservation laws.
- Offer alternative food and recreational options within worker camps to remove incentives for bushmeat hunting.
- Collaborate with local communities and law-enforcement agencies to strengthen awareness, monitoring, and reporting of wildlife offenses.

Integrating these measures will help maintain wildlife populations, support the objectives of the Biodiversity Management Plan, and ensure that both community- and worker-related pressures on fauna are minimized

2.4.6 Critical Habitat Triggers According to ESS 6

According to the World Bank's ESS6, a critical habitat is one that supports globally threatened species, endemic species, significant congregations of migratory species, or unique or threatened ecosystems. Surveys along the corridor recorded the presence of several globally threatened plant species and a few fauna of conservation concern near forested sections and wetlands. These occurrences meet the criteria for critical habitat designation, thereby triggering the need for heightened mitigation and biodiversity management measures under ESS6 guidelines.

Table 1: Basis for triggering Critical Habitat Assessment

ESS6 Critical Habitat Criteria	**Species / Biodiversity Features Identified**	**Potential Impacts and Net Gain Needs**
(a) habitat of significant importance to Critically Endangered or Endangered species, as listed in the IUCN Red List of threatened species or equivalent national approaches	*Entandrophragma angolense*, *Milicia excelsa* (both globally threatened timber trees); possibly *Lowe's monkey* (*Cercopithecus lowei*) near forest edges	Habitat loss from vegetation clearance and fragmentation of remaining high forest patches. Requires restoration (≥370 ha reforestation planned).
(b) habitat of significant importance to endemic or restricted-range species;	*Acanthixalus sonjae* (West African endemic frog), *Dendrohyrax interfluvialis* (Benin tree hyrax) in forested and riparian zones	Disturbance to microhabitats (streams, canopy cover); mitigated by buffer zones and restricted clearing schedules.
(c) habitat supporting globally or nationally significant concentrations of migratory or congregatory species	Migratory and forest-edge birds (sunbirds, bee-eaters, hornbills, weavers; 71 species recorded)	Loss of feeding and nesting habitat; potential collision risk. Bird diverters, marker balls, and ecological buffers required.
(d) highly threatened or unique ecosystems	Riparian wetlands and remnant semi-deciduous forest	Hydrological alteration and fragmentation.

	fragments (Draw River, Tano Ehuro, Boin Tano)	Restoration of 370 ha forest, alignment micro-siting to avoid core IBAs.
(e) ecological functions or characteristics that are needed to maintain the viability of the biodiversity values described above in (a) to (d).	Connectivity corridors, seed dispersal, pollination, carbon sequestration zones	Edge fragmentation and soil compaction threaten ecological function. Measures include habitat connectivity and enrichment planting.

2.4.7 Determining the Counterfactual Scenario

The counterfactual scenario illustrates the likely trajectory of biodiversity in the project landscape in the absence of project-specific mitigation measures. Without careful planning and management of the transmission corridor, local impacts from vegetation clearance, soil disturbance, and increased human access could amplify existing pressures such as agricultural expansion, logging, and hunting. These drivers are largely exogenous to the Project, reflecting wider land-use and demographic trends in the Western Region. The purpose of this BMP is therefore not to address all regional causes of biodiversity loss, but to conserve, restore, and enhance biodiversity specifically affected by the transmission line's footprint and operational activities. Broader threats to forest and wetland degradation will continue to be managed through national and community conservation initiatives, to which this Project contributes complementarily but not comprehensively.

2.4.8 Extent of Critical Habitat Impacted

It is estimated that approximately 2,367 hectares (ha) of habitat with potential critical features will be directly or indirectly affected by the project. The estimated 2,367 ha can be categorized based on land-cover analysis in (Appendix 9). Approximately 1,136 ha (48%) comprise mixed agroforestry systems, 355 ha (15%) natural forest and forest-edge habitats, 403 ha (17%) scrub and upland vegetation, 284 ha (12%) riparian fields and wetlands, and 189 ha (8%) settlements and disturbed areas. This distribution underscores that while agroforestry dominates the landscape, the natural forest and riparian habitats though smaller in extent represent critical biodiversity features..

2.4.9 Land Clearing and Inundation

Construction of the transmission line will require land clearing across the 40m ROW, resulting in the loss of approximately 500 hectares of natural and semi-natural vegetation. This includes tree felling, removal of underbrush, and site leveling for tower foundations. Access roads and temporary water impoundments during construction may further exacerbate land disturbance. These activities can disrupt local hydrology, increase sedimentation in streams, and diminish habitat availability for ground-dwelling and canopy species alike.

2.4.10 Induced Development from Improved Access

One indirect impact of the project is the facilitation of access into previously remote or semi-inaccessible forest areas. This can stimulate unplanned development activities such as illegal logging, artisanal mining, and settlement expansion. These activities contribute to habitat loss, increase fire risks, and lead to further degradation of biodiversity hotspots. To address these risks, the project must implement physical barriers, community awareness programs, and collaborate with law enforcement to monitor land use changes along access roads and tower routes.

2.4.11 Electrocution Risks

Power infrastructure poses significant electrocution risks to birds and bats, especially species that perch or roost on electrical components. Large raptors and frugivorous bats are particularly susceptible. To mitigate this risk, the project will install bird diverters, insulate exposed conductors, and adjust spacing of components to prevent bridging. Regular maintenance and monitoring of mortality incidents will also inform adaptive engineering measures.

2.4.12 Collision Risks

While the overall collision risk is considered low, certain bird species especially those flying at dawn or dusk in low visibility conditions may collide with the transmission wires. Species like hornbills and egrets that use linear flight paths across clearings are most vulnerable. Measures such as marker balls, lighting modifications, and strategic siting in open landscapes can significantly reduce collision incidents.

2.4.13 Habitat Loss and Fragmentation from Transmission Line Development

Beyond direct clearing, the alignment of the transmission line creates a linear barrier through habitats, which can disrupt wildlife movement, gene flow, and ecosystem processes. Fragmentation effects are particularly significant for interior forest species and edge-sensitive plants. These impacts are long-term and often cumulative, hence the need for landscape-level planning, habitat restoration in buffer zones, and connectivity conservation through ecological corridors.

2.4.14 Mitigating Habitat Loss and Fragmentation

To address habitat loss resulting from ROW clearance and associated activities, the project will implement a landscape-level strategy that includes reforestation, vegetation buffering, and ecological corridor rehabilitation. Habitat corridors within and around the project zone will be mapped and preserved or enhanced through targeted planting of native species. Vegetative buffers of 5–15 meters will be maintained around construction zones to reduce edge effects and microclimate alterations. Ecological zoning will prioritize restoration in key connectivity nodes that link forest reserves and fragmented habitats. Habitat enhancement will also include the creation of nesting sites and cover for fauna displaced by project works (Appendix 1-4). Monitoring of post-construction biodiversity trends will guide adaptive management strategies to ensure restoration effectiveness.

Baseline biodiversity surveys conducted for the Ghana-Côte d'Ivoire Interconnection Reinforcement Project recorded 71 bird species along the corridor, including hornbills, sunbirds, bee-eaters, and weavers (Appendix 1). The alignment traverses a mosaic of semi-deciduous forest patches, agroforestry landscapes, and anthropogenic wetlands such as rice paddies and fishponds, which are seasonally important for both resident and migratory birds. Although no IUCN-listed endangered avifauna were confirmed, the corridor supports species that play key ecological functions such as insect control and seed dispersal, highlighting the area's value for maintaining ecological processes and biodiversity connectivity.

Areas of High Bird Activity

- Proximity to Forest Reserves (Draw River, Boin Tano, and Tano Ehuro): These are designated Biodiversity Important Areas (BIAs) / KBAs within 10 km of the corridor and support significant bird assemblages.
- Riparian Wetlands and Agricultural Wetlands (e.g., near Nsuaem and Omanpe): Low-lying areas adapted for rice and aquaculture provide seasonal foraging grounds for waterbirds and waders.

- Agroforestry Mosaics (Wassa Amenfi and Dunkwa sectors): Cocoa farms with remnant native trees provide canopy connectivity and resources for insectivorous and frugivorous birds.

At present, the corridor avoids direct intrusion into core IBAs. However, as more precise field data are gathered, minor alignment adjustments (micro-siting) will be implemented in line with the mitigation hierarchy (avoid-minimize-restore) to ensure no net loss of biodiversity and compliance with World Bank ESS6.

The BMP specifically identifies and maps Important Bird Areas (IBAs) and wetlands located near the impact corridor (IC), as well as other habitats heavily used by birds within a 10 km radius of the alignment. GPS coordinates were logged for these sites, together with information on habitat extent and quality. The document also includes a sketch map of the IBAs along the transmission line route and highlights the need to consider West African migratory routes, which bring additional conservation relevance.

In line with World Bank ESS6 and international best practice, the study therefore provides the requested pre-construction information on bird habitats, with spatial data, habitat quality ratings, and integration into the wider biodiversity risk management framework. As construction planning advances, these findings will guide micro-siting decisions, mitigation measures (e.g. buffers around wetlands), and monitoring protocols to ensure no net loss of biodiversity.

Table 2: Bird Habitats (IBAs and Wetlands) within 10 km of the Ghana-Côte d'Ivoire Interconnection Corridor

Name of Site / IBA	**Coordinates**		**Apx. Extention (km²)**	**Habitat Quality**	**Notes**
Draw River Forest Reserve (IBA)	5.02°N,	2.64°W	~120	High	Semi-deciduous forest, supports hornbills, bee-eaters, weavers; overlaps with KBA designation
Boin Tano Forest Reserve (IBA)	5.30°N,	2.70°W	~140	High	Key Biodiversity Area; refuge for forest species, including dwarf crocodile and migratory birds
Tano Ehuro Forest Reserve	5.28°N,	2.54°W	~75	Medium-High	Secondary forests and riparian zones, moderate bird richness; important for seed dispersers
Riparian Wetlands near Omanpe	5.46°N,	2.68°W	~15	Medium	Seasonal wetlands, rice paddies, and fishponds; critical for waterbirds and amphibians
Agroforestry Mosaic (Cocoa/Fallow with Remnant Trees)	Along corridor villages		Variable	Medium	Provides seasonal foraging habitat for sunbirds and weavers; maintains landscape connectivity

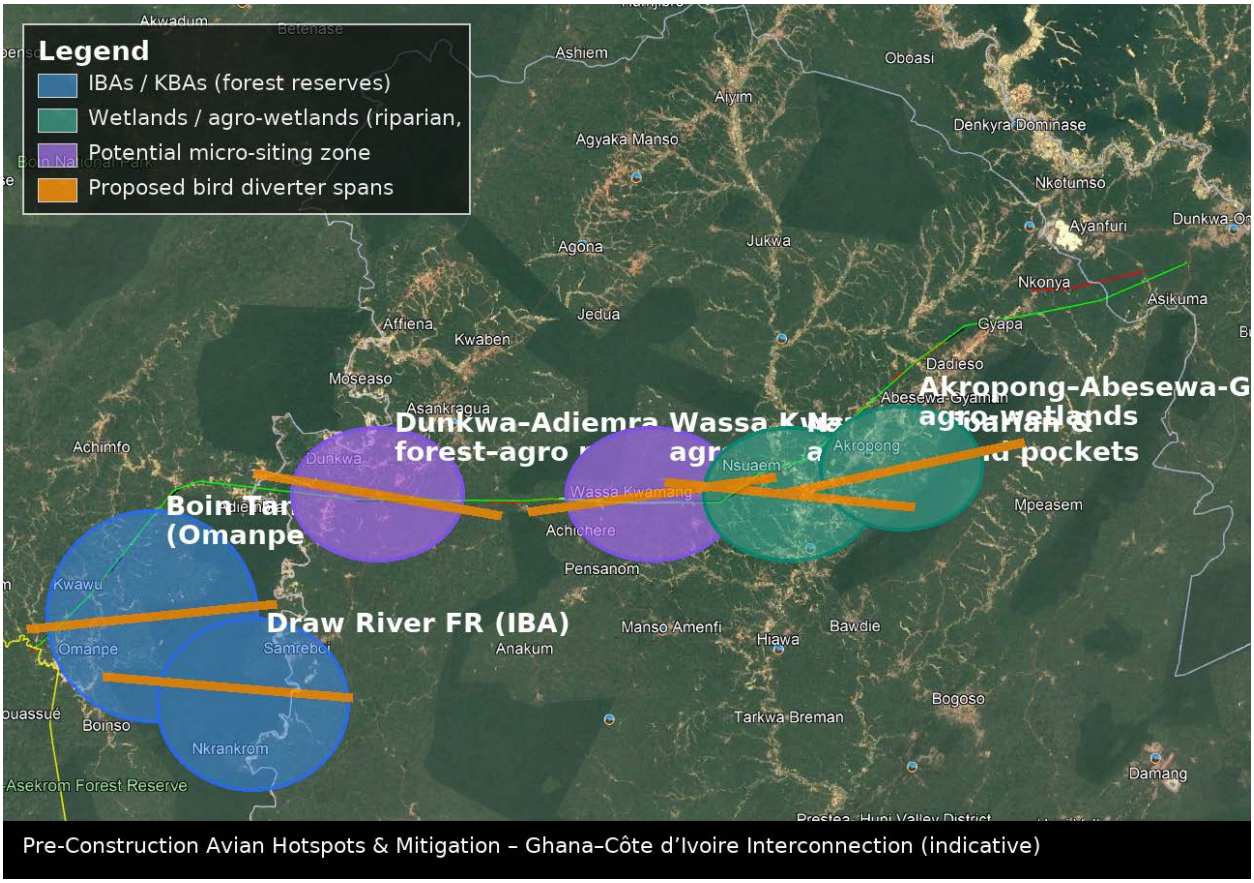

Figure 1: Pre-construction Avian Hotspots and Mitigation- Ghana-cote d'Ivoire interconnection

- Blue=IBAs/KBAs (forest reserves) indicators near Boin Tano / Omanpe and Draw River.
- Teal=wetlands/agro-wetlands (riparian, rice fields, fishponds) around Nsuaem and Akropong-Abesewa-Gyaman.
- Purple=potential micro-siting zones across forest-agro mosaics (Dunkwa-Adiemra, Wassa Kwamang).
- Orange bars=proposed bird diverter spans along the alignment in/near these hotspots.

3 BMP STRATEGY

The Biodiversity Management Plan (BMP) Strategy outlines the overarching approach to safeguarding and enhancing biodiversity throughout the project corridor. It integrates ecological protection with infrastructure development, ensuring the application of the mitigation hierarchy and compliance with international standards, particularly the World Bank's ESS6.

3.1 Introduction to the Integrated Corridor Management Approach

The Integrated Corridor Management Approach (ICMA) is a holistic framework that ensures that linear infrastructure projects, such as power transmission lines, are designed and implemented in ways that are ecologically sound, socially inclusive, and economically viable. It recognizes that large-scale infrastructure developments interact with diverse land uses, ecosystems, and communities, and therefore require coordinated planning across multiple sectors and administrative boundaries.

In the context of the Ghana–Côte d'Ivoire Interconnection Reinforcement Project, the ICMA facilitates the strategic alignment of transmission infrastructure with biodiversity conservation, land-use regulation, forest protection, and community development objectives. Rather than treating the project corridor as an isolated engineering undertaking, this approach integrates it within a broader landscape-level framework, recognizing ecological and socio-economic interdependencies along the entire 125 km corridor.

Key features of this approach include:

- Ecosystem-based planning, which incorporates biodiversity hotspots, hydrological systems, habitat corridors, and climate resilience into project design and mitigation planning.
- Cross-sectoral coordination, ensuring collaboration between energy planners, environmental regulators, forestry agencies, district authorities, and local communities to avoid conflicting land uses and duplication of efforts.
- Zoning and land-use harmonization, which identifies and maps critical ecological areas, agricultural lands, settlement zones, and cultural sites, so that infrastructure development can be optimized with minimal disruption.
- Community co-management, where stakeholders, especially those whose livelihoods depend on land and forest resources, participate in planning, decision-making, and benefit-sharing.

The approach also emphasizes ecological connectivity, particularly important in fragmented forest landscapes, by ensuring that wildlife corridors and riparian buffer zones are maintained or enhanced. This is critical for the movement and genetic flow of species and for sustaining ecosystem services that support agriculture, health, and livelihoods.

Furthermore, ICMA applies principles of adaptive management, where project implementation is guided by continuous monitoring, feedback, and learning. This allows for adjustments in work plans, mitigation measures, or restoration efforts based on environmental conditions or stakeholder input.

Ultimately, the Integrated Corridor Management Approach enables the project to achieve a balance between infrastructure development and sustainable environmental stewardship, reinforcing Ghana's commitments to green growth, biodiversity protection, and regional energy integration.

3.2 Biodiversity Management Fundamentals

These are foundational principles which will guide biodiversity actions in the project corridor. They embed ESS6 compliance, stakeholder engagement, habitat conservation, and impact mitigation into all phases of project execution.

3.2.1 Fundamental 1 - Managing Impacts on Biodiversity and Targeting Net-Gain of Critical Habitat

All project activities will follow the mitigation hierarchy: avoid, minimize and restore. Where critical habitats are affected, measurable net-gain strategies will be employed through reforestation, CREMA partnerships, and conservation investments.

3.2.2 Fundamental 2 - Adapt Biodiversity Management through Continuous Improvement

BMP strategies are not static; they evolve based on environmental monitoring results and community feedback. This ensures flexibility to adopt new technologies, address emerging risks, and enhance effectiveness over time.

3.2.3 Fundamental 3 - Leading Practice

The project adopts best international practices in biodiversity planning and management. These include the use of high-resolution ecological mapping, participatory conservation planning, and the integration of scientific and traditional ecological knowledge into project implementation.

3.2.4 Fundamental 4 - Identifying Opportunities to Enhance Biodiversity Conservation

Beyond mitigation, the BMP seeks proactive conservation opportunities, such as protecting ecologically sensitive riparian zones, enhancing degraded forests, and promoting habitat connectivity.

3.2.5 Fundamental 5 – Engagement and Partnerships

Stakeholder engagement is central to BMP implementation. Partnerships with local communities, NGOs, academic institutions, and government agencies support collaborative conservation planning and strengthen local ownership.

3.2.6 Fundamental 6 – Performance and Measurement

Performance indicators track biodiversity health, habitat quality, species presence, and mitigation success. These metrics guide adaptive actions, ensuring transparency and evidence-based decision-making.

3.2.7 Fundamental 6 – Performance and Measurement

Biodiversity management is fully integrated with environmental, social, and engineering teams. This ensures that ecological considerations are factored into project design, procurement, construction, and operation.

3.3 Location

Five districts in the Western North, Western, and Central Regions will be the site of the proposed transmission line's construction and operation, along with the Dunkwa II substation (Appendix 1). These districts are the following:

- Aowin Municipal (Western North Region),
- Wassa Amenfi West Municipal (Western Region),
- Wassa Amenfi Central District (Western Region)
- Wassa Amenfi East Municipal (Western Region),
- Upper Denkyira East Municipal (Central Region).

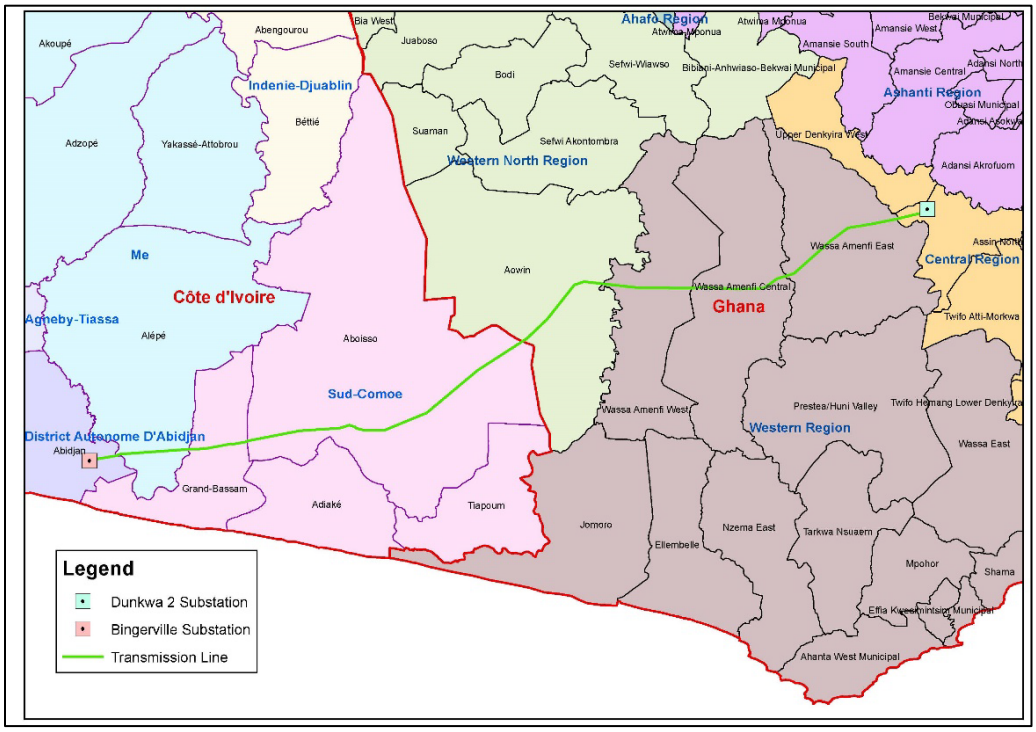

Figure 2: Administrative map of study area

3.4 Biodiversity Important Areas (BIA)

BIAs within the corridor is closed to Draw River, Boin Tano, Tano Nimri, Tano Anwia, Mamiri, Bura River and Tano Ehuro Forest Reserves recognized for their rich biodiversity and ecological services. These areas contain threatened species and sensitive habitats, triggering ESS6 mitigation obligations. Despite the fact that Ghana's high forest zone contains numerous permanent forest reserves, the proposed transmission line route does not intersect any of these reserves or IBAT-designated areas.

3.4.1 Key Biodiversity Interventions in the Region

Several previous projects in the region, including those funded by the World Bank and other international partners, have laid the groundwork for biodiversity conservation and forest resource management. These initiatives offer valuable insights and lessons that can inform the biodiversity strategies for the Ghana-Cote d'Ivoire Interconnection Project.

1. **Forest Resource Management Project (FRMP)**: Jointly supported by the World Bank, Denmark (DANIDA), and the United Kingdom's Overseas Development Administration (ODA), the

FRMP from 1989 to 1997 aimed to enhance the capacity of forest agencies to monitor and evaluate policies for sustainable forest management. A key outcome was the implementation of management plans for protected areas, which are crucial for biodiversity conservation. These lessons are vital for ensuring the transmission line project does not undermine ongoing efforts to protect sensitive areas.

2. **Forest Sector Development Projects (FSDP I and II)**: These projects, launched in the mid-1990s, focused on developing a self-sustaining forest service and enhancing institutional frameworks for forest and biodiversity conservation. In particular, the projects emphasized the need for effective stakeholder engagement and community involvement in forest resource management. The CREMA (Community Resource Management Areas) model introduced during this period is particularly relevant for this project, as it offers a way for local communities to actively participate in managing the biodiversity around the transmission corridor.

3. **Natural Resource Management Programme (NRMP)**: Running from 1999 to 2006, this multi-donor program aimed to establish sustainable land, forest, and wildlife management systems across Ghana. The NRMP included specific interventions for high forest and savannah resource management, emphasizing the need to conserve biodiversity in protected and unprotected areas alike. For the Cote d'Ivoire-Ghana Interconnection Project, applying the best practices from this program, especially in areas adjacent to forest reserves and protected ecosystems, will be crucial to minimizing biodiversity loss.

4. Previous Achievements in Biodiversity Conservation

A number of programs in the region have demonstrated the effectiveness of community-based approaches to wildlife and forest management. These include:

- **Protected Areas Management and Wildlife Conservation Project (PAMWCP)**: This project, implemented in the late 1990s, helped establish the foundations for wildlife management across Ghana, particularly through the involvement of local communities in managing biodiversity within and outside of protected areas. The establishment of Management Advisory Boards (MABs) and Community Resource Management Committees (CRMCs) highlights the importance of local community participation in conservation efforts.
- **Protected Areas Development Programme (PADP)**: Funded by the European Union, the PADP introduced the CREMA model, which allows communities to manage wildlife in designated areas. This model is particularly relevant to the current project, as it can be adapted to involve local communities in managing biodiversity along the transmission line route, thus enhancing both conservation outcomes and local livelihoods.

- **Coastal Wetlands Management Project (1993–1999)**: This World Bank-financed project focused on the conservation of key wetland ecosystems at RAMSAR sites along Ghana's coast. The lessons from this project, particularly in managing sensitive ecosystems, can be applied to the management of wetlands or riparian areas that may be affected by the transmission line.

3.4.2 Biodiversity Context for the Ghana-Cote d'Ivoire Interconnection Reinforcement Project

The project area includes high biodiversity zones with unique flora and fauna, many of which are threatened by habitat loss, land-use changes, and human activities. Biodiversity in these regions provides essential ecosystem services such as water purification, climate regulation, and pollination, which are critical for the sustainability of local communities. The project route traverses areas with a range of ecosystem types, including secondary forest, agricultural lands, and community lands, all of which require careful management to avoid long-term ecological degradation.

The Protected Areas System Plan developed by the Ministry of Lands and Natural Resources and the Forestry Commission will be a critical reference for the implementation of the BMP. This plan identifies key areas that must be protected, and the project will need to ensure that transmission lines and infrastructure do not encroach on these sensitive areas.

3.4.3 Alignment with World Bank ESS 6 Guidelines

The Cote d'Ivoire-Ghana Interconnection Reinforcement Project's Biodiversity Management Plan (BMP) has been developed to meet the World Bank's ESS 6 guidelines by incorporating the following key principles:

1. **Avoidance**: Where possible, the project will avoid routes and areas that could cause significant harm to biodiversity, particularly those with endangered species or critical habitats. Therefore, route alignment and micro-siting were adjusted to steer clear of high-value biodiversity areas, notably the Draw River, Tano Ehuro, and Boin Tano Forest Reserves, as well as wetland and riparian habitats mapped in Appendix 7. No reserve is intersected by the 40 m Right-of-Way.

2. **Minimization**: In cases where biodiversity impacts cannot be completely avoided, the project will minimize harm through careful planning and construction methods that reduce habitat disruption and pollution. Within unavoidable sections, impacts are reduced through scheduling construction outside breeding and migratory seasons, employing erosion-control measures, and installing avian-safe line fittings such as diverters and anti-perching devices.

3. **Restoration**: Temporary construction areas, tower pads, and access routes will be re-vegetated with native species listed in Appendix 9, and riparian vegetation will be stabilized through enrichment planting.

4. **Community Engagement**: Following the CREMA and CRMC models, local communities will be actively involved in managing biodiversity, ensuring that conservation efforts align with local needs and contribute to livelihood improvement. Following the CREMA and CRMC models, local communities participate in biodiversity monitoring, restoration planting, and anti-poaching activities, linking conservation outcomes with livelihood improvement

3.5 Working Zones and Timeframes

To minimize ecological disruption during project implementation, the BMP employs a strategic zoning approach that segments construction activities according to ecological sensitivity and seasonal biodiversity dynamics. This method ensures that project activities are not only technically and logistically efficient but also environmentally responsible.

The project area has been categorized into distinct working zones based on habitat type, presence of critical species, proximity to protected areas, and ecosystem function (Appendix 1; figure 5). These zones include:

- **High-sensitivity zones,** such as riparian buffers, forest reserves, and wetlands, which host endangered species or provide critical breeding, nesting, or migratory stopover habitats;
- **Moderate-sensitivity zones**, including secondary forests and agroforestry mosaics; and
- **Low-sensitivity zones**, such as degraded lands or previously converted agricultural fields.

Timing of construction activities will be strictly regulated to avoid peak ecological periods. For instance, clearing and excavation near breeding grounds or migratory corridors will be prohibited during breeding seasons (e.g., March-June for birds and amphibians). Similarly, activities in wetland areas will be deferred during rainy seasons to prevent water quality degradation and sedimentation impacts.

To enforce these protocols, an ecological calendar and a zoning map will be developed and integrated into the contractor's work schedule. Environmental supervisors will be deployed to monitor compliance and authorize entry into sensitive zones only during approved time windows. In addition, buffer periods will be established before and after ecological events to provide a margin of safety for sensitive species.

This approach supports risk isolation, where high-impact activities such as blasting, large-scale vegetation clearance, or heavy equipment mobilization are time-bound and restricted to zones where ecological impact is minimal or where mitigation infrastructure (e.g., wildlife crossings or noise barriers) is already in place.

Overall, the use of working zones and ecologically informed timeframes reflects the project's commitment to adaptive management, compliance with World Bank ESS6, and the safeguarding of critical biodiversity values throughout the project lifecycle.

3.6 Reforestation Targets

As part of the standard mitigation measures , a minimum of 370 hectares of degraded forest and buffer zones along the transmission corridor will be targeted for reforestation and ecological restoration: eventhough the transmission line passes through an existing degraded areaThese areas were identified through ecological baseline surveys as being of moderate to high conservation importance, with potential for natural regeneration when adequately supported.

The reforestation initiative will prioritize the use of native and site-adapted tree species that are ecologically compatible with the surrounding landscape. Species selection will consider biodiversity value, soil stabilization potential, and traditional community uses. Key objectives include:

- Restoring habitat connectivity between fragmented forest patches to enable movement of wildlife, especially for species that rely on continuous canopy cover;
- Improving ecosystem services, such as water regulation, microclimate buffering, and carbon sequestration;
- Enhancing soil integrity and controlling erosion, particularly in areas where vegetation loss has exposed steep or vulnerable terrain.

Implementation will follow a phased, participatory approach, engage local communities and leverage existing Community Resource Management Areas (CREMAs). These community-based governance structures will be supported through capacity building, tools, and incentives to ensure long-term protection and maintenance of the restored areas. Partnerships will also be established with the Forestry Commission and local NGOs to ensure technical oversight and sustainability.

To ensure the effectiveness of the reforestation program, monitoring protocols will be developed to track tree survival rates, canopy closure, and biodiversity recovery over a minimum period of five years. Restoration efforts will also be aligned with Ghana's national forest restoration policies and international commitments under the Bonn Challenge and AFR100 initiatives.

This integrated reforestation effort is a critical component of the BMP's goal to achieve no net loss and preferably net gain of biodiversity, demonstrating a long-term commitment to landscape-level ecological resilience.

4 COUNTRY REGULATIONS AND INSTITUTIONS

4.1 Environmental Regulations for Flora and Fauna

Ghana has established several legal instruments to safeguard its biodiversity, including flora and fauna. The *Environmental Protection Agency Act, 1994 (Act 490)* mandates the EPA to oversee environmental protection and enforce regulations that ensure biodiversity conservation. The *Environmental Assessment Regulations, 1999 (LI 1652)* requires Environmental Impact Assessments (EIAs) for any major project, ensuring that risks to flora and fauna are anticipated and mitigated before development begins.

The *Wild Animals Preservation Act, 1961 (Act 43)* provides the legal basis for the protection of certain wild animal species, restricting hunting and trade of those listed as endangered or protected. The *Wildlife Reserve Regulation, 1971 (LI 710)* designates wildlife reserves and outlines how these areas should be managed to preserve habitats for flora and fauna. These laws are reinforced by the IUCN Red List and Ghana's own national classification systems used to determine species conservation status.

4.2 Water Resource, Forestry, and Corridor Management Regulations

The *Water Resources Commission Act, 1996 (Act 522)* established the Water Resources Commission (WRC) to regulate and manage Ghana's water resources. This includes preserving aquatic biodiversity, protecting wetlands, and ensuring sustainable use of water bodies that support flora and fauna.

The *Forestry Commission Act, 1999 (Act 571)* mandates the Forestry Commission to manage and conserve forest resources, including reserved forests and production forest lands. This regulation supports biodiversity by enforcing controlled logging, reforestation, and conservation practices, often in partnership with community-based groups such as CREMAs (Community Resource Management Areas).

The *Lands (Statutory Wayleaves) Act, 1963 (Act 186)* regulates the acquisition of land for infrastructure projects. It includes provisions to protect ecologically sensitive areas such as forests and wetlands within corridors earmarked for development, ensuring that land acquisition processes account for environmental and biodiversity impacts.

5 BMP ACTION PLAN

The BMP Action Plan outlines a structured and phased strategy for addressing the diverse biodiversity risks associated with the Ghana-Côte d'Ivoire Interconnection Project. It incorporates construction impact mitigation, infrastructure risk reduction, habitat restoration, wildlife management, and stakeholder engagement.

5.1 Construction-Related Impact Management

5.1.1 Minimizing Further Habitat Fragmentation and Losses

To reduce the ecological footprint of the transmission project, the BMP emphasizes the need to minimize habitat fragmentation and biodiversity loss. Micro-siting will be conducted using high-resolution ecological mapping and GPS tools to indicate ecologically sensitive habitats, including nesting areas, wetlands, and remnant forest patches. Environmental screening will precede all Right-of-Way (ROW) clearance to detect and preserve microhabitats critical to endangered or migratory species (Appendix 9). In areas where avoidance is not possible (that is within production forest reserves under Forestry Commission jurisdiction, riparian and wetland crossings, and across intensively cultivated community lands (Appendix 7), ecological buffer zones will be retained and demarcated to maintain habitat corridors and natural wildlife movement paths. Vegetation clearance will be conducted in stages to prevent sudden ecosystem disruption, and disturbed sites will be promptly rehabilitated using native plant species to restore continuity. This phased and spatially-sensitive approach helps mitigate long-term landscape fragmentation, preserve biodiversity connectivity, and maintain ecosystem services such as pollination, seed dispersal, and erosion control.

5.1.2 Controlling Access

To protect sensitive habitats and mitigate indirect environmental impacts from human intrusion, strict access control protocols will be implemented throughout the project corridor. Barriers, warning signs, and controlled entry points will be installed at construction zones, particularly near Biodiversity Important Areas (BIAs) and protected forests. All contractors and personnel will be restricted to approved access routes to prevent trampling of vegetation and disturbance of fauna. Community members will be engaged as ecological stewards and patrol officers to report illegal activities, including unauthorized entry, poaching, and illegal logging. Education programs and local bylaws will be supported to enhance community responsibility in preventing encroachment and maintaining ecological integrity during and after construction.

5.1.3 Fire Management

Fire poses a major threat to both project infrastructure and biodiversity, particularly during the dry season. As part of the BMP, a comprehensive fire management strategy will be implemented to prevent accidental fires and respond effectively in high-risk zones. Construction teams and local communities will undergo intensive training in fire prevention and suppression methods. Fire breaks strategic gaps in vegetation will be cleared and maintained along the ROW and in fire-prone buffer zones to slow fire spread. On-site firefighting equipment such as extinguishers, water tanks, and fire beaters will be provided and regularly maintained. Early warning systems will be established through community radio alerts, local fire brigades, and collaboration with the Ghana National Fire Service. Awareness campaigns will also address harmful practices such as slash-and-burn agriculture, promoting safer alternatives and traditional fire control practices that align with ecological conservation goals.

5.1.4 Managing Impacts of Traffic on Native Fauna

Construction traffic can disrupt wildlife movement, increase mortality rates through collisions, and contribute to habitat degradation. To mitigate these impacts, strict vehicular management protocols will be enforced in biodiversity-sensitive zones. Speed limits will be clearly marked and enforced to reduce collision risks with small mammals, reptiles, and birds. Nighttime construction and transport will be minimized or avoided altogether in areas such as riparian forests (Draw River, Boin Tano, Tano Ehuro), secondary regrowth zones (Wassa Amenfi, Nsuaem–Omanpe), and marshy farmlands (Sefwi Wiawso–Aowin), are known for nocturnal wildlife activity to prevent disturbance to species such as bats, civets, and owls. Designated wildlife crossing points such as underpasses and canopy bridges will be identified through ecological surveys (Appendix 9) and maintained to ensure safe animal passage. Drivers and site workers will be trained in wildlife encounter protocols, including immediate reporting and response measures. Regular monitoring of traffic impacts will inform additional mitigation strategies, ensuring that road construction and use are compatible with long-term biodiversity conservation.

5.2 Risk Mitigation of Transmission Infrastructure

5.2.1 Overview of Biodiversity Risks

Power transmission infrastructure presents key ecological risks, particularly electrocution and collision hazards to birds, bats, and arboreal mammals. Large raptors, hornbills, bee-eaters, and frugivorous bats are vulnerable due to their wingspans, flight behaviors, and roosting patterns near high-voltage components. These risks are elevated where transmission lines intersect forest canopies, wetlands, and agroforestry mosaics, especially in proximity to Biodiversity Important Areas (BIAs) such as the Draw River,

Boin Tano, and Tano Ehuro Forest Reserves. Electrocution occurs when animals bridge the gap between energized parts or between energized parts and grounded structures. Collision risks arise when birds and bats fail to detect conductors or ground wires, particularly in low-visibility conditions such as dawn, dusk, fog, or during migratory movements. Both hazards can cause direct mortality and disrupt ecological connectivity, undermining biodiversity objectives.

An integrated mitigation approach has therefore been adopted to minimize these risks throughout the project life cycle from design and construction to operation and maintenance.

5.2.2 Integrated Mitigation Measures

Engineering and Design Measures

- Avian-safe configurations: Employ insulated conductors and expand spacing between energized components to prevent bridging.
- Anti-perching and anti-climbing devices: Install on pylons and towers to deter birds and climbing mammals.
- Dynamic bird diverters: Fit spirals, flappers, or reflective spheres especially dynamic flappers on the upper (earth) wires across the middle 60 % of each span to enhance visibility and reduce collision rates.
- Canopy bridges and rope ladders: Provide safe crossings for arboreal mammals in forested sections.
- Horizontal conductor arrangements: Use where feasible to improve visibility compared with vertical layouts.
- Safe perching platforms: Provide designated perches away from high-voltage lines in open landscapes.

Siting and Habitat Management

- Apply micro-siting to avoid proximity to wetlands, forest edges, and known roosting or nesting areas.
- Maintain vegetative buffers (5-15 m) along sensitive zones to reduce edge effects.
- Manage vegetation to discourage nesting close to conductors while retaining natural cover for ground fauna.
- Establish ecological corridors linking fragmented habitats, guided by baseline biodiversity mapping.
- Avoid construction during breeding or migratory seasons (e.g., March-June for birds and amphibians).

Monitoring and Adaptive Management

- Implement routine ecological monitoring to track electrocution or collision incidents.
- Maintain a mortality log and use findings to inform design refinements or retrofitting.
- Conduct post-construction avifaunal surveys and community-based reporting through CREMAs and local monitors.
- Review and adapt mitigation measures annually based on monitoring data.

Community and Institutional Roles

- Train engineers, contractors, and site workers on biodiversity risk management and emergency response.
- Engage local communities as ecological stewards to report wildlife incidents and prevent poaching or disturbance near transmission lines.
- Collaborate with the Forestry Commission, EPA, and District Assemblies to ensure sustained enforcement and awareness.

5.2.3 High-Risk Zones and Species Matrix

The table below summarizes the primary risk conditions and corresponding mitigation measures for priority segments of the Ghana-Côte d'Ivoire Interconnection Reinforcement Project.

Table 3: High-Risk Segments, Biodiversity Threats, and Mitigation Measures for Transmission Infrastructure matrix

Alignment Segment	Primary Risk	Risk Conditions	Key Species / Groups	Mitigation Measures
Omanpe – Boin Tano Forest Reserve	Electrocution	Towers near forest canopy; raptors and bats roosting	Eagles, kites, vultures, fruit bats	Insulated conductors; expanded spacing; anti-perching devices; canopy bridges; routine monitoring
Draw River Forest Reserve Sector	Collision	Dense forest canopy; linear bird flight paths	Hornbills, sunbirds, bee-eaters	Dynamic bird diverters; horizontal conductor configuration; adaptive monitoring
Nsuaem Riparian Wetlands	Collision	Wetland crossings; dawn/dusk flights	Egrets, herons, waders	Marker balls and spirals; route micro-siting to avoid wetland edges; vegetation buffer

Alignment Segment	Primary Risk	Risk Conditions	Key Species / Groups	Mitigation Measures
Akropong-Besewa-Gyaman Agro-Wetlands	Collision	Seasonal ponds; high bird congregation	Waterbirds, migratory species	Bird flappers on mid-span wires; maintain 15 m buffers around ponds
Dunkwa-Adiemra Agroforestry Mosaic	Electrocution / Collision	Mixed cocoa/forest patches with tall trees	Arboreal mammals, frugivorous birds	Canopy bridges; diverters; selective pruning to maintain safe clearances
Wassa Kwamang Sector	Collision	Fruit-bearing trees attracting canopy species	Frugivorous and canopy birds	Dynamic diverters; horizontal layout; continuous monitoring

5.2.4 Design concept to prevent collisions and electrocution risks

The design concept must include bird beacons to prevent collisions risks, a measure that has been proved to be reasonably successful in reducing collisions fitting the earth wire with anti-collision devices. The fitting of the marking devices are typically done from a helicopter, which adds considerable costs to the project. Statistical studies show that dynamic devices (usually called bird flappers), have moving parts as opposed to static devices where there are none. Dynamic devices are very effective in reducing collisions as the birds seem to see them very well probably because of the movement that attracts attention. Only the middle 60% of each span needs to be marked as this is where most of the collisions occur.

Figure 3: Examples of the dynamic bird flapper devices

The disadvantage of dynamic devices is that they are subject to extensive wear and tear, inevitably limiting the lifespan of the device. Wear could result on the device itself as well as on the cable to which it is attached. The devices will be described in detail in the technical specifications.

Different combinations of strategies that enhance the visibility of the lines and modify the surrounding habitat could reduce the risks of bird collisions with high voltage power lines. Here are some effective measures:

Line Marking Devices

- *Bird Diverters*: Install bird diverters like spirals, flappers, or spheres on power lines to make them more visible. These devices can reflect light or glow in the dark, alerting birds to the presence of the wires.
- *Line Marking Tapes*: Apply high-visibility tapes or markers that flutter in the wind, making the lines more conspicuous.

Line Design and Configuration

- *Bundling Conductors*: Use bundled conductors instead of single wires. This makes the structure more visible and reduces the risk of collision.
- *Horizontal Configuration:* Arrange lines horizontally rather than vertically to increase visibility.
- *Lower Line Height:* Where feasible, lower the height of the power lines to avoid flight paths of birds.

Habitat Management

- *Vegetation Management*: Modify vegetation around power lines to discourage birds from nesting or perching near high-risk areas. Vegetation modification refers to selective pruning of tall canopy species, replacement with low-growing native shrubs and grasses, and removal of potential nesting

or perching structures within the ROW. This practice maintains ecological cover and soil stability while discouraging bird nesting and ensuring safe conductor clearance, consistent with the BMP's reforestation and habitat restoration framework. (Appendix 2)

- *Alternative Habitats*: Create or enhance alternative habitats away from power lines to attract birds to safer areas.

Installation of Perches and Platforms

- *Perching Deterrents:* Install perching deterrents on poles and structures to prevent birds from landing near high-risk areas.
- *Safe Perches*: Provide safe perching platforms away from the high voltage lines to attract birds to safer locations.

Monitoring and Research

- *Regular Monitoring:* Implement a monitoring program to identify collision hotspots and evaluate the effectiveness of mitigation measures.
- *Research and Development*: Support ongoing research into new technologies and strategies for reducing bird collisions. Collaborate with local research institutions, conservation NGOs, and the Wildlife Division to test and refine biodiversity mitigation measures such as bird diverters, canopy bridges, and habitat restoration methods. Support may include data sharing, field collaboration, or small-scale applied research initiatives focused on enhancing mitigation effectiveness and adaptive management along the transmission corridor.

Public Awareness and Collaboration

- *Stakeholder Collaboration*: Work with wildlife organizations, conservationists, and the public to develop and implement effective strategies.
- *Education Campaigns*: Conduct awareness campaigns to inform the public and relevant stakeholders about the risks and mitigation measures.

Regulatory and Policy Measures

- *Compliance with Guidelines:* Ensure that power line designs and installations comply with national and international guidelines for bird protection.
- *Incentives for Bird-Safe Practices*: Encourage utilities to adopt bird-safe practices through incentives and regulatory measures.

Implementing these strategies requires a coordinated effort between power companies, environmental organizations, and government agencies to effectively reduce the risks of bird collisions with high voltage power lines.

5.3 Reforestation and Forest Management

5.3.1 Collection of Plant Material, Management of Nurseries and Planting Services

Seed collection will be community-led, focusing on native species. Nurseries will be established near project sites to reduce transport emissions and improve seedling survival. Training will be provided in nursery management and ecological planting techniques. Local seed banks will be created to preserve genetic diversity and support long-term restoration goals. Special attention will be given to species with high ecological value and conservation status. Community members, especially women and youth, will be engaged through employment and skill development opportunities.

5.3.2 Forest Restoration and Ecological Connectivity

Degraded areas within the corridor will be rehabilitated using site-adapted species. Restoration will aim to reconnect fragmented forest patches, particularly around BIAs. The project will align with Ghana's national reforestation and REDD+ strategies. Restoration sites will be prioritized based on ecological sensitivity and proximity to wildlife corridors. Mixed-species planting schemes will mimic natural forest structures and enhance biodiversity resilience. Regular field monitoring will assess seedling establishment, soil stability, and species diversity.

5.3.3 Forest Management

Forest management will be co-implemented with CREMAs and District Assemblies. Although no CREMAs currently exist within the project corridor, several communities (e.g., Wassa Amenfi, Dunkwa, Nsuaem, and Akropong-Gyaman) have local forest and resource user groups that can serve as entry points for CREMA establishment. The BMP will, in collaboration with the Forestry Commission and relevant District Assemblies, support the creation and operationalization of CREMAs through training, boundary mapping, and participatory forest governance arrangements. There have been preliminary engagements during baseline and ESIA consultations. Memoranda of Understanding (MoUs) will be developed to define roles, resource-use rights, and monitoring responsibilities once CREMAs are constituted. Regular audits will assess the status of forest health and tree survival rates. Management plans will include seasonal activity schedules and fire risk maps. Collaborative governance structures will promote transparency and conflict resolution. Forestry extension services will support communities in sustainable harvesting and non-timber forest product (NTFP) development.

5.4 Wildlife Management

5.4.1 Wildlife and Habitat Management

Habitat use by key species will be monitored using camera traps and transect surveys. Trained personnel will respond to critical encounters or threats. Enrichment planting will be used to enhance food availability and cover in degraded zones. Species-specific conservation action plans will be developed for vulnerable fauna. Buffer zones will be established around nesting and breeding sites to minimize disturbances. Partnerships with wildlife conservation organizations will facilitate technical support and ecological research.

5.4.2 Wildlife Encounters

A Wildlife Response Protocol will be developed for construction teams. Training will be given on safe handling and reporting. Mobile wildlife units will be deployed in high-risk zones to relocate animals, if necessary. Reporting hotlines will be established for real-time incident logging. All wildlife sightings and interventions will be documented and used to inform mitigation updates. Collaboration with the Wildlife Division will ensure regulatory compliance and best practices.

5.5 Stakeholder Participation

5.5.1 Strengthening Capacities for Institutionalizing Integrated Catchment Management

Workshops and training modules will be organized for local institutions and NGOs. Technical capacity in biodiversity monitoring, GIS, and ecosystem valuation will be strengthened. Collaborative governance models will be supported for long-term biodiversity management. Catchment-based planning frameworks will be introduced to support sustainable resource use. Training will include ecosystem service valuation and integration into land-use planning. Pilot projects will showcase best practices for replication across districts.

5.6 Community Engagement

5.6.1 Biodiversity Awareness, Communication and Education

Educational campaigns will target schools, farmers, and traditional leaders. Communication tools such as posters, community radio, and drama will disseminate conservation messages. Annual Biodiversity Days will be organized to celebrate local conservation champions. Interactive biodiversity learning centers will be established in target communities. Participatory videos and local storytelling will help translate technical messages. School curriculum integration will promote long-term ecological stewardship.

5.6.2 Aligning Resettlement Programmes with the BMP

Resettlement Action Plans (RAPs) will incorporate biodiversity safeguards. Relocated communities will be supported with training in eco-friendly agriculture, forest stewardship, and alternative livelihoods to reduce pressure on natural resources. Monitoring frameworks will ensure resettlement activities align with BMP goals. Customary tenure systems will be respected in resettlement planning. Social safeguards will prioritize the inclusion of vulnerable groups in environmental planning.

5.6.3 Alternative Sustainable Livelihoods for Communities

Biodiversity-friendly income activities such as beekeeping, agroforestry, and sustainable harvesting of non-timber forest products (NTFPs) will be introduced. Skills training and micro-finance support provided under the RAP will be aligned to promote green enterprises and conservation-oriented farming practices. Vulnerable groups, especially women and youth, will receive targeted assistance to strengthen household resilience while contributing to habitat restoration and sustainable land use.

6 PROGRAM OF IMPLEMENTATION

The implementation of the BMP will be operationalized through a comprehensive and multi-tiered program that ensures structured execution of all planned activities across the project lifecycle. The program is designed to integrate ecological safeguards seamlessly into the technical, engineering, and social dimensions of the Ghana-Côte d'Ivoire Interconnection Project.

This implementation strategy is grounded in the World Bank's Environmental and Social Standard 6 (ESS6), and aligns with Ghana's national biodiversity policies and conservation priorities. The program is structured across three key phases: pre-construction, construction, and post-construction/operations, each encompassing tailored mitigation and enhancement measures.

Pre-Construction Phase: This phase focuses on the identification and preparation for biodiversity-sensitive operations. Activities include detailed ecological surveys and mapping of critical habitats, development of site-specific mitigation plans, establishment of plant nurseries for restoration materials, and training of contractors and local stakeholders in BMP protocols. Engagement with communities and institutions will ensure local insights are integrated into early-stage planning. The pre-construction avifaunal survey will be undertaken by a qualified ornithologist prior to project implementation. This will cover IBAs, wetlands, and high bird-use habitats within the 10 km buffer zone. The study will document habitat types, bird species richness, and GPS-tagged habitat locations (appendix 1,7,9 and figure 5) to inform risk zoning and monitoring efforts.

Construction Phase: During active construction, BMP implementation will prioritize minimizing direct and indirect ecological impacts. Core activities will include habitat preservation through micro-siting, enforcement of access controls, real-time wildlife monitoring, and execution of rapid-response measures for fauna encounters. Environmental control officers will ensure compliance through routine site inspections. Educational outreach will run in parallel to inform workers and local residents of their roles in biodiversity protection.

Post-Construction/Operations Phase: Following construction, the BMP will transition to restoration and adaptive management. Focus areas include reforestation of degraded areas, long-term biodiversity monitoring, restoration of ecological corridors, and continued support for alternative livelihoods to reduce resource pressure. Monitoring data will inform management decisions and guide corrective actions.

Institutional Arrangement and Coordination: The BMP program will be led by a dedicated Biodiversity Coordination Unit (BCU) housed within the GRIDCO Environmental and Social Management Team. The BCU

will coordinate with external regulatory bodies such as the EPA, Forestry Commission, Wildlife Division, and District Assemblies, as well as community-based organizations and local NGOs. Clear roles, responsibilities, and communication channels will be outlined through Memoranda of Understanding (MoUs).

Monitoring, Evaluation, and Adaptive Management: A structured Monitoring and Evaluation (M&E) framework will track key performance indicators (KPIs) including species presence, forest cover, and community participation metrics. Periodic biodiversity audits and stakeholder review forums will assess progress and inform iterative improvements. Lessons learned will be integrated into the program to maintain alignment with conservation goals.

Annual Work Planning and Budgeting: Annual work plans will be developed outlining targets, timelines, responsibilities, and required resources for each BMP component. These will be reviewed and adjusted based on ecological findings and socio-economic feedback. Budget allocations will include funding for technical training, reforestation materials, wildlife response units, and community livelihood support.

Overall, the BMP Program provides a robust and flexible structure to ensure biodiversity conservation is fully embedded in all aspects of project planning, implementation, and legacy management.

7 INSTITUTIONAL FRAMEWORK, ROLES AND RESPONSIBILITIES

The successful implementation of the BMP depends on a well-defined institutional framework that facilitates coordination among stakeholders, promotes accountability, and ensures that all responsibilities are clearly assigned and executed effectively. This framework aligns with the World Bank ESS6 requirements and with the operational arrangements and institutional roles defined under Ghana's environmental management system. It integrates public institutions, private contractors, community actors, and technical support teams in a unified effort toward biodiversity conservation and ecosystem sustainability.

7.1 Stakeholder Engagement

Stakeholder engagement is a cross-cutting mechanism embedded in the institutional framework to promote transparency, build trust, and foster collaboration. Continuous engagement will occur through consultation meetings, joint field assessments, feedback platforms, and participatory monitoring activities. Key stakeholders include local communities, traditional leaders, CREMAs, District Assemblies, regulatory authorities (EPA, Forestry Commission, Wildlife Division), contractors, and civil society organizations. A Stakeholder Engagement Plan (SEP) will guide engagement strategies and ensure inclusive participation, particularly of women, youth, and marginalized groups.

7.2 Institutional Framework

The institutional framework comprises various implementing and supporting bodies organized around planning, implementation, monitoring, and reporting functions. It includes a central Biodiversity Coordination Unit (BCU), site-specific Environmental and Social (E&S) teams, and community-based structures. Oversight is provided by the Environmental Protection Authority (EPA), while the Forestry Commission and Wildlife Division offer technical direction. District-level coordination is maintained through local assemblies and decentralized environmental offices. International partners and biodiversity consultants may offer strategic guidance and third-party validation.

7.3 Roles and Responsibilities

7.3.1 Project Environmental Manager

Responsible for overall environmental compliance and supervision of BMP implementation. Coordinates with regulatory agencies, prepares environmental performance reports, and ensures integration of BMP measures into the project's Environmental and Social Management Plan (ESMP).

7.3.2 Project Construction Manager

Ensures that construction activities align with environmental standards and biodiversity safeguards. Works closely with the Environmental Manager to implement mitigation measures, supervise contractor compliance, and minimize ecological disruption during site works.

7.3.3 Project Stakeholder Engagement Team

Leads the development and execution of the Stakeholder Engagement Plan (SEP). Facilitates community consultations, grievance redress mechanisms, and participatory conservation initiatives. Maintains transparent communication channels between the project and its stakeholders.

7.3.4 Contractors – All Packages (Including All Staff and Subcontractors)

All contractors are required to integrate BMP specifications into their operational procedures. This includes adherence to micro-siting protocols, access control, waste management, and wildlife protection measures. They must ensure that all staff and subcontractors receive training on environmental and biodiversity safeguards.

7.3.5 ICM Facilitation Team

The Integrated Corridor Management (ICM) Facilitation Team ensures that landscape-level planning and ecosystem connectivity are integrated into infrastructure development. They collaborate with planning agencies and conservation groups to align project development with long-term land use and biodiversity goals.

7.3.6 BMP Facilitation Team

This team supports technical delivery of the BMP, including monitoring species indicators, managing reforestation programs, and supporting habitat restoration activities. They also assist with data collection, technical training, and field coordination of conservation activities.

7.3.7 Technical Assistants

Technical assistants provide field-level support for biodiversity monitoring, ecological data entry, reforestation efforts, and environmental inspections. They assist in the documentation of project compliance and liaise with community teams on restoration tasks.

7.3.8 Patrol Teams

Community-based patrol teams will be mobilized to monitor protected areas, prevent illegal activities (e.g., logging, hunting), and support early fire detection. These teams will operate in partnership with CREMAs, Forest Services Division, and Wildlife Division and be equipped with basic tools and training for ecological enforcement.

This institutional arrangement will be periodically reviewed and adjusted based on implementation experiences, biodiversity monitoring results, and stakeholder feedback to ensure continued effectiveness and accountability.

Table 4: BMP Institutional Work Matrix outlines each role/entity, their primary responsibilities, and supporting institutions involved in the BMP implementation.

Role/Entity	Primary Responsibilities	Support Entities
Project Environmental Manager	Ensure BMP compliance, reporting, coordination with regulatory agencies, and integration into ESMP.	EPA, Forestry Commission, Wildlife Division
Project Construction Manager	Implement mitigation measures, supervise environmental compliance during construction.	Environmental Manager, Contractors
Project Stakeholder Engagement Team	Lead stakeholder engagement, facilitate grievance redress, and ensure community involvement.	Communities, NGOs, District Assemblies
Contractors All Packages	Integrate BMP into operations, follow environmental safeguards, and train staff/ subcontractors.	Environmental & Social Team, Construction Teams
ICM Facilitation Team	Align infrastructure with landscape-level conservation and land use planning.	Planning Agencies, Conservation NGOs
BMP Facilitation Team	Support BMP delivery through data collection, training, and coordination of restoration activities.	BCU, Forestry Commission, Consultants
Technical Assistants	Assist in biodiversity monitoring, reforestation, data entry, and liaison with communities.	BCU, Community Liaison Officers
Patrol Teams	Monitor protected areas, prevent illegal activities, and support early fire detection.	CREMAs, Wildlife Division, Forest Services Division

7.4 Institutions

Several institutions are directly responsible for enforcing the above regulations and ensuring biodiversity conservation in Ghana:

- **Environmental Protection Authority (EPA):** The EPA is responsible for environmental policy implementation and enforcement, including project permitting, compliance monitoring, and EIA oversight. It plays a key role in approving development projects that impact biodiversity.
- **Forestry Commission (FC):** Through its Forest Services Division and Wildlife Division, the FC oversees the management of forest reserves, wildlife sanctuaries, and biodiversity conservation areas. It also coordinates community engagement in forest management. The following are the FC district offices which have jurisdiction: Tarkwa, Asankragua, Enchi Forestry District and Western Regional Wildlife Division.
- **Water Resources Commission (WRC):** The WRC monitors and manages surface and groundwater use. It ensures that development projects do not compromise freshwater ecosystems or water quality essential for biodiversity. The corridor, oversight is coordinated through the following Basin Secretariats: Tano River Basin Secretariat, based in Goaso, responsible for the Tano River and its tributaries, including sections near Omanpe, Nsuaem, and Boin Tano Forest Reserve, where the transmission line intersects riparian wetlands and fish-farming areas. Pra River Basin Secretariat, headquartered in Obuasi, overseeing the Pra Basin and its sub-catchments, including freshwater bodies around Dunkwa-on-Offin and Upper Denkyira East, where sections of the corridor cross or adjoin small streams and wetlands draining into the Pra system.
- **Volta River Authority (VRA):** The VRA, established under the Volta River Development Act (Act 46), oversees hydroelectric projects like the Akosombo Dam. It has a mandate to monitor and mitigate environmental impacts on aquatic and terrestrial ecosystems in the Volta basin.
- **Ministry of Lands and Natural Resources (MLNR):** The MLNR sets national policy for land, forests, and biodiversity. It supports biodiversity protection through strategic frameworks such as the Protected Areas System Plan and the National Biodiversity Strategy and Action Plan (NBSAP).
- **District Assemblies and Local Authorities:** These institutions are increasingly engaged in local land use planning, permitting, and oversight of CREMA activities. They facilitate the integration of environmental concerns into district-level development plans and play a role in ensuring local compliance with biodiversity regulations. The following are the district assemblies which have jurisdiction: the Upper Denkyira East, Wassa Amenfi East, Wassa Amenfi West, Aowin Municipal, and Wassa Amenfi Central Districts in the Central, Western, and Western North Regions within Ghana.

8 CAPACITY AND TRAINING

8.1 Capacity

The success of the BMP implementation hinges on the availability of skilled personnel and institutional capacity at both central and community levels. Capacity development will focus on enhancing the knowledge, skills, tools, and infrastructure necessary to effectively implement biodiversity conservation measures. Key areas of capacity include ecological monitoring, environmental compliance, restoration techniques, stakeholder engagement, and reporting. GRIDCO's Biodiversity Coordination Unit (BCU), and Environmental and Social (E&S) teams, the 5 beneficiary District Assemblies, CREMAs, and frontline and subcontractors (for all packages) will be the primary beneficiaries of capacity-building initiatives. Periodic needs assessments will guide capacity investment to ensure alignment with project demands and evolving ecological challenges.

8.2 Training

Targeted training programs will be developed and implemented for all BMP stakeholders. These include pre-service and on-the-job training sessions for project staff, contractors, and community actors. Training modules will cover biodiversity monitoring methods, wildlife handling protocols, BMP compliance requirements, and reforestation techniques. In addition, awareness campaigns and educational materials will be provided to enhance understanding of biodiversity conservation goals across project zones. Specialized sessions will be organized for women and youth to increase their participation in conservation efforts. All training efforts will be documented, evaluated, and adapted based on feedback and effectiveness.

9 MONITORING AND EVALUATION

9.1 Management Purposes

Monitoring and evaluation (M&E) is a core component of the BMP, providing real-time data to assess the effectiveness of conservation interventions and guide adaptive management. The M&E system will enable timely identification of risks, validate compliance with mitigation measures, and track biodiversity health indicators. It will inform strategic decisions regarding habitat restoration, species conservation, and community engagement efforts. The system will also ensure accountability by aligning with regulatory and donor reporting requirements.

9.2 Management Actions

The BMP M&E framework will include baseline assessments, routine field monitoring, and periodic audits. Key indicators to be tracked include species population trends, forest cover change, seedling survival rates, and community participation levels. Data will be collected by trained technical assistants using standardized tools such as transect logs, aerial imagery, and species sighting forms, and reviewed by the Biodiversity Coordination Unit (BCU) in collaboration with regulatory partners such as the EPA and Forestry Commission.

Where monitoring reveals implementation gaps, declining biodiversity indicators, or emerging threats such as encroachment, illegal hunting, or fire outbreaks prompt management responses will be activated. These may include reinforcing protection zones, replanting degraded sites with native species, intensifying patrolling efforts, and retraining field teams on mitigation protocols. The framework also allows for ecological triggers (e.g., threshold levels of canopy loss or species decline) to initiate contingency plans.

Quarterly review meetings involving project implementers, regulatory stakeholders, and local CREMAs will be convened to evaluate monitoring results, address challenges, and revise management approaches. Feedback loops will ensure that lessons learned are continuously integrated into BMP practices. Where appropriate, adaptive measures such as the re-design of buffer zones or expansion of wildlife crossings will be adopted to ensure dynamic, evidence-based biodiversity conservation.

10 REPORTING

Comprehensive reporting mechanisms will be established as a central pillar of BMP's transparency and accountability structure. These mechanisms will ensure that stakeholders at all levels ranging from regulatory authorities to local community members receive timely, clear, and evidence-based updates on the progress and outcomes of BMP implementation. Reporting will serve not only as a compliance function but also as a strategic communication and decision-support tool.

GRIDCO's Environmental Manager and the Biodiversity Coordination Unit (BCU) will lead the reporting process, collating data from field monitoring teams, technical assistants, and community-based patrol units. Reports will be compiled monthly and quarterly, summarizing activities conducted, biodiversity indicators monitored, challenges encountered, risk management actions taken, and any revisions made to mitigation strategies. These documents will also highlight progress against key performance indicators and include visual aids such as GIS maps, graphs, and photographic evidence.

Annual Biodiversity Performance Reports will be prepared and submitted to regulatory bodies such as the Environmental Protection Agency (EPA), Forestry Commission, and Wildlife Division, as well as to project financiers and development partners. These reports will help demonstrate GRIDCO's compliance with statutory and funding obligations and contribute to international biodiversity reporting commitments, including those aligned with Ghana's NBSAP and the Convention on Biological Diversity.

To promote grassroots transparency and inclusiveness, community feedback forums will be held biannually in each district along the corridor. These meetings will present monitoring results in local languages using culturally relevant communication tools such as storytelling, pictorial charts, and community theater. Stakeholder inputs collected during these sessions will be documented and integrated into future management decisions.

Digital platforms and standardized templates will be employed to streamline report preparation, storage, and access. A centralized BMP information system will be maintained for use by the project team and regulatory stakeholders. Lessons learned from reporting will be used to improve field operations and refine BMP methodologies, contributing to a dynamic and responsive biodiversity conservation strategy.

11 DETAILED ANNUAL TASK LISTS AND BUDGET UNTIL THE END OF PROJECT

A structured annual task plan has been developed to guide the implementation of BMP actions over the project duration. This plan outlines yearly priorities for reforestation, wildlife management, training, community engagement, and monitoring activities. Key milestones include baseline data completion in Year 1, full reforestation roll-out by Year 2, and habitat connectivity establishment by Year 3. Annual biodiversity awareness campaigns and training sessions will be scheduled each year.

The estimated budget has been aligned with the detailed task list to ensure adequate resourcing of all biodiversity management components. It provides for key activities such as biodiversity baseline studies and long-term ecological monitoring, consultations and capacity building, GSBA and critical habitat monitoring, avifaunal and arboreal risk mitigation, biodiversity performance monitoring, and electrocution and collision risk prevention. Each budget line is subject to annual review in collaboration with implementing partners and financial stakeholders, while a financial audit and quarterly expenditure tracking system will ensure transparency and accountability in the BMP's implementation.

Table 5: Detailed Annual task List and Budget

No.	ITEM	KEY ACTIVITIES	Estimated Cost (USD)
1	In-depth Study of Biodiversity and Long-term Ecological Monitoring	-Fine-scale biodiversity surveys (flora, fauna, herpetofauna, avifauna) along corridor hotspots.	$900,000.00

		- Integration of site-specific avian risk analysis into project risk management - Establish partnerships with local ornithologists and conservation NGOs (e.g., WAPCA, Ghana Wildlife Society) for long-term data analysis. - Baseline mapping of GSBAs, IBAs, and riparian ecosystems	
2	Consultations, Sensitization, and Capacity Building	- Stakeholder engagement, community consultations, and participatory planning. - Capacity-building activities, including forestry extension services, sustainable harvesting, and NTFP development for communities. - Environmental education and biodiversity awareness campaigns. - Community monitoring training and local reporting systems.	$400,000.00
3	GSBAs and Critical Habitat Monitoring	- Routine biodiversity and vegetation monitoring in Draw River, Tano Ehuro, and Boin Tano Forest Reserves. - Joint monitoring patrols with Forestry Commission and CREMAs. - Vegetation enrichment and reforestation of 370 ha degraded habitat. - Reporting and compliance audits with EPA and World Bank.	$600,000.00
4	Avifaunal and Arboreal Risk Mitigation	- Installation of insulation on energized parts of towers and fitting of anti-perching devices. - Installation of dynamic bird diverters, reflective markers, canopy bridges, and rope ladders.	$700,000.00

		- Deployment of drones and motion-triggered cameras for monitoring wildlife movement along restricted paths. - Annual maintenance and equipment replacement.	
5	Indicators and Biodiversity Performance Monitoring	- Development of biodiversity indicators and metrics. - Monitoring of avian mortality, flora regeneration, and ecological recovery. - Independent audit and third-party validation of biodiversity outcomes. - Preparation of annual performance reports and adaptive management revisions.	$450,000.00
6	Electrocution and Collision Risk Prevention	- Avian-safe infrastructure retrofitting (insulated conductors, expanded spacing). - Dynamic bird flappers, marker balls, and anti-collision beacons across high-risk spans. - Helicopter-based installation of line markers and on-ground inspection training. - Incorporation of collision/electrocution data into GRIDCo's E&S database.	$850,000.00
7	Institutional Coordination, Reporting, and Adaptive Management	- GRIDCo ESMU coordination with EPA, Forestry Commission, and WRC. - Periodic BMP review meetings, stakeholder workshops, and annual plan updates - Printing, logistics, and communication support for biodiversity documentation.	$200,000.00
Total Estimated Budget			$4,100,000.00

Budget Line Explanations:

1. In-Depth Study of Biodiversity and Long-Term Ecological Monitoring: This allocation covers detailed biodiversity surveys across the transmission corridor, including flora, fauna, herpetofauna, and avifauna. Activities involve baseline mapping of Globally Significant Biodiversity Areas (GSBAs), Important Bird Areas (IBAs), and riparian ecosystems. It also funds partnerships with local scientific institutions and NGOs (e.g., WAPCA, Ghana Wildlife Society) for long-term monitoring and data management. The cost includes equipment for field data collection, analytical tools, and technical consultancy for ongoing ecological assessments.
2. Consultations, Sensitization, and Capacity Building: This supports stakeholder and community engagement processes essential for participatory biodiversity management. It funds district-level consultations, community meetings, and awareness campaigns on biodiversity conservation and sustainable resource use. Training sessions will build the capacity of local forestry officers, CREMAs, and community monitors on ecological stewardship, sustainable harvesting, and non-timber forest product (NTFP) development. The allocation also covers production of IEC (Information, Education, and Communication) materials and logistical support for workshops.
3. GSBAs and Critical Habitat Monitoring: Funds under this line ensure continuous ecological monitoring of Draw River, Tano Ehuro, and Boin Tano Forest Reserves, identified as critical habitats and Key Biodiversity Areas (KBAs). The activities include joint patrols with the Forestry Commission, biodiversity data collection, vegetation enrichment, and the reforestation of about 370 hectares of degraded lands. Costs also cover annual compliance audits and reporting to the EPA and World Bank.
4. Avifaunal and Arboreal Risk Mitigation: This budget provides for engineering and ecological mitigation measures aimed at reducing bird collision and electrocution risks. It includes the procurement and installation of bird diverters, reflective markers, canopy bridges, and insulation of energized parts of towers. Drones and motion-sensor cameras will be deployed to monitor wildlife movement and effectiveness of mitigation devices. Provisions are made for annual maintenance and replacement of worn-out equipment.
5. Indicators and Biodiversity Performance Monitoring: This allocation supports the development and tracking of biodiversity performance indicators in line with ESS6 requirements. Activities include monitoring avian mortality, forest regeneration, and ecosystem recovery, conducting independent third-party biodiversity audits and preparing annual adaptive management reports. It also covers data management systems, reporting templates, and dissemination of monitoring results to stakeholders.

6. Electrocution and Collision Risk Prevention: Funds here address the installation of avian-safe infrastructure components such as insulated conductors, marker balls, dynamic bird flappers, and anti-collision beacons. The budget includes helicopter-based installation on high-risk spans, on-ground inspection training for GRIDCo engineers, and integration of monitoring data into the corporate Environmental & Social (E&S) database. These interventions aim to achieve measurable reductions in bird and bat fatalities.
7. Institutional Coordination, Reporting, and Adaptive Management: This covers coordination and oversight activities led by GRIDCo's Environmental and Social Management Unit (ESMU). It includes periodic BMP review meetings, stakeholder workshops, preparation of progress reports, and dissemination of communication materials. Funds will also support logistics, printing, and adaptive management reviews to align implementation with annual monitoring outcomes and stakeholder feedback.

12 PLAN UPDATE AND REVIEW

The BMP is a living document and will be subject to periodic review and update to reflect lessons learned, monitoring feedback, and emerging risks or opportunities. The plan will be reviewed annually during a multi-stakeholder workshop led by GRDICO's Environmental Manager and BCU, and will involve the Forestry Commission, EPA, local CREMAs, and community leaders.

The review will assess progress toward BMP objectives, update ecological baselines where necessary, and revise action plans and mitigation measures based on M&E findings. The review will also consider any regulatory changes or Bank's feedback requiring plan amendments. A formalized change management procedure will govern updates, and revised versions of the plan will be disseminated to all implementing and oversight institutions.

The Biodiversity Management Plan will be updated to incorporate new ecological data and site-specific risk mitigation measures across all major biodiversity groups. While avifaunal monitoring remains a key focus due to electrocution and collision risks, future updates will also integrate findings on mammals, amphibians, reptiles, invertebrates, and flora identified along the Ghana-Côte d'Ivoire Interconnection corridor.. Revised GIS maps, habitat descriptions, and mitigation designs will be annexed. The final version will align with IFC PS6 and ESS6 requirements for biodiversity impact management.

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APPENDICES

Appendix 1. Detailed maps and instructions

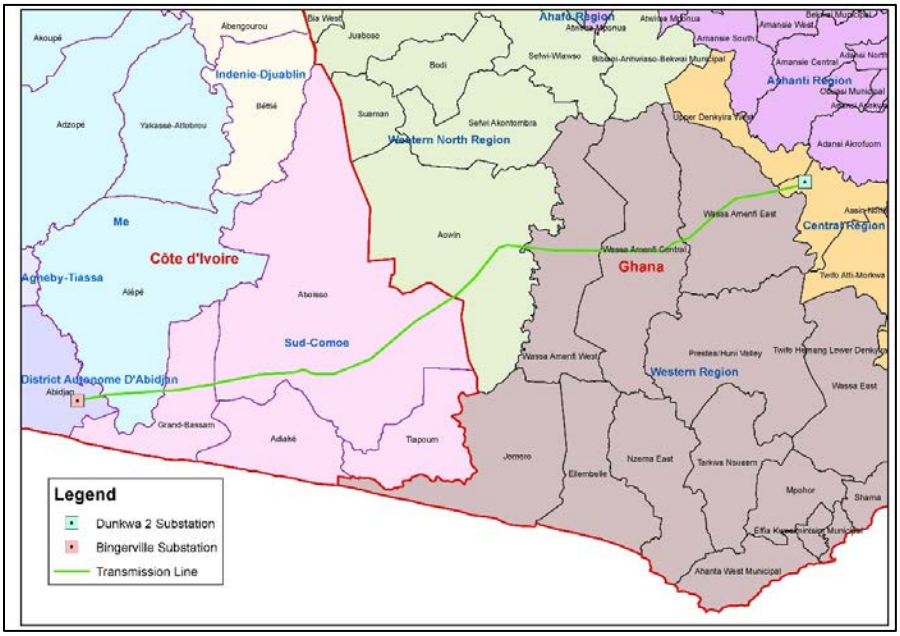


Figure 4 Administrative map of study area

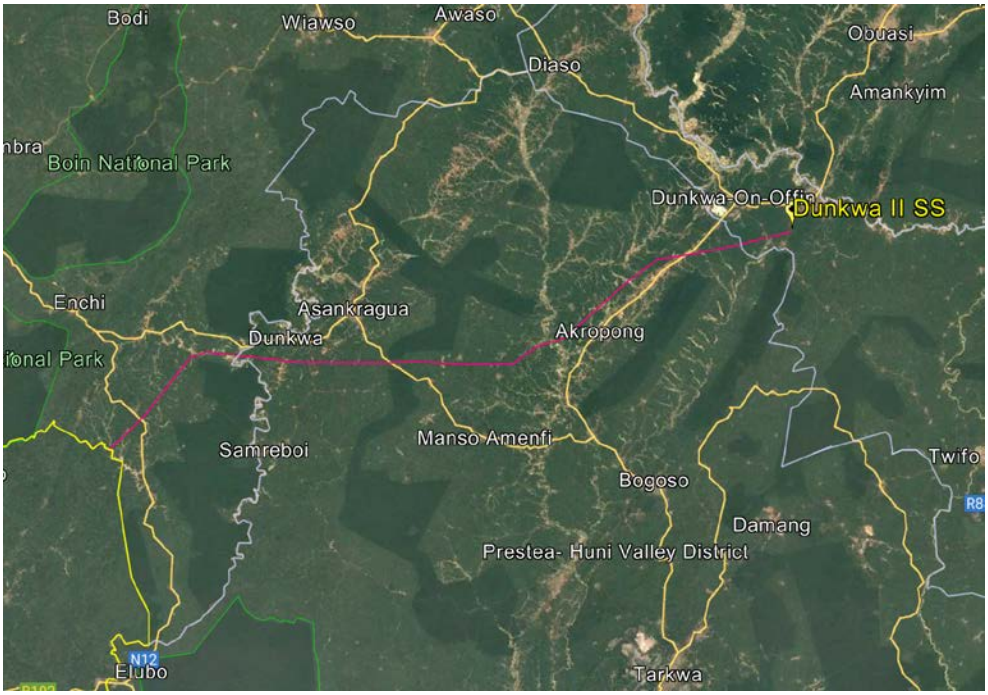


Figure 5: Ghanaian corridor section

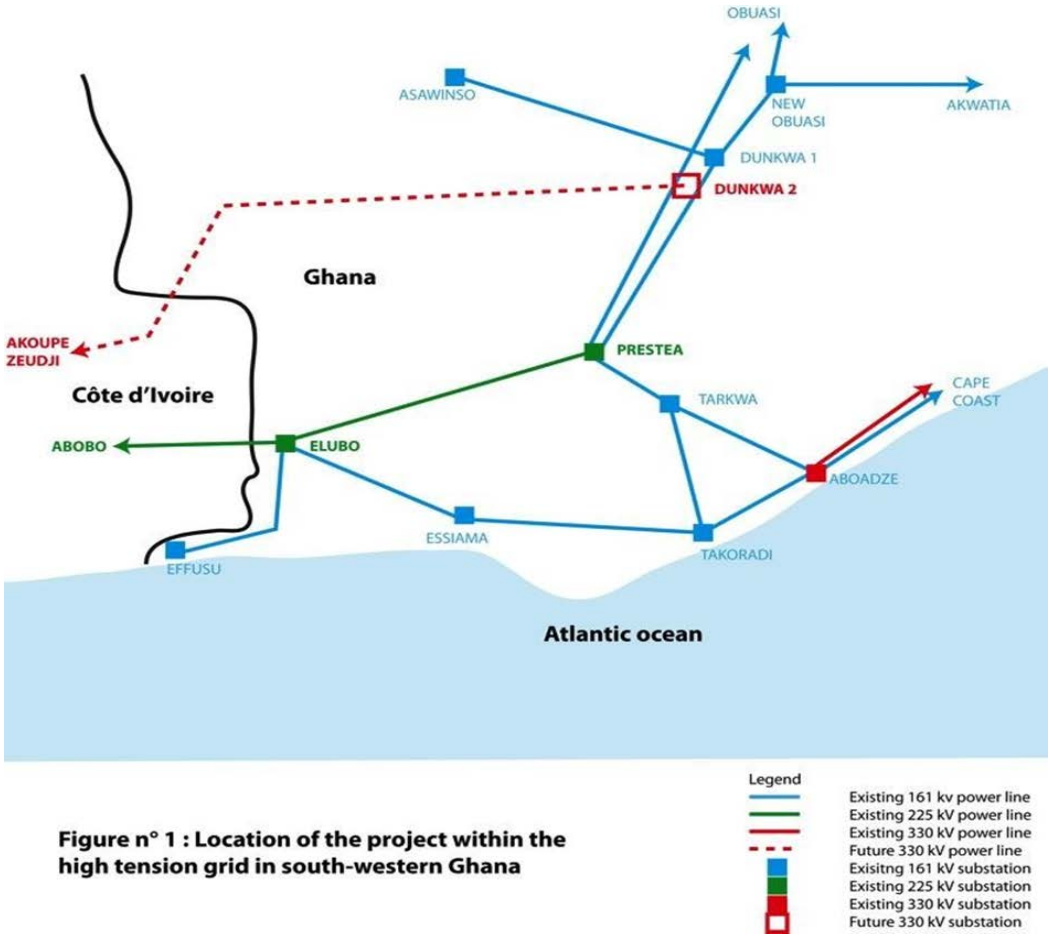


Figure 6: Project location within the high-tension electricity network in SW Ghana

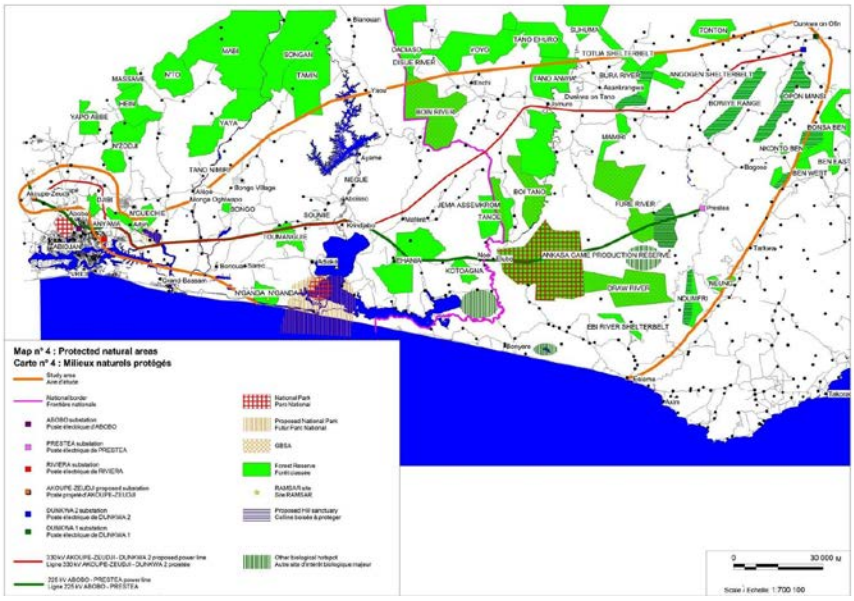


Figure 7: A map showing the distribution of the forest reserves close the project area

Appendix 2. Suggested plant species for use in reforestation

Indigenous Timber and Shade Tree Species

Common Name	Scientific Name
Odum	*Milicia excelsa*
Mahogany	*Khaya ivorensis*
Emire	*Terminalia ivorensis*
Wawa	*Triplochiton scleroxylon*
Dahoma	*Piptadeniastrum africanum*
Onyina (Ceiba)	*Ceiba pentandra*
Ofram	*Terminalia superba*
African rosewood	*Guibourtia ehie*

Table 6 Indigenous Timber and Shade Tree Species

Agroforestry and Multipurpose Trees

Common Name	Scientific Name
Mango	*Mangifera indica*
Cocoa shade tree (Albizia)	*Albizia zygia*
Neem	*Azadirachta indica*
Avocado	*Persea americana*
Moringa (Drumstick tree)	*Moringa oleifera*
Leucaena	*Leucaena leucocephala*
Gliricidia	*Gliricidia sepium*

Table 7: Agroforestry and Multipurpose Trees

Riparian and Wetland Species

Common Name	Scientific Name
Raffia Palm	*Raphia hookeri*

Common Name	Scientific Name
African Oil Palm	*Elaeis guineensis*
Bamboo	*Bambusa vulgaris*
Waterberry	*Syzygium guineense*
Riverine Ficus	*Ficus sur*

Table 8: Riparian and Wetland Species

Fodder and Soil Improvement Species

Common Name	Scientific Name
Acacia	*Acacia auriculiformis*
Senna	*Senna siamea*
Tephrosia	*Tephrosia vogelii*
Pigeon Pea	*Cajanus cajan*

Table 9: Fodder and Soil Improvement Species

These species should be selected based on site-specific conditions such as soil type, rainfall pattern, ecological zone (e.g., semi-deciduous, moist forest), and reforestation goals (e.g., biodiversity conservation, erosion control, agroforestry integration). Restoration plans should prioritize native species and align with national forestry guidelines and CREMA strategies where applicable.

Appendix 3. Wildlife culvert examples

Wildlife culverts are engineered underpasses designed to facilitate safe animal movement beneath roads, mitigating habitat fragmentation and reducing wildlife-vehicle collisions. These structures vary in design to accommodate different species and environmental conditions. Below are examples illustrating the diversity and functionality of wildlife culverts:

1. Circular Corrugated Metal Culverts

A bobcat utilizing a circular corrugated metal culvert in the Pigeon River Gorge, North Carolina.

These culverts are commonly used for small to medium-sized mammals. Their corrugated texture provides footing, and when combined with fencing, they effectively guide animals beneath roadways.

2. Box Culverts with Natural Substrate

A box culvert monitored for wildlife usage in Ontario, Canada.

Box culverts offer a rectangular passage that can be lined with natural substrates like soil and vegetation, making them suitable for a variety of species, including amphibians and reptiles. Monitoring equipment, such as cameras, can be installed to study wildlife movement through these structures.

3. Square Culverts with Gangplanks

A square culvert underpass equipped with a gangplank in the Netherlands.

This design includes a wooden gangplank to assist smaller animals in traversing the culvert, especially when water is present. Such adaptations are crucial in wetland areas to ensure safe passage for species like amphibians and small mammals.

4. Large Arch Culverts for Ungulates

An arch culvert facilitating deer movement in Montana.

Designed for larger mammals, arch culverts provide ample space and a natural pathway, encouraging use by species such as deer and elk. Their open design allows for natural light and vegetation growth, making them more inviting to wildlife.

5. Amphibian Tunnels

The Henry Street salamander tunnel in Amherst, Massachusetts.

Specifically designed for amphibians, these small tunnels are often accompanied by guiding fences to direct species like salamanders and frogs safely under roads during migration periods.

They are vital in areas with significant amphibian populations to prevent road mortality. These examples demonstrate the importance of tailoring culvert designs to the specific needs of local wildlife populations and environmental contexts. Incorporating features like natural substrates, adequate sizing, and guiding structures enhances the effectiveness of these crossings.

References

Alamy Stock Photo. (n.d.). *Square wildlife crossing culvert underpass with gangplank for animals under a highway in the Netherlands* [Photograph]. Retrieved from https://www.alamy.com

Eco-Kare International. (2015). *Wildlife monitoring using drainage culverts.* Eco-Kare International. Retrieved from https://eco-kare.com

High Plains Stewardship Initiative (HPSI). (2021). *Arch culvert design for ungulate passage.* Yale School of the Environment. Retrieved from https://highplainsstewardship.org

Smokies Safe Passage. (2019). *Bobcat using wildlife underpass in the Pigeon River Gorge.* Smokies Safe Passage. Retrieved from https://smokiessafepassage.org

Wikimedia Commons. (2009). *Henry Street Salamander Tunnel in Amherst, Massachusetts* [Photograph]. Retrieved from https://commons.wikimedia.org/wiki/File:Henry_Street_Salamander_Tunnel.jpg

Appendix 4. Structures facilitating wildlife dispersal on steep slopes

Facilitating wildlife dispersal on steep slopes presents unique challenges due to terrain complexity, erosion risks, and species-specific movement behaviors. Effective structures in such environments must be carefully designed to ensure functionality and safety for both wildlife and the surrounding ecosystem. Below are examples and design considerations for structures that aid wildlife movement on steep slopes:

1. Steep-Slope Wildlife Overpasses

Wildlife overpasses, also known as "landscape bridges," are vegetated bridges that span over roadways, allowing animals to cross safely. On steep terrains, these structures require careful design to maintain appropriate gradients for wildlife use.

Design Considerations are as follows: Gradient: Approach ramps should have a gentle slope, ideally not exceeding a 5:1 ratio (horizontal: vertical), to accommodate a wide range of species.

- Width: A minimum width of 165 to 230 feet is recommended to support various wildlife species.
- Vegetation: Incorporating native vegetation mimics the natural habitat, encouraging use by wildlife. Example: Banff National Park, Canada: Features multiple wildlife overpasses that have successfully facilitated the movement of species like elk and bears across the Trans-Canada Highway.

2. Viaducts and Elevated Roadways

In areas where constructing overpasses is challenging, elevating the roadway itself allows wildlife to pass underneath. This approach minimizes habitat fragmentation and maintains natural movement corridors. Design Considerations:

- Height and Clearance: Sufficient clearance under the viaduct is essential to accommodate the target species.
- Habitat Continuity: Ensuring the area beneath remains natural and undisturbed encourages use by wildlife.

Example: Snoqualmie Pass, Washington, USA: The I-90 corridor includes elevated road sections that allow for wildlife movement beneath, aiding species like deer and elk.

3. Modified Culverts and Underpasses

Standard culverts can be adapted to facilitate wildlife movement on steep slopes. By increasing their size and incorporating natural substrates, these structures become more inviting to wildlife. Design Considerations are as follows:

- Dimensions: A minimum height of 2.4 meters and width of 6.1 meters is recommended for medium to large mammals.
- Substrate: Lining the bottom with natural materials like soil and vegetation encourages use by various species.

Example: Florida Panther Underpasses: Along I-75, enlarged culverts have been installed to facilitate safe crossings for panthers and other wildlife.

4. Rope Bridges and Canopy Crossings

For arboreal species, rope bridges or canopy crossings provide safe passage over roads, especially in forested steep terrains. Design Considerations are as follows:

- Placement: Should connect continuous canopy cover to encourage use by tree-dwelling species.
- Materials: Durable, weather-resistant materials ensure longevity and safety.

Example: Eco-Link@BKE, Singapore: An ecological bridge that connects two nature reserves, facilitating movement of arboreal species like the common palm civet.

5. Living Root Bridges

In certain regions, traditional methods like living root bridges, formed by guiding the roots of trees across gaps, have been used to create natural crossings.

Design Considerations:

- Species Selection: Utilize tree species with strong, flexible roots, such as Ficus elastica.
- Timeframe: These structures take years to develop but offer sustainable and resilient crossings.

Example: Meghalaya, India: The Khasi and Jaintia tribes have cultivated living root bridges over centuries, enabling safe passage over rivers and ravines.

When designing wildlife dispersal structures on steep slopes, it's crucial to consider species-specific needs, local topography, and long-term sustainability. Incorporating native vegetation, ensuring appropriate gradients, and selecting suitable materials will enhance the effectiveness of these structures in promoting wildlife connectivity.

Appendix 5. Structures facilitating arboreal wildlife movement and avoidance of bird's collision

Arboreal species, such as monkeys, squirrels, and certain marsupials, often face challenges when their habitats are fragmented by roads or other infrastructures. To address this, several structures have been developed. To further facilitate arboreal wildlife movement and mitigate bird collisions, various structures and design strategies have been implemented worldwide. These solutions aim to maintain habitat connectivity for tree-dwelling species and reduce avian mortality due to human-made obstacles.

Structures facilitating arboreal wildlife movement

1. Canopy Bridges

Canopy bridges are structures that connect tree canopies across roads or clearings, allowing arboreal animals to move safely. They can be made from ropes, nets, or rigid materials. Example: In Rio de Janeiro, Brazil, large metal canopy crossings have been installed to aid species like the brown howler monkey and black capuchin monkey.

2. Glider Poles

For gliding species, such as certain possums, tall poles are erected on either side of roads to provide launch and landing points. Example: In Australia, glider poles have been used to facilitate safe crossings for gliding marsupials.

3. Vegetated Overpasses

These are overpasses covered with native vegetation, creating a natural corridor for wildlife. While primarily used by terrestrial animals, they can also benefit arboreal species if designed appropriately. Example: The Eco-Link@BKE in Singapore is a vegetated bridge that connects two nature reserves, aiding various wildlife movements.

Figure 8: Pictures of canopy bridges

Strategies to Prevent Bird Collisions

Bird collisions with buildings and other structures are a significant cause of avian mortality. Several strategies have been developed to mitigate this issue:

1. Bird-Friendly Glass

Glass treated with patterns, frits, or UV-reflective coatings can make windows more visible to birds, reducing collisions. Example: The Jacob K. Javits Convention Center in New York City underwent renovations to include bird-friendly glass, resulting in a significant drop in bird collisions.

2. External Screens and Netting

Installing screens or netting outside windows can act as a physical barrier, preventing birds from hitting the glass.

3. Lighting Management

Reducing or modifying artificial lighting, especially during migration periods, can decrease bird disorientation and collisions. Example: Audubon suggests measures like turning off unnecessary lights at night and using bird-friendly lighting designs to minimize attraction to buildings.

4. Marking devices

The fitting of the marking devices are typically done from a helicopter, which adds considerable costs to the project. Statistical studies show that dynamic devices (usually called bird flappers), have moving parts as opposed to static devices where there are none. Dynamic devices are very effective in reducing collisions as the birds seem to see them very well probably because of the movement that attracts attention. Only the middle 60% of each span needs to be marked as this is where most of the collisions occur.

Line Marking Devices

- *Bird Diverters*: Install bird diverters like spirals, flappers, or spheres on power lines to make them more visible. These devices can reflect light or glow in the dark, alerting birds to the presence of the wires.
- *Line Marking Tapes*: Apply high-visibility tapes or markers that flutter in the wind, making the lines more conspicuous.

Figure 9 :Examples of the dynamic bird flapper devices

Appendix 6. Standard Operational Procedures (SOP) for Land Clearing and Rehabilitation

This SOP provides a structured approach to land clearing and rehabilitation, ensuring that activities are conducted responsibly, safely, and in compliance with environmental standards. Regular reviews and updates to this SOP should be undertaken to incorporate lessons learned and evolving best practices.

1. Roles and Responsibilities

Project Manager (PM):

- Oversees the entire land clearing and rehabilitation process.
- Ensures compliance with environmental regulations and project timelines.

Environmental Officer (EO):

- Conducts environmental assessments and monitors ecological impacts.
- Coordinates with regulatory bodies for necessary permits.

Site Supervisor (SS):

- Manages on-site operations, including equipment and personnel.
- Ensures adherence to safety protocols and SOP guidelines.

Rehabilitation Specialist (RS):

- Develops and implements land rehabilitation plans post-clearing.
- Monitors the success of revegetation and soil stabilization efforts.

Safety Officer (SO):

- Conducts risk assessments and ensures the safety of all personnel.
- Provides training on safety procedures and emergency responses.

Community Liaison Officer (CLO):

- Engages with local communities to inform and involve them in the project.
- Addresses concerns and incorporates community input into planning.

2. Background

Land clearing is a critical initial step in preparing a site for development or restoration. It involves the removal of vegetation, debris, and obstacles to facilitate construction or rehabilitation activities. Proper planning and execution are essential to minimize environmental impacts, comply with legal requirements, and ensure the safety of workers and surrounding communities.

3. Phasing of Land Clearing SOP

a. Preparation Phase: Planning and Obtaining Necessary Approvals

Objective: Establish a comprehensive plan and secure all required permissions to ensure that land clearing activities are conducted legally, safely, and with minimal environmental impact.

Key Actions:

i. Site Assessment:
   - Conduct detailed surveys to identify vegetation types, soil conditions, topography, and the presence of any protected species or habitats.
   - Map out areas requiring special attention or conservation.

ii. Regulatory Compliance:
   - Identify all applicable local, regional, and national regulations related to land clearing and environmental protection.
   - Obtain necessary permits and approvals from relevant authorities, such as environmental agencies and local governments.

iii. Stakeholder Engagement:
   - Engage with local communities, landowners, and other stakeholders to inform them about the planned activities and gather input.
   - Address any concerns and incorporate feedback into the planning process.

iv. Resource Planning:
   - Develop a detailed plan outlining the scope of work, timelines, required equipment, personnel, and budget.
   - Establish protocols for safety, waste management, and environmental protection.

b. Pre-Clearing Phase: Site Assessments and Stakeholder Engagement

Objective: Prepare the site and ensure all stakeholders are informed and involved before commencing clearing activities.

Key Actions:

i. Detailed Site Surveys:
   - Perform in-depth assessments to identify any changes since the initial survey.
   - Mark boundaries, sensitive areas, and zones requiring specific management practices.

ii. Environmental Safeguards:
   - Implement erosion and sediment control measures, such as silt fences and buffer zones.

- Plan for the protection of water bodies, wetlands, and wildlife habitats.

iii. Stakeholder Communication:
- Provide updates to stakeholders about the upcoming activities.
- Ensure that all concerns are addressed and that there is a clear understanding of the project's objectives and methods.

iv. Logistical Preparations:
- Mobilize equipment and personnel to the site.
- Set up access routes, storage areas, and safety zones.

c. Clearing Phase: Execution of Land Clearing Activities

Objective: Carry out land clearing operations efficiently while minimizing environmental impact and ensuring safety.

Key Actions:

i. Vegetation Removal:
- Systematically remove trees, shrubs, and underbrush as per the clearing plan.
- Utilize appropriate machinery and techniques to minimize soil disturbance.

ii. Debris Management:
- Collect and process cleared vegetation for reuse, recycling, or disposal.
- Ensure that debris is managed in compliance with environmental regulations.

iii. Soil Preservation:
- Preserve topsoil for future rehabilitation efforts.
- Avoid compaction and contamination of soil resources.

iv. Monitoring and Reporting:
- Continuously monitor environmental indicators such as air quality and noise levels.
- Document progress and any incidents, adjusting operations as necessary.

d. Post-Clearing Phase: Rehabilitation and Monitoring of the Cleared Area

Objective: Restore the cleared land to a stable and productive state, ensuring long-term environmental sustainability.

Key Actions:

i. Site Rehabilitation:

- Implement revegetation plans using native species to restore ecological balance.
- Stabilize soils through mulching, terracing, or other appropriate methods.

ii. Monitoring and Maintenance:
- Regularly assess the success of rehabilitation efforts, including plant survival rates and soil stability.
- Maintain erosion control structures and replace failed plantings as needed.

iii. Reporting:
- Document all rehabilitation activities and outcomes.
- Submit reports to relevant authorities and stakeholders, highlighting successes and areas needing improvement.

iv. Community Engagement:
- Inform local communities about the completion of clearing activities and involve them in monitoring and maintenance where feasible.

4. Preparation Phase Management Actions

- Site Assessment:
  - Conduct ecological surveys to identify sensitive habitats and species.
  - Map out areas requiring protection or special handling.
- Permitting and Compliance:
  - Obtain necessary environmental and land use permits.
  - Ensure compliance with local, regional, and national regulations.
- Planning:
  - Develop a detailed land clearing plan, including timelines and resource allocation.
  - Identify and plan for erosion control and sediment management measures.
- Stakeholder Engagement:
  - Inform and consult with local communities and stakeholders.
  - Incorporate feedback into planning and address concerns proactively.

5. Pre-Clearing Phase Management Actions

- Demarcation:
  - Clearly mark boundaries of the area to be cleared.
  - Identify and protect conservation zones and heritage sites.
- Resource Mobilization:
  - Deploy necessary equipment and personnel to the site.
  - Ensure all machinery is inspected and in good working condition.

- Safety Briefings:
    - Conduct safety training sessions for all workers.
    - Review emergency procedures and communication protocols.
- Environmental Safeguards:
    - Install erosion control measures such as silt fences and sediment traps.
    - Set up buffer zones around water bodies and sensitive areas.

6. Clearing Phase Management Actions

- Vegetation Removal:
    - Systematically remove trees, shrubs, and undergrowth as per the clearing plan.
    - Utilize appropriate methods to minimize soil disturbance.
- Debris Management:
    - Collect and dispose of cleared vegetation responsibly.
    - Recycle or repurpose materials where possible.
- Soil Handling:
    - Preserve topsoil for use in rehabilitation efforts.
    - Avoid compaction and contamination of soil resources.
- Monitoring:
    - Continuously monitor environmental indicators such as air quality and noise levels.
    - Adjust operations as needed to mitigate adverse impacts.

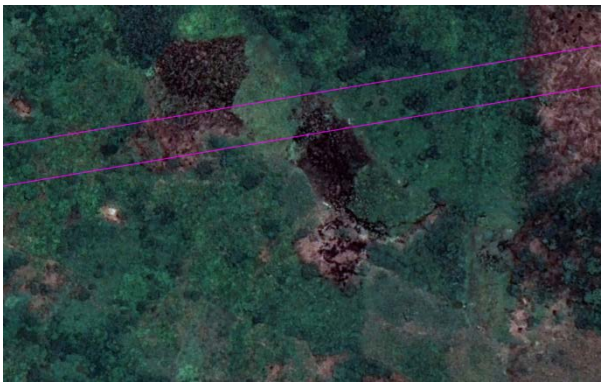
7. Post-Clearing Phase Management Actions

- Site Rehabilitation:
    - Implement revegetation plans using native species.
    - Stabilize soils through mulching, terracing, or other appropriate methods.
- Monitoring and Maintenance:
    - Regularly assess the success of rehabilitation efforts.
    - Maintain erosion control structures and replace failed plantings.
- Reporting:
    - Document all activities and outcomes related to land clearing and rehabilitation.
    - Submit reports to relevant authorities and stakeholders as required.
- Community Engagement:
    - Inform local communities about the completion of clearing activities.
    - Involve them in monitoring and maintenance where feasible.

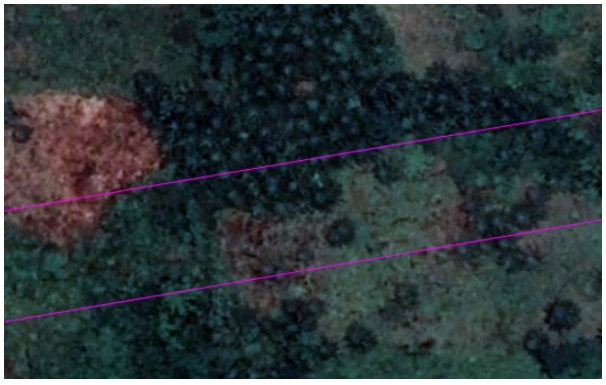
Appendix 7: Maps

The following pictures show examples for each class with the relevant corridor.

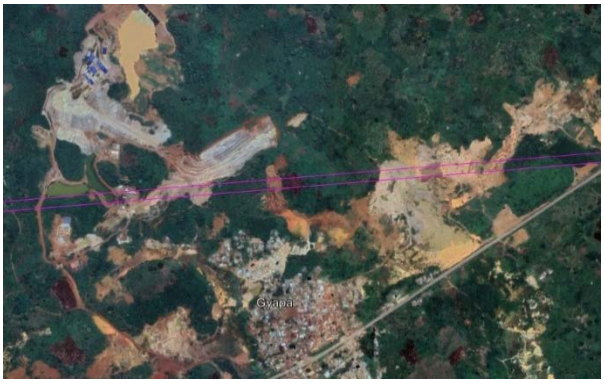
The impact on the forest



The impact on the shrubland



The impact on the Tree/palm areas



The impact on the urban area

Figure 10: Pictures of examples for each class of land cover

For easier comprehension, the land-use status in the districts of the 400/330 kV Ghana-Côte d'Ivoire Interconnection project has been represented in a bar chart to give an immediate picture of the impact magnitude resulting from this preliminary analysis.

Appendix 8: BAP - Biodiversity Action Plan

1: Carry out bypass sections during the period of least potential disturbance, with priority given to natural sites with high biological diversity

Expected Results

- Avoidance of habitat destruction and disturbance to wildlife.

Result Indicators

- Construction of bypass routes.

Impact Indicators

- Number of sensitive habitats spared by the works;
- The number of disturbance cases should be close to zero.

Operating Procedure

- Carry out participatory planning of the works between GRIDCo, the company in charge of the works, the project owner, the Ministry of Environment and the local communities;
- Execute the works within the specified period.

Implementation Schedule

Operations	Year 1	Year 2	Year 3	**Periods of the year**											
				J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
A.1.1 Participatory planning of the work execution															
A.1.2 Execution of the work															

2: Implement a collision risk reduction system

Expected Results

- Reduced collisions with wildlife, vehicles, and other machinery.

Result Indicators

- A collision risk reduction system implemented.

Impact Indicators

- Occurrence of collision risk close to zero.

Operating Procedure

- Establish driving rules for construction machinery;
- Raise awareness among other users of tracks and roads near the route.

Implementation Schedule

Operations	Year 1	Year 2	Year 3	Periods of the year											
				J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
Implementation of collision risk reduction systems															

3: Improve signage in directly impacted natural sites

Expected Results

- Collision risks with vehicles are significantly reduced.

Result Indicators

- Number of recorded collision cases (to be compared with a baseline situation).

Impact Indicators

- Decrease in the frequency of collisions with animals (reptiles, mammals).

Operating Procedure

- Install vertical road signs (warning, speed limit, information);
- Prohibit truck traffic at night (during the construction phase).

Implementation Schedule

Operations	Year 1	Year 2	Year 3	Periods of the year											
				J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
Installation of signage in directly affected natural sites															

4: Conduct communication/awareness sessions for local communities on the works and biodiversity conservation actions

Expected Results

- Information and awareness sessions conducted during the construction and operation phases.

Result Indicators

- Number of information and awareness sessions conducted;
- Number of people reached.

Impact Indicators

- Availability of useful information about the works for local communities;
- Intensity/frequency of conflicts between communities and construction companies (number);
- Frequency of accidents/collisions (number).

Operating Procedure

- Organize preparatory meetings with local communities;
- Develop terms of reference for information/awareness sessions;
- Conduct information and awareness campaigns for local communities and company personnel;
- Monitor conflicts and accidents.

Implementation Schedule

Operations	Year 1	Year 2	Year 3	**Periods of the year**											
				J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
Raising awareness among the population															

5: Implement a waste collection system

Expected Results

- Reduction of chemical and organic pollution;
- Decrease in areas overrun by waste;
- Reduction in wildlife mortality due to pollution or poisoning;
- Reduction of risks of contamination of water resources.

Result Indicators

- Cleanliness status of construction sites and along the line route.

Impact Indicators

- Quantities of waste collected;
- Quantities of waste treated;
- Quantities of waste transferred to specialized treatment sites.

Operating Procedure

- Establish a system for the collection of solid and liquid waste;
- Implement a waste sorting system;
- Implement a waste recycling and treatment system (e.g., incinerators).

Implementation Schedule

Operations	Year 1	Year 2	Year 3	Periods of the year											
				J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
Establish a waste collection system															

6: Develop access roads for construction vehicles (sand, water, gravel, etc.) while avoiding areas of high biodiversity concentration

Expected Results

- Improved mobility for the transport of materials and equipment;
- Biodiversity and habitats preserved.

Result Indicators

- Access roads constructed.

Impact Indicators

- Single routes established without disturbing wildlife or destroying vegetation when accessing resources and supplying construction sites.

Operating Procedure

- Construct the necessary number of access roads.

Implementation Schedule

Operations	Year 1	Year 2	Year 3	Periods of the year											
				J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*		*D*
Constructing access roads for construction site vehicles															

7: Restore degraded natural habitats

Expected Results

- Conservation of plant and animal biodiversity;
- Increase in forested and pastoral areas.

Result Indicators

- Number of hectares restored.

Impact Indicators

- Plant and animal species maintained.

Operating Procedure

- Rehabilitate degraded sites;

- Plant trees;
- Fence off sensitive habitats;
- Protect against bushfires.

Implementation Schedule

Operations	Year 1	Year 2	Year 3	**Periods of the year**											
				J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
Restoring degraded natural habitats															
Reforestation with local species															

8: Establish and implement a specific monitoring program for target species

Expected Results

- Improved understanding of the population dynamics of species that indicate environmental disturbance.

Result Indicators

- Monthly counts of indicator species of environmental disturbance.

Impact Indicators

- Level of knowledge regarding disturbances in sensitive habitats.

Operating Procedure

- Conduct monthly wildlife counts;
- Carry out regular flora inventories;
- Process and analyze data.

Implementation Schedule

Operations	Year 1	Year 2	Year 3	**Periods of the year**											
				J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
Establish and implement a specific monitoring programme for target species.															

9: Establish a common monitoring framework to track the dynamics of animal populations in natural sites with high biodiversity concentration

Expected Results

- Monitoring framework for animal population dynamics established.

Result Indicators

- Existence and functionality of a biodiversity monitoring framework.

Impact Indicators

- Level of exchange of qualitative and quantitative data on species and habitats affected by the project (monthly data).

Operating Procedure

- Organize an information meeting and establish the framework;
- Harmonize the monitoring framework across the Wilayas;
- Set up and centralize data and publish biodiversity information;
- Centralize data.

Implementation Schedule

Operations	Year 1	Year 2	Year 3	**Periods of the year**											
				J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
Monitoring animal population dynamics in natural sites															

10: Strengthen the ecological monitoring capacity of the Regional Delegations of the MEDDTE

Expected Results

- Operational biodiversity monitoring capacities are strengthened at the level of the different Wilayas.

Result Indicators

- Monitoring protocols established;
- Quantity and type of specific equipment for each monitoring method.

Impact Indicators

- Availability of quantitative and qualitative data series on biodiversity components.

Operating Procedure

- Bird monitoring;
- Mammal and reptile monitoring;
- Habitat monitoring;

- Mobility resources for monitoring operations.

Implementation Schedule

Operations	Year 1	Year 2	Year 3	Periods of the year											
				J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
Strengthening ecological monitoring capabilities															

11: Strengthen bushfire control measures in grazing areas

Expected Results

- Operational capacities for bushfire control are strengthened in grazing areas along the line.

Result Indicators

- Quantity and type of bushfire control equipment;
- Length of firebreaks established.

Impact Indicators

- Number of hectares of grazing land protected from bushfires.

Operating Procedure

- Acquire bushfire control equipment;
- Open manual and mechanical firebreaks in grazing areas.

Implementation Schedule

Operations	Year 1	Year 2	Year 3	Periods of the year											
				J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
Opening of manual and mechanical firewalls in the project area															

12: Strengthen the capacities of community groups supporting wildlife and flora protection

Expected Results

- Technical capacities of local populations strengthened.

Result Indicators

- Number of training sessions organized;
- Number of participants trained.

Impact Indicators

- Level of community involvement in monitoring and surveillance of biological resources.

Operating Procedure

- Organize training sessions for local communities on the following topics:
  - Identification, capture, monitoring, and counting of waterbirds;
  - Habitat quality monitoring;
  - Floristic inventories;
  - Terrestrial fauna inventories;
  - Surveillance techniques.

Implementation Schedule

Operations	Year 1	Year 2	Year 3	**Periods of the year**											
				J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
Organisation of training sessions for the benefit of local populations															

13: Implement an awareness program on the importance of biodiversity to ensure sustainable development

Expected Results

- Communities along the line are made aware of the economic and biological values of natural resources and their importance for achieving sustainable development.

Result Indicators

- Number of people made aware of the importance and values of wildlife and plant resources.

Impact Indicators

- Level of knowledge regarding the values and importance of wildlife and plant resources;
- Behavioral changes regarding wildlife and biological resources.

Operating Procedure

- Develop an awareness program;
- Implement the awareness program.

Implementation Schedule

Operations	Year 1	Year 2	Year 3	**Periods of the year**											
				J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*

Implement an awareness programme on the importance of biodiversity															

14: Ensure monitoring of PGB implementation

Expected Results

- The BAP is implemented adequately according to the established plan;
- The BAP communication plan is implemented adequately.

Result Indicators

- Number of activities implemented according to the established plan;
- Number of monitoring meetings organized;
- Number of field visits conducted;
- Number of implementation status reports prepared;
- Implementation status of the BAP (percentage of activities fully completed compared to planned activities).

Impact Indicators

- Quality of restored habitats;
- Numbers of indicator species (inventory data, recorded collisions);
- Level of stakeholder involvement (number of categories of actors involved in implementation and communication sessions).

Operating Procedure

- Establish a BAP implementation committee;
- Conduct participatory planning of BAP activities;
- Monitor BAP implementation (quarterly meetings, field missions);
- Implement the communication plan.

Implementation Schedule

Operations	Year 1	Year 2	Year 3	**Periods of the year**											
				J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
Ensure monitoring of BAP implementation															

15: Support the socio-economic activities of vulnerable communities located along the route

Expected Results

- The income from socio-economic activities of the local populations is strengthened.

Result Indicators

- Income generated from socio-economic activities (increase).

Impact Indicators

- Profitability of socio-economic activities;
- Level of organization of community groups (existence of legal status, functioning of governance and management mechanisms);
- Level of women's empowerment.

Operating Procedure

- Support the formalization of basic community organizations;
- Strengthen the capacities of existing organizations;
- Provide material and financial support for the development of Income Generating Activities (IGAs).

Implementation Schedule

Operations	Year 1	Year 2	Year 3	**Periods of the year**											
				J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*
Support the socio-economic activities of vulnerable communities located along the route															

Appendix 9: Report of Survey of Vegetation and Faunal Assessment

REPORT OF SURVEY OF VEGETATION AND FAUNAL ASSESSMENT

400/330KV COTE D'IVOIRE-GHANA INTERCONNECTION REINFORCEMENT PROJECT

SURVEY OF VEGETATION AND FAUNA WITHIN THE 40M BY 125KM RIGHT OF WAY (ROW)

Summary

The report presents a comprehensive biodiversity assessment conducted as part of the Environmental and Social Impact Assessment (ESIA) for the 400/330kV Cote d'Ivoire-Ghana Transmission Line reinforcement project. The project route spans 125 km from Babianiha near Dunkwa in the Central Region to Omanpe in the Western Region, traversing various land use types. The assessment focuses on documenting vegetation and fauna within a 40-meter-wide right-of-way (ROW) to evaluate the potential impact on local biodiversity. The objectives of the study were as follows:

- Document and analyze vegetation and structural characteristics along the ROW;
- Quantify flora and fauna species diversity and abundance;
- Assess direct and indirect impacts on biodiversity, especially critical habitats and endangered species;
- Propose mitigation measures to minimize biodiversity loss;
- Create a framework for ongoing monitoring.

The method used were as follow: Field Surveys were conducted across 21 sampling sites at 6 km intervals along the 125 km route, using GPS to navigate the ROW. The assessment focused on vertebrate fauna (birds, mammals, amphibians, reptiles) and vascular plants. Bird surveys were conducted in the early morning and late afternoon, using visual and auditory identification methods. Mammals were surveyed through direct and indirect sightings (e.g., tracks, nests). Herpetofauna were examined by exploring refuges like logs and water bodies. The Rapid Botanical Survey (RBS) method was used to evaluate plant diversity, and trees with a diameter of ≥10cm were counted. The IUCN Red List was applied to assess the conservation status of species.

Results of the study indicated that the ROW primarily passes through off-reserve agricultural areas, with land uses including cocoa farms, oil palm and rubber plantations, food crop farms, fallow lands, and riparian marshes. The survey identified 108 vascular plant species, including trees like *Milicia excelsa*, *Terminalia ivorensis*, and *Khaya ivorensis*. The vegetation is largely secondary and tertiary growth due to significant human activity. Fauna communities were sparse due to intensive agriculture and human presence. Bird surveys recorded 71 species, while mammals included *Maxwell's Duiker* and *Bushbuck*. The herpetofauna community was limited, consisting of 16 species. The area holds both local and global conservation significance: Most species are classified as "Least Concern" on the IUCN Red List. Exceptions include herpetofauna such as the dwarf crocodile and Gabon viper, which are vulnerable. Seven plant species are listed as globally threatened, including *Milicia excelsa* and *Nesogordonia papaverifera* (both vulnerable). Many species have rare conservation status based on Ghana's Star Rating system. The construction will involve vegetation clearance, leading to habitat fragmentation and biodiversity loss. Specific impacts include: Clearing vegetation and preventing regrowth will alter the landscape, affecting species' habitats; disturbed areas may promote the spread of invasive species like *Broussonetia papyrifera*; large mammals and reptiles are expected to be more vulnerable due to habitat disturbance and hunting pressure. Recommendations have been made to control invasive species as part of the maintenance regime; Implement erosion control in areas prone to soil erosion; engage stakeholders to prevent the spread of crop pests and diseases; Avoid routing access roads through sensitive areas like marshes.

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Introduction

As part of the Environmental and Social Impact Assessment (ESIA) for the GRIDCO High Tension Transmission Line project, a comprehensive biodiversity baseline study was conducted. This study focuses on the proposed 400/330kV Cote d'Ivoire-Ghana Transmission Line reinforcement project, which extends 125 kilometers from Babianiha near Dunkwa in the Central Region to Omanpe in the Western Region of Ghana. Given the substantial environmental and social impacts anticipated from the construction and operation of this transmission line, it is crucial to assess the potential effects on local flora and fauna within the project's corridor.

The study initially planned for two field surveys one during the dry season and one during the wet season, which includes both 'wet' and 'wetter' phases typical of Ghana's high forest zone. However, due to the expectation of minimal seasonal variation in the fauna community for this area, only one field season of data collection was conducted.

Objectives

1. To document and analyze the current vegetation types and their structural characteristics along the 40-meter wide by 125-kilometer-long transmission line corridor.
2. To identify and quantify the species diversity and abundance of both flora and fauna within the designated right of way, highlighting any significant ecological patterns.
3. To assess the potential direct and indirect impacts of the transmission line construction on local biodiversity, including effects on critical habitats and endangered species.
4. To propose effective mitigation measures to minimize adverse impacts on the identified flora and fauna and ensure the conservation of key biodiversity areas during and after construction.
5. To design a framework for ongoing monitoring of vegetation and fauna to track changes and assess the effectiveness of implemented mitigation measures.

Methodology

A biodiversity assessment was conducted along the transmission line's right-of-way, focusing on vertebrate fauna and vascular plants. The assessment covered the entire line route, with 21 sampling sites systematically selected at 6.0 km intervals, representing different topographies, land uses, and vegetation covers. The route was navigated using a KMZ shapefile on a Locus Map app, and assessments were carried out within a 40m for a distance of 3.0km at each site, with the transmission line route forming the central line.

Fauna assessment employed the transect count method, a reliable and cost-effective approach, conducted from August 21 to September 5, 2024. Observations took place from 6:00 am to 5:30 pm each day, focusing on identifying vertebrate species within the transmission line's right-of-way. Bird surveys took place from 6:00 am to 9:00 am and 3:00pm to 5:30 pm each day on species identification, through direct observation and sound, using binoculars and field guides for unfamiliar species and calls African Birds Sounds (Chappuis, 2000), whereas taxonomic order and nomenclature follow Borrow and Demey (2010).

Large mammals were surveyed using transect walks along trails, footpaths, and access routes at each site, recording both direct sightings and indirect signs such as tracks, footprints, feacal droppings and nests. These mammals play crucial ecological and socio-cultural roles, including seed dispersal and biological control, but are vulnerable in areas with high human population density. Kingdon (1997) was used as the main field to confirm the identity of species encountered and nomenclature follows same.

Herpetofauna, particularly amphibians and reptiles, were surveyed by examining refuges like rocks, fallen logs, and water bodies. Amphibians are early indicators of environmental health due to their sensitivity to pollutants. Identification followed standard references, focusing on species that are often the first to decline in degraded environments. Nomenclature followed Hughes (1988) and Leache *et al*. (2006) while reptiles followed Hoogmoed (1974) and Chippaux (1999)

Vascular plant species and vegetation cover were assessed using the Rapid Botanic Survey (RBS) method, which provides a detailed evaluation of plant diversity and

distribution within the landscape. The survey included counting trees with a diameter at breast height (dbh) of ≥ 10cm or Girth of 31.5cm, with plant taxonomy following updated nomenclature standards (Hawthorne & Jongkind, 2006).

Data Analysis

Where field data collection methods permitted, species diversity and richness were assessed for each taxon. The conservation significance of each taxon was determined using the IUCN Red List of Threatened Species, while the Ghana Wildlife Conservation Regulation was applied to evaluate the protection status of species in Ghana. All fauna species listed in Appendix I of the Wildlife Conservation Regulation are fully protected, making it illegal to hunt or capture them at any time of the year.

Checklists of recorded fauna species were created for each taxon using the most relevant taxonomic references. Bird species checklists for each plot were compiled using Borrow and Demey (2010), which also provided the avifauna taxonomy, nomenclature, and information on the conservation status, abundance, relative abundance, density and relative density of the birds recorded. The global and national conservation status of each bird species was evaluated using the 2024 IUCN Red List of Threatened Birds and Ghana's Wildlife Conservation Regulation 1971 (LI 685), with a particular focus on globally threatened, biome-restricted, and range-restricted species. All IUCN threat categories were considered in the conservation status assessment of the recorded species.

The checklist for large mammals was created using Kingdon (1997). Due to the data collection methods and the nature of the acquired data, assessments of species diversity and richness were not feasible. Data analysis concentrated primarily on evaluating the global conservation and national protection significance of the recorded species, utilizing the IUCN Red List and Wildlife Conservation Regulation 1971 (LI 685).

Checklists of recorded flora were created for each taxon using the most relevant taxonomic references (Hawthorne & Jongkind, 2006). Information on the conservation status, abundance, relative abundance, density and relative density of the flora recorded. The rarity of plant species identified in the study was assessed using Ghana's Star Rating system and the IUCN Red List.

Results and Discussions

Land Cover Types Along the Transmission Line

The transmission line traverses an off-reserve agricultural area within Ghana's high forest zone. The vegetation in this region is largely modified, consisting of secondary and tertiary succession stages of the once-lush high forest. The remaining vegetation is primarily farm bush and farmlands Along the right of way, four distinct land use types were identified: plantation agriculture, food crop farms, farm fallows, and riparian marshes.

Cocoa farms, oil palm, and rubber plantations were the primary forms of plantation agriculture observed along the transmission line. Among these, cocoa farms were the most widespread, with plantations at various stages of maturity. Oil palm and rubber plantations were common, but appearing only sporadically along the route. The farms and plantations were intermixed with characteristic tree species typical of the moist evergreen and moist semi-deciduous forest zones.

Tree species like *Milicia excelsa, Terminalia ivorensis, Khaya ivorensis, Khaya anthotica, Nauclea diderrichii, Petersianthus macrocarpus, and Nesogordonia papaverifera* were frequently found in some of the cocoa farm patches.

Riparian forest patches, characterized by typical riparian vegetation along streams and riverine areas, were among the most common habitat types along the transmission line (Figure 1). These patches seemed to represent areas of disturbed natural vegetation within the transmission line's landscape.

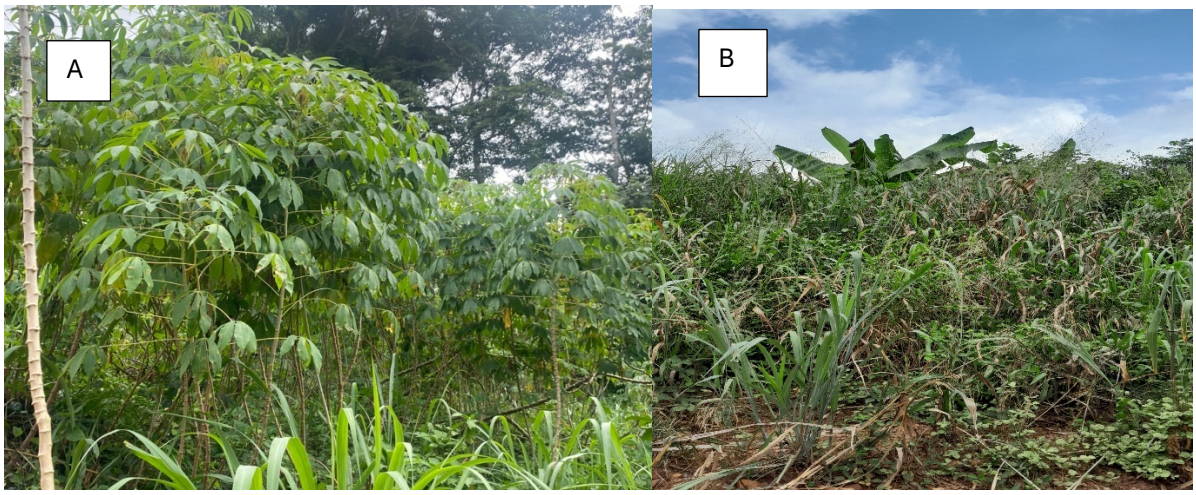
Picture of Riparian Forest

These areas are generally unsuitable for farming due to their seasonal or permanent inundation. They were found in almost all 21 sampling sites evaluated and contained characteristic flora species typical of the moist semi-deciduous and moist evergreen vegetation zones.

Food crop farms growing staples like cassava, plantains, maize, and mixed crops were a prominent and widespread land use along the transmission line. Rice fields in wet valleys were also frequently observed along the route. While food crop farms were mixed with economic crops, some areas featured extensive stretches of food crops, especially cassava, maize, and rice.

Adjacent to these food crop farms were fallow lands in various stages of regeneration. These fallow areas were not continuous but were scattered among the cultivated lands. The fallow areas were characterized by vegetation in different stages of regeneration, with species like *Chromolaena odorata, Alchornea cordifolia, Trema orientalis, Cecropia peltata, Rauvolfia vomitoria, Macaranga barteri* and *Musanga cecropioides* being prominent in the flora community.

Cocoa farms



Cassava forms(a) and fallow lands (b)

Pictures of Oil Palm plantation

Fauna Species Community in the Proposed Line Route Corridor

In heavily cultivated regions, fauna communities are typically sparse, with low species diversity and richness. This is largely due to the high human activity, intense farming practices, significant hunting pressure, and the absence of secure refuges, which make fauna, particularly large mammals, more vulnerable as they are often hunted for food. The decline of fauna communities in Ghana's off-reserve cultivated landscapes is driven by rapid deforestation and habitat degradation. Wildlife in many cultivated areas within the high forest zone is now mainly limited to small rodents, common birds, and herpetofauna associated with open habitats. This is partly due to the widespread use of inappropriate farming practices, including herbicides, weedicides, and burning.

Avifauna

Birds are among the most prevalent and easily observed fauna in most terrestrial ecosystems. A bird survey conducted along the right of way of the transmission line recorded 71 species from 26 avian families. The species identified were primarily common birds associated with cultivated areas in the high forest zone. Although the high forest zone is the most biodiversity-rich area in Ghana, the birds observed were mostly those linked to open habitats within this zone. Species diversity and richness were relatively low, likely due to the high intensity of farming and human activities across the transmission line landscape.

The bird species observed in the study were those typically found in both closed and open habitats within forest areas, reflecting the general vegetation cover at the sites. Although the sites are within Ghana's high forest zone, known for its rich diversity of flora and fauna, the intense human activity has significantly altered the vegetation. Since birds are often specific to particular habitats, changes in habitat conditions usually lead to changes in the bird community. The conservation value of the area, in terms of avifauna, was relatively low; none of the 71 bird species recorded is of conservation concern, with all being classified as "Least Concern" on the IUCN Red List of Threatened Species.

Mammals

The presence of large mammals in and around the right of way of the transmission line was minimal. The area, dominated by food and cash crop cultivation, experiences high human activity and habitat disturbance, compounded by hunting pressure, resulting in the near absence of large mammals. The mammal assessment recorded the presence of some medium mammal species indirectly such as Maxwell's Duiker (*Philantomba maxwellii*) Bay Duiker (*Cephalophus dorsalis*); Black Duiker (*Cephalophus niger*); Bushbuck (*Tragelaphus scriptus*); Brush-tailed Porcupine (*Atherurus africanus*) and few of African Palm Squirrel (*Epixerus ebii*) were observed directly. Signs were at sampling sites 2, 3, 8,12 and evidence of grass cutter (*Thryonomys swinderianus*) feeding in fallow farm areas across several sites.

Grass-cutter was the most commonly observed species and tree hyrax were heard in night hours in the project area. Droppings of civet cats and trails of brush-tailed porcupines were some of the signs of large mammals noted at certain sites. The situation with the large mammal community is typical of cultivated landscapes, where hunting pressure and human activities have greatly reduced their presence. However, a rare sighting of a bushbuck was made in a cocoa farm at transect 19. None of the large mammal species encountered in the study is of conservation concern, with all listed as "Least Concern" on the IUCN Red List of Threatened Species.

Herpetofauna

Despite the presence of some water bodies within the transmission line area, herpetofauna species were relatively scarce. The recorded herpetofauna community, consisting of snakes, lizards, and frogs, included species that are commonly found throughout Ghana's high forest zone. However, this community was notably limited, likely representing remnants of a once more diverse herpetofauna population that has been significantly reduced due to probably years of intense agricultural activities. The apparent scarcity of herpetofauna species can be attributed to the extensive use of agrochemicals, particularly herbicides, which have had a detrimental impact on fauna in the area.

The study identified 16 herpetofauna species belonging to 10 families, comprising seven amphibians and eight reptiles. Among the reptiles, there were four snakes and five lizards. The herpetofauna species observed were predominantly common species, likely the remnants of a previously thriving community that has been decimated by intense land use, adversely affecting the herpetofauna population. Details of a Check list of the herpetofauna species found in *Appendix 2*.

A picture of male Agama agama (agama lizard)

Flora

Despite Ghana's high forest zone being home to numerous permanent forest reserves, the proposed transmission line route does not intersect any of these reserves. Instead, the entire 125 km stretch traverses through off-reserve, cultivated land. The vegetation along the transmission line route has been significantly altered due to various human activities. The remaining plant communities in the right of way primarily consist of secondary and tertiary successions of the original climax flora that once dominated the area. The land use along the transmission line includes mainly food crops and cash crops, with cocoa plantations being the most prominent. Other identified land uses include food crop farms, oil palm plantations, and rubber plantations. Among these cultivated areas, there are also fallow lands left to regenerate. Riparian buffers around rivers and streams, with their distinctive plant communities, show remnants of the natural vegetation that once covered the landscape.

Throughout the transmission line's length, the multilayered canopy typical of Ghana's high forest zone has been replaced by an open, discontinuous canopy with isolated trees in cocoa plantations and various shrubs and climbers in fallow areas. The plant composition includes a mix of deciduous and evergreen species, along with species characteristic of degraded forest zones.

Flora Community Composition

A rapid botanical survey conducted at 21 sampling sites along the transmission line recorded a total of 108 vascular plant species across several families. The distribution of these species was relatively uniform among the 21 sampling sites, with many species appearing throughout but varying in frequency. Species

richness was 1,173 at the density of 18.6 tree/km site. The other plant life forms recorded included 29 species of shrubs, herbs, climbers, and lianas with abundance of 315 and density of 5.0/km.

Conservation Significance Along the Transmission Line Route

The conservation significance of an area is determined by the value of its flora and fauna. As noted earlier, the fauna community's conservation value is relatively low, with the exception of two herpetofauna species listed on the Red List of Threatened Species. All other fauna recorded are classified as Least Concern on the IUCN Red List.

In contrast, the flora community's conservation value is notable due to its high diversity. Out of the 108 recorded vascular plant species, seven (7) are listed as globally threatened on the IUCN Red list including two Near Threated and five Vulnerable as follows: *Entandrophragma angolense:* Vulnerable (VU)*; Guarea cedrata:* Vulnerable (VU)*; Milicia excelsa:* Near Threatened (NT)*; Milicia regia:* Near Threatened (NT)*; Nauclea diderrichii:* Vulnerable (VU)*; Nesogordonia papaverifera:* Vulnerable (VU)*; Terminalia ivorensis:* Vulnerable (VU). In addition to the species of global conservation concern, many of the plant species recorded within the transmission line's right of way are classified with Red, Scarlet, or Pink Star ratings, indicating their rarity. Thus, despite the significant modification of vegetation around the transmission line, there are still plant species that are rare in their occurrence and distribution within their geographic range (Appendix 3,4).

Expected Impact of the Proposed Transmission Line

The proposed transmission line project will involve clearing vegetation within the designated right-of-way, which will disrupt local ecosystems, leading to habitat fragmentation and loss for various species. The impact of this construction will vary depending on the terrain and existing land uses. For instance, significant habitat disruption is anticipated in areas with pristine forest as vegetation is removed for the construction. To maintain the right-of-way, tree removal and prevention of regrowth will create a long stretch of open land with altered vegetation structures. In agricultural regions, the use of heavy machinery may halt agricultural production.

The route for the 400/330 kV Cote d'Ivoire-Ghana transmission line primarily traverses off-reserve cultivated land. While no pristine forests are affected, the construction and operation of the power line will modify land use within the right-of-way. The 40-meter-wide right-of-way along the 125 km transmission line will undergo changes during and after construction, likely becoming unsuitable for farming due to the removal and suppression of vegetation. Consequently, one expected impact is the reduction in farming opportunities within the right-of-way.

Additionally, the construction and maintenance of the above-ground power transmission line may have potential adverse effects on wildlife, especially birds. Although the baseline assessment did not find any congregator bird species that could be disrupted by the transmission line, it is anticipated that wildlife,

particularly large mammals and reptiles, may become more vulnerable. The baseline assessment revealed limited presence of these species.

The transmission line route features intensive food and cash crop cultivation. The construction of the line could result in the formation of a long stretch of open area with altered vegetation structures, potentially facilitating the spread of invasive species such as *Broussonetia papyrifera*, which is already expanding in other parts of the high forest zone.

Moreover, constructing the transmission line close to existing lines could further create open habitats in vital cocoa production areas, possibly triggering the spread of the cocoa swollen shoot virus disease (CSSVD) in cocoa farms along the route. The construction and maintenance could also increase edge effects, potentially impacting cocoa farms and other parts of the landscape.

Expected Impact on Local Biodiversity and Species of Conservation Concern

Despite the significant conservation value of the areas along the transmission line, the construction and maintenance of the line are not expected to adversely affect local biodiversity. The transmission line area is part of a larger landscape where the fauna and flora are distributed over a broader geographic range. The species recorded have wide distributions beyond the construction area, meaning that while there will be some localized impacts during and after construction, these are not expected to affect the broader landscape's biodiversity.

Although the area includes species of global conservation concern, particularly among the flora, the expected impact will be localized and not severely affect the overall biodiversity and conservation value of the region. This is because no species of global conservation significance is endemic to this area or even to Ghana; they have broader distributions within the Upper Guinea forest biome.

Critical habitats, such as riparian vegetation in wet marshes and along streams, are not anticipated to be negatively impacted by the construction and maintenance of the above-ground transmission line for several reasons:

1. Above-Ground Construction: The transmission line will be built above ground, reducing direct physical disturbance to riparian and wetland areas. This avoids excavation and grading that could damage sensitive vegetation and soil.
2. Selective Vegetation Management: Vegetation management around transmission lines typically involves selective clearing rather than widespread deforestation, allowing critical riparian vegetation to be preserved, especially where it is crucial for ecosystem stability and water quality.
3. Buffer Zones: Buffer zones are often established around critical habitats to ensure construction and maintenance activities occur at a safe distance, protecting the integrity of riparian zones.
4. Use of Existing Routes: Construction activities are planned to use existing access routes, minimizing the creation of new paths that could disrupt riparian vegetation and limit additional intrusion by humans and machinery.

5. Environmental Management Plans: These plans usually include measures to protect sensitive areas, such as riparian zones, including erosion control, runoff management, and careful placement of transmission towers.
6. Small Footprint: The physical footprint of transmission towers is relatively small, and with careful placement, these towers can avoid critical habitats. Maintenance activities can be performed with minimal disturbance, often using techniques that do not require heavy machinery near sensitive areas.
7. Ongoing Monitoring: Continuous monitoring during and after construction can help identify and address any unforeseen impacts on riparian habitats, with adaptive management strategies allowing adjustments to mitigate negative effects.

Recommended Mitigation Measures

i. Integrate the identification and control of invasive species into the regular maintenance schedule for the transmission line.

ii. Implement erosion control measures, such as planting cover crops, in areas prone to soil erosion, especially where there are significant elevation changes.

iii. Where feasible, consider planting trees to mitigate edge effects in sensitive cocoa-growing regions.

iv. GRIDCO should collaborate with organizations such as the Department of Crop Services under the Ministry of Food and Agriculture and the Ghana Cocoa Board to prevent and manage the spread of crop pests and diseases.

v. Exercise caution when constructing the transmission line through riparian zones and marsh forests to minimize impacts on delicate habitats and ecosystems. Install culverts over streams to prevent localized flooding.

vi. Whenever possible, GRIDCO should avoid routing maintenance access roads through marsh forests and areas that are seasonally inundated along the transmission line.

Appendix 1: Checklist of avian species encountered during the survey

Common Name/Family	Scientific Name	Cons. Status	Abundance	R. Abundance	Density	R.Density
Phasianidae						
Ahanta francolin	*Pternistis ahantensis*	LC	21	1.05	0.33	1.05
Columbidae						
Tambourine Dove	*Turtur tympanistria*	LC	20	1.00	0.32	1.00
Blue-headed Wood-Dove	*Turtur brehmeri*	LC	23	1.15	0.37	1.15
African Green-Pigeon	*Treron calvus*	LC	32	1.60	0.51	1.60
Laughing Dove	*Spilopelia senegalensis*	LC	14	0.70	0.22	0.70
Musophagidae						
Yellow-billed Turaco	*Tauraco macrorhynchus*	LC	23	1.15	0.37	1.15
Cuculidae						
Black-throated Coucal	*Centropus leucogaster*	LC	6	0.30	0.10	0.30
Blue Malkoha	*Ceuthmochares aereus*	LC	14	0.70	0.22	0.70
Dideric Cuckoo	*Chrysococcyx caprius*	LC	10	0.50	0.16	0.50
African Emerald Cuckoo	*Chrysococcyx cupreus*	LC	17	0.85	0.27	0.85
Apodidae						
Black Spinetail	*Telacanthura melanopygia*	LC	48	2.40	0.76	2.40
Sabine's Spinetail	*Rhaphidura sabini*	LC	16	0.80	0.25	0.80
African Palm-Swift	*Cypsiurus parvus*	LC	42	2.10	0.67	2.10

Sarothruridae						
White-spotted Flufftail	*Sarothrura pulchra*	LC	26	1.30	0.41	1.30
Accipitridae						
Red-thighed Sparrowhawk	*Accipiter erythropus*	LC	6	0.30	0.10	0.30
Black Goshawk	*Accipiter melanoleucus*	LC	9	0.45	0.14	0.45
Bucerotidae						
African Pied Hornbill	*Lophoceros fasciatus*	LC	51	2.54	0.81	2.54
White-crested Hornbill	*Horizocerus albocristatus*	LC	17	0.85	0.27	0.85
Piping Hornbill	*Bycanistes fistulator*	LC	12	0.60	0.19	0.60
Alcedinidae						
African Dwarf Kingfisher	*Ispidina lecontei*	LC	18	0.90	0.29	0.90
Blue-breasted Kingfisher	*Halcyon malimbica*	LC	13	0.65	0.21	0.65
Meropidae			0	0.00	0.00	0.00
Little Bee-eater	*Merops pusillus*	LC	28	1.40	0.44	1.40
Coraciidae			0	0.00	0.00	0.00

Appendix 1 Continued

Common Name/Family	Scientific Name	Cons. Status	Abundance	R. Abundance	Density	R.Density
Blue-throated Roller	*Eurystomus gularis*	LC	22	1.10	0.35	1.10
Lybiidae						
Yellow-billed Barbet	*Trachyphonus purpuratus*	LC	15	0.75	0.24	0.75
Naked-faced Barbet	*Gymnobucco calvus*	LC	21	1.05	0.33	1.05

Speckled Tinkerbird	*Pogoniulus scolopaceus*	LC	12	0.60	0.19	0.60
Red-rumped Tinkerbird	*Pogoniulus atroflavus*	LC	6	0.30	0.10	0.30
Yellow-throated Tinkerbird	*Pogoniulus subsulphureus*	LC	25	1.25	0.40	1.25
Hairy-breasted Barbet	*Tricholaema hirsuta*	LC	9	0.45	0.14	0.45
Picidae						
Fire-bellied Woodpecker	*Chloropicus pyrrhogaster*	LC	12	0.60	0.19	0.60
Buff-spotted Woodpecker	*Campethera nivosa*	LC	13	0.65	0.21	0.65
Oriolidae						
Western Black-headed Oriole	*Oriolus brachyrynchus*	LC	32	1.60	0.51	1.60
Black-winged Oriole	*Oriolus nigripennis*	LC	12	0.60	0.19	0.60
Platysteiridae						
West African Wattle-eye	*Platysteira hormophora*	LC	24	1.20	0.38	1.20
Red-cheeked Wattle-eye	*Platysteira blissetti*	LC	14	0.70	0.22	0.70
Dicruridae						
Velvet-mantled Drongo	*Dicrurus modestus*	LC	9	0.45	0.14	0.45
Monarchidae						
Blue-headed Crested-Flycatcher	*Trochocercus nitens*	LC	14	0.70	0.22	0.70
Black-headed Paradise-Flycatcher	*Terpsiphone rufiventer*	LC	25	1.25	0.40	1.25
Nicatoridae						
Western Nicator	*Nicator chloris*	LC	26	1.30	0.41	1.30

Macrosphenidae						
Kemp's Longbill	*Macrosphenus kempi*	LC	13	0.65	0.21	0.65
Gray Longbill	*Macrosphenus concolor*	LC	17	0.85	0.27	0.85
Green Hylia	*Hylia prasina*	LC	19	0.95	0.30	0.95
Tit-hylia	*Pholidornis rushiae*	LC	22	1.10	0.35	1.10
Cisticolidae						
Yellow-browed Camaroptera	*Camaroptera superciliaris*	LC	18	0.90	0.29	0.90
Olive-green Camaroptera	*Camaroptera chloronota*	LC	17	0.85	0.27	0.85

Appendix 1 Continued

Common Name/Family	Scientific Name	Cons. Status	Abundance	R. Abundance	Density	R.Density
Hirundinidae						
Fanti Sawwing	*Psalidoprocne obscura*	LC	30	1.50	0.48	1.50
Pycnonotidae						
Slender-billed Greenbul	*Stelgidillas gracilirostris*	LC	11	0.55	0.17	0.55
Swamp Greenbul	*Thescelocichla leucopleura*	LC	28	1.40	0.44	1.40
Red-tailed Greenbul	*Criniger calurus*	LC	16	0.80	0.25	0.80
Gray Greenbul	*Eurillas gracilis*	LC	13	0.65	0.21	0.65
Yellow-whiskered Greenbul	*Eurillas latirostris*	LC	23	1.15	0.37	1.15
Little Greenbul	*Eurillas virens*	LC	55	2.74	0.87	2.74

Common Bulbul	*Pycnonotus barbatus*	LC	58	2.89	0.92	2.89
Pellorneidae						
Brown Illadopsis	*Illadopsis fulvescens*	LC	12	0.60	0.19	0.60
Sturnidae						
Splendid Glossy Starling	*Lamprotornis splendidus*	LC	36	1.80	0.57	1.80
Nectariniidae						
Collared Sunbird	*Hedydipna collaris*	LC	16	0.80	0.25	0.80
Blue-throated Brown Sunbird	*Cyanomitra cyanolaema*	LC	10	0.50	0.16	0.50
Olive Sunbird	*Cyanomitra olivacea*	LC	25	1.25	0.40	1.25
Buff-throated Sunbird	*Chalcomitra adelberti*	LC	13	0.65	0.21	0.65
Ploceidae						
Black-necked Weaver	*Ploceus nigricollis*	LC	32	1.60	0.51	1.60
Red-vented Malimbe	*Malimbus scutatus*	LC	20	1.00	0.32	1.00
Village Weaver	*Ploceus cucullatus*	LC	223	11.13	3.54	11.13
Viellots Weaver	*Ploceus nigerrimus*	LC	150	7.49	2.38	7.48
Blue-billed Malimbe	*Malimbus nitens*	LC	36	1.80	0.57	1.80
Red-headed Queala	*Quelea erythrops*	LC	57	2.84	0.90	2.84
Estrildidae						
Orange-cheeked Waxbill	*Estrilda melpoda*	LC	54	2.69	0.86	2.69
Black-and-White Mannikin	*Spermestes bicolor*	LC	6	0.30	0.10	0.30
African Firefinch	*Lagonosticta rubricata*	LC	49	2.45	0.78	2.45
Black-bellied Seedcracker	*Pyrenestes ostrinus*	LC	17	0.85	0.27	0.85

Bronze Mannikin	*Spermestes cucullata*	LC	106	5.29	1.68	5.29
Chestnut-breasted Nigrita	*Nigrita bicolor*	LC	27	1.35	0.43	1.35

Appendix 1 Continued

Common Name/Family	Scientific Name	Cons. Status	Abundance	R. Abundance	Density	R.Density
Gray-headed Nigrita	*Nigrita canicapillus*	LC	18	0.90	0.29	0.90
TOTAL			2004	100.00	31.81	100.00

Appendix 2: Checklist of Herpetofauna during the survey

Common Name	**Scientific Name**	**IUCN**	**Abundance**	**R. Abundance**	**Density**	**R.Density**
DICROGLOSSIDAE						
Crowned Bullfrog	Hoplobatrachus occipitalis	LC	17	10.56	0.27	10.56
HYPEROLIIDAE			0	0.00	0.00	0.00
Hallowell's sedge frog	Hyperolius concolor	LC	7	4.35	0.11	4.35
PHRYNOBATRACHIDAE			0	0.00	0.00	0.00
Ahl's river frog	Phrynobatrachus latifrons	LC	23	14.29	0.37	14.29
Boutry river frog	Phyrnobatrachus calcaratus	LC	18	11.18	0.29	11.18
Natal puddle frog	Phrynobatrachus natalensis	LC	14	8.70	0.22	8.70
BUFONIDAE			0	0.00	0.00	0.00
Common toad	Sclerophrys regularis	LC	26	16.15	0.41	16.15
REPTILES			0	0.00	0.00	0.00
AGAMIDAE			0	0.00	0.00	0.00
Agama lizard	Agama agama	LC	13	8.07	0.21	8.07
GEKKONIDAE			0	0.00	0.00	0.00
Nigeria leaf-toed gecko	Hemidactylus ansorgii	LC	5	3.11	0.08	3.11
SCINCIDAE			0	0.00	0.00	0.00
Senegal Mabuya	Trachylepis affinis	LC	10	6.21	0.16	6.21

Guinea Mabuya	Trachylepis albilabris	LC	10	6.21	0.16	6.21
VARANIDAE			0	0.00	0.00	0.00
Nile Monitor	Varanus niloticus	LC	6	3.73	0.10	3.73
Snakes			0	0.00	0.00	0.00
VIPERIDAE			0	0.00	0.00	0.00
bush viper	Atheris broadleyi	LC	1	0.62	0.02	0.62
spotted night adder	Causus maculatus	LC	4	2.48	0.06	2.48
ELAPIDAE			0	0.00	0.00	0.00
West Africa Greenv Mamba	Dendroaspis viridis	LC	3	1.86	0.05	1.86
TESTUDINIDAE			0	0.00	0.00	0.00
Forest hinged-backed tortoise	Kinixys erosa	LC	4	2.48	0.06	2.48
Total			161	100.00	2.56	100.00

Appendix 3: Checklist of tree species enumerated along the transmission line route

Name of tree	Family	Guild	Star rating	IUCN rating	Abundance	R. Abundance	Density	R. Density
Aidia genipiflora	Rubiaceae	Shade-b	gn	LC	6	0.5	0.1	0.5
Albizia adianthifolia	Fabaceae	NPLD	gn	LC	19	1.6	0.3	1.6
Albizia ferruginea	Fabaceae	NPLD	Sc	LC	18	1.5	0.3	1.5
Albizia zygia	Fabaceae	NPLD	gn	LC	21	1.8	0.3	1.8
Alchornea cordifolia	Euphorbiaceae	Pioneer	gn	LC	21	1.8	0.3	1.8
Allanblackia parviflora	Clusiaceae	NPLD	Pk	LC	3	0.3	0.0	0.3
Alstonia boonei	Apocynaceae	Pioneer	gn	LC	21	1.8	0.3	1.8
Amphimas pterocarpoides	Fabaceae	NPLD	gn	LC	13	1.1	0.2	1.1
Anthocleista nobilis	Loganiaceae	Pioneer	gn	LC	9	0.8	0.1	0.8
Anthocleista vogelii	Loganiaceae	Pioneer	gn	LC	9	0.8	0.1	0.8
Antiaris toxicaria	Moraceae	NPLD	gn	LC	14	1.2	0.2	1.2
Artocarpus altilis	Moraceae	Exotic		LC	7	0.6	0.1	0.6
Bambusa vulgaris	Apocynaceae	Swamp	gn	LC	12	1.0	0.2	1.0
Baphia nitida	Fabaceae	Shade-b	gn	LC	19	1.6	0.3	1.6
Baphia pubecens	Fabaceae	Pioneer	gn	LC	13	1.1	0.2	1.1
Blighia sapida	Sapindaceae	NPLD	gn	LC	10	0.9	0.2	0.9
Blighia welwitschii	Sapindaceae	NPLD	gn	LC	6	0.5	0.1	0.5

Bombax buonoposenze	Bombacaceae	Pioneer	gn	LC	10	0.9	0.2	0.9
Bridelia grandis	Euphorbiaceae	Pioneer	gn	LC	9	0.8	0.1	0.8
Canarium schweinfurthii	burseraceae	Pioneer	Pk	LC	7	0.6	0.1	0.6
Carapa procera	Meliaceae	Shade-b	gn	LC	9	0.8	0.1	0.8
Carpolobia lutea	Polygalaceae	Shade-b	gn	LC	6	0.5	0.1	0.5
Cedrela odorata	Meliaceae	Exotic		LC	6	0.5	0.1	0.5
Ceiba pentandra	Bombacaceae	Pioneer	gn	LC	21	1.8	0.3	1.8
Celtis mildbraedii	Ulmaceae	Shade-b	gn	LC	13	1.1	0.2	1.1
Celtis zenkeri	Ulmaceae	NPLD	gn	LC	11	0.9	0.2	0.9
Chassalia kolly	Rubiaceae	Pioneer	gn	LC	12	1.0	0.2	1.0

Appendix 3 Continued

Scientific Name	Family	Guild	Star rating	IUCN Redlist	Abundance	R. Abundance	Density	R. Density
Cleistopholis patens	Annonaceae	Pioneer	gn	LC	4	0.3	0.1	0.3
Cola gigantea	Sterculiaceae	NPLD	gn	LC	8	0.7	0.1	0.7
Cola millenii	Sterculiaceae	NPLD	gn	LC	7	0.6	0.1	0.6
Cola nitida	Sterculiaceae	Shade-b	Pk	LC	6	0.5	0.1	0.5
Cordia platythyrsa	Boraginaceae	Pioneer	gn	LC	4	0.3	0.1	0.3
Daniella ogea	Fabaceae	Pioneer	Pk	LC	14	1.2	0.2	1.2
Dialium dinklaigei	Fabaceae	NPLD	gn	LC	13	1.1	0.2	1.1
Diospyros heudelotii	Ebenaceae	Shade-b	bu	LC	7	0.6	0.1	0.6
Distemonanthus benthamianus	Fabaceae	NPLD	Pk	LC	6	0.5	0.1	0.5
Dracaena arborea	Agavaceae	Pioneer	gn	LC	3	0.3	0.0	0.3
Dracaena fragrans	Agavaceae	Shade-b	gn	LC	8	0.7	0.1	0.7
Drypetes afzelii	Euphorbiaceae	Shade-b	gn	LC	4	0.3	0.1	0.3
Drypetes principum	Euphorbiaceae	Shade-b	gn	LC	5	0.4	0.1	0.4
Elaies guineensis	Arecaceae	Pioneer	Pk	LC	21	1.8	0.3	1.8
Entandropragma angolense	Meliaceae	NPLD	R	VU	9	0.8	0.1	0.8
Ficus exasperata	Moraceae	Pioneer	gn	LC	21	1.8	0.3	1.8
Ficus ottonifolia	Moraceae	Strangler	gn	LC	6	0.5	0.1	0.5
Ficus sur	Moraceae	Pioneer	gn	LC	7	0.6	0.1	0.6
Ficus thonningii	Moraceae	Pioneer	gn	LC	3	0.3	0.0	0.3
Funtumia africana	Apocynaceae	Pioneer	gn	LC	17	1.4	0.3	1.4
Funtumia elastica	Apocynaceae	NPLD	Pk	LC	14	1.2	0.2	1.2
Glyphaea brevis	Sterculiaceae	Pioneer	gn	LC	1	0.1	0.0	0.1
Grewia mollis	Malvaceae	Pioneer	gn	LC	15	1.3	0.2	1.3
Guarea cedrata	Meliaceae	NPLD	R	VU	5	0.4	0.1	0.4
Hallea ledermannii	Rubiaceae	NPLD	R	LC	9	0.8	0.1	0.8

Hannoa klaineana	Simaroubacea e	Pioneer	gn	LC	9	0.8	0.1	0.8
Harunguna madagascariensis	Guttiferae	Pioneer	gn	LC	10	0.9	0.2	0.9
Hollarhena floribunda	Apocynaceae	Pioneer	gn	LC	10	0.9	0.2	0.9
Khaya grandifoliola	Meliaceae	NPLD	R	LC	5	0.4	0.1	0.4
Khaya ivorensis	Meliaceae	NPLD	Sc	LC	6	0.5	0.1	0.5
Lantana camara	Verbenaceae	Pioneer	gn	LC	11	0.9	0.2	0.9

Appendix 3 Continued

Common Name/Family	Scientific Name	Guild	Cons. Status	IUCN Redlist	Abunda nce	R. Abundance	Density	R.Density
Maesopsis eminii	Rhamnaceae	Pioneer	gn	LC	7	0.6	0.1	0.6
Margaritaria discoidea	Euphorbiaceae	Pioneer	gn	LC	12	1.0	0.2	1.0
Microdesmis puberula	Pandaceae	Shade-b	gn	LC	10	0.9	0.2	0.9
Milicia excelsa	Moraceae	Pioneer	Sc	NT	20	1.7	0.3	1.7
Milicia regia	Moraceae	Pioneer	Sc	NT	9	0.8	0.1	0.8
Monodora myristica	Annonaceae	Shade-b	gn	LC	9	0.8	0.1	0.8
Morinda lucida	Rubiaceae	Pioneer	gn	LC	21	1.8	0.3	1.8
Morus mesozygia	Moraceae	Pioneer	gn	LC	5	0.4	0.1	0.4
Musanga cecropiodes	Moraceae	Pioneer	gn	LC	12	1.0	0.2	1.0
Myrianthus arboreus	Moraceae	Shade-b	gn	LC	16	1.4	0.3	1.4
Myrianthus libericus	Moraceae	Shade-b	gn	LC	9	0.8	0.1	0.8
Nauclea diderrichii	Rubiaceae	Pioneer	sc	NT	6	0.5	0.1	0.5
Nesogordonia papaverifera	Sterculiaceae	Shade-b	Pk	VU	10	0.9	0.2	0.9
Newbouldia laevis	Bignoniaceae	Pioneer	gn	LC	21	1.8	0.3	1.8
Panicum maximum	Poaceae	Pioneer	gn	LC	11	0.9	0.2	0.9
Pentaclethra macrophylla	Fabaceae	NPLD	gn	LC	16	1.4	0.3	1.4
Persea americana	Lauraceae	Exotic		LC	4	0.3	0.1	0.3
Petersianthus macrocarpa	Lecythidaceae	Pioneer	gn	LC	10	0.9	0.2	0.9

Phyllocosmus africanus	Ixonanthaceae	NPLD	gn	LC	5	0.4	0.1	0.4
Piptadeniastrum africanum	Fabaceae	NPLD	Pk	LC	9	0.8	0.1	0.8
Psydrax subscordata	Rubiaceae	NPLD	gn	LC	12	1.0	0.2	1.0
Pterygota macropcarpa	Sterculiaceae	NPLD	R	LC	7	0.6	0.1	0.6
Pycnanthus angolensis	Myristicaceae	NPLD	Pk	LC	18	1.5	0.3	1.5
Raphia palma-pinus	Raphia Palm	NPLD	Gold	LC	21	1.8	0.3	1.8
Rauvolfia vomitoria	Apocynaceae	Pioneer	gn	LC	14	1.2	0.2	1.2
Rhaphia hookeri	Arecaceae	Swamp	gn	LC	11	0.9	0.2	0.9
Ricinodendron heudelotii	Euphorbiaceae	Pioneer	gn	LC	14	1.2	0.2	1.2

Appendix 3 Continued

Scientific Name	Family	Habit	Star Rating	IUCN Redlist	Abundance	R. Abundance	Density	R.Density
Rothmania hispida	Rubiaceae	Shade-b	gn	LC	7	0.6	0.1	0.6
Scottellia klaineana	Flacourtiaceae	Shade-b	Pk	LC	6	0.5	0.1	0.5
Solanum erianthum	Solanaceae	Pioneer	gn	LC	15	1.3	0.2	1.3
Solanum torvum	Solanaceae	Pioneer	gn	LC	9	0.8	0.1	0.8
Spathodea campanulata	Bignoniaceae	Pioneer	gn	LC	18	1.5	0.3	1.5
Spondias mombin	Anacardiaceae	Exotic		LC	7	0.6	0.1	0.6
Sterculia rhinopetala	Sterculiaceae	NPLD	Pk	LC	8	0.7	0.1	0.7
Sterculia tragacantha	Sterculiaceae	Pioneer	gn	LC	19	1.6	0.3	1.6
Strombosia glaucescens	Olacaceae	Shade-b	gn	LC	8	0.7	0.1	0.7
Terminalia ivorensis	Combretaceae	Pioneer	Sc	VU	18	1.5	0.3	1.5
Terminalia superba	Combretaceae	Pioneer	Pk	LC	21	1.8	0.3	1.8
Tetrapleura tetraptera	Fabaceae	Pioneer	gn	LC	11	0.9	0.2	0.9

Tetrochidium didymostemon	Euphorbiaceae	Pioneer	gn	LC	12	1.0	0.2	1.0
Trema orrientalis	Ulmaceae	Pioneer	gn	LC	13	1.1	0.2	1.1
Trichilia monadelpha	Meliaceae	NPLD	gn	LC	19	1.6	0.3	1.6
Trichilia preureana	Meliaceae	NPLD	gn	LC	7	0.6	0.1	0.6
Trichilia tessmannii	Meliaceae	NPLD	gn	LC	6	0.5	0.1	0.5
Trilepesium madagascariense	Moraceae	NPLD	gn	LC	1	0.1	0.0	0.1
Triplochiton scleroxylon	Sterculiaceae	Pioneer	Sc	LC	17	1.4	0.3	1.4
Voacanga africana	Apocynaceae	Pioneer	gn	LC	8	0.7	0.1	0.7
Xylia evansii	Fabaceae	NPLD	bu	LC	7	0.6	0.1	0.6
Xylopia aethiopica	Annonaceae	Swamp	bu	LC	12	1.0	0.2	1.0
Zanthoxylon gilletii	Rutaceae	Pioneer	gn	LC	12	1.0	0.2	1.0
Total					1173	100.0	18.6	100.0

Appendix 4: Checklist of climbers, shrubs and herbaceous plants enumerated along the transmission line route

Species Name	FAMILY	Habit	Guild	Star rating	Abundance	R. Abundance	Density	R. Density
Acacia kamerunensis	Fabaceae	Cl	NPLD	gn	21	6.7	0.3	6.7
Anchomanes difformis	Araceae	Hb	Shade-b	gn	7	2.2	0.1	2.2
Ataenidia conferta	Marantaceae	Hb	Shade-b	gn	7	2.2	0.1	2.2
Baissea zygodoides	Apocynaceae	Cl	Shade-b	bu	7	2.2	0.1	2.2
Chromolaena odorata	Asteraceae	Hb	Pioneer	gn	19	6.0	0.3	6.0
Cnestis ferrugimea	Connaraceae	Cl	Pioneer	gn	11	3.5	0.2	3.5
Costus afer	Zingiberaceae	Hb	Pioneer	gn	9	2.9	0.1	2.9
Costus dubils	Zingiberaceae	Hb	Pioneer	gn	10	3.2	0.2	3.2
Culcasia angolensis	Araceae	Cr	NPLD	gn	6	1.9	0.1	1.9
Culcasia scandens	Araceae	Cr	Shade-b	gn	7	2.2	0.1	2.2
Culcasia striolata	Araceae	Cr	Shade-b	gn	10	3.2	0.2	3.2
Dalbergia saxatilis	Fabaceae	Cl	NPLD	gn	7	2.2	0.1	2.2
Dioscorea bulbifera	Dioscoreaceae	Cl	NPLD	Pk	9	2.9	0.1	2.9
Flagellaria guineensis	Flagellariaceae	Cl	Pioneer	gn	10	3.2	0.2	3.2

Griffonia simplicifolia	Fabaceae	Cl	NPLD	gn	21	6.7	0.3	6.7
Mimosa pudica	Fabaceae	Cl	Pioneer	gn	19	6.0	0.3	6.0
Morinda morindoides	Rubiaceae	Cl	Pioneer	gn	14	4.4	0.2	4.4
Olyra latifolia	Poaceae	CR	Shade-b	gn	10	3.2	0.2	3.2
Palisota hirsuta	Commelinaceae	Hb	Pioneer	gn	11	3.5	0.2	3.5
Parquetina nigrescens	Phytolaccaceae	Cl	Pioneer	gn	9	2.9	0.1	2.9
Paullinia pinnata	Sapindaceae	Cl	Pioneer	gn	19	6.0	0.3	6.0
Piper guineense	Piperaceae	Cl	Shade-b	Pk	15	4.8	0.2	4.8
Sida acuta	Malvaceae	Hb	Pioneer	gn	9	2.9	0.1	2.9
Smilax krausiana	Smilaceae	Cl	Pioneer	gn	12	3.8	0.2	3.8
Stachytapheta cayennensis	Verbenaceae	Hb	Pioneer	gn	5	1.6	0.1	1.6

Appendix 4 Continued

Common Name/Family	Scientific Name	Habit	Guild	Star rating	Abundance	R. Abundance	Density	R. Density
Strophanthus hispidus	Apocynaceae	L	Pioneer	Pk	7	2.2	0.1	2.2
Tetracera alnifolia	Dilleniaceae	L		gn	9	2.9	0.1	2.9
Thaumatococcus danielii	Marantaceae	Hb	Pioneer	R	10	3.2	0.2	3.2
Zornia glochidiata	Fabaceae	Hb	Pioneer	gn	5	1.6	0.1	1.6
Total					315	100.0	5.0	100.0