FEASIBILITY ASSESSMENT FOR THE ESTABLISHMENT OF BOTANICAL GARDEN AT THE UNIVERSITY OF LIBERIA FENDELL CAMPUS

CNC-L
CHAMPIONS FOR NATURE CONSERVATION LIBERIA

FEASIBILITY ASSESSMENT FOR THE ESTABLISHMENT OF BOTANICAL GARDEN AT THE UNIVERSITY OF LIBERIA FENDELL CAMPUS

THE REPORT

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REPORT PREPARED FOR THE
UNIVERSITY OF LIBERIA AND
THE ENVIRONMENTAL
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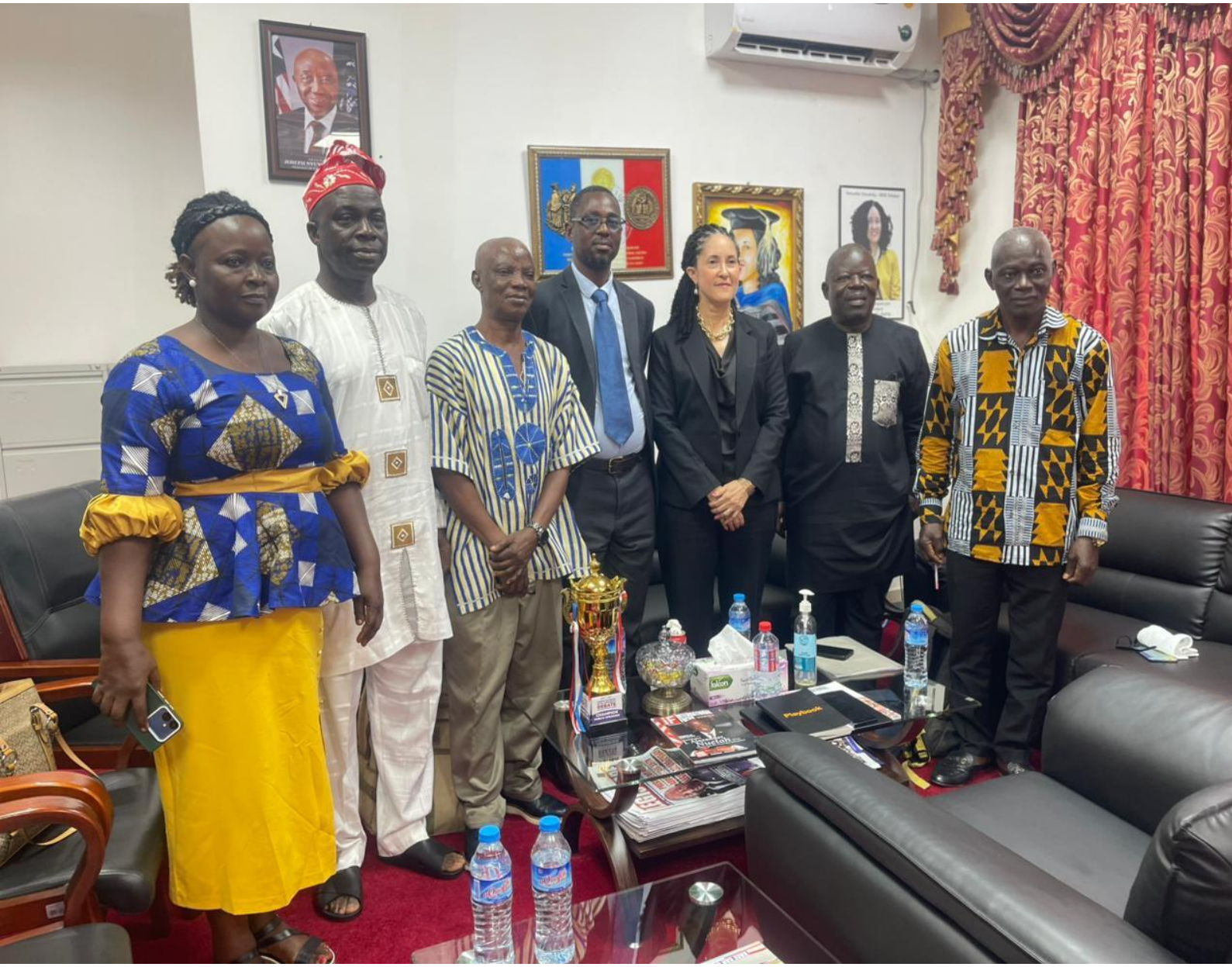

Members of the faculty of the William Richard Tolbert College of Agriculture and Forestry along with Executives of CNCL meet with the President of the University of Liberia /November 2025/ UL Campus Fendell- photo credit A. Zean CNCL CEO

List of Acronyms and Abbreviations

BGCI: Botanic Gardens Conservation International
BioNet: Biodiversity Network
CAPEX: Capital Expenditure
CI: Conservation International
CNC-Liberia / CNCL: Champions for Nature Conservation Liberia
DEM: Digital Elevation Model
E&E: Environment and Energy
EPA: Environmental Protection Agency of Liberia
ESIA: Environmental and Social Impact Assessment
ESMP: Environmental and Social Management Plan
FAO: Food and Agriculture Organization of the United Nations
FDA: Forestry Development Authority of Liberia
FFI / FF: Fauna & Flora International
GEF: Global Environment Facility
GPS: Global Positioning System
IUCN: International Union for Conservation of Nature
LC: Least Concern (IUCN Red List status)
NBSAP: National Biodiversity Strategy and Action Plan
NDC: Nationally Determined Contributions
PV: Photovoltaic
SCC: Species of Conservation Concern
SDG: Sustainable Development Goal (United Nations)
TMP: Traditional Medicinal Plant
UL: University of Liberia
UNDP: United Nations Development Programme

Glossary of Key Terms

Alluvial Soils: Soils deposited by running water, typically rich in silt, sand, and clay, found within floodplains and low-lying river beds.
Anthropogenic: Environmental changes, pressures, or degradations caused directly or indirectly by human activity.
Arboretum: A botanical collection composed exclusively of living trees, shrubs, and woody vines cultivated for scientific research and education.
Argillic Horizon: A subsurface soil layer characterized by a significant accumulation of silicate clays, typical of highly weathered soils like Ultisols.
Avifauna: The collective bird species inhabiting a specific geographic region or habitat zone.
Biodiversity Net (BioNet): A systemic mapping and modeling tool used to identify and select habitats crucial for conserving key species and ecological corridors.
Biophysical: Relating to the combined biological and physical characteristics of an environment (e.g., vegetation, climate, and soil geology).
Botanical Garden: A controlled institution holding documented collections of living plants for the purposes of scientific research, conservation, display, and education.
Canopy Cover: The layer of leaves and branches formed by individual tree crowns, acting as a protective ceiling over an ecosystem.
Carbon Sequestration: The long-term capture and storage of atmospheric carbon dioxide in vegetation, soils, and geologic formations to mitigate climate change.
Concretion: A hard, compact mass of mineral matter (typically iron and aluminum oxides in tropical contexts) formed by precipitation within a soil layer.
Cryptic Species: Wildlife species that are visually hidden, camouflaged, or inherently elusive, making them difficult to detect without specialized equipment like mist nets.
Ecotourism: Environmentally responsible travel to natural areas that promotes conservation, sustains the well-being of local communities, and incorporates environmental education.
Edge Effects: The changes in population or community structures that occur at the boundary of two or more distinct habitats, often introducing stress or invasive species.
Endemic: A native plant or animal species restricted to a specific, defined geographical area (e.g., a species unique to the Upper Guinean Forest).
Ex-Situ Conservation: The preservation of components of biological diversity outside their natural habitats (e.g., seed banks, botanical gardens, or wildlife sanctuaries).
Flora: The collective plant life occurring in a particular geographic region or geological period.
Floristic Composition: The specific variety, abundance, and taxonomic identity of plant species that make up a given vegetative community.
Gleisols: Hydromorphic soils found in wetland areas, characterized by prolonged waterlogging which restricts oxygen and leads to a distinctive grayish color matrix.
Geomorphological: Pertaining to the physical features, structures, and evolution of the Earth's surface terrain.
Germplasm Conservation: The collection and long-term preservation of plant genetic materials (such as seeds, pollen, or tissue cultures) to protect genetic diversity.
Ground-Truthing: The collection of direct, firsthand empirical data on-site to verify and validate remote sensing models or satellite imaging patterns.
In-Situ Conservation: The preservation of ecosystems and natural habitats, and the maintenance of viable populations of species in their natural surroundings.
Laterization: A tropical soil weathering process where heavy rainfall leaches away silica, leaving behind subsoils heavily enriched with iron and aluminum oxides (laterites).
Living Laboratory: An interactive, real-world field site utilized for hands-on academic training, ecological experiments, and longitudinal environmental research.
Monoculture: The exclusive cultivation or dominance of a single crop or plant species over a large geographical area, often reducing local biodiversity.
Naturopathic: Relating to a system of therapeutics focused on natural, plant-based remedies and traditional healthcare practices.

Net-Hour: A standard metric used in ornithology to measure sampling effort; calculated by multiplying the total number of mist nets deployed by the number of hours they remain active.
Ornithological: Pertaining to the scientific study of birds, including their behaviors, habitats, and regional population dynamics.
Perennial: Watercourses, streams, or springs that maintain a continuous, uninterrupted flow of surface water throughout the entire calendar year.
Phanerozoic: The current geologic eon, spanning from roughly 541 million years ago to the present, during which abundant animal and plant life has existed.
Plinthite: An iron-rich, clay-like mineral mixture common in tropical soils that hardens irreversibly into ironstone concretions when repeatedly exposed to wetting and drying cycles.
Reconnaissance (Recce): A standardized, low-impact field survey method executed along straight line paths to rapidly collect baseline biodiversity indicators and animal signs.
Riparian: Relating to or situated on the banks of a river, stream, or any other natural freshwater course.
Seed Banking: The systematic collection, dehydration, and low-temperature storage of seeds to preserve plant genetic resources against extinction risks.
Siltation: The accumulation of fine sand, mud, or earthy sediment in watersheds, typically caused by soil erosion from adjacent cleared land.
Species of Conservation Concern (SCC): Wild flora or fauna species classified as threatened, endangered, or vulnerable under national laws or international standard matrices like the IUCN Red List.
Succession: The gradual and predictable process by which ecosystems change, develop, or degrade over time following a physical disturbance.
Taxonomy: The branch of science concerned with the classification, naming, and systematic ordering of living organisms based on shared characteristics.
Topography: The detailed graphic configuration or physical arrangement of natural and artificial features defining a land landscape.
Transect: A designated path or linear line across an ecosystem along which a researcher systematically counts, tracks, and maps specific biological phenomena.
Ultisols: Highly weathered, acidic tropical soils featuring an accumulation of subsurface clay and low natural fertility, common in humid forest environments.
Urbanization: The developmental process through which rural areas transform into urban centers, marked by infrastructural expansion and shifting population densities.
Viability: The capacity of an economic, social, or environmental initiative to maintain long-term functional success, technical execution, and independent operational security.
Wetlands: Swamps, marshes, or saturated land areas where soils are regularly covered by shallow water, driving specialized aquatic plant and animal habitats.
Zonation: The strategic demarcation of a landscape into distinct management areas or sectors based on ecological sensitivity and permitted human activity profiles.

Table of Contents

List of Figures

List of Tables

FOREWARD

The University of Liberia (UL) and the Environmental Protection Agency (EPA) extend their profound gratitude to all stakeholders, interviewees, and consultation participants whose insights and engagement made the publication of this report possible.

Special recognition is due to the following leadership figures for their strategic guidance and unwavering institutional support throughout this process: The Vice President for Institutional Development (University of Liberia) and her administrative team. The Project Focal Person to the President of the University of Liberia. The Dean, Chairman and Associate Dean William Richard Tolbert College of Agriculture and Forestry and the Department of General Forestry (University of Liberia). The completion of this feasibility study relies heavily on the specialized expertise provided by the core technical team. Distinct appreciation is extended to: The Executive Director and National Consultants of CNCL, alongside the dedicated student body of the University of Liberia, for their rigorous efforts in data compilation and report drafting.

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I gratefully acknowledge the operational, technical, and collaborative assistance provided by academic and conservation networks: UNDP Liberia and local conservation institutions for their technical guidance, Partner Universities for providing critical operational support.

Finally, the University of Liberia and its partners express their deepest gratitude to the Environmental Protection Agency (EPA) and the United Nations Development Programme (UNDP) for providing the essential financial funding required to execute this project.

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Dr. Layli Maparyan
President
University of Liberia

EXECUTIVE SUMMARY

Executive Summary: Feasibility Study for the Establishment of a Botanical Garden at the University of Liberia, Fendell Campus

This final draft presents the feasibility study conducted by Champions for Nature Conservation (CNC-Liberia) to assess the viability of establishing a Botanical Garden at the University of Liberia (UL) Fendell Campus. The initiative is strategically designed to advance biodiversity conservation, environmental education, academic research, and ecotourism. Concurrently, it aims to enhance the university's capacity for nature-based learning and reinforce its position in sustainability leadership within Liberia.

Scope of the Assessment

The study evaluated the technical, environmental, social, and financial feasibility of the proposed development. The scope of the assessment encompassed:

1. Detailed site analysis and environmental surveys.
2. Structured stakeholder consultations and community engagement.
3. Infrastructure requirement mapping and institutional governance design.
4. Development of a conceptual master plan, inclusive of two- and three-dimensional (2D and 3D) architectural visualizations.

Of the 5,800 acres of legally deeded university land in the Fendell area, the assessment evaluated four primary blocks (Blocks A, B, C, and D) totaling 605 hectares (1,494 acres). This land is currently allocated to the College of Agriculture and Forestry, alongside the specific botanical plot designated by the Institutional Development division and adjacent areas.

Strategic Objectives of the Botanical Garden

Biophysical and socio-environmental findings indicate that the Fendell Campus possess highly favorable conditions for this initiative, featuring ample land area, diverse native vegetation, and close proximity to both academic institutions and urban centers. The proposed facility is designed to serve a quad-centric purpose:

a. **Living Laboratory**: A dedicated space for academic research and experiential learning in botany, ecology, and environmental science.
b. **Conservation Hub**: A sanctuary for the protection and ex-situ propagation of Liberia's rich flora, with an emphasis on endemic and threatened species.
c. **Public Engagement Space**: A recreational and educational facility to foster environmental stewardship among students, local communities, and visitors.
d. **Sustainable Livelihoods**: A center for sustainable economic activities, including seed banking, germplasm conservation, medicinal plant cultivation, and ecotourism.

Site Selection and Zonation Dynamics

Based on initial technical, botanical, faunal, social, and financial evaluations, Block A and a portion of Block B—encompassing a total area of 280.54 hectares (693.22 acres)—were originally selected for development. This initial site selection was justified by several optimal parameters:

1. **Topographical Variety**: A diverse landscape featuring hills, level plains, gentle slopes, and natural watercourses.
2. **Ecological Diversity**: Rich native biodiversity, including 185 documented plant species across 119 genera and 44 families, alongside 40 recorded bird species categorized as "Least Concern" under the IUCN Red List.
3. **Cost Efficiency**: Intact topsoil structures and minimal soil disturbance, significantly reducing initial land preparation and soil-borrowing costs.
4. **Social Feasibility**: Initial assessments indicated an absence of land tenure disputes and strong positive reception from neighboring communities.

Re-evaluation and Final Spatial Allocation

During a subsequent field verification site visit—which included the President of the University of Liberia—critical shifts in environmental and social conditions were observed in the primary target areas. The site verification revealed high levels of recent soil and vegetation disturbance, alongside escalating land tenure disputes and community hostility.

Consequently, the University President directed that development on Blocks A and B be suspended until these socio-legal conflicts are formally resolved. Following a critical secondary assessment of alternative plots, the study recommends **73.5 hectares within Blocks C and D** for the immediate establishment of the botanical garden.

Implementation, Governance, and Frameworks

The study outlines a phased development strategy spanning a five-year period. Initial operations will prioritize site boundary fencing, land preparation, and the construction of core infrastructure (such as a nursery, visitor center, and educational trail networks) before scaling up to specialized plant collections and advanced research units.

To ensure robust institutional management, consultations were held with key stakeholders, including the United Nations Development Programme (UNDP), the Forestry Development Authority (FDA), the UL President, and the Department of General Forestry. The consensus supports a **semi-autonomous governance structure**. Under this framework, strategic decision-making will be overseen by a Botanical Garden Technical/Advisory Committee comprised of key institutional partners, including:

i. Forestry Development Authority (FDA)
ii. Environmental Protection Agency (EPA)
iii. Conservation International (CI)
iv. Fauna & Flora International (FFI)
v. Food and Agriculture Organization (FAO)
vi. Botanic Gardens Conservation International (BGCI)

Conclusion

The feasibility study confirms that establishing a botanical garden at the University of Liberia Fendell Campus is highly viable and carries profound national significance. This project provides a clear operational roadmap to transform the Fendell Campus into a national center of excellence for botanical research, aligning directly with Liberia's national strategic priorities regarding climate resilience, the green economy, and ecosystem restoration

NATIONAL LEGISLATION AND REGULATIONS GOVERNING THIS REPORT

This is a 'Consultancy report' and is compiled in terms of the National Environmental Protection and Management Laws, 2002 and adopted in 2003 (section 3), to mean the Ecosystem and Environmental management.

THE CONSULTANCY

CHAMPIONS FOR NATURE CONSERVATION LIBERIA was awarded this consultancy # EPA/E&E/CON/ICS/003/2025 on August 26, 2025 to provide specialist botanical consulting services to conduct Feasibility Study and Assessed the suitability and viability of the establishment of the Botanical Garden at the UL Fendell Campus.

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CONDITIONS RELATING TO THIS REPORT

The content of this report is based on the consultant's best scientific and professional t e a m knowledge as well as available information from the communities and the university of Liberia. Champions for Nature Conservation Liberia (CSO) in consultation with the EPA and the UL reserves the right to modify the report in any way deemed fit should new, relevant or previously unavailable or undisclosed information become known to the team from on- going research or further work in this field, or pertaining to this Assessment.

CNCL request that this report must not be altered or added to without the prior written consent of the CNCL now or in the future. This also refers to electronic copies of the report which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must make reference to this report. If these action or notes form part of a main report relating to this Assessment or report, this report must be included in its entirety as an appendix or separate section to the main report.

1. INTRODUCTION

1.0 Project Rationale and Institutional Imperative

The Fendell Campus of the University of Liberia (UL) encompasses a vast **5,800-acre land area** that possesses profound ecological and educational potential. In the wake of accelerating urbanization and deforestation across Greater Monrovia and its environs, there is a critical, documented deficit of urban green spaces. This rapid environmental transformation underscores an urgent need to conserve indigenous, threatened, and rare plant species. As Liberia's premier state-run institution of higher learning, the University of Liberia is uniquely positioned—and institutionally obligated—to spearhead the establishment of a botanical garden. This initiative will serve as a multifaceted platform to advance:

- **Academic Excellence**: Providing living laboratories for advanced undergraduate and graduate teaching, scientific research, and field-based experiments.
- **Environmental Stewardship**: Catalyzing community outreach, regional biodiversity preservation, and climate change adaptation frameworks.
- **Economic Sustainability**: Enhancing resource mobilization by driving ecotourism and generating independent institutional revenue.

Scope and Objectives of the Feasibility Study

This study evaluates the technical, environmental, financial, social, and institutional parameters determining the long-term viability and operational sustainability of the proposed botanical garden. Beyond its immediate scientific and recreational functions, the project honors and highlights the historical legacy of the University of Liberia, which has historically driven agricultural research and cultural preservation in the region.

This research initiative was successfully executed with the strategic administrative and technical support of:

1. **The Department of General Forestry** (UL)
2. **The Office of the Vice President for Institutional Development** (UL)
3. **The Special Representative of the President of the University of Liberia**
4.

1.1 History of the Project

Global Context and Functional Role of Botanical Gardens

Globally, botanical gardens serve as vital institutional centers for botanical resource management, scientific inquiry, ex-situ biodiversity conservation, and public environmental education. By functioning as specialized repositories, these institutions actively support national and regional frameworks aimed at conserving economically vital and threatened plant genetic resources. Furthermore, they bridge the gap between scientific communities and the public, elevating collective awareness regarding the indispensability of flora to global ecosystem stability and future planetary health.

Administrative Genesis and Contractual Framework

The formal operationalization of this project began on **August 26, 2025**, when the Environmental Protection Agency (EPA) of Liberia executed a formal contract (**Contract No. EPA/E&E/CON/ICS/003/2025**) with Champions for Nature Conservation Liberia (CNCL). Under this contractual agreement, CNCL was commissioned to conduct a comprehensive feasibility study to evaluate the ecological suitability and operational viability of establishing a botanical garden on the UL Campus.

2. TERMS OF REFERENCE

2.1 Name of the Project

University of Liberia Botanical Garden (Feasibility Study and detailed costed designed of the Botanical Garden in Fendell, University of Liberia [UL] Campus

2.2 Mission Statement for the Project

The mission of the Botanical Garden is to provide a place where people can enjoy and interact with nature, where the community at large can be educated about xeric plants and the environment in which they live, be a model for conservation and finally where endangered plant species can be propagated and returned to their natural habitats.

- Offer a diverse population of plants from all over the world, arranged by region so as to provide a more accurate representation of those environments
- Provide excellent education programs for all levels of interest (beginner to advanced) students and researchers, as well as state of the art propagation facilities
- Serve as an example of conservation to the surrounding communities by taking advantage of available "green" technologies both new and old (e.g. — solar power, rain water harvesting, etc)
- Add to the cultural distinction of the UL FENDELL Landscape

2.3 General. Objectives

- Conduct an in-depth feasibility study to determine the viability of establishing a botanical garden at the UL Fendell campus, taking into consideration the environmental conditions, institutional capacity, visitors, and financial viability assessment.
- Review successful botanical gardens in similar contexts (e.g., university-affiliated, tropical regions) to draw lessons learned and best practices.
- Based on the feasibility study, in collaboration with UL Forestry Department and other stakeholders, identify and evaluate specific sites at the UL Fendell campus that are most suitable for the botanical garden.
- Define site selection criteria (e.g., size, topography, existing vegetation, accessibility, water availability, future expansion potential).
- Conducting preliminary site visits and assessments of identified sites.
- Select the most suitable site.
- Undertake a detailed survey of the selected site to capture its precise topographical features, hydrological patterns, existing flora and fauna, and significant natural elements.

- Establish survey benchmarks and a clear demarcation of the selected site boundaries. -(Fig 1)
- Identify and map existing natural features, significant trees, ecotourism attractions, forest patches, wetlands, water bodies, and any existing infrastructure. (Table 1.)
- Utilizing survey data, develop accurate digital base maps of the selected site. These maps will serve as the foundation for all subsequent design work.
- Based on the feasibility study findings, site analysis, and UL's vision, develop a comprehensive conceptual master plan. This plan will articulate the overall layout, themed garden areas (e.g., medicinal plants, native flora, flower garden, research forests), major visitor amenities, research and educational facilities, service areas, and circulation paths and trails, etc. (Fig 5)
- Translate the conceptual master plan into a 3D conceptual model. This model will provide a visual representation of the proposed garden design, including key architectural elements (e.g., visitor center, greenhouses, research facilities) and landscape features. (Fig 7-10) Based on the conceptual master plan, provide a preliminary, high-level cost estimate for the entire botanical garden project.
- Outline a preliminary operational model for the botanical garden, including initial staffing considerations, core programming, and potential revenue streams. Provide recommendations for integrating long-term sustainability (financial, environmental, social) into the garden's development and operation.
- Document lessons learned and challenges

2.4 Specific Objective/Results

The specific terms of reference followed for this assessment are as follows:

1. Produce a Comprehensive Feasibility Study report
2. Produce a Conceptual Master Plan for the University Botanical Garden
3. Produce a Digital 3D Conceptual model
4. Developed a detailed Costed Design and Produce Lessons learned as well as challenges associated with the establishment of the Botanical Garden

3.0 Physiographic and Ecological Characterization

The target study area is situated within the 5,800-acre Fendell Campus estate of the University of Liberia (UL). The surveyed site exhibits a diverse and highly altered landscape, reflecting varying degrees of anthropogenic impact and ecological resilience:

I. Lowland and Disturbed Terrains: The primary lowland zones are characterized by secondary grasslands, highly disturbed parcels with sparse vegetation, active agricultural gardens, and abandoned cultivation patches.
II. Hydrological Features: The area features a functional creek network that historically supplied water resources to the university arboretum, alongside several natural watercourses intersected during field transects.
III. Anthropogenic Pressures: Significant portions of the wetland habitats have been subjected to landfilling for community housing developments. Additionally, clear-cutting for localized charcoal production has stripped the primary vegetation in select tracks, though the underlying topsoil structures remain entirely intact.
IV. Upland Topography and Biodiversity: The northern periphery of the site transitions into a rugged, hilly terrain. Despite fragmentation, this zone maintains a fair canopy cover when viewed remotely. Crucially, it retains significant ecological value, preserving plant species of conservation concern and presenting an ideal foundation for a botanical garden.
V. Faunal Indicators: Preliminary field observations recorded physical footprints and grazing marks indicating the presence of native wildlife, specifically the bushbuck (*Tragelaphus scriptus*).

3.1 Legal Status of the Garden Site

The land designated for the project consists of 5,800 acres extending from the Fendell Campus toward Bentol. This total acreage has been officially surveyed, demarcated, and deeded to the University of Liberia. The statutory ownership and legal title of the land are secure and indisputable, establishing a firm legal foundation for long-term institutional development.

3.2 Availability of Sites

3.2.1 Comparative Track Evaluation and Selection

The field team executed a comprehensive evaluation across four designated parcels, classified as Tracks A, B, C, and D. Following a rigorous analysis of biophysical data and socio-economic variables, portions of Tracks C and D were selected as the optimal location for the botanical garden.

This site selection is justified by several operational advantages:

1. Minimal Anthropogenic Encroachment: Tracks C and D exhibit a significantly lower density of human settlements and informal structures compared to other surveyed blocks.
2. Socio-Legal Feasibility: The limited number of informal occupants identified within these boundaries presents a manageable relocation scenario.
3. Institutional Remediation: Successful development of this site is contingent upon the University of Liberia establishing an institutional relocation framework and enforcement mechanism prior to the commencement of physical construction.

3.3 Socio-Economic and Demographic Profile of Local Communities

The peri-urban corridor surrounding the University of Liberia Fendell Campus—extending toward Bentol within Montserrado County—exhibits rapid population growth and shifting economic dynamics. These

baseline parameters directly impact the human geography around the proposed Tracks C and D:

- **Demographics and Settlement Trends**: The local population is predominantly composed of Kpelle, Gola and Bassa ethnic groups, alongside a highly diverse mix of migrants from other Liberian counties seeking economic opportunities near the capital. The average household size ranges between 4.5 and 5.0 individuals. Due to intense urbanization pressures in Greater Monrovia, the Fendell area has experienced a sustained influx of informal settlers and encroachers, resulting in an annual localized growth rate outstripping rural averages.
- **Livelihood Strategies and Economic Activities**: The socioeconomic fabric of the surrounding communities is highly reliant on informal, small-scale industries. Primary local livelihoods include subsistence agriculture (such as cassava patches and market gardening), charcoal production (which drives localized deforestation), and petty trading. A substantial segment of the population experiences moderate-to-high economic vulnerability and relies heavily on natural resources extracted directly from university-deeded land.
- **Land Tenure and Social Receptivity**: While initial assessments indicated a peaceful environment, subsequent verification field trips exposed friction points regarding land limits and displacement anxieties. Informal occupants inside Tracks C and D operate without legal deeds but maintain deep-seated community attachments. Consequently, successful project execution requires a multi-sectoral approach combining secure boundary reinforcement with proactive, fair alternative livelihood or relocation incentives.

3.4 Geological Formations and Soil Composition

The physical geography of the Fendell-Bentol corridor dictates the engineering and botanical parameters of the garden site. The area's underlying geology and soil profile reflect typical characteristics of the Liberian mainland crystalline basement:

3.4.1 Geological Framework

The project area lies within the stable Precambrian **Leo-Man Shield** (Archean domain). The bedrock consists primarily of ancient crystalline metamorphic formations, dominated by **granitic gneisses and migmatites**. These basement rocks are occasionally intruded by younger Phanerozoic diabase and gabbro dikes. Structurally, the fractured nature of this underlying crystalline basement serves as the regional aquifer system, directing the hydrological pathways and natural spring lines that feed the site's surface watercourses.

3.4.2 Soil Taxonomy and Characteristics

The soils across the Fendell terrain are categorized into specific tropical orders shaped by heavy seasonal rainfall and intense weathering (laterization):

- **Ultisols (Latosols)**: This represents the dominant soil order across the rolling uplands of the Fendell-Bentol stretch. These soils are heavily weathered, highly acidic (low pH), and have a high clay content in their argillic horizons. They display poor natural fertility and are deficient in key macronutrients like nitrogen and available phosphorus, but they are physically stable and support deep-rooting tree species.
- **Plinthic and Ironstone Concretions**: Lower erosional slopes and upland fringes feature gravelly soils rich in iron and aluminum oxides (Laterites). These soils contain high concentrations of ironstone concretions (hardened plinthite), which offer excellent mechanical load-bearing capacity for trails and light infrastructure but require targeted organic enrichment for delicate botanical propagation.

Alluvial and Hydromorphic Soils (Inceptisols/Gleisols): Found within the low-lying wetlands and creek beds of the site, these soils are composed of quartz-rich kaolinitic clays and organic matter. They are characterized by poor drainage and seasonal waterlogging, making them highly suited for specialized wetland flora and conservation-focused hydrologic zoning, rather than structural buildouts.

Figure 1. Map showing various tracks within the Botanical Garden Surveyed 2025

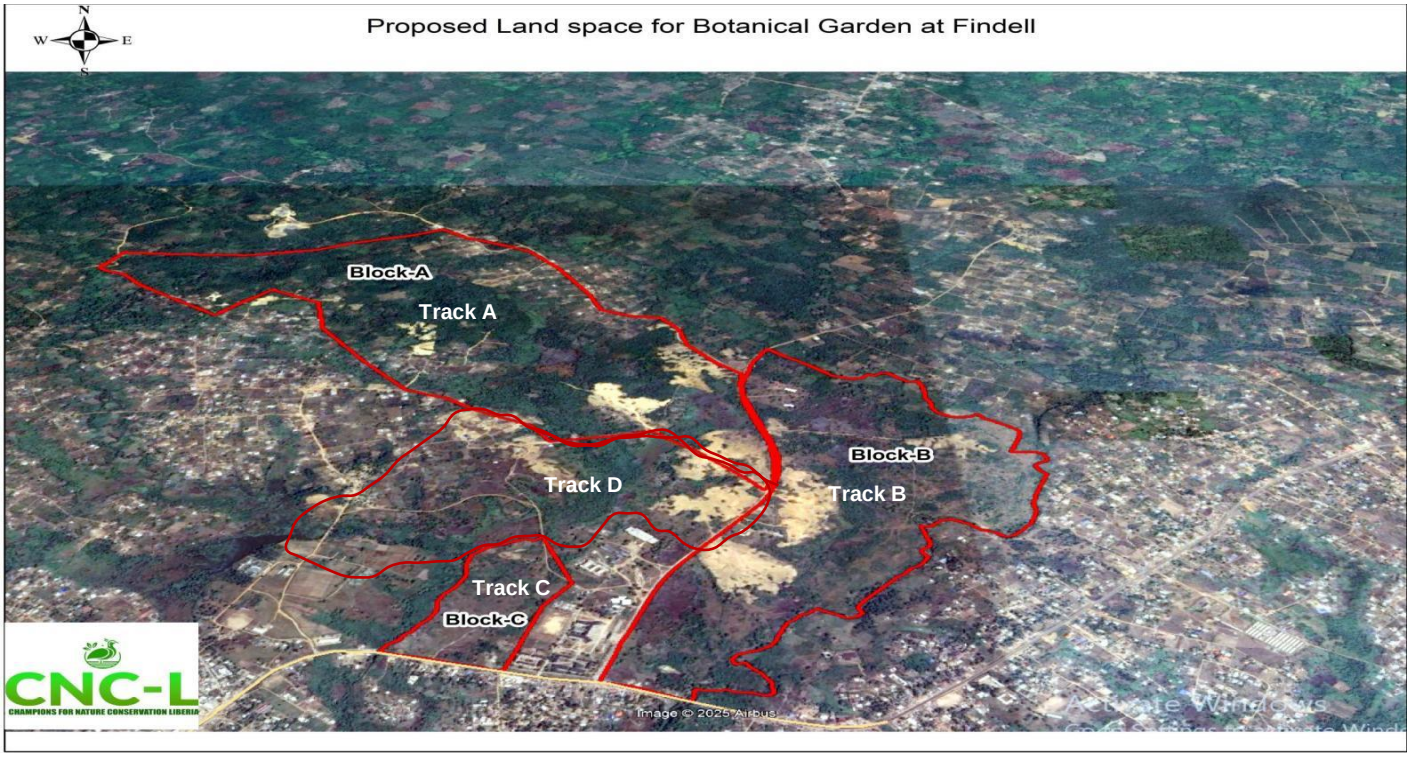
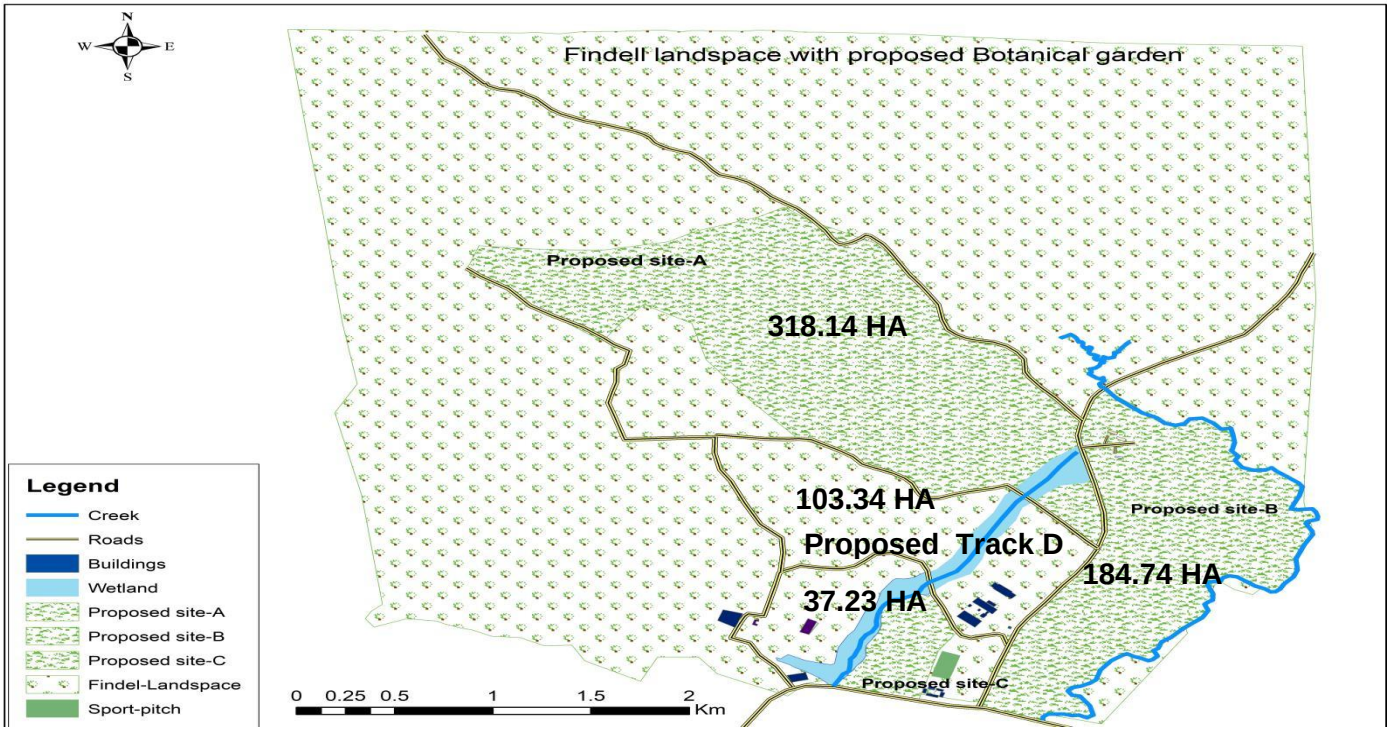


Figure 2. Map showing All four tracks assessed with land-size at the UL Fendell Landscape 16/9/2025 N. Wrights



- Global Positioning System (GPS): Field technicians recorded sample waypoint positions across the landscape using a *Garmin GPSMAP 60Cx* handheld receiver.
- Georeferenced Photography: Field photographs were embedded with precise coordinate metadata to map ecological features and visible human footprint markers.
- Vegetation Mapping and Classification: Botanical typologies were classified using *The Vegetation of Sierra Leone, Nigeria, Ghana, Guinea, Benin, and Liberia (UL Plant Map)* framework, drawing heavily from the *2025 UL Assessment Report* compiled by Kpadehyea et al.
- Spatial Projection Software: In-depth vegetation analysis was refined through specialized geographic data processing software to project spatial modeling of regional plant distribution.

4. Ecosystem Threat Assessment Matrix

Based on the field data collected and analyzed by the consulting team, there are currently no documented biological threats originating from invasive alien species or native flora, fauna, and avian populations within the target landscape. However, the ecosystem faces a severe, immediate, and accelerating threat from anthropogenic pressures—specifically rapid informal human settlement and land encroachment.

4.1 Integration of Biodiversity and Institutional Planning

The macro-spatial framework for this study is rooted in previous boundary assessments conducted by the University of Liberia's Department of Institutional Development. Operating within the 5,800-acre Fendell estate, institutional planners had previously designated and marked specific target locations—labeled FR, FR5, F1, and A6—for the botanical garden, a proposed forest training center, and agricultural field laboratories (as detailed in the *UL Institutional Development Map 2025*).

To ensure an unbiased selection process, this feasibility study expanded its scope to evaluate all four institutional zones, alongside Blocks A, B, C, and D, determining which specific acreage possesses the optimal biophysical and socio-legal characteristics for sustainable development.

4.2 Ecological Sensitivity and Baseline Data Constraints

The ecological integrity and sensitivity of the project site were evaluated based on the presence or absence of Species of Conservation Concern (SCC) and ecologically significant flora and fauna. Conservation statuses were verified using the *International Union for Conservation of Nature (IUCN) Red List of Threatened Species*.

A critical baseline constraint for this study is the complete absence of prior comprehensive botanical literature for this specific Fendell corridor. No historical studies exist that concurrently capture the floristic composition, faunal populations, and topographic outlines of these plots. Consequently, all baseline ecological and geographic datasets presented in this report have been generated firsthand by the consulting team, with technical assistance from the UL Department of General Forestry and the Department of Institutional Development.

4.3 Site Visit Dynamics and Seasonality Limitations

The primary field surveys were conducted during the peak of the West African rainy season (September). This timing introduces an inherent seasonal limitation into the study's findings:

- Faunal and Avian Deficiencies: The survey concluded prior to the dry season (November to February), which is the peak period for migratory avian species and the flowering cycles of various tropical flora.

- Data Limitations: Consequently, while non-perennial species were actively documented, certain migratory birds, seasonal fauna, and unflowered botanical specimens were undetectable during the brief field window.

Despite these seasonal restrictions, the team successfully documented key indicator species, establishing a positive baseline for the site's ecological potential:

Common Name	Scientific Name	Taxonomic Group	IUCN Red List Status
Red-vented Malimbe	*Malimbus scutatus*	Avian (Bird)	Endangered (EN)
Slender Mongoose	*Herpestes sanguineus*	Mammalian (Fauna)	Least Concern (LC)
Myrianthus	*Myrianthus libericus*	Botanical (Plant)	Indigenous / Least Concern (LC)

The wider landscape can be botanically categorized by its dominant canopy structures. Highly degraded

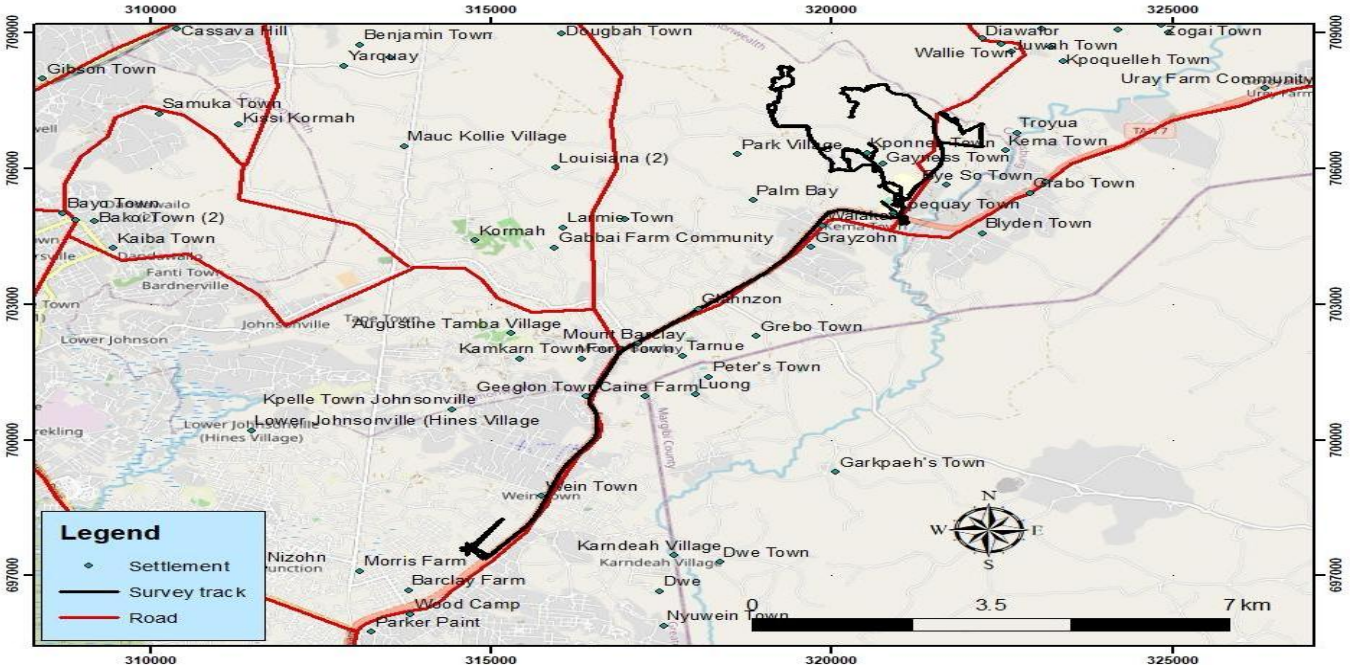


Figure 3. Map showing Botany tracks during field assessment of the vegetation16/09/2025

5.1 Mammalian Inventory

5.1.1 Survey Methodology

The mammalian survey was executed by dividing the target landscape into distinct sampling zones. Field data collection utilized the standardized reconnaissance (recce) transect method, capturing direct visual encounters, vocalizations, and indirect diagnostic signs such as feeding remnants, tracks, and fecal pellets (dung).

[Total Mammalian Survey Area]

- ► Site 1: High Richness (7 Species) ──► Direct sightings of squirrels & mongoose
- ► Site 2: Moderate Richness (4 Species) ──► Mix of active foraging & direct sightings
- ► Site 3: Low Richness (2 Species) ──► Fragmented terrain, ground squirrel dominant

5.1.2 Site-Specific Fauna Distribution

The survey revealed varying degrees of species richness across the sampled zones, reflecting local habitat variations and patch connectivity:

Site 1 (High Richness Zone)

Field data sheets documented seven distinct wildlife species, characterized by active foraging behaviors and diverse niches:

a. Punctate Sun Squirrel (*Heliosciurus punctatus*): Direct visual observation at a distance of 10 meters.
b. Western Palm Squirrel (*Epixerus ebii*): Direct visual observation at a distance of 21 meters.
c. Fire-footed Rope Squirrel (*Funisciurus pyrropus*): Direct visual observation at a distance of 15 meters.
d. Slender Mongoose (*Herpestes sanguineus*): Direct visual observation at a distance of 24 meters.
e. Marsh Cane Rat (*Thryonomys swinderianus*): Confirmed via fresh feeding signs and vegetation clipping.
f. Common Cusimanse (*Crossarchus obscurus*): Confirmed via weathered fecal matter (old dung).
g. Soft-furred Rat (*Praomys* spp.): Documented via an opportunistically intercepted specimen from a local hunter (photographic preservation denied).

Site 2 (Moderate Richness Zone)

Field monitoring recorded four wildlife species, indicating a transition toward slightly more disturbed habitats:

i. Punctate Sun Squirrel (*Heliosciurus punctatus*): Direct visual observation at a distance of 18 meters.
ii. Western Palm Squirrel (*Epixerus ebii*): Direct visual observation at a distance of 25 meters.
iii. Striped Ground Squirrel (*Xerus erythropus*): Direct visual observation at a distance of 30 meters.
iv. Marsh Cane Rat (*Thryonomys swinderianus*): Confirmed via old fecal deposits.

Site 3 (Low Richness Zone)

Ecological monitoring in this zone encountered only two wildlife species, suggesting high habitat fragmentation or lower canopy cover:

i. Striped Ground Squirrel (*Xerus erythropus*): Direct visual observation at a distance of 19 meters.
ii. Western Palm Squirrel (*Epixerus ebii*): Confirmed exclusively via fresh foraging and feeding sites.

Site 4 data sheet shows that no wild species information was assembled.

Table 1. Listing of Animal Species and location UL Fendell landscape Feasibility Assessment (Derrick C.M Paye, 2025)

No	Scientific name	IUCN Status	No	English name	Northing	Easting
2	Heliosciurus punctatus	Least Concern (LC)	2	Punctate Sun Squirrel	321661	707216
3	Thryonomys swinderianus	Least Concern (LC)	3	Marsh Cane Rat	321727	707091
4	Epixerus ebii	Least Concern (LC)	4	Western Palm Squirrel	321865	706994
5	Crossarchus obscurus	Least Concern (LC)	5	Common Cusimanse	321883	706459
6	Funisciurus pyropus	Least Concern (LC)	6	Fire-footed Rope Squirrel	321912	706904
7	Herpestes sanguincus	Least Concern (LC)	7	Slender mongoose	321436	704888
8	Praomys	Least Concern (LC)	8	Soft-Furred Rat	321247	705141
11	Thryonomys swinderianus	Least Concern (LC)	11	Marsh Cane Rat dung	321504	707357
12	Heliosciurus punctatus	Least Concern (LC)	12	Punctate Sun Squirrel	320975	707271
13	Epixerus ebii	Least Concern (LC)	13	Western Palm Squirrel	321088	706931

5.2 Ornithological Survey

5.2.1 Status of Avifauna in Liberia

The Republic of Liberia supports a diverse avifauna comprising hundreds of documented bird species, nine of which are currently classified as globally threatened or endangered. This high species richness highlights the regional importance of preserving intact West African forest fragments and establishing specialized conservation sanctuaries.

5.2.2 Survey Scope and Objectives

An intensive ornithological survey was conducted from September 16 to September 19, 2025, as a core component of the baseline biodiversity assessments on the University of Liberia (UL) Fendell Campus. Executed to support the establishment of the proposed botanical garden, the primary objectives of this avian assessment were to:

1. Identify and Catalog: Document the baseline species composition of avifauna across the candidate project sites.
2. Ecological Characterization: Describe the utilization of local ecological niches and habitat types by resident and migratory birds.
3. Conservation Evaluation: Assess the vulnerability, population status, and specific conservation requirements of the recorded species against international benchmarks.

Comprehensive data matrices summarizing the absolute abundance, species richness, and overall avian diversity indexes across the surveyed tracks are detailed in the accompanying tables *D* .

5.2.3 Field Methodology: Avian Sampling and Mist Netting Protocols

To capture a comprehensive baseline of the avian community, the ornithological survey utilized a standardized combination of passive mist netting and fixed-point count stations:

1. Passive Mist Netting: Field technicians deployed a series of fine-mesh nylon mist nets across the primary habitat types in Tracks C and D. Nets were strategically erected within microhabitats, including dense understory vegetation, forest edges, and natural riparian corridors. This approach targeted cryptic, skulking, and understory-dwelling species that are regularly missed during visual surveys.
2. Operational Schedule: The mist nets were monitored continuously at 20-minute intervals during peak avian activity periods (06:00 to 10:00 and 15:30 to 18:00) to ensure specimen safety and minimize capture-induced stress.
3. Data Recording: Captured individuals were safely extracted, identified to the species level, examined for reproductive indicators, and immediately released on-site following biometric documentation.

The survey utilized a standardized array of 12 high-grade nylon mist nets, each measuring 12 meters in length with a 36-millimeter mesh size. Over the four-day sampling period, the nets were operated for a cumulative total of 204 net-hours. This standardized sampling effort ensured a mathematically representative assessment of the cryptic understory avian community across the target tracks.

Table 2. LIST AND LOCATION OF BIRD SPECIES SURVEY-UL FEASIBILITY STUDY 2025 FENDELL LANDSCAPE- E. LOQUEL 2025

No	English name	Scientific name	Family name	SIZE	IUCN status	Latitude	Longitude
1	Double-spurred Francolin	Pternistis bicalcaratus	Phasianidae	12	Least concern (LC)	6.381744	-10.6197
2	Swamp Palm Bulbul	Thescelocichla leucopleura	Pycnonotidae	2	Least concern (LC)	6.383218	-10.6207
3	Red-bellied Paradise Flycatcher	Terpsiphone rufiventer	Monarchidae	1	Least concern (LC)	6.38867	-10.6197
4	Little Grey Flycatcher	Muscicapa epulata	Muscicapidae	2	Least concern (LC)	6.388667	-10.6197
5	Superb Sunbird	Cinnyris superbus	Nectariniidae	1	Least concern (LC)	6.389475	-10.6203
6	Black Crake	Zaporina flavirostra	Rallidae	1	Least concern (LC)	6.389135	-10.6198
7	Red-vented Malimbe	Malimbus scutatus	Ploceidae	4	Least concern (LC)	6.38957	-10.6181

8	White-faced Whistling Duck	Dendrocygna viduata	Anatidae	6	Least concern (LC)	6.389335	-10.6166
9	Yellow Longbill	Macrosphenus flavicans	Musophagidae	1	Least concern (LC)	6.389296	-10.6166
10	Simple Greenbul	Chlorocichla simplex	Pycnonotidae	2	Least concern (LC)	6.388932	-10.6157
11	Plain-backed Pipit	Anthus leucophrys	Motacillidae	1	Least concern (LC)	6.388927	-10.6146
12	Grey-rumped Swallow	Pseudhirundo griseopyga	Hirundinidae	4	Least concern (LC)	6.388925	-10.6146
13	Common Sandpiper	Actitis hypoleucos	Scolopacidae	7	Least concern (LC)	6.388813	-10.6145
14	Striated Heron	Butorides striata	Ardeidae	1	Least concern (LC)	6.388448	-10.6145
15	African Pygmy Kingfisher	Ispidina picta	Alcedinidae	1	Least concern (LC)	6.388326	-10.6145
16	Blue-spotted Wood Dove	Turtur afer	Columbidae	5	Least concern (LC)	6.387403	-10.6145
17	African Jacana	Actophilornis africanus	Jacanidae	1	Least concern (LC)	6.383388	-10.6278
18	Crimson Seedcracker	Pyrenestes sanguineus	Estrildidae	5	Least concern (LC)	6.379923	-10.6309
19	Malachite Kingfisher	Corythornis cristatus	Alcedinidae	1	Least concern (LC)	6.379978	-10.631
20	Reed Cormorant	Microcarbo africanus	Phalacrocoracidae	2	Least concern (LC)	6.379985	-10.631
21	Little Bee-eater	Merops pusillus	Meropidae	3	Least concern (LC)	6.380023	-10.631
22	African Thrush	Turdus pelios	Tudidae	1	Least concern (LC)	6.379775	-10.6304
23	African Harrier-Hawk	Polyboroides typus	Accipitridae	2	Least concern (LC)	6.379568	-10.6299

24	African Palm Swift	Cypsiurus parvus	Apodidae	2	Least concern (LC)	6.381057	-10.6285
25	Snowy-crowned Robin-Chat	Cossypha niveicapilla	Muscicapidae	1	Least concern (LC)	6.379997	-10.6257
26	Common Bulbul	Pycnonotus barbatus	Pycnonotidae	5	Least concern (LC)	6.379987	-10.6257
27	Western Plantain-eater	Crinifer piscator	Musophagidae	2	Least concern (LC)	6.380027	-10.6257
28	Carmelite Sunbird	Chalcomitra fuliginosa	Nectariniidae	1	Least concern (LC)	6.380208	-10.6259
29	Grey-backed Camaroptera	Camaroptera brevicaudata	Cisticolidae	3	Least concern (LC)	6.379925	-10.6262
30	Moustached Grass Warbler	Melocichla mentalis	Macrosphenidae	1	Least concern (LC)	6.379898	-10.6262
31	Yellow-mantled Widowbird	Euplectes macroura	Ploceidae	4	Least concern (LC)	6.37929	-10.6265
32	Yellow-throated Longclaw	Macronyx croceus	Motacillidae	1	Least concern (LC)	6.379193	-10.6265
33	Klaas's Cuckoo	Chrysococcyx klaas	Cuculidae	1	Least concern (LC)	6.378799	-10.6263
34	Bronze Mannikin	Lonchura cucullata	Estrildidae	20	Least concern (LC)	6.37898	-10.6276
35	Pied Crow	Corvus albus	Corvidae	6	Least concern (LC)	6.379057	-10.6278
36	Red-eyed Dove	Streptopelia semitorquata	Columbidae	6	Least concern (LC)	6.379137	-10.628
37	Village Weaver	Ploceus cucullatus	Ploceidae	10	Least concern (LC)	6.379325	-10.6286
38	Ethiopian Swallow	Hirundo aethiopica	Hirundinidae	5	Least concern (LC)	6.379306	-10.6286
39	Tawny-flanked Prinia	Prinia subflava	Cisticolidae	2	Least concern (LC)	6.379112	-10.6286

40	Vieillot's Black Weaver	Ploceus nigerrimus	Ploceidae	3	Least concern (LC)	6.379107	-10.6286

Figure 4. BIRD FLYWAY AND NESTING SITES: The study area in relation to Bird flyway and nesting sites (EMMANUEL LOQUEL 15/09/2025) overlaid on a Google Maps ™ aerial image.

5.3 Floristic Assessment

5.3.1 Baseline Objectives and Taxon Diversity

This floristic assessment provides a comprehensive overview of the current vegetative composition, structure, and ecological characteristics defining the proposed development sites. The primary objective of the botanical field survey was to systematically record both indigenous and exotic plant species present within the candidate tracts. Establishing this baseline dataset serves as a fundamental criterion for selecting the most ecologically viable, resilient, and structurally appropriate location for the botanical garden.

The botanical research team documented a total of 185 unique plant species distributed across 119 genera and 44 taxonomic families. The high taxonomic diversity reflects the heterogeneous landscape of the Fendell estate and indicates a robust foundation for an ex-situ conservation collection.

5.3.2 Taxonomic Family Distribution and Dominance

The floristic composition is heavily dominated by a few highly adaptable and diverse tropical plant families. The distribution of documented species across the dominant families is structured as follows:

[Documented Plant Diversity: 185 Species / 44 Families]

- Fabaceae (Legume Family) ——— 22 Species (Highest Dominance)
- Euphorbiaceous (Spurge Family) ——— 15 Species
- Rubiaceous (Madder Family) ——— 12 Species
- Poaceae (Grass Family) ——— 10 Species
- Malvaceae & Guttiferae ——— 6 Species Each
- Remaining 38 Families ——— 1 to 5 Species Each

This distribution highlights a transition landscape. The high prevalence of *Fabaceae*, *Euphorbiaceae*, and *Rubiaceae* points to pockets of resilient secondary forest, while the prominent representation of *Poaceae* confirms the presence of open, disturbed savannas and clearings.

5.4 Ecological Sensitivity and Anthropogenic Pressures

The ecological integrity of the assessed tracks exhibits varying degrees of fragility, driven primarily by ongoing, unregulated human disturbances. This vulnerability is particularly critical within the high-stand, secondary forest patches identified in Tracks 2 and 3. Despite the protective advantages of the rugged terrain—characterized by steep hills and erosional slopes—these zones are subject to daily, destructive resource extraction.

Local populations actively harvest the remaining mature woody plant species for two primary informal industries:

1. Charcoal Production: Driving rapid clear-cutting, microclimate dehydration, and topsoil degradation.
2. Makeshift Construction Materials: Removing structurally dominant pole-trees and sub-canopy timber.

Without immediate institutional intervention and physical site security, these extractive activities will accelerate the localized extirpation of rare, endemic, and threatened flora. Crucially, this disturbance directly threatens keystone vegetative assets, including Traditional Medicinal Plants (TMPs) and sensitive environmental indicator species. The ongoing removal of these species compromises the ecological seed bank, threatening to push the ecosystem past a critical threshold where natural regeneration and recovery become impossible.

5.5 Ecological Potential and Degradation Trajectory

The current baseline data reveals a stark contrast between the land's high conservation potential and its accelerating degradation trajectory. While the remaining floral diversity and intact topsoil layers provide an excellent foundation for a world-class botanical sanctuary, the ongoing unsustainable resource extraction poses an immediate threat to the environment.

If current harvesting practices and land-use changes continue unchecked, the site's natural resilience will be permanently compromised. The removal of the woody canopy layer exposes the land to severe tropical weathering and soil erosion, initiating a process of ecological retrogressive succession. Left unmanaged, this trajectory will permanently transform these diverse secondary forest fragments into species-poor, highly degraded tropical grasslands, destroying the site's capacity to support nature-based learning and biodiversity conservation.

Table 3. Listing of Tree, Grass, Liana and herb Species including location and category on IUCN list at the UL Fendell landscape Feasibility Assessment (James Kpadehyea, 2025)

Scientific Name	Frequency	Habit	IUCN Status	Range	Habitat
Vitex micrantha	3	Tree	LC	Guinea to Cameroon	Terrestrial
Duparquetia orchidacea	2	Liana	LC	Liberia to Congo	Terrestrial
Raphia hookeri	3	Grass	LC	Senegal to Nigeria, D.R. Congo, Angola and Uganda	Aquatic
Hallea ledermannii	1	Tree	NT	Liberia to Gabon	Terrestrial
Mareya micrantha	2	Tree	LC	Guinea to Congo	Terrestrial
Laccosperma opacum	1	Climber	LC	Liberia to Congo	Terrestrial
Macaranga spinosa	1	Tree	LC	Widespread in Tropical Africa	Wetland
Heterotis rotundifolia	2	Herb	LC	Tropical Africa	Wetland
Diospyros cooperi	2	Tree	LC	Sierra Leone to Ghana	Terrestrial
Anthocleista nobilis	3	Tree	LC	Senegal to Ghana	Terrestrial
Carpolobia lutea	1	Tree-let	LC	Guinea to Cameroon	Terrestrial

Anthonotha macrophylla	1	Tree	LC	Sierra Leone to Congo and Gabon	Terrestrial
Dalbergia saxatilis	2	Shrub	N/A	Senegal to D. R. Congo, and Uganda to Sudan	Terrestrial
Rauvolfia vomitoria	3	Shrub	LC	Tropical Africa	Terrestrial
Carapa procera	3	Tree	LC	Senegal to Congo and South America	Terrestrial
Craterispermum caudatum	3	Tree	LC	Sierra Leone to Nigeria	Terrestrial
Costus afer	2	Herb	N/A	Sierra Leone to Togo	Terrestrial
Morinda lucida	2	tree	LC	Widespread in Tropical Africa	Terrestrial
Combretum aculeatum	2	Liana	LC	Tropical Africa	Terrestrial
Alchornea cordifolia	2	Shrub	LC	Widespread in Tropical Africa	Terrestrial
Nauclea diderrichii	1	Tree	NT	Widespread in Tropical Africa	Terrestrial
Myrianthus libericus	3	Tree	LC	Guinea to Ghana	Terrestrial
Gaertnera cooperi	1	Tree	LC	Liberia to Ghana	Terrestrial
Euphorbia hirta	2	Herb	N/A	Pan-Tropical	Terrestrial
Diospyros cooperi	1	Tree	LC	Sierra Leone to Ghana	Terrestrial
Dichrostachys cinerea	1	Shrub	LC	Widespread in Tropical Africa	Terrestrial
Funtumia elastic	3	Tree	LC	Widespread in Tropical Africa	Terrestrial
Milicia regia	1	Tree	VU	Senegal to Ghana	Terrestrial
Sterculia tragacantha	2	Tree	LC	Tropical Africa	Terrestrial
Psidium guajava	1	Shrub	LC	Widespread in Tropical Africa	Terrestrial
Pterocarpus santalinoides	2	Shrub	LC	Widespread in Tropics	Wetland
Hurungana madagascariensis	1	Tree	LC	Africa and Madagascar	Terrestrial
Millettia barteri	1	Tree	N/A	Senegal to Congo	Terrestrial

Trichilia monadelpha	1	Tree	LC	Upper Guinea	Terrestrial
Psydrax arnoldiana	1	Tree	LC	Senegal to Togo	Terrestrial
Smeathmannia laevigata	2	Tree	N/A	Senegal to Liberia	Terrestrial
Hugonia rufipilis	1	Shrub	N/A	Senegal to Congo	Terrestrial
Senna alata	1	Shrub	LC	Tropical Africa	Terrestrial
Ficus sur	1	Tree	LC	Global	Terrestrial
Voacanga africana	1	Tree	LC	Widespread in Tropical Africa	Wetland
Allanblackia parviflora	1	Tree	VU	Sierra Leone to Ghana	Terrestrial
Microdesmis keayana	2	Shrub	LC	Upper Guinea to Nigeria	Terrestrial
Hallea ledermannii	1	Tree	NT	Liberia to Gabon	Terrestrial

5.6 Topographic and Hydrological Assessment

5.6.1 Geomorphological and Topographic Profile

The physical landscape of the proposed botanical garden site features a highly variable terrain that directly shapes its ecological zoning and infrastructural potential. The topographic profile transitions across three distinct geomorphological zones:

- Northern Ridge Formations: The northern sector of the site is defined by rugged, hilly terrain with moderate-to-steep erosional slopes. This elevated topography provides excellent scenic vistas suitable for ecotourism lookouts and prevents high-density human encroachment, thereby preserving the site's remaining secondary forest canopy.
- Central Lowlands and Flat Plains: The central portions feature level ground and gentle slopes. This stable terrain minimizes land-preparation costs and provides the ideal topography for administrative facilities, visitor centers, plant nurseries, and accessible public trail networks.
- Depression Basins and Inundated Zones: The lower elevations transition into natural catchments and low-lying swamp close to the Science and agriculture departments. These zones act as sediment traps and collect surface runoff from the surrounding landscape.

5.6.2 Hydrological Network and Watershed Integrity

The target area possesses a robust and functional drainage system that offers significant advantages for sustainable water management. The primary hydrological features include:

- Perennial Surface Watercourses: Field transects confirmed the presence of an intact network of permanent streams and creeks flowing through the tracks. This includes the primary historic creek that previously sustained the university arboretum, ensuring a continuous, gravity-fed water supply for seasonal irrigation and plant propagation.
- Freshwater Wetland Systems: The survey mapped 5.75 acres of permanent and seasonal aquatic wetlands. These hydromorphic zones serve as critical water-purification catchments, regulate the local microclimate, and prevent downstream flooding.

- Conservation Value: From a botanical perspective, this diverse hydrological network supports specialized riparian and aquatic flora, adding valuable habitat variation to the sanctuary. However, protecting these watercourses requires immediate zoning enforcement to halt ongoing wetland landfilling and sand mining along the periphery.

Table 4. Habitat category descriptions and criteria

Habitat category by tracks	Description
Track 1 Transformed Highly Degraded and more infrastructure project	Well disturbed land with scanty vegetation, mostly flat land, Gardens prevalent, abandoned cassava patches, Ideal creek that once fed the arboretum with water resource, larger land space top soil removed for community housing specifically wetlands land fill.
Track 2 Low degrade wetland Less Degraded and better Topsoil, les structure	Hilly terrains and level grounds, and gentle slopes, Some important plant species for the beginning of a botanical garden, several ideal water courses, visible feeding marks of deer, very common Land topsoil completely intact, except for the fringes newly cleared for structures to be built and access roads, wide clear-felled sites for massive charcoal production
Track 3 Low degraded land	Hilly terrains and level grounds, and gentle slopes, some important plant species for the beginning of a botanical garden, several ideal water courses, visible feeding marks of deer, very common, Land topsoil completely intact, except for the fringes newly cleared for structures to be built and access roads, Wide clear-felled sites for massive charcoal production, Unfavorable scenes as we saw signs of ill-responsible ritual practice (please see photo 99)
Track 4 degraded land with habitat	Major creek on site, in fact it is the largest water body of all four sites, Poor vegetation stand with mostly grass and scanty tree species, Multiple infrastructures jamming the main Fendell campus, Recorded butterflies

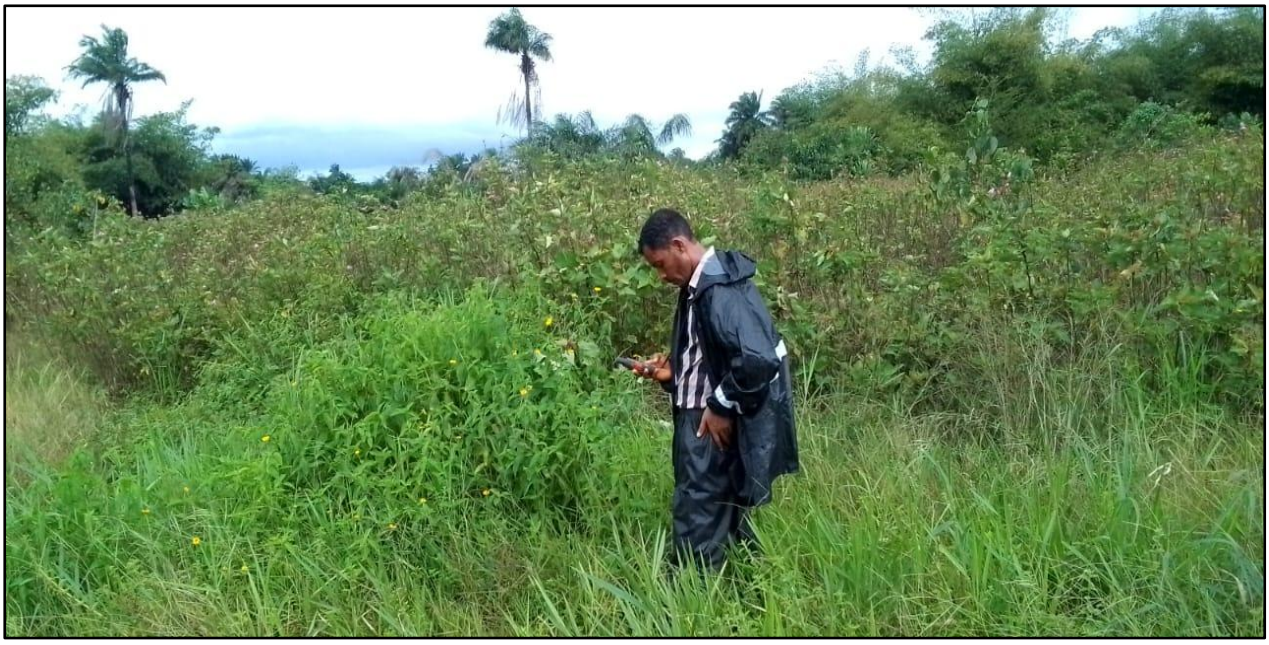


Fig: 4 Picture of grassland and palm trees on the proposed sites Track B-Derrick 15/09/2025/Fendell UL

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Fig: 4 CNCL staff holding discussion with Citizens of Kpaqua town, 16/09/2025, Abigail Zean

6 Socio-Economic and Community Engagement Assessment

6.1 Methodology and Objectives of Stakeholder Consultation

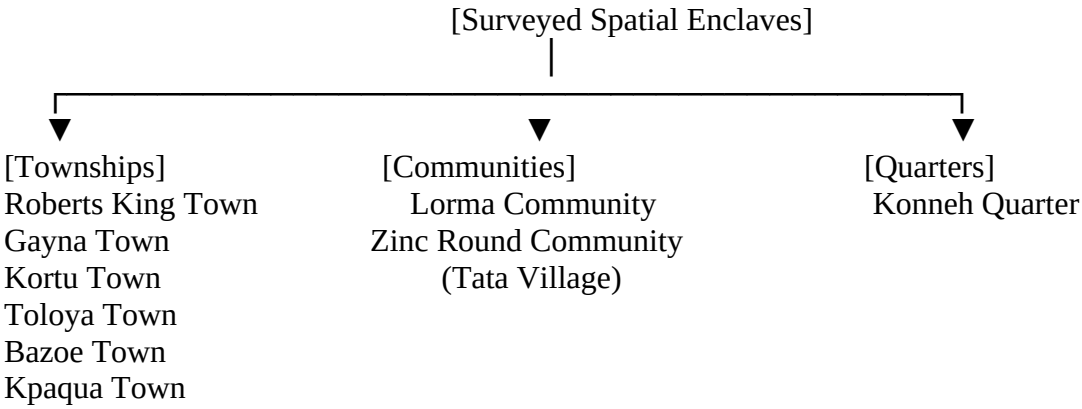
To systematically evaluate the social feasibility of site selection for the proposed botanical garden, Champions for Nature Conservation Liberia (CNC-Liberia), in collaboration with the University of Liberia (UL), executed an intensive four-day joint community engagement and situational assessment. Conducted from September 17 to September 19, 2025, this field initiative blended structured household interviews with public awareness campaigns across the Fendell Campus peripheries and its adjacent settlements.

The primary objectives of this socio-economic assessment were to:

i. Evaluate Land Tenure Security: Determine the historical and current existence of boundary disputes, customary claims, or legal contentions between local community enclaves and the University of Liberia.
ii. Assess Displacement Impact: Identify individuals or households previously affected by land friction, university expansion, or court-ordered evictions within the deeded 5,800-acre university estate, while establishing formal pathways to seek institutional redress.
iii. Baseline Demographic Mapping: Collect granular household indicators, including total family heads, gender-disaggregated dependency data, the number of children per household, and the socio-economic status of female-headed households.
iv. Audit Social Infrastructure: Map localized access to essential public services, including vehicular road networks, primary health care services, and functional primary/secondary educational facilities for local youth.
v. Determine Local Social Receptivity: Gauge local community alignment and sentiment regarding the specific boundaries identified for the botanical garden, ensuring a participatory approach to land zoning.

6.2 Geographic Scope and Informant Demographics

The field assessment and awareness campaigns were strategically deployed across a representative cross-section of the Fendell-Bentol peri-urban landscape. The deployment successfully audited six distinct towns, two organized communities, and one specialized quarter:



To capture an objective narrative of local socio-legal dynamics, the study facilitated direct focus group discussions and one-on-one structured interviews with a diverse array of local leadership and civil society actors. Key informants included:

1. Traditional Leadership: Institutional town chiefs and customary elders holding ancestral memory of local land occupancy.
2. Civic Representatives: Elected community chairpersons, youth leaders, and women's group executives.
3. Vulnerable Demographics: Informal daily wage-earners, farmers, and long-term unregistered residents.
4. Social Sector Workers: Local healthcare providers, community organizers, and educators operating within the Fendell zone.

Table 5: **Communities, and quarters in Fendell within or out of the sites.**

No	Description	Family Head	Children	Women	Male	Num. of houses/ Church/Mosque	Is there Any Land disputes b/w UL & communities?	Is there Any Land disputes/ court eviction?	Any Social services/road access& educational facilities for children
1	Roberts king Town	40	268	159	189	40 1Mosque	No	No	No
2	Kortu Town	33	174	106	69	53	No land dispute& there is a demarcation between the UL and Kortu Town	N0	No
3	Gayna Town	16	28	15	18	16	No	No	No
4	Toloya Town	30	30	10	40	9/1palava hut	Yes, during the Ellen regime	Yes, Town Chief, Thomas Morris was affected	

5	Kpaqua Town	61	96	77	84	45	No	No	1 school, 4 churches, 1 Mosque
6	Byeso Town	18	29	21	12	12	Yes. Demolition took place in Bayso Town, and families were affected.	.	Nothing
7	Zinc-round/Tata village		90	49	107	10	No	No	Nothing
8	Lorma comm								
9	Konneh Quarter	5	16	5	3	2, 1 Mosque	No	No	1handPump No school, but have access to a good road

6.3 SELECTION OF THE SITE (Using SWOT Analysis)

Brief Strength/Weakness/Opportunity/Threat analysis for each of the sites
SWOT Analysis

1 Strengths

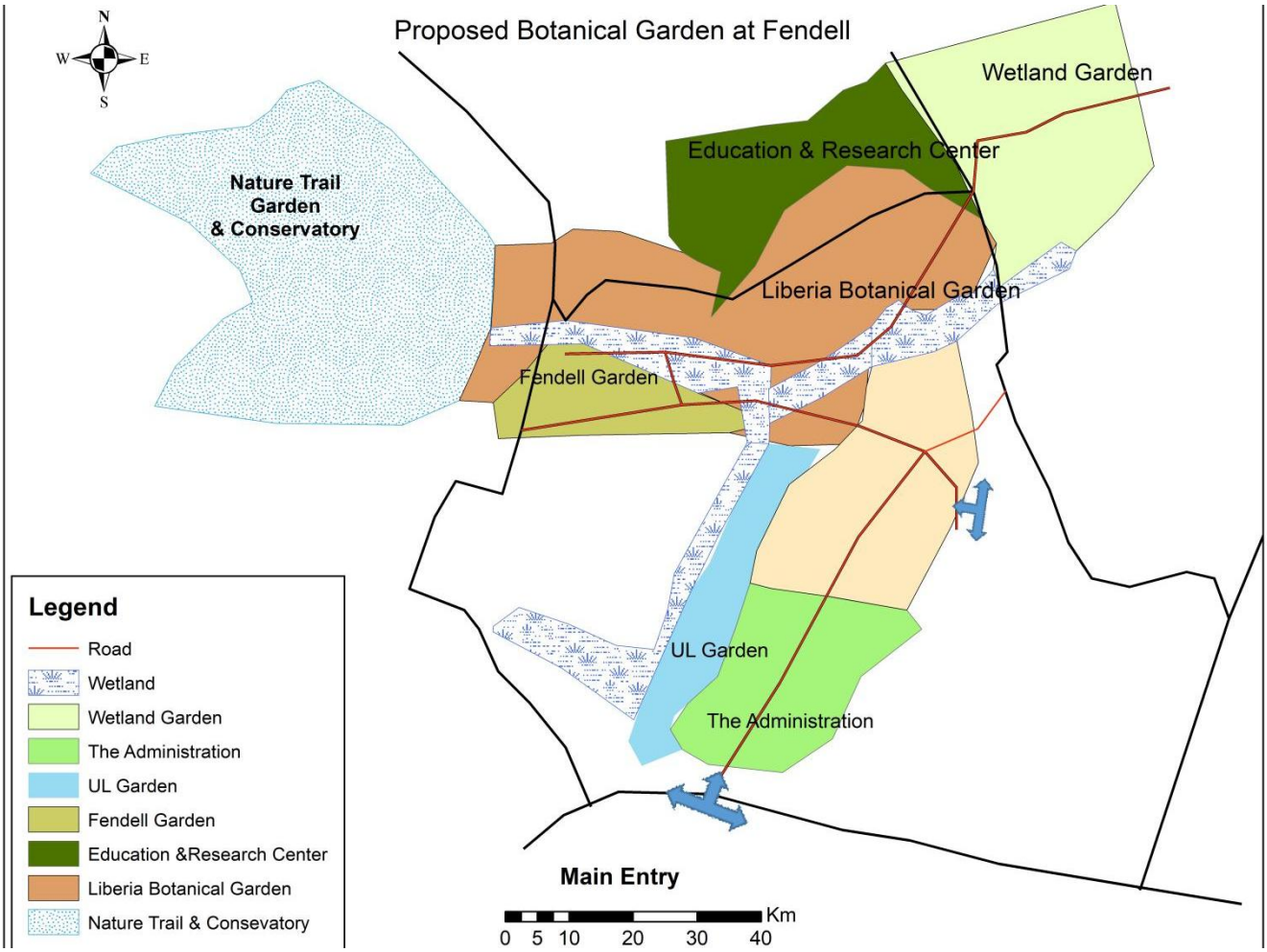
a) Strong support and interest from local government, businesses and individuals.
b) An attractive, scenic area of countryside accessible from Fendell, Carreyburg.
c) The plan is to involve people, especially local businesses, in job creation schemes within the project and also help with the Garden itself (e.g. plant sales, farmers markets, etc). This can attract funding.
d) Seeds of native and non-native plants are available to grow.
e) The attractive initial area will make a good impression on visitors.
f) Technical expertise exists in the region to construct the Botanical Garden.
g) Dry Season visitors more than double the population in the area for 6 to 8 months of the year.

2 Opportunities

a) There is low plant awareness in the general public — a chance to educate and show them something new.
b) A chance to develop an attraction for visitors in an area with few attractions.
c) A chance to use attractive planting, the Visitor Center, the natural beauty of Fendell landscape to make a statement that has impact.
d) Design garden so that maximum shade is produced during the Dry season to encourage additional visitors.
e) The Garden's proposed position just off the Bentol road and the Kakata Junction is easily accessible from UL Campus and from Bentol city.
f) There are residential areas and other attractions nearby — they will be positive for the Garden as it enhances the beauty of the area and provide exposure.
g) Local people and the University of Liberia students/faculty are positive about the project at the moment. A chance to use them as employees as well as volunteers as guides, assistant gardeners and for help with outreach.

h) The Garden will be unique — there is no other Botanical Garden that is set up the same way in the region.
i) The Garden can be a tourist attraction for students, community members/foreign visitors.
j) The Garden can host local farmers markets, art & crafts shows and plant sales throughout the year.

Fig: 5 Map of proposed sites selected and Land-size based on our study for the Garden Establishment, Fendell N. Wright 18/9/2025



3 Weaknesses

a) Distance from human habitat is too close, the encroachment of human settlement posed serious threat.
b) Low Season —dry season are too hot for visitors. And raining season too wet
c) Damage — litter, fires, possible deliberate damage if unhappy with the Garden.
d) Expensive to fencebut consider the use of bamboo or fruit plants
e) Some available sites are zoned residential and could take a year or so to be re-zoned commercial.
f) Local people may be hustle to land ownership and take over.
g) It will take time to expand areas of interest — to offer something new.
h) Some of the collections will be immature, therefore not so interesting for a few years.

4 Threats

i) Funding — sources may dry up.
j) Being unable to re-zone the land could nix the Garden for that location.
k) Competitors?
l) Lower visitor numbers as other leisure attractions increase in the Monrovia.

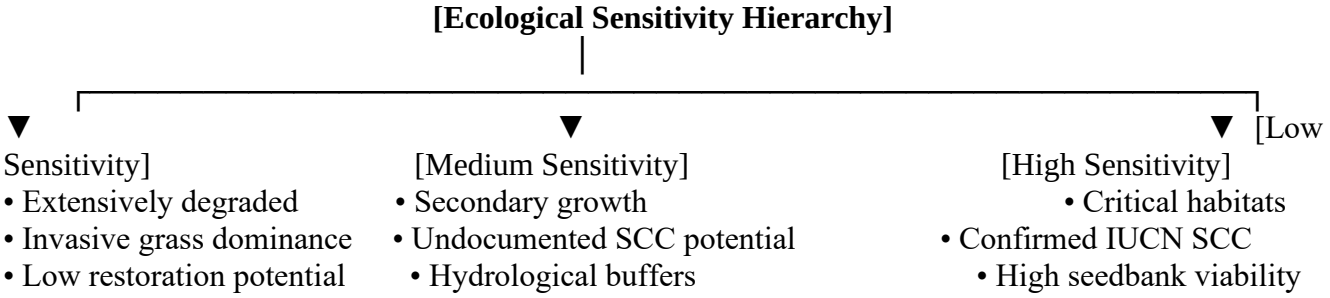
7 Ecological Sensitivity and Conservation Zoning

7.1 Methodological Framework for Sensitivity Analysis

Within this framework, ecological sensitivity is defined as the intersection of a landscape's *conservation value* and its *degree of resilience to disturbance*.

a. Conservation Value: This parameter integrates international conservation classifications, ecosystem threat statuses, ecological connectivity, structural habitat conditions, the persistence of localized ecological processes, and the specific role a site plays in supporting regional biodiversity.
b. Resilience to Disturbance: This parameter measures an ecosystem's structural vulnerability to anthropogenic pressures and its baseline capacity for environmental restoration.

7.2 Site-Specific Sensitivity Ratings and Zoning Criteria



7.2.1 Low Sensitivity Rating (Tracks 1, 4,)

A low sensitivity designation is assigned to zones that have been profoundly altered by human activity or ecological degradation. The strategic classification is based on the following indicators:

a. Severe Habitat Transformation: Large segments of Track C have been heavily modified by informal human settlements and agricultural activities, resulting in widespread colonization by opportunistic, invasive grass monocultures.
b. Low-to-Medium Restoration Capacity: While a small number of persistent indigenous species remain as remnants of the historical natural vegetation, overall floristic diversity is low. The sheer density of aggressive, weedy alien species compromises the landscape's natural recovery potential.
c. Development Suitability: Because intense environmental degradation limits the viability of delicate botanical collections or large-scale reforestation in these specific sub-zones, these areas are primarily designated for administrative infrastructure, visitor transit corridors, and high-impact utility buildouts.

7.2.2 Medium Sensitivity Rating (Tracks 2 and 3: Secondary Buffers)

A medium sensitivity rating is applied to recovering secondary forest stands and transitional landscapes. This classification is driven by the following parameters:

a. Representative Vegetation Cover: These tracts support a woody vegetation structure that is moderately representative of the historical regional canopy, though no Species of Conservation Concern (SCC) were officially confirmed here during the wet-season survey.
b. Latent Ecological Value: There is a high probability that these zones shelter seasonal or cryptic SCC that were dormant during the rainy season. These are expected to be confirmed during subsequent dry-season monitoring.

c. Spatial Proximity to Critical Ecosystems: This zone contains segments that lack sensitive surface vegetation but are located next to high-sensitivity blocks or vital wildlife movement corridors.
d. Medium Restoration Potential: The underlying soil profile remains relatively stable and intact. This stability suggests a viable, persistent soil seedbank of common native flora and specialized species that would readily germinate following natural ecological disturbances or managed fire-ecology cycles.
e. Hydrological Disconnect: It must be noted that while the wetland habitats within these blocks are classified as High regarding hydrological and watershed sensitivity, this medium rating applies strictly to the terrestrial botanical attributes of these plots.

7.2.3 High Sensitivity Rating (Tracks C or 2: Core Conservation Zones)

High sensitivity classifications are restricted to ecologically intact, biologically diverse, or highly resilient zones that are critical to the project's conservation mandates:

a) Confirmed Species of Conservation Concern (SCC): These core zones are confirmed habitats for key mammalian, avian, and botanical species. This includes documented plant taxa holding high threatened statuses on the IUCN Red List, such as *Ruschia geminiflora* (Vulnerable), *Lachenalia reflexa* (Endangered), *Muraltia mitior* (Endangered), and *Aspalathus cf. retroflexa ssp. bicolor* (Critically Endangered).
b) High Restoration and Seedbank Viability: Despite suffering localized degradation along their boundaries, these plots exhibit very high restoration potential. The standing vegetation structure and diverse canopy indicate a robust, deep, and viable persistent soil seedbank. Following targeted watershed restoration and water-bank management, these areas are poised for rapid natural regeneration and increased species richness.
c) Strategic Selection for Tracks A and B: This high restoration potential matches the baseline parameters of Tracks A and B, where intact soils, low human habitation, natural watercourses, and high seedbank viability create an optimal environment for a botanical sanctuary.
d) Mitigated Impact Path: Restricting low-impact, conservation-only development (such as elevated boardwalks or scientific research stations) to these sectors ensures that the project causes zero negative impact on local human settlements while fully preserving critical wildlife and botanical assets.

*Fig: 6 Picture of current nursery site at Fendell wetland close within Track C/-Nathan 15/09/2025/Fendell /CNC*L

8: Impact Assessment

8.1 Methodological Framework for Impact Evaluation

The impact assessment evaluates the prospective biophysical changes likely to manifest within the affected Fendell Campus ecosystem. This analysis specifically scopes modifications to existing flora, ecological processes, species of conservation concern (SCC), and specialized wildlife habitats. Anticipated impacts are categorized and evaluated across the following dimensions:

- The "No-Action" (No-Go) Alternative: Baseline projections of the landscape's ecological trajectory if the project is rejected.
- Direct, Indirect, and Cumulative Impacts: Explicit mapping of ecological risks across both the construction and operational lifecycles of the proposed development.

The assessment targets the officially selected 73.85-hectare spatial layout within Tracks C and D. Under this planned configuration, core secondary forest stands, resident avian communities, and mammalian populations will bypass major direct negative impacts. The design strategically integrates existing assets—such as the Chinese-built facility and designated agricultural sites—to prevent any net loss of academic infrastructure to the new development. High-sensitivity sub-zones, including the central permanent water body, will serve as dedicated mitigation sites. However, proximity to adjacent human settlements will still induce localized habitat fragmentation and microclimate alterations. Rigorous environmental management is mandatory to insulate sensitive riparian habitats and nesting avifauna from structural disturbances.

8.2 "No-Action" (No-Go) Development Scenario

The "No-Action" alternative analyzes the ecological trajectory of the Fendell ecosystem in the total absence of construction. If the botanical garden is not established, the current land use pattern will persist under the university's baseline maintenance regime:

- Management Realities: Maintenance within Tracks C and D would remain restricted to occasional mechanical brush-cutting to manage wild grasses and suppress aggressive alien invasive plants.
- Impact Significance: Because this scenario leaves the territory open to unchecked local charcoal burning, informal sand mining, and unmanaged urban encroachment, the long-term ecological trajectory for the No-Go option is rated as Low Negative.

8.3 Direct Environmental Impacts (Construction Phase)

Direct environmental impacts will occur primarily during the initial engineering phase, driven by vegetation clearing for nature trails, recreational zones, and administrative buildings. The project footprint lies within land varying from transformed to degraded condition:

The localized loss of these 18.0 cumulative hectares of vegetative cover represents a High Negative impact at a local scale over the long term. However, by enforcing strict boundary controls, reusing cleared organic biomass, and executing site-clearing outside avian breeding windows, this impact can be successfully mitigated to a Medium Negative significance rating.

8.4 Operational Phase Impacts and Edge Effects

Operational impacts focus on long-term ecological stress, specifically edge effects, habitat fragmentation along managed road verges, ongoing agricultural encroachment for charcoal production, and altered hydrology within the Track C and D wetland basins:

- Tracks C and D Framework: Due to existing fragmentation across these parcels, long-term edge effects are projected to stabilize at a Medium Negative significance rating. This reflects the challenge of managing a fractured boundary adjacent to active community zones.

- Comparative Track C. Analysis: By comparison, if Track C. were utilized, its concentrated layout and westward positioning would naturally insulate its core conservation zones. Without mitigation, Track C yields a Medium Negative rating, but with boundary controls, its operational footprint drops to a Low Negative significance rating due to superior habitat contiguity.

8.5 Indirect and Cumulative Impacts

Indirect impacts manifest gradually over extended operational timelines and are often less apparent during initial monitoring cycles:

- Genetic Isolation & Pollination Pressures: Potential indirect risks include reduced genetic diversity caused by the isolation of floral fragments and corresponding declines in local pollinator vectors.
- Historical Context: Because historical regional developments and urban expansion have already isolated the Fendell Campus ecosystem from larger, continuous forest blocks, the additional indirect impacts induced by this specific project are statistically Insignificant.

8.6 Sustainable Green Infrastructure and Architectural Specifications

To minimize its structural footprint and act as a model for regional climate change adaptation, the botanical garden will incorporate sustainable engineering and eco-friendly design elements:

8.6.1 Resource Self-Sufficiency and Catchment Design

- Renewable Energy Integration: The facility will deploy solar photovoltaic (PV) arrays to power administrative and research zones. Funding permitting, solar-canopy covered parking structures will be installed during Phase 1; alternatively, they will remain a core capital goal for subsequent expansion phases.
- Hydrological Engineering: Rainwater harvesting architectures will be integrated into all major structures to capture roof runoff, providing a sustainable, zero-cost water source for seasonal nursery irrigation and the primary riparian exhibits.

8.6.2 Boundary Security and Collection Protection

- Perimeter Fencing: To insulate the delicate ex-situ plant collections from foraging wildlife and unauthorized human extraction, the entire 73.85-hectare boundary will be secured with heavy-duty, non-invasive perimeter fencing.

8.6.3 Universal Access and Low-Impact Civil Works

- Pedestrian Trail Infrastructure: Public walking paths will be engineered with wide, low-gradient profiles to ensure universal accessibility for elderly and mobility-impaired visitors.
- Permeable Surficial Materials: Internal paths will feature a natural, quarter-inch minus crushed rock aggregate. Rigid, high-durability surfaces like flagstone or pavestone will be restricted to high-traffic areas, including entryway plazas, sanitation facilities, greenhouses, the research library, and the restaurant terrace.

8.6.4 Multifunctional Visitor Center Layout

The primary structural anchor of the development will consist of a centralized, multi-use Visitor Center designed to consolidate administrative and commercial operations:

- Commercial & Public Spaces: A curated botanical gift shop, an art gallery, a dedicated regional rock and mineral exhibition gallery, and a full-service restaurant.
- Scientific & Research Units: A specialized naturopathic and ethnobotanical research repository.
- Administrative Infrastructure: Executive staff offices and secure multi-stakeholder conference rooms.

9. Gardens Infrastructure

9.1 The Design

The design of the Garden will include rainwater harvesting (for irrigation and a riparian exhibit) and solar power technologies to make the Garden as self-sufficient and "green" as possible.
Because of the Gardens proximity and access to the surrounding grassland and farmland. The entire parcel will be fenced in a way to keep foraging human and animals out which would damage the plant collection.

Funding and incentives will determine whether or not solar covered parking structures will be used initially. If not able to do initially, it will be a goal of the Garden to add it in the future. Walking paths will be as flat and wide as possible to accommodate the elderly and disabled. The walk surfaces will be natural $^{1}/_{4}$" minus crushed rock (flagstone or pavestone in the entryways, around the bathrooms & greenhouses, library and in the restaurant area).
The Visitors Center will also house the gift shop, naturopathic/ethnobotanical center, art gallery, rock and mineral gallery, restaurant, staff offices and meeting room.

*Fig: 7 Map of Proposed Gardens and Infrastructures E. Kalapelee 15/09/2025/Fendell /CNC*L-SEE ANNEX 1

9.2. Likely Cost, Management, opportunities

The construction cost of the botanical garden is been estimated in phases based on the structures, start-up work, maintenance and staffing.

In terms of funding, allocation through the national legislature is recommended and should account for 50%, donor organization should account for 30% while, the remaining 20% should be source from crowd funding in addition to bank funding and personal funds from the University of Liberia. Depending on the success of the crowdfunding efforts, investors will also be an option. Gate admissions, memberships, facility rentals/plant/gift shop/Cafe sales will pay for payroll, recurring costs and maintenance.

a. Likely Stakeholders

We believed that Local and neighboring businesses, local and seasonal customers, NGOs/CSOs and the Government of Liberia are considered-stakeholder under this arrangement.

b. Likely visitors — number and type

The likely visitors will include plant enthusiasts, tourists, schools or other visitors, students, and residents of Liberia.
The highest visitors may be recorded from mid-October through March with average number of visitors per day reaching 200 to 300 range. In April & May, the average number of visitors per day could reach 100 to 200 range while from June through September, the average number of visitors per day could range from 50 to 100.

c. Management

We are proposing that there should be an Office Manager/HR, Director of Horticulture and Collections, Director of Education and Visitor Services, and Director of Conservation and Science. Some of these positions will be phased in over the first few years of operations.

d. Staffing

Staff will be needed for the Visitors Center (entrance, art gallery, rock and mineral display area, library, gift shop, grounds keeping and café). Volunteers will also be utilized in these and other areas. Staffing will be the first priority; additional management staff will be phased in over the first year of operation. Staffing for the Visitor Center, volunteers, Office management and grounds keeping staff.

e. Volunteer involvement

A good portion of the staff would be on a volunteer basis. Volunteers would be used for guides, experts as well as for basic garden maintenance (clearing walkways, weed removal, restroom maintenance, etc.). The volunteers would report to a Volunteer Coordinator. The main sources of the volunteer staff would be international and local visitors and possibly students from UL and other Universities.

f. Planting Material

Significant portion of the planting materials can be obtained locally There are a number of nurseries already existing at the Old College of Agriculture and Forestry site that will serve as hub of the plants that can provide the initial necessary planting materials.

All trees, shrubs, cacti, succulents and other plants are available locally (first choice, or at the Nursery site) or will come from other collection.

g. Fire

The Garden will be exposed to open land space on two sides in the proposed locations and therefore would be exposed to wild fire should one start. There is also the possibility of a lightning strike starting a fire within the Garden's borders. In either case, the Gardens sprinkler system would be utilized to minimize any damage to the collections.

h. Weeds

Weeds will be controlled through manual removal; chemicals will not be used.

i. Local influence

The garden will be a local attraction. Other local businesses will benefit from the Garden because of additional traffic through the area either on the Bentol or Kakata road. The Town of Bentol Junction may also benefit from the additional traffic in terms of tax revenue, awareness, as well as businesses looking to relocate.

j. Commercial opportunities

There will be a naturopathic/ethnobotanical center on site separate from the garden, as well as an art gallery and rock/mineral display with items for sale. Food/drinks/plants/souvenirs/rentals as well as seasonal farmers markets, arts and crafts shows. These activities should be run by the botanical garden administration with some consideration for private businesses.

10 Project Justification, Conclusion, and Recommendations

10.1 Strategic Project Justification

Initial field assessments designated Block A and a portion of Block B as the primary candidates for development due to optimal biophysical indicators. However, a joint verification mission—which included the President of the University of Liberia—revealed critical shifts in the socio-environmental landscape. The primary plots showed high levels of recent vegetation clearing, soil disturbance, severe land tenure disputes, and community hostility. Consequently, the University administration placed an immediate hold on Blocks A and B until these socio-legal conflicts are formally resolved.

In response to these prevailing constraints, a secondary assessment was executed across alternative parcels, leading to the selection of 73.5 hectares within Blocks C and D [0]. This definitive site selection is justified by six primary institutional and ecological parameters:

1. Enhanced Institutional Control: The University of Liberia maintains absolute statutory command and greater administrative oversight over these specific tracks, minimizing legal vulnerabilities.
2. Perennial Hydrological Resources: The site features a stable, sustainable water network capable of driving gravity-fed irrigation and supporting diverse aquatic plant collections.
3. High Ecotourism and Avian Potential: The presence of functional wetland ecosystems offers an ideal environment for development into high-value bird-watching zones and ecotourism hubs.
4. Mitigated Anthropogenic Encroachment: Compared to adjacent blocks, Blocks C and D exhibit minimal human settlements and lower rates of informal boundary encroachment.
5. Optimal Spatial Proximity: The site is strategically positioned near the main highway and shares close proximity with three vital academic hubs: the College of Agriculture, the College of Science, and the Chinese-built facility.
6. Intact Soil Profiles: Low baseline soil disturbance significantly reduces initial land-clearing costs and preserves native subterranean seedbanks.

10.2 Operational Recommendations

To transition this project from a feasibility framework into practical execution, the study outlines seven critical recommendations:

1. Baseline and Impact Assessments: Conduct comprehensive, localized ecological and soil surveys alongside a formal Environmental and Social Impact Assessment (ESIA) prior to executing the master plan.
2. Institutional Land Security: Formally secure and protect the 73.5-hectare boundary using binding university policies and legal land-banking declarations.
3. Phased Architectural Programming: Develop a granular, long-term master plan coupled with an itemized, phased capital expenditure (CAPEX) budget model.

4. Global Strategic Alliances: Establish formal technical partnerships with leading international botanical networks, including Botanic Gardens Conservation International (BGCI) and the Royal Botanic Gardens, Kew.
5. Diversified Capital Mobilization: Source development funding by combining state allocations, international environmental donor grants (e.g., UNDP, GEF), and private sector sustainability investments.
6. Immediate Infrastructure Security: Prioritize the installation of secure perimeter fencing around the entire designated 73.5-hectare landscape before launching any internal field activities.
7. Pilot Implementation Scalability: Launch a small-scale, highly managed demonstration garden as a pilot phase to test propagation protocols and build institutional capacity before full-scale expansion.

10.3 Conclusion

This feasibility study confirms that establishing a Botanical Garden at the University of Liberia Fendell Campus is technically viable, environmentally restorative, socially desirable, and financially justifiable. Long-term sustainability and success are highly achievable, provided the project utilizes a phased implementation model and maintains robust multi-stakeholder partnerships across national and international levels.

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Appendix G: Financial Projections, Capital Expenditure (CAPEX), and Operational Budget Models

DETAILED COST BUDGET FOR THE UL BOTANICAL GARDEN FENDELL
University of Liberia – Estimated Costs (USD)

1. LAND PREPARATION & SITE DEVELOPMENT (73Ha)

Item	Description	Estimated Cost (USD)
Land clearing (73.85 ha)	Brush clearing, grading	**$39,000**
Earthworks	Leveling, water channels, road grading	**$26,000**
Internal access roads	5–7 km compacted roads	**$45,000**
Perimeter fencing (≈5.5 km)	Chain-link fence + concrete posts	**$85,000**
Main gate & guardhouse	2 main entrance block	**$8,500**
Land survey & mapping	Professional surveying & GIS	**$4,200**
Subtotal		**$207,700**

2. NURSERY & PLANT COLLECTION (Large-Scale)

Item	Description	Cost
Central nursery development	Shade houses, propagation areas	**$15,000**
Three satellite nurseries	Distributed on site	**$9,000**
Greenhouse (2 units)	Propagation of sensitive species	**$17,000**
Native plant collection	Field expeditions, transport	**$12,000**
Exotic species collection	Tropical & ornamental imports	**$6,500**
Soil improvement materials	Compost, topsoil, organic matter	**$3,500**
Plant labeling system	Metal tags, poles	**$3,200**
Subtotal		**$66,200**

3. INFRASTRUCTURE & FACILITIES (University Standard)

Item	Description	Cost
Car Park, CCTV and Booth	Car Parks, Booths, CCTV instalations	**$72,000**
Herbarium facility	Storage, equipment, drying area	**$28,000**
Irrigation system (59 ha)	Water lines, pumps, tanks	**$21,000**
Borehole + solar pump	Renewable water supply	**$11,500**
Walking trails (7–10 km)	Gravel paths, wooden bridges	**$22,000**
Benches, shelters, pavilions	10–12 structures	**$9,800**
Signage & interpretation	Learning boards, mapping	**$6,500**
Solar lighting	Main pathways & buildings	**$12,000**
Public toilets (3 blocks)	Male/Female, water system	**$15,000**
Waste management system	Composting zone, bins	**$2,500**
Subtotal		**$200,300**

4. EQUIPMENT & SUPPLIES

Item	Description	Cost
Gardening equipment	Professional tools	**$3,000**
Power equipment	Brush cutters, mowers	**$6,500**
Utility vehicle (1 pickup)	Transport for staff	**$22,000**
Small tractor + trailer	Clearing & maintenance	**$18,000**
Office equipment	Computers, printers	**$3,200**
Subtotal		**$52,700**

5. STAFFING (Annual – Large Garden)

Position	Qty	Monthly	Annual Cost
Garden Director	1	$700	$8,400
Horticulturists	4	$400	$19,200
Gardeners	12	$200	$28,800
Security officers	8	$150	$14,400
Research assistants	2	$350	$8,400
Administrative assistant	1	$250	$3,000
Technical staff	2	$300	$7,200
Subtotal			**$89,400**

6. OPERATIONS & MAINTENANCE (Annual)

Item	Cost
Fuel, maintenance & repairs	**$8,500**
Seeds, fertilizers & soil inputs	**$4,500**
Utilities	**$3,200**
Staff training	**$2,000**
Community outreach & education	**$2,500**
Contingency (10%)	**$2,100**
Subtotal	**$22,800**

GRAND TOTAL ESTIMATED COST (A)

Section	Cost (USD)
Land Preparation	$207,700
Nursery & Plants	$66,200
Infrastructure	$200,300
Equipment	$52,700
Staffing (Year 1)	$89,400
Operations (Year 1)	$22,800
TOTAL ESTIMATED COST	**$639,100**

FOUR MAIN BUILDINGS FOR THE UNIVERSITY OF LIBERIA BOTANICAL GARDEN

Below are the **recommended structures** for the university-level botanical garden:

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1. RESEARCH & EDUCATIONAL CENTER

Purpose:

- ICT center
- Laboratories for plant analysis
- Lecture room (40–60 seats)
- Herbarium storage room
- Meeting room

Estimated Cost: USD 110,000

Key Features:

- Two-floor structure
- Solar power + backup system
- Digital database area
- Plant specimen storage cabinets

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2. VISITOR AND RECREATION CENTER

Purpose:

- Public visitor hall
- Exhibits on Liberia's plant biodiversity
- Reception and ticketing
- Mini-museum and learning displays
- Gift shop & café (optional)

Estimated Cost: USD 140,000

Key Features:

- Natural lighting
- Display boards and botanical artwork
- Restroom block included

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3. NURSERY/GREENHOUSE COMPLEX AND SERVICE CENTER

Purpose:

- Seed propagation area
- Two greenhouses (shade + humidity control)
- Storage for tools and inputs
- Office for horticulture staff
- Service center

Estimated Cost: USD 105,000

Key Features:

- 2,000–3,000 m² nursery
- Drip irrigation
- Shade-net structures
- Compost preparation section

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4. ADMINISTRATION & OUTREACH CENTER

Purpose:

- Training hall (50–80 participants)
- Workshops for schools & communities
- Small library and resource center
- Space for exhibitions and events
- Office space for staff and managers

Estimated Cost: USD 125,000

Key Features:

- Projectors and teaching equipment
- Worktables for practical lessons
- Solar lighting
- ICT corner

SUMMARY COST FOR THE 4 BUILDINGS (B)

Building	**Estimated Cost (USD)**
Research & Educational Center	$110,000
Visitor and Recreation Center	$140,000
Nursery/Greenhouse Complex and service center	$105,000
Administrative center	$125,000
TOTAL (Range)	**$480,000**
GRAND TOTAL A+B	**1,119,000**

[BREAKDOWN OF MAIN BUILDING COST]

1. RESEARCH & EDUCATIONAL CENTER
Total Estimated Cost: USD 110,000
A. Building Construction (Core Structure) – $65,000
- Foundation, concrete, steel, block walls – **$22,000**
- Roofing (zinc or aluminum + trusses) – **$8,000**
- Doors & windows (aluminum/glass) – **$9,000**
- Internal partition walls – **$4,500**
- Plumbing & restrooms – **$6,000**
- Painting & finishing – **$14,500**

B. Internal Facilities – $30,000
- 1 lecture room (40–60 seats) – **$6,000**
- Meeting room setup – **$4,000**
- Laboratory setup (basic benches, sinks, shelving) – **$10,000**
- Herbarium storage cabinetry – **$10,000**

C. Utilities – $15,000
- Solar power (off-grid mini system) – **$12,000**
- Water connection (tank, pump, plumbing) – **$3,000**

D. Furniture & Equipment – $10,000
- Office furniture & computers – **$8,500**
- Filing/storage – **$1,500**

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2. EDUCATION & VISITOR CENTER
Total Estimated Cost: USD 140,000
A. Building Construction – $60,000
- Hall (public space) + ticketing area – **$30,000**
- Walls, flooring, windows – **$20,000**
- Exhibition space construction – **$10,000**

B. Exhibition & Visitor Facilities – $25,000
- Botanical display boards – **$5,000**
- Display tables, cases, stands – **$3,000**
- Mini-museum panels – **$10,000**
- Café/gift shop optional fit-out – **$7,000**

C. Utilities & Solar – $12,000
- Solar lighting – **$8,000**
- Water & restroom block – **$4,000**

D. Furniture & Equipment – $10,000
- Reception desks, chairs – **$2,000**
- Public seating – **$4,000**
- Projector & screens – **$4,000**

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3. NURSERY & GREENHOUSE AND SERVICE CENTER
Total Estimated Cost: USD 105,000
A. Nursery Structures – $30,000
- Shade house (netting + posts) – **$15,000**
- Seedling tables/benches – **$5,000**
- Storage/tool shed – **$4000**
- Water lines & taps – **$6,000**

B. Two Greenhouses – $40,000

- Framed poly/UV-plastic structures – **$20,000**
- Humidity control & ventilation – **$20,000**

C. Nursery Inputs – $5,000

- Potting soil, compost, trays – **$2,000**
- Seed storage containers – **$1,000**
- Irrigation sprinklers/drip lines – **$2,000**

D. Equipment – $6,000

- Sprayers, watering tools – **$1,000**
- Wheelbarrows, cutters, rakes – **$1,500**
- Small power equipment – **$3,500**
- Vehicle 4x4 pick-up--**24,000**

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4. ADMINISTRATiVE &OUTREACH CENTER

Total Estimated Cost: USD 125,000

A. Building Construction – $45,000

- Main training hall (50–80 seats) – **$20,500**
- Restrooms – **$3,500**
- Storage room – **$1,500**
- Floor tiles, windows, doors – **$15,000**

B. Training Facilities – $21,000

- Chairs & tables (80 pax) – **$5,500**
- Whiteboards, flip charts – **$1,000**
- Projector & digital screens – **$4,000**
- ICT corner (laptops, printer) – **$10,500**

D. Solar & Utilities – $59,000

- Solar lighting system – **$8,000**
- Water system – **$2,000**
- Vehicle for 3 staff--**$49,000**