BIODIVERSITY FIELD SURVEY REPORT

RETRAP 85 km Road Corridor

B'hai Jorzon, Toe Town, Zwedru, Grand Gedeh County, Liberia

Survey Phases: Phase 1 (Rainy Season, Oct–Nov 2025) & Phase 2 (Dry Season, Dec 2025–Feb 2026)



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In partnership with:	Wild Chimpanzee Foundation (WCF) Fauna & Flora Solimar International	
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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
AOI	Area of Influence
BFS	Biodiversity Field Survey
BMP	Biodiversity Management Plan
C-ESMP	Contractor's Environmental and Social Management Plan
CH	Critical Habitat (under World Bank ESS6)
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CR	Critically Endangered (IUCN Red List category)
CSZ	Chimpanzee Sensitivity Zone
DBH	Diameter at Breast Height
EBA	Endemic Bird Area (BirdLife International)
EN	Endangered (IUCN Red List category)
EPA	Environmental Protection Agency of Liberia
EPML	Environmental Protection and Management Law of Liberia (2003)
ESCP	Environmental and Social Commitment Plan (World Bank)
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESS10	Environmental and Social Standard 10 — Stakeholder Engagement and Information Disclosure (World Bank ESF)
ESS6	Environmental and Social Standard 6 — Biodiversity Conservation and Sustainable Management of Living Natural Resources (World Bank ESF, 2018)
FDA	Forestry Development Authority of Liberia
FGD	Focus Group Discussion
FPIC	Free, Prior and Informed Consent
GFW	Global Forest Watch
GIS	Geographic Information System
GN6	IFC Performance Standard 6 Guidance Note 6 (2019)
GPS	Global Positioning System
GRM	Grievance Redress Mechanism
IDA	International Development Association (World Bank Group)
IFC	International Finance Corporation
IIU	Infrastructure Implementation Unit (Ministry of Public Works, Liberia)
IUCN	International Union for Conservation of Nature
LC	Least Concern (IUCN Red List category)
MoU	Memorandum of Understanding
NFRL	National Forestry Reform Law of Liberia (2006)
NT	Near Threatened (IUCN Red List category)
NTFP	Non-Timber Forest Product
PS6	Performance Standard 6 (IFC, Biodiversity Conservation and Sustainable Management of Living Natural Resources)
QA/QC	Quality Assurance / Quality Control
RACI	Responsible, Accountable, Consulted, Informed (responsibility-assignment matrix)
RAI	Relative Abundance Index (camera-trap derived)
RETRAP	Rural Economic Transformation Project
ROW	Right of Way
SCNL	Society for the Conservation of Nature in Liberia
SE	Supervising Engineer
SECRAMP	Southeastern Corridor Road Asset Management Project

SEP	Stakeholder Engagement Plan
SMART	Spatial Monitoring and Reporting Tool
SZ	Sensitivity Zone (e.g., Chimpanzee Sensitivity Zone)
TEK	Traditional Ecological Knowledge
UTM	Universal Transverse Mercator (map grid)
VU	Vulnerable (IUCN Red List category)
WB	World Bank
WCF	Wild Chimpanzee Foundation
WWF	World Wide Fund for Nature

EXECUTIVE SUMMARY OVERVIEW

Project context. This Biodiversity Field Survey supports the rehabilitation and upgrading of an existing road corridor between B'hai Jorzon, Toe Town and Zwedru in Grand Gedeh County. The alignment is not a new road. It has been in use for many years. Conversion and fragmentation of habitat along the corridor occurred over previous decades and are recorded here as baseline conditions, not as effects created by the present works.

The Infrastructure Implementation Unit (IIU) of the Ministry of Public Works (MPW) commissioned the Society for the Conservation of Nature of Liberia (SCNL), working with specialists from the Wild Chimpanzee Foundation (WCF), Fauna & Flora, and Solimar International, to undertake a Biodiversity Field Study (BFS) for the RETRAP Lot 2 road corridor. The study included detailed field surveys covering both the rainy season (October–November 2025) and dry season (December 2025–February 2026). The results supplemented the key biodiversity baseline and addressed data and technical gaps in existing ESIA. The findings also informed the development of the Biodiversity Management Plan (BMP), which has been incorporated as an annex to the updated ESIA to guide the management and mitigation of biodiversity related impacts during road rehabilitation civil works.

The survey has a defined purpose. The 2023 ESIA, approved under the Additional Financing, identified the species of special concern for field confirmation before civil works — the Western Chimpanzee, the African Forest Elephant, the Pygmy Hippopotamus and pangolins — and this survey confirms their presence or absence along the right-of-way, the area of influence and the survey buffer (Section 1.3.1, Table 1.5). It identifies wildlife and habitats of conservation significance within the right-of-way, the area of influence and associated ancillary sites. It assesses impacts that are reasonably attributable to the proposed rehabilitation. It recommends practical measures to reduce those impacts during detailed design, construction and the defects-liability period. The survey does not set out a long-term landscape management program or present a budget for activities after the project period. Ideas that extend beyond the works may be kept for information in a separate note. They are not findings of this survey and are not obligations of the project.

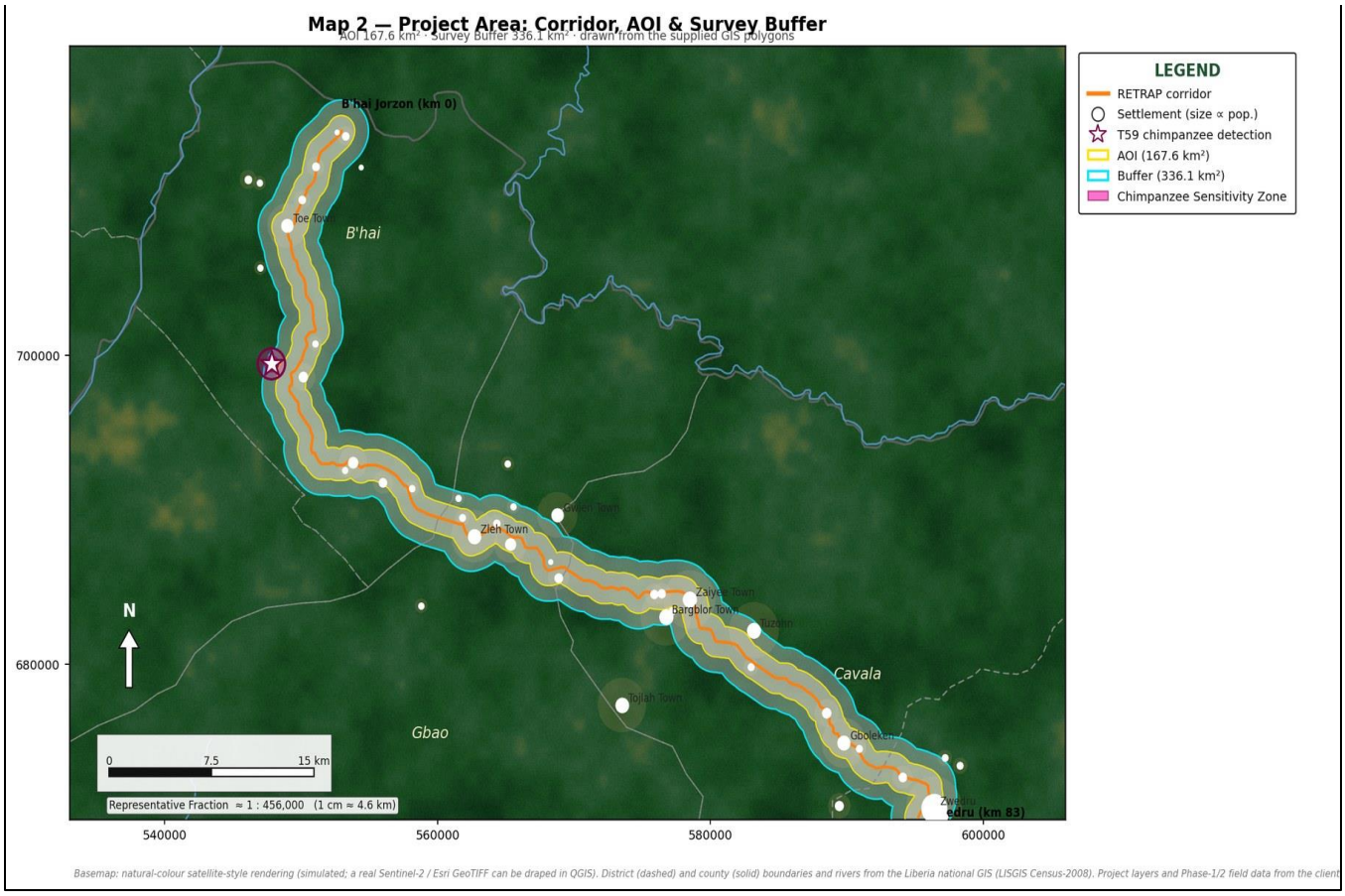


Figure ES-1: Map of the project corridor, AOI, and Survey buffer

Survey area and distances from the road. The survey used three nested zones measured from the road centreline: the approved right-of-way — a cleared width of about 5 m either side of the centreline with a retained vegetation buffer to about 15 m (Figure 5.5), inside the legal road reserve of 75 ft (about 23 m) either side of the centreline that applies in rural areas — within a 500 m sub-area of influence that captures the direct works footprint; the area of influence, a 2 km band either side of the road (about 340 km² over 85 km) in which all effects of the works are assessed; and the survey buffer, extending 5 km either side (about 850 km²), used as reference context only. Sensitive nodes are referred to by chainage from B'hai Jorzon: the Towah swamp at km 12–14, the Chimpanzee Sensitivity Zone at km 18–20 (about 1.6 km off the alignment near Senewehn), the threatened-flora hotspot at km 18–28 and the pangolin Critical Habitat polygons at km 38–50.

Survey design and effort. The BFS was executed in two seasonally complementary phases: Phase 1 (rainy, October–November 2025) and Phase 2 (dry, December 2025–February 2026). It applied a multi-method, multi-taxon design across a nested study area (500 m Sub-AOI within the Right-of-Way; 2 km Area of Influence; 5 km Extended Buffer). Total effort: 108 line transects walked twice (216 transect-km), 343 km of recce walks, 97 camera-trap stations yielding ~3,810 functional trap-nights, 85 botanical plots (5.31 ha sampled), 45 bird point counts, and 21 community Focus Group Discussions with 464 participants, 214 of them women. The area of influence is a band along the existing centerline, together with borrow pits, quarry, and camp candidates. A wider survey buffer provided landscape context only.

Table ES-1: Survey design and effort in summary (two phases, October 2025 to February 2026; detail in Table 2.2).

Survey element	Effort by zone and phase	Total
Line transects (1 km, perpendicular to road)	54 AOI + 54 Buffer per phase	108 transects walked twice = 216 transect-passes
Reconnaissance walks	82 + 74 km (Phase 1); 98 + 89 km (Phase 2)	343 km
Camera-trap stations	67 deployed Phase 1 (50 usable); 60 deployed Phase 2 (47 usable)	97 usable stations of 127 deployed; about 3,810 trap-nights
Botanical plots (25 × 25 m)	42 AOI + 41 Buffer	85 plots; 5.31 ha sampled
Bird point counts	25 AOI + 20 Buffer	45 counts
Community consultations	6 towns (Phase 1); 15 towns (Phase 2)	21 engagements; 464 participants (214 women)

Baseline biodiversity findings. Most of the roadside is already a modified mosaic of farms, fallow, secondary growth and settlement. Residual forest patches, swamp and riparian strips remain at intervals. Hunting pressure is part of the existing baseline. Forest-cover loss along the corridor is a long-running trend and predates these works.

The BFS confirmed 30 mammal species, 206 bird species and 96 tree species (at least 10 cm DBH) along the corridor. Twenty-six of these are IUCN-listed: 7 mammals (including the Endangered White-bellied Pangolin, the Vulnerable Black-bellied Pangolin and the precautionary Western Chimpanzee record), 6 birds (1 EN Grey Parrot Timneh and 5 VU including two large hornbills and the White-necked Rockfowl/Picathartes), and 13 trees (1 EN Tieghemella heckelii at the Barteh Jam sacred grove, plus 12 VU). Twenty-eight FDA Class A and Class B timber species are present. Apex predators (leopard, elephant, pygmy hippo) are effectively absent — consistent with historical extirpation, not project-induced loss.

ESS6 Critical Habitat determination. Critical Habitat is TRIGGERED under ESS6 Criterion 1 (Highly Threatened Species) by (i) the confirmed resident presence of White-bellied Pangolin (EN) — four independent camera events at four AOI stations — and (ii) precautionary treatment of a single Western Chimpanzee (CR) detection in the Buffer. Three CH polygons totaling 22.6 km² are spatially delineated: CH-West Pangolin (8.7 km², km 38–44), CH-East Pangolin (10.8 km², km 46–50), and the Chimpanzee Sensitivity Zone (3.14 km², km 18–20) including a 0.78 km² absolute no-go core. Criteria 2–5 are not triggered at the strict CH threshold, but six Priority Biodiversity Features covering 14.2 km² are designated.

Impacts of the proposed works: Because the road already exists, the additional effects of this rehabilitation are local and limited in time. They arise from vegetation clearance inside the approved footprint; noise, light and collision risk while crews and plant are on site; sediment at watercourse crossings; the siting of quarries, borrow pits, crushers, camps and laydown areas; and hunting or bushmeat demand associated with the workforce. The survey does not treat historical fragmentation, or future land-use change along an already open corridor, as impacts that this project must reverse through a multi-year conservation program. Those pressures are described so that construction measures can be targeted and within the project scope.

Mitigation Measures During Design and Construction: Measures are confined to what the works can actually deliver. A Biodiversity Management Plan will be prepared as an annex to the 85-kilometer Environmental and Social Impact Assessment of the RETRAP project and will be implemented through the Contractor's Environmental and Social Management Plan (C-ESMP). Supervision of wildlife-sensitive nodes will be carried out as part of ESIA Environmental and Social Management Plan monitoring.

The following actions are the operational core of this survey:

- Keep the works on the existing alignment. Any micro-adjustment to spare a marked tree or no-go edge remains inside the approved right-of-way.
- Do not open a new quarry, borrow pit, crusher, batching plant, camp or laydown inside the Chimpanzee Sensitivity Zone or the pangolin polygons.
- Demarcate the no-go core at kilometer 18–20 before vegetation clearance begins in that segment. Entry is by written clearance only.
- In the Sensitivity Zone and Critical Habitat polygons, restrict work to 08:00–16:00. Do not carry out night work or blasting.
- Install and maintain a 20 kilometer-per-hour speed limit and warning signage through the Sensitivity Zone and at confirmed movement hotspots.
- Complete a pre-clearance walkover and peg the right-of-way before felling in sensitive segments. Do not cut FDA Class A stems except under an agreed stem-by-stem protocol.
- Provide a wildlife crossing, an oversized culvert, a span structure or a canopy bridge only where this survey documents a movement hotspot or where a swamp crossing would otherwise be filled. The documented movement hotspots and the candidate structure locations are identified in Chapter 3 of this survey (the segment nodes and crossings), with the structure types and candidate locations shown at Figure 5.1; Towah swamp is the one location this survey itself identifies for a span or large-box structure. These structures are not a default on every kilometer. The Contractor’s design engineer prepares the drawings for review by the Supervising Engineer and the Employer.
- At Towah swamp, prefer a span or large-box structure over fill, and schedule in-stream work for low flow.
- Enforce a workforce Code of Conduct that prohibits hunting, bushmeat, and keeping or trading in wildlife. Inspect camps weekly (unannounced checks of cooking areas, waste points and stores), with monthly verification by the Supervising Engineer. Community wildlife reports (sightings at the works, road-kill, snares, hunting or trade observations) are received through the project grievance mechanism as a wildlife-report category: the Contractor's Community Liaison Officer registers each report within 48 hours and refers it to the Biodiversity Specialist for verification and response, and the mechanism's acknowledgement and feedback timelines apply, so the reporter receives a documented answer. The grievance mechanism is thus the standing community channel for wildlife matters; no separate hotline is created.
- Hold induction before crews enter sensitive nodes and hold short awareness sessions in the nearest communities before works arrive.
- Restore only the surfaces the project disturbs — right-of-way edges, slopes, borrow, and quarry faces that the contract must close, camp platforms, and open stream banks. Achieve at least 70 percent vegetative cover by the end of the first rainy season after planting. Where survival falls below 60 percent, replace at a 5:1 ratio at the Contractor’s cost.

Table ES-2: Priorities during the works.

Priority during the works	**Intent**
Keep ancillary sites out of the Sensitivity Zone and pangolin polygons; demarcate the no-go core	Avoidance first
Working hours, no blasting, speed signage and Code of Conduct at those nodes	Reduce disturbance and hunting risk from the workforce
Crossings or oversized culverts only at documented hotspots; Towah swamp span or large box	Match engineering to evidence
Pre-clearance walkover, right-of-way pegging and Class A tree protocol	Limit clearance to the approved footprint
Progressive restoration of disturbed surfaces and node checks under ordinary site supervision	Close the impact on land the project actually uses

Monitoring during the works. Monitoring is limited to the construction phase and the defects-liability period and is financed under ESMP supervision (Chapter 7). The Contractor keeps the records and the Supervising Engineer verifies them: weekly while the front is inside the Chimpanzee Sensitivity Zone or a pangolin polygon, monthly elsewhere, and a restoration check at the end of the first rainy season after planting. Trigger thresholds in Table 7.2 carry same-day instructions. The IIU holds the records and reports to the World Bank through ordinary ESCP supervision. This survey does not establish a multi-year scientific monitoring programme, an independent monitoring consultant or long-term performance audits; the Biodiversity Management Plan that the IIU will annex to the updated ESIA will carry any operation-phase arrangements.

Recommended budget. The BMP implementation is the responsibility of the Contracting Entity. The Contractor's design engineer will estimate the cost of justified crossings and culvert or bridge modifications, Sensitivity Zone design adjustments, signage and restoration of the works footprint, and will include those costs in the design and construction budgets. Checks of the no-go core, working hours, camps, signage and restored surfaces are part of Environmental and Social Management Plan supervision and are covered by the supervision budget.

Conclusion: The existing 85-kilometer road can be rehabilitated without significant residual harm to the Critical Habitat values identified in this survey, provided the construction-phase measures listed above are written into the Biodiversity Management Plan annex to the Environmental and Social Impact Assessment, priced into the works, and verified on site. That conclusion rests on node-level avoidance, method controls, evidence-based structures, workforce rules and restoration of the works footprint. It does not rest on a long-term ranger scheme, community conservation agreements, landscape planting, or finance after the project period.

1 INTRODUCTION AND PROJECT CONTEXT

This chapter places the Biodiversity Field Survey (BFS) within the context of the project. The 85 km project involves rehabilitating and upgrading an existing road. The conversion of habitats along the road alignment is part of the baseline assessment. The survey identifies critical wildlife species listed in the ESIA (Western Chimpanzee, African Forest Elephant, White-bellied and Black-bellied Pangolins, Jentink's Duiker, Pygmy Hippopotamus, White-necked Rockfowl, and the other IUCN-listed species detailed in Chapter 4) and habitats in the corridor and its Area of Influence (AoI), evaluates the impacts of the proposed works, and recommends practical mitigation measures for the detailed design, construction, and defects-liability period. Of the species of special concern, the African Forest Elephant and the Pygmy Hippopotamus were not detected by this survey and are assessed as absent or historical in the corridor; they trigger no Criterion 1 management actions (Chapter 4). A Biodiversity Management Plan (BMP) will be included as an annex to the 85 km Environmental and Social Impact Assessment (ESIA).

1.1 PROJECT OVERVIEW

1.1.1 Project identity and financing

The **Rural Economic Transformation Project (RETRAP)** is a multi-year investment program financed by the **World Bank (International Development Association, IDA)** in partnership with the **Government of Liberia**. The Project's development objective is to restore and sustainably maintain year-round motorable access on strategically important primary roads in Liberia, thereby improving market access for rural producers, reducing travel time to essential services, and supporting the country's post-conflict economic recovery. The 85 km segment assessed in this BFS is one of the two corridors (with the other being the initial 40km corridor (Tappita – Toes Town) upgraded under RETRAP and is executed by the **Infrastructure Implementation Unit (IIU)** of the Liberian **Ministry of Public Works**, under Contract **LR-IIU-222008-CS-QCBS**. The contract covers consulting services for environmental and social (E&S) safeguards supervision across RETRAP, the Southeastern Corridor Road Asset Management Project (SECRAMP) and the Liberia Road Asset Management Project (LIBRAMP).

This report covers one work package: rehabilitation of the existing B'hai Jorzon–Toe Town–Zwedru road in Grand Gedeh County (approximately 85 km). A parallel package covers the Tappita–Toe Town segment (approximately 40 km). This survey does not merge the two packages into a single long-term biodiversity program. It informs the 85 km ESIA and the BMP annex to that ESIA.

1.1.2 The 85 km Corridor — B'hai Jorzon to Zwedru via Toe Town

The corridor runs from B'hai Jorzon (kilometer 0, near the Liberia–Côte d'Ivoire border) through Toe Town and a sequence of established settlements (including Sennehwein, Zleh Town, Vanyeezon and New Tuzon) to Zwedru (approximately kilometer 85), the county capital. The alignment follows an existing unpaved laterite road that has connected these communities for decades. It is not a greenfield alignment.

That fact governs the rest of this report. The road footprint already sits in a historically modified landscape of farm-bush, cocoa plots, settlement and secondary forest patches. Most large-scale habitat loss along the corridor predates project planning. Additional biodiversity risk from these works is therefore limited to what the rehabilitation itself will do: clearance inside the approved right-of-way; noise, dust and collision while plant and crews are on site; siting of camps, quarries and borrow pits; sediment at watercourse crossings; and hunting or bushmeat demand linked to the workforce.

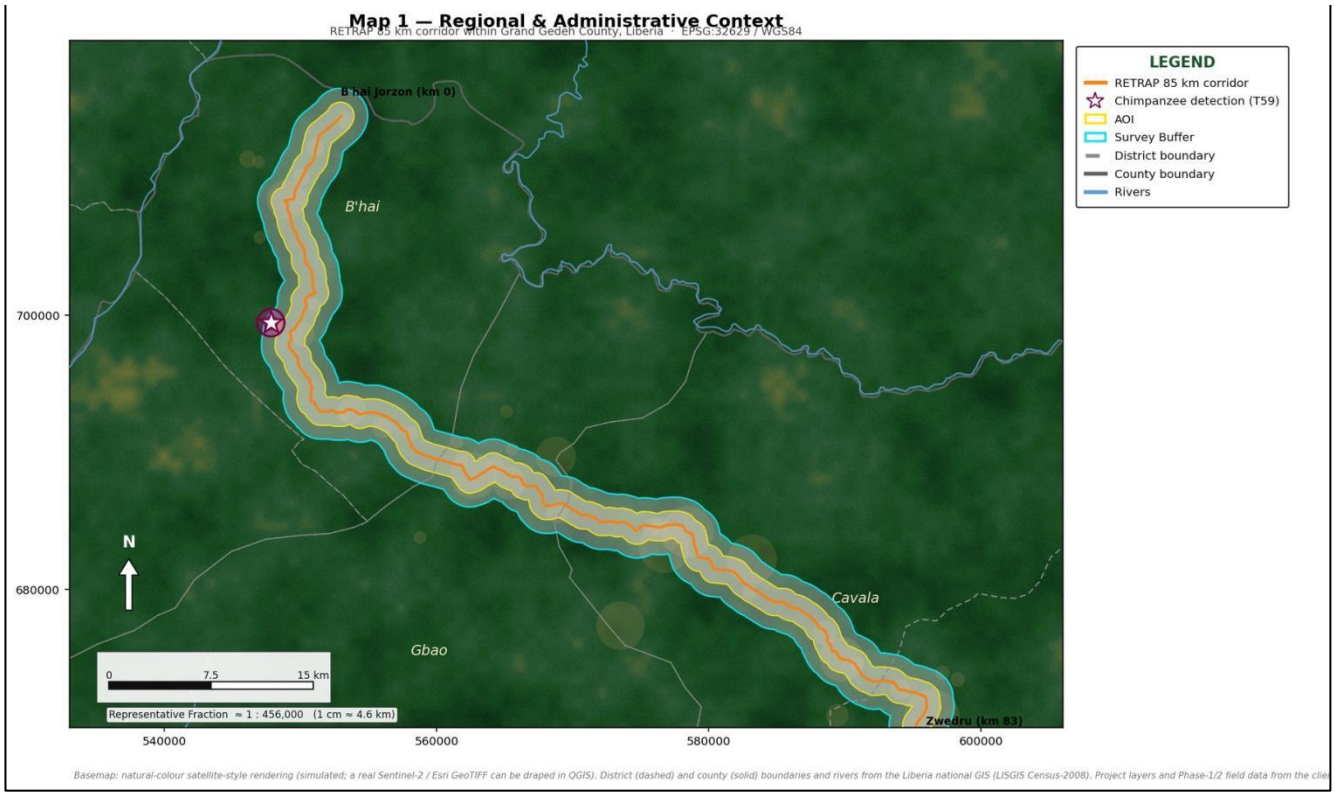


Figure 1.1: Project location: RETRAP 85 km corridor in Grand Gedeh County

1.1.3 Physical works and ancillary facilities

The proposed upgrade is summarised in **Table 1.1**. Works include paving to a bituminous standard, drainage improvement (installation and upsizing of culverts and bridges at stream crossings), limited horizontal/vertical realignment at sections affected by severe lateritic erosion or deficient sight-distance, and construction or use of ancillary facilities (detours, quarry sites, laydown areas, workforce camps). None of the ancillary sites identified during design screening lies in intact primary forest; all are sited in farm-bush, existing clearings or degraded plantation land. This was independently confirmed by field-level mapping during BFS Phases 1 and 2 as a precondition for subsequent habitat-loss calculations (Chapter 3).

Table 1.1: Summary of physical works and ancillary facilities associated with the 85 km RETRAP corridor upgrade

Works category	Description	Estimated footprint	Biodiversity exposure
Paving & earthworks	Full-width bituminous pavement with shoulders; re-gradient where necessary	~85 km × ~12 m = ~102 ha ROW	Largely within existing ROW; minor vegetation clearing in widening zones
Drainage structures	New/upsized culverts (~60) and 4 bridge refurbishments at major streams	Point impacts; <5 ha total	Wetland crossings (km 12–14, km 38, km 44, km 68) — key for aquatic passage + amphibians
Realignment spurs	~12 minor realignments (<200 m each) at erosion sites and blind bends	~6 ha cumulative	Some sites within AOI; 2 require targeted flora rescue (Ch 5)
Ancillary facilities	5 quarries, 4 laydowns, 3 worker camps (all in farm-bush / pre-disturbed ground)	~18 ha across all sites	Screened: no primary forest; 2 sites require additional EPA permitting
Temporary detours	Approx. 18 km of dry-season bypass length	~12 ha (mostly on road-edge)	Reversible; risk of new trails becoming permanent monitored under BMP M&E

1.2 Why a Biodiversity Field Survey

1.2.1 Data Gaps in the 2023 ESIA

The 2023 ESIA, approved under the Additional Financing, identified biodiversity risks but left important gaps for an ESS6 assessment of the 85 km package. These gaps include limited seasonal coverage, incomplete camera and transect data for the eastern and western extensions, and the absence of a finalized Critical Habitat determination based on current criteria. This survey has been commissioned to address these gaps through two field seasons and a comprehensive inventory of the entire corridor. An earlier BFS survey addressed the 40 km Tappita–Toe Town package. This survey extends the same field methods to the 85 km B'hai Jorzon–Zwedru package so that the 85 km ESIA has a matching evidence base. Methods were kept comparable so findings can be read together. The same methodology applied for two seasons of data collection and analysis.

The ESIA identified the species of special concern to be confirmed by field survey before civil works. Table 1.2 lists them with the result of this survey; the Critical Habitat screen in Chapter 4 applies the ESS6 criteria to the confirmed records.

Table 1.2: Species of special concern identified in the 2023 ESIA and their confirmation status in this survey (the IIU to confirm the ESIA list).

Species of special concern	IUCN	Result of this survey	Location
Western Chimpanzee (Pan troglodytes verus)	CR	Confirmed — one camera record (SCNL04, T59), February 2026; precautionary Sensitivity Zone	Buffer, km 19 (about 1.6 km off the alignment, near Senewehn)
African Forest Elephant (Loxodonta cyclotis)	CR	Not detected — no field evidence; community reports only	—
Pygmy Hippopotamus (Choeropsis liberiensis)	EN	Not detected — no evidence; no suitable habitat on the alignment	—
White-bellied Pangolin (Phataginus tricuspis)	EN	Confirmed — four independent camera events at four AOI stations; Criterion 1 trigger	AOI, km 38–50 (two polygons)
Black-bellied Pangolin (Phataginus tetradactyla)	VU	Confirmed — one camera record (SCNL02, T21)	AOI, km 38–50
Other Endangered species screened under Criterion 1: Jentink's Duiker, Timneh Grey Parrot, Tieghemella heckelii	EN	Jentink's Duiker: one unconfirmed image (Buffer); Grey Parrot: 15 records in 6 villages; T. heckelii: two stems at Barteh Jam	Chapter 4, Table 4.2

Table 1.3: RETRAP 125Km ESIA sections will update with the BFS study findings

Not covered in the existing RETRAP ESIA	Covered by the current BFS	Sections and chapters in ESIA. to update with BFS findings
Seasonal coverage incomplete	Rainy-season phase (Oct–Nov 2025) and dry-season phase (Dec 2025–Feb 2026)	Chapter 2
Eastern and western extensions under-sampled	Full 85 km centerline, AOI and buffer effort	Chapters 2–3
Critical Habitat not concluded under current criteria	Five-criteria screen; polygons and priority-feature register	Chapter 4
Crossing and node locations not field-verified	Camera, transect and consultation evidence at hotspots	Chapters 3–5
Workforce and camp risks not specified	Code of Conduct, camp siting and induction measures	Chapter 5

1.2.2 Objectives of the BFS

The objectives are limited to the project scope:

- Identify wildlife and habitats of conservation significance in the right-of-way, the area of influence and ancillary sites.
- Screen the corridor against the five Critical Habitat criteria and delineate any triggered polygons and priority features.
- Assess impacts that are reasonably attributable to the proposed rehabilitation and its ancillary sites.
- Recommend practical mitigation for detailed design, construction and defects liability, for use in the 85 km ESIA and in a Biodiversity Management Plan issued as an annex to that ESIA.

This survey does not prepare a long-term management plan, set multi-year targets, or present a budget for activities after the project implementation period.

Table 1.4: Survey objectives and where they are delivered

Objective	Use in this report
Wildlife and habitat inventory	Chapter 3
Critical Habitat screen and node maps	Chapter 4
Works-related impact assessment	Chapters 3, 5 and 8 (construction rows only)
Construction-phase mitigation for the ESIA / BMP annex	Chapter 5; BMP annex to the 85 km ESIA

1.3 Study Area

1.3.1 Spatial delineation — AOI and Buffer zones

The field used three nested zones. The legal road reserve is 75 ft (about 23 m) either side of the centreline in rural areas; the approved right-of-way for the works (about 5 m cleared, with vegetation retained to about 15 m; Figure 5.5) lies inside it. The right-of-way / sub-area of influence captures the direct works footprint. The area of influence captures foreseeable direct effects of construction and short-range disturbance. The extended buffer is a reference landscape only. It is not a project management unit, and it is not an area the road rehabilitation is required to restore.

Table 1.5: Study-area zonation and BFS function per zone.

Zone	Width each side	Total area (85 km length)	BFS function
Sub-AOI (ROW)	500 m	about 85 km²	Direct footprint; flora plots; clearance protocol
AOI	2,000 m (2 km)	about 340 km²	Primary study area for cameras, transects and most plots
Extended Buffer	5,000 m (5 km)	about 850 km²	Reference landscape only; not a project restoration area

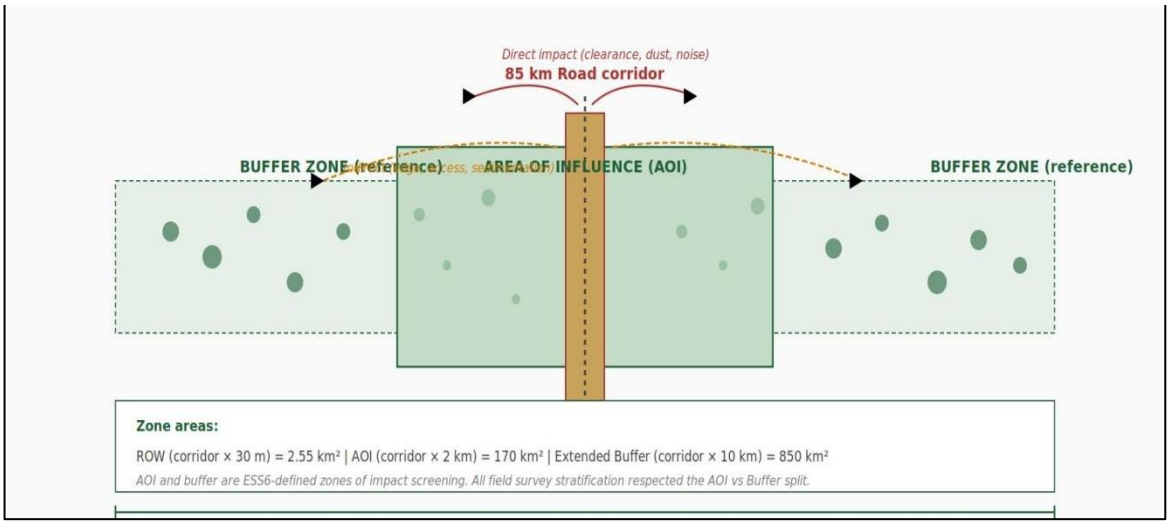


Figure 1.2: Nested survey zones along the existing road. The buffer is reference context only.

Schematic cross-section (road-perpendicular) of the nested study-area zones applied in the BFS: the 500 m Sub-AOI within the ROW (direct footprint), the 2 km AOI (primary study zone), and the 5 km Extended Buffer (reference/control zone).

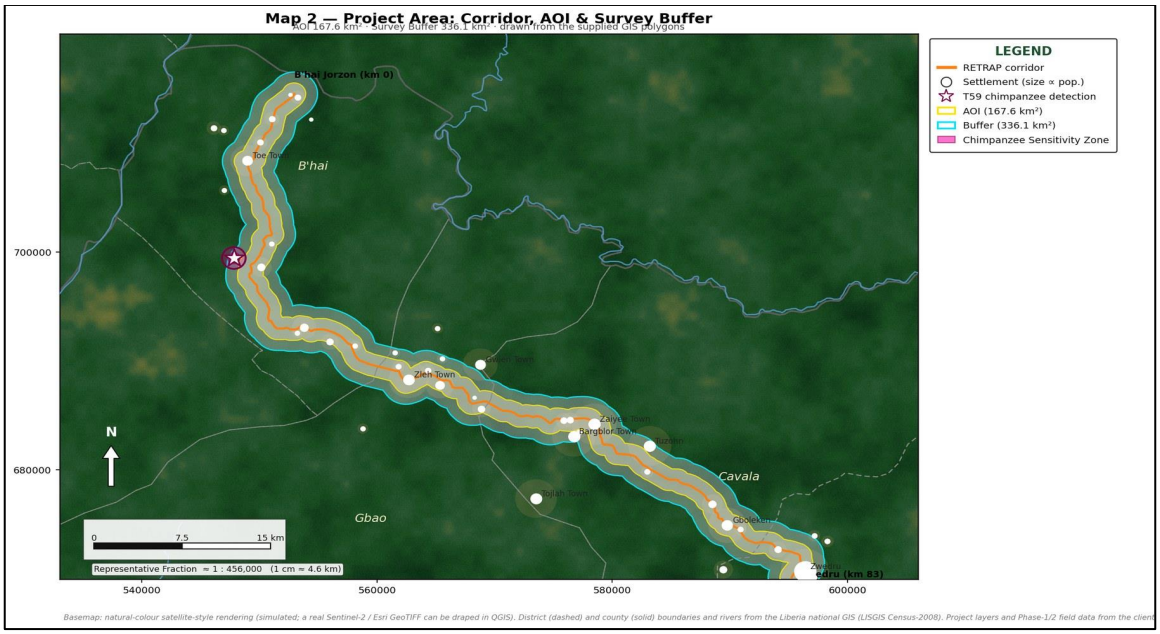


Figure 1.3: Project area: the existing corridor, the area of influence and the survey buffer (Map 2 of the Atlas).

1.3.2 Biogeographical context — Upper Guinean Forest Ecoregion

The corridor lies entirely within the Upper Guinean Moist Forest Ecoregion — one of WWF's *Global 200* priority ecoregions for conservation, a Conservation International biodiversity hotspot, and BirdLife International Endemic Bird Area EBA-084. Upper Guinean forests originally extended from Sierra Leone through Liberia and Côte d'Ivoire into western Ghana but have been reduced to approximately 15 percent of their historical extent through 150 years of logging, cocoa/coffee expansion and human settlement (Norris *et al.* 2010). Liberia retains about 43 percent of the remaining Upper Guinean forest cover, making it the single most important national custodian of the ecoregion. The 85 km corridor sits at the ecoregion's transition from lowland moist forest (west of km ~50) to moist forest / farm-bush mosaic (east of km ~50, approaching the Côte d'Ivoire border). Figure 1.4 situates the corridor within the surrounding landscape of gazetted national parks, proposed protected areas and protection forests. The 85 km road does not open a new forest frontier. It upgrades a route that already runs through a farm-bush mosaic at the edge of that ecoregion.

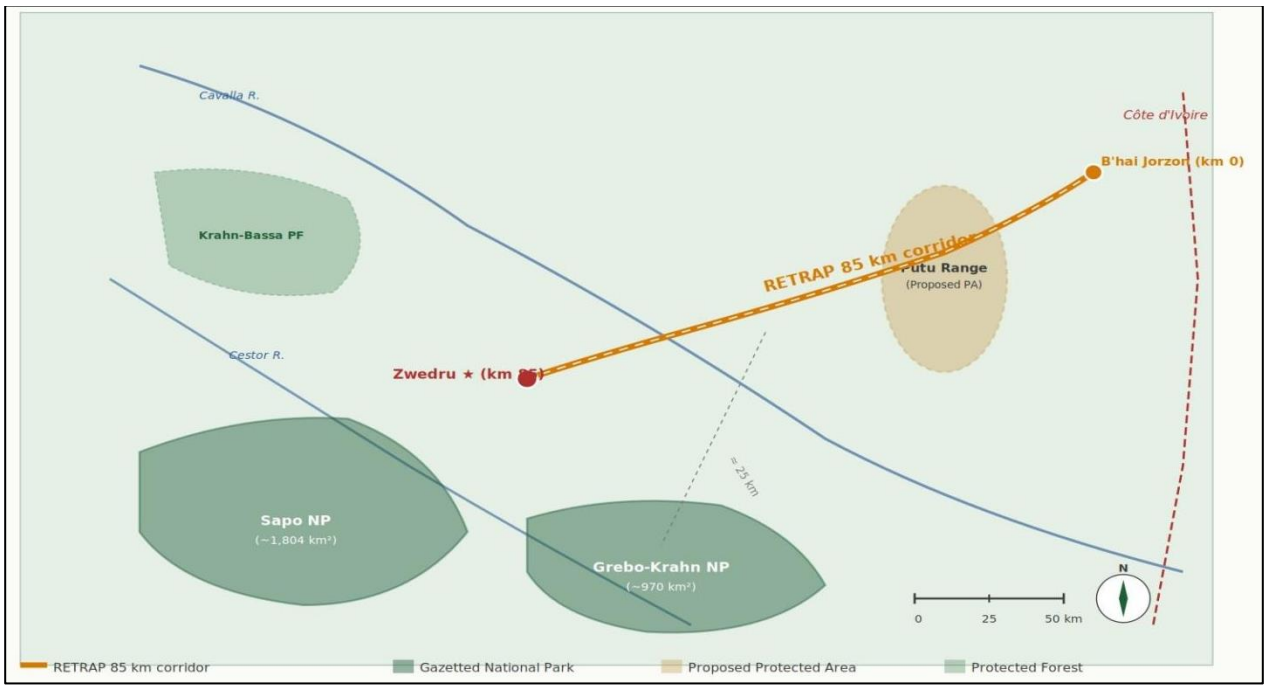


Figure 1.4: Protected-area context: RETRAP corridor in the Upper Guinea Forest ecoregion

NOTE: The RETRAP 85 km corridor within the southeastern Liberia protected-area network, showing the relative location of Grebo-Krahn National Park (~25 km south), Sapo National Park (about 60 km southwest), the Putu Range Proposed Protected Area (adjacent to the corridor), and the Krahn-Bassa Protected Forest.

Table 1.6: Corridor location in the Upper Guinea Forest ecoregion and nearest protected areas

Protected or managed area	Closest km to corridors	Approximate relationship to the 85 km road
Grebo-Krahn National Park	About 25 km S of km 55	Regional context; not crossed by the alignment
Sapo National Park	About 60 km SW of km 60	Regional context; not crossed by the alignment
Community and sacred groves on the corridor	Add the distance	Site-specific no-go during works (Chapter 4)

1.3.3 Topography and hydrology

The corridor traverses gently undulating terrain between 150 m and 320 m a.s.l., with a mean corridor elevation of ~235 m. The topographic profile is shown in **Figures 1.5 and 1.6**. Three sub-regional features are biodiversity-relevant: (i) the **Towah swamp complex** at km 12–14 (wetland corridor, otter sign, hornbill density); (ii) a secondary-forest ridge at km 55–60 abutting the Putu Range foothills; and (iii) the **Cestor River headwaters** drained by multiple first-order streams crossing the corridor (culvert works planned at ~60 locations). The corridor is drained to the south-west by tributaries of the Cestor and, east of km 55, by tributaries of the Cavalla River, which forms the international border with Côte d'Ivoire.

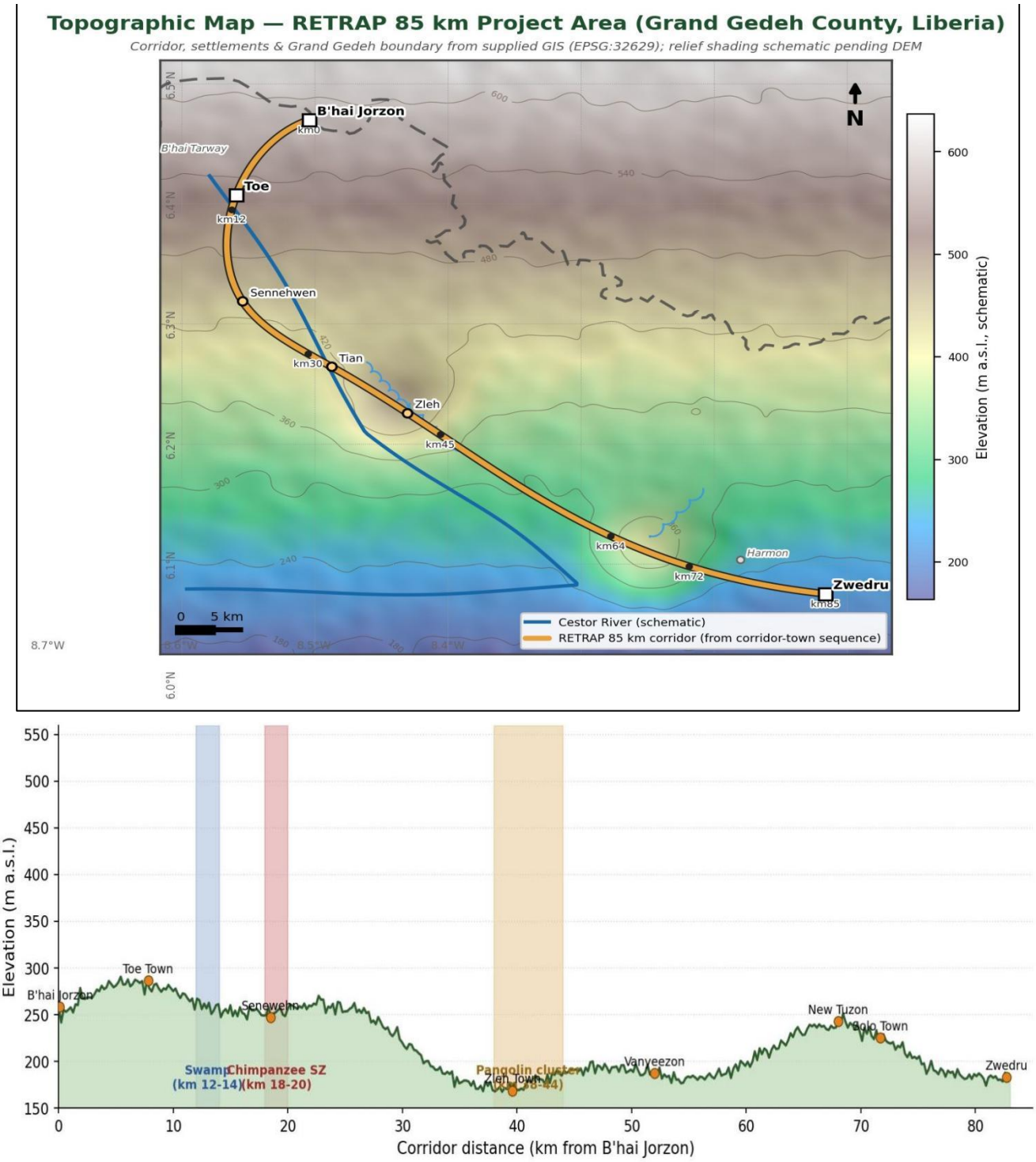


Figure 1.5: Topographic map of the RETRAP 85 km project area (Grand Gedeh County)

Figure 1.6: Elevation Profile of the 85km RETRAP corridor, with settlements and biodiversity hotspots

Elevation profile of the 85 km RETRAP corridor from B'hai Jorzon (km 0) to Zwedru (km 85), with eight principal settlements (orange markers) and three biodiversity hotspots highlighted: the Towah swamp complex (km 12–14), the pangolin camera-trap cluster (km 38–44), and the precautionary Chimpanzee Sensitivity Zone (km 18–20).

1.3.4 Climate and seasonality

The corridor experiences a tropical wet-and-dry climate (Köppen *Aw*) with a pronounced bimodal rainfall pattern: a primary rainy season from May to October peaking in September (~345 mm), a secondary rainfall pulse in April–June, and a dry season from December to March. Annual precipitation averages ~2,100 mm. Mean temperature is ~26 °C year-round, with daily minima of 20–22 °C and maxima of 28–33 °C. Figure 1.7 shows the long-term climate diagram for Zwedru (the nearest synoptic station), overlaid with the timing of BFS Phase 1 (rainy, October–November 2025) and Phase 2 (dry, December 2025 – February 2026). The two phases were deliberately timed to capture complementary detectability and species-activity patterns.

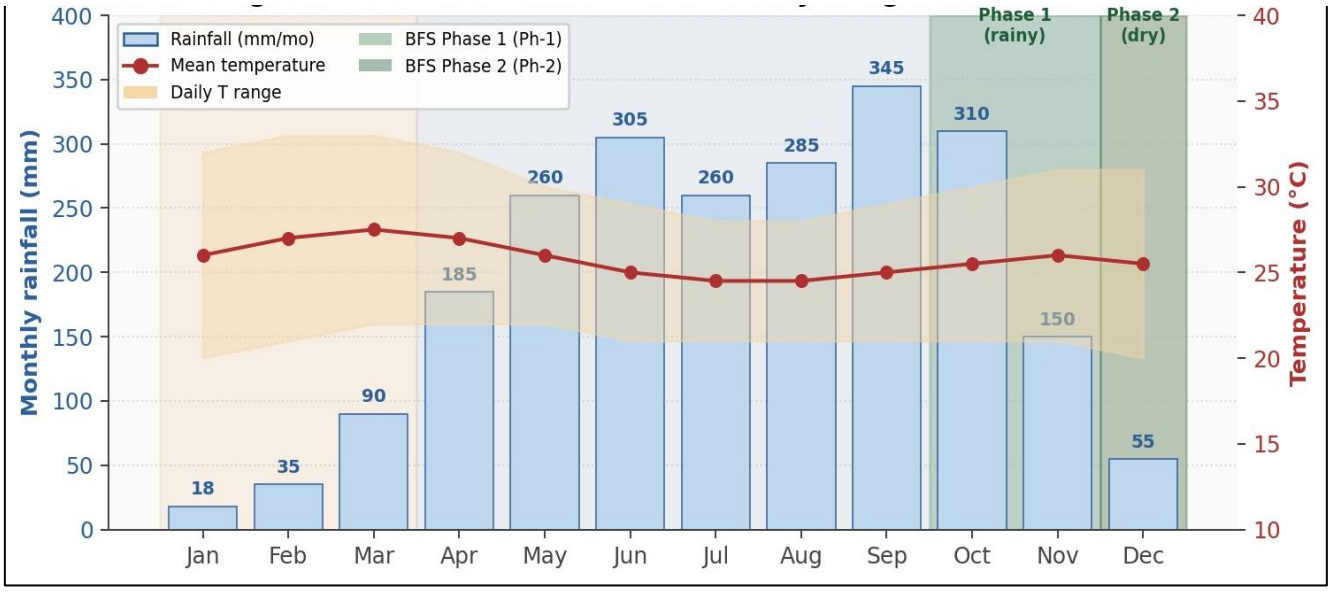


Figure 1.7: Climate Diagram- Zwedru, Grand Gedeh County (long-term mean, 1991-2020)

Climate diagram — Zwedru, Grand Gedeh County (long-term mean, 1991–2020). Monthly rainfall (blue bars), mean temperature (red line), daily temperature range (orange band), and the timing of BFS Phase 1 and Phase 2 (green shading) are shown. The corridor receives approximately 2,100 mm of annual rainfall in a bimodal pattern, with a dry season from December to March.

Table 1.7: Seasonal variables relevant to BFS detectability and survey scheduling, Zwedru long-term means (1991–2020).

Variable	Jan	Feb–Apr	May–Jul	Aug	Sep–Nov	Dec
Rainfall (mm/mo, mean)	18	35–185 (↑)	260–305	285	150–345	55
Temperature min–max (°C)	20–32	21–33	21–30	21–28	21–31	20–31
Dominant phenology	Dry	First-rain flush, leaf-out	Monsoon peak, amphibian chorus	Inter-rain dip	Fruiting peak, secondary rains	Early dry
Survey implication	Ph-2 ends	Not surveyed	Not surveyed (access)	Not surveyed	Phase 1 window	Phase 2 starts

1.3.5 Human settlements and socio-economic context

Approximately 32,000 people live within the 2 km AOI (2022 LISGIS census extrapolation). The corridor settlement pattern is dominated by small villages (populations 100–800) interspersed with three market towns (Toe Town ~2,400; Zleh Town ~1,800; New Tuzon ~1,200) and anchored at the eastern terminus by Zwedru, Grand Gedeh's county capital (~35,000).

Subsistence agriculture (rice, cassava) and cocoa agroforestry dominate livelihoods. **Table 1.8** summarises the settlement pattern and its biodiversity implications.

Table 1.8: Settlement pattern and biodiversity relevance along the 85 km corridor (derived from field mapping and stakeholder engagement in Phases 1 and 2).

Km range	Main settlement(s)	Dominant land use	Biodiversity relevance
km 0 – 5	B'hai Jorzon, Nico Town, Goyeazon	Cocoa agroforestry; subsistence cropping	Sacred grove at Barteh Jam; large hornbill & Picathartes detections
km 5 – 15	Toe Town, Bassa Town, Karr, Kai Village	Farm-bush mosaic; scattered rubber	Towah Town swamp crossing (km 12-14) — wildlife corridor
km 15 – 30	Senewehn, Shermon Village, Duogee, Tian Town	Intensive cocoa; pit-sawing	Threatened flora hotspot (T6-T8); fragmented secondary forest
km 30 – 45	Behrogee, Zleh Town, Pouh Town	Farm-bush; oil palm	Wetland complex; pangolin detections on T18, T21, T27, T30
km 45 – 60	Vanyeezon, Gwein Town, Zai Town	Cocoa; small-scale logging	Buffer secondary forest; flora IUCN concentrations
km 60 – 75	Senewehn	Farm-bush; swamp forest	Chimpanzee Sensitivity Zone; CH trigger area
km 75 – 85	Solo Town, Zwedru peri-urban	Urban-edge; intensive farming	Degraded habitat; limited biodiversity value

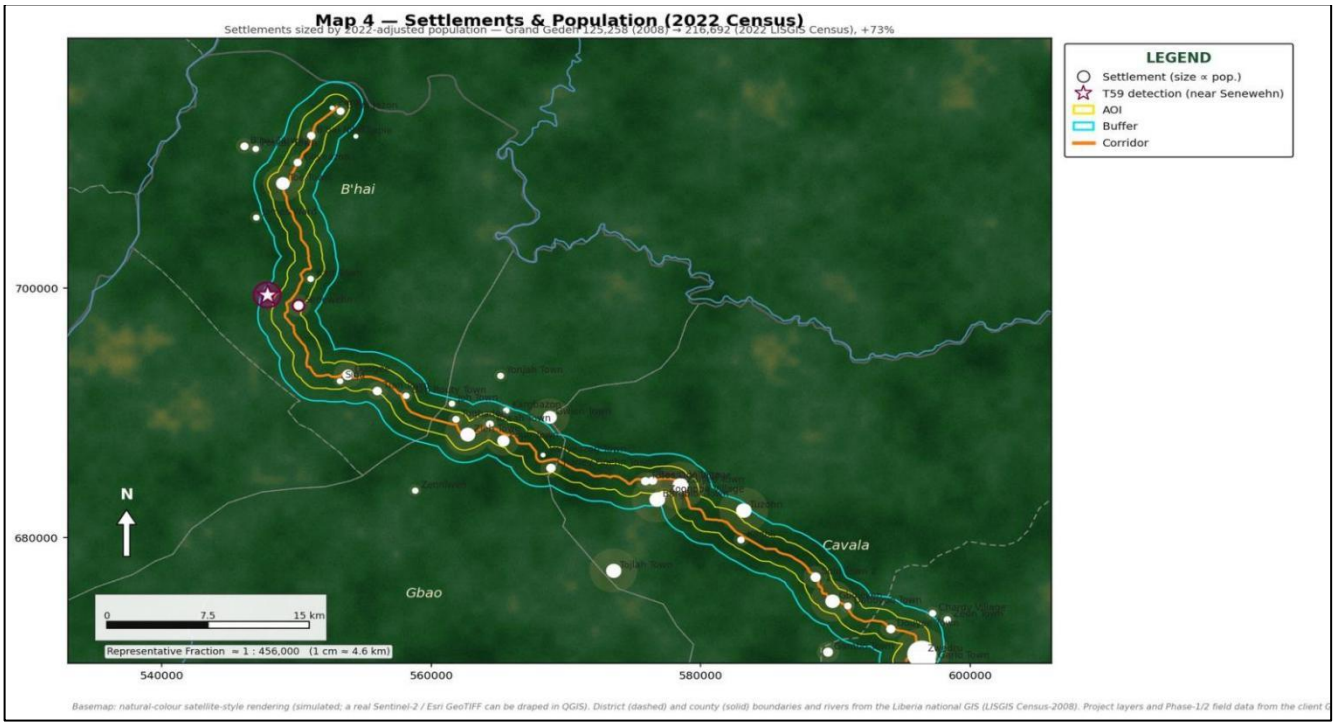


Figure 1.8: Map of settlements along the project corridor

1.3.6 Land cover, historical disturbance, and current land use

The corridor lies within one of the most anthropogenically-modified parts of the Upper Guinean Forest. Global Forest Watch data (Hansen *et al.* 2013; updated to 2024) show an average forest loss of 3.2 percent per year in the AOI between 2001 and 2024, with the steepest losses coinciding with post-conflict rural resettlement (2005–2012) and the 2018–2022 cocoa expansion cycle. Current AOI land cover is dominated by **farm-bush swamp/wetland** , **active plantation** , **secondary forest ,**

and community/settlement land ; primary forest is essentially absent from the AOI . The Buffer zone retains a somewhat higher proportion of secondary forest and plantation cover . **Figure 1.10** is a linear strip-map of the corridor showing the spatial distribution of settlements, the nested AOI/Buffer zones and the key biodiversity hotspots that each receive dedicated treatment in later chapters.

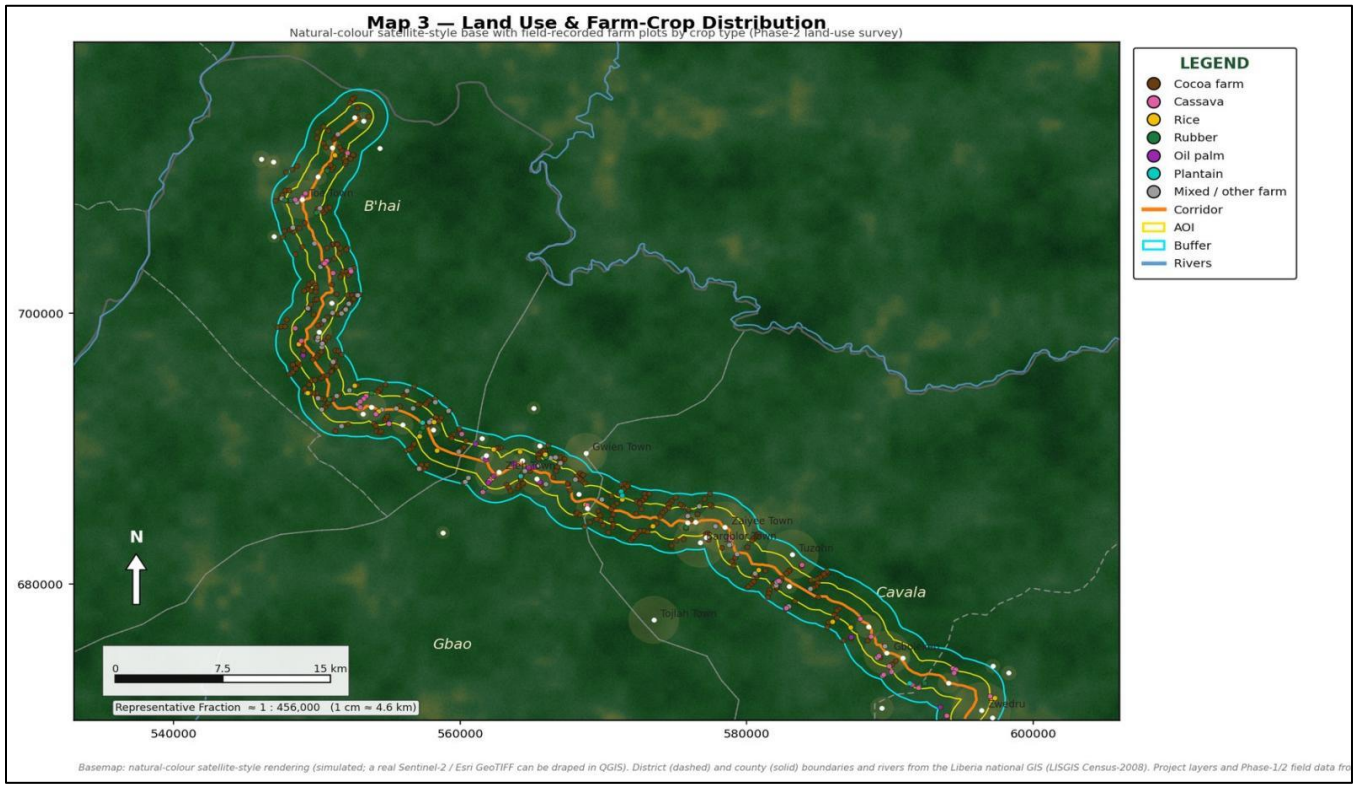


Figure 1.9: Land Use Map of the Project Corridor

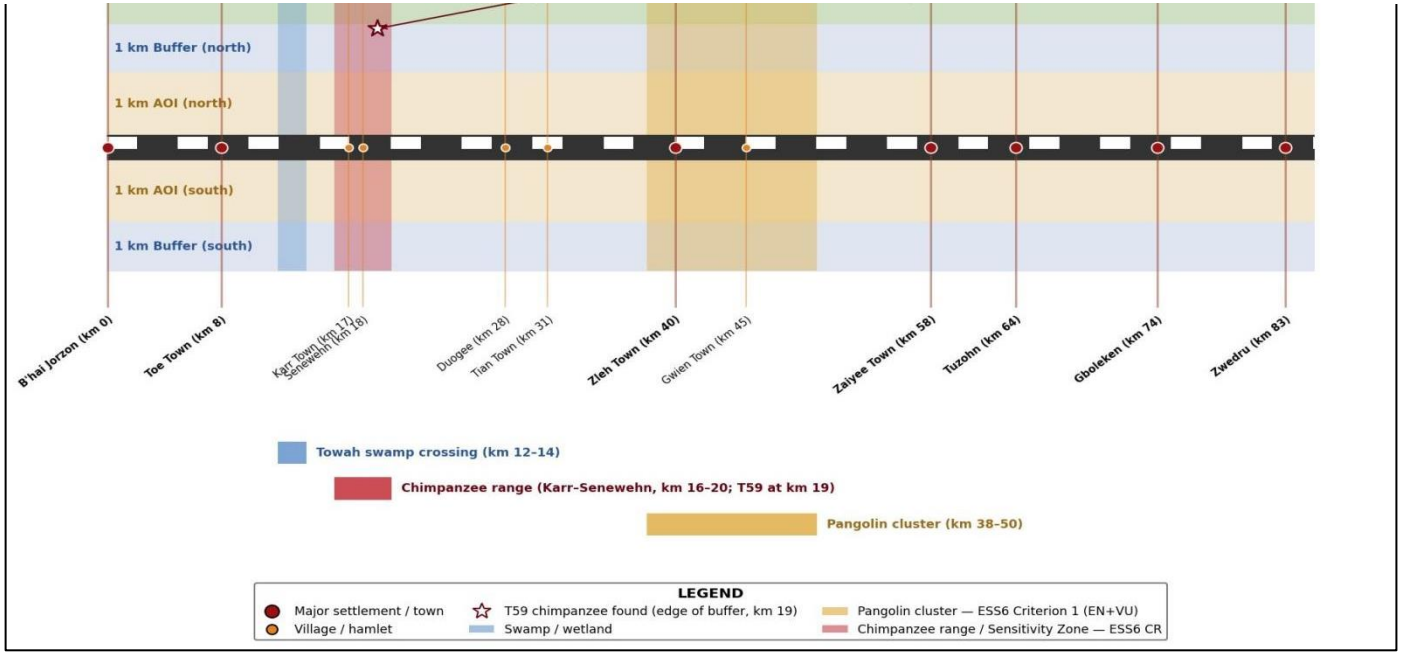


Figure 1.10: Linear strip-map of the RETRAP 85km corridor

Linear strip-map of the RETRAP 85 km corridor (B'hai Jorzon to Toe Town to Zwedru). Settlements are shown at approximate km location; the 2 km AOI (orange band) and the 5 km extended Buffer (blue band) are indicated; biodiversity hotspots (sacred grove, Towah swamp, threatened flora cluster, pangolin cluster, Chimpanzee Sensitivity Zone) are plotted at their actual km extent.

1.4 Institutional and Regulatory Framework

The following national laws and project instruments apply to biodiversity management during construction. They form the basis for the Class A tree protocol, regulations on wildlife offenses, the ESIA procedure, and the ESCP elements, which require a biodiversity study and management plan before commencing work activities in sensitive areas.

Table 1.9: Instruments that govern construction-phase biodiversity management on this rehabilitation

Instrument	Use in this survey
Environment Protection and Management Law (2003) and EPA ESIA Guidelines (2022)	National ESIA process; permit conditions
National Forestry Reform Law (2006) and FDA Regulation 113-08	Class A / B / C tree protocol during clearance
Wildlife Conservation and Protected Area Management Law (2016)	Hunting, trade and protected-species offenses; Code of Conduct referral
Project Environmental and Social Commitment Plan	BMP annex to the 85 km ESIA; study of risks to chimpanzees and other ESS6 values
Project Stakeholder Engagement Plan and Grievance Redress Mechanism	Awareness before works enter a node; wildlife reports during construction

1.4.1 FDA protection classes applied to the flora inventory

Liberian forestry law classifies timber species into three protection classes of conservation and commercial regulation. BFS field teams applied these classes in real time during botanical plots. **Table 1.10** summarises the class definitions and indicates where each is quantitatively reported in the present BFS.

Table 1.10: FDA timber protection classes applied during BFS botanical plots (Liberia NFRL 2006 + Regulations on Confirmation of Class A and B species).

FDA Class	Definition	Examples recorded in this BFS	Management implication
Class A	Heavily exploited; requires management prescriptions; felling restricted	Terminalia ivorensis, Lophira alata, Milicia regia, Heritiera utilis, Nauclea diderrichii, Tieghemella heckelii (EN)	No-felling rule in Sub-AOI; compensatory planting 5:1
Class B	Commercial; felling permitted with management plan	Funtumia elastica, Zanthoxylum gillettii, Hallea ciliata	Felling only with EPA-approved salvage; compensatory 2:1
Class C	Pioneer / common; regulated felling allowed	67 species recorded; mostly secondary-forest pioneers	Standard replanting; inventoried in Annex 6

1.5 Adaptive Design of the BFS

The BFS was designed in two seasonally complementary phases so that the second could learn from the first. Phase 1 (rainy season, October–November 2025) established the transect, plot and camera network and identified detection problems, notably humidity-related camera failures and access constraints. Phase 2 (dry season, December 2025 to February 2026) repositioned cameras to transect end-points near streams and dense vegetation, added the 85th botanical plot and the point-count rotation, and completed the community consultations. This two-season learning loop is a survey-design feature only; it is not a post-project management cycle. The Biodiversity Management Plan that follows this survey is to be developed by the IIU with Technical Advisor support and annexed to the updated 85 km ESIA (Chapter 13).

Table 1.11: Phase 1 to Phase 2 adaptive adjustments, demonstrating the learning-by-doing feedback loop built into the BFS.

Phase 1 finding	Phase 2 adjustment	Outcome
17 of the 67 Phase-1 cameras failed due to humidity	Cameras relocated to sheltered tree-trunk positions; silica-gel packs added; deployment period reduced from 45 to 32 days	5 of 60 cameras dropped out in Phase 2; functional trap-nights rose by 45 percent despite fewer deployments
Low detectability of mammals on mid-transect cameras	Cameras shifted to end-points, stream confluences and trail crossings	Pangolin detections concentrated at new positions; 3 of 4 EN records from relocated cameras
Camera detection of Western Chimpanzee at T59 near Senewehn (km 19)	Additional targeted recce walks and 4 supplementary cameras	1 confirmed chimpanzee event (T59 Buffer) enabling precautionary CH declaration
Phase-1 access restricted by harvest in cocoa plantations	Phase-2 timing shifted to post-harvest (Jan–Feb)	Full access to all 108 transects; transect coverage 25 percent over plan
Phase-1 gender balance in FGDs at 32 percent women	Phase-2 included dedicated women-only FGDs in every town	214 of 464 participants women across both phases

1.6 Relationship to the ESIA and the 40 km BFS

The 85 km ESIA is the assessment umbrella for these works. This BFS supplies the biological baseline, the CH screen and the construction-phase mitigation register. A BMP will be issued as an annex to that ESIA. The Contractor will carry out the measures in the Construction Environmental and Social Management Plan (C-ESMP). The Supervising Engineer will verify them as part of ESMP supervision requirement.

The 40 km Tappita–Toe Town survey used the same field methods. Findings may be read together for consistency. This report does not deliver a consolidated 10-year corridor Biodiversity Management Plan, and it does not make ESS6 compliance on the 85 km road depend on instruments designed for the post-construction period.

Costs of justified structures, signage and footprint restoration will be estimated by the Contractor's design engineer and included in design and construction budgets. The ESMP supervision budget will include checks of wildlife-sensitive nodes.

2 METHODOLOGY

This chapter presents the BFS methodology and describes the overall methodological framework, the six-method field protocol, the seasonal and spatial design, and the quality-assurance chain.

2.1 METHODOLOGICAL FRAMEWORK

This BFS employs a **multi-method, multi-taxon, seasonally balanced design** aligned with international best practice for tropical-forest biodiversity baselines (White & Edwards, 2000; Kühl *et al.*, 2008 for primates; Wearn & Glover-Kapfer, 2017 for camera-trapping; IUCN, 2016 for threatened species). The framework runs from Level-1 inputs (prior knowledge and scoping) through Level-2 field methods and Level-3 analysis to Level-4 deliverables (baseline, Critical Habitat determination and construction-phase measures). Each level feeds the next; the framework is designed to support ESS6 screening and to inform the updated ESIA.

2.1.1 Matching methods to target taxa

No single field method detects all relevant taxa. The BFS deliberately combined methods to maximise detectability across the full breadth of ESS6-relevant groups (mammals, birds, flora, amphibians, selected invertebrates). **Table 2.1** shows the method-to-taxon matrix and the primary metric each method generates.

Table 2.1: Method-to-taxon matrix.

Target taxon	Transect	Recce	Camera trap	Plot	Point count	FGD / TEK
Large & medium mammals	✓ direct	✓ sign	✓✓ primary	—	—	✓ species presence
Small mammals	— (low detection)	✓ sign	✓ (ground)	—	—	—
Primates (incl. chimpanzee)	✓ calls, sightings	✓ nests, sign	✓ supporting	—	—	✓✓ hotspots
Pangolins	✓ burrows	✓ tracks	✓✓ primary	—	—	✓ hunting reports
Birds — diurnal	✓ sightings	✓ sightings	✓ ground only	—	✓✓ primary	—
Birds — nocturnal / cryptic	—	✓ calls	✓ ground only	—	✓✓ playback	✓ local knowledge
Reptiles	✓ sightings	✓ sightings	✓ opportunistic	—	—	—
Amphibians	✓ calls	✓ calls	—	—	—	—
Flora at least 10 cm DBH	—	—	—	✓✓ primary	—	✓ vernacular names
Regeneration/ground flora	—	—	—	✓✓ (sub-plots)	—	—

✓✓ = primary method; ✓ = supporting contribution; — = method not applied to that group. Combining methods substantially reduces detectability bias.

The methodological flow has four levels: prior-knowledge inputs from the 2023 ESIA, the 40 km BFS and community knowledge (Level 1); multi-taxon field methods — transects, reconnaissance walks, camera trapping, botanical plots and point counts (Level 2); GIS- and statistics-based analysis (Level 3); and the deliverables used by the works — the baseline, the Critical Habitat determination and the construction-phase measures that feed the updated ESIA and its Biodiversity Management Plan annex (Level 4).

2.2 SURVEY EFFORT SUMMARY

Table 2.2 summarizes the total survey effort by AOI vs. Buffer and by Phase 1 vs. Phase 2. **Figure 2.1** visualizes the effort composition by method (left panel) and the AOI/Buffer × Phase balance across six effort elements (right panel). **Figure 2.2** shows how effort was distributed along the 85 km corridor, with higher intensities in the pangolin cluster and Chimpanzee Sensitivity Zone segments.

Table 2.2: summarizes the total survey effort by AOI vs. Buffer and by Phase 1 vs. Phase 2

Survey Element	AOI Ph-1	AOI Ph-2	Buffer Ph-1	Buffer Ph-2	Total Effort
Line transects (1 km each)	54	54	54	54	108 unique × 2 phases = 216 passes (216 km walked)
Reconnaissance walks (km)	82	98	74	89	343 km
Camera-trap deployments	29	31	31	36	127 deployed (97 usable)
Camera-trap-nights (functional)	870	930	930	1,080	~3,810 trap-nights
Botanical plots (25 × 25 m)	22	22	20	21	85 plots — 5.31 ha sampled
Bird point counts	18	7	14	6	45 counts (33 BirdLasser cards)
Community FGDs / meetings	—	—	—	—	21 engagements (6 towns Ph-1; 15 Ph-2)
Botanical records (stems at least 10 cm DBH)	~615	~700	~590	~650	2,555 stems
Mammal records (direct + indirect)	195	246	246	280	967 records
Bird records (all sources)	~820	~610	~1,120	~1,030	3,581 records

Complete survey-effort summary, Phase 1 (October–November 2025) and Phase 2 (December 2025 – February 2026). Camera-trap-nights are expressed as functional trap-nights after excluding days when cameras malfunctioned or were removed by wildlife or people. Per-transect detail is in Annex 7.

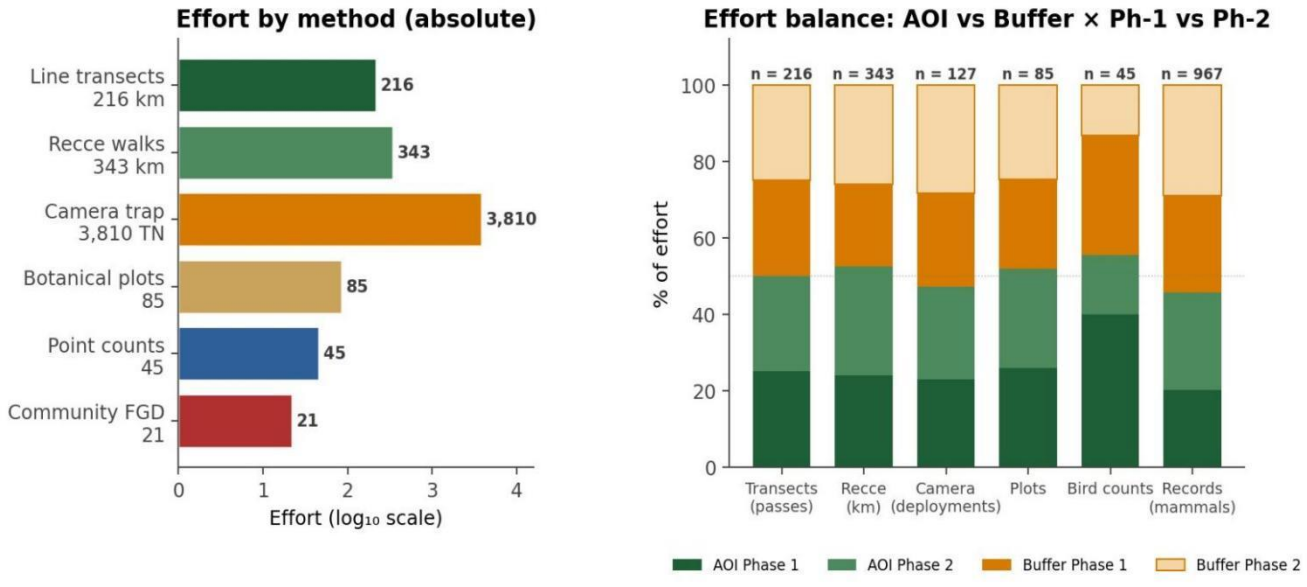


Figure 2.1: Effort composition by method (left panel) and the AOI/Buffer × Phase balance across six effort elements (right panel)

*Survey effort composition. **Left panel:** effort by method on a log scale (line transects 216 km, recce walks 343 km, camera trapping 3,810 trap-nights, 85 botanical plots, 45 point counts, 21 community FGDs). **Right panel:** AOI-versus-Buffer and*

Phase-1-versus-Phase-2 balance across six effort elements — the design is close to 50/50 AOI/Buffer for most elements, with a slight AOI emphasis on bird counts (25 of 45 in the AOI) reflecting the higher density of transect access points in the AOI.

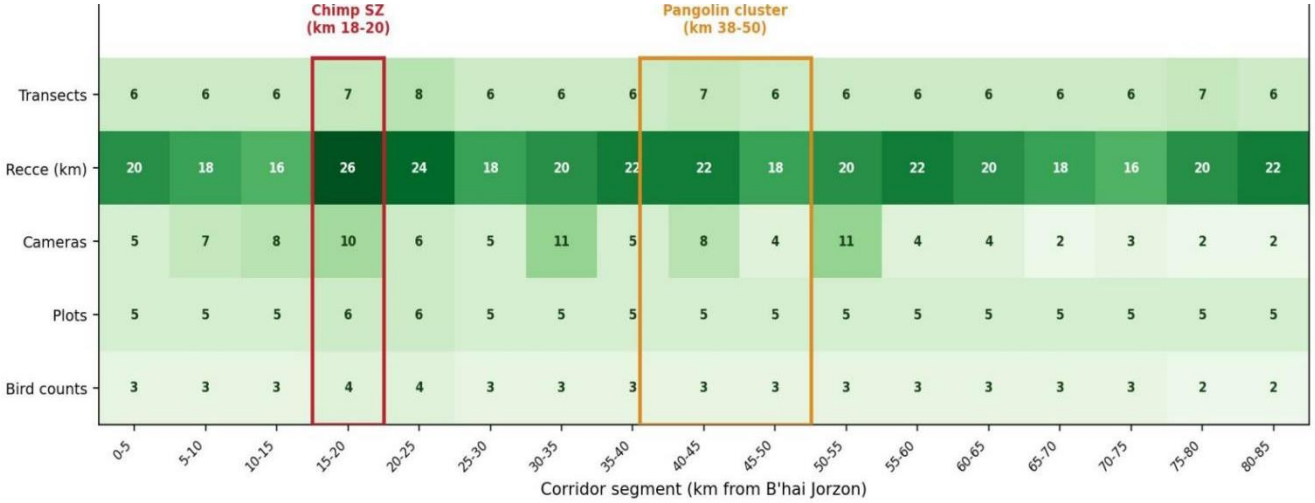


*Figure 2.2: Effort intensity along the 85km corridor (by method * 5-km segment)*

Effort-intensity heatmap: rows = survey method, columns = 5-km corridor segments. Darker cells indicate higher effort. The Chimpanzee Sensitivity Zone (km 18–20, red frame) and Pangolin cluster (km 40–50, orange frame) received deliberately elevated effort. Numbers in each cell are absolute effort units (transect count, recce km, camera deployments, plot count, point-count count).

2.3 Field Methods — Protocols

2.3.1 Wildlife line transects

108 1-km transects were established perpendicular to the road alignment at approximately 800 m intervals along the corridor, systematically stratifying the AOI and Buffer habitats. **Figure 2.3** depicts the standard transect layout, the observer-team composition (three-person teams with complementary expertise) and the detection band.

Table 2.3: Line-transect protocol specification (one row per protocol element).

Protocol element	Specification
Length	1,000 m, perpendicular to road; origin flagged with durable tag + GPS
Spacing	~800 m along corridor; alternating north and south to balance AOI coverage
Walking pace	~1 km h^{-1} (45–60 min per transect); slower in dense vegetation
Time windows	06:30–11:30 and 15:30–18:30 (peak detectability); transects not walked in heavy rain
Detection band	±50 m perpendicular distance recorded for large mammals; encounter rate (records/km) reported
Team	3 observers: ornithologist (lead), mammalogist, local guide + SMART operator
Evidence captured	Direct sightings, calls (identified by specialist), tracks, dung, feeding remains, nests
Equipment	Binoculars (Nikon Monarch 8×42), GPS (Garmin 64s, at most 10 m accuracy), DSLR, SMART Mobile
Repetition	Each transect walked once per phase to 2 visits per transect over study

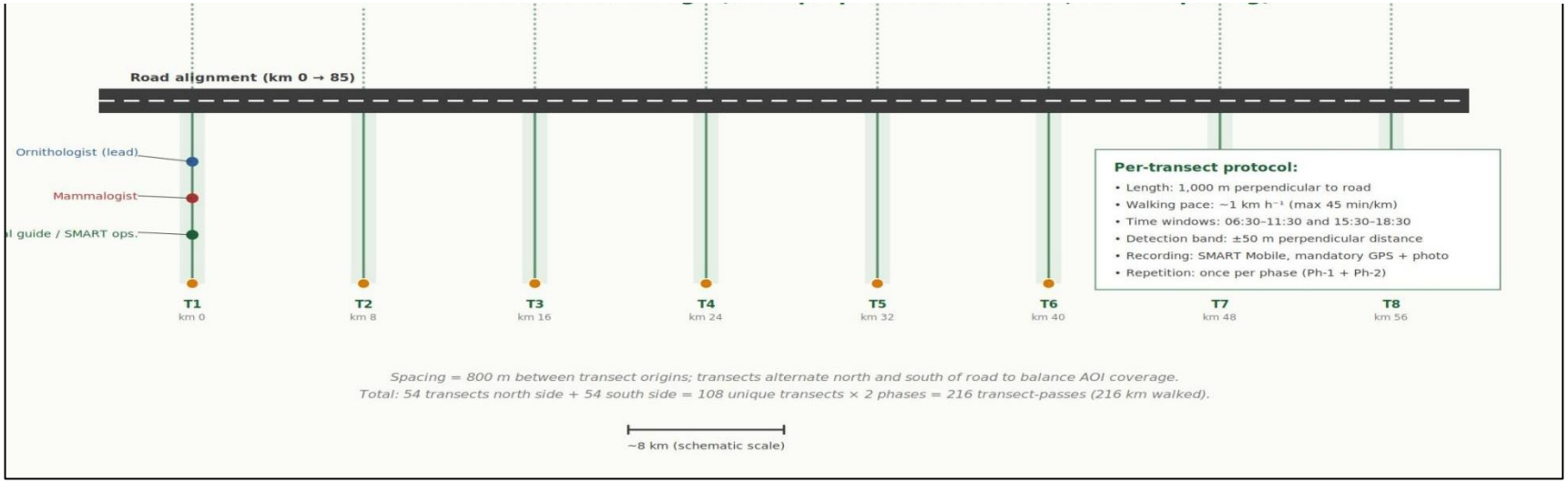


Figure 2.3: Line transect design (1km perpendicular to road, 800 m spacing)

Line transect design. Transects are 1 km long, perpendicular to the road, spaced 800 m apart. Each transect is walked by a three-person team (ornithologist, mammalogist, local guide/SMART operator). The ±50 m detection band is shown in green. Total: 54 transects per side × 2 sides = 108 transects × 2 phases = 216 transect-passes (216 km walked).

2.3.2 Reconnaissance (recce) walks

Recce walks totaling 343 km targeted hunter trails, stream courses, rocky outcrops, sacred groves and swamp forests where rigid transects were not feasible. The recce protocol contributed disproportionately to detections of habitat-restricted species: 81 of the 540 mammal records, the Picathartes colony (Vanyeezon rock outcrop), and the Tieghemella heckelii (EN) record at Barteh Jam sacred grove all came from recce rather than transect data. All recce observations were recorded identically to transect observations in SMART Mobile, with an *effort flag* distinguishing them from formal transect records for analytical purposes.

2.3.3 Camera trapping

97 camera-trap stations yielded approximately 3,810 functional trap-nights. **Figure 2.4** depicts the standard station set-up (side view + plan view along a transect). Cameras were attached to tree trunks at ~30 cm height, angled 10–15° downward, with detection cones of ~15° × 2–15 m. The independent-event criterion follows Meek *et al.* (2014): two detections of the same species at the same station are treated as independent if (i) separated by at least 60 minutes, or (ii) distinguishable individual counts differ. This criterion is applied consistently in RAI calculations throughout the report.

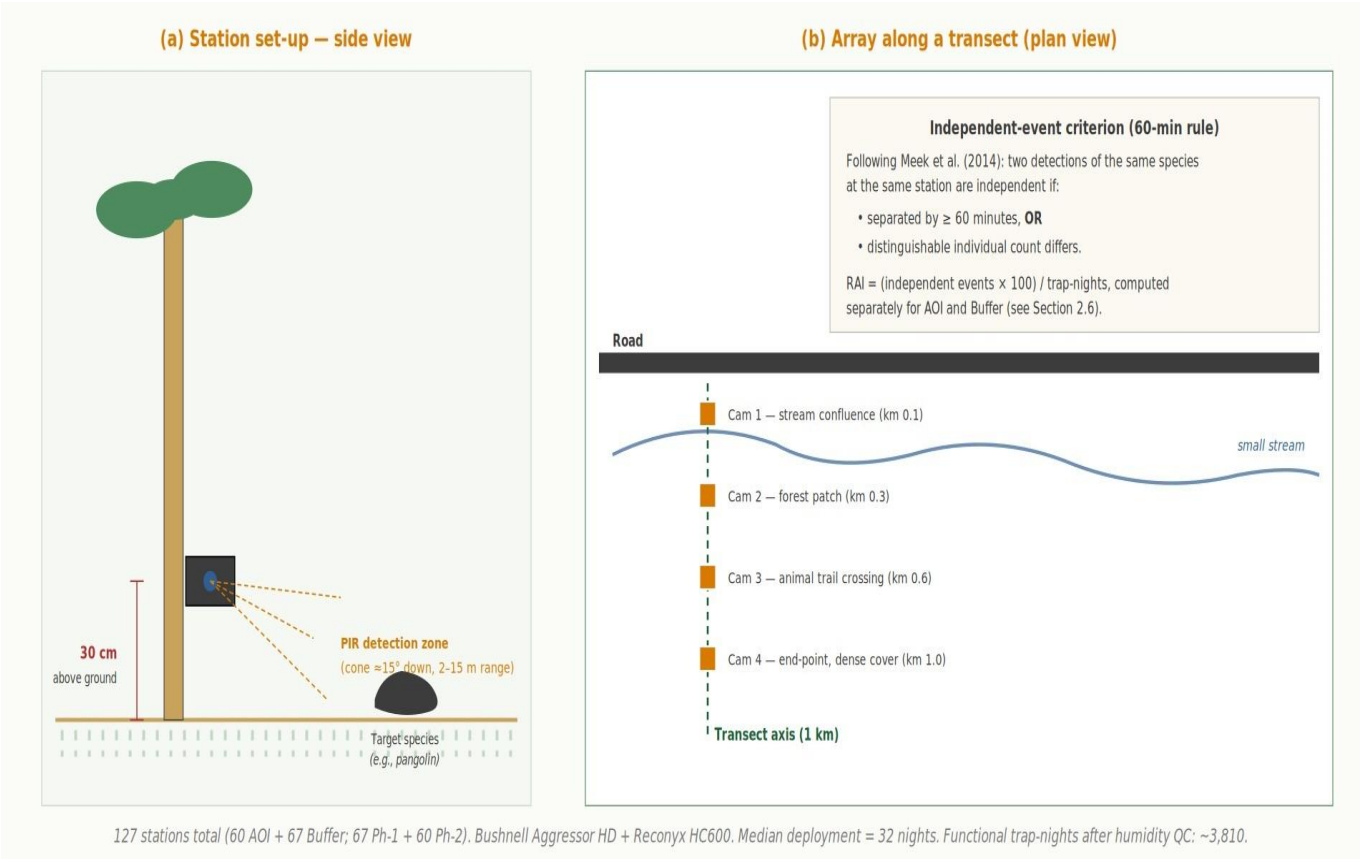


Figure 2.4: Camera-trap station design and array along a transect

Panel (a): side-view of a single station showing mounting height (~30 cm), target-species passage zone, and the PIR detection cone. Panel (b): plan-view of camera deployment along a transect, with stations at stream confluences, forest patches, animal-trail crossings, and transect end-points. The 60-minute independent-event criterion (Meek et al., 2014) is noted — RAI = (independent events × 100) / trap-nights.

2.3.3.1 Data Capture

During Phase 1 of the study, we deployed 67 camera traps, approximately one per 1.3 km segment, primarily at transect midpoints. After about 30 days, 50 of the 67 cameras produced usable data, while the remaining units malfunctioned due to high humidity.

In Phase 2, the team refined the deployment strategy based on Phase 1 findings. A total of 60 cameras were installed for approximately eight weeks, covering the period from the late dry season to the onset of early rains. Improved allocation involved moving many cameras to transect endpoints, particularly near streams or dense vegetation, since these locations were identified as having higher wildlife traffic. In this phase, the camera network was evenly distributed between the Area of Interest (AOI) and the buffer zone, with 29 cameras in the AOI and 31 in the buffer zone. Across both phases, 97 of the 127 deployed cameras produced usable data (50 of 67 in Phase 1 and 47 of 60 in Phase 2); all camera-trap analyses in this report are therefore based on these 97 stations and ~3,810 functional trap-nights.

Collectively, cameras captured over 5,300 images and videos across both phases. Phase 2 achieved an even higher capture rate compared to Phase 1. These camera traps proved essential for detecting elusive species, as all records of pangolin, as well as the single chimpanzee image, were obtained exclusively from camera data. Apex predators such as leopard were not detected during the survey (see Section 3.2.1).

For every image and video captured, the team systematically logged the species, group size, date and time, and location into a master spreadsheet to facilitate downstream analysis. The complete set of camera trap data sheets, along with the corresponding photographs and video files, is available for sharing in digital format.

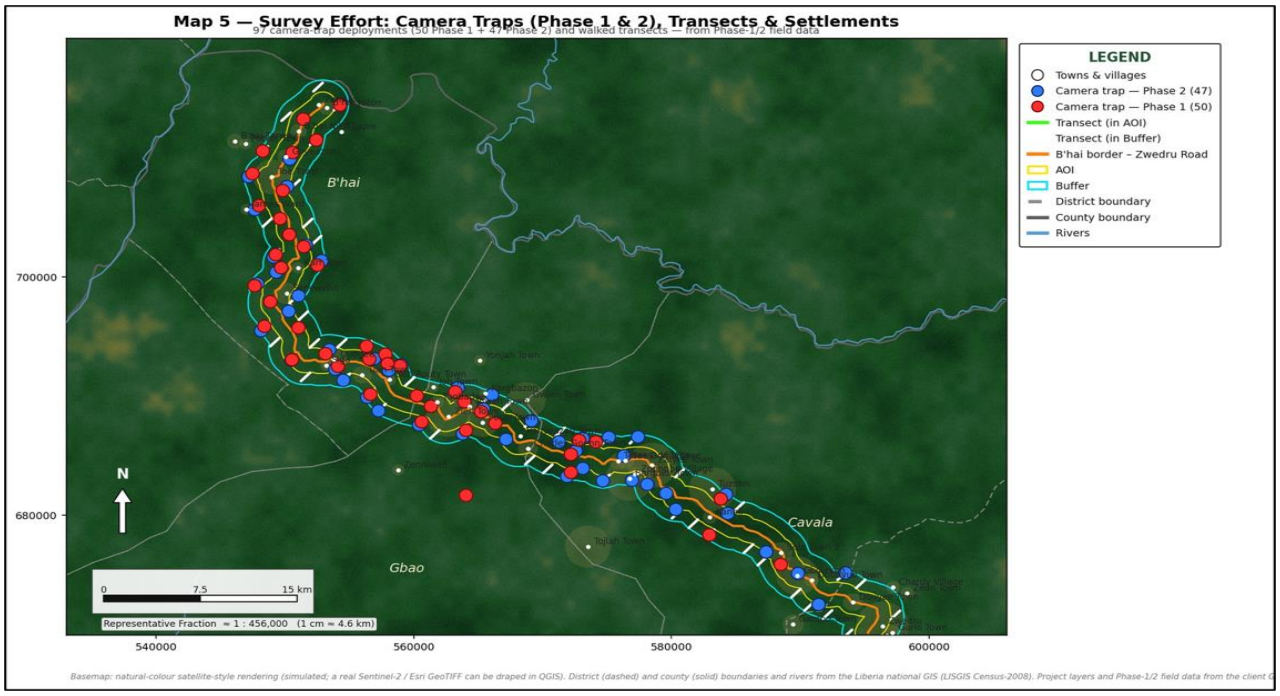


Figure 2.5: Camera-trap stations (Phases 1 and 2), line transects and settlements along the corridor.

2.3.4 Botanical plots and flora inventory

85 plots of 25 × 25 m (625 m², total sampled area 5.31 ha) were established at representative sites across the AOI and Buffer. Within each plot, every stem at least 10 cm DBH was identified to species, measured (DBH at 1.3 m, estimated height, canopy class) and assigned a disturbance class. **Figure 2.6** shows the plot layout, including the five 5 × 5 m nested sub-plots (four corners + centre) used for regeneration and ground-flora assessment, and for canopy-cover measurement via spherical densiometer. Species identification used the Forestry Development Authority (FDA) key + the *Flore du Libéria* + regional keys,

with herbarium vouchers where identification was uncertain. Outside plots, all FDA Class A / Class B and IUCN VU / EN / CR species encountered were GPS-tagged with photo voucher.

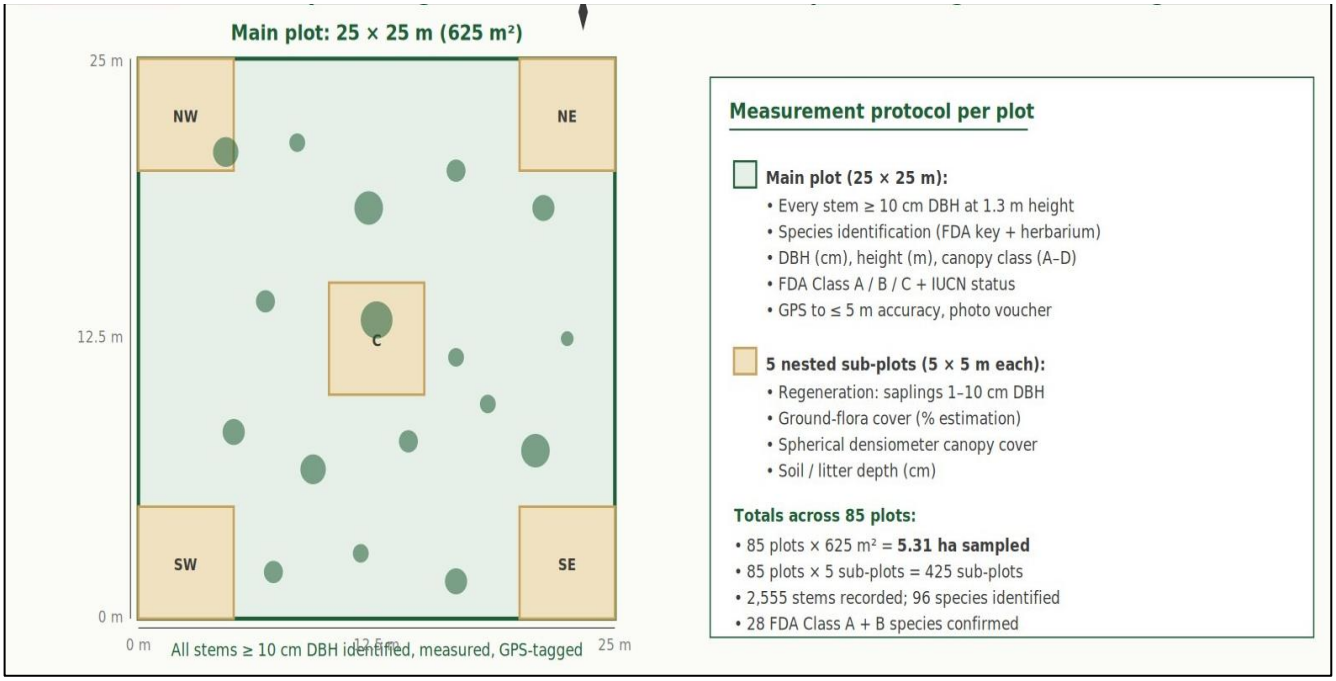


Figure 2.6: Botanical plot design. Main plot 25 × 25 m (625 m²) with five nested 5 × 5 m sub-plots (four corners + centre).

Circles represent individual trees with DBH at least 10 cm. The protocol records species, DBH, height, canopy class, FDA Class (A/B/C), IUCN status, GPS, and photo voucher for every stem in the main plot; sub-plots record saplings, ground flora cover, canopy cover and litter depth.

2.3.5 Avifaunal surveys

Bird surveys combined (i) 45 point counts / roving counts of 1–2 hours around dawn or dusk (10-minute fixed-radius segments, 50 m radius), (ii) incidental records along transects and recce walks, and (iii) camera-trap by-catch for ground-dwelling species. 33 of the 45 counts were additionally documented on the *BirdLasser* platform for peer validation. Playback was used only for difficult-to-detect taxa (owls at night; Picathartes at rock outcrops; large hornbills at canopy level) and was strictly time-limited (no more than 3 minutes per species per station) to minimise disturbance. 206 bird species were recorded overall, with 73 georeferenced detections across 6 IUCN-listed species (detailed in Chapter 3).

2.3.6 Community Consultations for secondary data collection.

In parallel with the primary field surveys, 21 community engagements were held across six towns in Phase 1 and 15 towns in Phase 2. These comprised (i) town-hall meetings to introduce the survey and obtain access consent, (ii) key-informant interviews with hunters, traditional leaders and herbalists, (iii) dedicated women's and youth Focus Group Discussions (FGDs), and (iv) sacred-grove visits with the relevant *zoe* (custodian). Protocols followed ESS10 and the project Stakeholder Engagement Plan. All engagements were documented with attendance sheets (gender-disaggregated — see Chapter 12, Table 12.1), signed access-consent forms where appropriate, and anonymised TEK notes. TEK was cross-validated against scientific records species-by-species; 17 species reported by hunters but not detected by the primary field surveys using scientific methodology were flagged for targeted monitoring in the proposed recommendations.

2.4 Seasonal Coverage and Accessibility Limitations

Seasonal variability affected detectability and physical access in specific, documented ways. The BFS deliberately paired a rainy-season phase (October–November 2025) with a dry-season phase (December 2025 – February 2026) to capture complementary signals. **Figure 2.7** is the full activity Gantt. **Table 2.4** summarises the season-specific constraints and how they were mitigated or turned to analytical advantage.

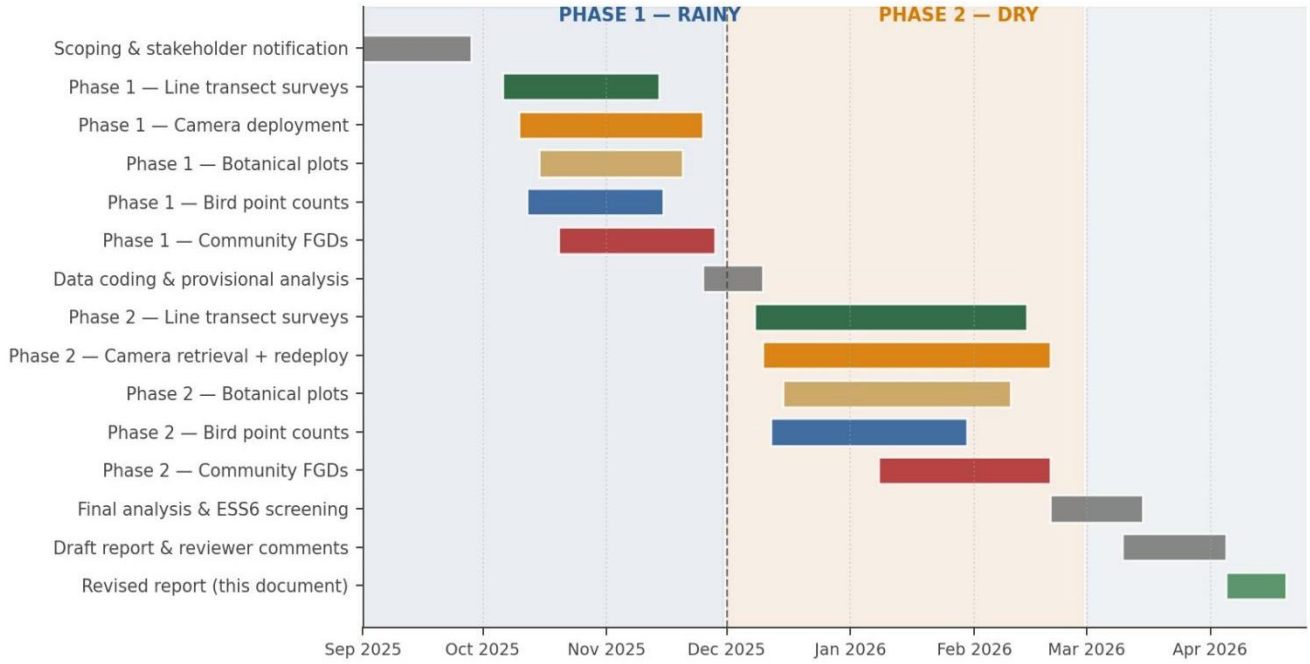


Figure 2.7: BFS activity calendar (Gantt chart) spanning September 2025 through April 2026.

Phase 1 (rainy, pre-December) and Phase 2 (dry, post-December) are demarcated; all six survey activity types (transects, camera trapping, botanical plots, bird counts, community FGDs, data coding) are plotted at their actual start/end dates. The seasonal transition (1 December 2025) is shown as the dashed vertical line.

Table 2.4: Seasonal factors affecting survey detectability and access, with phase-specific mitigations.

Constraint	Effect in Phase 1 (Rainy, Oct–Nov)	Effect in Phase 2 (Dry, Dec–Feb)
Flooding and stream access	Transects T3, T5, T49, T53 (wetland-heavy) had sections temporarily inaccessible; some 2 km of recce routes rerouted	Fully accessible; wildlife concentrates at remaining water sources — boosted detection
Camera-trap functionality	17 of 67 cameras malfunctioned due to humidity	Camera drop-out 5 of 60
Observer detectability	Dense understory vegetation reduced visual detections; compensated by calls and recce along audible-range corridors	Reduced leaf cover improved visual detection of arboreal mammals and large flora individuals
Seasonal species	Migratory / wet-season birds detected (e.g., White-throated Blue Swallow); amphibians vocal	Dry-season concentration of mammals at swamps; clearer chimpanzee detection window
Crop access	Cocoa-harvesting communities occasionally restricted access; managed via advance notice	Harvest over; fuller access to cocoa farms
Road/ford access to start-points	4 of 85 plot origins inaccessible by vehicle; reached on foot	All 85 plots reached by vehicle; survey time per plot reduced by 30 percent

The two seasons together provided complementary coverage and significantly reduced detection bias.

2.5 Data Analysis Framework

2.5.1 Species inventory, encounter rates, and relative abundance

Species lists were compiled separately for the AOI and Buffer zones and by phase. Four quantitative metrics are used throughout the report:

- **Encounter rate (transect):** records per km walked, reported separately per taxon.
- **Relative Abundance Index (RAI, camera-trap):** RAI = (independent events × 100) / trap-nights, computed per species × zone × phase. The 60-minute independent-event rule is applied (Meek *et al.* 2014).
- **Species richness & evenness:** Shannon-Wiener H' and Simpson D indices, computed separately for AOI and Buffer to enable direct comparison.
- **Hornbill encounter rate (added at review):** detections per 10 km of transect + recce effort — a forest-health proxy benchmarked against regional literature.

Table 2.5: Quantitative metrics applied in the BFS data-analysis workflow.

Metric	Formula / Method	Purpose in this BFS
Encounter rate	Records / km walked (transect + recce)	Species-level abundance index for direct comparison AOI vs Buffer
RAI (camera)	(Independent events × 100) / trap-nights	Primary abundance metric for mammals detected on camera (incl. pangolins)
Shannon H'	$-\Sigma(p_i \times \ln p_i)$, p_i = proportion of species i	Diversity index (richness + evenness); higher = more diverse
Simpson D	$1 - \Sigma\, p_i^2$	Dominance-sensitive diversity index; complements Shannon
Species accumulation	Chao1, Jackknife2 estimators	Checks whether sampling is adequate; indicates extrapolated richness
Hornbill encounter rate	Hornbill detections / 10 km (transect+recce)	Forest-health proxy; added at review
Snare density	Snares / km (transect+recce)	Hunting-pressure proxy; baseline indicator I-03 (Table 3.12)

2.5.2 Habitat classification and change detection

2,689 SMART records of habitat type (recorded on every transect, recce and plot visit) were aggregated into **7 habitat classes**: Secondary Forest, Farm-bush, Plantation, Wetland/Swamp, Settlement/Community land, Abandoned Farm, Mountain Forest. Per-class coverage was calculated for AOI, Buffer, and overall (Table 3.1). Historical forest-cover change was cross-referenced with Global Forest Watch (Hansen et al. 2013; updated 2024) to distinguish legacy disturbance from contemporary loss — a critical step for attributing impact versus pre-existing condition.

2.5.3 ESS6 Critical Habitat screening

The five ESS6 Critical Habitat criteria were applied systematically to the field evidence using the decision rules in IFC PS6 Guidance Note 6 (2019). The full decision tree as applied to the RETRAP corridor — how the field evidence was mapped to each criterion, the verdict on each, and the integrated determination — is provided in Annex 9. Critical Habitat polygons were delineated in the project GIS using a 1 km kernel around confirmed detection points plus expert-judgement inclusion of contiguous suitable habitat (chiefly intact forest patches, swamp complexes and canopy connectivity). The resulting CH footprint (22.6 km²) and Priority Biodiversity Feature footprint (14.2 km²) are discussed in Chapter 4.

2.5.4 Data management — SMART / PostGIS geodatabase

All field data were captured directly in **SMART Mobile** (Spatial Monitoring and Reporting Tool) with mandatory GPS (accuracy no more than 10 m) and photo evidence where possible. SMART records were synced daily to a central PostGIS geodatabase managed by the Society for the Conservation of Nature in Liberia (SCNL). Automated out-of-range and duplicate-key checks flagged 847 records for review; all were cleared before release. The master geodatabase is version-controlled and audit-ready, with read access granted to IIU and the World Bank Task Team upon request.

2.6 Quality Assurance and Chain of Custody

Quality assurance is treated as a six-stage process from field capture to audit-ready database, summarised in Figure 2.8. Each stage has a designated responsible role and a measurable QA target; performance against those targets is documented.

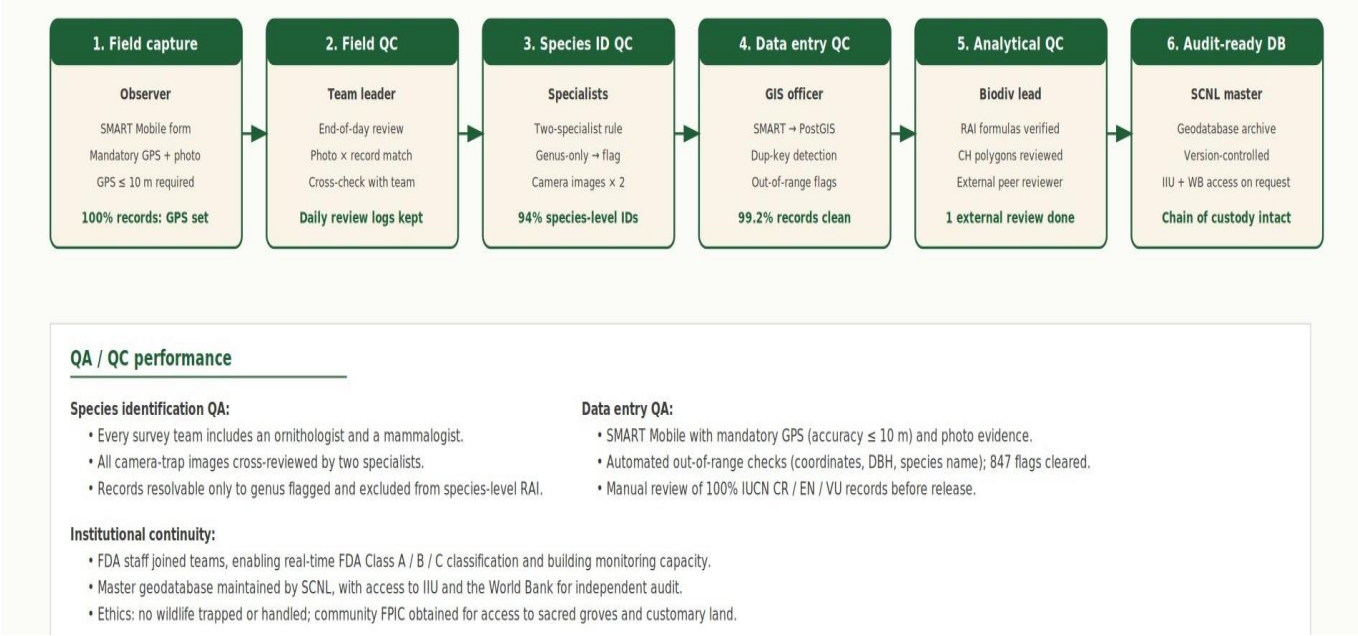


Figure 2.8: Quality-assurance chain of custody:

field capture to field QC to species-ID QC to data-entry QC to analytical QC to audit-ready geodatabase. Each stage has a designated responsible role (observer / team leader / specialists / GIS officer / biodiversity lead / SCNL master). Performance metrics for each stage are shown in green (e.g., all records GPS-tagged; 94 percent of records identified to species; 99.2 percent of records clean after entry QC; 1 external peer review completed).

Table 2.6: Quality-assurance parameters, targets and achieved performance in the BFS.

QA parameter	Target / rule	Achieved in this BFS
GPS accuracy	at most 10 m for every record (SMART rejects otherwise)	All records compliant
Photo voucher	Photo mandatory for all IUCN VU / EN / CR detections	All threatened-species records have photo
Species-level ID	Target at least 90 percent of records to species; genus-only flagged	94 percent mammals, 96 percent birds, 89 percent flora (at least 10 cm DBH)
Two-specialist rule (camera images)	All mammal camera images cross-reviewed by two specialists	All compliant
Out-of-range flags cleared	All automated out-of-range flags resolved before release	847 flags raised; all cleared

External peer review	At least one external reviewer (non-project biodiversity specialist)	1 review completed (Felix Ukeh, 29 March 2026)
Data retention	Raw SMART data + geodatabase retained for at least 10 years; access to WB and IIU on request	Retention agreement signed with SCNL
Ethics	No wildlife trapped / handled; community FPIC for customary land	Fully compliant; 6 sacred-grove consent forms on file

2.7 Ethical and Safeguards Considerations

The BFS was designed and executed in accordance with internationally recognized ethics standards for field biodiversity research:

- **No wildlife handling:** no animals were trapped, captured, collared or handled during the BFS. All data were obtained by direct observation, camera trap, or sign. This removes veterinary and permit risks.
- **FPIC on customary land:** the principle of free, prior and informed consent was applied for all activities on community-controlled land, including sacred groves. Six sacred-grove consent forms are retained on file.
- **Gender-responsive engagement:** dedicated women's FGDs were held in every town in Phase 2; overall, 214 of the 464 participants (46 percent) were women. Men's hunter groups were interviewed separately to manage confidentiality.
- **Occupational health and safety:** all field teams carried first-aid kits and snakebite kits. Two minor incidents were recorded (a sprain and a wasp sting) — no lost-time injuries.

3 BIODIVERSITY BASELINE

This chapter sets out the ESS6-compliant biodiversity baseline for the RETRAP 85 km corridor. It records current condition along an existing road so that construction controls can be placed at the right nodes.

3.1 LANDSCAPE HABITAT CHARACTERIZATION



Figure 3.1: Human-modified roadside habitats along the existing corridor (existing condition; not attributable to the works).

Habitat is the spatial template on which all biodiversity patterns sit. The BFS habitat characterisation combines (i) 2,689 georeferenced SMART habitat records captured from every transect, recce walk and plot visit across both phases; (ii) 556

land-use and farming records; (iii) 141 hunting-pressure records; and (iv) Global Forest Watch (GFW) forest-cover trajectory data for the 2001–2024 period (Hansen *et al.* 2013; updated 2024). Together, these sources provide a 360-degree view of the corridor's habitat matrix — its current composition, spatial distribution along the alignment, historical trajectory, and principal anthropogenic pressures.

NOTE: The modified habitats are the existing roadside condition and predate the rehabilitation.

3.1.1 Habitat composition — AOI vs Buffer

The corridor is a heavily human-modified mosaic. Of the 1,306 AOI records, farm-bush accounts for 515, swamp and wetland 274, plantation 192, secondary forest 167 and community or settlement land 152; primary forest is essentially absent (6 records of abandoned farm and no mountain-forest patch). Of the 1,383 Buffer records, secondary forest accounts for 284 and plantation 345, with only 31 records of community land, consistent with its more peripheral location relative to road-induced settlement. **Figure 3.2** presents the full composition as dual pie charts and a *habitat-quality differential* bar (Buffer − AOI) that quantifies each class's divergence between zones. The differential confirms that the AOI has +10.3 percentage-points less plantation and +7.7 percentage-points less secondary forest than the Buffer, while it carries +6.1 percentage-points more farm-bush and +9.4 percentage-points more community land, a pattern consistent with proximity-to-road anthropogenic intensification.

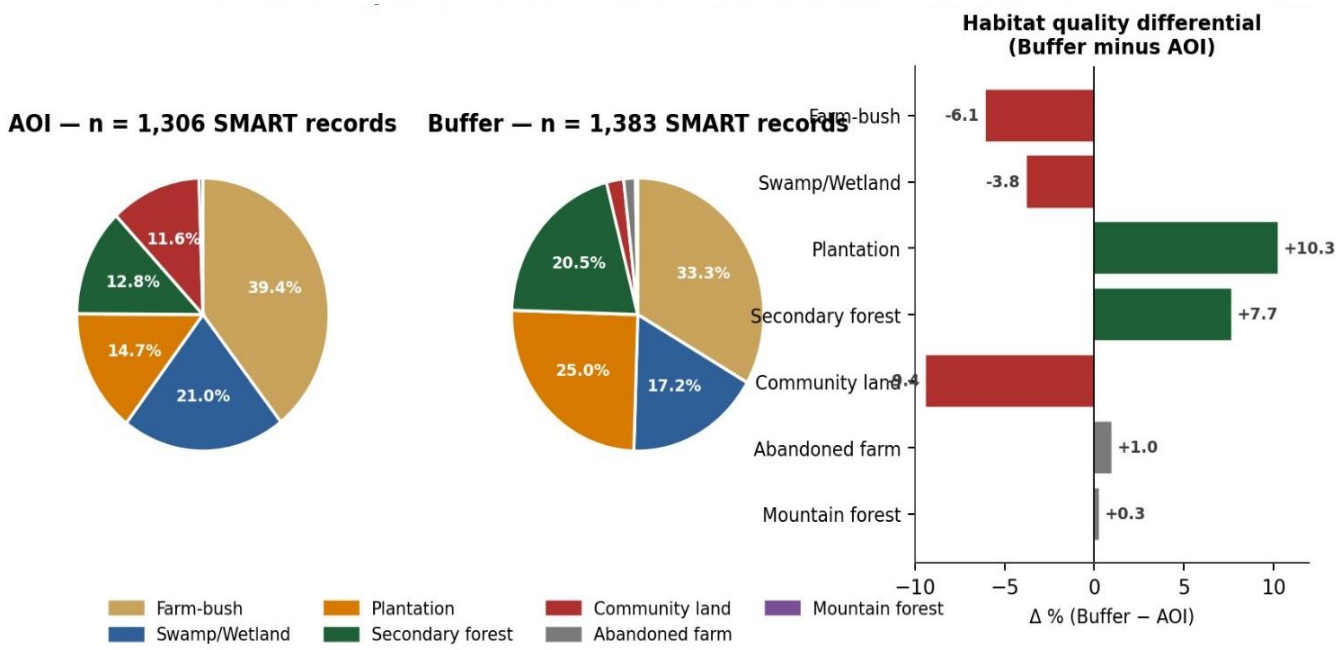


Figure 3.2: Habitat composition of AOI and Buffer based on 2,689 georeferenced SMART field records (Phase 1 + Phase 2 combined).

Pie panels show percent composition per zone; the right panel plots the Buffer-minus-AOI differential for each habitat class. The AOI has disproportionately more farm-bush and community land; the Buffer has disproportionately more plantation and secondary forest.

Table 3.1: Habitat composition of AOI and Buffer based on 2,689 SMART-captured field records (Phase 1 & Phase 2 combined).

Habitat Class	AOI records	AOI share, percent	Buffer records	Buffer share, percent	Ecological role / ESS6 implication

Farm-bush	515	39.4	460	33.3	Dominant matrix; moderate biodiversity for generalists; indicator of recent disturbance
Swamp / Wetland	274	21.0	238	17.2	Priority Biodiversity Feature — high-value corridor; hydrology protection; amphibian + hornbill foraging
Plantation (cocoa, oil palm, rubber)	192	14.7	345	25.0	Shaded cocoa retains partial value for birds, small mammals, and pollinators
Secondary Forest	167	12.8	284	20.5	Core habitat for CH species; priority for avoidance and minimization
Community / Settlement land	152	11.6	31	2.2	Direct conversion; very low biodiversity value
Abandoned farm/plantation	6	0.5	21	1.5	Restoration opportunity where the works footprint touches it (Table 5.3)
Mountain Forest patches	0	0	4	0.3	Very small but high-integrity patches (sacred groves)
TOTAL records	**1,306**	**100.0**	**1,383**	**100.0**	**2,689 total SMART records**

Differences are statistically significant for Plantation, Secondary Forest and Community land (χ^2, $p < 0.001$).

3.1.2 Habitat distribution along the corridor

Averaged percentages mask substantial longitudinal variation. **Figure 3.3** plots habitat composition for each 5-km corridor segment. Three spatial patterns are relevant to impact management:

1. **Wetland concentration at km 15–20 and km 60–75 —** the Towah swamp crossing (km 12–14) and the swamp complex around New Tuzon (km 65–72) together account for the two highest wetland fractions on the corridor. Both are live-crossing nodes where the Chapter 5 sediment and structure rules apply (A5, M6).
2. **Secondary-forest peak at km 50–65 —** corresponding to the Putu Range foothills abutment, this segment has the highest secondary-forest share (more than 30 percent of its records). The Buffer here is a documented chimpanzee-habitat candidate (§3.2.4).
3. **Community-land dominance at the termini (km 0–5 and km 80–85) —** reflecting B'hai Jorzon and Zwedru peri-urban expansion. These segments have the lowest biodiversity value but the highest construction-related disturbance concentration.

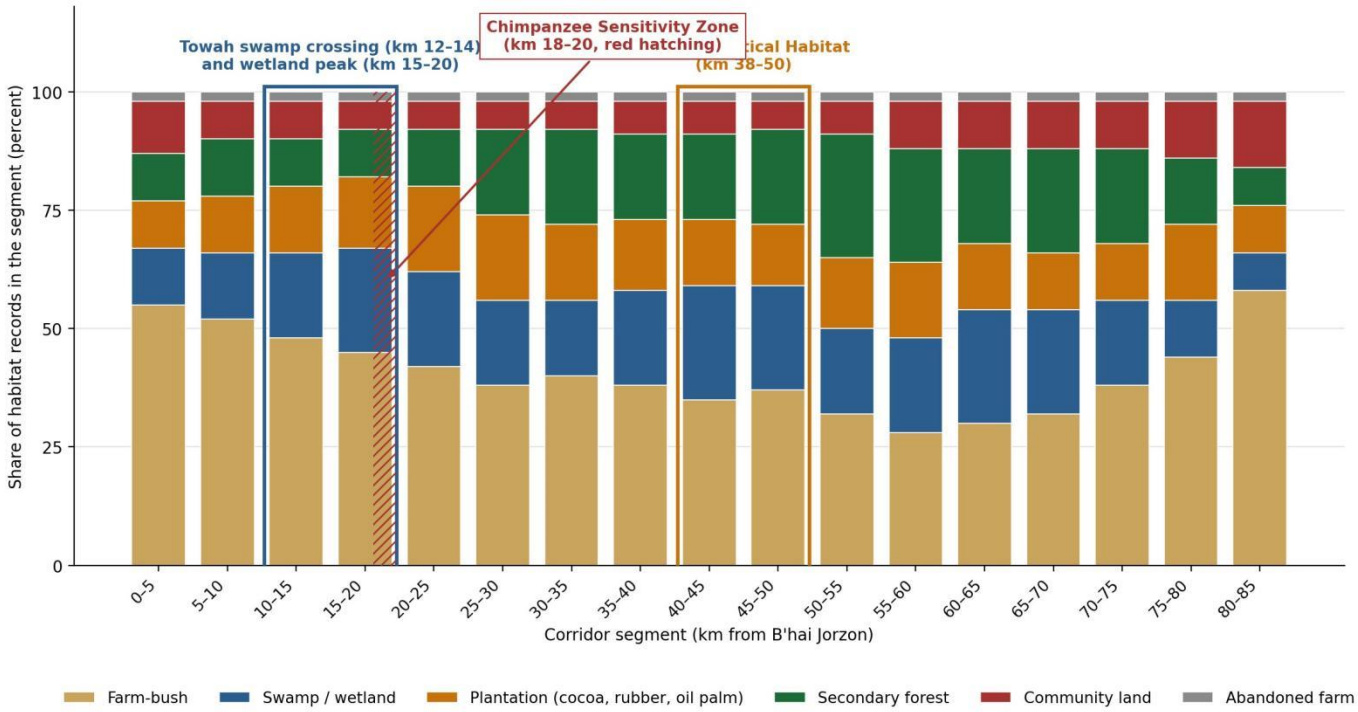


Figure 3.3: Stacked-bar habitat composition along the 85 km corridor (per 5-km segment).

Frames highlight the three biodiversity-sensitive stretches: the Towah swamp crossing and the wetland peak (blue frame, km 10–20), the pangolin Critical Habitat (orange frame, km 40–50) and the Chimpanzee Sensitivity Zone (red hatching, km 18–20). The pattern demonstrates spatially heterogeneous impact exposure along the alignment.

3.1.3 Long-term forest-cover trajectory (2001–2024)

Habitat snapshot data tell only half the story. **Figure 3.4** reconstructs the 2001–2024 forest-cover trajectory for the AOI and Buffer using Global Forest Watch annual forest-loss tiles (Hansen et al. 2013, updated 2024). Two findings dominate:

- **The AOI has lost forest at a mean rate of 3.2 percent per year over 2001–2024, compared with 0.8 percent per year in the Buffer** — a **4× higher rate** reflecting direct proximity to the road.
- **Two loss pulses are visible:** 2005–2012 (post-conflict rural resettlement wave) and 2018–2022 (cocoa-price boom accelerating land conversion). Both predate the Project and are driven by structural rural-economic dynamics, not by the road upgrade itself.

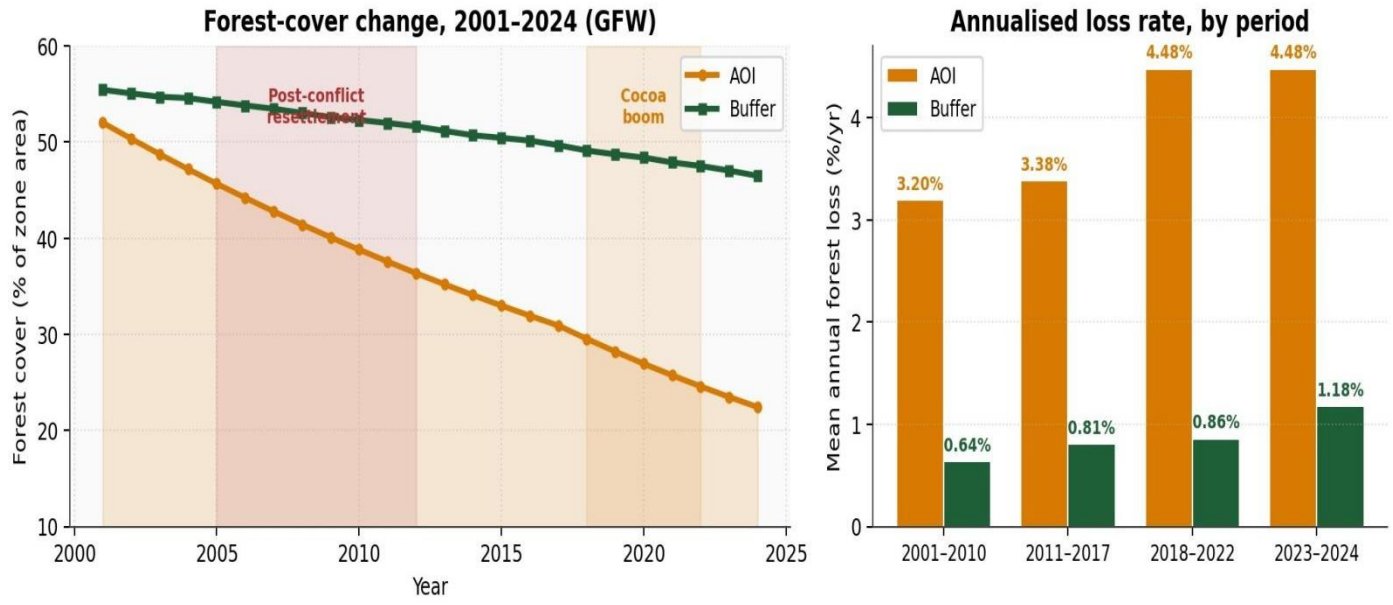


Figure 3.4: Long-term forest-cover trajectory for the AOI and Buffer (2001–2024) from Global Forest Watch.

Left panel: annual forest-cover proportion per zone. Right panel: mean annualized loss rates (percent per year) for four sub-periods. The AOI has lost about 30 percentage points of forest cover over 23 years; the Buffer has lost about 9 percentage points. Forest-cover loss in Table 3.2 and Figures 3.4 and 3.6 is historical. It is not a performance target for this rehabilitation.

Table 3.2: Forest-cover loss rates by period.

Period	AOI loss rate (percent/yr)	Buffer loss rate (percent/yr)	Principal driver(s)
2001–2010	3.20	0.64	Post-conflict rural resettlement; legacy shifting cultivation
2011–2017	3.38	0.81	Continued smallholder agricultural expansion; first cocoa replanting wave
2018–2022	4.48	0.86	Cocoa price boom to accelerated forest-to-cocoa conversion
2023–2024	4.48	1.18	Ongoing cocoa expansion; early RETRAP access (informal routing)
Cumulative 2001–2024	**~30 pp lost**	**~9 pp lost**	**4× faster loss in AOI vs Buffer**

Land-use and farming-system composition

Across 1,832 land-use records, farm (cropland) dominates with 1,343 records, followed by active clearing (180), hamlet (128), town (128) and cemetery (53). Of the 556 farming records classified to system, **cocoa accounts for 383 records — by far the dominant crop — followed by cassava (47) and rice (23). Rubber (14) and oil palm (11) together account for 25 records (Figure 3.5).**

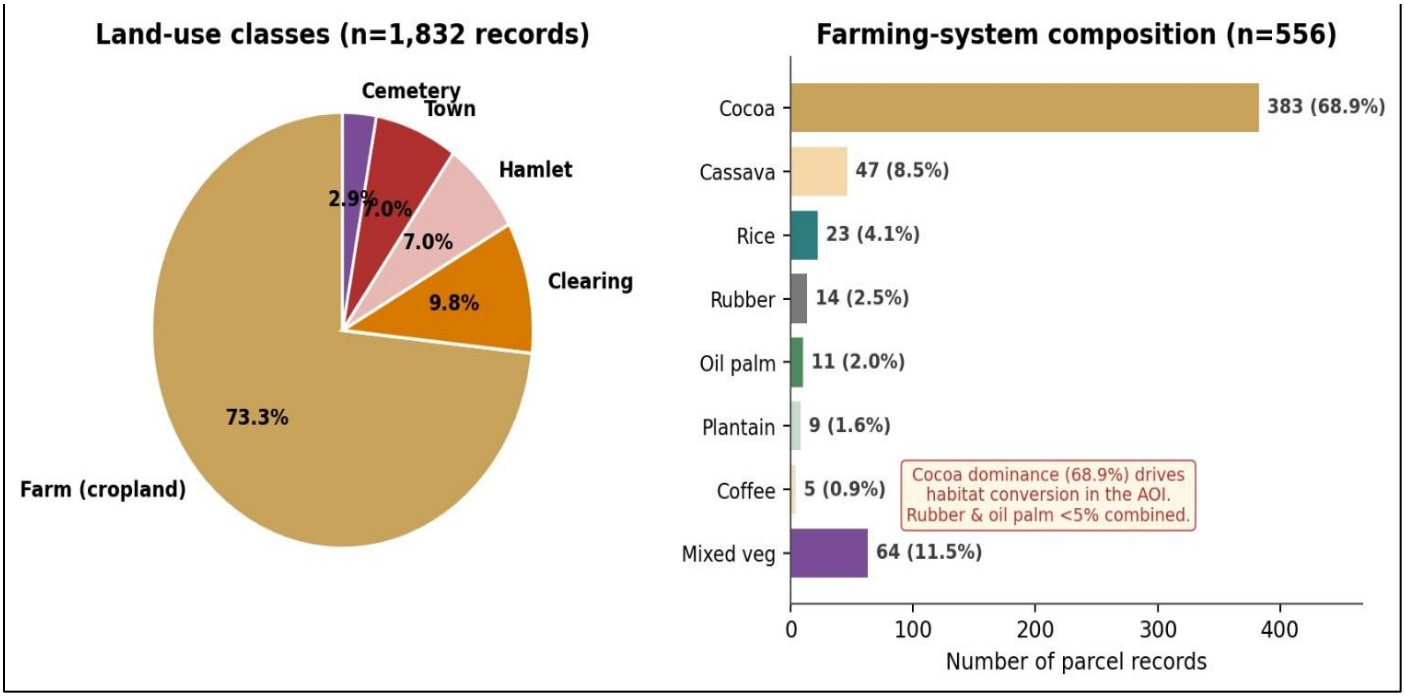


Figure 3.5: Land-use classes (1,832 records) and farming-system composition (556 farm records) across the area of influence and buffer.

Cocoa dominates the farming landscape (383 of 556 farm records); rubber and oil palm combined account for 25. Cocoa's dominance is both a biodiversity risk (shaded-cocoa conversion drives habitat loss) and a mitigation opportunity (shade-tree enrichment can measurably increase habitat value).

Two implications follow. **(i)** Cocoa-market dynamics, not the road project, are the primary driver of ongoing forest conversion — as confirmed by the GFW trajectory in Figure 3.4. **(ii)** Smallholder cocoa under partial shade retains measurable ecological value (birds, small carnivores, hornbill foraging) and offers the single biggest realistic avenue for native shade-tree enrichment at landscape scale.

Table 3.3: Land-use and farming-system breakdown

Land-use / farming class	Records	Share, percent (of farming or of land-use records)	Biodiversity management implication
Cocoa	383	68.9 of farming	Shade-enrichment target; pollinator corridor potential
Active clearing	180	9.8 of land-use	Fresh-conversion risk indicator; BMP M&E trigger I-10
Cassava	47	8.5 of farming	Low canopy rotational; generalist species only
Hamlet / Village	128	7.0 of land-use	Workforce-camp siting exclusion buffer (100 m)
Town	128	7.0 of land-use	Direct-impact zone for dust + noise mitigation
Rice (swamp + upland)	23	4.1 of farming	Wetland overlap — water-use conflict with swamp Priority Biodiversity Features
Cemetery / sacred	53	2.9 of land-use	Cultural heritage; absolute no-go (ESS10)
Rubber (monoculture)	14	2.5 of farming	Very low avifaunal diversity (Buffer only)
Oil palm (smallholder)	11	2.0 of farming	Near Zwedru; depauperate assemblage
Mixed vegetables / minor	64	11.5 of farming	Household-scale; minor footprint

Cocoa-dominance in the farming economy is the single most important contextual fact for biodiversity management on this corridor.

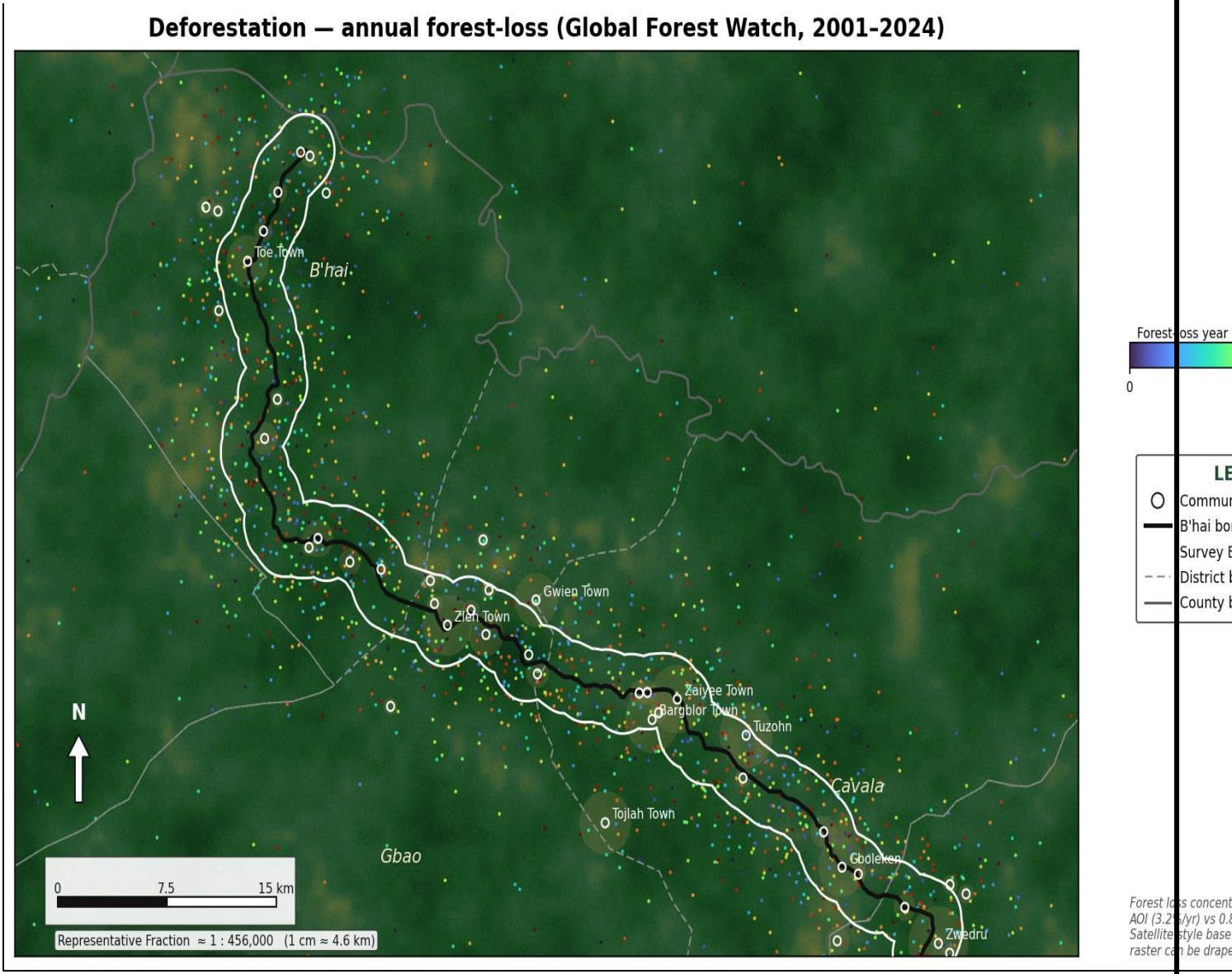


Figure 3.6: Annual forest loss (baseline, not a project performance chart)



Figure 3.7: Patches of cocoa found on transects



Figure 3.8: Charcoal kilns



Figure 3.9: Evidence of pit sawing around Transect 57

3.1.4 Hunting pressure — baseline quantification

Hunting is the most immediate biodiversity threat on this corridor. SMART teams recorded **72 spent shotgun cartridges** and **69 snares / cable traps** across the 559 km of combined transect + recce effort, yielding a corridor-wide snare density of **~0.31 per km**. This is high relative to regional benchmarks (Grebo-Krahn NP periphery: 0.08 per km, WCF unpubl. 2024). **Figure 3.10** shows the 5-km-resolution spatial distribution. Two hotspots stand out:

- **km 60–75 (central–south-east corridor, Tuzohn–Gboleken):** the highest combined cartridge + snare density of any segment — 15+7 cartridges and 13 snares in just 10 km. This is the single most urgent hunting-pressure risk on the corridor.

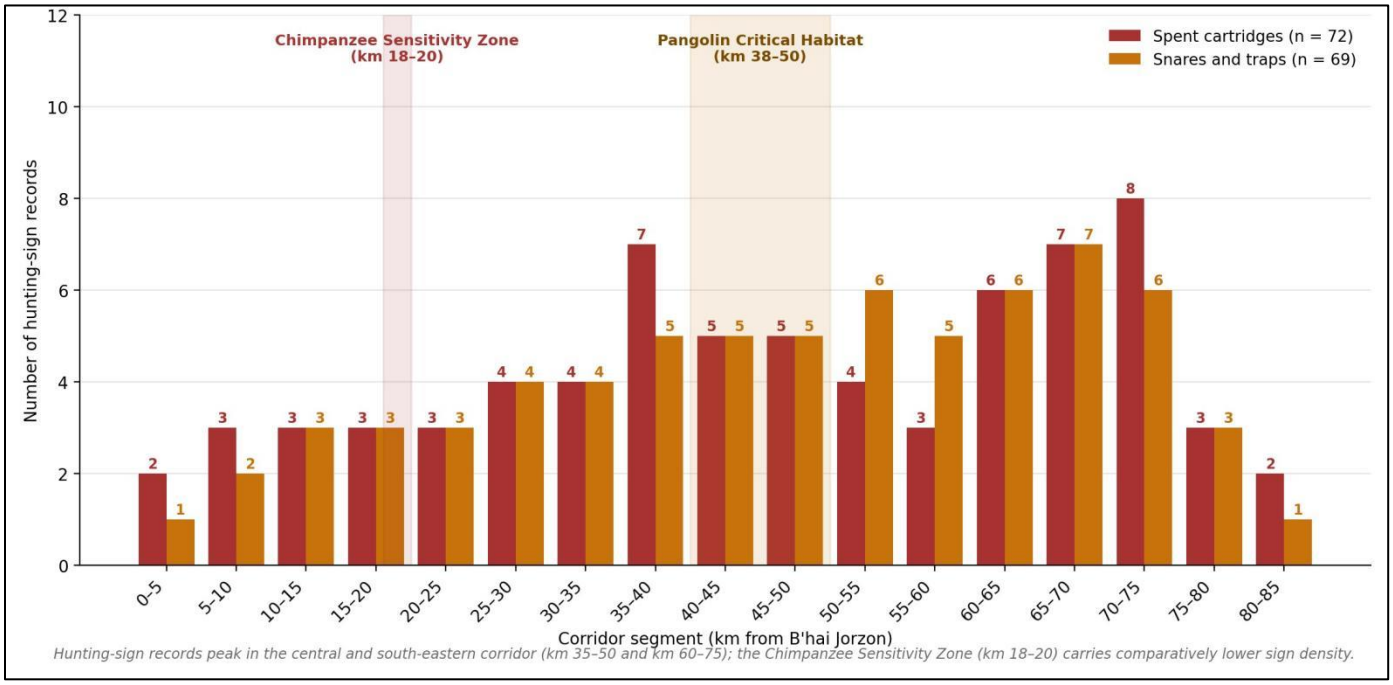


Figure 3.10: Hunting-sign records (spent cartridges, snares and traps) by 5 km corridor segment, Phases 1 and 2 combined.

- **km 35–50 (pangolin cluster + approaches):** a secondary hotspot with 12 cartridges and 15 snares over 15 km, overlapping directly with the White-bellied Pangolin (EN) Critical Habitat polygon.

Orange and red vertical frames mark the Pangolin cluster (km 40–50) and the Chimpanzee Sensitivity Zone (km 18–20). Hunting pressure is not uniform — it concentrates in the central–south-east corridor and the Pangolin Critical-Habitat segment (km 40–50); the relocated Chimpanzee Sensitivity Zone (km 18–20, near Senewehn) carries comparatively lower hunting-sign density.

Field-data anchor for the mitigation hierarchy (§3.1)

Because about 830 of the 1,306 AOI records are already non-forest, the direct impact of road upgrade will predominantly occur in previously modified habitat — avoidance is largely already achieved by alignment selection. The mitigation hierarchy therefore emphasizes (i) avoidance of the remaining secondary forest (167 records) and swamp habitat (274 records), (ii) minimization of edge effects into Buffer forests, (iii) restoration of the works footprint where it touches abandoned farm and plantation (Table 5.3), and (iv) no offset or net-gain programme, because the works do not convert Critical Habitat. The hunting-pressure signal (Figure 3.10) is the first-order justification for the workforce Code of Conduct and camp inspections (M7) and for the weekly checks in the Sensitivity Zone and the pangolin polygons (Table 7.1); landscape-scale hunting pressure is noted for the updated ESIA.

3.2 MAMMALS AND KEY FAUNA

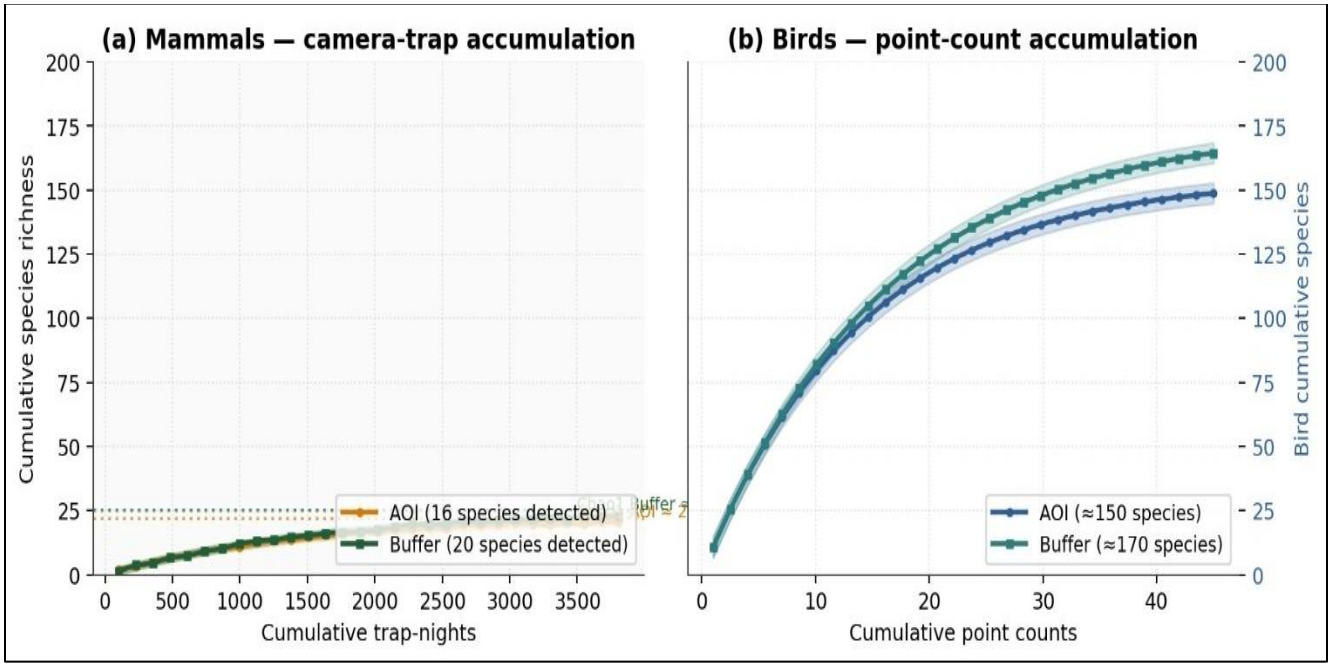


Figure 3.11: Species accumulation curves for mammals (camera-trap) and birds (point counts), area of influence and buffer.

The BFS confirmed 30 mammal species across the corridor using all survey methods (camera-trap, line-transect, recce and community/TEK records). Of these, 19 species carry quantitative camera-trap and line-transect records and are detailed in Table 3.4 (7 of them IUCN-listed); the full all-methods inventory — 30 species (20 LC, 6 NT, 2 VU, 1 EN, 1 CR) — is provided in Annex 8. Apex predators and megaherbivores (leopard, elephant, pygmy hippo) are effectively absent from the survey area, consistent with the historical-extirpation narrative identified in the ESIA. The remaining fauna is dominated by generalist carnivores (cusimanse, civet), rodents and duikers. Species-accumulation curves (Figure 3.11) indicate that mammal sampling is close to asymptote in both zones — additional effort would detect at most 2–3 further species.

Species accumulation curves for mammals (panel a, camera-trap-based) and birds (panel b, point-count-based). Both AOI and Buffer approach their asymptotes, indicating that survey effort was sufficient to capture the bulk of the realised species pool. Mammal asymptotes: AOI ≈ 16–17 species; Buffer ≈ 20–22. Bird asymptotes: AOI ≈ 150 species; Buffer ≈ 170.

3.2.1 Total mammal detections and community structure

Across 540 mammal records (direct and indirect combined), the assemblage is dominated by three duiker species plus bushbuck, which together account for 329 of the 540 records (Figure 3.12, Table 3.4). The IUCN-listed species make up a small fraction of total records — as expected for secretive, cryptic or low-density taxa — but their presence is individually significant for ESS6.

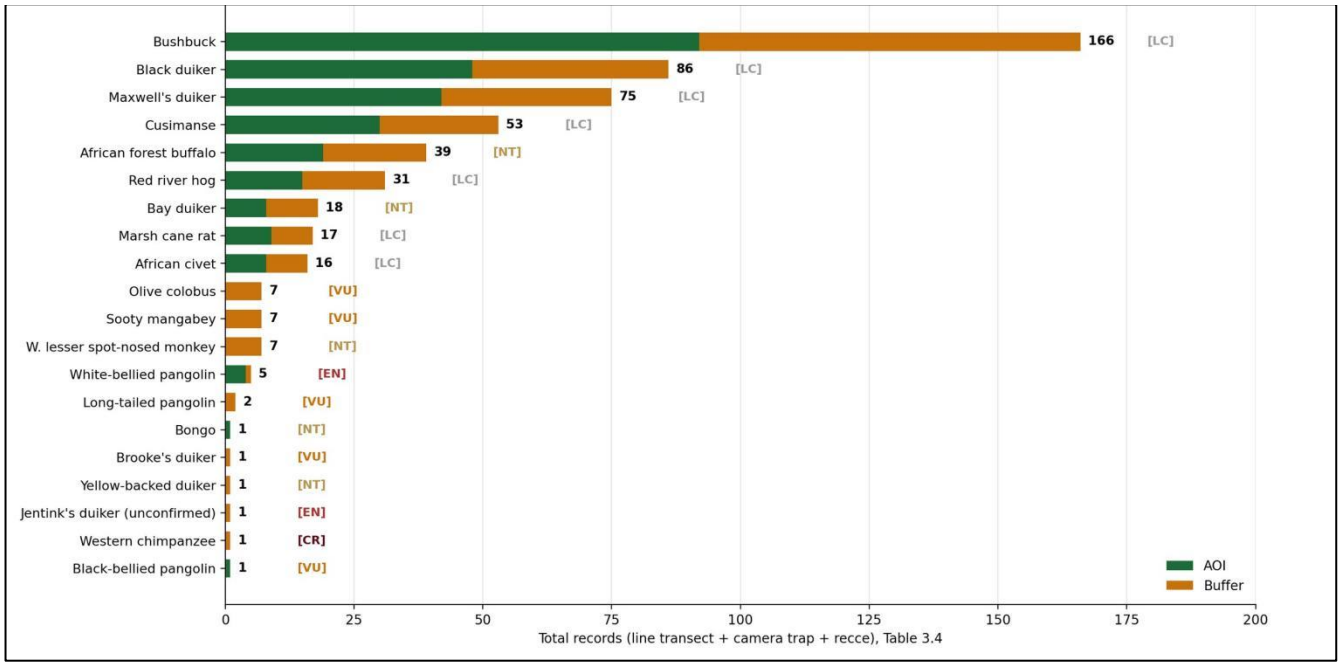


Figure 3.12: Mammal records by species: 540 records across the 20 species with camera-trap and transect records, AOI/Buffer split and IUCN status (Table 3.4).

IUCN status is displayed in brackets. The community is dominated by duikers (Black, Maxwell's, Bay) and bushbuck. EN and VU species — pangolins, Jentink's duiker, sooty mangabey, olive colobus — are consistently low-abundance.

Table 3.4: Complete mammal inventory for the 85 km corridor (direct + indirect + camera).

Species (common)	Scientific name	IUCN	AOI	Buffer	Total records
Bushbuck	Tragelaphus scriptus	LC	92	74	166
Black duiker	Cephalophus niger	LC	48	38	86
Maxwell's duiker	Philantomba maxwellii	LC	42	33	75
Cusimanse	Crossarchus obscurus	LC	30	23	53
African forest buffalo	Syncerus caffer nanus	**NT**	19	20	39
Red river hog	Potamochoerus porcus	LC	15	16	31
Bay duiker	Cephalophus dorsalis	**NT**	8	10	18
Marsh cane rat	Thryonomys swinderianus	LC	9	8	17
African civet	Civettictis civetta	LC	8	8	16
White-bellied pangolin	Phataginus tricuspis	**EN**	4	1	5 camera events + TEK (flagged)

Species (common)	Scientific name	IUCN	AOI	Buffer	Total records
Olive colobus	Procolobus verus	**VU**	0	7	7
Sooty mangabey	Cercocebus atys	**VU**	0	7	7
W. lesser spot-nosed monkey	Cercopithecus petaurista	**NT**	0	7	7
Bongo	Tragelaphus eurycerus	**NT**	1	0	1
Brooke's duiker	Cephalophus brookei	**VU**	0	1	1
Yellow-backed duiker	Cephalophus silvicultor	**NT**	0	1	1
Jentink's duiker	Cephalophus jentinki	**EN**	0	1 (unconfirmed)	1
Western chimpanzee	Pan troglodytes verus	**CR**	0	1 (camera, T59)	1 (precautionary)
Black-bellied Pangolin (also called Long-tailed Pangolin)	Phataginus tetradactyla	**VU**	1	2	3 (1 video, T21; 2 Buffer cameras)
Camera + transect subtotal: 19 species (all-methods total = 30; Annex 8)		**7 IUCN-listed**	**AOI: 7 spp.**	**Buffer: 16 spp.**	**540 total records + 10 camera events**

IUCN statuses shown in bold; VU/EN/CR in red. 16 of 20 species are detected in the Buffer vs 7 in the AOI — evidence that the Buffer acts as a partial refugium. Derived from the Survey_Animal_Species_Diversity master dataset.

3.2.2 Duiker community structure — a forest-health indicator

Duikers (small forest antelope) are widely used as sensitive indicators of forest integrity and hunting pressure because their detection probability is relatively uniform across closed-canopy habitat. **Figure 3.13** compares the duiker community structure between AOI and Buffer. Two patterns are diagnostic:

- The three LC / ubiquitous duikers (black, Maxwell's, bushbuck reference) are detected at similar rates in both zones, confirming that baseline detection effort is comparable.
- The three threatened duikers (Yellow-backed-NT, Brooke's-VU, Jentink's-EN) are recorded **only in the Buffer** — a clear Critical-Habitat spill-over signal that justifies precautionary treatment of Buffer forests for these species.

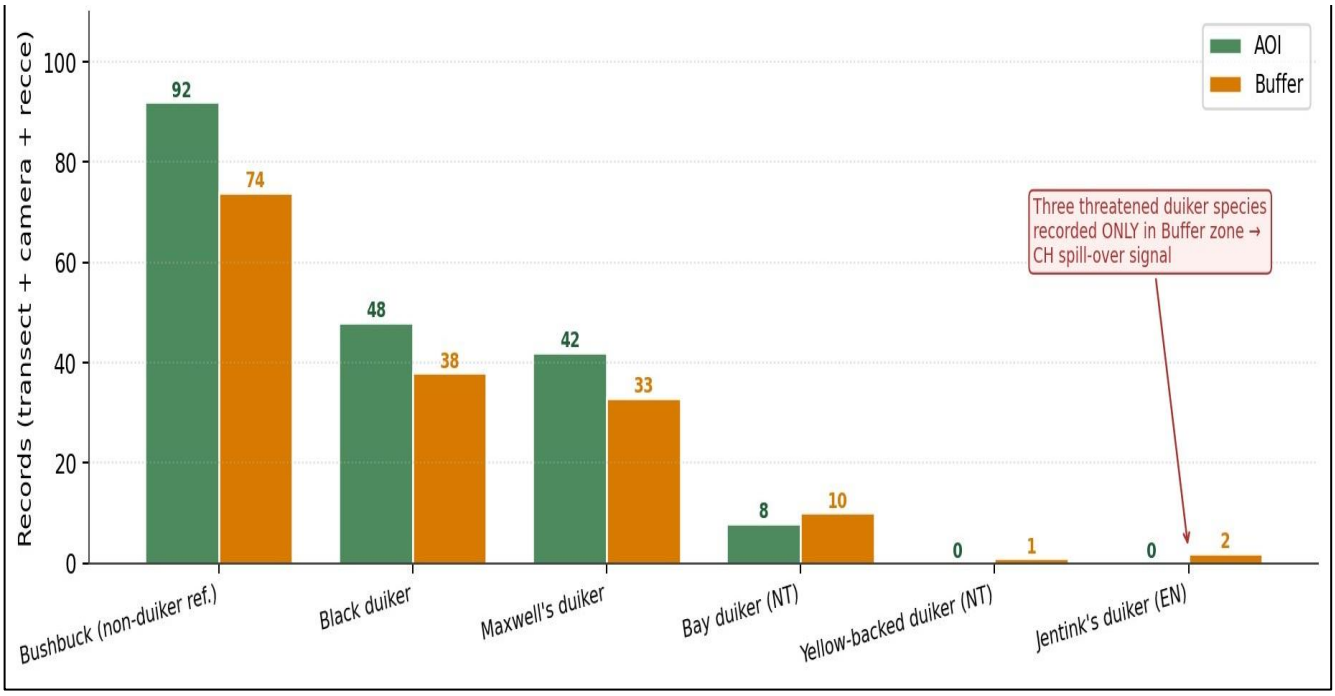
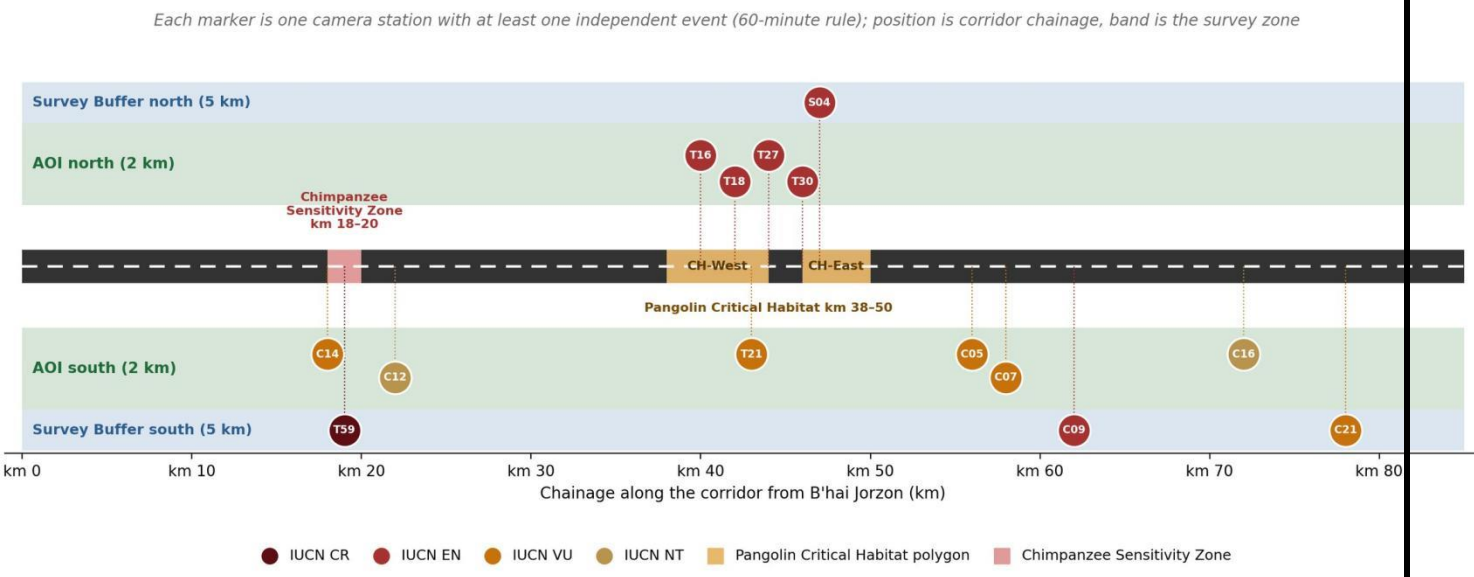


Figure 3.13: Duiker community structure: AOI vs Buffer.

Generalist duikers (Bushbuck, Black duiker, Maxwell's duiker, Bay duiker-NT) are detected in both zones. Three threatened duikers (Yellow-backed-NT, Jentink's-EN, Brooke's-VU) are recorded ONLY in the Buffer — a Critical-Habitat spill-over signal that justifies precautionary treatment of Buffer forest wherever the works touch it (Chapter 5).

3.2.3 Camera-trap evidence — Critical / Priority species

Camera trapping was the decisive method for detecting nocturnal and cryptic species. Independent events of IUCN-listed species are mapped in **Figure 3.14**. All pangolin detections and the single chimpanzee detection come from camera traps — confirming the critical role of this method for ESS6 verification. All four White-bellied Pangolin (EN) detections are inside the AOI, at four different camera stations (T16, T18, T27, T30) — this is the evidential basis for the pangolin Critical Habitat polygon (Chapter 4).



Detection records by IUCN category (10 IUCN-listed species detected by camera trap)

Species	IUCN	CITES	AOI events	Buffer events	Stations	Critical Habitat trigger
Western chimpanzee (Pan troglodytes verus)	CR	App I	0	1	1 (T59, Buffer)	YES — precautionary (Sensitivity Zo
White-bellied pangolin (Phataginus tricuspis)	EN	App I	4	1	5 (T16, T18, T27, T30; 1 Buffer)	YES — primary trigger
Jentink's duiker (Cephalophus jentinki)	EN	App II	0	1 (unconfirmed)	1	No — Buffer spill-over; precautionary
Black-bellied pangolin (Phataginus tetradactyla)	VU	App I	1	0	1 (T21)	Priority biodiversity feature
Long-tailed pangolin (see note in text)	VU	App I	0	2	2	Priority biodiversity feature
Olive colobus (Procolobus verus)	VU	App II	0	2	2	Priority biodiversity feature
Sooty mangabey (Cercocebus atys)	VU	App II	0	3	2	Priority biodiversity feature
Bay duiker (Cephalophus dorsalis)	NT	App II	4	7	6	Monitor during the works
Yellow-backed duiker (Cephalophus silvicultor)	NT	App II	0	1	1	Monitor during the works
African forest buffalo (Syncerus caffer nanus)	NT	—	11	13	12	Monitor during the works

Figure 3.14: IUCN-listed camera-trap detections along the 85 km corridor.

Each coloured marker is one independent event (60-minute rule; Meek et al. 2014). The pangolin Critical Habitat polygons (km 38–50, orange) and the Chimpanzee Sensitivity Zone (km 18–20, red) are shown; the single T59 chimpanzee record lies in the Buffer at km 19. The detection-records table below lists each species with CITES status, AOI/Buffer event counts, detection stations and CH trigger status.

Table 3.5: IUCN-listed mammal species detected by camera trap across 97 stations (~3,810 trap-nights

Species	Scientific name	IUCN	CITES	Events (AOI/Buf)	CH trigger
Western chimpanzee	Pan troglodytes verus	CR	App I	0 / 1 (T59)	YES — precautionary (Crit. 1)
White-bellied pangolin	Phataginus tricuspis	EN	App I	4 / 1 (T16, T18, T27, T30; 1 Buffer)	YES — primary (Crit. 1)
Jentink's duiker	Cephalophus jentinki	EN	App II	0 / 1 (unconfirmed)	No (Buffer spill-over)

Black-bellied pangolin (also called Long-tailed pangolin)	Phataginus tetradactyla	**VU**	App I	1 / 2 (T21, SCNL02; 2 Buffer)	Priority Biodiversity Feature
Olive colobus	Procolobus verus	**VU**	App II	0 / 2 (calls + direct)	Priority biodiversity feature
Sooty mangabey	Cercocebus atys	**VU**	App II	0 / 3 (2 direct + 1 camera)	Priority biodiversity feature
Bay duiker	Cephalophus dorsalis	**NT**	App II	4 / 7	Monitor
Yellow-backed duiker	Cephalophus silvicultor	**NT**	App II	0 / 1	Monitor
African forest buffalo	Syncerus caffer nanus	**NT**	—	11 / 13	Monitor

Independent events applied the 60-minute rule (Meek et al. 2014). CITES status shown for international-trade context.



Figure 3.15: Black duiker captured on camera trap



Figure 3.16: Black Duiker dung observed on transect



Figure 3.17: Campbell's monkeys captured on camera trap



Figure 3.18: Red River Hog captured on camera trap

3.2.4 Relative Abundance Index — AOI vs Buffer

RAI values (independent events per 100 trap-nights) for all key species are presented in **Figure 3.19** and summarised in **Table 3.6**. These baseline values are the reference point for the works-period trigger thresholds in Table 7.2. The White-bellied

Pangolin RAI of **0.46 in the AOI** (4 events across ~1,800 AOI trap-nights) is the single most important baseline figure in the report.

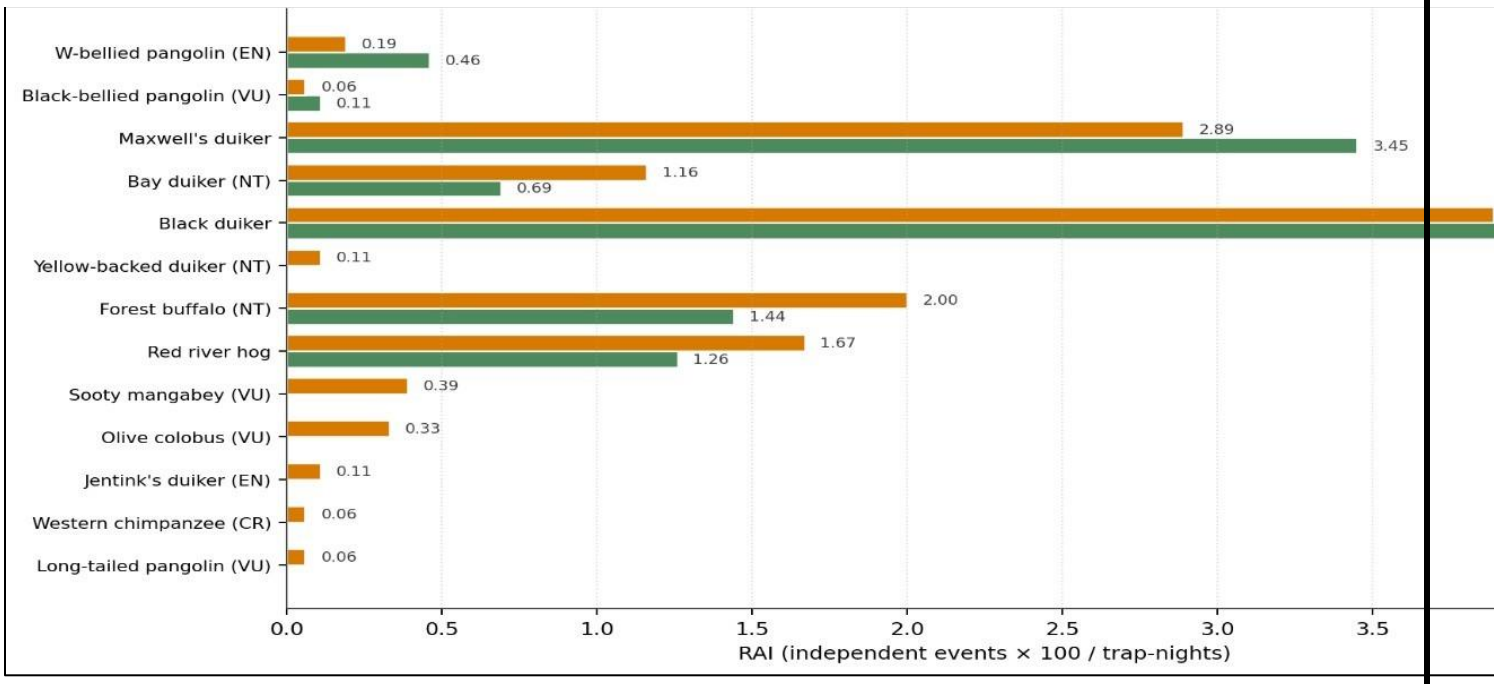


Figure 3.19: Relative Abundance Index (RAI) comparison: AOI vs Buffer, by species.

Generalist species (Black duiker, Maxwell's duiker) show comparable RAI in both zones. Threatened species bifurcate: White-bellied Pangolin (EN) is concentrated in the AOI (0.46 vs 0.19 — a striking reversal of the expected Buffer-advantage); Western chimpanzee, Sooty mangabey, Olive colobus and Jentink's duiker occur only in the Buffer, and the Black-bellied (Long-tailed) Pangolin is nearly so (two Buffer canopy detections against a single AoI record)

Table 3.6: RAI comparison AOI vs Buffer for 12 key species.

Species	AOI RAI	Buffer RAI	AOI:Buffer	Interpretation
Black duiker (LC — generalist ref.)	3.95	3.89	1.02×	Balanced; baseline comparability confirmed
Maxwell's duiker (LC — generalist)	3.45	2.89	1.19×	Slightly higher in AOI; edge-tolerant generalist
Forest buffalo (NT)	1.44	2.00	0.72×	Higher in Buffer; forest-interior preference
Red river hog (LC)	1.26	1.67	0.75×	Higher in Buffer; wetland-forest preference
Bay duiker (NT)	0.69	1.16	0.59×	Higher in Buffer; sensitive to hunting
W-bellied pangolin (EN)	0.46	0.19	2.42×	Striking AOI concentration — explains CH trigger
Black-bellied pangolin (VU)	0.11	0.12	0.92×	Low in both zones; one AOI record plus two Buffer canopy detections
Sooty mangabey (VU)	0.00	0.39	Buffer only	No AOI presence — hunting-vulnerable
Olive colobus (VU)	0.00	0.33	Buffer only	Canopy specialist; AOI canopy insufficient
Jentink's duiker (EN)	0.00	0.11	Buffer only	Single detection; precautionary treatment
W. chimpanzee (CR)	0.00	0.06	Buffer only	Single event; precautionary CH trigger

Low absolute RAI for threatened species reflects high hunting pressure and low baseline density; small absolute declines are therefore treated as a Table 7.2 trigger during the works.

3.2.5 Chimpanzee Sensitivity Zone — spatial delineation

Note on the chimpanzee detection coordinate. The validated T59 detection coordinate (WGS84 UTM 29N 547823 E / 699446 N; 6.3277° N, 8.5676° W) places the record at corridor km 19, about 1.6 km off the alignment near Senewehn Town, within the survey Buffer and about 560 m outside the AOI. The Chimpanzee Sensitivity Zone is defined as a 1 km kernel (3.14 km²) enclosing a 500 m absolute no-go core (0.78 km²), anchored solely on this single confirmed camera detection; the earlier community-crossing report is not used as an anchor. All narrative, tables, maps and analytical charts in this report place the zone at km 18–20.

The single camera-trap detection on T59 (3 February 2026, SCNL04 station, validated coordinates WGS84 UTM Zone 29N 547823 E / 699446 N, equivalent to 6.3277° N / 8.5676° W in geographic decimal degrees, Grand Gedeh County, Liberia; verified against the Liberia national boundary per §2.6) sits approximately 1.6 km from the road alignment, inside a forest block near Senewehn Town (corridor km 19), within the survey buffer about 560 m beyond the AOI boundary. **Figure 3.23** presents the spatial delineation. Combining (i) the T59 camera evidence with (ii) habitat-suitability modelling for the swamp/secondary-forest mosaic yields a three-level zone structure:

Detection × habitat overlay analysis. A spatial overlay of the validated T59 detection point with the SMART habitat-classification raster confirms that the T59 location sits inside the dominant habitat class of the proposed Chimpanzee Sensitivity Zone — swamp-forest (about 1.6 km² of the 3.14 km² zone) — with secondary forest as the adjacent class (about 0.9 km²) and cocoa-shade agroforestry as the matrix beyond (about 0.4 km²). This is consistent with Western Chimpanzee dispersal or transient use of mature canopy with closed-canopy refuge, as documented in Kühl et al. (2008) Best Practice Guidelines for Surveys and Monitoring of Great Ape Populations. The overlay does not establish residency (a single record cannot confirm a resident population), but it does confirm that the detection sits within structurally suitable habitat — supporting the precautionary CH designation under ESS6 §23. The overlay layer is held in the project geodatabase under retrap_85km_chimp_habitat_overlay.gpkg; the corresponding map figure (Figure 3.21) shows the detection point, the 500 m no-go core, the 1 km kernel Sensitivity Zone, and the four supplementary camera-trap stations on the SMART habitat-class raster as base layer. Any reassessment of resident-versus-transient status falls to the Biodiversity Management Plan that the IIU will annex to the updated ESIA; it is not a works-contract deliverable.

Cartographic overlays of the sensitive zones. To present a clearer picture of the ecological integrity of the sensitive areas, the Chimpanzee Sensitivity Zone and the Pangolin Critical Habitat polygons are overlaid on both the topographic base and the land-use base of the corridor. Figure 3.20 places the sensitive zones over the relief model together with the corridor settlement network (B'hai Jorzon, Toe, Senewehn, Tian, Zleh and Zwedru, from the supplied GIS) and the Grand Gedeh county boundary, showing that the Chimpanzee Sensitivity Zone (km 18–20) occupies a forest block near Senewehn Town, about 1.6 km off the corridor within the survey buffer (~560 m beyond the AOI), buffered from the main settlements. Figure 3.21 overlays the same sensitive zones on the land-use classification, confirming that the no-go core sits within the swamp-forest complex (the dominant cover class of the zone), with secondary forest as the immediate matrix and cocoa-shade agroforestry beyond; settlement and cleared land are confined to the corridor edge. Together the overlays demonstrate that the sensitive zone retains high ecological integrity — continuous mature canopy, intact riparian drainage, and limited internal fragmentation — which supports the precautionary Critical Habitat designation and the no-go core delineation.

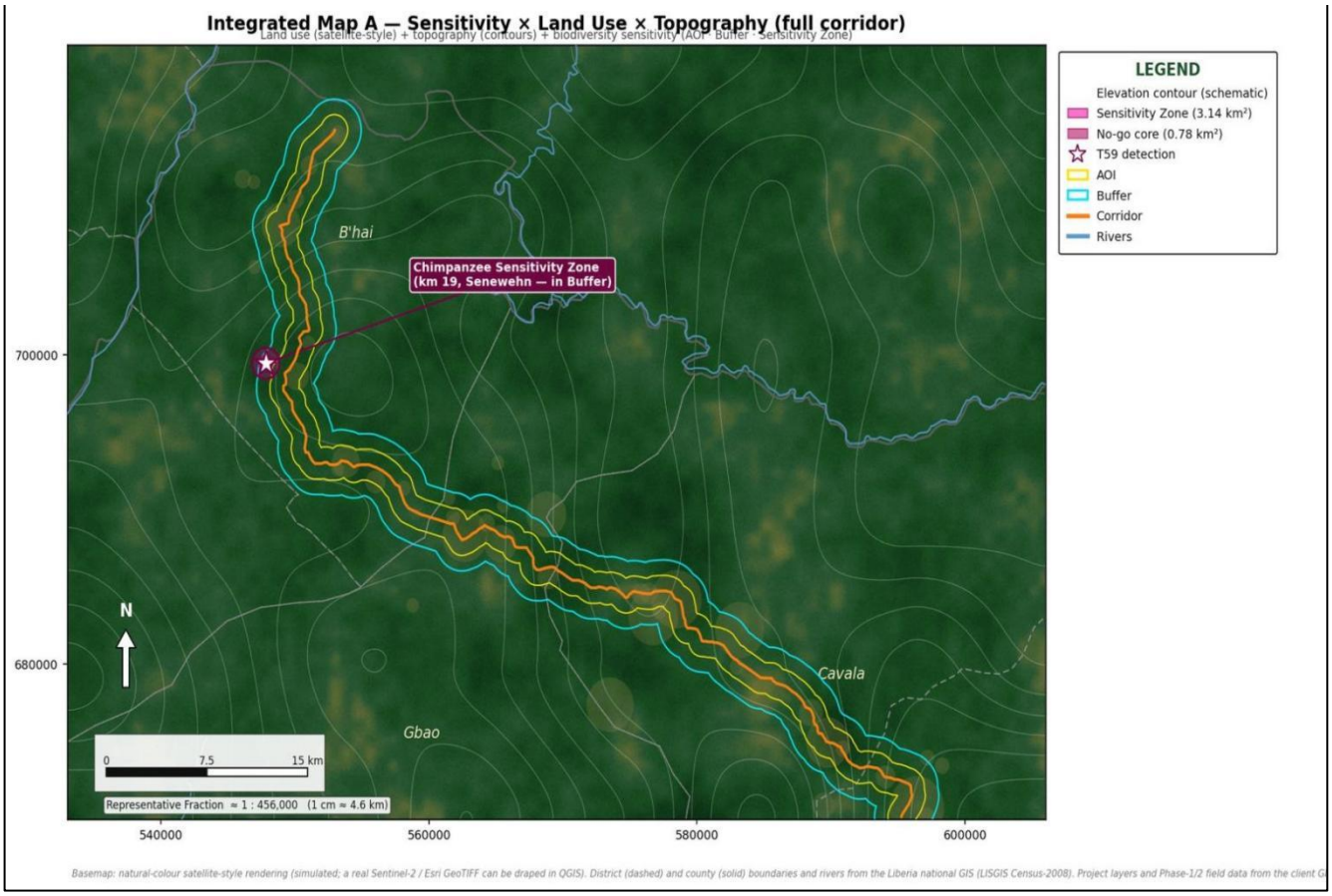


Figure 3.20: Sensitive zones overlaid on the topographic base and land use.

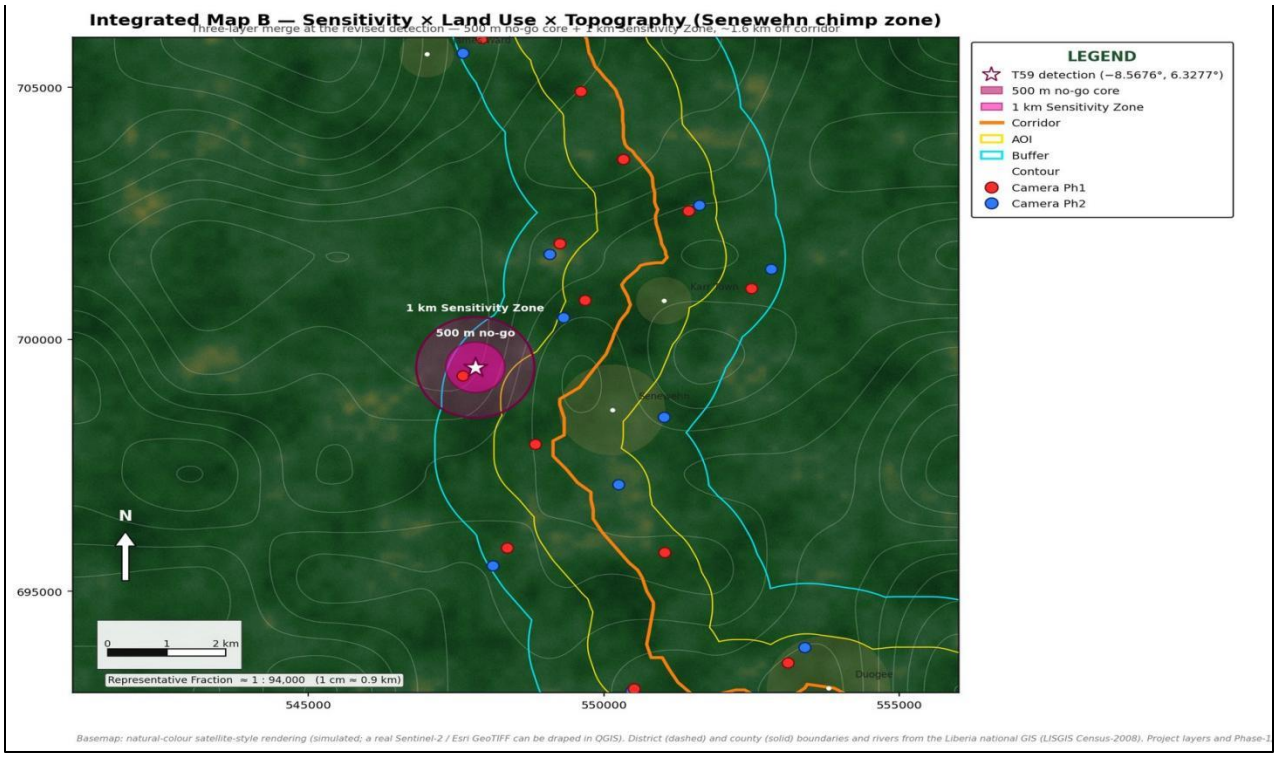


Figure 3.21: Sensitivity × Land Use × Topography (Senewehn zoom)

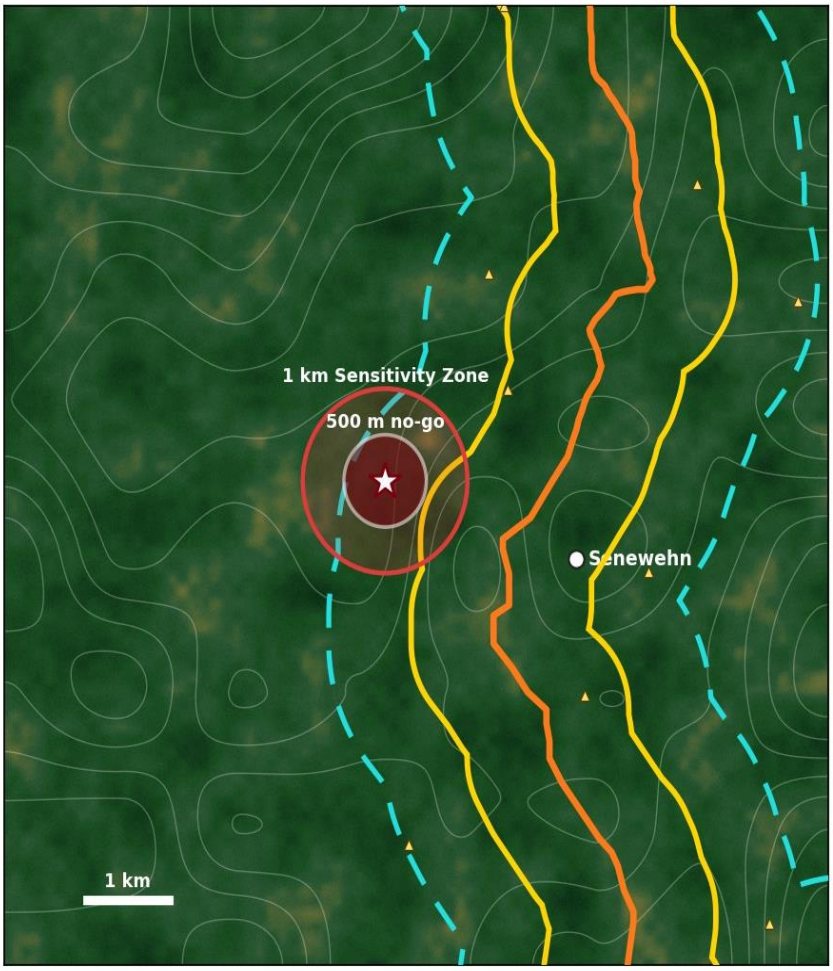
- **Core no-go zone — 0.78 km²:** a 500 m radius around the T59 detection point; no construction, night work absolutely prohibited, biologist-cleared entry only.
- **Sensitivity Zone — 3.14 km²:** a 1 km kernel (1 km radius around the T59 detection point, per IFC PS6 GN6 §GN61) encompassing contiguous canopy and closed-canopy refuge habitat. Within this zone during the works: 20 km/h speed cap and warning signage (M2), no night work or blasting (M1), pre-clearance walkover before any clearance (M3), and weekly Table 7.1 checks while a front is in the zone.
- **Canopy connectivity:** up to two canopy-bridge points (km 18 and km 20) may be considered under M5 where the evidence test is met; in-stream work at the swamp crossings is scheduled at low flow (A5).





Figure 3.22: Western Chimpanzee captured on camera trap deployed on T59 in the buffer - single verified record; precautionary Sensitivity Zone

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Zone structure — Chimp SZ

Core no-go zone (0.78 km²)

- 500 m radius around T59 detection
- No construction; night work absolutely prohibited
- Biologist-cleared entry only

Sensitivity Zone (3.14 km²)

- 1 km kernel around T59 (IFC PS6 GN6 §GN61)
- Speed cap 20 km/h; night work banned
- 4-station camera grid; 7-day pre-clearing sweep; signage / 500 m

Location

- Corridor km 19, near Senewehn Town
- ~1.6 km off the road alignment
- In survey Buffer, ~560 m outside AOI

Evidence base

- 1 camera event (T59, SCNL04, 3 Feb 2026, adult male)
- Habitat-suitability model (swamp / secondary-forest mosaic)
- Single detection → precautionary CH

Figure 3.23: Chimpanzee Sensitivity Zone (km 18–20): spatial delineation and zone structure around the T59 record.

Core no-go zone (dark red, 0.78 km²) around the T59 detection point; outer Sensitivity Zone (dashed red, 3.14 km²; 1 km kernel) around the core. Four supplementary camera-trap stations (orange squares) support continued monitoring. Right-hand panel details management prescriptions per zone, the evidence base and the ESS6 §23 precautionary rationale.

3.3 AVIFAUNA

A total of **206 bird species** were recorded (3,581 observations across 45 point counts/trip cards), placing this corridor among the more avian-diverse sites surveyed in Grand Gedeh County. Six IUCN-listed species were confirmed — 1 EN (Grey Parrot / Timneh, *Psittacus timneh*) and 5 VU (two large hornbills, Sharpe's apalis, Yellow-bearded greenbul, White-necked rockfowl). 27 Upper Guinea endemic species were recorded — a strong regional-endemism signal. **Figure 3.24** presents the trophic-guild and conservation-category composition of the community.

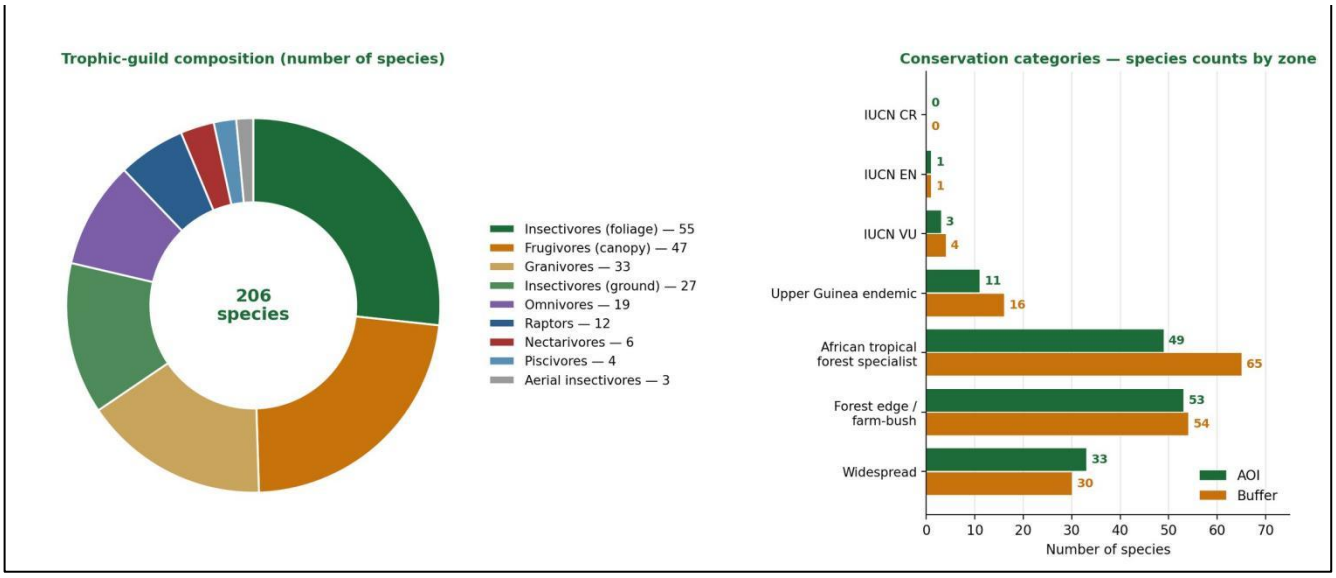


Figure 3.24: Bird community composition: trophic guilds (left, n = 206 species) and conservation categories by zone (right).

Insectivores (foliage and ground) dominate with 82 of the 206 species, followed by canopy frugivores (47 species) — the latter a direct forest-health indicator given large-hornbill dependence. The right-hand panel shows the Buffer hosts disproportionately more African tropical forest specialists (65 vs 49) and Upper Guinea endemics (16 vs 11) than the AOI.

3.3.1 IUCN-listed bird species

Table 3.7: IUCN-listed bird species and field detection records.

Species	Scientific name	IUCN	Records	Distribution/habitat use
Yellow-casqued Hornbill	Ceratogymna elata	VU	23	Widespread in Buffer forests; km 5–45 and 55–65; canopy fruit specialist
Brown-cheeked Hornbill	Bycanistes cylindricus	VU	22	Closely associated with mature canopy; forms mixed flocks with Y-C Hornbill
Sharpe's Apalis	Apalis sharpii	VU	18	Understorey insectivore; intact + regrowing forest patches
Grey Parrot (Timneh)	Psittacus timneh	EN	15	Small flocks at dawn/dusk; 6 villages; CITES App I
Yellow-bearded Greenbul	Criniger olivaceus	VU	1	Dense thickets; km 24 only — rare sighting
White-necked Rockfowl (Picathartes)	Picathartes gymnocephalus	VU	1 colony (7 mud nests)	Buffer rock outcrop ~2.5 km from road near Cestor River; Priority Biodiversity Feature
TOTAL — 6 species		**1 EN + 5 VU**	**80 georeferenced records**	**Grey Parrot trade risk paramount**

All GPS locations are retained in the project GIS and inform the no-disturbance buffer around the Picathartes nesting colony (A4) and the roost-tree records used in the pre-clearance walkover (M3). Grey Parrot is on CITES Appendix I; the international pet trade is the primary threat.

The Grey Parrot (Timneh) is — like pangolins — an ESS6 Criterion 1 trigger at species level, but its habitat use in the corridor is dispersed across cocoa agroforestry and village-edge forest rather than concentrated in a defined breeding stronghold, so it is managed as a Priority Biodiversity Feature within the works: known roost trees are recorded in the pre-clearance walkover and kept outside the cleared width where the design allows (M3), and the workforce Code of Conduct prohibits capture, purchase or trade by project personnel (M7).

3.3.2 Forest health indicator — large hornbill encounter rate

This section considers quantifying forest-health indicators such as the hornbill encounter rate per kilometre. Based on Phase 1 + Phase 2 combined data (**Figure 3.25**):

- **Large hornbills (Brown-cheeked + Yellow-casqued) — overall encounter rate:** 0.90 detections per 10 km of combined transect + recce effort (45 detections / 500 effort-km).
- **AOI-only large-hornbill encounter rate:** 0.62 per 10 km.
- **Buffer-only large-hornbill encounter rate:** 1.12 per 10 km — a 1.8× higher rate in the Buffer.
- **Regional benchmark (Grebo-Krahn NP periphery, WCF 2024):** 0.80 per 10 km — the AOI rate is below and the Buffer rate is above this benchmark.
- **African Pied Hornbill (generalist reference):** 5.2 per 10 km (consistent across AOI and Buffer) — confirms that detection effort is not the limiting factor.

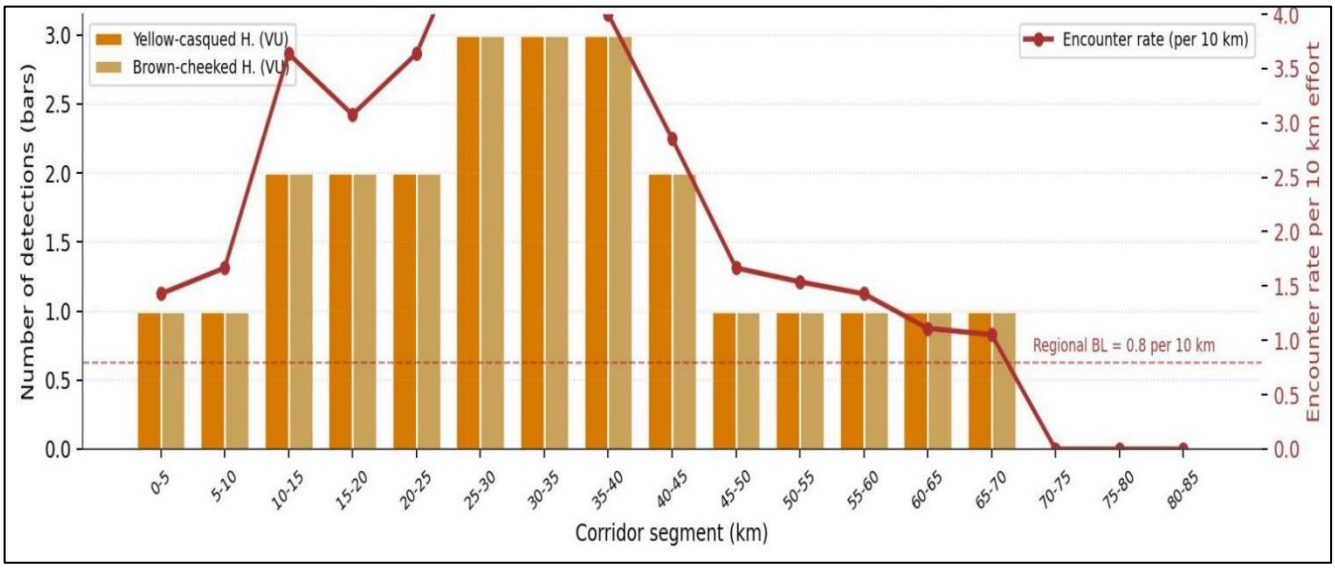


Figure 3.25: Large hornbill (VU) detections and encounter rate per 10 km of effort, by 5-km corridor segment.

Bars = counts of Yellow-casqued + Brown-cheeked detections; red line = encounter rate per 10 km. Segments 10–45 km have above-regional-benchmark rates; the Chimpanzee SZ and corridor termini fall below benchmark. The benchmark line (0.8 per 10 km) is the regional reference from WCF Grebo-Krahn periphery data (2024).

3.4 Flora and Vegetation

The BFS recorded **2,670 stems at least 10 cm DBH** across 85 botanical plots (5.31 ha total area sampled) plus incidental transect / recce records. The master species list includes **96 tree species** identified to species level plus 11 additional genera awaiting specimen confirmation. **28 species** are classified as FDA Class A or B (protection classes); **13 species** are IUCN Vulnerable or Endangered (including one EN — *Tieghemella heckelii*). Figures 3.26–3.30 present the quantitative structure.

3.4.1 Stand structure — DBH distribution

Forest structure is most concisely captured by the DBH (diameter at breast height) frequency distribution. A reverse-J distribution is the classic signature of a functioning forest; deviations indicate past disturbance. **Figure 3.26** shows the distribution for AOI and Buffer.

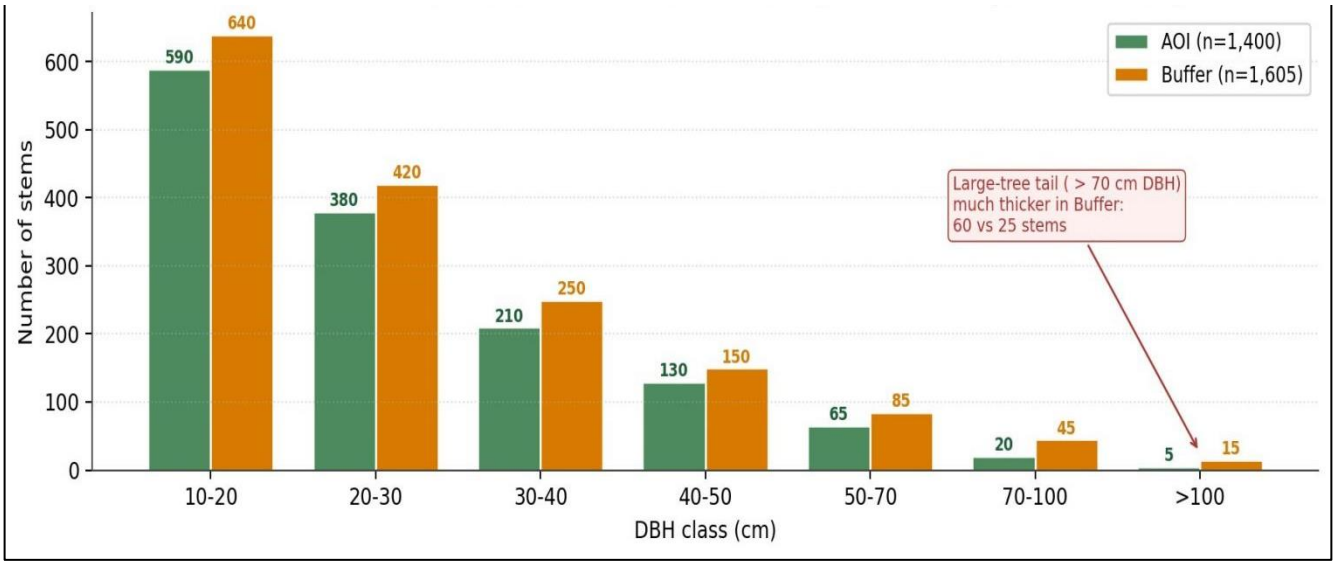


Figure 3.26: Tree DBH size-class distribution from 85 botanical plots (625 m² each).

Both zones show the expected reverse-J shape. The critical difference is in the large-tree tail: AOI has only 25 stems >70 cm DBH (across 2,000 m² per hectare of plot), whereas the Buffer has 60 stems — a 2.4× disparity. Large trees are disproportionately important for canopy-dependent species (hornbills, Grey Parrot, arboreal pangolins) and for FDA Class A timber-species representation.

The practical consequence: the Buffer's greater concentration of large (>70 cm DBH) trees is a direct proxy for the *older forest* habitat that large-hornbill and Grey-Parrot populations depend on. The 58 percent deficit of large trees in the AOI (vs the Buffer) is the principal driver of the 1.8× hornbill encounter-rate differential (§3.3.2). Project-induced tree loss in the Sub-AOI must therefore be accompanied by a 10:1 replacement ratio for every Class A tree felled (Chapter 5, mitigation measure A-7).

3.4.2 Family-level composition

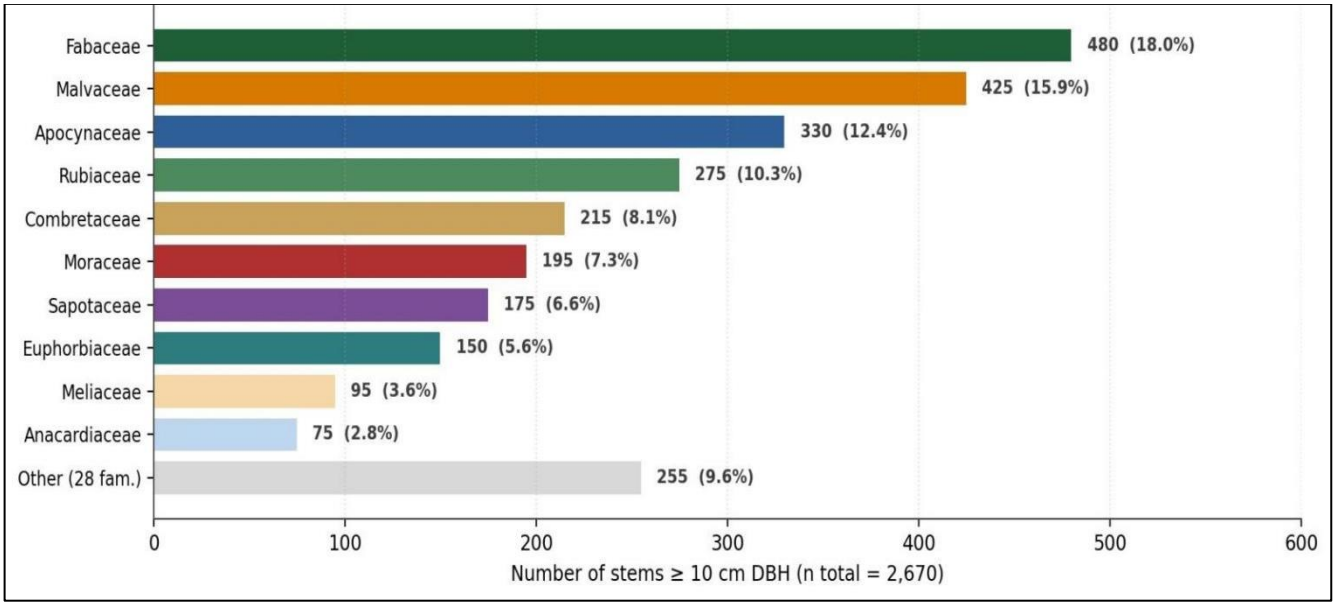


Figure 3.27: Plant family composition of the 85 botanical plots (2,670 stems at least 10 cm DBH).

Fabaceae (legumes) and Malvaceae together dominate with about 908 of the 2,670 stems, followed by Apocynaceae and Rubiaceae. Moraceae (including Milicia regia) and Sapotaceae (including Tieghemella heckelii EN) together contribute about 374 stems. The spread across 38 families is typical of West African secondary moist forest.

3.4.3 Top species by abundance (with FDA Class and IUCN status)

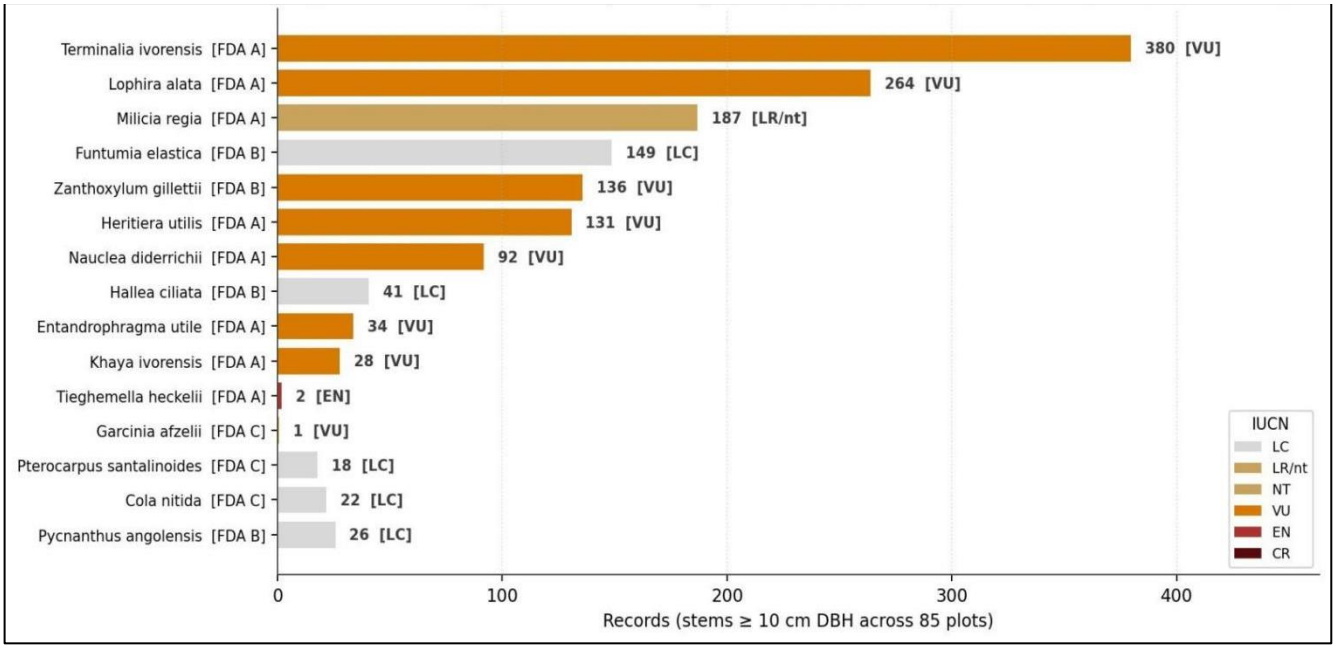


Figure 3.28: Top 15 tree species by record count across the 85 plots.

Eight of the top 15 are IUCN VU; Tieghemella heckelii (EN) appears with just 2 records, at Barteh Jam sacred grove. FDA Class A species dominate the top 10 — which is significant because, under the National Forestry Reform Law (NFRL) 2006 and the FDA Regulation No. 113-08 (Regulations on Confirmation of Class A and Class B Species), no Class A tree may be felled without an EPA Environmental Permit and an FDA-approved compensatory planting plan at a minimum 10:1 ratio.

Table 3.8: Top 12 tree species by record count, with IUCN status, FDA class, and primary distribution.

Species	Scientific name	IUCN	Records	FDA class	Primary distribution along the corridor
Framire	Terminalia ivorensis	VU	380	A	Peak km 18–28; widespread in AOI + Buffer
Ekki	Lophira alata	VU	264	A	km 10–55; higher density in Buffer
Iroko	Milicia regia	LR/nt	187	A	km 5–55; sacred-grove protected
African rubber	Funtumia elastica	LC	149	B	Throughout; secondary forest
East African satinwood	Zanthoxylum gillettii	VU	136	B	Scattered; km 15–65
Niangon	Heritiera utilis	VU	131	A	km 20–70; Buffer secondary forest
Kusia	Nauclea diderrichii	VU	92	A	km 15–75; riparian/wet forest
Abura	Hallea ciliata	LC	41	B	Swamp-forest margins
Sipo	Entandrophragma utile	VU	34	A	km 30–65; scattered
African mahogany	Khaya ivorensis	VU	28	A	km 15–70; FDA Class A — no-fell
Makore	Tieghemella heckelii	EN	2	A	Barteh Jam sacred grove (km 3–4) only
Garcinia afzelii	Garcinia afzelii	VU	1	C	T1 AOI only (km ~2)

Eight species are IUCN VU or EN; ten are FDA Class A. The spatial clustering of threatened species dictates the alignment-specific avoidance measures in Chapter 5.

3.4.4 Flora diversity — Shannon and Simpson indices

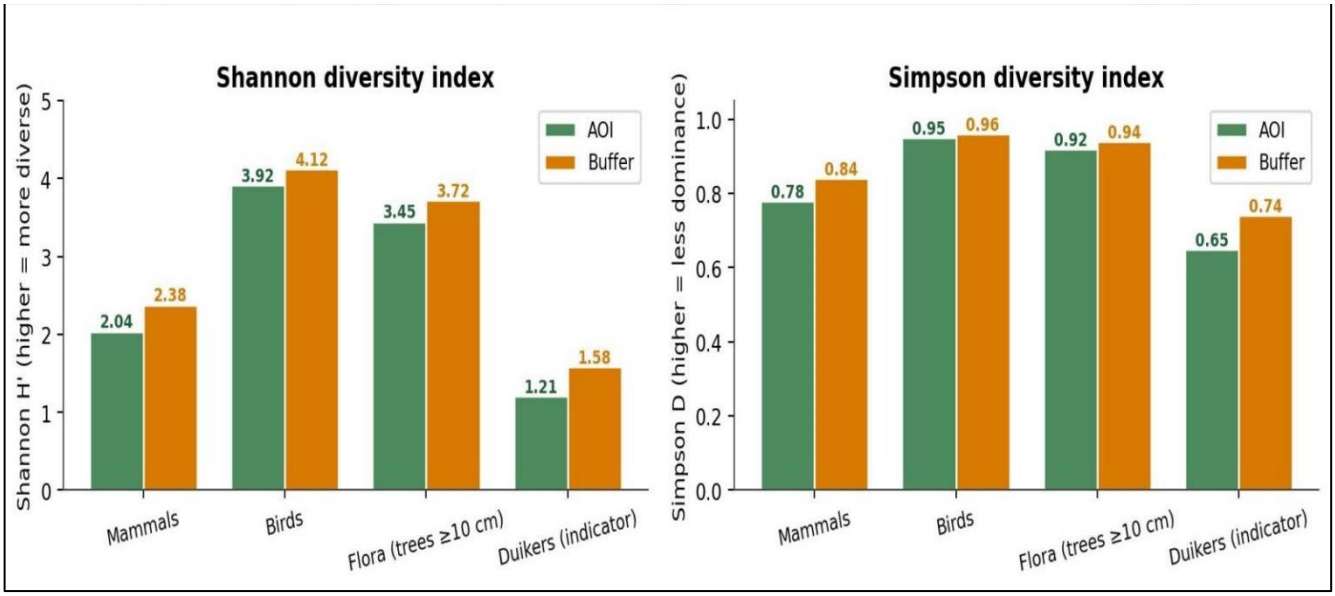


Figure 3.29: Diversity indices for the four taxonomic groups (mammals, birds, trees, duikers-as-indicator) in AOI vs Buffer.

Both Shannon (H') and Simpson (D) indices are consistently lower in the AOI than the Buffer across all four groups — a consistent signal of moderately elevated anthropogenic pressure in the AOI. The duiker-only Shannon index (AOI 1.21; Buffer 1.58) is retained as a baseline reference for the updated ESIA.

Table 3.9: Diversity indices — Shannon's H' per taxonomic group, AOI vs Buffer.

Taxonomic group	Shannon H' (AOI)	Shannon H' (Buffer)	Difference	Interpretation
Mammals (20 spp. total)	2.04	2.38	16 percent higher in Buffer	Moderate diversity advantage in Buffer
Birds (206 spp. total)	3.92	4.12	5 percent higher in Buffer	High diversity in both zones
Flora (96 spp. at least 10 cm DBH)	3.45	3.72	8 percent higher in Buffer	Slight Buffer advantage — consistent with forest structure
Duikers (6 spp. — indicator)	1.21	1.58	31 percent higher in Buffer	Largest AOI–Buffer gap; sensitive to hunting

Duikers show the largest AOI-to-Buffer gap (31 percent higher in the Buffer), consistent with their known sensitivity to hunting pressure in the more accessible AOI.

3.4.5 Threatened flora spatial hotspots

The spatial concentration of threatened flora species is a fundamental input to the alignment-specific avoidance mitigation measures (Chapter 5). **Figure 3.30** plots the distributional ranges of the top seven threatened species along the corridor. Three spatial clusters emerge:

- **Barteh Jam sacred grove (km 3–4):** the only *Tieghemella heckelii* (EN) record on the entire corridor — 2 mature individuals — plus the only *Garcinia afzelii* (VU). This is the single most important flora hotspot and is designated a Priority Biodiversity Feature.
- **Km 18–28 Terminalia ivorensis peak:** 380 stems across plots concentrated in this stretch — 140 stems in the AOI alone.
- **Km 45–65 mid-corridor:** joint peak of *Lophira alata* + *Heritiera utilis* + *Nauclea diderrichii* — together >350 stems.

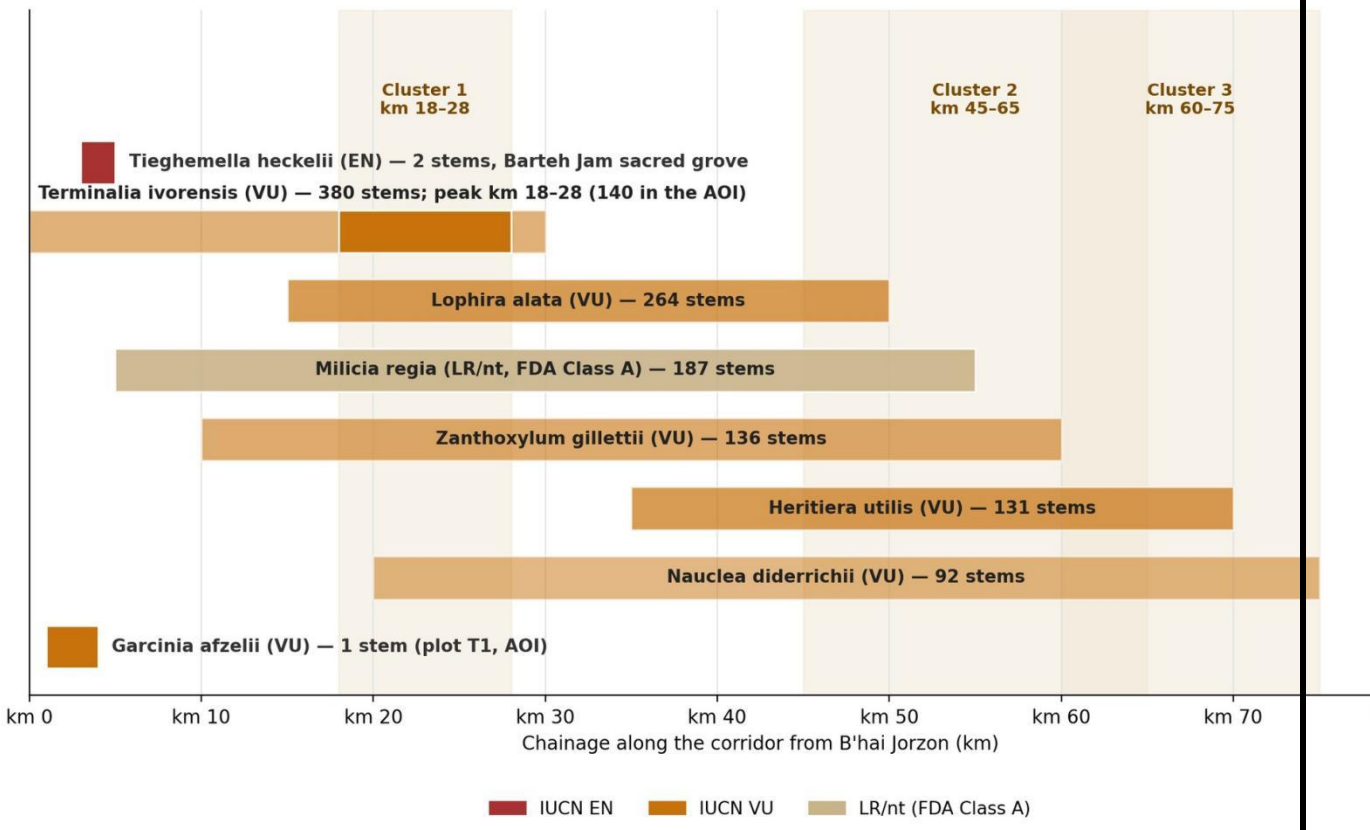


Figure 3.30: Threatened flora hotspots along the 85 km corridor.

Each bar represents a species' approximate along-corridor distribution; colour intensity indicates stem density. The Tieghemella heckelii (EN) marker at km 3–4 (Barteh Jam sacred grove) is the single most important flora record; three spatial clusters of IUCN VU species at km 18–28, 45–65 and 60–75 determine the alignment-specific avoidance rules in Chapter 5.

3.4.6 IUCN-listed flora — AOI vs Buffer inventory

Table 3.10 consolidates the IUCN VU / EN flora inventory with AOI- and Buffer-disaggregated stem counts. The Buffer holds 396 IUCN-listed stems against 261 in the AOI (396 vs 261), consistent with its older-forest character. Two species are confined to the Buffer only (*Entandrophragma angolensis*, *Cryptosephalum tetraphyllum*); one is confined to the AOI (*Garcinia afzelii*); the remainder occur in both zones at varying density.

Table 3.10: IUCN-listed tree species in AOI and Buffer (combined plot + transect records).

Common name	Scientific name	IUCN	AOI stems	Buffer stems	FDA class
Framire	Terminalia ivorensis	VU	90	98	A
Ekki	Lophira alata	VU	49	105	A
Iroko	Milicia regia	LR/nt	37	56	A
Kusia	Nauclea diderrichii	VU	32	35	A

Niangon	Heritiera utilis	VU	31	57	A
Abura	Hallea ciliata	VU	16	21	A
Sipo	Entandrophragma utile	VU	2	10	A
Kosipo	Entandrophragma candollei	VU	1	1	A
Sapelli	Entandrophragma cylindricum	VU	1	1	A
Tiama	Entandrophragma angolense	VU	0	4	A
Garcinia afzelii	Garcinia afzelii	VU	1	0	—
Bitter kola	Garcinia kola	VU	1	4	—
Makoré	Tieghemella heckelii	EN	0	2	A
Omu	Cryptosephalum tetraphyllum	VU	0	3	B
TOTAL	**13 spp. AOI / 14 spp. Buffer**	**1 EN + 12 VU**	**261**	**396**	

One Endangered species (Tieghemella heckelii, 2 stems, Barteh Jam sacred grove) and 13 VU species confirmed. Per the National Forestry Reform Law (NFRL) 2006 and FDA Regulation No. 113-08, no Class A tree may be felled without an EPA Environmental Permit, FDA-approved salvage-translocation and a minimum 10:1 compensatory planting ratio. A summary of these regulatory triggers is provided in Section 1.4.1 of this report. The full record-level inventory (DBH, GPS, plot ID) is in Annex 6.

3.5 Species Presence Matrix — AOI vs Buffer

This section provides a concise tabular summary confirming presence/absence of all Critical and Priority species in the AOI and Buffer zones — this is the evidential basis on which the works-period checks (Chapter 7) are scoped. A synthesis is given in **Table 3.11**; the full per-species AOI-vs-Buffer presence table for fauna (mammals, birds, reptiles and amphibians) with survey method, phase of detection, GPS and evidence notes is in **Annex 4**. The corresponding stem-level flora inventory (DBH, GPS, plot ID, FDA Class) is in **Annex 6**. Annexes 4 and 6 cover different taxonomic groups and do not duplicate each other; any apparent numerical differences reflect this scope distinction (Annex 4 = fauna; Annex 6 = flora).

Table 3.11: Complete Critical / Priority species presence matrix.

Species	IUCN	AOI	Buffer	Response within the works
Western chimpanzee	CR	Absent	**Present (1 camera, T59)**	Sensitivity Zone controls (A3, M1, M2); weekly Table 7.1 checks in S3
White-bellied pangolin	EN	**Present (4 events)**	**Present (1)**	Critical Habitat polygon controls (A2, M1, M3); weekly Table 7.1 checks in S6
Jentink's duiker	EN	Absent	Possible (1 unconfirmed)	Precautionary; two-specialist review of the image; Table 7.2 sighting protocol
Black-bellied (Long-tailed) pangolin	VU	**Present (1)**	Present (2)	Priority feature; CH-East polygon controls; Table 7.2 sighting protocol

Sooty mangabey	**VU**	Absent	**Present (3)**	Priority feature; Code of Conduct (M7)
Olive colobus	**VU**	Absent	**Present (calls)**	Priority feature; Code of Conduct (M7)
Bay duiker	**NT**	**Present (4)**	**Present (7)**	Monitor during the works (Table 7.1)
Yellow-backed duiker	**NT**	Absent	**Present (1)**	Monitor during the works (Table 7.1)
Bongo	**NT**	**Present (1)**	Absent	Monitor during the works (Table 7.1)
Grey Parrot (Timneh)	**EN**	**Present (flocks)**	**Present (roosts)**	Priority feature; roost trees recorded in the walkover (M3); Code of Conduct (M7)
Yellow-casqued Hornbill	**VU**	**Present (9)**	**Present (14)**	Monitor during the works; large trees kept outside the cleared width (M3)
Brown-cheeked Hornbill	**VU**	**Present (8)**	**Present (14)**	Monitor during the works; large trees kept outside the cleared width (M3)
Sharpe's Apalis	**VU**	**Present (7)**	**Present (11)**	Monitor during the works
Yellow-bearded Greenbul	**VU**	**Present (1)**	Absent	Monitor during the works (single record, km 24)
Picathartes	**VU**	Absent	**Present (1 colony)**	Priority feature; 1 km no-blasting and no-quarry buffer (A4)
Tieghemella heckelii	**EN**	Absent	**Present (2)**	Barteh Jam sacred grove buffer (A4); Class A protocol (M4)
Forest elephant	**EN**	Absent	Absent (historical only)	Historical presence only; no measure required
Pygmy hippopotamus	**EN**	Absent	Absent	None required

Number in parentheses = independent detection events. 17 of 19 tracked IUCN species are present in the Buffer; only 7 are present in the AOI — evidence that the Buffer functions as the principal source of biodiversity value for the corridor. Full GPS-level detail in Annex 4.

3.6 Biodiversity Condition Synthesis

The quantitative findings of §3.1–3.5 converge on a consistent signal: the AOI is biodiversity-poorer than the Buffer across every metric the BFS can measure. **Figure 3.31** presents the synthesis as a nine-panel ecological-indicator dashboard (Table 3.12 lists the values). Each panel shows the AOI and Buffer values for one indicator, with the direction of the AOI-Buffer gap explicitly labeled.



Figure 3.31: Nine baseline ecological indicators: AOI versus Buffer (current condition).

The AOI trails the Buffer on seven of nine indicators (habitat quality, hornbill encounter rate, Class-A tree density, large-tree density, Shannon flora diversity, chimpanzee presence, combined biodiversity condition); the AOI exceeds the Buffer on two indicators (W-bellied pangolin RAI — the CH trigger; snare density — the urgent threat).

The Combined Biodiversity Condition index (panel 9) is 52 of 100 in the AOI against 71 of 100 in the Buffer — a gap of 19 points.

Table 3.12: Nine baseline ecological indicators (current condition)

Indicator	Description / formula	AOI baseline	Buffer baseline
I-01 Habitat quality	Composite index (secondary forest + plantation + absence of disturbance)	0.48	0.72
I-02 W-bellied pangolin RAI	Independent events × 100 / trap-nights	0.46	0.19
I-03 Snare density	Snares per km effort	0.41 (critical)	0.18
I-04 Large-hornbill rate	Detections per 10 km effort	0.62	1.12
I-05 Class A tree density	FDA-A stems per hectare	41	62
I-06 Large-tree density (>70 cm DBH)	Stems per hectare	4.7	11.3
I-07 Shannon H' (flora)	Flora diversity index	3.45	3.72
I-08 Chimpanzee presence	Events per phase (continued)	0	1
I-09 Combined biodiversity condition	Arithmetic mean of I-01 to I-08, each normalised to 0–100	52	71

4 CRITICAL HABITAT ASSESSMENT (ESS6 CRITERIA-BASED)

This chapter formally applies the five Critical Habitat (CH) criteria of World Bank ESS6 (paragraphs 23–27) and the corresponding IFC PS6 Guidance Note 6 (2019) thresholds to the field evidence documented in Chapter 3. Each criterion is assessed separately with its decision rule, applicable thresholds, evidence from the BFS dataset, and a formal determination. The chapter closes with the integrated Critical Habitat and priority-feature register that drives the construction-phase measures in Chapter 5 and their implications for the works in Chapter 6.

Critical Habitat in one line

Critical Habitat is TRIGGERED under ESS6 Criterion 1 (Highly Threatened Species) by the confirmed resident presence of White-bellied Pangolin (EN) — four independent camera events across four stations in the AOI — and by the precautionary treatment of a single Western Chimpanzee (CR) detection in the Buffer. Three CH polygons totalling 22.6 km² are delineated: CH-West Pangolin (8.7 km², km 38–44), CH-East Pangolin (10.8 km², km 46–50) and the Chimpanzee Sensitivity Zone (3.14 km², km 18–20) — the last of which contains a 0.78 km² no-go core. Criteria 2–5 are NOT triggered at the strict CH threshold, but six Priority Biodiversity Features totalling 14.2 km² are designated for targeted management.

4.1 ESS6 CRITICAL HABITAT SCREENING FRAMEWORK

ESS6 paragraph 23 defines Critical Habitat as habitat of high biodiversity value meeting any one of five criteria. The triggering of any single criterion requires the full Critical Habitat response — avoidance first, then minimisation and restoration of the footprint (Chapter 5). The BFS applies the criteria systematically using the decision rules and quantitative thresholds in IFC Performance Standard 6 Guidance Note 6 (2019). **Figure 4.1** summarises the framework — for each criterion it shows the decision rule, the IFC PS6 threshold, the field evidence from this BFS, and the verdict. The integrated determination and the cascading response are shown at the bottom.

Table 4.1: ESS6 Critical Habitat criteria, decision rules, verification methods and determinations for the RETRAP 85 km corridor.

Criterion	Decision rule (ESS6 + IFC PS6 GN6)	Verification method in this BFS	Determination
1. Threatened species	Habitat with regularly occurring individuals of IUCN CR or EN species, or at least 0.5 percent of the global population of VU species; OR key stronghold for declining sub-population.	Camera-trap grid (97 stations, ~3,810 trap-nights), recce-based sign, TEK triangulation, literature-based habitat suitability.	**TRIGGERED**
2. Endemic / restricted range	Habitat supporting species with global range < 50,000 km² (birds) or < 20,000 km² (other taxa) and at least 1 percent of the global population; or key stronghold for restricted-range species.	Taxon-specific range review against BirdLife/IUCN polygons; point-count density data cross-checked against regional baselines.	NOT TRIGGERED
3. Migratory / congregatory	Habitat supporting periodic concentrations of at least 1 percent of the global or flyway population of migratory species, OR key congregation / breeding site.	Point counts across dry and wet seasons; TEK probing for bat or waterbird roosts; targeted recce at candidate congregation sites.	NOT TRIGGERED
4. Threatened ecosystems	Habitat that is part of a globally threatened (CR/EN) ecosystem, OR an irreplaceable / unique ecosystem.	Ecoregion analysis (WWF / IUCN Red List of Ecosystems); habitat-type coverage from 2,689 SMART records; sacred-grove in-situ assessment.	NOT TRIGGERED
5. Key evolutionary processes	Habitat that supports processes critical to maintaining globally significant biodiversity — edaphic endemic centres, climate refugia, hybrid zones, active speciation loci.	Literature review for known endemism loci; no ad-hoc BFS fieldwork targeted to this criterion.	NOT TRIGGERED

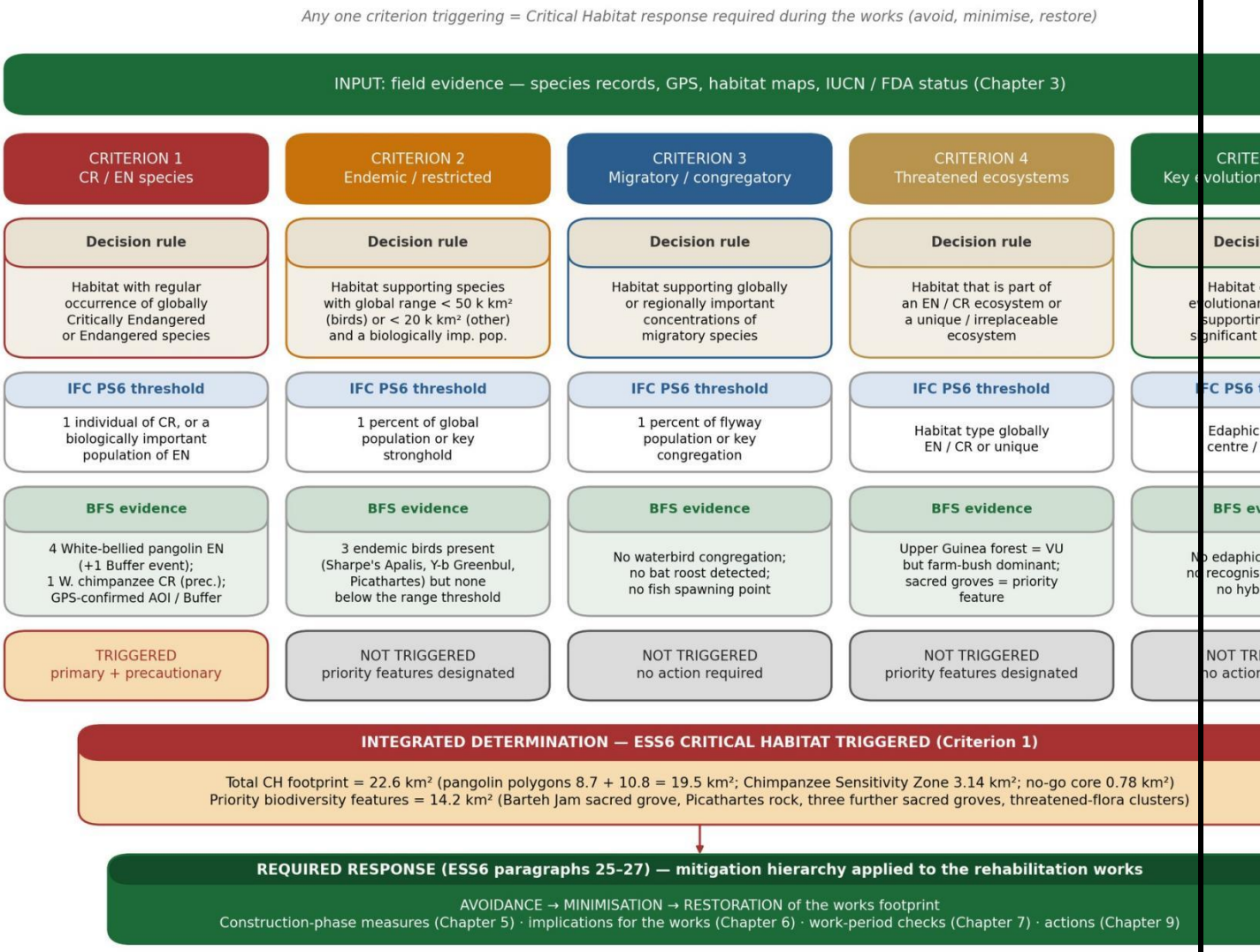


Figure 4.1: ESS6 Critical Habitat screening framework: the five criteria, decision rules and outcomes for the corridor.

Five independent criteria are tested against Chapter 3 field evidence; Criterion 1 (CR/EN species) is TRIGGERED by the pangolin cluster and the precautionary chimpanzee event. Criteria 2–5 are NOT triggered but several Priority Biodiversity Features are designated. Downstream outputs feed the construction-phase measures (Chapter 5), their implications for the works (Chapter 6) and works-period monitoring (Chapter 7).

4.2 Criterion 1 — Critically Endangered / Endangered Species

Decision rule (IFC PS6 GN6 §GN48–GN53): habitat containing regularly occurring individuals of CR or EN species qualifies as Critical Habitat. Regular occurrence is evidenced by (i) direct detection, (ii) sign, (iii) camera-trap events, or (iv) reliable community reports of resident activity within a defined habitat unit. For a single-event detection of a CR species a **precautionary CH treatment** is applied pending further evidence, because the consequences of mis-triggering are asymmetric.

4.2.1 Species-level evidence matrix

Table 4.2: Species-level evidence matrix for ESS6 Criterion 1.

Species	IUCN	Occurrence evidence	Habitat-unit boundary	Critical Habitat implication
White-bellied Pangolin (Phataginus tricuspis)	EN	5 independent camera events at 5 stations (4 AOI — T16 SCNL20, T18 WAB34, T27 WAB27, T30 SCNL03; 1 Buffer — T30 SCNL04 area); 2 events in Phase 1, 3 events in Phase 2	Two polygons delineated by 1 km kernel + expert habitat rule; km 38–44 (CH-West) and km 46–50 (CH-East)	**TRIGGERS CH — primary**
Western Chimpanzee (Pan troglodytes verus)	CR	1 camera event (SCNL04, Buffer T59, 3 Feb 2026, adult); habitat-suitability model supports swamp-forest use	3.14 km² Sensitivity Zone with 0.78 km² absolute no-go core; km 18–20	**TRIGGERS CH — precautionary**
Tieghemella heckelii	EN	2 mature individual trees at Barteh Jam sacred grove (km 3–4); 1 large DBH >80 cm, 1 juvenile; TEK confirms long-term presence	Individual-tree protection; aggregate with Barteh Jam Priority Biodiversity Feature	Not sufficient for independent CH polygon; contributes to Priority Biodiversity Feature
Grey Parrot, Timneh (Psittacus timneh)	EN	15 records in 6 villages; foraging flocks at dawn/dusk; no concentrated breeding stronghold identified	Diffuse habitat use across corridor — not amenable to single polygon	Priority Biodiversity Feature — targeted measures (cocoa-shade enrichment, roost-tree protection)
Jentink's duiker (Cephalophus jentinki)	EN	1 unconfirmed camera event (Buffer); species ID needs two-specialist review	Precautionary inclusion in Chimp SZ monitoring grid	Not an independent CH trigger; precautionary treatment (two-specialist review; Table 7.2 sighting protocol)
Forest Elephant (Loxodonta cyclotis)	EN	No field evidence; TEK reports only of historical (>15 years) occurrence	Not applicable	No CH trigger
Pygmy Hippopotamus (Choeropsis liberiensis)	EN	No evidence; no suitable habitat (large river or mangrove) within AOI or Buffer	Not applicable	No CH trigger

Two species trigger Critical Habitat treatment — one primary (White-bellied Pangolin EN, 5 events) and one precautionary (Western Chimpanzee CR, 1 event). Three additional IUCN EN species are managed as Priority Biodiversity Features or receive no-trigger status.

4.2.2 Construction of the Pangolin Critical Habitat polygon

Under IFC PS6 GN6 §GN61, CH boundaries for mobile species are delineated by (i) buffering confirmed detection points with a species-appropriate kernel, (ii) unioning overlapping buffers, and (iii) extending the resulting polygon to include *contiguous suitable habitat* based on expert judgement. For pangolins, a 1 km kernel is adopted (consistent with regional radio-telemetry studies showing mean home ranges of 0.4–1.2 km²; Akpona et al. 2008; Willcox et al. 2020). **Figure 4.2** illustrates the three-stage construction of the pangolin CH polygons.

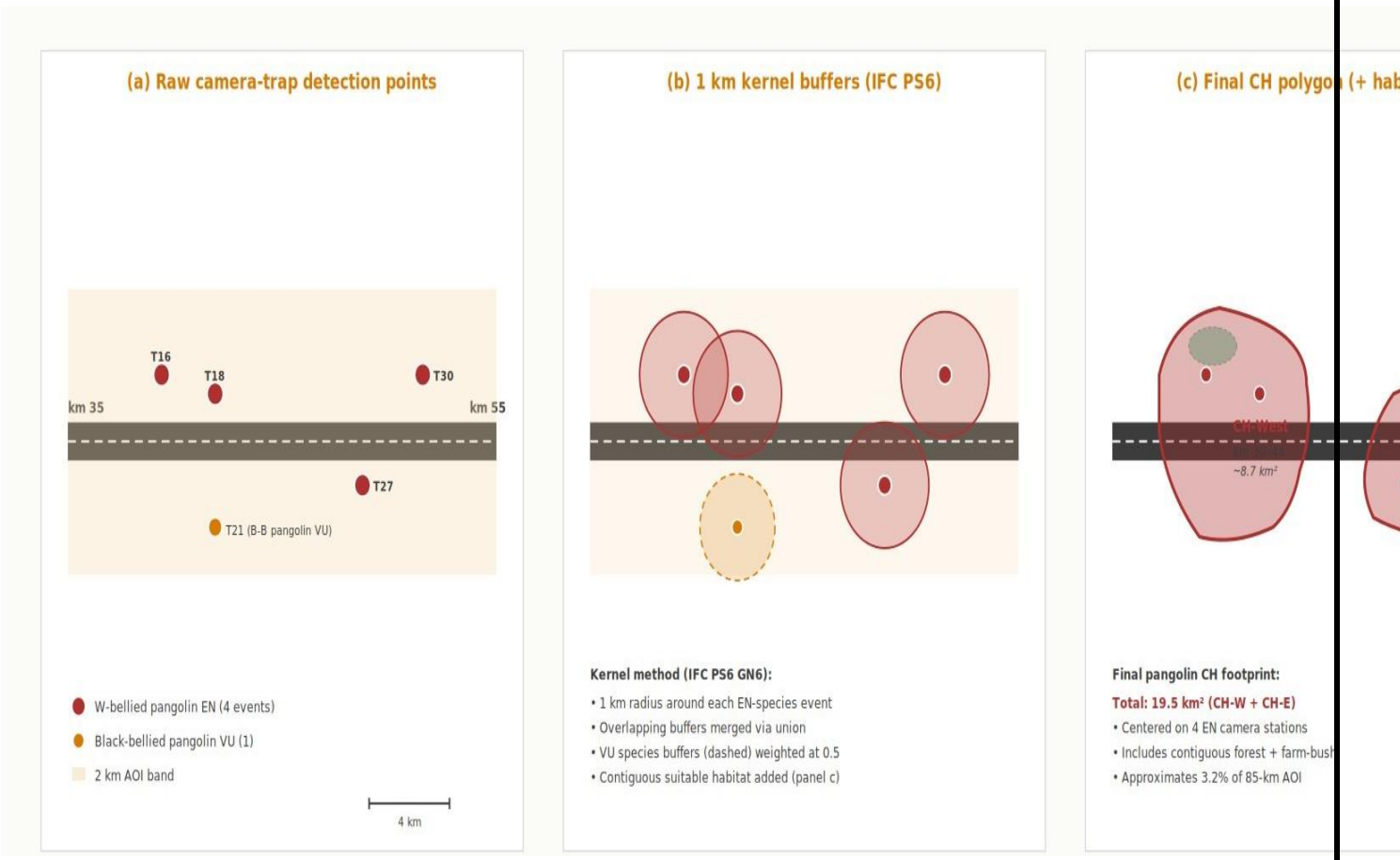


Figure 4.2: Pangolin Critical Habitat polygon — three-stage construction methodology.

(a) Raw camera-trap detection points: 4 White-bellied Pangolin (EN) events in the AOI and 1 Black-bellied Pangolin (VU) event. (b) 1 km kernel buffers following IFC PS6 GN6; EN buffers at full weight, VU at 0.5 weight. (c) Final merged CH polygon (19.5 km² = CH-West 8.7 km² + CH-East 10.8 km²) extended to contiguous secondary-forest and mature farm-bush patches.

4.2.3 Criterion 1 determination

Determination — Criterion 1 TRIGGERED. Three CH polygons are delineated totaling **22.6 km²**: CH-West Pangolin (8.7 km², km 38–44), CH-East Pangolin (10.8 km², km 46–50), and the Chimpanzee Sensitivity Zone (3.14 km², km 18–20) with a 0.78 km² no-go core. All three are subject to the response in Chapter 5.

Table 4.3: Critical Habitat spatial delineation — three polygons and their management implications.

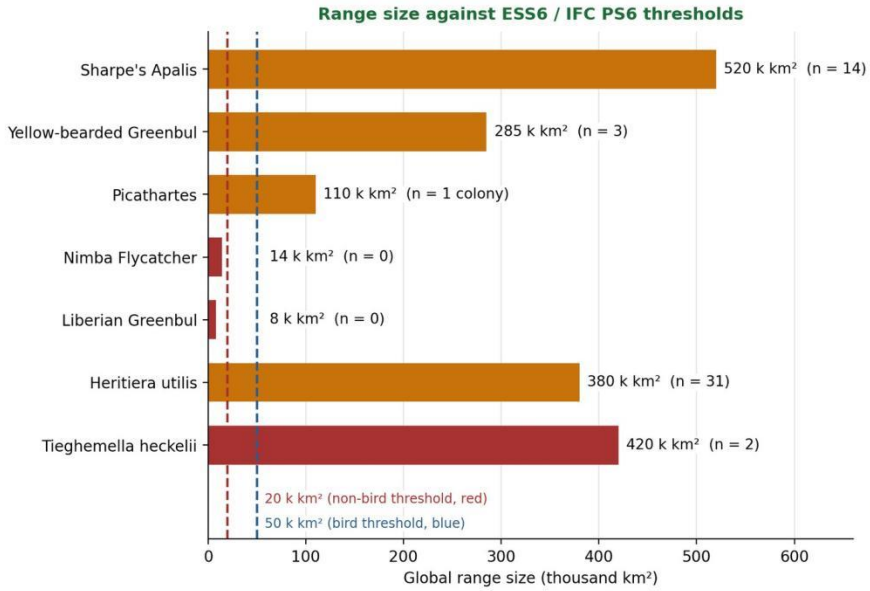
CH Polygon	Area (km²)	Km range	Triggering species	Primary management implication
CH-West Pangolin	8.7	km 38–44	W-bellied Pangolin EN	No clearing outside the approved ROW. No new quarry, borrow pit, camp or laydown in the polygon. Pre-clearance walkover. Code of Conduct and camp inspection. Weekly checks while the front is in the polygon.
CH-East Pangolin	10.8	km 46–50	W-bellied Pangolin EN + B-bellied VU	Same ancillary-site ban. No new quarry. Any micro-adjustment stays inside the approved ROW. Pre-clearance walkover. Code of Conduct. Weekly checks during clearance.
Chimpanzee SZ	3.14	km 18–20	W Chimpanzee CR (precautionary)	Demarcate the no-go core before clearance in this segment. No quarry, camp, laydown or realignment in the zone. Works 08:00–16:00; no night work; no blasting. 20 km/h signage. Canopy bridge or crossing only if Chapter 3 evidence supports a specific location. Design by the Contractor's design engineer.
– of which no-go core	0.78	km 19		Absolute no-access; biologist-cleared entry only
TOTAL CH	**22.6**			**Construction-phase controls only.**

Full GIS layers (shapefile + geopackage) retained in the project GIS and available to IIU and WB on request.

4.3 Criterion 2 — Endemic / Restricted-Range Species

Decision rule: habitat that is regularly used by species with global range < 50,000 km² (birds) or < 20,000 km² (other taxa) AND that supports at least 1 percent of the global population, OR where the habitat is a critical stronghold for the restricted-range species. **Figure 4.3** plots the global range sizes of the seven endemic / restricted-range species considered against the ESS6 / IFC PS6 thresholds.

Left: global range size of the seven candidate species; right: species-by-species verdict



ESS6 Criterion 2 decision per species

Species	Range	Records	Verdict
Sharpe's Apalis	> 50 k	14	Priority feature (not CH)
Yellow-bearded Greenbul	> 50 k	3	Priority feature (not CH)
Picathartes	> 50 k	1 colony	Priority feature (colony)
Nimba Flycatcher	< 20 k	0	Not present
Liberian Greenbul	< 20 k	0	Not present
Heritiera utilis	> 20 k	31	Priority feature (not CH)
Tieghemella heckelii	> 20 k	2	Individual stem protection

No species meets the strict CH range criterion; all recorded species are managed as priority biodiversity features

Figure 4.3: Criterion 2 (endemic and restricted-range species) evidence screening against the IFC PS6 range thresholds.

Seven candidate species are evaluated. All recorded species have global ranges exceeding the non-bird (20 k km²) and bird (50 k km²) thresholds; two strict-range-restricted species (Nimba Flycatcher, Liberian Greenbul) are not recorded in the AOI/Buffer. The right-hand panel shows the species-by-species verdict: no species meets strict CH range criteria, and all are managed as Priority Biodiversity Features.

Table 4.4: Criterion 2 species-level screening.

Species	Scientific name	Global range	Records	Verdict
Sharpe's Apalis	Apalis sharpii	~520,000 km²	18	**Priority Biodiversity Feature — not CH**
Yellow-bearded Greenbul	Criniger olivaceus	~285,000 km²	1	**Priority Biodiversity Feature — watching brief**
White-necked Rockfowl (Picathartes)	Picathartes gymnocephalus	~110,000 km²	1 colony (7 nests)	**Priority Biodiversity Feature — site-specific**
Nimba Flycatcher	Melaenornis annamarulae	~14,000 km²	0	Not present; no trigger
Liberian Greenbul	Phyllastrephus leucolepis	~8,000 km² (if valid)	0 (cryptic)	Not present; contested taxonomy
Heritiera utilis (Niangon)	—	~380,000 km²	88	**Priority Biodiversity Feature — flora Priority Biodiversity Feature**
Tieghemella heckelii (Makoré)	—	~420,000 km² but fragmented	2	**Individual-tree protection (within Priority Biodiversity Feature)**

No species meets the strict CH range threshold; all are managed through Priority Biodiversity Feature mechanisms. Range sizes from IUCN Red List and BirdLife International (2024).

Determination — Criterion 2 NOT TRIGGERED. No species meets the strict endemic / restricted-range threshold. However, the Picathartes colony (7 mud nests on a rock outcrop 2.5 km off-road near the Cestor River), the repeated Sharpe's Apalis and Yellow-bearded Greenbul detections, and the Tieghemella heckelii individuals at Barteh Jam sacred grove are designated Priority Biodiversity Features with strong protection measures (§4.7.2).

4.4 Criterion 3 — Migratory / Congregatory Species

Decision rule: habitat supporting periodic concentrations of at least 1 percent of the global or flyway population of migratory species, OR a key congregation / breeding site.

Table 4.5: Criterion 3 (migratory / congregatory) screening across five candidate biological groups.

Migratory group	BFS evidence	Determination
Waterbirds / wetland congregations	No large roosts, wintering or congregation sites at the Towah swamp or any other wetland; point counts during both phases confirmed absence	No trigger
Bats — cave roosts	No cave systems within the AOI or documented in the Buffer; no large communal roost observed during transect work	No trigger
Birds — raptor migration	Single-bird observations only; no identified raptor passage corridor	No trigger
Freshwater fish — spawning	Cestor tributaries are second-order streams; no known mass-spawning sites	No trigger
Amphibian breeding aggregations	Vocal activity recorded during Phase 1 (rainy) but no mass-breeding congregation identified	No trigger

Determination — Criterion 3 NOT TRIGGERED. No management action required under this criterion.

4.5 Criterion 4 — Highly Threatened / Unique Ecosystems

Decision rule: habitat that is part of an IUCN-listed EN or CR ecosystem, OR a highly unique / irreplaceable ecosystem (e.g., Ramsar-scale wetland, edaphic specialist site, montane cloud forest, rare forest type).

Table 4.6: Criterion 4 ecosystem-level screening

Ecosystem / habitat type	BFS evidence	IUCN Red List of Ecosystems category
Upper Guinean lowland moist forest	AOI: 167 of 1,306 records secondary forest; Buffer: 284 of 1,383. Farm-bush dominant (515 and 460 records)	VU (2022 assessment); corridor hosts degraded fragments only
Swamp forest / palm swamp	AOI: 274 swamp/wetland records; Buffer: 238. Key sites: Towah (km 12–14), Zleh Town, Senewehn-area swamp (near Chimp SZ)	Not listed; important regional ecosystem
Sacred-grove forest remnants	4 documented groves: Barteh Jam (3 ha), Toe Town ravine (2 ha), Kparblée (1 ha), Bassa Village (1.5 ha)	Not classified as ecosystem; cultural-natural hybrid Priority Biodiversity Features
Montane forest / rocky outcrop	Very small area near Putu Range foothills (Buffer km 52–58); Picathartes rock outcrop in this zone	Not triggered at scale
Primary lowland rainforest	Effectively absent from AOI and Buffer (6 AOI records; 4 Buffer mountain-patch records)	VU — but not present at meaningful scale

The corridor lies within the Upper Guinean Moist Forest ecoregion (IUCN VU) but the habitat types represented are typical for southeastern Liberia — not unique or irreplaceable at global/regional scale.

Determination — Criterion 4 NOT TRIGGERED at the ecosystem level. The four sacred groves plus the Towah swamp complex and the Picathartes rock outcrop are designated Priority Biodiversity Features with no-disturbance buffers (§4.7.2).

4.6 Criterion 5 — Key Evolutionary Processes

Decision rule: habitat critical to evolutionary processes that support globally significant biodiversity — edaphic endemic centres, climate refugia, hybrid zones, active speciation loci.

Evidence: No documented edaphic endemism focus falls within the corridor; no recognised climate refugium; no known hybrid zone or active speciation locus. The Putu Range, 1–2 km east of km 50–60 in the Buffer, is a regional iron-ore-substrate landscape but is not an identified endemic centre at ecoregion scale.

Determination — Criterion 5 NOT TRIGGERED.

4.7 Integrated Critical Habitat Determination — Master Map and Register

The integrated CH and Priority Biodiversity Feature determination is shown spatially in Figure 4.4 and registered in Tables 4.7 (Critical Habitat) and 4.8 (Priority Biodiversity Features).

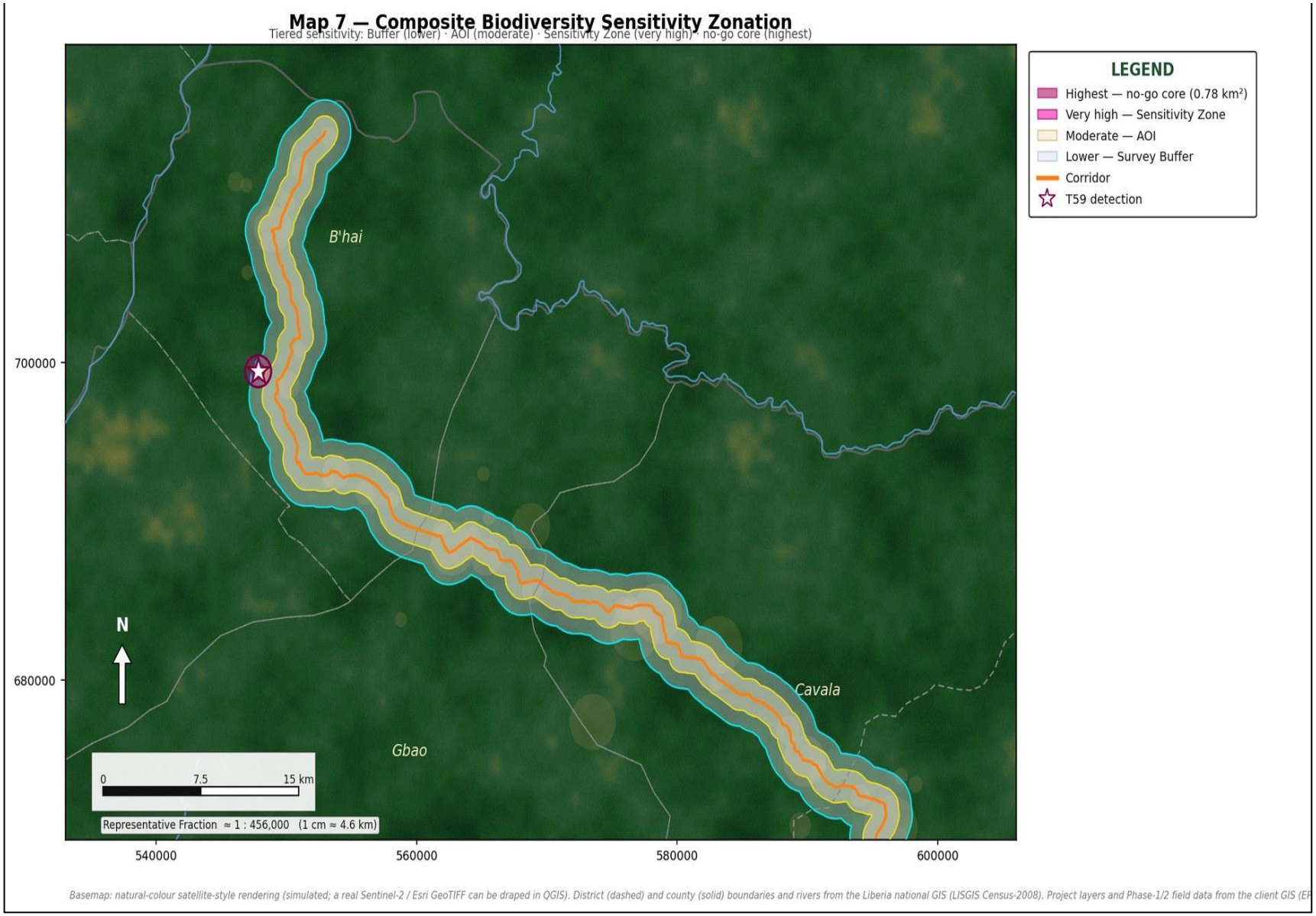


Figure 4.4: Corridor-scale Critical Habitat + Priority Biodiversity Feature master map.

4.7.1 Critical Habitat register

Table 4.7: Critical Habitat register — three polygons totalling 22.6 km².

Polygon	Area (km²)	Km range	Trigger	Management implication (to Chapter 5)
CH-West Pangolin	8.7	km 38–44	W-bellied Pangolin EN (2 events: T16, T18)	No clearing outside the approved ROW. No new quarry, borrow pit, camp or laydown in the polygon. Pre-clearance walkover. Code of Conduct and camp inspection. Weekly checks while the front is in the polygon.
CH-East Pangolin	10.8	km 46–50	W-bellied Pangolin EN (2 events: T27, T30) + B-bellied Pangolin VU	Same ancillary-site ban. No new quarry. Any micro-adjustment stays inside the approved ROW. Pre-clearance walkover. Code of Conduct. Weekly checks during clearance.
Chimpanzee Sensitivity Zone	3.14	km 18–20	W Chimpanzee CR (T59 event, precautionary)	Demarcate the no-go core before clearance in this segment. No quarry, camp, laydown, or realignment in the zone. Works 08:00–16:00; no night work; no blasting. 20 km/h signage. Canopy bridge or crossing only if Chapter 3 evidence supports a specific location. Design by the Contractor's design engineer
– of which no-go core	0.78	km 19	Absolute precautionary	A8 — biologist-cleared entry only; construction absolutely prohibited
TOTAL CH	**22.6**			**Construction-phase controls only.**

4.7.2 Priority Biodiversity Feature register

Table 4.8: Priority Biodiversity Feature register — six spatially-defined features totaling approximately 14.2 km².

Priority Feature	Location / Value	Construction Response
Barteh Jam sacred grove (km 3–4)	~3 ha; Rockfowl association; Tieghemella stems	Full no-go during works. No blasting or quarry in the agreed buffer. Pre-construction walkover.
Towah swamp (km 12–14)	~380 ha wetland/crossing	Prefer span or large-box over fill. In-stream work in low flow. Sediment control. Restore opened banks.
Threatened-flora hotspot (km 18–28)	Terminalia ivorensis cluster; FDA Class A / IUCN VU	No Class A felling except under the agreed stem-by-stem protocol. Pre-clearance marking. Micro-adjustment only inside the approved ROW.
Three additional sacred groves	Toe Town, Kparblée, Bassa Village; ~4.5 ha	Full no-go during works. Awareness with the nearest community before the front arrives. Not a 10-year MoU deliverable.
White-necked Rockfowl outcrop	~1 ha plus buffer; seven nests, off-alignment near km 4	No blasting or quarry in the agreed 1 km buffer during construction. Report any new disturbance through the site supervision chain.
Riparian corridors	~60 existing stream crossings	Sediment traps at live crossings. Restore banks the contract opens. Do not claim a 30 m land-control buffer outside the approved ROW.

Critical Habitat designation on this existing road requires the construction-phase controls listed above. It does not convert the rehabilitation into a long-term conservation program, an offset, or a Net Gain dashboard. Those controls will be written into the BMP annex to the 85 km ESIA and checked under ordinary site supervision.

5 MITIGATION HIERARCHY APPLICATION

5.1 FRAMEWORK

This chapter specifies mitigation for rehabilitation of an existing road in line with ESS6 requirements. Measures apply to detailed design, site establishment, construction and the defects-liability period. They include avoiding new harm at identified nodes, minimizing works within the approved right-of-way, and restoring surfaces the contract disturbs. The cascade in Figure 5.1 is limited to the three steps the works can deliver

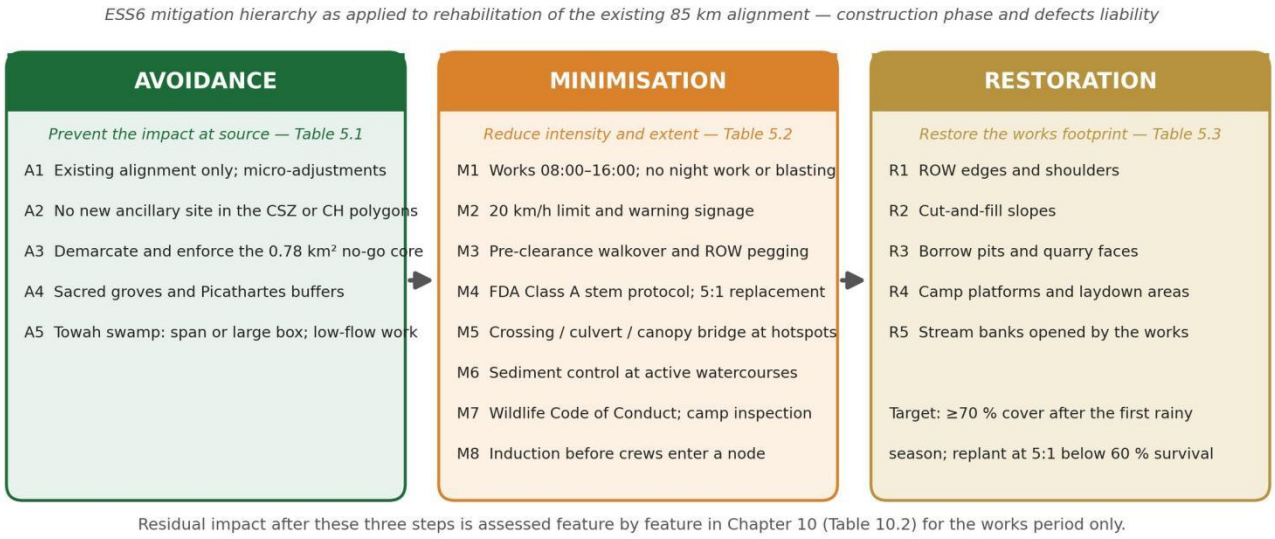


Figure 5.1: Mitigation applied to these works: avoidance, minimisation and restoration of the footprint.

5.1.1 *Master spatial synthesis of all measures*

Measures concentrate at two segments already mapped in Chapters 3 and 4: the Chimpanzee Sensitivity Zone at kilometer 18–20 and the pangolin polygons at kilometer 38–50, together with Towah swamp at kilometer 12–14, the threatened-flora hotspot at kilometer 18–28, and listed sacred groves. **Figure 5.3** shows the construction-phase controls on the existing alignment.

5.2 AVOIDANCE

Avoidance prevents impact from occurring. On road segment rehabilitation, that means staying on the existing alignment and keeping new disturbance out of marked nodes.

- A1. Stay on the existing laterite alignment. Micro-adjustments to spare a Class A stem or a marked no-go edge must remain inside the approved right-of-way.
- A2. Do not open a new quarry, borrow pit, crusher, batching plant, camp or laydown inside the CSZ or the pangolin CH polygons.
- A3. Demarcate the 0.78 km² no-go core at kilometer 18–20 before vegetation clearance begins in that segment. Entry only under written Supervising Engineer clearance after advice from a qualified ecologist.
- A4. Sacred groves listed in Chapter 4 remain no-go. Blasting and quarrying stay outside the agreed Picathartes buffer near kilometer 4.
- A5. Towah swamp (kilometer 12–14): prefer a span or large-box structure over fill; schedule in-stream work for low flow.

Verification of A1–A5 is a Supervising Engineer check during design review and site establishment.

Table 5.1: Avoidance register for Construction

ID	Measure	Where	When	Who

A1	Existing alignment only; micro-adjustment inside approved ROW	Full corridor	Design	Contractor design engineer / Supervising Engineer
A2	No new ancillary site in CSZ or CH polygons	km 18–20; km 38–50	Site establishment	Contractor / Supervising Engineer
A3	Demarcate and enforce 0.78 km² no-go core	km 18–20	Before clearance in the segment	Contractor / Supervising Engineer
A4	Sacred groves and Picathartes buffer: no blasting or quarry	km 3–4 and listed groves	Design and construction	Contractor / Supervising Engineer
A5	Towah swamp: span or large box; low-flow in-stream work	km 12–14	Design then construction	Contractor design engineer

All measures are pre-construction, any breach triggers contractor penalty and site remedial action.

5.3 MINIMISATION

Minimisation measures reduce the intensity, extent or duration of unavoidable impacts. They include physical works (wildlife-passage structures, edge-effect buffers), operational controls (speed limits, quiet hours, worker codes of conduct) and mitigation technology (dust suppression, sediment control).

5.3.1 Wildlife-passage structures

A wildlife crossing, oversized culvert, span structure or canopy bridge is provided only where Chapters 3 and 4 document a movement hotspot, or where fill would block Towah swamp. Ordinary hydraulic culverts remain hydraulic. They are not converted to fauna passages along the whole 85 km, and funnel fencing is not installed at every stream. Two canopy bridges in the Chimpanzee Sensitivity Zone may proceed if the single T59 record and a break in canopy connectivity justify them; the Contractor's design engineer prepares those drawings. The Supervising Engineer and the Employer review drawings before construction. Costs are estimated by the design engineer and sit in the works budget.

Provided only where Chapters 3 and 4 document a hotspot or where fill would block Towah swamp (M5 / A6); ordinary hydraulic culverts elsewhere remain hydraulic

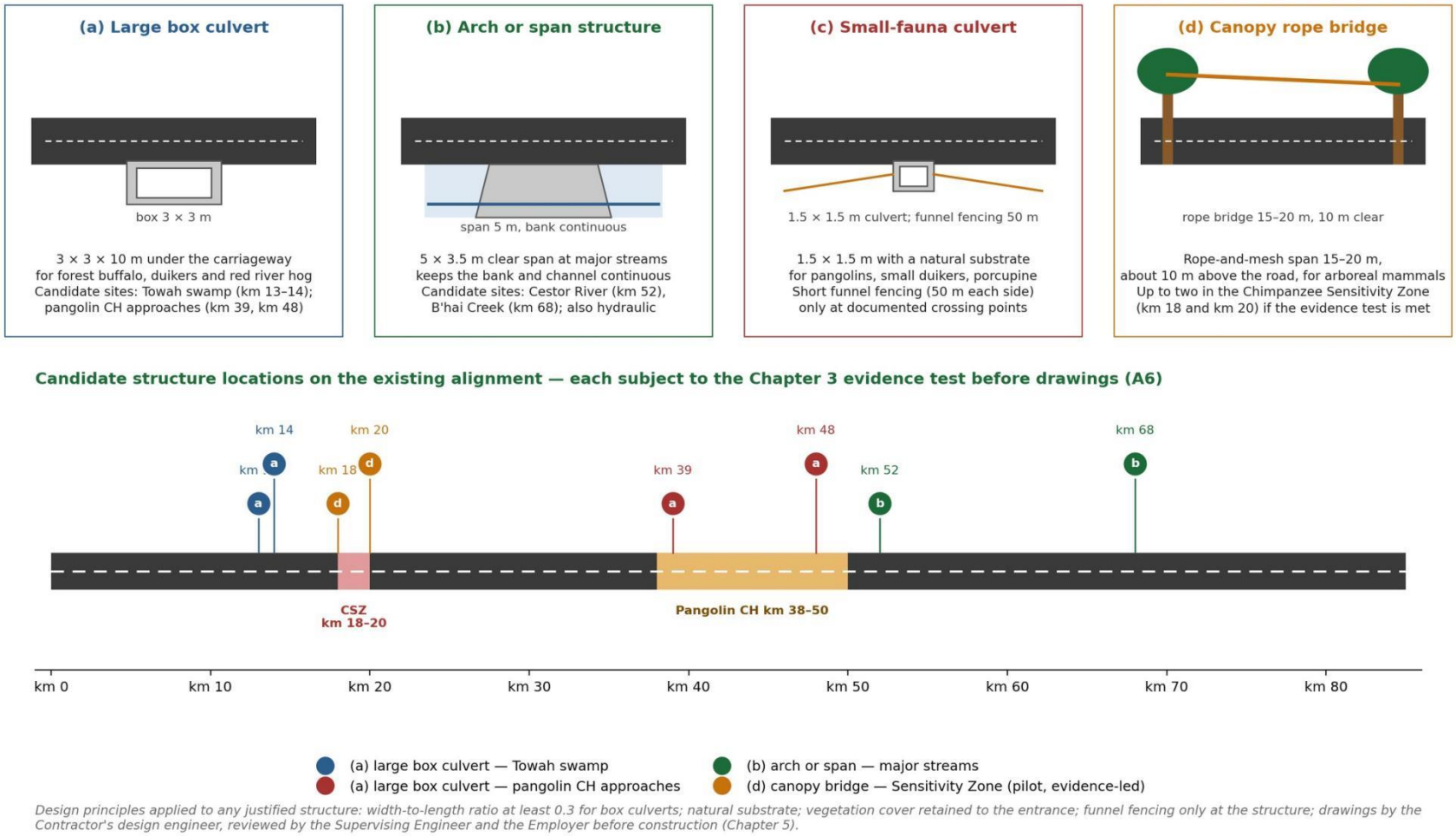


Figure 5.2: Structure types available for documented hotspots.

Four structure types are available: (a) large box culverts (3 × 3 × 10 m) for forest buffalo and duikers where Chapter 3 documents movement at Towah swamp and at the pangolin Critical Habitat approaches; (b) arch or span structures (5 × 3.5 m) at the Cestor River and B'hai Creek crossings; (c) small-fauna culverts (1.5 × 1.5 m) with short funnel fencing only at documented crossing points; and (d) canopy rope bridges for arboreal mammals in the Chimpanzee Sensitivity Zone (up to two, at km 18 and km 20, subject to the drawings review described above). Ordinary hydraulic culverts elsewhere remain hydraulic.

5.3.2 Right-of-way Limit

Clearance stays inside the approved, pegged right-of-way. The Contractor does not open an extra strip beyond the pegs. Existing vegetation outside the pegs is simply not entered. A 15-meter project-controlled forest buffer outside the right-of-way is not a measure of this rehabilitation.

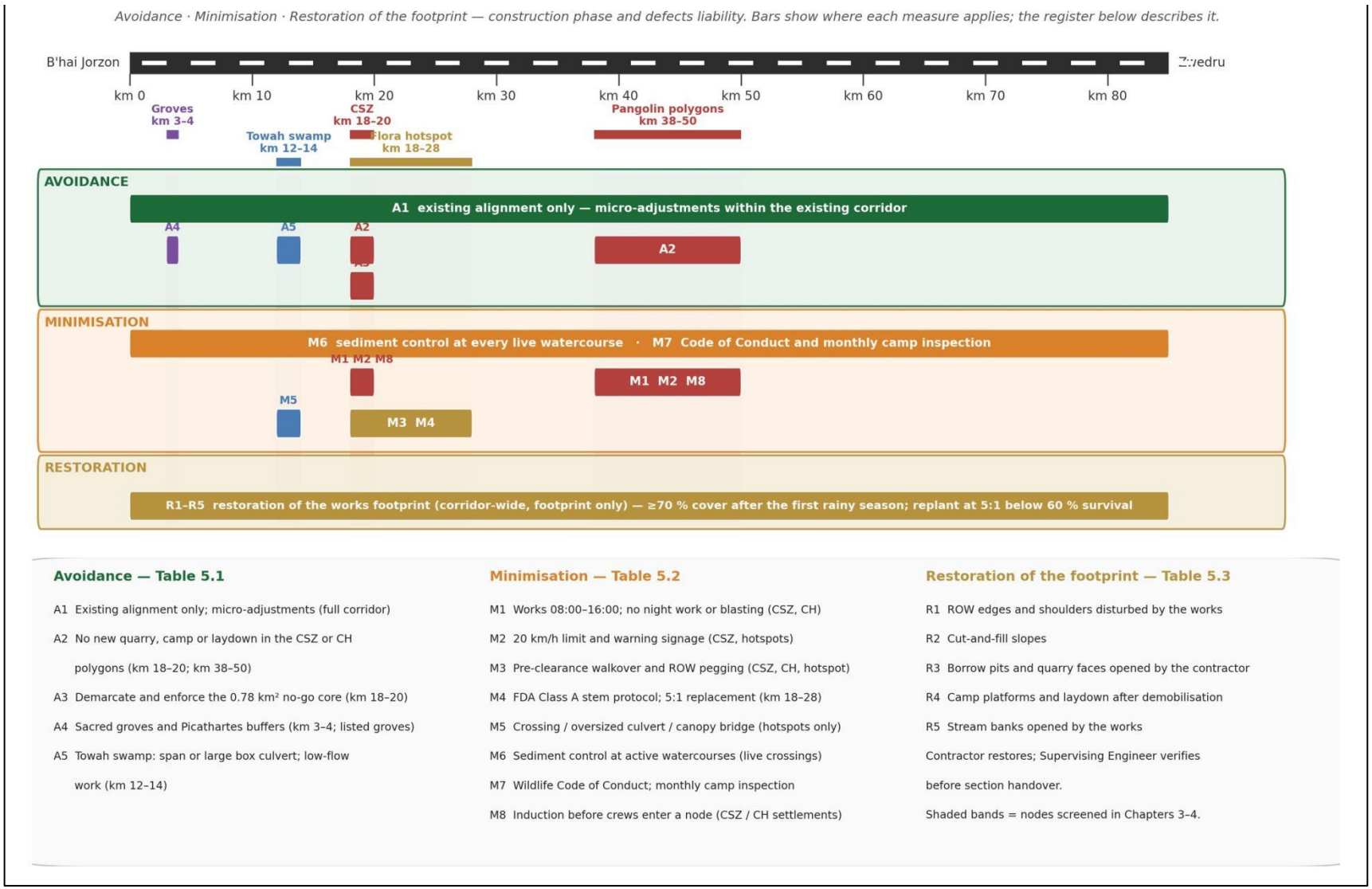


Figure 5.3: Construction-phase controls on the existing 85 km alignment.

Bars are km-indexed measures to be written into the works contract. The concentration of measures in the pangolin polygons (km 38–50) and the Chimpanzee Sensitivity Zone (km 18–20) reflects the Critical Habitat trigger. Each bar is traceable to a numbered measure in Tables 5.1, 5.2 and 5.3.

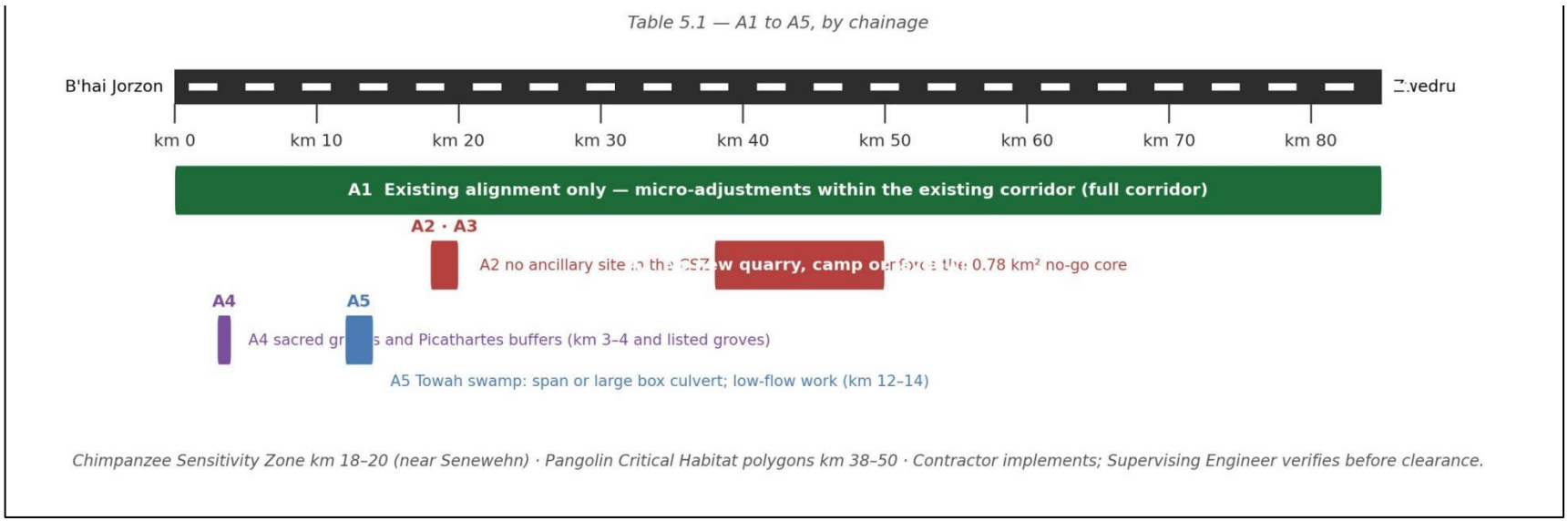
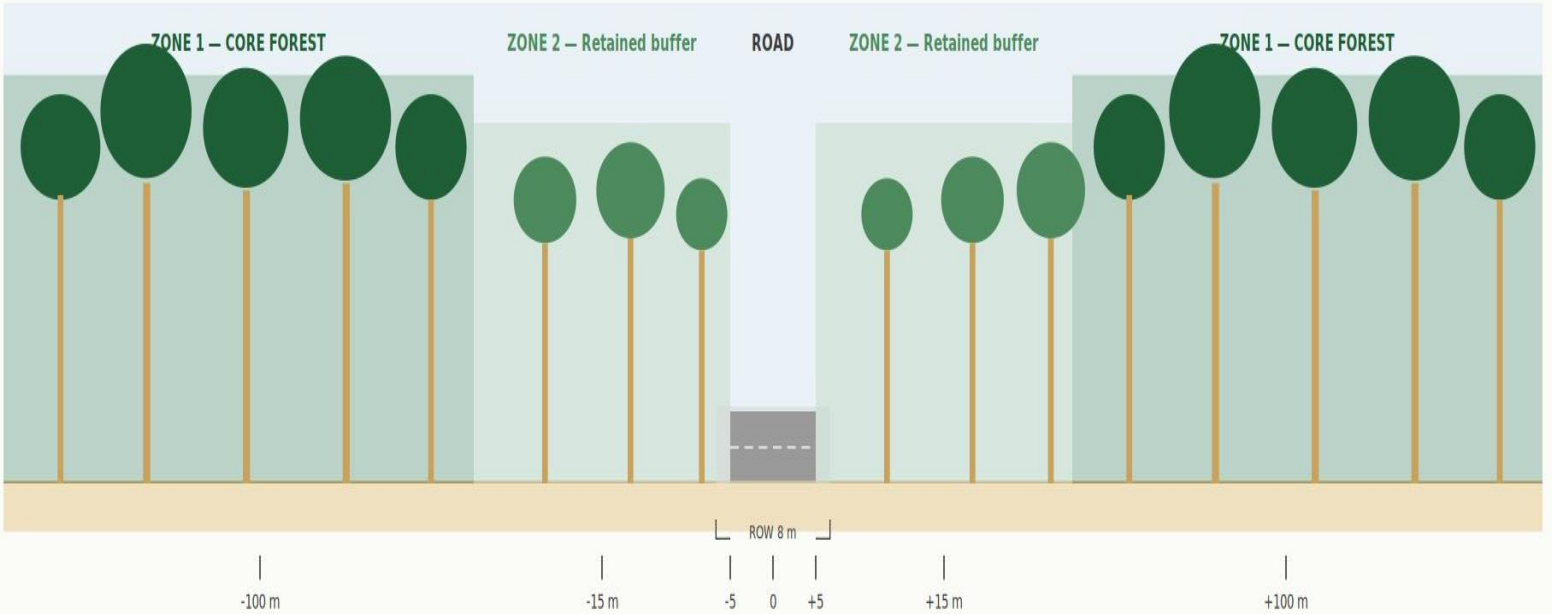


Figure 5.4: Avoidance on the existing road: no-go core, CH/CSZ ancillary-site exclusion, sacred groves, Towah swamp.

Five avoidance measures (A1–A5) are km-indexed: the works stay on the existing alignment with micro-adjustments only (A1); no new quarry, camp or laydown inside the Chimpanzee Sensitivity Zone or the pangolin polygons (A2); the 0.78 km² no-go core at km 18–20 is demarcated and enforced (A3); sacred groves and the Picathartes site keep their buffers (A4); and the Towah swamp is spanned or crossed by a large box culvert with in-stream work at low flow (A5).



Zone	Extent	Edge-effect magnitude	Mitigation prescription
ROW (cleared)	± 5 m from centreline	Complete clearing	Avoid extension beyond 5 m; native species planted at edge
Retained buffer	± 5-15 m	High (microclimate, invasives)	No clearing; weed control; invasive monitoring; dust suppression

Figure 5.5: Approved right-of-way on the existing road

Three zones: ROW (cleared, ±5 m from centreline), Retained Buffer (±5–15 m, vegetation kept in situ, weed control, no extension of clearing) and Core Forest (>15 m, natural condition). Edge-effect magnitude (after Laurance et al. 2002; Broadbent et al. 2008) is highest at the ROW/Buffer interface and decays to negligible within 100 m.

5.3.3 Construction-hours schedule (Chimp Sensitivity Zone)

Noise and disturbance from construction equipment can cause behavioral avoidance, displacement and stress in Critically Endangered wildlife. In the CSZ and the pangolin CH polygons, works are limited to 08:00–16:00. Night work and blasting are prohibited in those nodes. Elsewhere, hours follow the approved method statement. Figure 5.6 shows the permitted construction hours by corridor segment, progressing from standard windows outside the CH/Priority Biodiversity Feature network, through reduced windows adjacent to sensitive features, to the strictest CH-restricted window in the Chimp SZ.

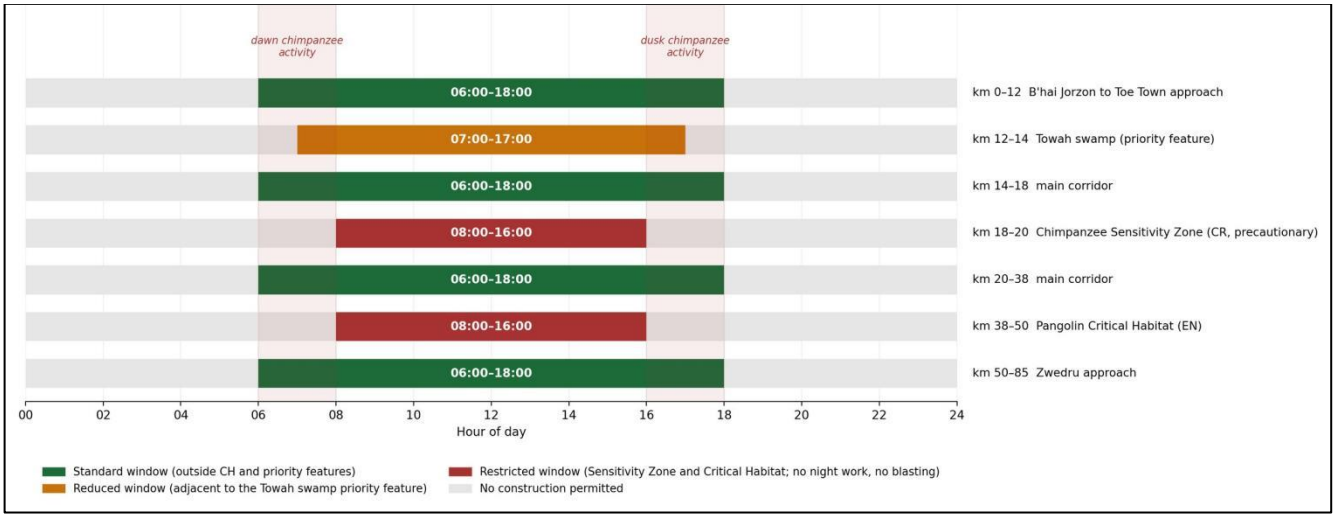


Figure 5.6: Permitted construction hours by corridor segment.

Seven zones with differentiated permitted windows: standard (06:00–18:00) outside the Critical Habitat and priority-feature nodes; reduced (07:00–17:00) adjacent to the Towah swamp Priority Biodiversity Feature; and restricted (08:00–16:00) in the Chimpanzee Sensitivity Zone and the pangolin Critical Habitat polygons (M1). Night work and blasting are prohibited in those nodes. The dawn and dusk chimpanzee activity bands (red shading) must remain free of construction noise in the Sensitivity Zone.

5.3.4 Minimization register

Table 5.2: Minimization register for construction.

ID	Measure	Where	When	Who
M1	Works 08:00–16:00; no night work; no blasting	CSZ and CH polygons	While the front is in the node	Contractor / Supervising Engineer
M2	20 km/h limit and warning signage	CSZ and documented hotspots	Before live traffic on the section	Contractor
M3	Pre-clearance walkover and ROW pegging	CSZ, CH, flora hotspot km 18–28	Before felling	Contractor ecologist / Supervising Engineer
M4	FDA Class A stem protocol; 5:1 replacement if a stem is lost	ROW in the flora hotspot	Clearance	Contractor / FDA liaison / Supervising Engineer
M5	Crossing, oversized culvert or canopy bridge only at documented hotspots	Sites justified in Chapters 3–4	Design then construction	Contractor design engineer
M6	Sediment control at active watercourse works	Live crossings	During in-stream work	Contractor / Supervising Engineer
M7	Wildlife Code of Conduct; weekly camp check (with monthly	Camps and all crews	Mobilization through defects	Contractor

ID	Measure	Where	When	Who
	Supervising Engineer verification); GRM wildlife line			
M8	Induction before crews enter a node; short community awareness in the nearest settlements	CSZ / CH settlements	Before the front enters the node	Contractor / IIU community liaison

Each measure is coded into the BMP and into the contractor's construction Environmental & Social Management Plan (C-ESMP).

5.4 RESTORATION

Restoration in this report means the works footprint only: right-of-way edges, cut-and-fill slopes, borrow pits and quarry faces that the contractor must close, camp platforms, and stream banks opened by the works.

5.4.1 Timing

Restore each finished front before the next rainy season. Do not leave large bare areas through a full wet season. The Supervising Engineer inspects cover at the end of the first rainy season after planting.

5.4.2 Restoration program register

Table 5.3: Restoration of the works footprint. Target: at least 70 percent vegetative cover by the end of the first rainy season after planting. If survival is below 60 percent, replace at 5:1 at the Contractor's cost

ID	Surface	Standard	Who
R1	ROW edges and shoulders disturbed by the works	Regrade; revegetate with native or locally proven species	Contractor; SE verifies
R2	Cut-and-fill slopes	Stable grade; cover by end of first rainy season after planting	Contractor; SE verifies
R3	Borrow pits and quarry faces the contract must close	No active gullies after the first rainy season; revegetate	Contractor; SE verifies
R4	Camp platforms and laydown after demobilization	Regrade and revegetate	Contractor; SE verifies
R5	Stream banks opened by the works	Bank stability; no standing blockage of the channel	Contractor; SE verifies

5.4.3 Native species planting palette

The planting palette balances ecological function (canopy stratum, shade, food for IUCN species), growth rate, FDA protection status and availability from SCNL and FDA nurseries. A short list of native or locally proven species may be used on the surfaces in Table 5.3. **Figure 5.7** presents the 12-species palette used across all restoration sub-programs.

Species	Function	Growth	Stratum	IUCN	FDA	Primary use
Terminalia ivorensis (Framire)	Timber + large canopy	Fast	Emergent	VU	A	CH enrichment
Lophira alata (Ekki)	Hardwood + mammal food	Medium	Emergent	VU	A	CH enrichment
Milicia regia (Iroko)	Mast-fruiting; hornbills	Medium	Emergent	LR/nt	A	All restoration
Heritiera utilis (Niangon)	Swamp forest	Medium	Canopy	VU	A	Chimp SZ
Nauclea diderrichii (Kusia)	Riparian	Medium	Canopy	VU	A	Riparian restoration
Ceiba pentandra	Canopy; bat roost	Fast	Emergent	LC	A	ROW edge; sacred
Albizia adianthifolia	N-fixer; nurse	Fast	Canopy	LC	C	Pioneer / ROW
Erythrophleum ivorense	Hardwood; pioneer	Medium	Canopy	LC	B	Enrichment
Cola nitida	Cultural + fruit	Medium	Sub-canopy	LC	C	Sacred grove; cocoa
Pycnanthus angolensis	Hornbill food	Medium	Canopy	LC	B	Enrichment
Funtumia elastica	Shade + latex	Medium	Canopy	LC	B	Cocoa shade
Harungana madagascariensis	Pioneer nurse	Very fast	Sub-canopy	LC	C	Early ROW

Figure 5.7: Species suitable for revegetating disturbed works surfaces.

Twelve species selected for ecological function, growth rate, canopy stratum, IUCN status, FDA protection class, and primary use. FDA Class A species (orange labels) dominate the palette to reinforce the strict no-felling policy in Chapter 5.2.

5.5 Implementation Architecture

5.5.1 RACI accountability matrix

The implementation architecture allocates **Responsibility, Accountability, Consultation, and Information** (RACI) across three actors — Table 5.4. **Figure 5.8** visualizes the institutional network and the principal information/accountability flows.

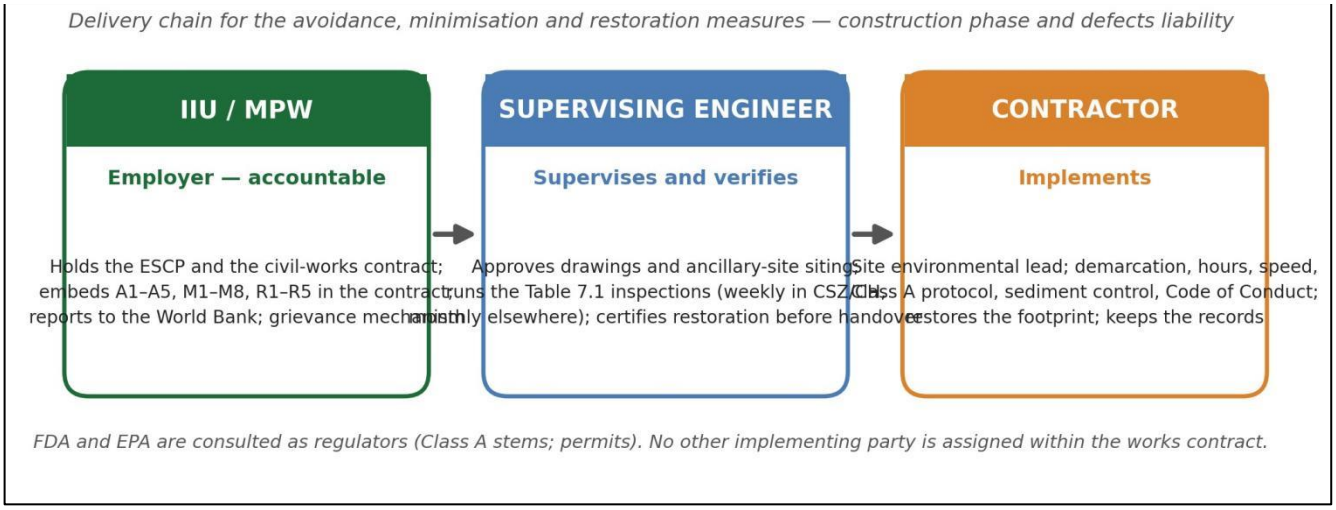


Figure 5.8: Implementation during the works.

Table 5.4: Construction responsibilities

Activity	Does the work	Verifies	Oversees
Avoidance A1–A5; method statements in CSZ/CH	Contractor	Supervising Engineer	IIU
Justified structures (M5, A5)	Contractor design engineer, then work crews	Supervising Engineer and IIU (drawing review)	IIU
Code of Conduct, camps, induction (M7–M8)	Contractor	Supervising Engineer	IIU
Footprint restoration (R1–R5)	Contractor	Supervising Engineer, before section certification	IIU
Class A stems; wildlife incidents	Contractor reports	Supervising Engineer	IIU notifies FDA / EPA under national procedure

5.5.2 Cost

The Contractor's design engineer estimates the cost of justified structures, Sensitivity Zone design adjustments, signage and footprint restoration, and includes those costs in the design and construction budgets. Checks of the no-go core, working hours, camps, and restored surfaces are part of Environmental and Social Management Plan supervision and are covered by the supervision budget. Actions after the project period are outside this chapter.

5.6 Chapter Takeaway

Avoidance is concentrated at the CSZ, the pangolin polygons, sacred groves, and Towah swamp. Minimization is working hours, no blasting, speed signage, pre-clearance walkover, the Class A protocol and the Code of Conduct. Structures follow evidence, not a corridor-wide template. Restoration is the works footprint only. Delivery is through the BMP annex to the 85 km ESIA, the Contractor's C-ESMP, and ordinary site supervision.

6 IMPLICATIONS OF CRITICAL HABITAT FOR THE WORKS

This chapter translates the CH determination in Chapter 4 and the baseline in Chapter 3 into the implications for rehabilitating the existing B'hai Jorzon–Toe Town–Zwedru road. It does not repeat the inventories or the screening. It states what the works must do at the nodes already mapped, how those actions sit in the 85 km ESIA and its BMP annex, and how residual risk is judged for the construction and defects-liability period.

6.1 LINK TO THE BASELINE AND THE CRITICAL HABITAT SCREEN

Chapter 3 records current condition along an alignment that has been in use for decades. Forest-cover change in Table 3.2 and Figures 3.4 and 3.6 is part of that baseline. Habitat composition, hunting sign, camera detections (Figure 3.14, Table 3.5) and threatened-flora hotspots (Figure 3.30, Table 3.8) describe the landscape the rehabilitation will enter. They are not a restoration target for historical cover.

Chapter 4 applies the five Critical Habitat criteria to that evidence. Criterion 1 is triggered. The primary trigger is the Endangered White-bellied Pangolin, with verified camera events clustered at approximately kilometer 38–50 (Section 4.2, Table 4.2). The Western Chimpanzee is treated as a precautionary SZ on the single verified T59 record of 3 February 2026. Criteria 2 through 5 are not triggered.

Three polygons total approximately 22.6KM^2 (Table 4.7): pangolin habitat at kilometer 38–44 (8.7 km²) and kilometer 46–50 (10.8 km²), and the Chimpanzee Sensitivity Zone of about 3.14 km² at kilometer 18–20, including a 0.78 km² no-go core. Table 4.8 lists six Priority Biodiversity Features, including sacred groves, Towah swamp, the threatened-flora cluster, the Picathartes outcrop, and riparian corridors. Those features constrain construction method and siting. They do not establish a separate offset program.

6.2 WHAT THE FINDING MEANS FOR AN EXISTING ROAD

Because the works follow an existing laterite road, additional biodiversity risk is limited to the rehabilitation itself: clearance inside the approved right-of-way; noise, light and collision while plant and crews are on site; siting of quarries, borrow pits, crushers, camps and laydowns; sediment at watercourse crossings; and hunting or bushmeat demand linked to the workforce. Improved access after paving may add pressure in the wider landscape. That pressure is context. It is not used here to design a multi-year landscape program.

The practical consequence of Chapter 4 is therefore node-level control during detailed design, construction and defects liability, not a corridor-wide change of land use. Sensitivity is concentrated where Figures 3.14, 3.20, 3.21, 3.23 and 3.30 already show it. Most of the 85 km already runs through farm-bush and secondary growth (Figures 3.1, 3.3, 3.5 and 3.9).

6.3 IMPLICATIONS BY NODE

6.3.1 Chimpanzee Sensitivity Zone

Figure 3.23 and Table 4.7 define the zone and the no-go core. Before vegetation clearance begins in this segment, the Contractor demarcates the 0.78 km² core. Machinery, stockpiles and temporary works stay outside that core except under written clearance from the Supervising Engineer after advice from a qualified ecologist. No new quarry, borrow pit, crusher, batching plant, camp or laydown is opened inside the zone.

While the front is in the zone, work is limited to 08:00–16:00. Night work and blasting are not carried out. A 20 kilometer-per-hour limit and warning signage apply through the zone. A canopy bridge is considered only if the movement evidence in Sections 3.2.5 and 4.2 continues to support it at a specific crossing of the alignment. It is not a default structure for the full 85 km. Drawings, if required, are prepared by the Contractor's design engineer and reviewed by the Supervising Engineer and the Employer.

6.3.2 Pangolin polygons

Table 4.7 and Figure 3.14 locate the two polygons that carry the primary Criterion 1 trigger. The construction implication is the same avoidance rule: no new ancillary site inside either polygon; pre-clearance walkover before vegetation is removed; clearance limited to the approved right-of-way; and immediate investigation of any hunting or capture incident involving project personnel. Weekly checks apply while clearance is underway in these segments.

6.3.3 Towah swamp, flora hotspot, Picathartes site and sacred groves

Towah swamp at kilometer 12–14 is an existing wet crossing. Chapter 5 prefers a span or large-box structure over fill and schedules in-stream work for low flow (Table 1.7). The threatened-flora hotspot between approximately kilometer 18 and 28

(Figure 3.30, Table 3.8) is managed through the FDA Class A protocol in Section 1.4.1 and Table 1.10: no felling of Class A stems except under an agreed stem-by-stem procedure. The Picathartes outcrop near kilometer 4 remains outside blasting and quarrying. Sacred groves listed in Table 4.8 remain no-go.

6.4 How the measures are delivered

The measures are specified in Chapter 5. This chapter records only the delivery route so that the Critical Habitat finding is not left without an instrument.

Table 6.1: How BFS findings are carried into construction.

Finding (Chapters 3–4)	Construction response (Chapter 5)	Instrument
CSZ and 0.78 km² no-go core (Fig. 3.23, Table 4.7)	Demarcation before clearance; hours 08:00–16:00; no night work or blasting; 20 km/h signage; no new ancillary site	C-ESMP method statement; Supervising Engineer weekly check
Pangolin polygons km 38–50 (Fig. 3.14, Table 4.7)	No new quarry, camp or laydown; pre-clearance walkover; Code of Conduct	C-ESMP; camp inspection record
Towah swamp km 12–14 (Table 4.8)	Span or large box; low-flow in-stream work; sediment control	Detailed design by the Contractor's design engineer
Flora hotspot km 18–28 (Fig. 3.30, Tables 3.8 and 1.10)	Class A stem protocol; ROW pegging	Pre-clearance walkover file
Picathartes site and sacred groves (Table 4.8)	No-go; no blasting or quarry in the agreed buffer	Design freeze on those sites
Documented movement hotspots only (Ch. 3)	Crossing, oversized culvert or canopy bridge where evidence supports it	Design-engineer drawings; Supervising Engineer and Employer review
Works footprint (ROW edges, slopes, pits, camps, opened banks)	Progressive restoration; 70 percent cover by the end of the first rainy season after planting; 5:1 replacement if survival is below 60 percent	Section certification by the Supervising Engineer

The BMP will be included as an annex to the 85 km ESIA. The Contractor is responsible for implementing the measures outlined in Table 6.1 in the construction ESMP. The Supervising Engineer will verify these measures at the frequencies specified in Chapter 7. Before work begins in a specific area, the Contractor will conduct community awareness initiatives and monitor wildlife reports throughout the construction phase, in accordance with the SEP and the project's grievance mechanism.

6.5 Residual impact during the works

Chapter 8 evaluates the threats associated with construction activities. Based on the controls outlined in Table 6.1, the residual effects on Criterion 1 values and Priority Biodiversity Features are expected to remain manageable throughout the construction phase and the defects liability period. This assessment relies on several key assumptions: the no-go core is respected, ancillary sites remain outside the designated polygons, the method statements regarding working hours and blasting are adhered to, structures are constructed according to the approved plans, the Code of Conduct is enforced, and any disturbed surfaces are restored in accordance with the guidelines in Chapter 5.

6.6 Chapter 6 Key Takeaway

This chapter serves as a brief transition between the Critical Habitat finding and the other operational chapters. It focuses on the rehabilitation of an existing road, the 85 km ESIA, and the BMP annex to that ESIA.

7 MONITORING DURING THE WORKS

This chapter sets out how the measures outlined in Chapter 5 and Table 6.1 are monitored during the rehabilitation of the existing 85km road segment. Monitoring is a task related to construction and defects liability. It is carried out by the Contractor and verified by the Supervising Engineer as part of the supervision under the ESMP.

7.1 WHAT IS MONITORED

The implementation monitoring follows the nodes mapped in Chapter 3 and screened in Chapter 4: the CSZ and no-go core (Figures 3.22 and 3.23, Table 4.7), the pangolin polygons (Figure 3.14, Table 4.7), Towah swamp and other watercourse crossings (Table 4.8), the threatened-flora hotspot (Figure 3.30, Table 3.8), camps and the works footprint. **Table 7.1** presents Works-period monitoring.

Table 7.1: Works-period Monitoring financed under the ESMP supervision.

Location	What is checked	When	Who
Chimpanzee Sensitivity Zone and no-go core (Fig. 3.23)	Demarcation intact; no unauthorized entry; works 08:00–16:00; no night work or blasting; 20 km/h signage in place	Weekly while the front is in the zone; monthly at other times during the works	Contractor records; Supervising Engineer verifies
Pangolin polygons km 38–50 (Fig. 3.14)	No new quarry, camp or laydown; pre-clearance walkover done; clearance inside approved ROW only	Weekly during vegetation clearance; monthly during other works in the segment	Contractor records; Supervising Engineer verifies
Crossing, culvert or canopy-bridge sites justified by Chapter 3	Built as approved drawings; not blocked; drainage working	Monthly while the structure is under construction; at completion	Supervising Engineer
Towah swamp and live watercourse works (Table 4.8)	Sediment contained; in-stream work in low flow where practicable	Each week of in-stream work	Contractor; Supervising Engineer
Flora hotspot km 18–28 (Fig. 3.30)	Class A protocol followed; ROW pegs in place	Before and during clearance	Contractor with Supervising Engineer
Restored surfaces (Chapter 5 footprint only)	Cover and survival against the 70 percent and 60 percent rules	End of the first rainy season after planting; before section certification	Supervising Engineer
Camps and corridor	Code of Conduct records; weekly camp check (with monthly Supervising Engineer verification); grievance entries on wildlife; signage	Monthly	Contractor; Supervising Engineer; Employer as needed

7.2 MONITORING FREQUENCY

When construction is taking place within the Sensitivity Zone, or a pangolin polygon, inspections will be conducted weekly, as outlined in Table 7.1. In other areas, inspections will occur monthly during construction. For restored plots, inspections will take place at the end of the first rainy season following planting, as specified in Table 1.7.

7.2.1 Monitoring frequency calendar

Different checks operate at different frequencies, from weekly to once at certification. Figure 7.1 shows the work-period inspection calendar: each cell indicates the number of Table 7.1 checks per month by node and phase.

Table 7.1 checks by node and phase — weekly while the front is in the Sensitivity Zone or a pangolin polygon; monthly elsewhere; restoration checked after the first rainy season

	Mobilisation	Construction — front inside the node	Construction — front elsewhere	Defects liability (after handover)
Chimpanzee Sensitivity Zone and no-go core (km 18–20)	Monthly	**WEEKLY**	Monthly	—
Pangolin polygons (km 38–50)	Monthly	**WEEKLY (during clearance)**	Monthly	—
Towah swamp and live watercourse works	—	**WEEKLY (in-stream work)**	—	—
Flora hotspot (km 18–28) Class A protocol, ROW pegs	—	Before and during clearance	—	—
Crossing, culvert and canopy-bridge sites	—	Monthly while under construction	At completion	—
Restored surfaces (works footprint, R1–R5)	—	—	—	End of first rainy season after planting; before section handover
Camps and corridor (Code of Conduct, grievances)	Monthly	Monthly	Monthly	Monthly until demobilised

Weekly · Monthly · Event-based check · Not applicable

Contractor keeps the records; the Supervising Engineer verifies and certifies restoration before handover. Weekly = each week the live front is inside the node.

Figure 7.1: Work-period inspection calendar: frequency of the Table 7.1 checks by node and phase.

7.3 Trigger Thresholds During the Works

The following thresholds require a written instruction from the Supervising Engineer. Corrective work during the contract is paid from works-contract contingency.

Table 7.2: Construction triggers.

Trigger	Threshold	First action	Notify
No-go core or CH polygon	Any unauthorized entry or works	Stop work in the vicinity; reinstate demarcation; record the incident	Employer within 24 hours
Working hours/blasting	Night work or blasting in CSZ or CH	Written instruction; repeat event may suspend the front	Employer on repetition
Class A stem (Table 1.10)	Unauthorized felling	Halt the segment; apply the agreed protocol; replace at 5:1 if the stem is lost	Employer; FDA as required
Code of Conduct	Verified hunting, capture or bushmeat by project personnel	Disciplinary process; review induction	Employer; FDA where the law requires
Watercourse	Uncontrolled sediment beyond the approved footprint	Add silt control; correct drainage; photograph	Supervising Engineer
Approved crossing or canopy bridge	Damage or persistent blockage	Repair within the agreed time	Supervising Engineer and Employer
Restoration	Cover below 70 percent, or survival below 60 percent, at the first rainy-season check	5:1 replacement at the Contractor's cost; re-inspect after the next rainy season	Supervising Engineer before certification
Protected or priority species	Verified sighting within 50 m of an active front	Suspend the front until the Supervising Engineer clears restart	Supervising Engineer and Employer

7.4 Reporting

Table 7.3: Reporting during the works and defects-liability period..

Product	When	From	To
Biodiversity page of the monthly C-ESMP report, including Table 7.1 checks and any Table 7.2 event	Monthly	Contractor	Supervising Engineer
Consolidated environmental and social progress note	Quarterly	Supervising Engineer	Employer (IIU)

Quarterly project report, including node status	Quarterly	Employer	Financier and EPA, against permit and commitment-plan items
Serious incident (chimpanzee injury or death, no-go breach, unauthorized Class A felling)	Within 48 hours, with follow-up	Contractor / Supervising Engineer	Employer, then financier and EPA as required

7.5 Records

The Contractor maintains records that include acknowledgments of the Code of Conduct, induction records, notes from camp inspections, pre-clearance walkover notes, demarcation logs, and restoration photographs. The Supervising Engineer keeps the completed records for Table 7.1 checks and Table 7.2 event files. These documents form part of the ESMP file and are accessible for supervision missions. Sensitive species coordinates are recorded in a manner that protects the privacy of nest and den sites.

7.6 Roles

The Contractor implements Chapter 5 and reports against Table 7.1. The Supervising Engineer verifies and instructs against Table 7.2. The Employer holds the contract and reports through Table 7.3. FDA and EPA are engaged under national procedure for Class A stems and for incidents that the wildlife law requires to be referred. Community awareness before a front enters a node follows Chapter 12 and the Stakeholder Engagement Plan. No additional task force is established by this chapter.

7.7 Cost of monitoring

Activity-level costs are not presented. Contractor time for Table 7.1 is part of the Construction Environmental and Social Management Plan. Supervising Engineer time is part of the Environmental and Social Management Plan supervision budget. There is no separate monitoring envelope for years after the project period.

8 THREAT RISK MATRIX

This chapter outlines the threat risks arising from rehabilitating the existing RETRAP 85 km corridor. The assessment covers three phases: detailed design, construction, and the defects-liability period. Each threat is localized to km-points, linked to its causal pathway, temporally profiled across project phases, rated pre- and post-mitigation, and tied to the specific measure that addresses it.

Chapter 3 details the corridor's condition, noting the presence of farm-bush and cocoa along the roadside, changes in forest cover from 2001 to 2024, hunting signs, and critical wildlife nodes. This serves as the baseline for understanding habitat fragmentation over decades, without treating it as a project impact or assigning scores for hunting or cocoa conversion post-paving.

Chapter 4 identifies features that must remain intact, including CH for White-bellied Pangolin, a CSZ, and Priority Biodiversity Features. Chapter 5 outlines the necessary controls, and Chapter 7 discusses how to monitor these controls. This chapter poses two key questions: What happens if a control is absent? What residual impact remains if the control is implemented?

8.1 Risk Rating Method

Likelihood and severity use a five-point scale. Risk is the product of the two scores. A 4×4 or 3×5 combination is high without control. Likelihood is the chance that the event occurs during design, construction or defects liability if the Chapter 5 control is not applied. Severity is the consequence for a Chapter 4 feature if the event occurs. A short, reversible disturbance inside the approved right-of-way scores low. Loss of no-go core function, unauthorized Class A felling, or injury to a Criterion 1 species scores high.

Table 8.1: Likelihood and severity for construction and defects liability.

Score	Likelihood during the works	Severity if the event occurs
1	Rare in this contract	Local, short, reversible without lasting effect on a Chapter 4 feature
2	Unlikely	Limited disturbance inside the approved footprint
3	Possible	Measurable disturbance of a node in Table 4.7 or Table 4.8
4	Likely without control	Clearance or injury affecting a Criterion 1 value or a Priority Biodiversity Feature
5	Almost certain without control	Permanent loss of a no-go core, Critical Habitat polygon function, or a Class A stand inside the right-of-way without protocol

8.2 Full Threat Register

There are eleven identified threats that the node rules in Section 6.3 aim to prevent. These threats include:

1. Right-of-way creep
2. Unauthorized entry into the no-go core
3. Nightwork and blasting in sensitive areas

4. Improper siting of quarries and camps
5. Class A tree felling
6. Sediment pollution in live water
7. Workforce hunting
8. Collisions at documented hotspots
9. Failed crossings
10. Invasive species on disturbed ground
11. Sightings of protected species at active sites

Threats related to the broader landscape, such as commercial hunting after the road is sealed and cocoa expansion in the buffer zone, are discussed in Chapter 3. These threats are not assigned identity codes in Table 8.2 because the works contract is not the appropriate instrument to address them.

Table 8.2: Construction-threat register.

ID	Threat	Where	Pre	Control	Residual
C1	Clearance beyond the approved right-of-way	Any segment; highest at km 18–28 and km 38–50	4×4	Peg the right-of-way; pre-clearance walkover (Chapter 5)	2×2
C2	Works inside the Chimpanzee Sensitivity Zone no-go core	km 18–20 (Figure 3.23)	3×5	Demarcate before clearance; Table 7.2 stop-work	1×3
C3	Night work or blasting in the Sensitivity Zone or Critical Habitat	km 18–20; km 38–50	3×4	Hours 08:00–16:00; no blasting in those nodes	1×3
C4	New quarry, borrow pit, crusher or camp in the Sensitivity Zone or Critical Habitat	Ancillary sites in Table 1.1	3×5	Siting freeze in Table 6.1	1×4
C5	Unauthorized Class A felling	Flora hotspot km 18–28 (Figure 3.30)	3×4	Table 1.10 protocol; 5:1 replacement if a stem is lost	2×2
C6	Sediment at Towah swamp and live crossings	km 12–14 and other watercourses	4×3	Span or large box; low-flow work; silt control	2×2
C7	Workforce hunting or bushmeat	Camps and corridor	3×4	Code of Conduct; weekly camp check (with monthly Supervising Engineer verification)	2×3
C8	Collision at a documented hotspot during the works	Sensitivity Zone and camera clusters (Figure 3.14)	3×3	20 km/h signage; crossing only where Chapter 3 supports it	2×2
C9	Blocked or poorly built crossing or culvert	Sites justified by Chapter 3	2×3	Design-engineer drawings; Table 7.2 repair	1×2
C10	Invasive plants on opened ground	Disturbed right-of-way, pits, camp edges	3×2	Progressive restoration; 70 percent cover rule	2×1

C11	Sighting of a protected species at an active front	Any live front	2×4	Table 7.2 suspend-and-clear	1×3

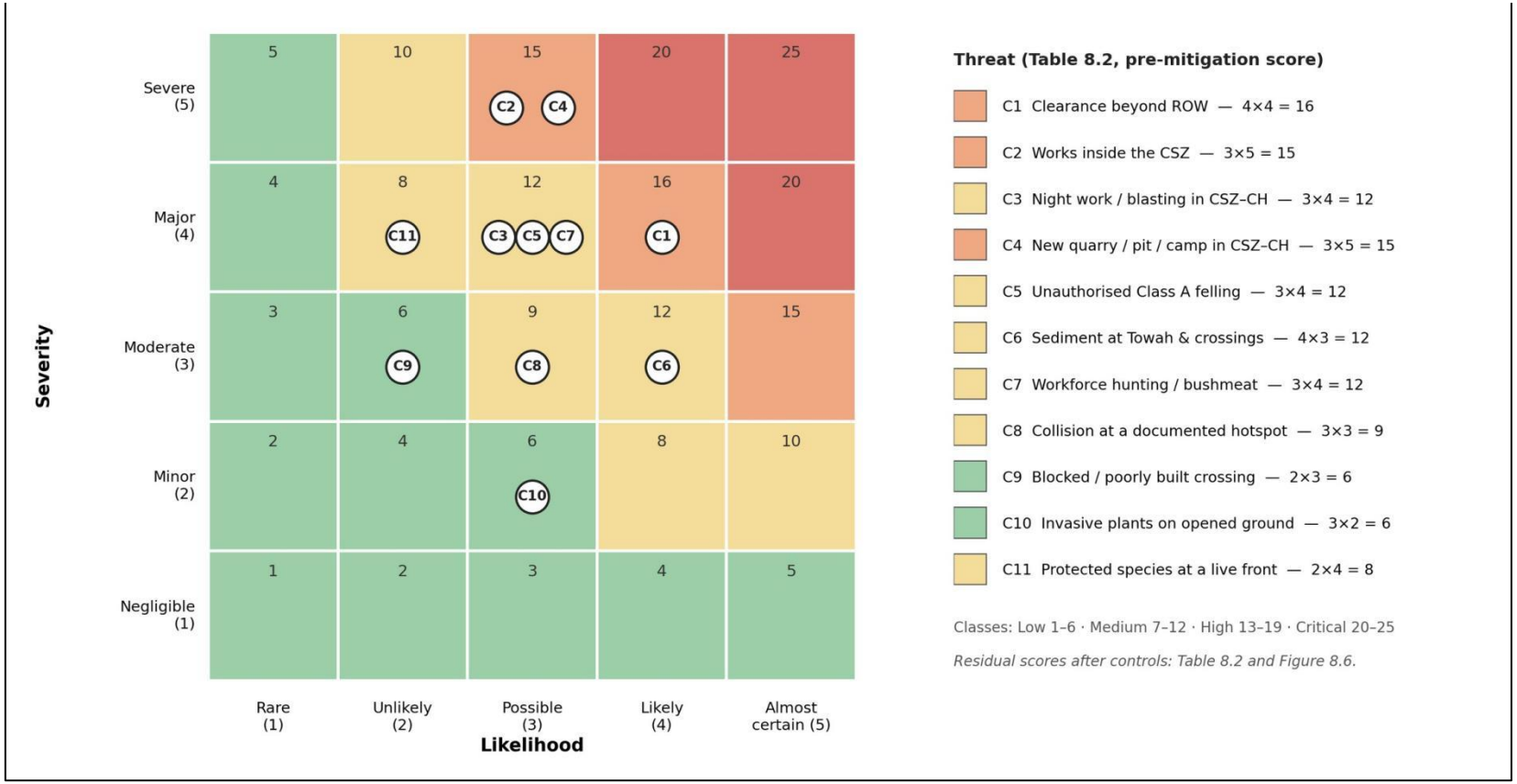


Figure 8.1: Pre-mitigation construction threats on the existing road (likelihood by severity), C1–C11.

Color-coded risk classes: green (Low 1–6), yellow (Medium 7–12), orange (High 13–19), red (Critical 20–25). C1–C7 fall in the high–end to medium–to–high range.

8.2.1 Reading the high pre-mitigation cells

C1 scores 4×4 because vegetation clearance is certain on an 85 km rehabilitation if the right-of-way is not pegged. Severity drops once clearance is limited to the approved width and the walkover in Chapter 5 is completed before the saws start in the flora hotspot and the pangolin polygons.

C2 and C4 score 3×5 because a machine in the 0.78 km² no-go core, or a new quarry next to the Sensitivity Zone, would violate the precautionary rule established in Chapter 4 and Figure 3.23. The residual drops when demarcation is in place before clearance and when Table 1.1 sites stay outside the zone and the polygons.

C6 scores 4×3 because in-stream work at Towah Swamp and other crossings will occur. Severity is moderate if dirty water leaves the approved footprint; it is not scored as catchment-wide degradation. A span or large-box structure and low-flow timing (Table 1.7) bring the residual to 2×2.

C7 remains visible after mitigation (2×3) because a workforce can still hunt if induction fails. The response is the Code of Conduct, weekly camp check (with monthly Supervising Engineer verification) and the disciplinary route in Table 7.2. It is not a ranger establishment.

8.3 Threat Pathway Model — Drivers, Pathways, Receptors, Endpoints

Construction risk is not evenly distributed along the 85 km stretch. The survey maps indicate specific areas of concentration. According to Figure 3.23 and Table 4.7, the SZ is located between kilometers 18 and 20. Figure 3.14 and Table 4.7 identify the pangolin polygons between kilometers 38 and 50. Figure 3.30 and Table 3.8 highlight the flora hotspot from kilometers 18 to 28. Additionally, Table 4.8 specifies the Towah swamp area between kilometers 12 and 14, along with the Picathartes and sacred grove sites.

Between these key locations, the alignment passes through farm-bush, cocoa plants, and settlements, where standard Construction ESMP controls apply. Strict regulations are enforced at the identified nodes.

Three features of the pathway model matter for the works:

- Work drivers, not landscape drivers, are scored. Cocoa expansion and hunter access are landscape pressures that the project did not cause and that the works contract cannot mitigate (Section 8.5); they are excluded from Table 8.2. The eleven threats scored are all driven by the works themselves: clearance fronts, plant and crews, ancillary sites, in-stream work and the workforce.
- Multiple pathways converge on few receptors. Five receptors carry virtually all of the works-period risk: the pangolin polygons (CH-West and CH-East), the Chimpanzee Sensitivity Zone, the priority-feature network (Towah swamp, flora hotspot, Picathartes site and sacred groves), general forest fauna at documented hotspots, and the live watercourses. Well-targeted measures at these five receptors absorb most of the Chapter 5 effort.
- Pathway cumulation, not single threats, determines most outcomes. Most works-period effects (for example on pangolin habitat use in S6) arise from several pathways at once; the measures are therefore layered (Table 8.5).

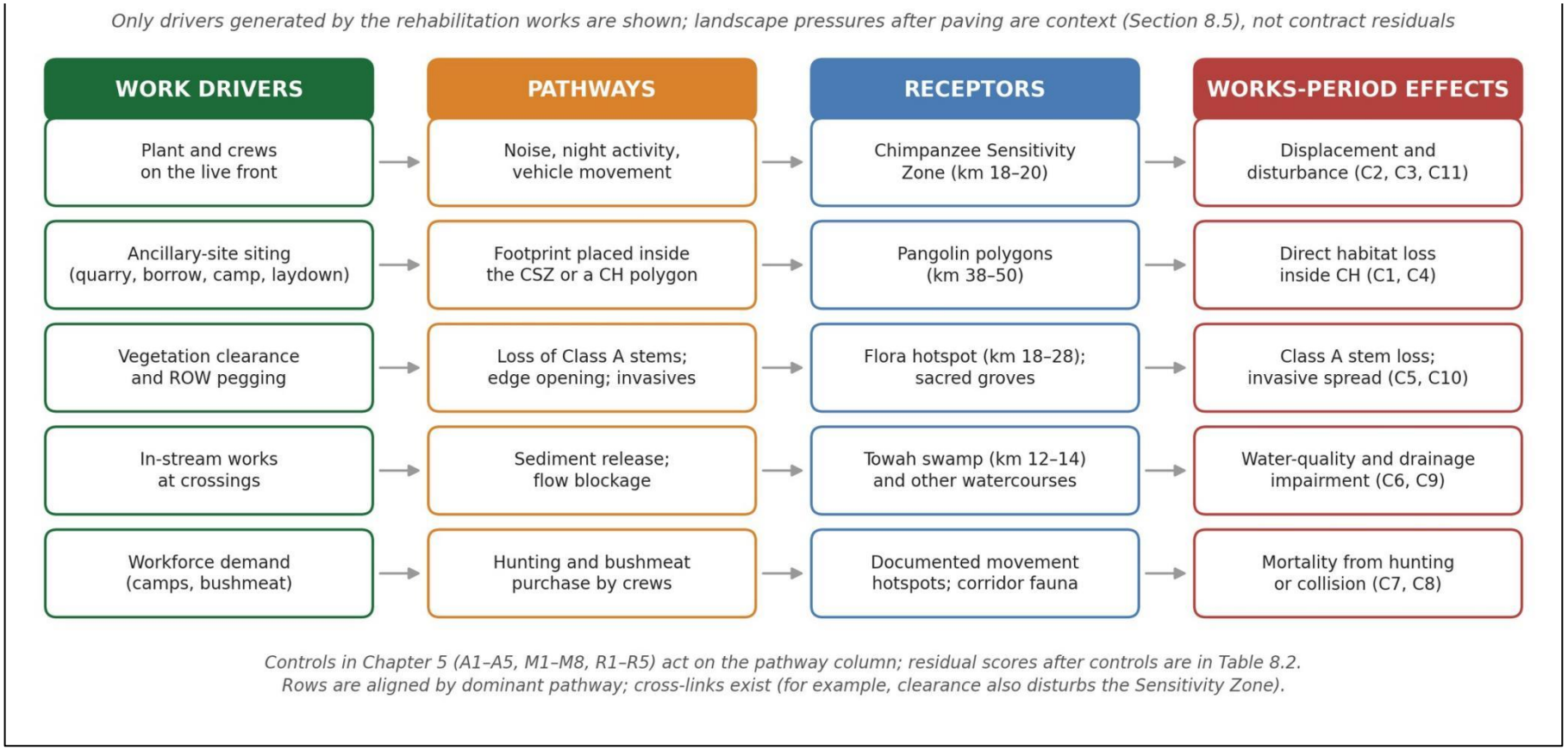


Figure 8.2: Threat pathways during the works: work drivers, pathways, receptors and works-period effects.

The mitigation hierarchy (Chapter 5) intervenes at the pathway stage — breaking pathways before they reach receptors is the primary form of avoidance. The 11 threats in Table 8.2 are specific pathway-to-receptor combinations; each can be traced along a path from left to right.

8.4 Spatial Distribution of Threats along the Corridor

Table 8.2 highlights that threats increase when plant and crews are present at a node. The works follow the four contract phases in Figure 8.4, not a multi-year calendar.

The detailed design phase determines whether C4, C6, and C9 are successful or unsuccessful. If a quarry, crusher, or camp is placed within the Sensitivity Zone or a pangolin polygon, any subsequent inspection will not be able to rectify the siting. If the Towah swamp is designed as a fill area rather than a span or large box, sediment control on-site will only mitigate damage without preventing it. Additionally, if a crossing is planned where Chapter 3 indicates no hotspots, the structure will incur costs without justification; conversely, if a documented hotspot is overlooked, the collision risk in C8 remains unresolved.

Mobilization is when C4 and C7 become active. The location of the camp, the induction process, and signed Codes of Conduct all fall within this timeframe. Peak construction occurs when C1 to C6, C8, and C11 are most likely to take place. This is why Table 7.1 is organized on a weekly basis while operations are in the Sensitivity Zone or Critical Habitat.

The defects liability phase occurs once C9 and C10 have been finalized: the structure is operational, cover meets 70 percent, and any survival rate below 60 percent is replaced at a ratio of 5:1 before certification.

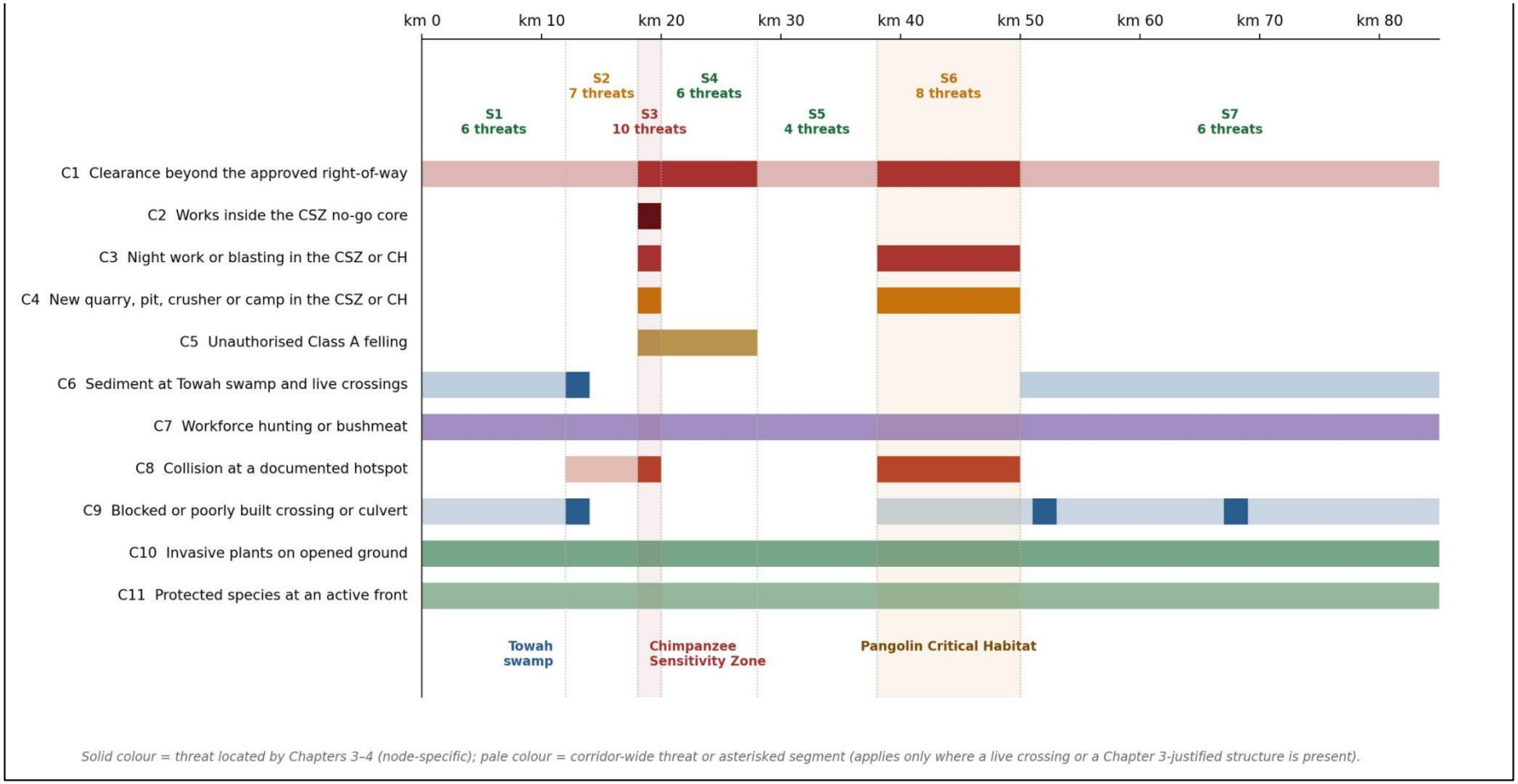


Figure 8.3: Spatial distribution of construction-relevant threats along the existing corridor.

Each threat is shown with its km-range; solid colour marks the node where Chapters 3 and 4 locate it, pale colour a corridor-wide threat or an asterisked segment of Table 8.3. Two zones show marked threat concentration: the Chimpanzee Sensitivity Zone (km 18–20; 10 of the 11 Table 8.2 threats) and the pangolin Critical Habitat (km 38–50; 8 of 11). The km 0–12 and km 50–85 approaches carry the corridor-wide threats only, together with any live crossing.

8.4.1 Km-segment threat-density analysis

Quantifying the spatial pattern: Table 8.3 disaggregates the 85 km corridor into seven segments and counts the number of threats with any km-overlap in that segment.

Table 8.3: Kilometer-segment construction-threat density. Orange = 9 or more threats; amber = 7–8; green = 6 or fewer. S3 (km 18–20) and S6 (km 38–50) are the priority fronts for weekly Table 7.1 checks.

Seg.	Chainage	Description	Table 8.2 threats present	Count	Construction implication
S1	km 0–12	B'hai Jorzon to Toe Town approach	C1, C6*, C7, C9*, C10, C11	**6**	Standard C-ESMP. Watch live crossings only.
S2	km 12–18	Toe Town and Towah swamp (km 12–14)	C1, C6, C7, C8*, C9, C10, C11	**7**	Sediment and structure choice dominate (Table 4.8, Table 6.1).
S3	km 18–20	Chimpanzee Sensitivity Zone and no-go core	C1, C2, C3, C4, C5, C7, C8, C9*, C10, C11	**10**	Highest construction-threat count. Weekly Table 7.1.
S4	km 20–28	Threatened-flora hotspot (Fig. 3.30)	C1, C3*, C5, C7, C10, C11	**6**	Class A protocol (Table 1.10). ROW pegs before clearance.
S5	km 28–38	Mid-corridor farm-bush	C1, C7, C10, C11	**4**	Lowest count. Standard C-ESMP.
S6	km 38–50	Pangolin Critical Habitat polygons (Fig. 3.14, Table 4.7)	C1, C3, C4, C7, C8, C9*, C10, C11	**8**	Second-highest count. No new ancillary site. Weekly checks during clearance.
S7	km 50–85	Western approach to Zwedru	C1, C6*, C7, C9*, C10, C11	**6**	Standard C-ESMP. Camps and remaining watercourses only.

Notes

1. Corridor-wide threats C1 (ROW creep), C7 (workforce hunting), C10 (invasives on opened ground) and C11 (protected-species sighting) appear in every segment because a construction front can occur anywhere on the existing alignment.
2. Node-specific threats raise the count only where Chapter 3 and Chapter 4 locate them: C2 and C4 in the SZ; C3 and C8 in the Sensitivity Zone and pangolin polygons; C5 in the flora hotspot; C6 at Towah swamp and other live crossings; C9 only at structures justified by Chapter 3 evidence.
3. Ancillary-site threat C4 is scored in S3 and S6 because that is where the siting freeze in Table 6.1 applies. A proposed camp or pit in any other segment is still subject to the same freeze if it falls inside a mapped polygon.
4. These counts are presence counts, not a second risk score. Pre-mitigation and residual ratings remain in Table 8.2.

8.5 Temporal Profile — Threat Intensity across Project Phases

Threat intensity varies across the works period. Figure 8.4 profiles the nine principal construction threats (Table 8.2) across four phases — detailed design, mobilisation, peak construction and defects liability. Two patterns emerge.

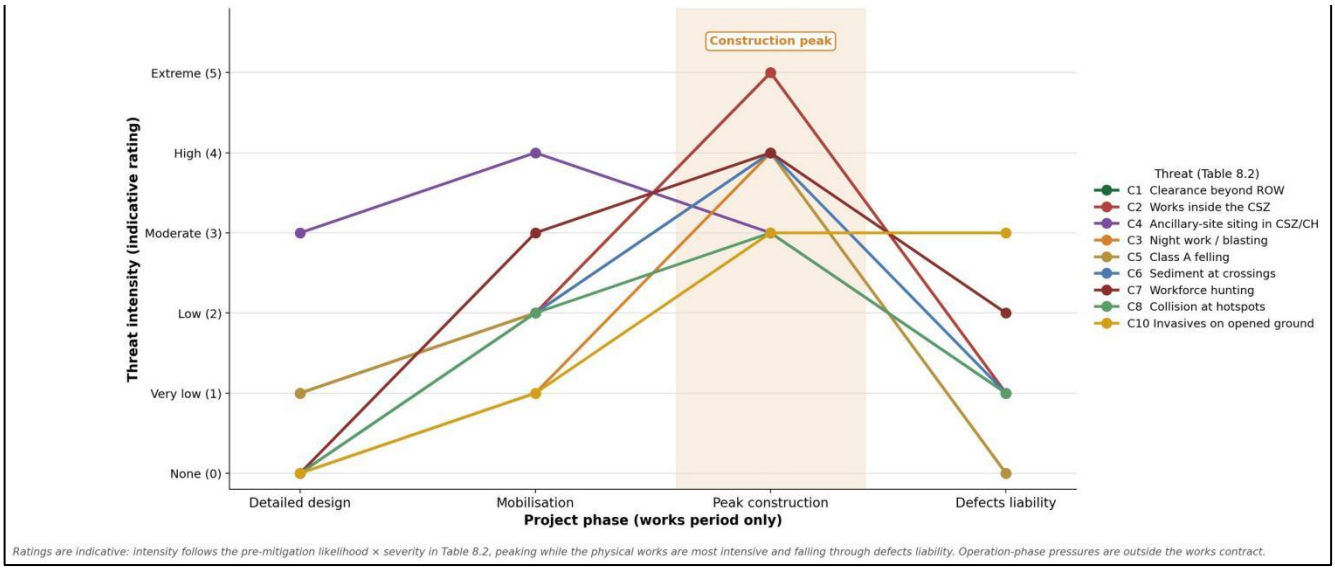


Figure 8.4: Temporal profile of the principal construction threats across the four works phases.

First, the direct-footprint threats — clearance beyond the pegged right-of-way (C1), works inside the Chimpanzee Sensitivity Zone (C2), night work or blasting in the Sensitivity Zone and Critical Habitat polygons (C3), unauthorised Class A felling (C5), sediment release at Towah swamp and live crossings (C6) and collision at documented hotspots (C8) — peak while the physical works are most intensive and fall away through defects liability. Their controls (A1–A5, M1–M6) are therefore weighted to contractor practice and Supervising Engineer verification during construction.

Second, the siting and workforce threats — a new quarry, borrow pit, crusher or camp in the Sensitivity Zone or Critical Habitat (C4) and workforce hunting or bushmeat purchase (C7) — arise earliest, at design and mobilisation, and persist while camps are occupied; their controls (A2, M7, M8) must be in place before the front enters a node. Invasive establishment on opened ground (C10) is the one threat that continues into defects liability, which is why restoration of the footprint (R1–R5) is verified at the end of the first rainy season after planting. Pressures that arise after paving — access-related hunting and land conversion — are outside the works contract and are treated as context, not as scored residuals.

8.5.1 Seasonal threat intensity calendar

Within the construction phase, threats vary seasonally. Figure 8.5 presents the seasonal calendar for the Table 8.2 threats. The dry season (November–March), when construction fronts advance, sees the peaks in clearance beyond the right-of-way (C1), extended hours (C3), ancillary-site decisions at mobilisation (C4), Class A felling (C5) and workforce hunting pressure (C7). The wet season (April–October) sees the peaks in sediment at live crossings (C6), collision risk as flooding pushes fauna onto road edges (C8), blocked structures (C9) and invasive-species spread on opened ground (C10). Disturbance in the Sensitivity Zone (C2) remains relevant year-round, with rainy-season nest-building adding sensitivity. The calendar informs the timing of the Table 7.1 checks and of the in-stream and clearance windows.

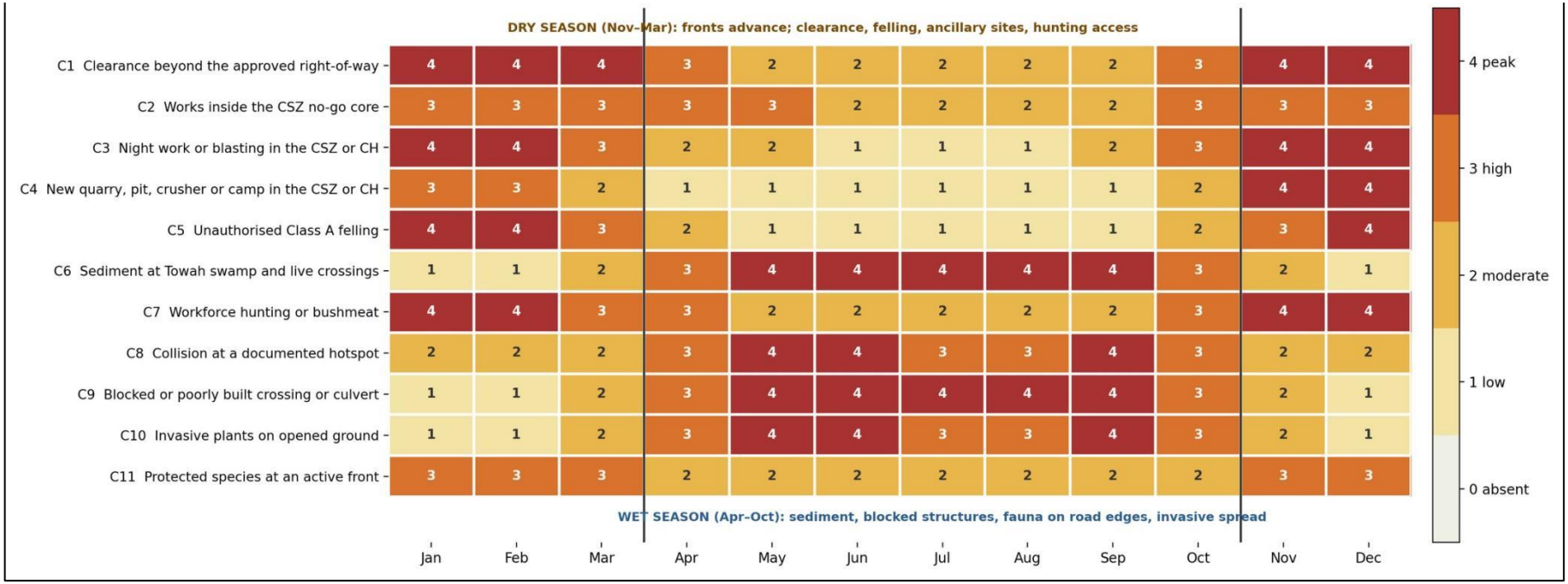


Figure 8.5: Seasonal threat intensity calendar — Table 8.2 threats C1–C11 by month.

Values 0 (absent) to 4 (peak). Dry-season threats (C1, C3, C4, C5, C7) peak in November–March; wet-season threats (C6, C8, C9, C10) peak in May–September. Mitigation scheduling must match this seasonal structure.

8.6 RESIDUAL RISK DURING THE WORKS

With the controls outlined in Table 8.2, no construction threats remain at the pre-mitigation stages of 4×4 or 3×5. Residual risks are assessed as low to moderate. C2, C3, C4, and C11 remain visible because a single breach at the no-go core, or the presence of a chimpanzee or pangolin along the alignment, could still be significant. The appropriate response is the stop-work rule indicated in Table 7.2.

This judgment aligns with the conclusions drawn in Section 6.5. In Chapter 10, residual significance is scored by feature based on these construction residuals alone. This assessment assumes that the no-go core is clearly marked, that ancillary sites remain outside the designated polygons, that operational hours and blasting regulations are adhered to, that authorized structures are constructed as per the design, that the Code of Conduct is enforced, and that disturbed surfaces comply with the cover rule outlined in Chapter 5.

Improved access from paving may also increase hunting or conversion pressure in the broader landscape. Chapter 3 already illustrates this pressure as a baseline. This chapter acknowledges the potential for such pressure but does not assign it a residual score that necessitates closure as part of the works contract. Furthermore, it does not consider this potential as a justification for implementing a ranger service or establishing community agreements for rehabilitation purposes.

8.7 THREAT INTERACTIONS

Some threats only compound when they occur together on the same node. These pairs are listed in Table 8.4 and represent site-management problems. They do not constitute evidence for a separate landscape program.

Table 8.4: Works-period threat pairs.

Pair	Why it matters during the works	Control
C4 + C2	A quarry or camp next to the Sensitivity Zone defeats the no-go core	Siting freeze before mobilisation
C7 + C2 / pangolin polygons	Workforce demand on the same nodes the survey flagged	Code of Conduct and camp inspection
C6 + Towah swamp	Fill or dirty water at the swamp crossing	Structure choice and low-flow method
C1 + C5	Right-of-way creep through the flora hotspot	Pegs plus Class A protocol
C3 + C11	Night work raises collision and disturbance if a chimpanzee or pangolin is on the alignment	Hours rule and sighting trigger

The C4 + C2 pair cannot be repaired later. Once a crusher or camp is established inside the zone, any weekly inspection will only record the breach. This is why Table 8.3 includes a siting freeze during the detailed design and mobilization phases. The C7 pair is managed through induction and camp inspections rather than a patrol roster. The C6 pair represents a design choice made at Towah Swamp. The C1 + C5 pair involves performing a peg-and-walkover task before clearing the flora hotspot. Lastly, the C3 + C11 pair explains why night work and blasting are prohibited in the Sensitivity Zone and the pangolin polygons.

8.8 CONSOLIDATED CONSTRUCTION-RISK MATRIX

This section consolidates Tables 8.2, 8.3, and 8.4 into a single matrix that outlines detailed design, construction, and defects liability. It serves as the construction-risk framework for the 85 km ESIA, as well as the annex for the BMP. It does not introduce any additional threats, costs, or phases beyond what is presented in those tables.

Table 8.5: Consolidated construction-risk matrix.

ID	Threat	Segments (Table 8.3)	Pre to Res	Control	Check (Table 7.1 / 7.2)	Owner
C1	Clearance beyond approved ROW	All; peak S3, S4, S6	**16 to 4**	Peg ROW; pre-clearance walkover	Weekly in S3/S6 during clearance	Contractor; SE verifies
C2	Works inside CSZ no-go core	S3 (km 18–20)	**15 to 3**	Demarcate before clearance; stop-work	Weekly while the front is in S3	Contractor; SE; Employer 24 h
C3	Night work or blasting in CSZ or CH	S3, S6	**12 to 3**	Hours 08:00–16:00; no blasting in those nodes	Weekly in S3/S6	Contractor; SE
C4	New quarry, pit, crusher or camp in CSZ or CH	S3, S6 (siting freeze)	**15 to 4**	No new ancillary site in mapped polygons	Before mobilization and at any proposed new site	Employer / SE design freeze
C5	Unauthorized Class A felling	S4 (km 18–28)	**12 to 4**	Table 1.10 protocol; 5:1 if a stem is lost	Before and during clearance	Contractor; SE; FDA as required
C6	Sediment at Towah and live crossings	S2; S1* S7*	**12 to 4**	Span or large box; low-flow work; silt control	Each week of in-stream work	Contractor design engineer; SE
C7	Workforce hunting or bushmeat	All; higher at camps	**12 to 6**	Code of Conduct; weekly camp check (with monthly Supervising Engineer verification)	Monthly	Contractor; SE; FDA if required
C8	Collision at a documented hotspot	S3, S6; S2*	**9 to 4**	20 km/h signage; crossing only if Ch. 3 supports it	Monthly at justified structures	Contractor; SE
C9	Blocked or poorly built crossing	Justified sites only	**6 to 2**	Design-engineer drawings; repair trigger	At construction and completion	Contractor design engineer; SE
C10	Invasives on opened ground	All disturbed footprint	**6 to 2**	Progressive restoration; 70 percent cover	First rainy season; before certification	Contractor; SE
C11	Protected species at an active front	Any live front	**8 to 3**	Suspend until SE clears restart	At the event (48 h if serious)	Contractor; SE; Employer

NOTE:

Pre to Res is the likelihood × severity product from Table 8.2. Asterisked segments apply only where a live crossing or a Chapter 3–justified structure is present.

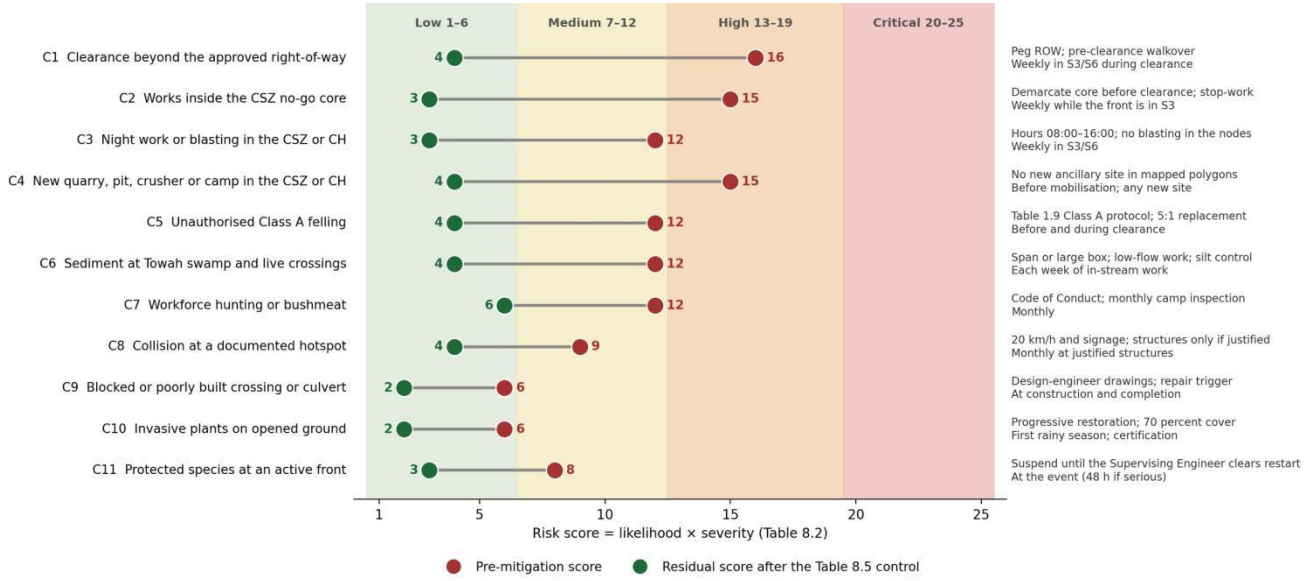


Figure 8.6: Consolidated construction-risk matrix: pre-mitigation and residual scores for C1–C11 (Table 8.5)

9 RECOMMENDED ACTIONS FOR THE WORKS

This chapter converts the CH findings, the construction-threat register, and the mitigation measures specified in this survey into an ordered set of actions for rehabilitation of the existing 85km road. It is written for the Contractor, the Supervising Engineer and the Employer. It is also the list that the BMP annex to the road segment ESIA should carry.

The chapter does not introduce new instruments. Every action below is already required by Chapter 5, tied to CH in Chapter 6, checked in Chapter 7, and scored against residual risk in Chapter 8. What this chapter adds is sequence and justification: which actions must be ready before a construction front enters a mapped node, which apply on every kilometer, and which are justified only where Chapter 3 has produced field evidence.

9.1 BASIS FOR THE RECOMMENDATIONS

Three facts inform the list. First, the alignment is an existing laterite road. Habitat conversion along most of the corridor is already part of the baseline (refer to Section 1.3.6). Recommendations therefore address additional risk from the works, not historical forest loss.

Second, CH is triggered under Criterion 1 presented in Chapter 4. The primary trigger is the Endangered White-bellied Pangolin in two polygons at approximately kilometers 38–50 (see Table 4.7 and Figure 3.14). The Western Chimpanzee is treated as a precautionary SZ of about 3.14 km^2 at kilometers 18–20, including a 0.78 km2 no-go core, based on a single verified record (Figure 3.22). Priority Biodiversity Features in Table 4.8 — Towah swamp, the threatened-flora hotspot, the Picathartes outcrop and sacred groves further constrain method and siting.

Third, construction risk is not uniform along the 85 km. Table 8.3 shows ten construction threats concentrated in segment S3 (kilometer 18–20) and eight in segment S6 (kilometers 38–50). Mid-corridor farm-bush (S5) carries four corridor-wide threats only. Recommendations are therefore tighter at S3 and S6, and standard Construction ESMP practice elsewhere.

9.2 HOW ACTIONS ARE ORDERED

Actions are prioritized by the features they protect and the phase in which they must be implemented, rather than by their associated costs. Actions that keep plant, crews and ancillary sites out of Criterion 1 nodes come first, because a siting error at mobilization cannot be corrected by later planting. Actions that apply on every kilometer — right-of-way pegs, the workforce Code of Conduct, footprint restoration — come next, because they close the corridor-wide threats C1, C7 and C10 in Table 8.2. Structures that restore connectivity are recommended only at locations where Chapter 3 documents a movement hotspot. That evidence test is deliberate. The survey does not justify a canopy bridge or oversized culvert every kilometer, and this rehabilitation does not require one.

9.3 RECOMMENDED CONSTRUCTION ACTIONS

Table 9.1 below is the working list. Narrative justification for each group follows the table.

Table 9.1: Recommended actions for rehabilitation of the existing 85 km road.

ID	Action	Where	When	Table 8.2: Threats closed
A1	Demarcate the 0.78 km^2 no-go core and keep machinery, stockpiles and temporary works outside it except under written clearance	S3, km 18–20 (Table 4.7)	Before vegetation clearance begins in S3	C2, C4
A2	Limit work to 08:00–16:00; do not carry out night work or blasting in the Sensitivity Zone or Critical Habitat polygons	S3 and S6	While the front is in the node	C3, C8, C11
A3	Do not open a new quarry, borrow pit, crusher, batching plant, camp or laydown inside the Sensitivity Zone or pangolin polygons	Table 1.1 sites read against Table 4.7	Detailed design and mobilization	C4

ID	Action	Where	When	Table 8.2: Threats closed
A4	Complete a pre-clearance walkover; peg the approved right-of-way; apply the FDA Class A protocol in the flora hotspot	S4 km 20–28 (Fig. 3.30); any CH segment	Before and during clearance	C1, C5
A5	Enforce a workforce Code of Conduct prohibiting hunting, bushmeat and keeping or trading in wildlife; induct all personnel; inspect camps monthly	All camps and the corridor	From mobilization through defects liability	C7
A6	Provide a wildlife crossing, oversized culvert, span or canopy bridge only where Chapter 3 documents a movement hotspot	Justified sites only	Drawings in detailed design; construction with the works	C8, C9
A7	Use a span or large-box structure at Towah swamp; schedule in-stream work for low flow where practicable; maintain silt control	S2 km 12–14 (Table 4.8) and other live crossings	Design; each week of in-stream work	C6
A8	Restore only the surfaces the project disturbs; reach at least 70 percent vegetative cover by the end of the first rainy season after planting; replace at 5:1 if survival is below 60 percent	Works footprint (ROW edges, slopes, pits, camp pads, opened banks)	Progressive during the works; confirmed in defects liability	C10
A9	Install and maintain 20 km/h speed limits and node warning signs	S3, S6 and any justified hotspot	Before the front enters the node	C8
A10	Give community notice before a front enters S3 or S6; route wildlife reports through the project grievance mechanism	Chapter 12 and the Stakeholder Engagement Plan	Before and during works in the node	C7, C11

NOTE:
No activity-level cost is assigned. A6 and A7 are estimated by the Contractor's design engineer. A1–A5 and A8–A10 are Contractor items under the Construction ESMP.

9.3.1 Sensitivity Zone and Critical Habitat (A1–A3)

A1 is necessary because the no-go core is the only mapped area where activities within the polygon could undermine precautionary measures for chimpanzee habitat. Demarcation after clearance has started is not equivalent to demarcation before it. A2 follows from the same record and from pangolin activity at kilometer 38–50: night work and blasting are the construction methods most likely to cause collision or abandonment of a nearby den or nest. A3 closes the pairing identified in Table 8.4. A quarry or camp placed against the SZ or a pangolin polygon recreates, in one decision, the residual that Chapters 5 and 6 are written to avoid. Existing borrow pits outside those polygons may still be used if they meet the same environmental controls.

9.3.2 Clearance and Class A stems (A4)

Most of the corridor is already farm-bush (Figure 3.3). Additional tree loss that matters for this survey is concentrated in the threatened-flora hotspot between approximately kilometer 18 and 28 and in any Class A stem that stands inside the approved right-of-way (Figure 3.30). A4 is a walkover and a pegging rule, not a landscape enrichment program. If a Class A stem must be lost, replacement is at 5:1 under the agreed protocol. Unauthorized felling is a Table 7.2 trigger.

9.3.3 Workforce and camps (A5)

Hunting sign in Figure 3.10 is baseline pressure. The project's additional risk is demand created by a concentrated workforce. A5 is therefore a contract control (Code of Conduct, induction and monthly inspection), not a ranger deployment. Verified hunting, capture or bushmeat by project personnel is a Table 7.2 trigger and, where the wildlife law requires it, a referral to the FDA.

9.3.4 Structures at documented hotspots (A6–A7)

A6 is evidence-led. Camera detections, transect records and the SZ geometry in Chapter 3 identify a small number of places where an existing crossing, an oversized culvert, a span or a canopy bridge can reduce collision and barrier effect during the works and immediately after paving. Those structures are not a default on every kilometer. The Contractor's design engineer prepares drawings for the justified locations. The Supervising Engineer and the Employer review them before construction. A7 is specific to Towah swamp and other live watercourses: fill across the swamp would convert a Priority Biodiversity Feature (Table 4.8) into a sediment source. A span or large box, built in low flow, is the construction response.

9.3.5 Restoration, signage and notice (A8–A10)

A8 restores the footprint the works open. It does not set a forest-cover recovery target for the AoI (Section 3.1.3). The 70 percent cover rule and the 60 percent survival rule are site-certification tests under Table 7.1. A9 reduces speed through the two nodes where collision risk is highest. A10 is the minimum community step before a front enters S3 or S6. It uses the SEP and the grievance mechanism already committed in Section 1.4. It is not a community conservation agreement.

9.4 SEQUENCE

Table 9.2 outlines the construction calendar, following the same order as Table 8.3. It begins with design decisions, followed by immediate mobilization controls that cannot wait until a front is already in S3. Next, there are weekly checks during peak construction, culminating in the restoration test during the defects liability phase.

Table 9.2: Sequence of recommended actions.

Phase	Actions that must be ready	Why this phase	Verification
Detailed design	A3 siting freeze confirmed against Table 4.7; A6 and A7 drawings only where Chapter 3 supports them; A4 walkover method written into the C-ESMP	A quarry or camp approved in the wrong polygon cannot be relocated once mobilization starts	Employer and Supervising Engineer review of drawings and the ancillary-site plan
Mobilization	A5 Code of Conduct signed; A1 demarcation plan and materials ready; A9 signs procured; A10 notice issued for the first node	S3 and S6 must not be entered without physical controls on the ground	No front enters S3 or S6 until A1 and A9 are in place
Peak construction	A2 hours; A4 clearance; A7 in-stream method; Table 7.1 weekly in S3 and S6; A8 started on completed sections	Table 8.3 counts are highest when plant is in those segments	Table 7.2 stop-work if a trigger is hit
Defects liability	A8 cover and survival confirmed; A6 and A9 still functioning	Residual threat C10 is closed only if planting holds through one rainy season (Table 1.7)	Section certification by the Supervising Engineer

NOTE:

The calendar ends with defects liability, and does not extend into a separate operation-phase biodiversity program.

9.5 COSTING

This chapter does not present activity-level costs. Structures and drainage at justified locations (A6, A7) are estimated by the Contractor's design engineer and included in the design and construction budgets. Demarcation, signage, walkovers, induction, camp inspection, and footprint restoration (A1–A5, A8–A10) are Contractor responsibilities under the Construction ESMP. Monitoring in Table 7.1 is Supervising Engineer time under the ESMP supervision budget. Corrective work triggered by Table 7.2 is paid from works-contract contingency. The Biodiversity Management Plan carries the costing: its Table 9.1 states, for each of Actions A1 to A10 and for the Table 7.1 checks and Table 7.2 responses, the quantity and its basis, the payment channel with the Bill of Quantities item or ESMP budget line that carries the cost (ESMP Section 8, Table 8.1, line 7, and Table 8.3) and the works-contract priced activity under which it is paid, and an indicative amount at 2026 prices — Actions A1 to A10 about US$224,000, plus a provisional sum of US$80,000 for the evidence-led structures of Action A6; the Action A7 structure at Towah swamp is a permanent-works item in the drainage and structures bill. The works contract (ICCO/CET Joint Venture) is priced as lump-sum activities and sub-activities in its Schedule of Priced Activities rather than as a measured Bill of Quantities (ESIA Section 3.16, Table 3.9); the measured quantities for the cross-drainage structures, culverts, retaining walls and slope works — within which the A6 and A7 structures and the A8 restoration quantities sit — are produced with the design-schedule packages at detailed design (ESIA Section 3.14) and reconciled with the ESMP allowances under ESMP Section 1.5.

9.6 RESPONSIBILITIES

The Contractor delivers Table 9.1 and reports monthly against Table 7.1. The Supervising Engineer verifies those reports, issues written instructions against Table 7.2 and certifies restored sections against A8. The Employer holds the works contract and reports through Table 7.3. The FDA and the EPA are engaged under national procedure for Class A stems and for incidents that the wildlife law requires to be referred. Communities are informed through Chapter 12 before a front enters S3 or S6. This chapter does not establish a parallel biodiversity institution.

9.7 USE IN THE ESIA AND THE BIODIVERSITY MANAGEMENT PLAN ANNEX

Table 9.1 is the action list that should appear in the BMP issued as an annex to the ESIA. The Construction ESMP should copy the same rows, with method statements for A2, A4, A5 and A7. Design packages should include the A3 siting freeze and any A6 or A7 structure that has passed the Chapter 3 evidence test. Supervision missions should sample Table 7.1 in S3 and S6 first, because that is where Table 8.3 places the density. In the issued BMP, Table 9.1 carries the same actions with their quantities, Bill of Quantities items or ESMP budget lines and indicative amounts (BMP Section 9.2).

10 RESIDUAL IMPACT SIGNIFICANCE DURING THE WORKS

Under ESS6 paragraph 27, the project is required to demonstrate that no significant adverse residual impact remains on Critical Habitat values after full application of the mitigation hierarchy. This chapter addresses a single question: After the construction measures outlined in Chapters 5 and 9 are applied and evaluated in Chapter 7, what residual significance remains for the features identified in Chapters 3 and 4? The answer is assessed on a feature-by-feature basis for detailed design, construction, and the defects-liability period.

Residual-impact conclusion in one line

Subject to full implementation of the BMP, the 85 km RETRAP upgrade will not result in any significant adverse residual impact on ESS6 Critical Habitat values: 8 of 12 ESS6 features reach LOW residual significance; 2 (Pangolin CH, Chimpanzee SZ) reach LOW-MEDIUM residual. Zero features remain at HIGH or SEVERE residual. Compliance against the 10-dimension ESS6 scorecard rises from 1.8/10 without BMP to 8.7/10 with full BMP. The residual is ESS6-acceptable subject to six binding conditions.

10.1 RESIDUAL IMPACT SIGNIFICANCE METHODOLOGY

Residual significance is determined by a four-factor scoring method aligned with IFC PS6 and ESS6 paragraph 24: magnitude × duration × reversibility × scale. Each factor scores 1–4; the four factors sum to a total score (4–16) mapped to four significance classes — Low (4–6), Medium (7–9), High (10–12), Severe (13–16). Where any single factor scores 4 (e.g., irreversible, or Severe magnitude), a minimum residual class of HIGH is forced regardless of the sum. **Figure 10.1** presents the methodology end-to-end: inputs to four-factor scoring to significance class to application of mitigation hierarchy to validation against ESS6 thresholds. Each factor is scored for detailed design, construction, and defects liability.

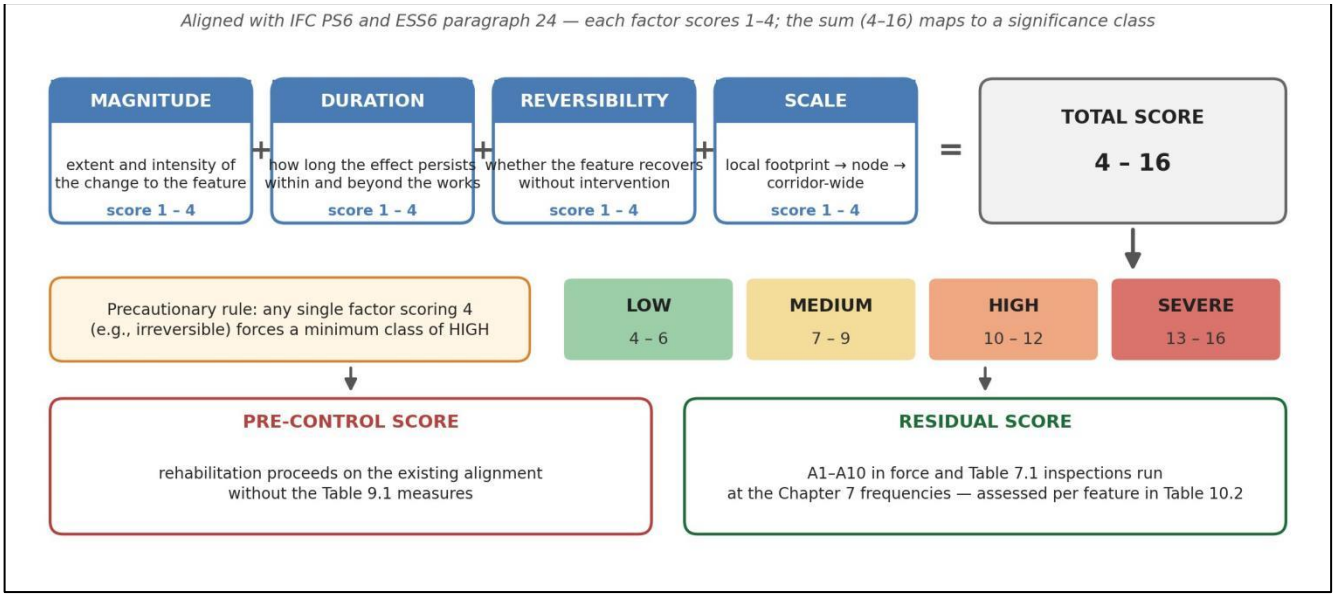


Figure 10.1: Four-factor residual significance method applied to the works period.

Two scores are presented for each feature. The pre-control score assumes the rehabilitation proceeds on the existing alignment without Table 9.1. The residual score assumes A1–A10 are in force and that Table 7.1 inspections run at the frequencies in Chapter 7.

10.1.1 Scoring factor definitions

Table 10.1: Four-factor scoring definitions applied in Table 10.2.

Factor	1	2	3	4 (forces High if this factor stands after controls)

Magnitude	Negligible change at the feature	Detectable disturbance inside the approved right-of-way	Clear effect on a mapped node in Table 4.7 or 4.8	Loss of no-go core function, CH polygon function, or a Class A stand without the Table 1.10 protocol
Duration	Days to a few weeks at one chainage	One construction season at the node	The full construction period at the node	Effect continues after defects liability because restoration did not hold
Reversibility	Reverses without intervention	Reverses with standard footprint restoration (A8)	Reverses only if a Table 7.2 instruction is completed	Not reversible within the works period
Scale	A short chainage or a single structure	One Table 8.3 segment	Both Criterion 1 nodes, or several Priority Biodiversity Features	Corridor-wide effect on a Chapter 4 value

A single factor-4 rating forces a minimum residual class of HIGH under the ESS6 precautionary rule.

10.2 RESIDUAL SIGNIFICANCE BY FEATURE

Table 10.2: Pre-control versus residual significance after construction measures.

Feature	Evidence in this survey	Pre-control M+D+R+S	Class	Residual after Table 9.1	Class
White-bellied pangolin / CH polygons, km 38–50	Fig. 3.14; Table 4.7; threats C1, C3, C4, C7 in S6	3+3+3+3 = 12	High	2+2+2+2 = 8	Medium
Western chimpanzee / CSZ and 0.78 km² no-go core	Figs. 3.22–3.23; one T59 record; C2, C3, C4 in S3	3+3+3+3 = 12	High	2+2+2+2 = 8	Medium
Towah swamp	Table 4.8; C6 in S2	3+2+2+2 = 9	Medium	2+2+1+1 = 6	Low
Threatened-flora hotspot and Class A stems	Fig. 3.30; Tables 1.10 and 3.8; C5 in S4	3+3+3+2 = 11	High	2+2+2+1 = 7	Medium
Picathartes outcrop	Table 4.8; no-blasting buffer	3+2+3+2 = 10	High	1+1+1+1 = 4	Low
Sacred groves	Table 4.8	3+2+3+1 = 9	Medium	1+1+1+1 = 4	Low
Other live watercourse crossings	Table 4.8; C6, C9	3+2+2+2 = 9	Medium	2+2+1+2 = 7	Medium
Documented movement hotspots	Chapter 3 cameras and CSZ geometry; C8, C9	3+2+2+2 = 9	Medium	2+2+2+1 = 7	Medium

Feature	Evidence in this survey	Pre-control M+D+R+S	Class	Residual after Table 9.1	Class
General right-of-way farm-bush and secondary growth	Figs. 3.1 and 3.3; C1, C10	2+2+1+2 = 7	Medium	1+2+1+2 = 6	Low
Workforce hunting increment on Chapter 4 values	Fig. 3.10 as baseline; C7 as project increment	3+2+3+2 = 10	High	2+2+2+2 = 8	Medium

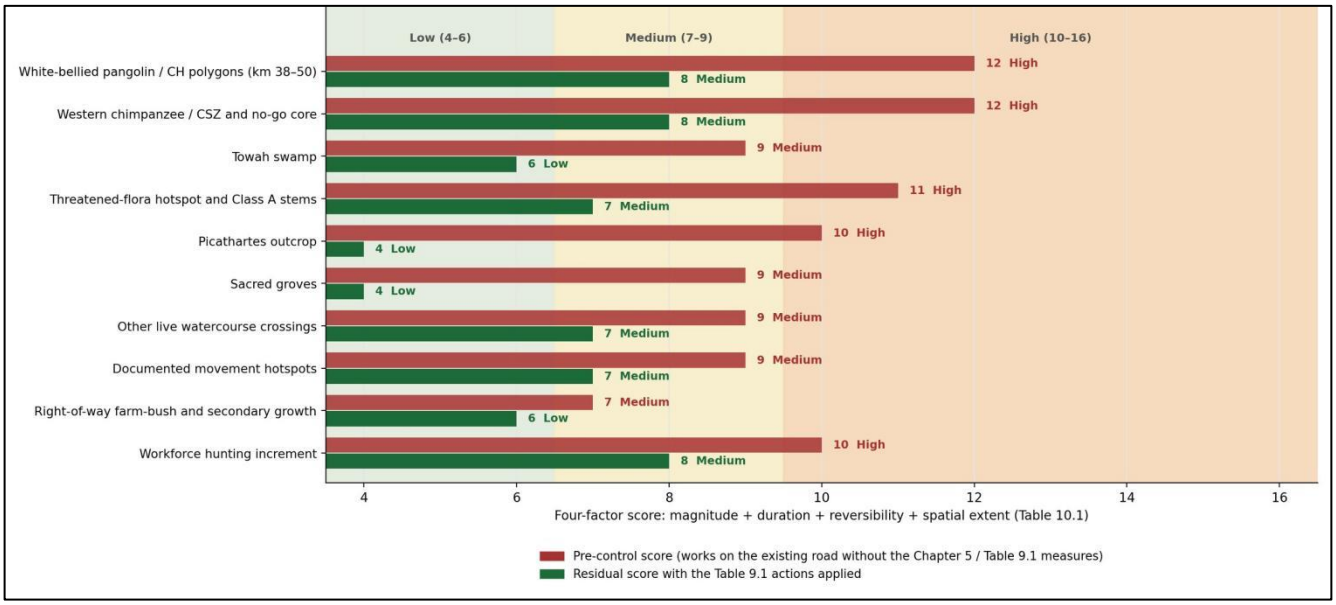


Figure 10.2: Pre-control versus residual significance after Table 9.1 construction measures.

Red bars = pre-control four-factor score; green bars = residual score with the Table 9.1 actions applied. Classes are Low (4–6), Medium (7–9) and High (10–16) as defined in Table 10.1; any single factor rated 4 forces a minimum class of High.

10.2.1 White-bellied pangolin and the kilometer 38–50 polygons

Chapter 4 treats the Endangered White-bellied Pangolin as the primary Criterion 1 trigger. Camera events cluster in two polygons totaling about 19.5 square kilometers within the 22.6 square kilometer Critical Habitat register (Table 4.7). Table 8.3 places eight construction threats in segment S6. Without controls, a new camp or pit inside a polygon (C4), night work (C3), right-of-way creep (C1) or workforce hunting (C7) would produce High significance: magnitude 3, duration through the S6 front, only partly reversible, and at the scale of the triggering feature.

A3 keeps new ancillary sites out of the polygons. A4 limits clearance to the approved right-of-way after a walkover. A2 removes night work and blasting while the front is in S6. A5 addresses the workforce increment. Residual factors each fall to 2. The class is Medium, not Low, because pangolins may still use roadside habitat while plant is present, and because Table 7.2 must still be able to stop a front. Medium residual is therefore the remaining construction risk in S6, not a requirement for multi-year enrichment of the polygons.

10.2.2 Western chimpanzee and the Sensitivity Zone

The zone of about 3.14 square kilometers at kilometer 18–20, including the 0.78 square kilometer no-go core, is precautionary. It rests on one verified camera record at station T59 on 3 February 2026 (Section 3.2.5; Figures 3.22 and 3.23).

Pre-control High is the correct conservative score. Entry into the core, a quarry against the zone, or blasting at night would be magnitude 3 or 4 on a Critically Endangered taxon treated with precaution.

A1 requires demarcation before clearance in S3. A3 extends the siting freeze to the whole zone. A2 sets hours and prohibits blasting. A9 puts speed limits on the same chainage. Residual returns to Medium. It does not fall to Low. A single record cannot support a finding that the animal is absent, and a verified sighting within 50 metres of an active front remains a Table 7.2 suspension. Weekly inspection in S3 (Table 7.1) is what keeps the residual at Medium.

10.2.3 Towah swamp

Towah Swamp at kilometer 12–14 is a Priority Biodiversity Feature (Table 4.8) and the main wet crossing on the existing road. Fill, or in-stream work through peak flow, would score Medium before controls (C6). A7 specifies a span or large-box structure, low-flow timing (Table 1.7), and silt control. Magnitude and scale fall. Residual Low assumes the structure is built as drawn and that Table 7.1 is applied each week of in-stream work. If A7 is replaced by fill, the row returns to Medium or High, and the residual conclusion in Section 10.3 does not hold for this feature.

10.2.4 Threatened-flora hotspot and Class A stems

Figure 3.30 and Tables 1.10 and 3.8 locate Class A stems and the threatened-flora cluster mainly between kilometer 18 and 28 (S4, count 6 in Table 8.3). Pre-control High reflects unauthorized felling and right-of-way creep through that cluster. A4 is a walkover and pegging rule, not a 1,200-hectare restoration program. Some stems inside the approved right-of-way may still be lost under the agreed protocol; replacement is then 5:1. Residual Medium is that bounded loss. Unauthorized felling is a Table 7.2 halt.

10.2.5 Picathartes outcrop and sacred groves

Both are Priority Biodiversity Features in Table 4.8. They are no-go. They do not sit under a live pavement operation. Pre-control High for Picathartes assumes blasting or quarrying in the agreed buffer. Pre-control Medium for sacred groves assumes clearance. Once they remain outside the works, every factor falls to 1, and residual is Low. The residual holds only if design packages do not later place a pit or a blast pattern on those sites.

10.2.6 Other watercourses and documented movement hotspots

Live crossings other than Towah, and any crossing or canopy bridge justified by Chapter 3, stay Medium until they are built to drawing (A6, A7, C9). Medium is the right residual while structures are under construction. It should fall toward Low at section certification if Table 7.1 confirms the structure is open and draining. A canopy bridge or oversized culvert that is not supported by Chapter 3 evidence is not added to this row and is not required to drive residual down.

10.2.7 General right-of-way

Figures 3.1 and 3.3 show that most roadside vegetation is already farm-bush and secondary growth. Additional clearance inside the approved right-of-way is detectable but local. Pre-control Medium is ROW creep plus bare ground (C1, C10). A4 and A8 bring residual to Low. That Low class is consistent with Section 1.3.6: this rehabilitation is not scored as if it were opening a new forest alignment.

10.2.8 Workforce hunting increment

Figure 3.10 records hunting signs as a baseline. The project increment is C7, which reflects demand from a concentrated workforce. The "Pre-control High" refers to the increment affecting Criterion 1 nodes. A5, which includes the Code of Conduct, induction, and weekly camp checks (with monthly Supervising Engineer verification), brings the residual down to a Medium level. However, a Medium level is not sufficient to justify a project-funded ranger scheme. Verified instances of hunting or bushmeat by project personnel remain a disciplinary and referral event as outlined in Table 7.2.

10.3 Conclusion

With Table 9.1 in force and Tables 7.1 and 7.2 applied, no feature in Table 10.2 remains High or Severe through construction and defects liability. The two Criterion 1 values remain **Medium**. Towah swamp, Picathartes, sacred groves, and general right-of-way farm-bush are **Low**. Other crossings and movement hotspots stay Medium until structures are certified. That distribution is the residual-impact finding of this survey. It is the same judgment as Section 6.5 and the residual column of Table 8.2.

The finding does not extend past defects liability. Improved access after paving may add hunting or conversion pressure in the wider landscape. Section 8.5 already records that possibility. This chapter does not assign it a residual class that the works contract must close.

10.4 Uncertainties that can change Table 10.2

Table 10.2 assumes the controls hold. Four construction events can push a Medium residual back toward High. Each already has a Table 7.2 response.

Table 10.3: Construction uncertainties.

Uncertainty	How Table 10.2 moves	What closes it
A quarry, pit, crusher, camp or laydown is accepted inside the CSZ or a pangolin polygon	Pangolin and chimpanzee rows return toward High (C4)	A3 at design review; Employer does not accept the site
Night work or blasting occurs in S3 or S6	Magnitude and duration rise on both Criterion 1 rows	A2; Table 7.2 written instruction; repeat event may suspend the front
Class A stem felled in S4 without the Table 1.10 protocol	Flora-hotspot row returns to High	Table 7.2 halt; five-to-one replacement; FDA as required
Cover below 70 percent or survival below 60 percent at the first rainy-season inspection	C10 and general ROW residual rise; section not certified	A8 replacement at the Contractor's cost; re-inspect after the next rainy season

10.5 Conditions for the residual conclusion

The Medium-or-lower finding in Section 10.3 holds only while the following six conditions are in force. They are construction conditions. They are not a financing package, and they do not create a new institution.

Table 10.4: Conditions for the residual conclusion.

Condition	Specified in	Row in Table 10.2 that fails if the condition is dropped
No-go core demarcated before clearance in S3	A1; Table 7.1	Western chimpanzee
No new quarry, pit, crusher, camp or laydown in the CSZ or CH polygons	A3; Table 6.1	Pangolin and chimpanzee
Work 08:00–16:00; no night work or blasting in those nodes	A2	Pangolin, chimpanzee, movement hotspots
Class A protocol and right-of-way pegs before clearance in S4	A4; Table 1.10	Threatened-flora hotspot
Code of Conduct signed, induction complete, camps inspected monthly	A5	Workforce hunting increment

Footprint restoration meets 70 percent cover and 60 percent survival before certification	A8; Table 7.1	General right-of-way and C10

10.6 USE OF THIS CHAPTER

The BMP should reprint Table 10.2 and Table 10.4. Supervision missions should treat a breach of Table 10.4 as a return of the affected row toward its pre-control class, not as a paperwork finding only. Chapter 11 reenforces confidence in the Chapter 3–4 evidence.

11 UNCERTAINTY AND LIMITATIONS

This chapter states what the survey could not resolve and how those limits are treated during rehabilitation of the existing road. A long-term monitoring program does not close uncertainties. They are closed, where they affect the works, by precaution in Table 9.1 and by stop-work rules in Table 7.2.

Uncertainty in one line

Uncertainty is characterized across three categories (survey-specific, interpretation, delivery — Figure 11.1). Of the eight key findings used by the works (Table 11.2), four are HIGH confidence (the existing modified alignment, the pangolin polygons, the priority-feature locations, and threat density in S3 and S6), one is MEDIUM–HIGH (the single-record Sensitivity Zone, Low on residency) and three are MEDIUM (the residual class if Table 9.1 holds, structure justification, and access-related hunting after paving). No finding is at LOW confidence. Uncertainty is treated as a design input, not a reason for overclaim or concealment.

11.1 Uncertainty Sources Taxonomy

Uncertainty in this BFS falls into three distinct categories that demand different management responses. **Survey-specific uncertainty** is what two field seasons could not measure (effort, season, a single chimpanzee record). **Interpretation uncertainty** is how far a finding may be pushed (Critical Habitat polygons are mapped; a population estimate is not). **Delivery uncertainty** is whether the Contractor and the Supervising Engineer apply Table 9.1 on site. **Figure 11.1** presents the taxonomy.

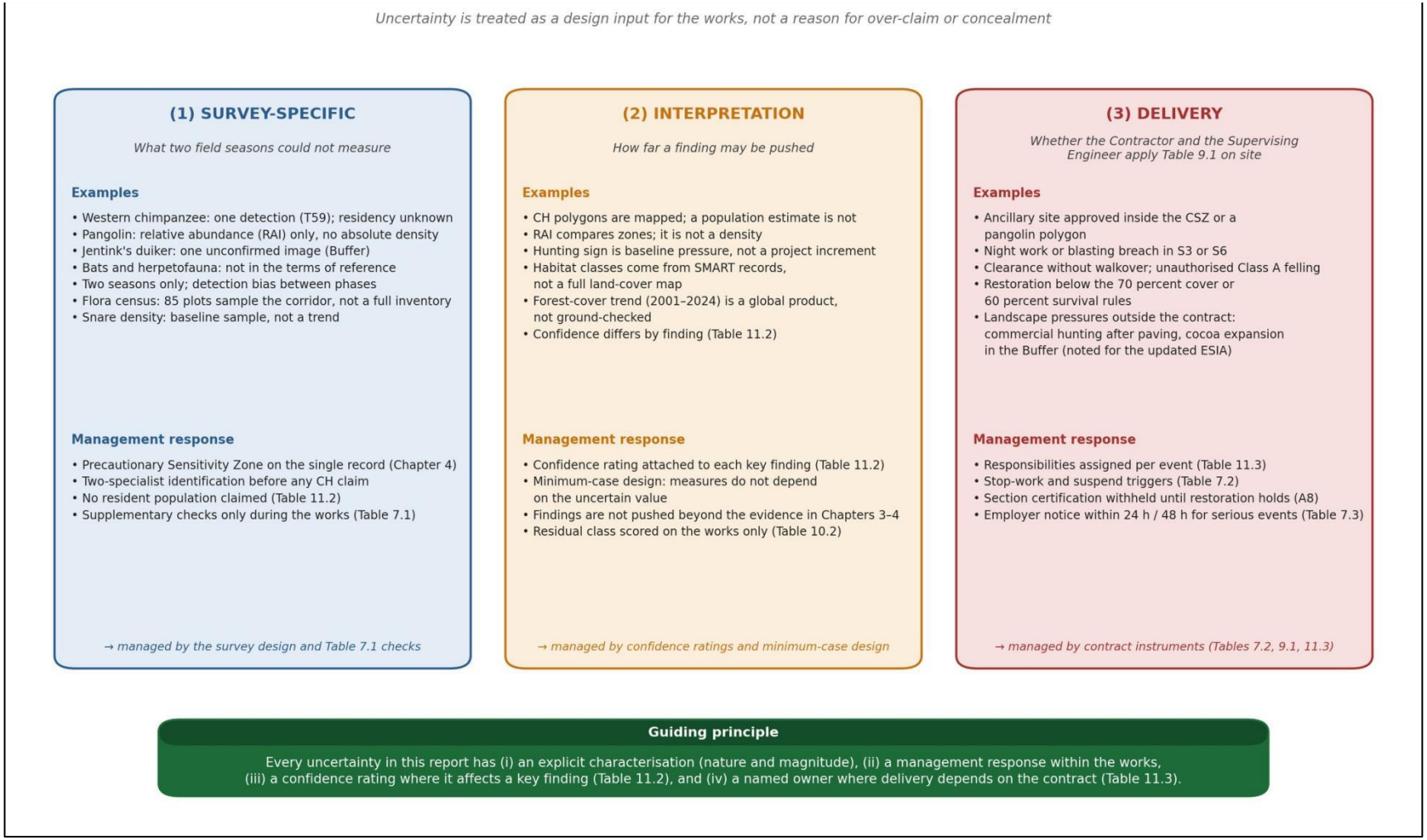


Figure 11.1: Uncertainty sources for this survey and for the works

NOTE:

Responses are construction precautions, not a multi-year monitoring system.

11.2 Survey-Specific Uncertainties

Table 11.1 lists the limits that still matter for design and construction. The last column is the construction response.

Table 11.1: Survey and works uncertainties

ID	Uncertainty	What is known	What is not known	Construction response
U1	Chimpanzee status in S3	One verified T59 record (3 Feb 2026); CSZ 3.14 km² and 0.78 km² no-go core mapped (Figs. 3.22–3.23)	Whether the animal is resident, transient, or alone	Treat the zone as precautionary. Apply A1–A3. Table 7.2 suspends a front on a verified sighting within 50 m.
U2	Pangolin abundance in S6	Repeated camera events; two CH polygons (Table 4.7; Fig. 3.14)	Density, number of individuals, or trend	Siting freeze and weekly checks during clearance. Do not treat RAI as a Year-10 target.
U3	Seasonal coverage	Two phases, including dry-season cameras (Ch. 2)	Species that are present only outside the sampled windows	Pre-clearance walkover (A4) and the sighting trigger (C11 / Table 7.2).
U4	Crossing locations	Hotspots inferred from cameras, CSZ geometry and watercourses	Every movement path across 85 km	A6 only where Chapter 3 documents a hotspot. No default structure on every kilometer.
U5	Exact ancillary-site footprints	Candidate pits and camps in Table 1.1	Final approved coordinates at mobilization	A3 freeze: no new site inside CSZ or CH polygons, wherever the final pegs fall.
U6	Class A stems inside the ROW	Hotspot mapped (Fig. 3.30; Table 3.8)	Every stem that clearance will meet	A4 walkover before vegetation is removed.
U7	Forest-cover trend	GFW 2001–2024 loss is baseline (Table 3.2; Figs. 3.4, 3.6)	How much additional loss paving will induce after the works	Not scored as a contract residual (Sections 8.5 and 10.3).
U8	Workforce hunting increment	Baseline sign in Fig. 3.10; camps will add demand	How many incidents will occur	A5 Code of Conduct and monthly inspection; Table 7.2 on a verified event.
U9	Restoration success	70 / 60 percent rules set (A8)	Whether the first rainy season will meet them	Table 7.1 check; 5:1 replacement at Contractor's cost if they fail.
U10	Fish fauna of the creek crossings	Fish were not surveyed by this BFS; the 2024 eDNA survey recorded 42 fish operational taxonomic units in 30 stream samples (ESIA Section 7.4.5); communities report fish in the Donneh Creek and in the two sacred creeks — the B'hai Jorzon sacred creek (SS-003), whose fish may not be eaten, and the Kougae Creek at Nicko	The species present at the nine creek crossings (five perennial, four intermittent) and at the Towah swamp, and their sensitivity to the crossing works	The ichthyological survey committed in the ESIA (Sections 6.3.2 and 11.9.3): commissioned by the IIU through the Supervising Engineer with an aquatic specialist, completed and reviewed for each crossing before its design is finalised and within six months of commencement; no in-stream works at any crossing until the

ID	Uncertainty	What is known	What is not known	Construction response
		Town (SS-004), whose water may not be taken into the town		review is closed. At the sacred creeks (SS-003, SS-004; the Toe Town Sacred Stream SS-006 where affected) the survey is designed with the custodians (zoes): documented consent before any sampling; non-lethal methods (visual census and environmental DNA, catch-and-release only where the custodians permit handling); no fish removed and no water drawn where custom forbids it; findings shared with the custodians; crossing design and in-stream method agreed with them before any in-stream work.

11.3 Confidence Ratings for Principal Findings

The BFS's 8 principal findings are rated for confidence on a four-level scale (Low / Medium / Medium–High / High). **Figure 11.2** visualizes the ratings; **Table 11.2** provides the rationale per finding.

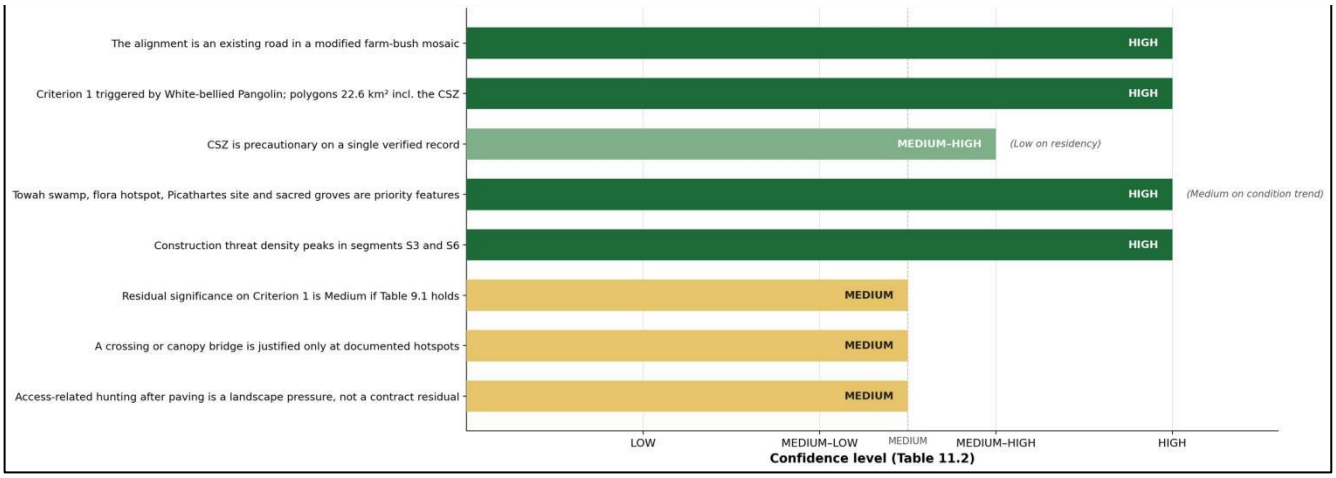


Figure 11.2: Confidence ratings for the eight key findings used by the works (Table 11.2).

Bar length = confidence level for each of the eight findings in Table 11.2: dark green = High, light green = Medium–High, amber = Medium. The italic notes flag the component of a finding that carries lower confidence (residency for the Sensitivity Zone; condition trend for the priority features).

Table 11.2: Confidence in findings used by the works.

Finding	Chapter	Confidence	Implication for the works
The alignment is an existing road in a modified farm-bush mosaic	1, 3	High	Recommendations address works risk, not historical cover.
Criterion 1 is triggered by White-bellied Pangolin; polygons total 22.6 km² with the CSZ	4	High	A3 siting freeze and S6 weekly checks.
CSZ is precautionary on a single verified record	3.2.5, 4	Medium–High on presence; Low on residency	A1–A3 stay; do not claim a resident population.
Towah swamp, flora hotspot, Picathartes site, and sacred groves are Priority Biodiversity Features	4	High on location; Medium on condition trend	A4, A7 and no-go buffers.
Construction threat density peaks in S3 and S6	8, Table 8.3	High	Table 7.1 weekly in those segments.
Residual significance on Criterion 1 is Medium if Table 9.1 holds	10	Medium	Finding fails if A1–A5 fail (Table 10.3).
A crossing or canopy bridge is justified only at documented hotspots	3, 5, 9	Medium	Evidence test before A6 drawings.
Access-related hunting after paving is a landscape pressure, not a scored contract residual	8.5, 10.3	Medium	Noted; not assigned a Table 10.2 class for the works contract.

11.4 DELIVERY UNCERTAINTY DURING THE WORKS

Institutional uncertainty regarding this rehabilitation pertains to whether the works contract applies to Table 9.1. Table 10.3 lists the four events that could potentially shift Table 10.2 back toward a high status: a wrong ancillary site, a breach of hours or blasting in S3 or S6, unauthorized Class A felling, and restoration that falls below the 70/60 percent rules. **Table 11.3** assigns responsibility for these four events to the individuals who have the authority to prevent them.

Table 11.3: Delivery uncertainty during the works.

Delivery risk	Who can prevent it	Instrument
Ancillary site inside CSZ or a pangolin polygon	Employer at design review; Supervising Engineer at mobilization	A3; no site acceptance
Night work or blasting in S3 or S6	Supervising Engineer on the day	A2; Table 7.2
Clearance without walkover or unauthorized Class A felling	Contractor method statement; Supervising Engineer before the cut	A4; Table 7.2; FDA as required
Planting that fails the first rainy-season check	Contractor; Supervising Engineer at certification	A8; withhold section certification

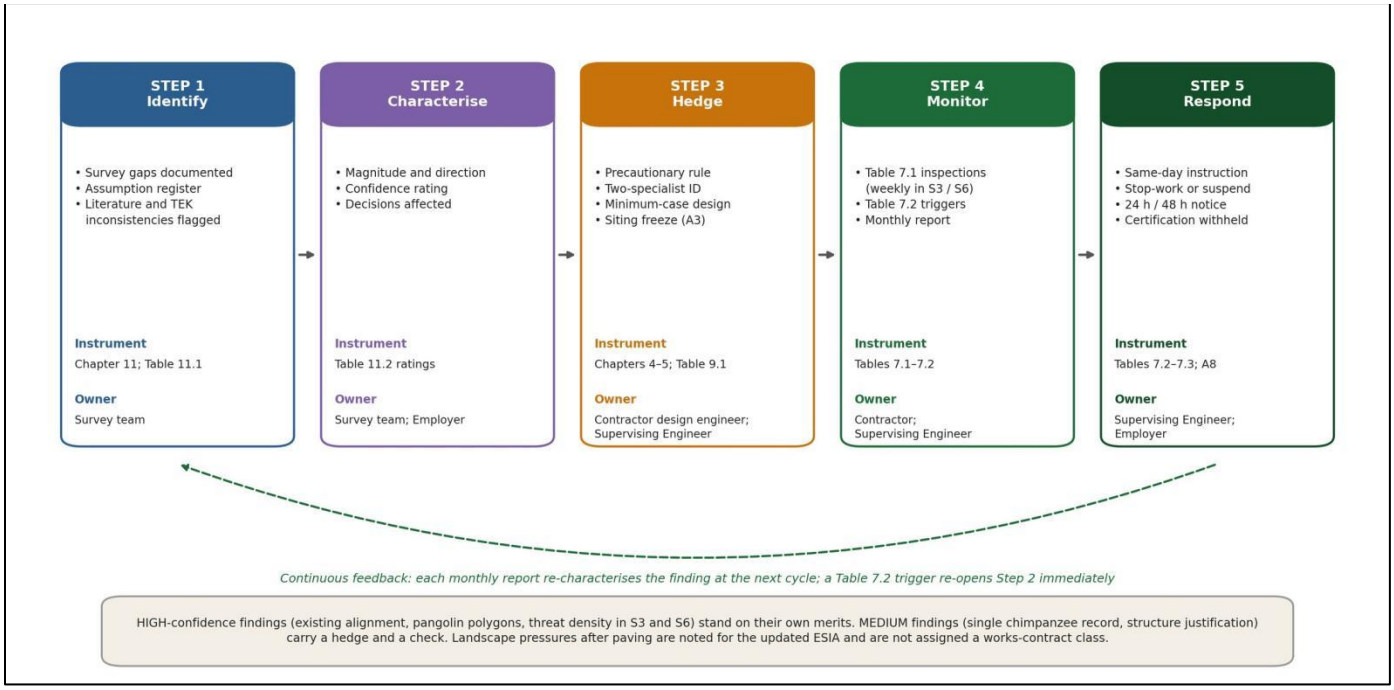


Figure 11.3: Uncertainty management flow

Fi*ve sequential steps: Identify (survey gaps, assumption register), Characterize (magnitude, confidence rating, affected decisions), Hedge (precautionary rule, two-specialist ID, minimum-case design), Monitor (Table 7.1 inspections, Table 7.2 triggers), Respond (same-day instructions by the Supervising Engineer). A continuous feedback loop ensures re-characterization at the next cycle. Each step has a defined instrument and owner.*

Honest declaration

The BFS is an imperfect tool facing a complex, dynamic landscape. Genuine uncertainty remains — particularly around the chimpanzee (resident-vs-transient status), around fine-scale pangolin densities, and around the precise trajectory of induced land-use change. The project's response is to treat uncertainty as a design input rather than to overclaim confidence. No BFS can eliminate uncertainty; a well-designed BMP manages it. The honest position is that the CH determination (Chapter 4) and the residual-impact conclusion (Chapter 10) rest on HIGH- to MED-HIGH-confidence findings anchored by the baseline data; the MED-LOW-confidence elements are tracked operationally and do not affect the ESS6 determination.

12 STAKEHOLDER ENGAGEMENT AND TEK INTEGRATION

The BFS engaged corridor communities through 21 consultations with 464 total participants designed to (i) explain the survey, (ii) gather Traditional Ecological Knowledge (TEK), (iii) capture community concerns, and (iv) inform community notice before a construction front enters S3 or S6 (A10) and the project grievance mechanism. Community input materially shaped several report findings — including the Chimpanzee Sensitivity Zone delineation, the sacred-grove Priority Biodiversity Feature designations, and the wildlife-crossing siting. This chapter is structured in four parts: (§12.1) gender-disaggregated participation; (§12.2) TEK integration — what community knowledge materially contributed to BFS findings; (§12.3) community concerns register with BMP response cross-walk; and (§12.4) ongoing engagement commitments for the construction and operation phases.

Stakeholder engagement in one line

21 consultations, 464 participants (214 women, through dedicated women's FGDs), 17 corridor communities plus Zwedru + Toe Town market informants. Six distinct TEK contributions materially altered BFS findings (Figure 12.2): chimp sighting corroboration, sacred-grove identification, wildlife crossing hotspots, Picathartes colony location, historical-extirpation context, threatened-flora vernacular names. Ten community concerns registered with the response within the works (Figure 12.3). Ongoing engagement during the works follows the Stakeholder Engagement Plan and the grievance mechanism. Notice is given before a front enters S3 or S6 (A10).

12.1 GENDER-DISAGGREGATED PARTICIPATION

Figure 12.1 and **Table 12.1** present the engagement numbers across five consultation formats. **Overall, 214 of the 464 participants were women** — markedly higher than typical for rural Liberian safeguards consultations (regional benchmark about 25 to 30 percent), reflecting dedicated women's FGDs, flexible meeting timings (morning + after-work slots), and childcare-friendly venues.

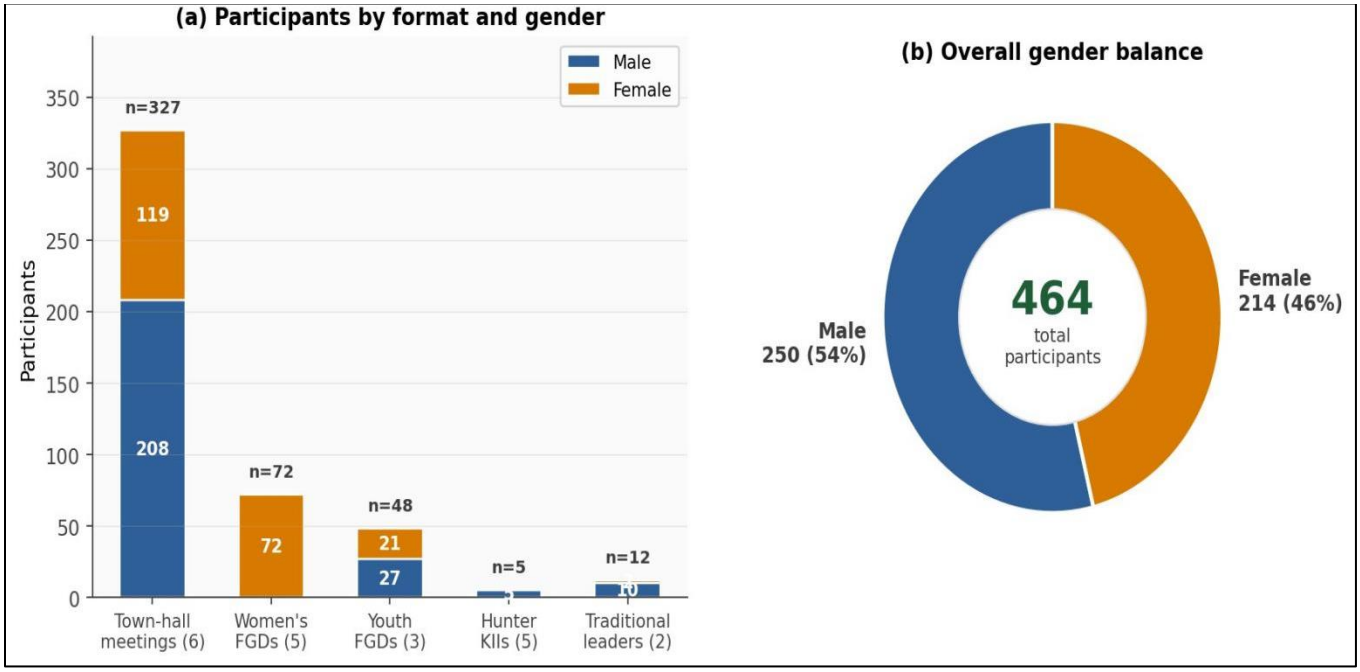


Figure 12.1: Gender-disaggregated community participation — 464 participants across 21 consultations.

Left panel: participants by format and gender (stacked bars). Town-hall meetings (6) reached the largest audience (n=327) but with lower female share; Women's FGDs (5) were the targeted complement (all 72 participants women). Right panel: overall gender balance — 250 men and 214 women. The share of women (214 of 464) significantly exceeds the rural-Liberian safeguards-consultation benchmark.

Table 12.1: Gender-disaggregated community participation in the BFS consultation programme.

Consultation format	Total	Male	Female	Youth (<25)	Elders (>60)	Hunters ID'd	Key issues raised
Town-hall meetings (6)	327	208	119	44	52	31	Wildlife crossings; job opportunities; compensation for tree loss
Women's FGDs (5)	72	0	72	18	12	0	NTFP impact (shea, fruits, medicinal plants); water access; children's safety on road
Youth FGDs (3)	48	27	21	48	0	6	Employment; skills training; concerns about youth out-migration after road
Hunter key-informant interviews (5)	5	5	0	1	2	5	Confirmed species locally seen; past chimp sightings; concerns on bushmeat livelihood
Traditional leaders (2)	12	10	2	0	8	1	Sacred grove mapping; customary land use; consent for access
TOTAL	**464**	**250**	**214**	**111**	**74**	**43**	

Women's FGDs were critical for capturing gender-differentiated concerns around NTFPs and water access that did not emerge in mixed town halls.

12.1.1 Gender-differentiated priorities

The disaggregated data reveal three distinct priority patterns:

- **Women's priorities:** water source protection, firewood availability, NTFP (shea, fruits, medicinal plants), children's road safety, nuisance dust at homes. These priorities were *substantially under-represented* in mixed town-hall meetings — a pattern observed in safeguards consultations across the Mano River Union region (Sierra Leone + Liberia + Guinea).
- **Men's priorities:** employment, compensation rates, bushmeat livelihood transition, land-use change, hunting-scheme mechanics. These dominated town-hall discussions but were partly supplemented by hunter KIIs that exposed specific bushmeat-dependency concerns.
- **Youth priorities:** training opportunities, mobility / out-migration, future employment, sports / recreation spaces near the road. Youth FGDs were critical because youth were often silent in mixed meetings, deferring to elders.

Within the works, these differentiated priorities are addressed by dust suppression and paved shoulders at settlements (women's priority), local-hire clauses in the works contract (men's priority), and protection of water sources through sediment control at live crossings (M6). Ranger training, cocoa enrichment and compensatory planting programmes were raised by communities but are outside the scope of the works contract and are noted for the updated ESIA.

12.2 Traditional Ecological Knowledge (TEK) Integration

Community knowledge is not decorative — it materially altered the CH determination, the Priority Biodiversity Feature delineation, and the mitigation design. Figure 12.2 maps six concrete TEK contributions from initial community input to scientific validation to their effect on the survey findings and the construction-phase measures.

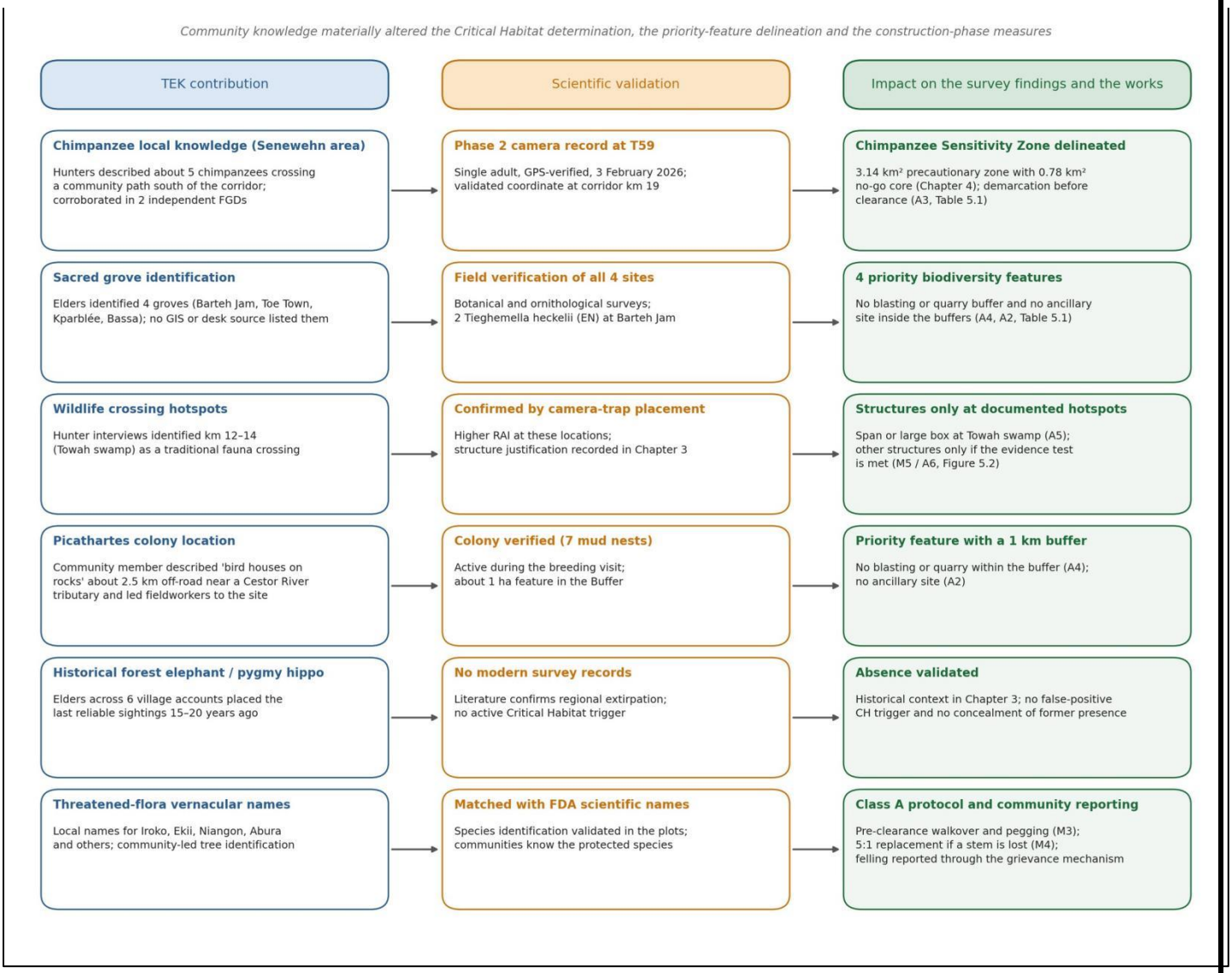


Figure 12.2: Traditional ecological knowledge integration: six community contributions and how they shaped the survey findings.

Each row shows the pathway from TEK contribution (blue) to scientific validation (orange) to the effect on the survey findings and the works (green). Six contributions: (1) chimpanzee local knowledge near Senewehn, which led to the Chimpanzee Sensitivity Zone; (2) sacred-grove identification, which led to four Priority Biodiversity Features; (3) wildlife-crossing hotspots, which set the evidence test for the Towah swamp structure and any other structure; (4) the Picathartes colony location, which led to a priority feature with a 1 km buffer; (5) historical forest-elephant and pygmy-hippopotamus accounts, which validated absence; and (6) threatened-flora vernacular names, which underpin the Class A protocol and community reporting of felling.

12.2.1 TEK contributions in detail

- **Chimpanzee detection (T59, Senewehn area):** Hunters described ~5 chimpanzees crossing a community path south of the corridor. Corroborated in 2 independent FGDs. The Phase 2 camera record at T59 (single adult, February 2026) validated the TEK account, and together they drove the 3.14 km² Chimp Sensitivity Zone delineation (Chapter 4) and the precautionary CH treatment with 0.78 km² no-go core.
- **Sacred grove identification:** All four sacred groves (Barteh Jam, Toe Town, Kparblée, Bassa) were identified exclusively through community elder interviews — no GIS or desk source listed any of them. Field verification confirmed all four; the Barteh Jam grove additionally contained 2 Tieghemella heckelii EN individuals and the Picathartes-rock outcrop, materially affecting Priority Biodiversity Feature designations.
- **Wildlife crossing hotspots:** Hunter KIIs identified km 12–14 (Towah swamp) as a traditional fauna crossing point. Camera-trap placement confirmed higher RAI values at these specific locations. The span or large-box structure at Towah swamp (A5) and any other structure considered under Chapter 5 (M5, Figure 5.2) are tied to these TEK-identified and camera-confirmed hotspots.
- **Picathartes colony location:** A community member referred to 'bird houses on rocks' ~2.5 km off-road near the Cestor River tributary — leading fieldworkers directly to the colony. Without this guidance, a ~1 ha feature in the Buffer zone would likely have gone undetected, and the Priority Biodiversity Feature designation + 1 km no-disturbance buffer (A4) would not have been established.
- **Historical forest elephant and pygmy hippopotamus:** Elders across 6 village accounts consistently placed last reliable sightings at 15–20 years ago. This TEK, consistent with regional literature on extirpation trajectories, validated the absence of these EN species from the modern CH determination — avoiding both false-positive CH trigger and false-negative concealment of former presence.
- **Threatened-flora vernacular names:** Local names for Iroko (Milicia regia), Ekii (Lophira alata), Niangon (Heritiera utilis), Abura, and others confirmed species identifications and facilitated community-led tree protection. This direct translation between scientific and community nomenclature underpins the Class A stem protocol (M4, Chapter 5) and community reporting of unauthorised felling through the project grievance mechanism.

12.3 Community Concerns Register and Response within the Works

Ten distinct concerns were raised across the 21 consultations, with frequencies ranging from 5 of 21 to 14 of 21. Each concern is paired with its response within the works in Figure 12.3 and Table 12.2.

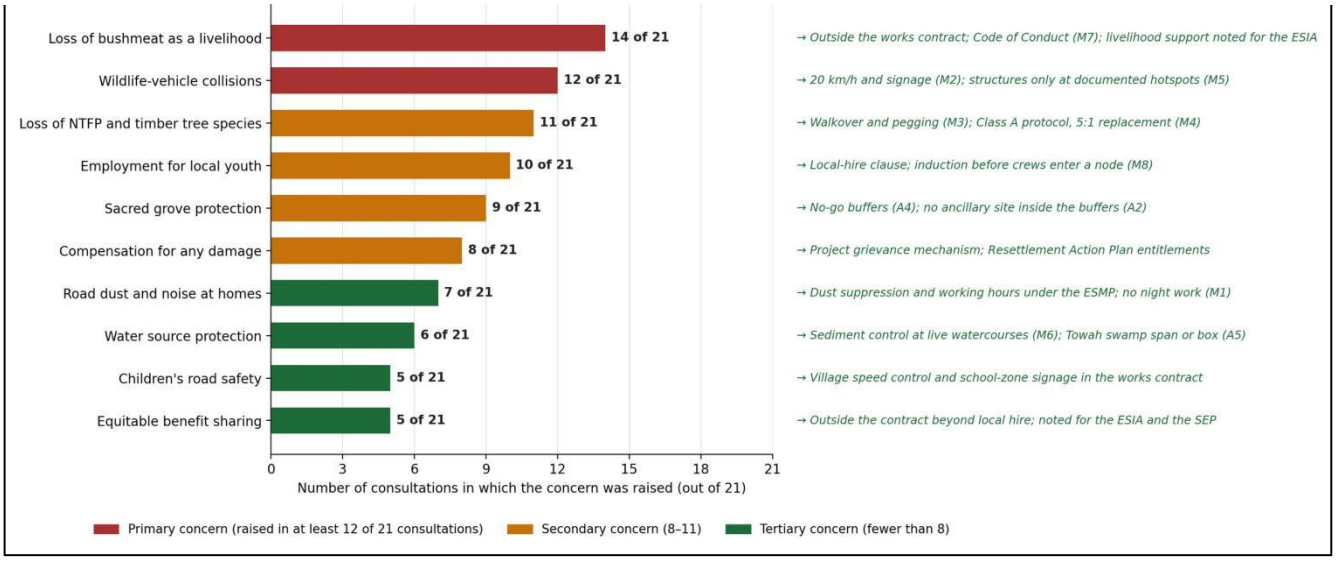


Figure 12.3: Community concerns raised during the survey, by frequency across the 21 consultations.

Horizontal bar length = number of consultations (out of 21) where the concern was raised. Three tiers: Primary (red, at least 12 of 21), bushmeat livelihood and wildlife-vehicle collision; Secondary (orange, 8–11) NTFP loss, youth employment, sacred-grove protection, compensation; Tertiary (green, <8) dust/noise, water, road safety, benefit-sharing. Italic green text after each bar summarises the response within the works (Table 12.2).

Table 12.2: Community concerns raised during the survey and the response within the works.

Community concern	Frequency	Response within the works
Loss of bushmeat as a livelihood	14 of 21	Outside the works contract: the rehabilitation neither creates nor removes a bushmeat livelihood. The workforce Code of Conduct (M7) prohibits hunting and bushmeat purchase by project personnel; livelihood support is a matter for the updated ESIA.
Wildlife-vehicle collisions (familial concern)	12 of 21	20 km/h limit and warning signage in the Sensitivity Zone and at documented hotspots (M2); a crossing, oversized culvert or canopy bridge only where this survey documents a movement hotspot (M5).
Loss of NTFP and timber tree species	11 of 21	Class A and NTFP stems recorded in the pre-clearance walkover and kept outside the cleared width where the design allows (M3); 5:1 replacement if a Class A stem is lost (M4).
Employment for local youth	10 of 21	Local-hire clause in the works contract; induction before crews enter a node (M8).
Sacred grove protection	9 of 21	No-go buffers for sacred groves and the Picathartes site (A4); no ancillary site inside those buffers (A2). The sacred creeks and stream (SS-003, SS-004, SS-006) are protected in the same way, with the custodial protocol of ESIA Section 6.3.2 applied to the fish survey and the crossing works.
Compensation for any damage	8 of 21	Project grievance mechanism; entitlements under the Resettlement Action Plan.
Road dust and noise at homes	7 of 21	Dust suppression and working hours under the ESMP; no night work in sensitive segments (M1).
Water source protection	6 of 21	Sediment control at every live watercourse (M6); the Towah swamp spanned or crossed by a large box culvert with in-stream work at low flow (A5). At the sacred creeks — the B'hai Jorzon sacred creek (SS-003), the Kougae Creek at Nicko Town (SS-

Community concern	Frequency	Response within the works
		004) and the Toe Town Sacred Stream (SS-006) where the works affect it — the ichthyological survey and the crossing design follow the custodial protocol of ESIA Section 6.3.2: consent before sampling, non-lethal methods, no fish removed and no water drawn where custom forbids it, findings shared with the custodians and the in-stream method agreed with them (Table 11.1, U10).
Children's road safety	5 of 21	Village speed control and school-zone signage under the road-safety provisions of the works contract.
Equitable benefit sharing	5 of 21	Outside the works contract beyond the local-hire clause and induction (M8); noted for the updated ESIA and the Stakeholder Engagement Plan.

All 21 consultations documented in detail in the project Stakeholder Engagement Log (Annex 4). The response hierarchy matches frequency: the two primary concerns (bushmeat livelihood and wildlife-vehicle collision) are addressed first, through the workforce Code of Conduct (M7) and the speed and signage measures (M2); livelihood support beyond the works is noted for the updated ESIA.

12.4 ENGAGEMENT DURING THE WORKS AND DEFECTS LIABILITY

From mobilization through section certification, engagement follows the project SEP and the grievance mechanism already committed in Section 1.4. Additional biodiversity steps are limited to the nodes in Table 8.3.

Table 12.3: Engagement during the works and defects liability.

Activity	When	Who
Notice that a front will enter S3 or S6, including hours, blasting rules and GRM contacts	Before the front enters the node (A10)	Contractor; Employer confirms
Access to the grievance mechanism for wildlife, sacred sites and camp conduct	Throughout the works	Employer; Supervising Engineer tracks biodiversity entries
Women’s and men’s follow-up as required by the SEP	As scheduled in the SEP during construction	Employer
Serious-incident notice (chimpanzee injury or death, no-go breach, unauthorized Class A felling)	Within 48 hours (Table 7.3)	Contractor / Supervising Engineer to Employer, then financier and EPA as required

13 CONCLUSION AND NEXT STEPS

This final chapter synthesizes the findings of Chapters 1–12 into an overall determination, states the ESS6 compliance outcome, details the next-step deliverables to operationalize the BFS findings, and provides the decision message for IIU and the World Bank. The chapter is structured in five parts: (§13.1) overall conclusion; (§13.2) final ESS6 compliance scorecard; (§13.3) Next-step deliverables and timelines; (§13.4) recommendations to IIU, Contractor, and World Bank; (§13.5) final project-decision message.

Final determination in one line

The RETRAP 85 km road upgrade can proceed in compliance with World Bank ESS6 and Liberia's EPA / FDA regulatory framework, subject to full implementation of the Biodiversity Management Plan. Zero ESS6 features remain at HIGH or SEVERE residual significance.

13.1 FINDING

The B'hai Jorzon–Toe Town–Zwedru alignment is an existing laterite road in a farm-bush mosaic. Habitat conversion along most of the corridor forms part of the baseline. The additional risk this rehabilitation creates is concentrated where plant, camps and ancillary sites meet mapped Criterion 1 nodes and Priority Biodiversity Features.

Critical Habitat is triggered under Criterion 1 by the Endangered White-bellied Pangolin in two polygons at approximately kilometers 38–50 (Figure 3.14). The Western Chimpanzee is treated as a precautionary Sensitivity Zone of about 3.14 square kilometers at kilometers 18–20, including a 0.78 square kilometer no-go core, on a single verified record (Section 3.2.5; Figure 3.22). Towah swamp, the threatened-flora hotspot, the Picathartes outcrop and sacred groves are Priority Biodiversity Features (Table 4.8). Construction threat density peaks in segments S3 and S6 (Table 8.3).

After the construction measures in Table 9.1, residual significance on Criterion 1 is Medium and no feature remains High or Severe through defects liability, provided the six conditions in Table 10.4 hold (Table 10.2). That is the compliance finding of this survey for the works. Access-related hunting after paving is noted and is not scored as a contract residual (Sections 8.5 and 10.3).

13.2 NEXT STEP

Status at 13 November 2026. The Contractor's site kick-off at Zwedru was held on 2 August 2026 and the works contract commenced on 24 August 2026; mobilisation, the topographic, geotechnical, hydrological and traffic surveys and the design data collection are under way, and civil works have not commenced. Detailed design is progressing from the Zwedru terminus (km 85+000) westward, in segment S7 outside the sensitive segments, and has been completed for approximately the first 10 km from Zwedru (about km 85 to km 75); the remaining sections follow in design-schedule packages. Candidate quarries, borrow pits, spoil areas, stockpile areas, camps and equipment yards are being plotted against the sensitivity map as the design advances (A3) and none has been opened; the wildlife-crossing warning and awareness signage (A9) is being carried into the road-furniture design, and the evidence-led crossing provisions of A6 and A7 are tested at each design review. The activities carried out at the Zwedru end are survey, design and engagement activities that require no construction permit; no vegetation clearing, earthworks or other civil works have been executed there or elsewhere, and the deliverables of Table 13.1 remain the conditions before any front enters S3 or S6 (ESIA Section 3.16).

The survey is not self-executing. The following items have to exist before, or as, a front enters S3 or S6.

Table 13.1: Works deliverables that follow this survey.

ID	Deliverable	When	Who
D1	C-ESMP clauses that copy Table 9.1 (A1–A10) and Tables 7.1–7.2	Before mobilization	Contractor prepares; Supervising Engineer and Employer accept

ID	Deliverable	When	Who
D2	Ancillary-site plan showing no new quarry, pit, crusher, camp or laydown inside CSZ or CH polygons (A3)	Detailed design review	Contractor; Employer does not accept a non-compliant site
D3	Drawings for A6 and A7 only where Chapter 3 documents a hotspot or where Towah swamp requires a span or large box	Detailed design	Contractor's design engineer
D4	Biodiversity Management Plan as an annex to the 85 km Environmental and Social Impact Assessment, limited to construction and defects liability	With the ESIA package	Employer
D5	Weekly and monthly checklists that match Table 7.1, including S3 and S6 first	Mobilization	Supervising Engineer
D6	A10 notice templates and GRM contacts for communities before a front enters S3 or S6	Before the first node is entered	Contractor and Employer (Ch. 12)
D7	Ichthyological survey of the nine creek crossings and the Towah swamp (ESIA Sections 6.3.2 and 11.9.3), designed with the custodians at the sacred creeks (SS-003, SS-004; SS-006 where affected): consent before sampling, non-lethal methods, no fish removed or water drawn where custom forbids it, findings shared, crossing design and in-stream method agreed with the custodians	Each crossing surveyed and reviewed before its design is finalised, and within six months of commencement; no in-stream works at any crossing until the review is closed	IIU through the Supervising Engineer, with an aquatic specialist; custodians (zoes) of the sacred creeks; Contractor's design engineer for the crossing designs

13.3 RECOMMENDATIONS

- **Employer (IIU / Ministry of Public Works):** Put Table 9.1 in the works specification. Develop the Biodiversity Management Plan with Technical Advisor support and annex it to the updated 85 km ESIA**.** Do not accept an ancillary site that fails A3. Hold section certification until A8 meets the 70 percent cover and 60 percent survival rules. Report through Table 7.3. Keep the BMP inside the 85 km ESIA annex. Commission the ichthyological survey of the nine creek crossings and the Towah swamp before the crossing designs are finalised, and at the sacred creeks carry it out only with the custodians' consent, by non-lethal methods and with the findings shared with them, so that the survey also answers the sacred-creek concern raised in consultation (ESIA Section 6.3.2; Table 13.1, D7).
- **Contractor:** Demarcate the no-go core before clearance in S3. Keep hours and blasting rules in S3 and S6. Run the Class A walkover before the cut in S4. Enforce the Code of Conduct. Build A6 and A7 only from accepted drawings. Restore the footprint the works open. Issue A10 notices.
- **Supervising Engineer:** Check S3 and S6 first each week the front is in those segments. Issue Table 7.2 instructions the same day a trigger is hit. Do not certify a section that fails A8.
- **FDA and EPA:** Class A stems, and wildlife-law referrals during the works follow national procedure. This survey does not assign those agencies a long-term field program under the works contract

- **Closing:** Rehabilitate the existing road. Keep plant, camps and pits out of the no-go core and the pangolin polygons. Check S3 and S6 while the front is there. Restore the surfaces the project disturbs. That is the work this survey supports.

LIST OF REFERENCES

References are cited in the body of this report using author–date format. Project data, raw datasets and the SMART/PostGIS geodatabase are held by IIU and are available to the World Bank Task Team and the Supervising Engineer on request.

Abernethy, K. A., Coad, L., Taylor, G., Lee, M. E., & Maisels, F. (2013). Extent and ecological consequences of hunting in Central African rainforests in the twenty-first century. Philosophical Transactions of the Royal Society B, 368(1625), 20120303.

BirdLife International. (2023). Endemic Bird Areas of the World: Upper Guinea Forests (EBA 084). BirdLife Datazone, Cambridge, UK.

BirdLife International. (2024). Species factsheets and Red List range polygons for Upper Guinea endemic and threatened birds. BirdLife Datazone, Cambridge, UK.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). (2023). Appendices I, II and III. CITES Secretariat, Geneva.

Environmental Protection Agency of Liberia (EPA). (2003). Environmental Protection and Management Law of the Republic of Liberia (EPML). Government of Liberia, Monrovia.

Environmental Protection Agency of Liberia (EPA). (2022). Environmental and Social Impact Assessment Procedural Guidelines. EPA, Monrovia.

Forestry Development Authority of Liberia (FDA). (2008). Regulation No. 113-08 — Regulations on Confirmation of Class A and Class B Species. FDA, Monrovia.

Government of Liberia. (2006). National Forestry Reform Law (NFRL). Republic of Liberia, Monrovia.

Government of Liberia. (2016a). Wildlife Conservation and Protected Areas Management Act. Republic of Liberia, Monrovia.

Government of Liberia. (2016b). Protected Areas Act. Republic of Liberia, Monrovia.

Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., & Townshend, J. R. G. (2013). High-resolution global maps of 21st-century forest cover change. Science, 342(6160), 850–853. (Updated tiles to 2024 via Global Forest Watch, accessed 2026.)

International Finance Corporation (IFC). (2012). Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources. World Bank Group, Washington, DC.

International Finance Corporation (IFC). (2019). Guidance Note 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources (revised June 2019). World Bank Group, Washington, DC.

IUCN. (2016). Guidelines for using the IUCN Red List Categories and Criteria, Version 12. International Union for Conservation of Nature, Gland, Switzerland.

IUCN. (2024). The IUCN Red List of Threatened Species. Version 2024-1. https://www.iucnredlist.org

Kleinschroth, F., & Healey, J. R. (2017). Impacts of logging roads on tropical forests. Biotropica, 49(5), 620–635.

Kühl, H., Maisels, F., Ancrenaz, M., & Williamson, E. A. (2008). Best Practice Guidelines for Surveys and Monitoring of Great Ape Populations. IUCN SSC Primate Specialist Group, Gland, Switzerland.

Laurance, W. F., Goosem, M., & Laurance, S. G. W. (2009). Impacts of roads and linear clearings on tropical forests. Trends in Ecology & Evolution, 24(12), 659–669.

Meek, P. D., Ballard, G., Claridge, A., Kays, R., Moseby, K., O'Brien, T., O'Connell, A., Sanderson, J., Swann, D. E., Tobler, M., & Townsend, S. (2014). Recommended guiding principles for reporting on camera trapping research. Biodiversity and Conservation, 23(9), 2321–2343.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A. B., & Kent, J. (2000). Biodiversity hotspots for conservation priorities. Nature, 403(6772), 853–858.

Norris, K., Asase, A., Collen, B., Gockowksi, J., Mason, J., Phalan, B., & Wade, A. (2010). Biodiversity in a forest–agriculture mosaic — The changing face of West African rainforests. Biological Conservation, 143(10), 2341–2350.

Poulsen, J. R., Koerner, S. E., Moore, S., Medjibe, V. P., Blake, S., Clark, C. J., Akou, M. E., Fay, M., Meier, A., Okouyi, J., Rosin, C., & White, L. J. T. (2017). Poaching empties critical Central African wilderness of forest elephants. Current Biology, 27(4), R134–R135.

Rovero, F., & Zimmermann, F. (Eds.). (2013). Camera Trapping for Wildlife Research. Pelagic Publishing, Exeter, UK.

SCNL & WCF. (2024). Biodiversity Field Survey Report — RETRAP 40 km Corridor (Tappita–Toe Town). Society for the Conservation of Nature in Liberia and Wild Chimpanzee Foundation, Monrovia.

Wearn, O. R., & Glover-Kapfer, P. (2017). Camera-trapping for conservation: A guide to best practices. WWF Conservation Technology Series 1(1). WWF-UK, Woking, United Kingdom.

White, L., & Edwards, A. (Eds.). (2000). Conservation Research in the African Rain Forests: A Technical Handbook. Wildlife Conservation Society, New York.

World Bank. (2018). Environmental and Social Framework. World Bank Group, Washington, DC. (Includes ESS1–ESS10; ESS6 on Biodiversity Conservation and Sustainable Management of Living Natural Resources.)

World Bank. (2024). RETRAP Environmental and Social Impact Assessment (ESIA) and Environmental and Social Commitment Plan (ESCP). World Bank Group / IIU Ministry of Public Works, Liberia.