

Biodiversity Action Plan; Bumbuna II Hydropower Project, Sierra Leone

Prepared by: **The Biodiversity Consultancy**

January 2019

Version 1 Draft

TABLE OF CONTENTS

| | | |
|-----|---|----|
| 1 | Executive summary | 3 |
| 2 | Introduction..... | 4 |
| 2.1 | Project description | 4 |
| 2.2 | Purpose and scope..... | 5 |
| 2.3 | Biodiversity management within Seli Hydropower | 6 |
| 2.4 | Stakeholder engagement during BAP development..... | 7 |
| 2.5 | Documents supporting the BAP | 7 |
| 3 | Biodiversity context | 9 |
| 3.1 | Critical Habitat-qualifying biodiversity | 11 |
| 4 | Summary of potential impacts and mitigation overview..... | 14 |
| 4.1 | Technical rationale for mitigation actions | 16 |
| 5 | General mitigation actions..... | 18 |
| 6 | Species-specific actions | 24 |
| 7 | Residual impact assessment..... | 29 |
| 8 | Offset strategy..... | 30 |
| 9 | Monitoring and evaluation strategy..... | 38 |
| 9.1 | Thresholds and adaptive management | 40 |
| 9.2 | <i>Ledermanniella yiben</i> monitoring | 40 |
| | References..... | 41 |

TABLE OF ACRONYMS AND ABBREVIATIONS

| Acronyms and abbreviations | |
|----------------------------|---|
| Aol | Area of Influence |
| BAP | Biodiversity Action Plan |
| BBI | Bumbuna I |
| BOS | Biodiversity Offset Strategy |
| BWMA | Bumbuna Watershed Management Authority |
| EPA | Environmental Protection Agency |
| EPC | Engineering Procurement and Construction |
| E&S | Environmental & Social |
| EHS | Environment, Health, Safety |
| ESHS MS | Environmental, Social and Health and Safety Management System |
| FOA | Freshwater Offset Action |
| GIS | Geographic Information System |
| GMA | General Mitigation Action |
| GPS | Global Positioning System |
| IAS | Invasive Alien Species |
| IFC | International Finance Corporation |
| JA | Joule Africa |
| M&E | Monitoring & Evaluation |
| MP | Management Plan |
| NPAA | National Protected Areas Authority |
| NTFP | non-timber forest products |
| NNL | No Net Loss |
| O&M | Operator and Maintainer |
| PA | Protected Area |
| PAG | Project Advisory Group |
| PS | Performance Standard |
| SSA | Species-Specific Action |
| TOA | Terrestrial Offset Action |
| ToR | Terms of Reference |
| WAPP | West Africa Power Pool |

1 Executive summary

This document is the Biodiversity Action Plan (BAP) for the Bumbuna II Hydropower Project (Bumbuna II or ‘the Project’). The Project is being developed by Joule Africa (JA) and will be implemented by Seli Hydropower, a Sierra Leonean project company. It is located in the Northern province of Sierra Leone within the Rokel River basin and consists of a new 55 MW powerhouse and reservoir spanning the river Seli at Yiben and an extension to the existing Bumbuna Hydroelectric Project Phase I (BBI).

This BAP presents the Project strategy to mitigate and manage biodiversity impacts during construction and operations in order to achieve no net loss for Natural Habitat and net gain for Critical Habitat-qualifying species. A risk-based prioritisation process has identified priority biodiversity from the suite of Critical Habitat-qualifying biodiversity to be a focus of BAP actions; priority biodiversity also acts as a proxy for wider biodiversity. The BAP outlines (Figure 1):

- ▶ Mitigation actions to address the loss, degradation and fragmentation of Natural Habitat, introduction of invasive species, accidental mortality, and overexploitation of fauna and flora;
- ▶ Actions to translocate *Ledermanniella yiben* (an endemic plant) and to offset residual impacts on the Western Chimpanzee;
- ▶ Actions to implement terrestrial and freshwater offsets; and
- ▶ Key indicators to monitor biodiversity losses and gains over time and adaptively manage Project actions to achieve no net loss/net gain objectives.

Fully developing offset actions that are socially, technically and institutionally feasible will require additional field assessments and stakeholder engagement.

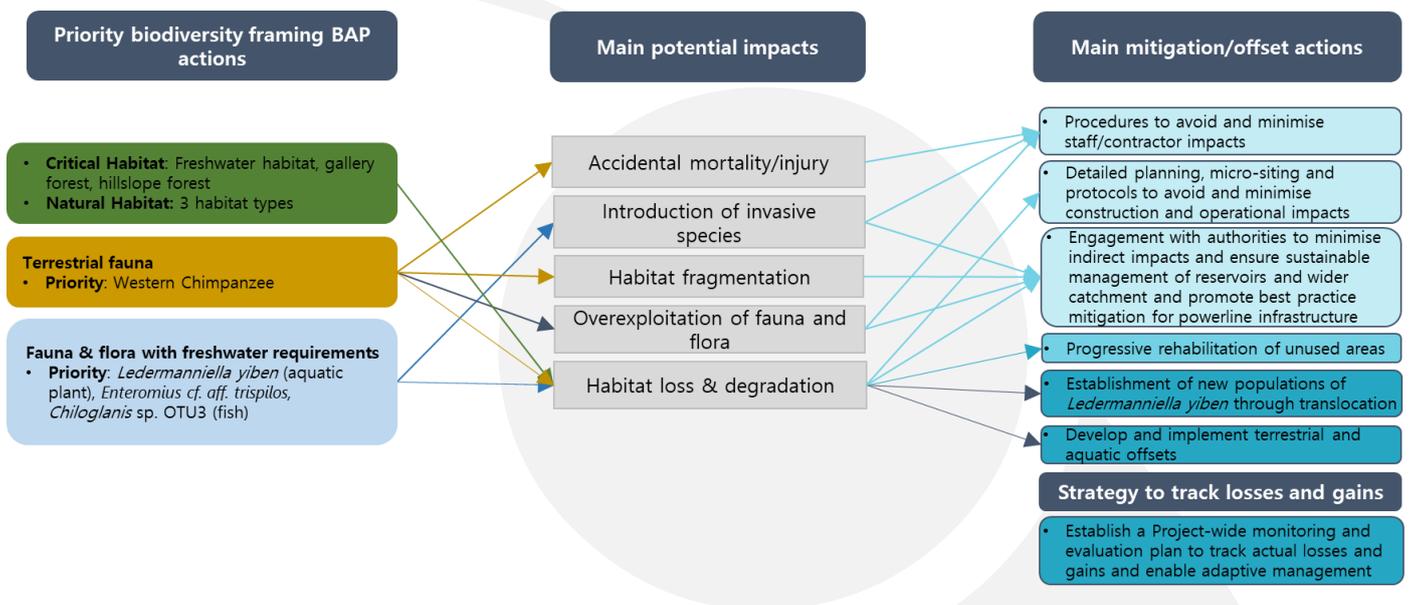


Figure 1: Overview of priority biodiversity and main potential impacts, mitigation and offset actions

This BAP is a living document that will be reviewed regularly and updated as appropriate. Implementation of the above actions will be further detailed in Project documents including offset management plans and the monitoring and evaluation plan. Implementation will require strong stakeholder engagement and partnerships. To operationalise the actions from this BAP, the Project will develop: (i) further biodiversity-specific plans, including biodiversity offset management plans and a biodiversity monitoring and evaluation plan; (ii) other plans with relevance to biodiversity, notably the influx management plan and the catchment and reservoir management plan which will include biodiversity and other mitigation measures; and detailed on-the-ground management plans that operationalise biodiversity mitigation as part of the suite of Environmental and Social Management System (ESMS) of Seli Hydropower (the Project developer), the Engineering Procurement and Construction (EPC) contractor and the Operation and Maintainer (O&M) of the Project.

2 Introduction

2.1 Project description

Bumbuna II is located in the Northern Province of Sierra Leone, within the districts of Tonkolili and Koinadugu. The Project infrastructure lies within the Rokel River basin, in the section of the river upstream of the Bumbuna falls, where the river is known as the River Seli (Figure 2). Bumbuna II is designed to build on the existing Bumbuna Hydropower Project Phase I (BBI) to provide a more reliable power supply. It consists of two components planned to generate a total of 143 MW of power (ERM 2017a):

1. **Yiben:** this will be constructed upstream of BHP- I on the river Seli and consist of the 55 MW powerhouse and approximately a 115 km² reservoir;
2. **Bumbuna Extension:** using the existing BBI reservoir, the Extension will generate a total of 88 MW power through a new intake and two 42 MW turbines (near to the Bumbuna dam), but also through a 4 MW turbine in the BBI powerhouse which generates power from the environmental flow.

Key features of each component of the Project include:

1. Yiben

- ▶ A 86 m high and 730 m wide dam, and a 115 km² reservoir;
- ▶ A powerhouse containing two 27.7 MW turbines;
- ▶ An overflow channel to bypass the dam, to remove flood water or for use during maintenance.

2. Bumbuna Extension

- ▶ A water intake and an approximately 1.9 km of underground tunnel to take water from the existing reservoir to the new powerhouse;
- ▶ A new powerhouse containing two 42 MW turbines;
- ▶ Concrete tailrace channel to return the water to the River Seli;
- ▶ 4MW turbine in the Environmental Flow Power House located at BBI.

Other supporting infrastructure will include workers' camps, quarries and a new non-hazardous landfill waste management facility.

Two powerlines will be used to export the power generated. One powerline is the CLSG line (Cote d'Ivoire, Liberia, Sierra Leone, Guinea), a 225 kV line linking the four countries. CLSG is being developed by Transco, a company owned by the four countries and is currently in the construction phase. The other powerline is the India EXIM line which will link Yiben with Freetown; this is being developed by the Ministry of Energy under the authority of the Government of Sierra Leone.

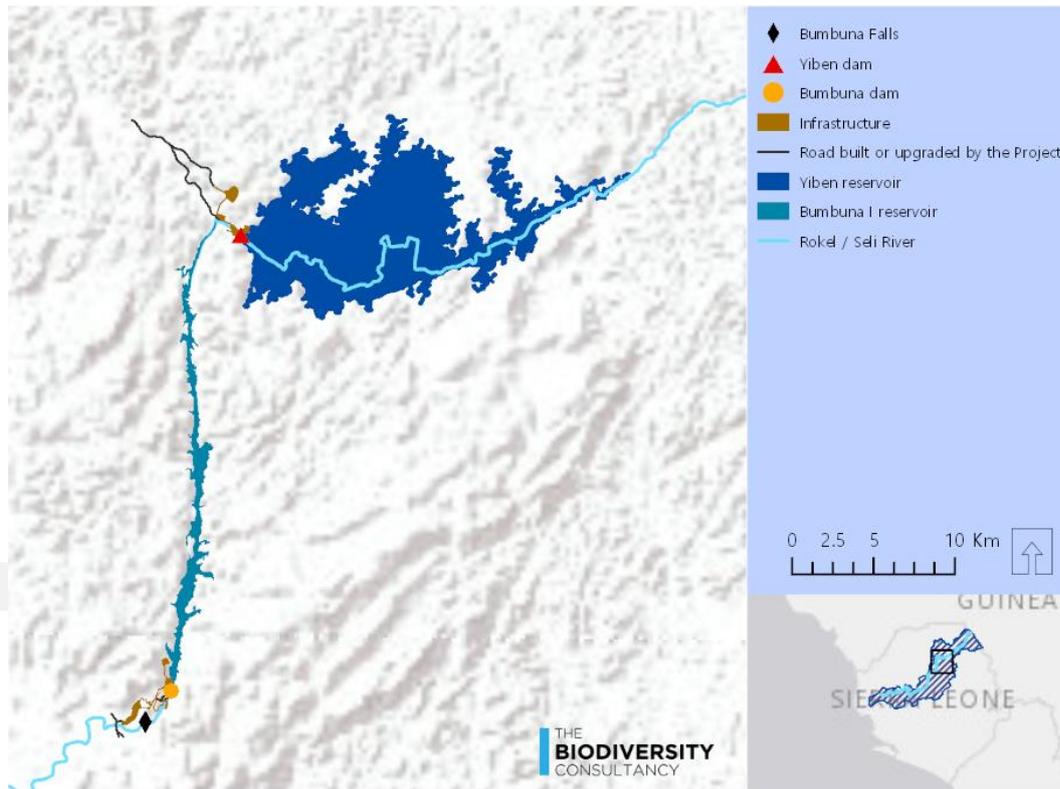


Figure 2: Project location and key components: the Bumbuna Extension and Yiben

2.2 Purpose and scope

Purpose

The Project is operating in an area of Critical and Natural Habitat (Section 2.5). It is therefore committed to complying with national legislation and aligning with international best-practice biodiversity management, such as International Finance Corporation (IFC) Performance Standard 6 (PS6) on Biodiversity Conservation and Sustainable Management of Living Natural Resources (IFC 2012)¹. The purpose of this BAP is to set out the Project strategy to mitigate and manage biodiversity impacts during construction and operations, and to establish the offset actions required to achieve a no net loss for Natural Habitat and net gain for Critical Habitat-qualifying biodiversity. This BAP demonstrates how this objective can be achieved and provides the basis for developing more detailed biodiversity management, monitoring and offset plans.

Temporal scope

Following commissioning, the Project will be operated by Seli Hydropower for 25 years before it is transferred to the Government of Sierra Leone (ERM 2017a). The infrastructure is considered to have an operational life of over 90 years or more. This BAP covers construction and operations for the period it is operated by Seli Hydropower and therefore does not include the later operational phase or decommissioning phase. A preliminary residual impact assessment has identified offset targets based on a 2018 biodiversity baseline (Seli Hydropower 2019a, 2019b). The BAP is a living document that can be updated as the Project monitors impacts on biodiversity and assesses the effectiveness of mitigation actions.

Project scope

The BAP includes biodiversity mitigation actions for both components of the Project (Yiben and the Bumbuna Extension), to enable the Project to achieve net gain objectives, but it does not include any substations or transmission lines as these are considered to be Government transmission line works in the Implementation Agreement between the Project and the Government. The energy infrastructure that will be used by the Project to export the generated power is being developed by the Ministry of Energy as part of its road map for the electricity sector (2018-2030) (Ministry of Energy 2018).

Biological scope

The BAP focuses on biodiversity identified through the Critical Habitat assessment. Ecosystem services are not explicitly included within the BAP. However, the mitigation actions proposed in the BAP will support the conservation of biodiversity that underpins the functionality of

¹ The Project has been developing documentation to align with the 2012 PS6 guidance note since 2016. The essence of the updated guidance note of November 2018 is the same as the 2012 version, i.e. to safeguard high biodiversity areas. Implications of aligning with the 2012 version (rather than the 2018 version) are therefore negligible.

ecosystems and the services they provide to people. The Project's social management plans will address issues of affected communities' access to, and use of, ecosystem services which have been identified through baseline studies (SRK Consulting 2017).

2.3 Biodiversity management within Seli Hydropower

The Project is being developed and implemented by Seli Hydropower (SH) with Joule Africa, the "parent company" to Seli Hydropower, providing technical support and oversight. Seli Hydropower is developing an Environmental, Social and Health and Safety Management System (ESHS MS) to cover the implementation of all components of the Project, including biodiversity. Within the ESHS team, the roles and responsibilities for implementing the BAP are defined in [Table 1](#). As the Project develops, further staff will be brought into the Environment team to provide technical support, particularly for coordinating the implementation of offset actions.

Effective biodiversity management will require coordination of the Environment team with the Social team and external stakeholders. To facilitate effective cross-team working, Seli Hydropower will establish an internal working group consisting of key Environment and Social team members. The working group will be maintained throughout construction and operations and will develop Terms of Reference (including objectives of the group, activities, frequency of meetings, appointment of a chairperson, etc.). Activities will include: development and maintenance of a joint spatially-referenced database of information relevant to the monitoring and adaptive management of biodiversity and social impacts and mitigation measures; coordination and planning of joint activities, and identification of activities which may pose conflicting outcomes for environmental and social objectives.

Table 1: Roles and responsibilities

| Role | Responsibility |
|---|--|
| General Manager | <ul style="list-style-type: none"> Overall management responsibility to ensure construction and operations are aligned with IFC PS6 and that the BAP is effectively implemented |
| ESHS Manager | <ul style="list-style-type: none"> Overall responsibility for BAP implementation, including ensuring that adequate and timely resources are available |
| Biodiversity Manager | <ul style="list-style-type: none"> Work with Seli Hydropower managers to ensure all BAP mitigation actions are embedded into the relevant construction and operations Management Plans, and contractual requirements and monitoring systems are in place to check compliance Ensure environmental and social Management Plans (including the Resettlement Action Plan) address the biodiversity requirements outlined in the BAP, and oversee the establishment and operation of a Seli Environmental & Social (E&S) working group Ensure the BAP and associated Plans are available to all Seli Hydropower employees and contractors Provide leadership and strategic advice on biodiversity matters to departmental managers and within the biodiversity team Develop and communicate on a regular basis to relevant department managers progress with targets related to biodiversity Liaise with relevant government, non-government and community stakeholders, to coordinate activities for biodiversity conservation, in particular the establishment of offsets Engage contractors to obtain specialist advice and support to achieve the objectives of the BAP |
| Biodiversity Coordinator | <ul style="list-style-type: none"> Implement the day-to-day management of the programmes necessary to meet the requirements of the BAP Work with contracted specialists to complete the actions required by the BAP Monitor and report on compliance with SH biodiversity commitments and legal obligations Provide training and guidance to SH staff and contractors on the requirements of this BAP |
| Environmental Specialist: Monitoring and Compliance | <ul style="list-style-type: none"> Ensure appropriate checks and balances are in place to verify that subcontractors are abiding by BAP actions and control measures of associated Management Plans Provide necessary implementation and monitoring support to meet the requirements of this BAP |
| Social/RAP coordinator | <ul style="list-style-type: none"> Work with Environment staff to implement the requirements of this BAP |
| Database Manager | <ul style="list-style-type: none"> Maintain the systems necessary to support the implementation and monitoring of this BAP |
| All employees and contractors | <ul style="list-style-type: none"> Comply with the requirements of this BAP |

2.4 Stakeholder engagement during BAP development

A summary of organisations and specialists consulted during the development of this BAP is provided in [Table 2](#).

Table 2: Organisations and specialists consulted during the development of the BAP

| Organization | Name and title | Topics discussed |
|---|--|---|
| National Protected Areas Authority (NPAA) | Mrs Kate Karemo-Garnett, Director of the NPAA Alhaji Malikie Siaka, Consultant in forest conservation Jopsef Bockarie, GIS specialist | Conservation priorities in Sierra Leone, selection of offset sites and activities for the Project |
| Environmental Protection Agency (EPA) | Momodu Bah, Director Joseph Turay, Assistant Deputy Director Field Operations and Extension Lovetta Juana, Head of Department Field Operations and Extension Tamba Nyaka, Head of Department Climate Change Secretariat | Scope of the BAP mitigation actions and offset sites |
| Forestry Division, Community Forest Unit | Alpha Umaru Leigh, Director Forestry Department | Community forests and co-management approaches in Sierra Leone |
| Bumbuna Watershed Management Authority (BWMA) | Hawa Sesay, Acting manager of the BWMA Abdulai Barrie, Previous manager of the BWMA | Lessons learnt from BBI and future approaches to catchment management |
| Tacugama Chimpanzee sanctuary | Bala Amarasekaran, Founder of Tacugama Chimpanzee Sanctuary | Threats to chimpanzees in the Project area and offset sites, activities to reduce threats and monitoring approaches |
| Dr John Oates | Dr John Oates, Independent expert primatologist (sat on the Environmental and Social Advisory Panel for BBI) | BBI project, lessons learnt from BBI and information of chimpanzees and primates in the Project area |
| Royal Botanical Gardens, Kew | Martin Cheek, Senior Research Leader (leading specialist in Podostemaceae in Africa and Madagascar) Xander van der Burgt, Curator and field officer (Africa and Madagascar) | Strategy and actions for <i>Ledermanniella yiben</i> to enable translocation and monitoring |
| Dr Aiah Lebbie | Dr Aiah Lebbie, Expert botanist. Lecturer, Head of Dept of Biological Science at Njala University | Strategy and actions for <i>Ledermanniella yiben</i> to enable translocation and monitoring |
| Dr Rainer Sonnenberg Dr Gina Walsh | African fish specialist, Alexander Koenig Research Museum African freshwater ecologist, Independent consultant | Mitigation and offset actions for priority fish species |
| Dr Cathryn MacCallum | Principal Social Scientist, SRK Consulting UK | Development of overlapping biological and social mitigation actions |

2.5 Documents supporting the BAP

Through extensive biodiversity surveys and assessments, the Project has developed a suite of documents to inform biodiversity mitigation and offset actions. The BAP, in effect, summarises these documents and they are therefore important reference materials when reading this plan (Table 3).

Table 3: Documents supporting the BAP

| Document | Purpose of the document | Reference |
|----------------------------------|---|-----------------------|
| Biodiversity strategy | ▶ To outline the Projects overarching goals, principles and approaches to achieving net gain for Critical Habitat and no net loss for Natural Habitat (a high-level document developed prior to this BAP) | Seli Hydropower 2018a |
| Critical Habitat assessment | ▶ To identify Natural Habitat and Critical Habitat-qualifying biodiversity associated with the Project as per the guidance notes of the IFC Performance Standard 6 from 2012 (IFC 2012a). | TBC 2017 |
| Risk-based prioritisation report | ▶ To identify priority biodiversity from the suite of Critical Habitat-qualifying biodiversity to be a focus of mitigation and monitoring actions for the Project | TBC 2019a |
| Residual impact assessment | ▶ To quantify the residual direct and indirect impacts of the Project, after the application of mitigation actions, and enable offset planning | Seli Hydropower 2019a |
| Offset strategy | ▶ To identify the suite of offset sites and actions required to enable the Project to achieve no net loss and net gain goals | Seli Hydropower 2019b |
| Bumbuna I legacy memo | ▶ To summarise the lessons learnt from the development and implementation of mitigation and offset actions for BBI for Bumbuna II (the Project). | TBC 2019b |

To operationalise the actions from this BAP, the Project will develop: (i) further biodiversity-specific plans, including biodiversity offset management plans and a biodiversity monitoring and evaluation plan; (ii) other plans with relevance to biodiversity, notably the influx management plan and the catchment and reservoir management plan which will include biodiversity and other mitigation measures; and detailed on-the-ground management plans that operationalise biodiversity mitigation as part of the suite of Environmental and Social Management System (ESMS).

3 Biodiversity context

The Project is located within the Rokel River catchment. The landscape around the Project consists of mainly hilly terrain with a mixture of natural habitats (hillslope forest, gallery forest and savannah/woodland), and modified habitats (farmed areas and fallow land). Recognising that the Project has the potential for impacts beyond its footprint, this BAP uses the term 'Project area' throughout to refer to a broad zone of influence. Three protected areas, the Bumbuna Conservation Area and Lake Sonfon are found within the Projects zone of influence (Figure 3) and the Farangaia forest reserve.

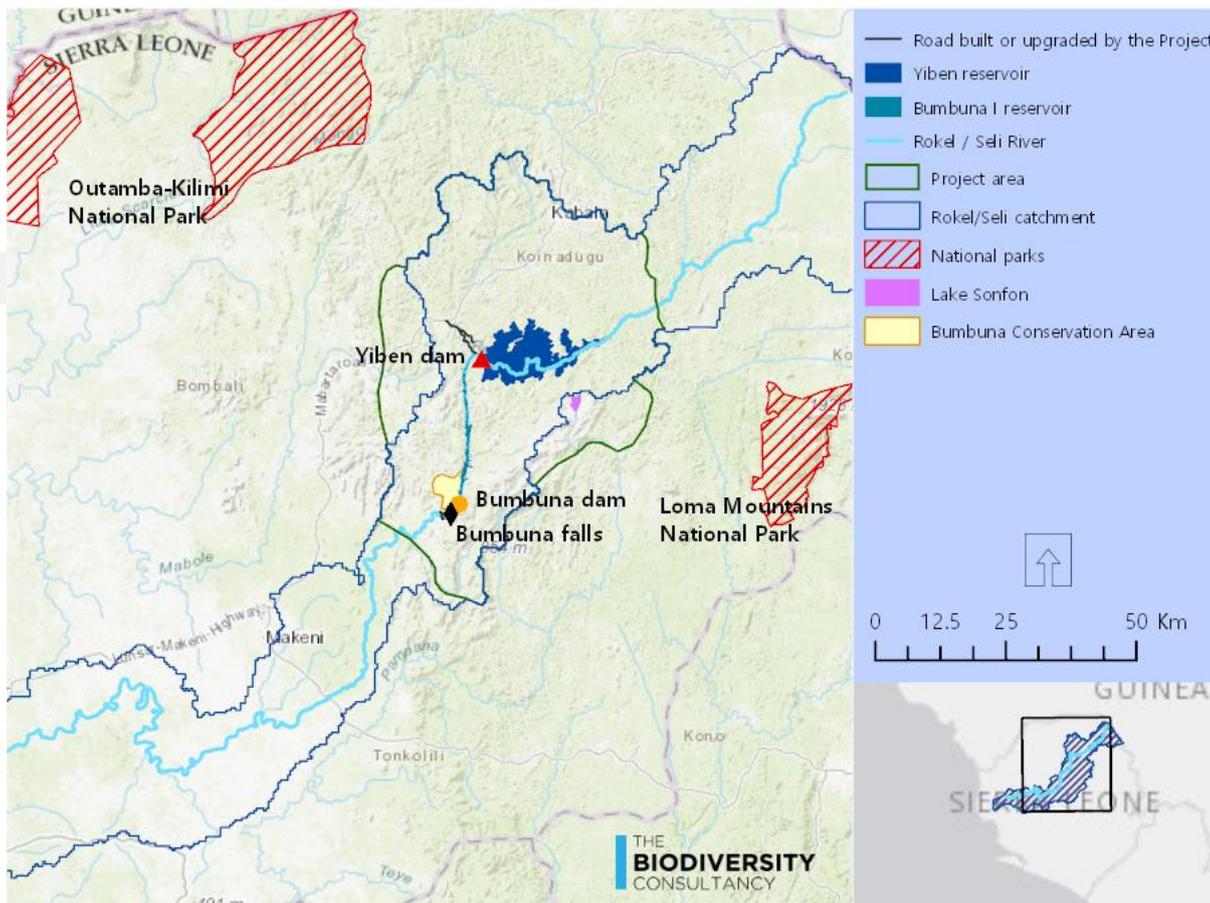


Figure 3: The Project area, the Rokel/Seli catchment and river and main protected areas within the region

Freshwater biodiversity

From a freshwater perspective, the Project is located within the Northern Upper Guinea freshwater ecoregion². The ecoregion supports a large number of endemic freshwater fauna including fish, amphibians, molluscs and crabs (Lévêque *et al.* 1989); about 28% of the 160 recorded species are endemic.

Within the ecoregion, the Project is located within the Rokel River catchment. The Rokel/Seli River is the second largest river in Sierra Leone, originating in the Guinean highlands and flowing west to enter the Atlantic Ocean adjacent to Freetown. The Rokel/Seli River is divided into upper and lower sections of river by the Bumbuna Falls. Upstream of the falls, where the BBI and Bumbuna II Project infrastructure is located, the river is known as the Seli River; downstream it is known as the Rokel River. The Bumbuna Falls forms a natural barrier for fish migration and divides the river into a lowland slow-flowing ("potamon") zone and an upper fast-flowing ("rithron") zone characterized by cooler waters and a lower species diversity (Payne *et al.* 2010). One species of fish is confirmed to be endemic to the upper Seli river (*Enteromius cf. aff. trispilos*), one other species (*Chiloglanis* sp. OTU3) is potentially endemic to the same area³. Many of the species of conservation concern are small-bodied and adapted to fast-flowing and clear waters in the upper zone where they prefer to live in small or medium sized tributaries. Many of these species (e.g. species from the nothobranchiid family) also require freshwater habitat with vegetated banks because: (i) they

² The Northern Upper Guinean aquatic ecoregion lies to the west of the Guinean range, extending from the foothills of the Fouta Djallon in Guinea, through Sierra Leone and into parts of Liberia and Guinea-Bissau.

³ The genetic analysis undertaken for the project has highlighted that the species is present in the area. However, only one specimen of the species was genetically sequenced. It is therefore not possible to assess its distribution range yet but based on expert opinion, the species is potentially endemic to the upper Seli river.

feed on insects that fall in from vegetation, and because, (ii) they deposit their eggs on submerged vegetation and roots (Sonnenberg & Walsh 2018).

The section of the Seli River between the future Yiben dam and the BBI dam is already degraded because of the development of BBI (much of this section is now the BBI reservoir). Only a few species of conservation concern have been recorded in this section since the construction of BBI⁴. The section of the river below the BBI dam and the Bumbuna Falls is also degraded due to downstream impacts from the BBI infrastructure and water flow management (see historical context of BBI below).

Non-fish species of conservation concern previously recorded in the Project area included the Slender-snouted Crocodile and the Pygmy Hippopotamus. The Slender-snouted Crocodile has not been recently recorded; the last record is from 2013 but it may still be present in very low numbers. The Pygmy Hippopotamus is confirmed to still be present but in very low numbers and only in areas with lower levels of human disturbance (Ganas-Swaray *et al.* 2018).

Two aquatic species of plant of conservation concern have also been recorded in the Project area; one of those is new to science and is called *Ledermanniella yiben*. Both species are from a poorly known family of plants called Podostemaceae or “riverweeds”. There are around 250 species in the Podostemaceae family, primarily tropical and subtropical aquatic plants that adhere to hard surfaces (generally rocks) in riverine rapids and waterfalls. They remain submerged when water levels are high but are exposed and flower during the dry season (Rutishauser *et al.* 2007). *Ledermanniella yiben* was described in 2017 (Cheek 2017) and is classed as Critically Endangered (CR). It has so far only been recorded growing in the Project area (and within the footprint of the future Yiben reservoir).

Historical context of BBI and freshwater biodiversity

The Environmental and Social Advisory Panel (ESAP) of BBI was established to provide independent advice to the Ministry of Energy on social and environmental matters. After the construction of BBI, the panel raised two concerns that were considered to have potentially significant downstream impacts for freshwater habitat below the BBI reservoir (Jenness *et al.* 2013):

1. Stratification in the reservoir leading to anoxic water release: Monitoring of the reservoir showed that the water surface (to 5 m) was of good quality, but there were signs of an anoxic layer (i.e. a layer without oxygen) at the bottom. The recommendation was to ensure that water quality was appropriately monitored at all water levels in the reservoir and that, if stratification continued, an air supply system be installed to avoid anoxic water going downstream. Deeper water quality monitoring stopped soon after 2012 as the expensive instruments for doing the monitoring were broken and never replaced (H. Sese, Bumbuna Watershed Management Authority, pers. comm. 2017).
2. Lack of a minimum environmental flow: The BBI dam is equipped with an environmental bypass designed to deliver an environmental minimum flow of 6 m³/s to the river downstream of the dam. This was not, however, operated as intended and the river on some occasions has completely dried up during the dry season in the section known as the “dry reach” between the environmental bypass and the first small tributary (Jenness *et al.* 2013).

Likely as a result of these two issues, a recent study carried out on ecological flow and habitat quality in the Rokel and Seli River (Ecotone 2018a) describes the stretch of river immediately downstream of the Bumbuna dam (the dry reach), and below the future Extension tailrace, as degraded and considered to be “modified” habitat.

Terrestrial biodiversity

From a terrestrial perspective, the Project lies in the Guinean Forest-Savanna ecoregion, a widespread habitat mosaic stretching across West Africa from the western lowland forest ecoregions to the West Sudanian Savanna. In the Project area, natural habitats include savannah/woodland, hillslope forest and gallery forest but these are largely fragmented and degraded and large sections of the Project area have been modified into agriculture, including young and mature fallows (SAR Sense Ltd. 2017). Natural habitats in the area support a number of threatened species and subspecies, including Western Chimpanzee, Black-and-White Colobus, Western Red Colobus, Ziama Horseshoe Bat and the tree *Vepris felicis*.

Western Chimpanzee is present in natural habitats within the landscape, with gallery and hillslope forests being most important for foraging, nesting and safety. Chimpanzees in the Project area are present at relatively low densities (0.13 [0.05-0.32]⁵ individuals/km²) (Ganas-Swaray *et al.* 2018). In Sierra Leone, the mean density of chimpanzees is estimated to be 0.67 [0.39-1.15] individuals/km² in forest reserves (but reaches 2.69 [1.44-5.01] individuals/km² in Loma Mountains National Park) and 0.97 [0.62-1.51] individuals/km² in protected wooded savannah (e.g. Outamba-Kilimi National Park). Nonetheless, the density estimated in the Project area is higher than has been estimated for other unprotected areas in the country (0.03 [0.02-0.06] individuals/km²) (Brncic *et al.* 2010). Threats to chimpanzees include habitat loss and fragmentation due to human activities (farming, mining, logging and illegal hunting). Compared to other primates, chimpanzees are better at adapting to modified habitats as they can travel between areas of remaining suitable habitat; [Figure 4](#) shows the chimpanzee groups identified during baseline surveys. Black-and-White Colobus and the Western Red Colobus are restricted to hillslope and gallery forests, with their populations severely fragmented and threatened by illegal hunting. These species are still present in the Project area but at very low densities and in only a few forest patches (Ganas-Swaray *et al.* 2018).

⁴ Three species were reported once each during surveys in 2010, 2013 and 2014

⁵ 0.05 and 0.32 individuals/km² is the estimated density within a 95% confidence interval

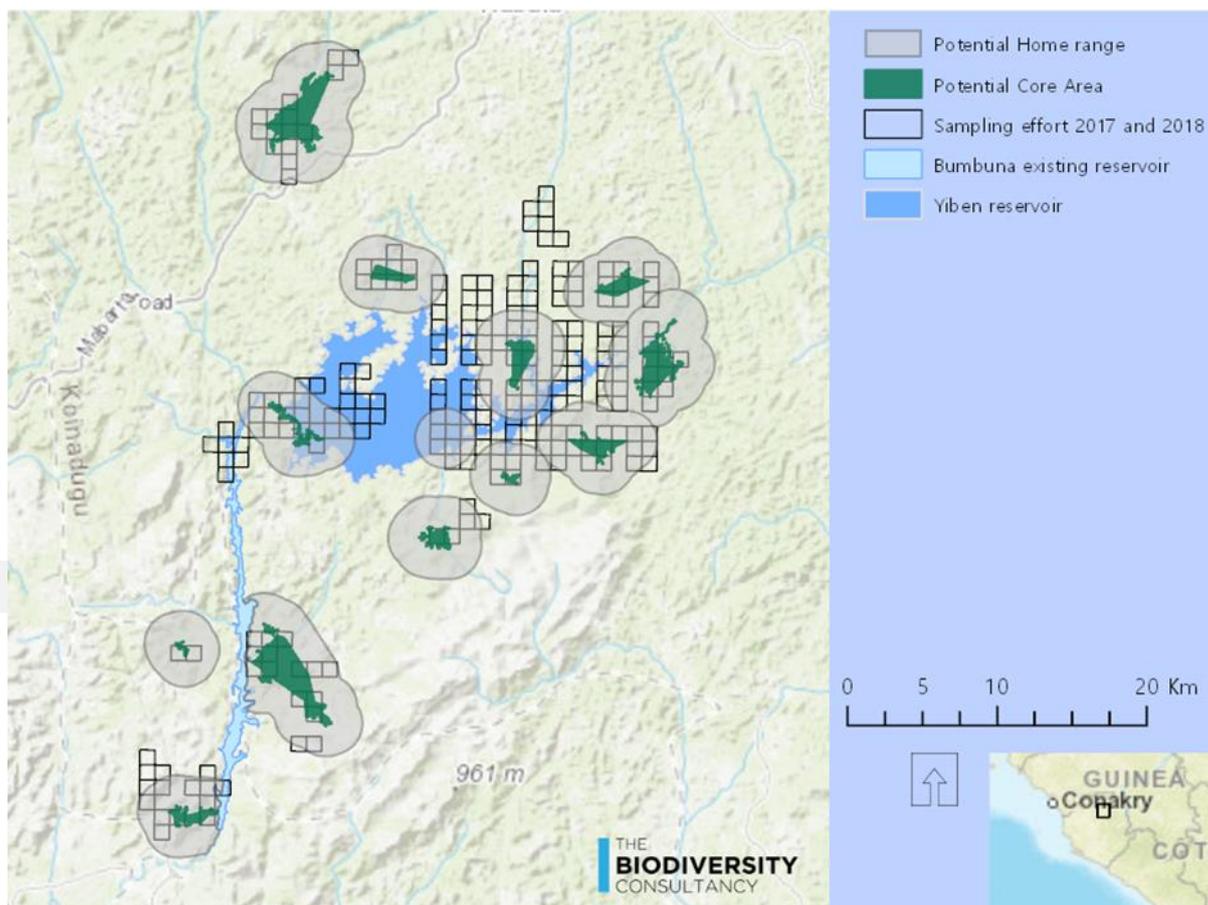


Figure 4: Chimpanzee groups identified during 2017 and 2018 surveys

Ziama Horseshoe Bat is an Endangered and restricted-range species which uses caves in moist habitat as roosting sites (Fahr 2008). It is likely that the species' range is much wider than currently known, owing to limited study on bats in West Africa. No specific threats to the species have been reported from the Project area.

The tree *Vepris felicis* is found in lowland and gallery forests. Although widely distributed in West Africa (T. Stevart, Missouri Botanical Garden, *in litt.* 2015), the species is rare and only known from a few locations within that range so is classified as globally Critically Endangered (Cheek 2017).

Historical context of BBI and terrestrial biodiversity

BBI aimed to establish an environmental management programme to mitigate and monitor impacts, and protect existing biodiversity. The programme included the establishment of the Bumbuna Conservation Area (BCA), set up as a biodiversity offset to protect Western Chimpanzees next to BBI Project infrastructure. The programme was designed to be implemented by the Bumbuna Watershed Management Authority and funded via the Bumbuna Trust Fund. There have been a number of challenges to the implementation and operation of the programme and as a result there has been continued degradation of terrestrial natural habitats and reductions in species' populations around BBI. Recent studies show evidence of a significant reduction in the number of chimpanzees within the BCA since 2007 (Ganas-Swaray *et al.* 2018; TBC 2019).

Implementation of biodiversity mitigation and management for the Project will learn from the lessons of BBI, but may also be hampered by negative stakeholder perceptions or experiences from BBI. The actions designed in this BAP reflect this historical context.

3.1 Critical Habitat-qualifying biodiversity

The Project defined two areas of analysis to determine Critical Habitat-qualifying biodiversity. The Project area was used to determine terrestrial Critical Habitat-qualifying species and the Rokel catchment was used to determine freshwater Critical Habitat-qualifying species. Priority biodiversity for the Project is defined as:

1. Species that qualify for Critical Habitat (TBC 2017);
2. Habitat types that support Critical Habitat-qualifying species (TBC 2019a);
3. Habitat types that are Natural Habitats (TBC 2017); and
4. Protected Areas (PAs) or Internationally-Recognized Areas that overlap the broad Project area (TBC 2017).

Within the suite of identified priority biodiversity (32 species, seven habitats, and three PAs), there is variation in terms of the conservation status, ecology, level of scientific understanding, Project and non-project influences, and cumulative impacts. Therefore, to highlight biodiversity that is a focus for BAP actions and monitoring, a prioritisation process was undertaken based on the likelihood of a Project impact and the potential consequence of any impact (TBC 2019a). This type of risk-based approach enables a Project to appropriately focus effort and resources on biodiversity at highest risk and has been applied to other projects aligning with best practice (e.g. [GAC project](#), Bujagali project (TBC 2018)).

The results of the risk-based prioritisation are summarised in ([Table 4](#)). The biodiversity classed as highest priority for BAP actions (Action Category 1) comprises species currently considered to be endemic to the Seli River (one freshwater fish and one freshwater plant⁶), one subspecies of great ape (Western Chimpanzee) and three habitat types that support these species (as well as other priority species). The suite of priority biodiversity also acts as a proxy for biodiversity in other Action Categories and wider biodiversity. Through habitat mapping and surveys, "Important Sites for Biodiversity" have been identified within the study area ([Figure 5](#)). These sites have been defined based on the presence of chimpanzee groups, other Critical Habitat-qualifying species, habitats that support these species (specifically gallery and hillslope forests), and existing Protected Areas. Measures to avoid and minimise impacts to these areas are part of planned mitigation actions (Section [5](#), GMA2).

⁶ Two additional fish and one frog are also provisionally placed in Action Category 1, pending the results of genetic analysis.

Table 4: Results of the prioritisation exercise to support BAP planning: priority biodiversity for BAP actions

| Action Category (AC) | Group | Priority biodiversity | Mitigation and monitoring approach |
|--|--|--|--|
| AC 1 High priority for habitat mitigation and/or species-specific measures | Mammals | Western Chimpanzee (<i>Pan troglodytes verus</i>) | Highest priority for both species-specific and habitat-focused mitigation and offset actions in order to achieve net gain (offset targets) |
| | Freshwater plants | <i>Ledermanniella yiben</i> | |
| | Amphibians | <i>Ptychadena cf. submascareniensis</i> 2* | |
| | Freshwater fishes | <i>Enteromius cf. aff. trispilos</i> , <i>Chiloglanis</i> sp. OTU3 | |
| | Natural Habitats | Galley forest, hillslope forest and freshwater habitat | |
| | Protected Areas & Internationally-Recognized Areas | Bumbuna Conservation Area | |
| AC 2 Contingency planning | Mammals | Ziama Horseshoe Bat (<i>Rhinolophus ziama</i>) | No significant impacts likely but would be significant if they occur. Implement good-practice mitigation at a broad level. If impacts are detected, elevate to Category 1 and develop species-specific measures. |
| | Reptiles | Slender-snouted Crocodile (<i>Mecistops cataphractus</i>) | |
| AC 3 General habitat mitigation measures | Mammals | Western Black-and-White Colobus (<i>Colobus polykomos</i>) and Pygmy Hippopotamus (<i>Choeropsis liberiensis</i>) | Non-significant impacts anticipated. Implement good-practice, tailored habitat mitigation. Use habitat or, if necessary, species-specific monitoring to check scale of impact. If monitoring suggests significant impacts are likely, elevate to Category 1. |
| | Birds | White-backed Vulture (<i>Gyps africanus</i>) and Hooded Vulture (<i>Necrosyrtes monachus</i>) | |
| | Amphibians | Freetown Long-fingered Frog (<i>Arthroleptis aureoli</i>), <i>Ptychadena submascareniensis</i> and Cameroon Grassland Frog (<i>Ptychadena retropunctata</i>) | |
| | Freshwater fishes | <i>Marcusenius meronai</i> , <i>Scriptaphyosemion cf. chaytori</i> , <i>Epiplatys</i> sp. aff. <i>njalaensis</i> , <i>Epiplatys</i> sp., <i>Archiaphyosemion cf. guineense</i> , <i>Scriptaphyosemion wieseae</i> , <i>Amphilius cf. platychir</i> OTU2, <i>Amphilius</i> sp. aff. <i>rheophilus</i> , <i>Chiloglanis</i> sp. OTU2, <i>Rhexipanchax kabae</i> and <i>Raiamas scarciensis</i> | |
| | Plants | <i>Ledermanniella aloides</i> and <i>Vepris felicis</i> | |
| | Natural Habitat | Natural savannah / woodland, inselberg, and river channel community | |
| | Protected Areas & Internationally-Recognized Areas | Lake Sonfon (Important Bird Area and proposed National Park) | |
| AC 4 Remain aware | Mammals | Diana Monkey (<i>Cercopithecus diana</i>) ⁷ and Western Red Colobus (<i>Piliocolobus badius</i>) | No significant impacts likely. Implement good-practice mitigation at a broad level. Use habitat monitoring as a proxy to check scale of impact. |
| | Freshwater fishes | <i>Enteromius liberiensis</i> , <i>Epiplatys lokoensis</i> and <i>Synodontis tourei</i> | |
| | Dragonflies | Yellow-fronted Threadtail (<i>Elatoneura dorsalis</i>) | |
| | Natural Habitats | Swamp & seasonally inundated grasslands | |
| | Protected areas | Farangbaia Forest Reserve | |

⁷ Diana monkey is very unlikely to be found in the Project area according to John Oates (primatologist).

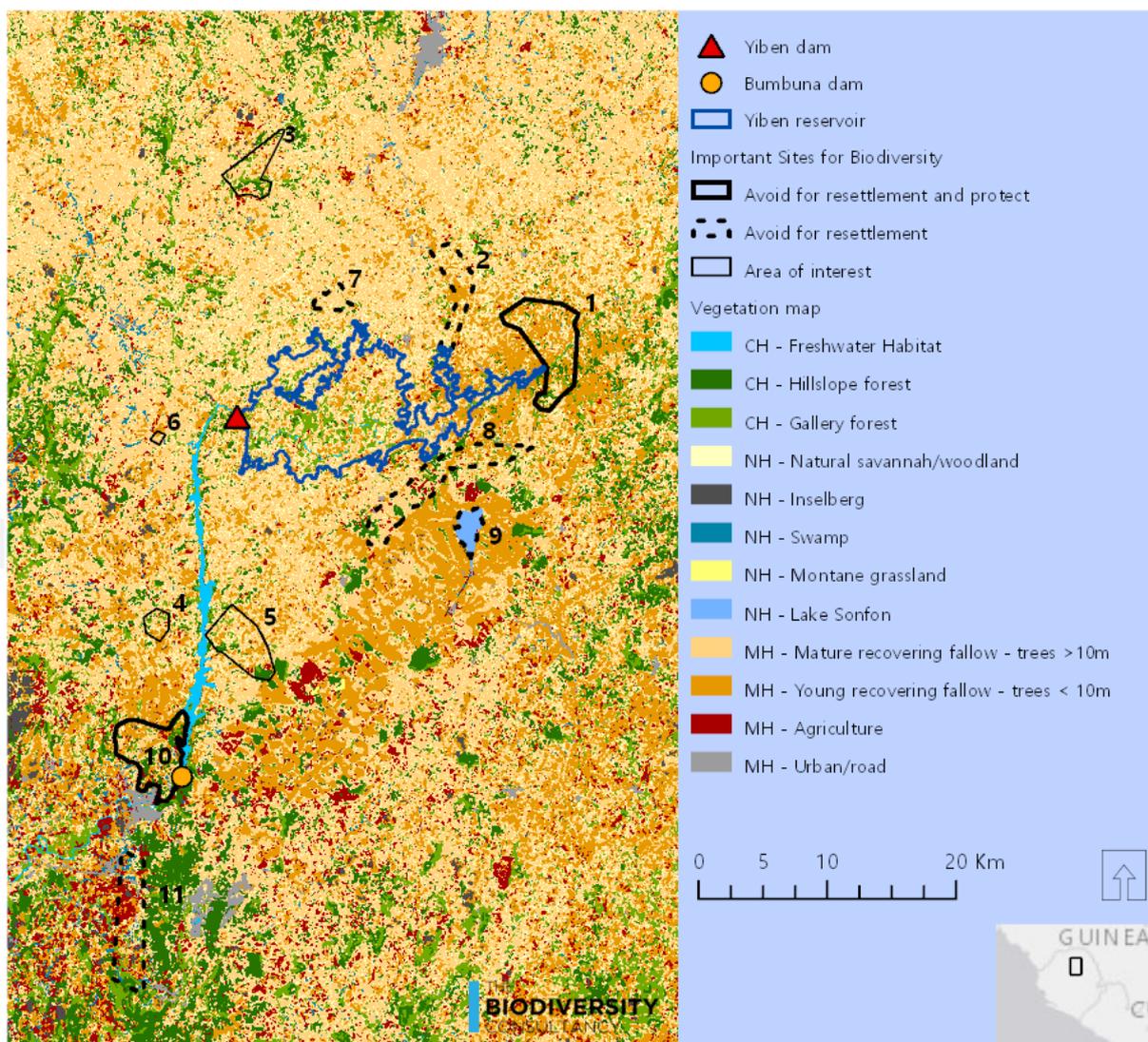


Figure 5: Map of Critical, Natural and Modified Habitat in the Project area, and Important Sites for Biodiversity (numbered areas)

4 Summary of potential impacts and mitigation overview

This section summarises the main potential impact pathways on Critical Habitat-qualifying species and Natural Habitat (Table 5), and the main actions that will be undertaken to mitigate (avoid, minimise, rehabilitate) and offset impacts, and to monitor losses and gains. The rationale for the proposed actions is provided in Section 4.1.

Table 5: Main potential impacts on priority biodiversity associated with the Project during the construction phase (early works and full construction⁸) and operations phase

| Main potential impacts | Main project components creating impact | Critical Habitat-qualifying species and Natural Habitats potentially impacted | Construction/ Operation |
|--|---|--|--------------------------|
| Habitat loss and degradation | Yiben reservoir area | Hillslope forest, gallery forest, natural savannah/woodland (particularly areas known to be used by chimpanzees and other threatened species), freshwater habitat (main river and tributaries) and associated freshwater species and loss of sole current known location for <i>Ledermanniella yiben</i> | Construction & Operation |
| | Upgrade of road to the Yiben site | | |
| | Clearance for infrastructure at Yiben and Bumbuna expansion | | |
| | Associated powerline from Yiben to Bumbuna expansion | | |
| | Induced economic influx to project area of influence | | |
| | Resettlement of affected communities | | |
| | Yiben dam construction and operation resulting in changes to the river flow regime, sedimentation and water quality upstream and downstream | | |
| Increased year-round water discharge from the Bumbuna Extension tailrace | | | |
| Habitat fragmentation | Yiben reservoir area | Freshwater habitat and associated fish species, terrestrial habitat used by chimpanzees and other threatened species | Construction & Operation |
| Overexploitation of fauna and flora | Hunting and collection of wild animals and plants by staff and contractors | Critical Habitat-qualifying species (especially chimpanzees, other primates and Pygmy Hippopotamus) | Construction & Operation |
| | Induced economic influx to project area of influence | | |
| | Resettlement of communities to new areas | | |
| Accidental mortality | Staff and contractor vehicles | Terrestrial species | Construction & Operation |
| | Filling of the Yiben reservoir | Terrestrial species and freshwater species (tributary specialists) | Construction |
| | Hydroelectric power facility (turbines, hydraulic shear, etc.) | Freshwater species | Operation |
| | Powerlines and sub-station | Vultures | Operation |
| Introduction of invasive species | Movement of staff and contractor vehicles and equipment | Terrestrial and freshwater animals (in particular amphibians) | Construction & Operation |
| | Spread of disease by staff and contractors | Terrestrial animals (in particular chimpanzees) | Construction & Operation |
| | Exposed banks of the Yiben reservoir and areas temporarily disturbed during construction | Terrestrial habitats | Construction & Operation |
| | Yiben and Bumbuna reservoirs | Freshwater species | Construction & Operation |

⁸ Filling of the Yiben reservoir will begin during the second year of the construction phase

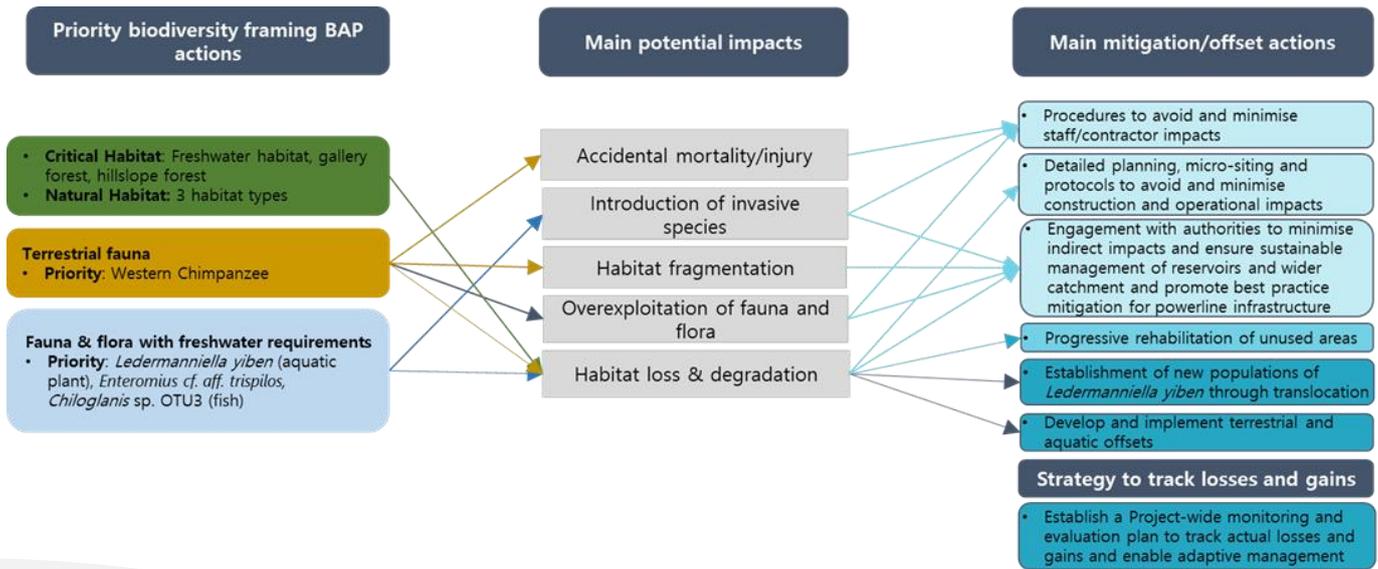


Figure 6: Overview of Bumbuna II's priority biodiversity, and main potential impacts, mitigation and offset actions

4.1 Technical rationale for mitigation actions

The Project will apply the mitigation hierarchy to avoid, minimise and rehabilitate impacts to biodiversity. Actions to address residual impacts will include terrestrial and freshwater offsets and species-specific measures. The main mitigation actions include:

Avoidance and Minimisation:

Procedures to avoid and minimise staff/contractor impacts (GMA1)

- ▶ Biodiversity focused procedures will be developed to ensure staff and contractors are aware of the species and habitats that are a priority for the Project and the actions they must undertake to avoid and minimise impacts to them. Compliance with procedures will be monitored and any breaches dealt with through strong penalty measures.

Detailed planning, micro-siting and protocols to avoid and minimise construction and operational impacts (GMA2)

- ▶ Detailed planning will ensure the Project is fully appraised of impact risks and, as appropriate, develops further measures to avoid and minimise impacts prior to construction activities for Alien Invasive Species and at quarry sites. A suite of protocols will be developed and implemented to guide construction and operational activities to minimise direct Project impacts to Important Sites for Biodiversity, freshwater habitats downstream of Yiben and Bumbuna infrastructure and habitats and species surrounding construction sites.
- ▶ Four sections of river will be impacted by the Project⁹. Three of these (downstream of the Yiben reservoir and downstream of the BBI reservoir) are predicted to remain in the same Ecotatus¹⁰ category (Ecotone 2018a), retaining similar habitat integrity and quality (and therefore mitigation actions are not required), but freshwater habitats in the Yiben Reservoir inundation zone itself will be heavily impacted (as these impacts cannot be avoided or minimised they will be offset).
- ▶ There will be some freshwater impacts between the Yiben Dam and the BBI reservoir. The full extent of these impacts remains under investigation, based on the extent to which the BBI reservoir already backs up towards the Yiben Dam. On the basis that this reservoir will not entirely, and certainly not always, reach the Yiben Dam, there is a need to maintain minimum environmental flows.
- ▶ The stretch of river between the BBI dam and the planned Extension tailrace (the “dry reach” of c. 4 km including the Bumbuna Falls) is already significantly impacted by existing BBI peaking generation operations. The Project plans to reduce overall flows, but to maintain a minimum environmental flow. Reduced flows may have some impacts on dry season spawning species and recruitment of rheophilic species, but conditions may improve for resident species as a result of a reduction in the current peaking influence on this stretch. An overall improvement in the quality of this stretch is achievable through modification of environmental flows to mimic dry-wet season flows.
- ▶ The stretch of river downstream of the Extension tailrace has also already been degraded by existing BBI operations. Operations of the current Project will result in an increase in dry season flows extending throughout the downstream river (until the estuary), and a delay in the onset of the wet season functional flows (only pronounced between Bumbuna Town and Magburaka). These hydrological changes are likely to negatively impact lowland species that only breed in the dry season, potentially quite far downstream (though to a decreasing

⁹ (i) The inundation zone of the Yiben reservoir; (ii) the extended Bumbuna footprint; (iii) the “dry reach” between the BHP-I dam and the Extension tailrace; and (iv) downstream of the tailrace.

¹⁰ The Ecotatus represents an ecological integrated state for drivers (hydrology, geomorphology, physico-chemical) and responses (fish, freshwater invertebrates etc.). This approach to assessing ecological state is widely applied in a South African context (Kleynhans & Louw 2007).

degree further from the Project). They are also likely to impact species which breed at the onset of the wet season (by effectively reducing the length of breeding season), for a certain distance downstream – potentially including *Marcusenias meronai* and *Synodontis tourei*. *Raiamas scarciensis* may also be affected also be affected by a change in water flow. A number of engineering options have been considered to reduce flow in the dry season, but all options have significant financial implications and would likely render the Project uneconomic (ERM 2017b, Annex E), meaning these impacts can only be offset rather than mitigated.

Negotiated and agreed actions with stakeholders (GMA3)

- ▶ Influx of economic migrants during the construction period is potentially a significant indirect impact to priority biodiversity (as well as to existing social infrastructure) through uncontrolled land clearance, increases in hunting pressures and the introduction of invasive species into the reservoirs. The Project will therefore work with local and traditional authorities to establish appropriate mechanisms to avoid and minimise influx prior to the commencement of construction activities (e.g. through radio campaigns to state the preference for only employing local people already registered in the area) and to manage the people that migrate into the area (e.g. to concentrate influx to a particular town where appropriate infrastructure can be provided).
- ▶ To manage potential indirect impacts to Important Sites for Biodiversity, the Project will work with local authorities and communities to avoid the relocation of communities to these areas and where avoidance is not possible, the Project will work with communities adjacent to these sites to establish Conservation Agreements (GMA3.1 and 3.2). The agreements will contain community-negotiated conservation actions that can be co-monitored.
- ▶ Indirect impacts to the Yiben reservoir will be managed through the implementation of the Yiben reservoir management plan. From a biodiversity perspective, the risk of eutrophication of the reservoir is considered to be low (Ecotone 2018b), so management actions will focus on avoiding the introduction of invasive species such as the Nile Perch, developing sustainable fisheries management and ensuring wider catchment activities do not lead to contamination or sedimentation of the reservoir or feeder streams (GMA3.3). Vegetation clearance prior to flooding of the reservoir will only be undertaken where there is either a future health and safety issue for Project activities and local communities or where there is an economic incentive for clearance. Communities may be allowed to farm in the shoreline zone (in areas that do not overlap with an important area for biodiversity) but farming activities will be monitored and where required interventions made to minimise erosion and sedimentation of the reservoir.
- ▶ Design and construction of the India EXIM powerline, connecting Yiben and the Bumbuna extension to the national grid, is under development by the Ministry of Energy and outside the direct control of the Project. However, Seli Hydropower will work closely with the Government to assess and manage biodiversity risks in alignment with IFC PS6 and encourage the use of mitigation measures to minimise collision and electrocution risks and develop offsets actions if required¹¹.

Rehabilitation (GMA4)

- ▶ The Project will apply a progressive rehabilitation approach to return areas no longer required by Project activities to a natural state.

Species-specific actions to achieve net gain

Species-specific actions for *Ledermanniella yiben* (SSA1-SSA5)

- ▶ The Yiben reservoir will flood the only known site of the freshwater plant, *Ledermanniella yiben*. Translocation trials are in the process of establishing new populations of *Ledermanniella yiben* and the Project will monitor these sites and adaptively manage translocation activities to achieve a net gain (Section 6).
- ▶ The Project will also support in-country *ex situ* approaches to conservation of *Ledermanniella yiben*.

Species-specific actions for Western Chimpanzee (SSA6 & SSA7)

- ▶ The Project will ensure actions to avoid and minimise impacts to chimpanzees are a focus of staff and contractor protocols. Important Sites for Biodiversity known to contain chimpanzee populations will be monitored in order to track and adaptively manage mitigation measures. Terrestrial offset actions will support the Project to achieve a net gain outcome for predicted residual impacts to chimpanzees.

Offset

- ▶ The Project's Yiben reservoir has a large, unavoidable footprint that will result in direct habitat loss, fragmentation, and accidental mortality of Critical Habitat-qualifying species. An estimate of the total area of direct and indirect impacts on habitat, and estimate of impacts to chimpanzees, has been used to guide the offset site selection process. Terrestrial and freshwater offset sites have been selected that are predicted to enable the Project to meet NNL/net gain requirements (Sections 7 and 8).

¹¹ Costs of mitigation and offsets for the India EXIM powerline are not part of the BAP

5 General mitigation actions

This section summarises the main mitigation actions that the Project will implement to address the impacts that construction and operations are most likely to cause to priority biodiversity ([Table 6](#)), in alignment with PS6. Specifically, mitigation measures address: accidental mortality; introduction of invasive alien species (IAS); habitat fragmentation; overexploitation of fauna and flora; habitat loss and degradation. Species-specific mitigation actions required for Action Category 1 species are discussed in [Section 6](#), and additional actions to achieve a net gain in [Section 8](#).



Table 6: Outline of general mitigation actions planned during construction and operations

| Mitigation: ID, measure and outline of required actions | | Applicability (Construction / Operations) | Timing | Frequency | Responsibility for ensuring action is implemented | Means of verification |
|---|--|---|--|--|---|---|
| Procedures to avoid and minimise staff/contractor impacts | | | | | | |
| GMA1 | <p><u>Avoidance through staff and contractor awareness</u></p> <p>Ensure staff and contractors abide by procedures to prevent biodiversity impacts</p> | Pre-construction, Construction and Operations | Prior to commencement of ground works to end of operations | Monthly reporting by Seli Hydropower and contractors once codes of conduct are operationalised | Seli Hydropower | <p>Codes of conduct that align with Project biodiversity strategy (set out in this BAP)</p> <p>Induction records of contractors and staff</p> <p>Breaches of conduct by staff and contractors</p> <p>Contractor reports</p> <p>Records of spot checks by Seli Hydropower of contractors</p> |
| <ol style="list-style-type: none"> Develop biodiversity procedures for contractors, employees and their families to outline the rules, codes of conduct and prohibitions relevant to the mitigation of impacts on biodiversity, to include: restriction of personnel movements to designated roads and paths to minimize habitat degradation and interaction with wildlife; prohibition of hunting and fishing and purchase of bushmeat; prohibition of collection of timber and non-timber forest products (NTFPs); prohibition of transporting of bushmeat or NTFPs in Project and contractor vehicles; prohibition of introduction of alien/exotic plants or animals including domestic pets; sanitation and hygiene measures; waste disposal; smoking area restrictions (to avoid fire); and vehicle speed limits. Ensure there are sufficiently strong penalties for staff and contractors who disregard the procedures. Ensure compliance with biodiversity mitigation procedures is explicitly included in the Terms of Reference for contractors and subcontractors. Develop an induction program to train new staff, contractors and visitors upon their arrival in the procedures and communicate the penalties for non-compliance. Develop specific training for roles that may impact priority biodiversity, e.g. training of vehicle operators to adhere to speed restrictions and avoid collisions with wildlife, training of security guards to check for bushmeat or other prohibited products on personnel and vehicles leaving/entering site, training for the social team on the synergies and potential conflicts of community and biodiversity work. Enforce the procedures with regular checks and balances to ensure compliance, e.g. verify that security teams undertake routine inspections of vehicles and staff bags entering and leaving site to check for prohibited products, verify records of journey times or Global Positioning System (GPS) recorders to check speed limits on roads are respected, verify that new staff and contractors are familiar with the codes of conduct. | | | | | | |
| Detailed planning, micro-siting and operational protocols to avoid and minimise impacts | | | | | | |



| Mitigation: ID, measure and outline of required actions | Applicability (Construction / Operations) | Timing | Frequency | Responsibility for ensuring action is implemented | Means of verification |
|---|---|---|---|---|--|
| <p>GMA2 <u>Avoidance and minimisation through implementation of construction and operational protocols, detailed planning and micro-siting</u></p> <p>Ensure staff and contractors comply with construction and operational protocols to avoid and minimise biodiversity impacts</p> | Pre-construction, Construction and Operations | Prior to and during ground works to end of operations | Monthly reporting by contractor(s) once protocols are operationalised | Seli Hydropower | <p>Protocols that align with Project biodiversity requirements</p> <p>Monitoring of breaches in protocols</p> <p>Spot checks by Seli Hydropower of contractor work</p> <p>Reporting by contractors</p> |
| <ol style="list-style-type: none"> 1. Establish which species or pathogens are at risk of being brought to the Project area via imported equipment or vehicles or movement of equipment and vehicles in-country. Develop and implement appropriate construction and operational protocols to clean vehicles and equipment: (i) prior to export (ii) on arrival in country; and (iii) on arrival to site; to identify and monitor high risk invasive species; and to control/eradicate any invasive species that do inadvertently become established (linked to GMA2.9). 2. Incorporate the Geographic information System (GIS) layer of 'Important Sites for Biodiversity' into project databases and share with all contractors and the social team to avoid construction and relocation of communities near these sites; where avoidance is not possible develop and implement actions to reduce impacts to these sites (GMA3.1). Also provide the GPS location of the <i>Ledermanniella yiben</i> site (with a 500 m upstream buffer) to early works contractors to avoid pollution/sedimentation impacts to the location of the species or immediately upstream (although impacts at this stage are highly unlikely due to the location of the site in relation to Yiben dam construction activities). 3. Commission botanical surveys of potential quarry sites by a suitably qualified expert to record the presence of any species of conservation concern. If species of conservation concern that likely qualify for Critical Habitat are recorded at potential quarry sites, undertake an alternatives analysis including biodiversity criteria to select the most appropriate quarry site. Ensure any impacts to species that likely qualify for Critical Habitat are recorded (e.g. area impacted and number of individuals). Where possible, the quarry site(s) should be located within the future Yiben reservoir footprint to avoid additional impacts. 4. Ensure contractors develop pre-clearance and clearance work protocols to demarcate areas for vegetation clearance and prohibit activities (people and vehicles) outside these areas. Clearance protocols will include requirements to: <ul style="list-style-type: none"> (i) record the type of habitat, the condition of the habitat, the land use and the area that will be disturbed prior to clearance and use this to inform rehabilitation activities; (ii) carefully remove top soil and appropriately store it for progressive rehabilitation activities (GMA4.1); and (iii) identify man-made fish ponds within the direct footprint of clearance activities and within the Yiben reservoir, and carefully drain all such ponds prior to clearance and/or flooding of the reservoir. Kill any fish species found within the ponds (and provide them to local people for consumption) to avoid the introduction of invasive or non-native species to the natural environment. 5. If contractors are procured to collect harvestable timber in the future Yiben reservoir area, contractual arrangements will include measures to ensure that clearance does not expand beyond the limits of the future reservoir area and that unauthorised clearance by third parties does not take place, e.g. through barriers on access roads, and that associated facilities such as saw mills are removed at the end of the contractual period. 6. Ensure contractors develop construction and operational protocols to minimise light, dust, noise and contamination impacts, including: only essential lighting is used in the construction area and directional lighting near rivers and stream; dust suppression techniques are regularly used along unsurfaced roads and in construction and quarry areas; the IFC EHS best practice guidelines are complied with in minimizing noise disturbance blasting; and blasting is conducted at the same each day. 7. Develop operational protocols to maintain the recommended minimum hydrological flows at all times during construction and operation: (i) from the Yiben dam, maintain a minimum environmental flow of 4m³/s in the dry season months (December – April) and 15m³/s in the wet season (May to November) in order to maintain a variable natural flow regime (ERM 2017b, Annex E); (ii) from the BBI dam | | | | | |



| Mitigation: ID, measure and outline of required actions | Applicability (Construction / Operations) | Timing | Frequency | Responsibility for ensuring action is implemented | Means of verification |
|---|---|---|---|---|--|
| <p>within the “dry reach”, maintain a minimum environmental flow of 6m³/s from July-January, but then mimic dry season reductions from February-June by reducing gradually to around 2m³/s in April before rising again towards July (Ecotone 2018a). There are no viable mitigation actions to reduce impacts below the Bumbuna extension tail race (Section 4.1).</p> <p>8. Develop and implement operational protocols to remove floating debris, including any invasive plant species from the dam intake grills for appropriate disposal to avoid downstream contamination.</p> <p>9. Develop water quality monitoring protocols to monitor water quality at different depth in Yiben and Bumbuna reservoirs and water quality of discharge. If problems such as low oxygen levels are detected adaptive management measures should be undertaken. For example, reaeration of discharge using turbulence-inducing structures or pumps.</p> | | | | | |
| Engagement with authorities to reduce indirect impacts | | | | | |
| <p>GMA3 <u>Minimisation through negotiated and agreed actions with stakeholders including communities, Chiefdom authorities, local and regional Government authorities</u></p> <p>Ensure indirect impact risks to biodiversity are addressed in social management plans and third-party management plans</p> | <p>Pre-construction, Construction, Operations</p> | <p>Prior to commencement of ground works to end of operations</p> | <p>Monthly reporting through project lifetime</p> | <p>Seli Hydropower</p> | <p>Overlap between relocated communities and 'Important Sites for Biodiversity'</p> <p>Agreements with relocated communities containing conservation actions</p> <p>Conservation Agreements with communities to manage 'Important Sites for Biodiversity'</p> <p>Existence of Management Plans for influx and reservoir management</p> <p>Tracking of implementation of activities in Management Plans</p> |
| <p>1. Work with affected communities and Chiefdom authorities to relocate communities and artisanal mining activities away from 'Important Sites for Biodiversity' (Figure 5). Where avoidance is not possible, reach agreement on conservation measures that the communities will undertake to minimise impacts to the sites that they are located near to, for example through land-use planning, conservation of areas of natural habitat, no hunting of species of conservation concern (such as the Western Chimpanzee, Pygmy Hippopotamus), or other socially and culturally appropriate measures. Include agreed conservation measures into planned resettlement agreements with each community and jointly monitor the implementation of conservation measures and the status of Important Sites for Biodiversity.</p> <p>2. Evaluate the potential scale and location of human influx that may occur during the construction period (and into operations as people may choose to stay in the area), and establish with local government authorities and Chiefdom authorities appropriate responses to manage influx prior to the commencement of construction activities to minimise social and environmental impacts (such as uncontrolled land clearance, increased hunting pressure and introduction of invasive species into reservoirs). Measures to deter people from speculatively moving to the area should be included into Influx Management Plans (e.g. radio campaigns to state preference for only employing local people already registered in the area) as well as measures to concentrate influx into specific towns where appropriate infrastructure can be put in place. Other responses to manage biodiversity impacts may include development of conservation agreements or similar mechanisms with communities living near 'Important Sites for Biodiversity' where influx is anticipated to occur, to agree protection measures, including community patrols and hunting restrictions for priority biodiversity, in exchange for compensation. Embed</p> | | | | | |



| Mitigation: ID, measure and outline of required actions | Applicability (Construction / Operations) | Timing | Frequency | Responsibility for ensuring action is implemented | Means of verification |
|--|---|--|--|---|-----------------------|
| <p>agreed measures into the relevant management plans (Influx Management and Monitoring Plan and the Sustainable Reservoir Management Plan) and work with relevant authorities and organisations to ensure effective implementation and joint monitoring (GMA3.3).</p> <p>3. Work with sustainable landscape specialists and local authorities and stakeholders to evaluate the most appropriate approach to managing the Bumbuna and Yiben reservoir areas, agree the activities that will be permitted within and around the Yiben reservoir and develop, implement and monitor management plans. For the management of the Bumbuna reservoir, one management option is to work with the existing BWMA that was created as part of BBI activities. To continue the BWMA activities, a clear Terms of Reference (ToR) for the scope of a new phase of management would be developed, along with an evaluation of capacity and resourcing required to implement required activities. Although the Bumbuna Conservation Area is now substantially degraded (TBC 2019b), a small group of chimpanzees remains and so specific actions to maintain – and where possible increase – remaining natural habitat should be part of the ToR. For the Yiben reservoir, management options include: extending the activities of the BWMA; establishing a new authority to work alongside the BWMA (or in place of the BWMA); or using a community-based management approach.</p> <p>To avoid management problems due to lack of funding, the management of both reservoirs will be assessed and made available for the whole Bumbuna II concession period, the funding mechanism that will be used for catchment management and offsets will be determined as part of this process. Terms of reference for the implementation of management activities will be developed with targets for key activities to ensure actions are implemented and achieving the required outcomes. Reservoir management will: ensure that invasive species, particularly fish species such as Tilapia and Nile Perch, are not introduced to the reservoirs (through raising awareness of the problem of invasive species with communities); ensure the sustainable management of fishing activities; monitor farming in the riparian zone of the Yiben shoreline (if farming is permitted) to maintain and enhance areas of natural vegetation adjacent to 'Important Sites for Biodiversity', (site #1 and site #2, Figure 3); monitor wider catchment activities to ensure they do not lead to erosion and sedimentation of the reservoirs or contamination of the reservoir or streams (GMA3.2); rehabilitate degraded habitats in 'Important Sites for Biodiversity' and evaluate the possibility of maintaining natural vegetation on islands within the Yiben reservoir.</p> <p>4. Work with the Ministry of Energy to ensure the biodiversity risks of the India EXIM transmission line are assessed and managed in alignment with IFC PS6 and, as required, mitigation measures to minimise collision and electrocution risks are applied. Provide technical support to the Ministry of Energy through the Project Advisory Group (PAG)¹² to ensure mitigation measures are implemented and any monitoring and/or offset actions are appropriately undertaken by the Ministry.</p> | | | | | |
| Progressive rehabilitation of unused areas | | | | | |
| <p>GMA4 <u>Rehabilitate areas disturbed during construction</u></p> <p>Undertake technical and biological rehabilitation to enable the natural restoration process based on effective techniques</p> | <p>Construction and Operations</p> | <p>Trial approaches during first year of construction and scale up</p> | <p>As disturbed areas are no longer required are available (mapped within the management plan)</p> | <p>Seli Hydropower</p> | <p>Site visits</p> |
| <p>1. Develop a rehabilitation plan to enable progressive rehabilitation of disturbed areas that are no longer used by the Project. The plan should include technical protocols to remove debris and contaminated soils and re-contour surfaces to achieve a gentle gradient with an even spread of top soil. Trials may be required to assess the most appropriate approach to biological rehabilitation; in some</p> | | | | | |

¹²The PAG consists of stakeholders from the Ministry of Energy, Ministry of Finance, Ministry of Lands, Country Planning and Environment, Ministry of Works, Sierra Leone Environmental Protection Agency, National Protected Areas Authority, National Revenue Authority, Seli Hydropower, Electricity Supply and Distribution Authority (EDSA), Electricity Generation and Transmission Company (EGTC), and community stakeholders and is set up to provide a monthly technical working group so that key Project issues can be addressed by relevant parties.



| Mitigation: ID, measure and outline of required actions | Applicability (Construction / Operations) | Timing | Frequency | Responsibility for ensuring action is implemented | Means of verification | |
|--|---|---|---|---|-----------------------|---|
| <p>circumstances the area could be left to passively rehabilitate (for example if the disturbed area is small and surrounded by native vegetation); in other circumstances (where larger areas have been disturbed) biological rehabilitation using seeder and/or direct planting of native plants, may be required. The aim of rehabilitation is to achieve a return of vegetation type similar to pre-disturbance, the condition of the vegetation is expected to naturally improve overtime. Protocols should include checks of rehabilitated areas to remove invasive species and monitor the progress of biological rehabilitation. If monitoring detects native vegetation is not growing in rehabilitated areas, further technical and biological rehabilitation may be required.</p> | | | | | | |
| <p>Adaptive management of mitigation and offset actions</p> | | | | | | |
| GMA5 | <p><u>Track and adaptively manage progress towards no net loss and net gain targets</u> Develop and implement an overarching biodiversity monitoring and evaluation plan to track losses and gains and enable adaptive management</p> | Pre-construction, Construction and Operations | Implement monitoring approach during Construction period, adapt and finalise for Operations | As per the requirements of the plan | Seli Hydropower | Biodiversity monitoring and evaluation plan Annual reports |
| <ol style="list-style-type: none"> 1. Develop an overarching biodiversity monitoring and evaluation plan (BMEP) to develop the methods for monitoring pressure, state and response indicators within both the Project area (to measure impacts/ biodiversity losses) and at offset sites (to measure biodiversity gains). Adaptive management thresholds will be provisionally developed to be tested during the construction period. The same state indicators will be used at offset sites to ensure losses and gains can be compared. However, the monitoring method for state indicators, and the indicators and methods for pressure and response indicators at offset sites, will be site-specific and therefore developed as part of offset development actions (TOA4 and FOA3). 2. Begin implementation of the monitoring plan within the Project area early in the construction period (year 1) to ensure all “monitoring baseline” data is complete for the identified method. For example, for priority fish species a thorough inventory of species presence and distribution within the upper Seli catchment is available from baseline field surveys. However, the monitoring approach will likely involve Environmental DNA (eDNA¹³) monitoring (as well as complementary periodic surveys) as this will be a more efficient monitoring approach over the operational phase of the Project; this will require some additional genetic analysis of specimens of priority species already collected by the Project and the development and trial of a monitoring design. 3. Review data collected during each of the first two years of the construction period and adapt methods and thresholds as required to ensure the data collected can usefully inform adaptive management. Continue implementation of the adapted BMEP, including periodic evaluation of methods and thresholds to enable the Project to demonstrate progress towards no net loss and net gain targets. | | | | | | |

¹³ eDNA monitoring refers to DNA deposited in the environment through excretion, shedding, secretions, etc. This can be collected in water samples and used to identify the species present within the sample. The Project has begun developing a genetic database of priority species and is well placed to apply this approach as part of freshwater monitoring

6 Species-specific actions

This section addresses mitigation actions for highest priority species (Action Category 1) that only involve the species (as is the case for *Ledermanniella yiben*) or require inclusion of a species-specific focus (as is the case for Western Chimpanzee). The species-specific actions (SSAs) for *Ledermanniella yiben* aim to achieve a net gain for the species (Table 7, Seli Hydropower 2018), particularly by:

1. Translocating seeds to new locations that meet the ecological requirements of the species so that, if no new populations are found prior to impacts, the species will remain viable in the wild;
2. Monitoring translocation sites to demonstrate in the short term that seeds are propagating and plants remain viable, in the medium term that plants are growing and flowering, and in the long term that self-sustaining populations have been achieved; and
3. Trialling ex-situ propagation to establish protocols that enable *Ledermanniella yiben* seeds to be artificially germinated, grown, produce viable seed, and be successfully seeded or planted out to new locations.

The Project considers that net gain will have been achieved for the *Ledermanniella yiben* when it can demonstrate that there are self-sustaining populations of *Ledermanniella yiben* in at least three new locations, and ideally six or more new locations¹⁴. The Project will also undertake additional conservation actions to establish a mini seed bank in Sierra Leone and build capacity of Sierra Leonian botanists to store and manage seeds of rare species in Sierra Leone, including *Ledermanniella yiben*.

Species-specific actions to avoid, minimise and monitor impacts to Western Chimpanzee are outlined in Table 8, but actions to achieve a net gain for this subspecies are part of terrestrial offset actions (Section 8).

¹⁴ If new wild populations of *Ledermanniella yiben* are found, this objective will be reviewed.

Table 7: Species-specific actions for *Ledermanniella yiben*

| Mitigation: ID, measure and outline of action required | | Applicability | Timeframe | Frequency | Responsibility for ensuring action is implemented | Means of verification |
|--|--|---------------------------------|--|----------------------------|---|---|
| SSA1 | <u>Search for and secure new wild populations of <i>Ledermanniella yiben</i></u> Undertake further surveys in priority sites that have the potential to support the growth of <i>Ledermanniella yiben</i> . | Construction | Prior to construction until priority sites have been visited | During dry season | Seli Hydropower | Exploration survey reports |
| | <ol style="list-style-type: none"> Based on habitat modelling (Ecotone 2018c) and specialist knowledge, prioritise rivers and sections of river in Sierra Leone and potentially adjacent countries (e.g. Guinea) for further survey work. Recent surveys in Guinea found a new population of <i>Lebbiea grandiflora</i> - the new species (and genus) encountered by Project work during surveys for <i>Ledermanniella yiben</i> in Sierra Leone. If focused survey effort in priority sites does not find new populations of the species, this action will be considered completed when agreed by specialists from Kew Gardens and Njala University. | | | | | |
| SSA2 | <u>Establish and maintain a mini seed bank in Sierra Leone and build capacity of national botanists to store and manage seeds of rare species, including <i>Ledermanniella yiben</i></u> | Pre-construction and operations | Prior to operations until end of operations | Ongoing | Seli Hydropower | Agreement with the national herbarium of Sierra Leone Mini seed bank records |
| | <ol style="list-style-type: none"> Enter into an agreement with the national herbarium of Sierra Leone, based in Njala University, to support the establishment, maintenance and management of a mini seed bank to store <i>Ledermanniella yiben</i> seeds for translocation work¹⁵. The establishment of a mini seed bank will likely require the purchase of drying equipment and a freezer for storage. Specific skills and technical knowledge will be required to manage the seed bank. The Project will therefore support capacity-building of a Sierra Leonian botanist to manage the seed bank and build the capacity of other botanists in Sierra Leone. Collection and management protocols for the seed bank will be established by the trained botanist. Capacity-building will likely be undertaken at the <u>Millennium seed bank</u> managed by Kew gardens in the UK. Collect seeds from the <i>Ledermanniella yiben</i> population at Yara. Dry seeds and check their viability prior to storage in the mini seed bank. Ensure sufficient seed stock is available for Project translocation work. | | | | | |
| SSA3 | <u>Establish new locations of <i>Ledermanniella yiben</i> through translocation (assisted colonisation¹⁶)</u> | Pre-construction and operations | October 2017 until 3+ new locations | Yearly (during dry season) | Seli Hydropower | Annual monitoring and translocation report |

¹⁵ Note: Project work to date includes extensive seed collection of *Ledermanniella yiben* and storage of seeds within the Millennium seed bank at Wakehurst in the UK. The collection holds ~1.25 Million seeds of *Ledermanniella yiben*, the viability of the seeds was tested to be 47%, Information is available through the Millennium seed bank partnership.

¹⁶ Following the IUCN Guidelines for reintroductions and other conservation translocations (2013) the technical term for the type of translocation the project is undertaking is "assisted colonisation". Assisted colonisation is defined as the intentional movement and release of an organism outside its indigenous range to avoid extinction of populations of the focal species. For the purposes of this BAP we use the more general term "translocation" throughout.



| Mitigation: ID, measure and outline of action required | Applicability | Timeframe | Frequency | Responsibility for ensuring action is implemented | Means of verification |
|---|-----------------------------|--|----------------------------|---|--|
| | | reach completion criteria (SSA4) | | | |
| <ol style="list-style-type: none"> Based on specialist knowledge and Project surveys, select sites for translocation trials in at least 10 locations¹⁷ in multiple rivers and tributaries. Where possible, translocations should be within existing Protected Areas to support long-term conservation. Seek permission from communities living near to translocation trial sites to undertake translocation trials. Methods to either sow seeds or translocate individuals will be based on the outcomes of previous trials. If annual monitoring (SSA4 and Section 9.2) demonstrates that the population at a translocation site is increasing, the Project will assess a community stewardship mechanism to ensure the long-term conservation of the site, e.g. through working with local communities to develop Conservation Agreements to protect the section of river upstream of the site from mining activities in exchange for an agreed conservation incentive and/or establishing an alert system with the Project to communicate any potential activities around the population or upriver of the population that may affect its viability. If annual monitoring (SSA4 and Section 9.2) records declines in indicators at a translocation site, investigations into potential reasons for failure will be undertaken and – where required – further trials in new sites established. | | | | | |
| <p>SSA4 <u>Monitor translocation sites to meet completion criteria</u></p> <p>Track changes to translocated populations to identify if completion criteria for a self-sustaining population are met</p> | Construction and operations | From October 2017 until completion criteria achieved | Yearly (during dry season) | Seli Hydropower | Annual monitoring and translocation report |
| <ol style="list-style-type: none"> Implement annual monitoring at translocation sites: the objective of translocation trials is to assist the colonisation of self-sustaining populations of <i>Ledermanniella yiben</i> in at least three new locations and ideally six or more new locations. Indicators and thresholds have been defined to monitor progress towards this objective and adaptively manage translocation activities if orange and red warning thresholds are crossed (Section 9.2). If an orange warning threshold is crossed, investigate likely causes of change and where possible implement corrective measures. If a red threshold is crossed, the translocation site is failing and a further site for a translocation trial will need to be identified and translocation activities implemented (SSA3). A self-sustaining population will have been achieved when the gold threshold for seed production (Section 9.2) is passed at a translocation site i.e. when 35% of plants at the translocation site produce seed over 10 consecutive years. Net gain will have been achieved when three translocation sites pass the gold threshold for seed for ten consecutive years. | | | | | |

¹⁷ IUCN guidance to define 'location' for a species is based on the primary threat to a population of the species. The primary threat for *Ledermanniella yiben* is considered to be artisanal mining (Dr A. Lebbie, Njala University, *pers. comm.* 2018) which creates large amounts of sediment downstream. The sediment settles on top of populations of *Ledermanniella yiben* (and other aquatic plants), causing mortality. For *Ledermanniella yiben*, a location is therefore defined as a main river or tributary where one or more populations of *Ledermanniella yiben* are found. The Project will undertake trial translocations in at least 10 locations (i.e. 10 main rivers and/or tributaries) with the aim of establishing self-sustaining populations in at least three locations.



| Mitigation: ID, measure and outline of action required | | Applicability | Timeframe | Frequency | Responsibility for ensuring action is implemented | Means of verification |
|--|--|------------------|-------------------------------|---|---|--|
| SSA5 | <p><u>Trial ex-situ propagation</u></p> <p>Support Kew Gardens to trial the propagation and growth of <i>Ledermanniella yiben</i> seeds to provide an insurance mechanism if problems are encountered with translocation.</p> | Pre-construction | January 2019 – September 2019 | Once (assess if further work is required at the end of the trial) | Joule Africa | <p>Kew Gardens report</p> <p>Propagation protocols</p> |
| | <ol style="list-style-type: none"> 1. Ensure Kew Gardens fulfils the objective of the trial, to the extent possible (i.e. establish protocols that enable <i>Ledermanniella yiben</i> seeds to be artificially germinated, grown, and resulting plants to produce viable seed and be successfully seeded or planted out to new locations for restoration). Establish further experimental trials based on the outcomes, if required. 2. Ensure Kew Gardens appropriately documents the experimental design and outcomes of the propagation trials to enable the approach, if successful, to be reproduced. | | | | | |



Table 8: Species-specific actions for Western Chimpanzee

| Mitigation: ID, measure and outline of action required | | Applicability | Timeframe | Frequency | Responsibility for ensuring action is implemented | Means of verification |
|--|---|-----------------------------|--|---|---|---|
| SSA6 | <u>Ensure staff and contractor codes of conduct highlight requirements to avoid and minimise impacts to Western Chimpanzee (GMA1)</u> | Construction and Operations | Prior to commencement of ground works to end of operations | Monthly reporting by contractor once codes of conduct are operationalised | Seli Hydropower | Codes of conduct that align with Project biodiversity requirements Induction records of contractors and staff Monitoring of breaches in conduct by staff and contractors Contractor reports Spot checks by Seli Hydropower of contractors |
| | 1. Ensure all new staff and contractors are able to visually identify Western Chimpanzee and embed the following specific requirements within codes of conduct for staff and contractors: no urination, defecation or spitting outside of designated bathroom facilities; if chimpanzees are sighted, do not approach the animals and report sighting to biodiversity staff; keep within vehicle speed limits; if chimpanzee are sighted near to a road stop the vehicle and wait for them to move away; no hunting of any species, including chimpanzee; no purchase of bushmeat, or its transportation in Project or contractor vehicles. | | | | | |
| SSA7 | <u>Monitor chimpanzee communities in Important Sites for Biodiversity in the Project area of influence and implement adaptive management actions if threats increase (GMA3.1 and 3.2)</u> | Construction and Operations | Throughout construction and operations | To be decided in the BMEP | Seli Hydropower | Annual Monitoring reports |
| | 1. The BCA and 'Important Sites for Biodiversity' ¹⁸ are key sites for biodiversity mitigation for the Project as they are known to contain important core habitat used by chimpanzee communities. Project actions GMA3.1, GMA3.2 and GMA3.3 are designed to maintain these areas and avoid hunting of chimpanzees and other priority species. The Project will undertake specific monitoring of these areas to assess threats to the habitat and the chimpanzee populations and, if threats are detected (e.g. encroachment, habitat degradation or evidence of hunting), undertake adaptive management and increase Project mitigation actions in those areas (Section 9). | | | | | |

¹⁸ Important Sites for Biodiversity numbers 1,3,4,7,8 and 9 in [Figure 5](#)

7 Residual impact assessment

A quantified residual impact assessment of priority biodiversity was carried out to assess the significance of residual impacts from Project activities after avoidance, minimisation and rehabilitation mitigations have been put in place. This impact assessment identifies offset targets to compensate for significant residual impacts on priority species and habitats, in order to achieve an overall net gain for biodiversity (Seli Hydropower 2019a). It is not practical to quantify residual impacts for all biodiversity, so the Project carried out a risk-based prioritisation exercise (TBC 2019a) to identify Critical Habitat-qualifying biodiversity with a high likelihood and consequence of Project impacts (Table 4). Based on the findings a habitat-based approach was used to assess direct and indirect impacts on most priority biodiversity. This approach focused on the three Natural Habitats which contain Critical Habitat-qualifying species, i.e. gallery forest, hillslope forest and freshwater habitat and natural savannah/woodland (a Natural Habitat). For species and subspecies of highest priority (Western Chimpanzee, the aquatic plant *Ledermanniella yiben*, and the fish *Enteromius sp. aff. trispilos*), the habitat-based approach was not appropriate as these species are impacted by additional threats to habitat degradation and loss (e.g. hunting for chimpanzees) or are not evenly distributed in their habitat. A species-specific approach was therefore applied to these three species/ subspecies.

The main **Project impacts** identified and include in the residual impact assessment were:

- ▶ Direct impacts:
 - The Project footprint, i.e. project infrastructure, roads and reservoir at full supply level;
 - Habitat degradation or disturbance around the Project footprint; and
 - Impacts from resettlement activities.
- ▶ Indirect impact:
 - Influx of economic migrants, resulting in habitat conversion for farmland and potentially in increases in hunting of species such as chimpanzees.

Approach to assess impacts

In the Project area, the majority (71%) of habitat has already been modified by human activities. Natural Habitat remains in small patches within a mosaic of Modified Habitat and is under threat from further conversion to agriculture and degradation by logging activities (SAR Sense Ltd. 2017). A declining baseline was therefore used to assess residual Project impacts on habitats. To accomplish this, a (precautionary) deforestation rate was estimated for the Project area and predicted Project impacts at the end of the Seli Hydropower concession compared to those that were predicted to have happened in the absence of the Project. The difference between the two estimates was considered to be the residual impact attributable to the Project. A static baseline was used for chimpanzees in order to be even more precautionary, and because of high uncertainty about the rate of population decline in the Project area (Seli Hydropower 2019a).

Throughout, a Quality Hectare (QH) metric (or Quality Kilometres [QKm] for freshwater) was applied to Project impacts. A QH metric ensures that there is uniform accounting or exchange between losses and gains across the Project area (losses) and offset areas (areas of gains). QH is a widely used metric that combines measures of habitat extent (hectares) and habitat condition (quality), in recognition that even "Natural Habitat" in the area is already somewhat degraded (Seli Hydropower 2019a).

Impacts from the Project footprint¹⁹ were estimated by overlaying the mapped footprint with the Project habitat map and species distribution maps. For resettlement and influx impacts, several scenarios were developed based on several possible uncertainties (such as the location of resettlement villages) and the potential effectiveness of Project mitigation measures (to avoid impacts to the Important Sites for Biodiversity) (Seli Hydropower 2019a).

Throughout, a precautionary approach was taken, to ensure that Project impacts are not likely to exceed estimates (and thus leave an unforeseen liability).

Results and significance

It is estimated that a total of c. 24,900 ha will be impacted by the Project. The impacted area is, however, largely made up of Modified Habitat (c. 17,550 ha), with just c. 3,800 ha of Critical (Natural) Habitat and c. 3,550 ha of other Natural Habitat being impacted. The 3,800 ha represents a loss of 12% of Critical Habitat in the Project area, although this is a significant impact, the loss will not affect the overall integrity of Critical Habitat in the Project area. Freshwater habitat residual impacts include 39 km of main river stem and 123 km of river tributaries, with consequent impacts on priority fish species. It is predicted that the Project will result in the loss of between 44-70 chimpanzees, and the only known site of the aquatic plant *Ledermanniella yiben*.

As residual impacts have been estimated on a precautionary basis, monitoring during implementation is likely to reveal that impacts are lower than this forecast, or mitigation more successful. In such a case, offset targets can be lowered.

Results are presented using the QH metric (Table 9) with estimates of the direct residual impact (i.e. impact of the Project footprint and resettlement after the application of mitigation actions) and indirect residual impact (i.e. impact from influx of economic migrants after the application of mitigation actions).

¹⁹ The Project footprint includes the Yiben reservoir, the permanent extension of the BBI reservoir to the base of the Yiben dam, Bumbuna Extension infrastructure, Yiben infrastructure and the upgrade of the access road to Yiben.

Table 9: Summary of preliminary residual impact assessment and offset targets (presented using the QH/Qkm metric)

| Biodiversity | Direct residual impact estimate | Indirect residual impact estimate | Offset target* |
|---|--|-----------------------------------|---|
| Hillslope forest | 279 QH | 625 QH | 902 QH |
| Gallery forest | 985 QH | 399 QH | 1,384 QH |
| Freshwater Habitat (also used as a proxy for the priority fish species <i>Enteromius sp. aff. trispilos</i> and <i>Chiloglanis sp. OTU3</i>) | 21 Qkm of main stem 66 Qkm of tributaries | | 21 Qkm 66 Qkm |
| Natural savannah/woodland | 1,138 QH | 859 QH | 1,996 QH |
| <i>Ledermanniella yiben</i> | 250 m ² | N/A | Self-sustaining populations in at least three new locations (and ideally six or more locations) ²⁰ |
| Western Chimpanzee (<i>Pan troglodytes verus</i>) | 29 to 34 individuals | 15 to 36 individuals | 70 individuals gain |

*to achieve a net gain the Project will aim to create a greater gain than the offset target figure

8 Offset strategy

The offset strategy sets out how the Project will develop, implement and monitor biodiversity offsets to achieve a net gain for Critical Habitat-qualifying biodiversity and no net loss for Natural Habitats. The offset strategy is detailed in a separate document (Seli Hydropower 2019b) and summarised here.

Based on the residual impact assessment offsets are required for: (i) terrestrial Critical and Natural Habitat and for the Western Chimpanzee; selection of offset sites and activities therefore focused on this biodiversity; (ii) freshwater habitat and one species of fish; and (iii) the aquatic plant *Ledermanniella yiben*. An offset site selection process has identified offset sites and actions to create biodiversity gains Figure 7). Developing multiple offsets will ensure that priority biodiversity is appropriately captured in offset activities and on-the-ground implementation risks and technical uncertainties are reduced. Preliminary forecasts of biodiversity gains based on the planned offset activities indicate that the Project can achieve an overall net gain (Seli Hydropower 2019b). This strategy and level of assessment, particularly as it has been developed on a precautionary basis, gives the assurance that the Project can adequately compensate for residual impacts upon Natural and Critical Habitat in order to achieve no net loss and net gain, respectively. As the Project progresses, this strategy will be further developed through field assessments, including extensive consultations with local stakeholders, into a full offset plan that will be used for implementation on the ground.

²⁰ If new wild populations of Yiben Riverweed are found, this objective will be reviewed

Figure 7: Overview of the Bumbuna II offset strategy

| Type | Terrestrial | | Aquatic | |
|----------------------------|---|---|--|--|
| Target biodiversity | <ul style="list-style-type: none"> • 2 Critical Habitats (gallery forest, hillslope forest) • 1 Natural Habitat (wooded savannah) • Western Chimpanzee | | <ul style="list-style-type: none"> • 1 Critical Habitat (freshwater) • <i>Enteromius</i> sp. aff. <i>trispilos</i>, <i>Chiloglanis</i> sp. OTU3 (fish) • <i>Ledermaniella yiben</i> (plant) | |
| Approach | Site-based conservation management | Community-based conservation management | Targeted sustainable development activities | Species-specific activities to translocate and protect locations |
| Location | Loma Mountains National Park | Wankako forest patch | Upper Seli river and tributaries | Multiple rivers and tributaries in the Seli catchment and other catchments |
| Net gain mechanism | Conservation management activities to avert loss of forest habitat and species and restore degraded habitat | | Activities with artisanal miners to restore and maintain freshwater quality | Establish new populations through translocation |

Establishing conservation programmes is challenging in any environment, and biodiversity offsets are no different. The offsets planned for Bumbuna II are complex and involve multiple conservation actions with many different stakeholders, in multiple sites over a long period of time. The offset strategy draws on years of experience (including from the establishment of offset sites and actions during Bumbuna I), to mitigate risks during offset design and implementation. Key risk mitigation components to the strategy include:

- ▶ The use of multiple offset sites and approaches to increase the likelihood of achieving net gain outcomes for priority species/habitats;
- ▶ Establishment of clear governance and management mechanisms to oversee offset implementation;
- ▶ Institutional capacity building to enable offset oversight and implementation; and
- ▶ Realistic estimates of offset costs and long-term funding approaches.

The offset strategy has received preliminary endorsement from key government stakeholders in Sierra Leone. The next step will be to undertake social and biological field assessments and further stakeholder consultation to refine approaches and enable the development of offset management plans. This is planned for the Project construction period (i.e. after financial close) (Figure 8).

The actions necessary to further develop and implement the offset strategy are listed in Table 10 for terrestrial offset actions (TOA) and Table 11 for freshwater offset actions (FOA).

It is currently estimated that offset programmes (Terrestrial, Freshwater and for *Ledermaniella yiben*) will require \$19m (direct costs) and \$14.6 (costs budgeted in Community Development Action Plan (CDAP) and ASM Livelihood restoration programme) of funding up to the end of the Project’s concession period. Cost estimates are only preliminary and will be refined through further field assessments and detailed planning of offset actions. Details on the cost estimates and options for offset funding which are under consideration by the Project are documented in the offset strategy offset (Seli Hydropower 2019b).

Figure 8: Overview of the offset development process for the Project

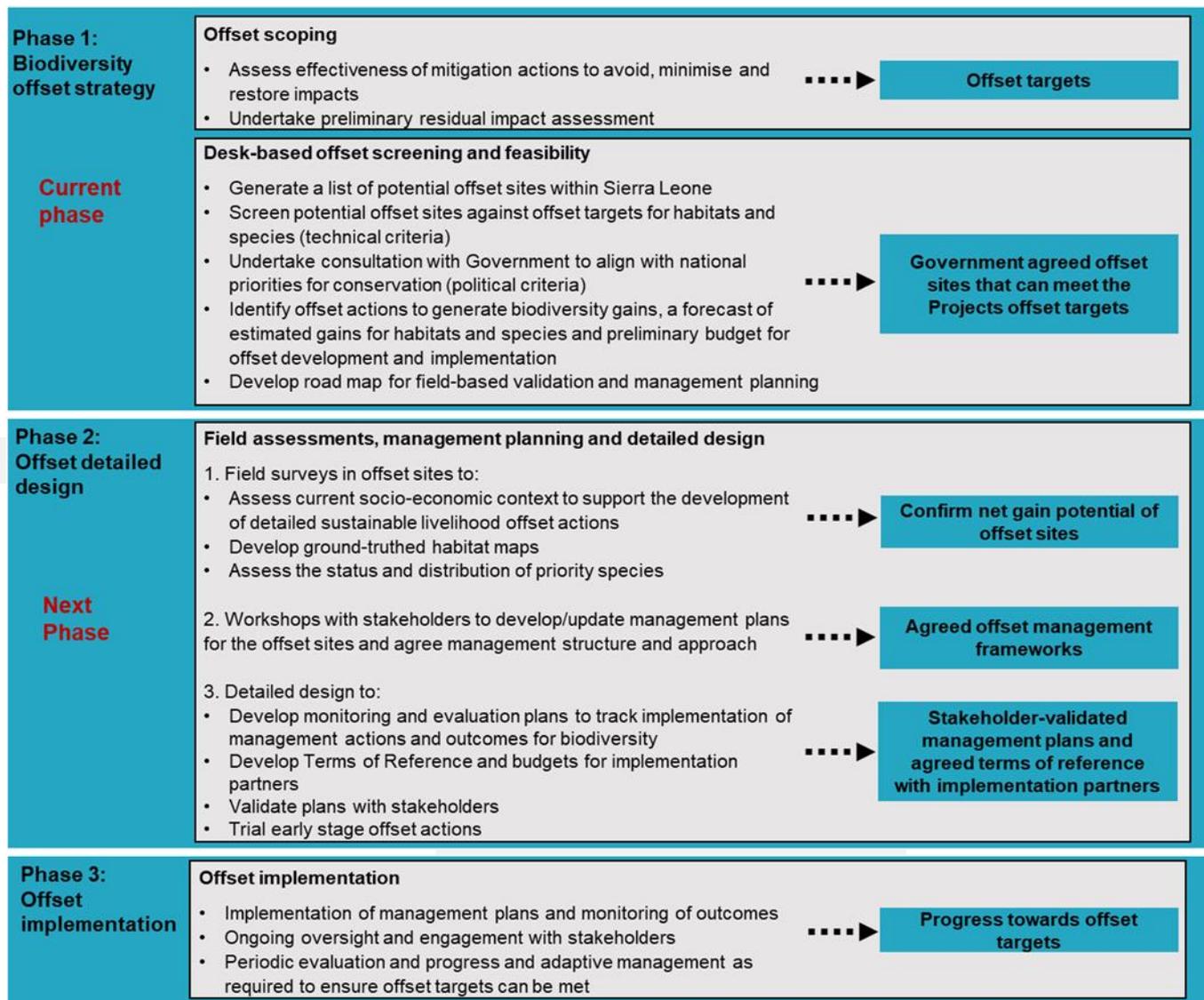




Table 10: Terrestrial Offset Actions (TOA)

| Offset: ID, measure and outline of action required | Applicability | Timeframe | Frequency | Responsibility for ensuring action is implemented | Means of verification |
|---|---------------|------------------------------------|-----------------------------------|---|--|
| <p>TOA1</p> <p><u>Field assessments in LMNP and Wankako forest patch</u></p> <p>Undertake social and biological surveys to gather baseline data to enable detailed management planning for LMNP Management Plan and the Wankako forest patch</p> | Construction | Construction period (year 1 and 2) | Dry season and wet season surveys | Seli Hydropower | Social and biological synthesis reports for LMNP and the Wankako forest patch |
| <ol style="list-style-type: none"> Biodiversity surveys will be undertaken to: (i) provide a baseline for chimpanzee populations in LMNP and Wankako forest patch; (ii) develop ground-truthed habitat maps for Loma and Wankako forest patch; and (iii) assess the likelihood of presence of priority biodiversity species, in particular <i>Ptychadena cf. submascareniensis</i> 2 (a frog), Ziama Horseshoe Bat, Slender-snouted Crocodile, Pygmy Hippo, White-backed Vulture, Hooded Vulture, <i>Vepris felicis</i> and Yellow-fronted Threadtail (a dragonfly). Social surveys will be undertaken: (i) around LMNP, to engage the 30 communities identified in the LMNP Management Plan (Forest Division 2012), to assess current resource use within the Park and to verify if management actions previously agreed to (Forest Division 2012) remain the most appropriate and effective for achieving sustainable development and conservation outcomes for offset target habitats and species; (ii) in and around the Wankako forest patch, to understand the socio-economic context of communities and assess community use of the forest area, to assess community interest in establishing the area as a formally recognised Community Forest, and to understand the terms of a socially-acceptable approach to sustainable community management of the forest patch (i.e. what incentives can be provided to communities to ensure they have a net benefit from engaging in sustainable management practices). A report synthesising the information collected will form the basis for updating the Loma Mountains NP Management Plan and, if socially acceptable, the process to establish Wankako as a Community Forest and a community management plan will be mapped out. The synthesis report will also update forecast estimates of terrestrial offset gains, if ground surveys reveal there may be significant variation from those forecast (Section Error! Reference source not found.). | | | | | |
| <p>TOA2</p> <p><u>Detailed management planning for LMNP and Wankako forest patch</u></p> <p>Hold a series of workshops to update the LMNP Management Plan and develop a Community Management Plan for Wankako forest patch (if appropriate); establish appropriate management and governance structures to enable offset implementation</p> | Construction | Construction period (year 3) | One-off | Seli Hydropower | Updated LMNP Management Plan Establishment of a Community Forest in Wankako and Wankako Management Plan |
| <ol style="list-style-type: none"> Engage with appropriate groups of stakeholders to: (i) for LMNP, share findings and agree management actions for the LMNP MP, agree a management structure for implementation of management actions that takes into account Project requirements for checks and balances to ensure offset funding is appropriately and effectively used to reach offset targets; and (ii) for Wankako forest patch, if communities agree to the establishment of a Community Forest in Wankako, establish the Community Forest and develop a Community Forest management plan – this will require its own stakeholder engagement process but also coordination with plans for LMNP (thus the same Biodiversity and Community teams and TA will support offset actions in both LMNP and Wankako Community Forest). Update the five-year LMNP MP, share the draft with all stakeholder groups (through community meetings/public consultations) and incorporate feedback as appropriate into the final plan. Apply a similar approach for the Wankako Community Forest MP. | | | | | |



| Offset: ID, measure and outline of action required | Applicability | Timeframe | Frequency | Responsibility for ensuring action is implemented | Means of verification |
|--|-----------------------------|------------------------------------|-------------------------------|---|---|
| <ol style="list-style-type: none"> Develop (and sign) a joint partnership agreement between the NPAA (and the Forestry Division if Wankako moves forward) and Seli Hydropower to define the vision, the terms, and the roles and responsibilities for the oversight and implementation of offset actions in LMNP and Wankako forest patch. Develop the Terms of Reference (ToRs) for the steering committee, TA organisation (encompassing protected areas management, livelihoods, biodiversity, and operations), Steering Committee and Community Conservation Committee. Begin the recruitment process for a TA organisation to support offset implementation (TOA3). | | | | | |
| <p>TOA3</p> <p><u>Offset implementation for LMNP and Wankako</u></p> <p>Develop and implement Annual Operating Plans to align with the five-year MPs for LMNP and Wankako</p> | Construction and operations | From year one to end of operations | Ongoing | Seli Hydropower | Annual Operating Plans and quarterly reports for LMNP Wankako annual work plan |
| <ol style="list-style-type: none"> Assess the most appropriate offset funding option during year one (e.g., up-front endowment fund, financing of a fund in the early years of operation, annual financing from revenues or profits backed by insurance or other financial guarantees, or a blend of approaches) and establish and capitalise the funding mechanism ready for offset implementation. Once the TA is in place, support will be provided to the Implementation Team to develop Annual Operating Plans (AOPs) and budgets that align with the actions of the LMNP five-year Management Plan, initially aligning with this previous offset strategy before a revised MP is in place. The AOP and budget will be approved by the Steering Committee prior to implementation (based on advice from the Project independent expert panel). Implementation of actions will build up slowly over the first two years whilst the capacity of the Implementation Team and staff develops. Quarterly reports of progress in, and outcomes of, implementation of the AOP will be provided to the Steering Committee for review and to secure the semi-annual release of funds for the next phase of activities. On an annual basis, the independent expert panel will review offset progress and provide recommendations to the Steering Committee to improve offset actions and outcomes. Quarterly or semi-annual reports and meetings will be held with the Community Conservation Committee to coordinate actions involving communities, and to ensure actions are aligned with expectations and with local and regional development plans. Each AOP and budget will be developed sufficiently prior to the end of year, for approval by the Steering Committee, to ensure that the implementation of management actions is continuous. Management of the Wankako Community Forest will be based on a structure agreed following discussions with the communities, traditional and local authorities and representatives of the Forestry Division. A yearly work plan and budget will be developed that aligns with overarching sustainable development actions that are agreed between the communities and authorities. | | | | | |
| <p>TOA4</p> <p><u>Monitoring and adaptive management to achieve terrestrial offset targets</u></p> <p>Monitor and evaluate offset actions to track progress towards offset targets; initiate adaptive management if thresholds are crossed</p> | Construction and Operations | From year one to end of operations | Ongoing (as per the M&E plan) | Seli Hydropower | Annual monitoring reports |
| <ol style="list-style-type: none"> An overarching Biodiversity Monitoring and Evaluation Plan (BMEP) will be developed as part of the General Management Actions (GMA5) to track losses (impacts) and gains (offsets). Site-specific monitoring and evaluation indicators that align with the overarching BMEP will be developed for LMNP and Wankako to track (i) the implementation of management actions (response indicators); (ii) changes in threat levels to priority biodiversity (pressure indicators), and (iii) changes in the population and distribution of chimpanzees and other priority species as appropriate, and changes in | | | | | |



| Offset: ID, measure and outline of action required | Applicability | Timeframe | Frequency | Responsibility for ensuring action is implemented | Means of verification |
|--|---|-----------|-----------|---|-----------------------|
| | <p>deforestation and degradation in the offset sites and buffer areas (status state indicators). Key response and pressure (and if appropriate state) indicators will have thresholds associated with them to trigger an adaptive management response if targets are not met.</p> <p>2. Monitoring and evaluation will be undertaken in accordance with the BMEP and site-specific indicators. Annual monitoring reports will be provided to the steering committee, with the results for each indicator. If monitoring detects that any threshold has been crossed without appropriate adaptive management being put in place, it will be raised immediately with the Implementation Team to undertake an assessment and appropriate adaptive management action.</p> | | | | |



Table 11: Freshwater Offset Actions (FOA)

| Offset: ID, measure and outline of action required | Applicability | Timeframe | Frequency | Responsibility for ensuring action is implemented | Means of verification |
|--|---------------|--------------------------------------|-------------------|---|---|
| <p>FOA1</p> <p><u>Extend the ASM study to the upper Seli catchment and develop a sustainable ASM plan</u></p> <p>Identify ASM sites, miners and activities that will be undertaken to develop more sustainable ASM practices in the upper Seli catchment</p> | Construction | Construction period (year 2) | During dry season | Seli Hydropower | Sustainable ASM plan for the upper river Seli |
| <p>1. Undertake a situational analysis of ASM activity in the upper Seli catchment (Mawaloko and upper Seli rivers) to: determine the scale and practice of ASM; identify potential livelihood diversification, approaches to implementing those; and identify a suite of supporting activities to enable sustainable ASM (e.g. capacity building, stakeholder engagement, revegetation of ASM sites, etc.). As part of the situational analysis, survey water quality at the ASM site and at 1 km intervals downstream until the next ASM, or for 10 km (parameters to include sediment load, turbidity, sediment deposition on vegetation/rock surface, heavy metal levels).</p> <p>2. Based on a “theory of change” or similar conceptual model, determine which ASM sites, miners and other stakeholders will be engaged, and which interventions and activities will be undertaken to reduce environmental impacts and improve social outcomes for miners, in order to achieve the freshwater offset targets. Work with key stakeholders to develop a sustainable ASM plan to deliver livelihood interventions, capacity building actions and other activities required to implement a sustainable ASM approach in the upper Seli river. Assess how the implementation of sustainable ASM in the upper Seli will be integrated into the livelihood actions undertaken with ASM miners in the Yiben reservoir to ensure a co-ordinated approach and efficient use of resources (staff and funding). Update estimates of freshwater offset gains and the sustainable ASM plan, based on water quality data collected at ASM sites, downstream of ASM sites.</p> | | | | | |
| <p>FOA2</p> <p><u>Freshwater offset implementation</u></p> <p>Implement the sustainable ASM plan to improve freshwater habitat quality and social outcomes</p> | Operations | Construction period (year 3) onwards | Ongoing | Seli Hydropower | Bi-annual implementation reports |
| <p>1. The sustainable ASM plan will be implemented by the same team undertaking sustainable ASM with Yiben ASM miners. Bi-annual progress reports will be provided to the Seli Hydropower environmental team to track implementation progress. The Project independent expert panel will be engaged on an annual basis (and ad-hoc if required) to review implementation progress and monitoring outcomes of freshwater offset actions (FOA3). They will make recommendations to Seli Hydropower and the implementation team on how to improve offset outcomes for freshwater offset targets.</p> | | | | | |
| <p>FOA3</p> <p><u>Monitoring and adaptive management to achieve freshwater offset targets</u></p> <p>Monitor and evaluate the actions and social and environmental outcomes of sustainable ASM to track progress towards offset targets; initiate adaptive management if thresholds are crossed</p> | Operations | Construction period (year 4) onwards | Ongoing | Seli Hydropower | Annual monitoring reports |
| <p>1. An overarching BMEP will be developed as part of the General Management Actions (GMA5) to track losses (impacts) and gains (offsets). A suite of indicators that align with the overarching BMEP will be developed for sustainable ASM activities to track: (i) the implementation of identified livelihood interventions, capacity building, and rehabilitation of abandoned ASM sites (response indicators); (ii) changes in the approach to ASM which will improve freshwater habitat quality (pressure indicators); and (iii) changes in the quality of freshwater habitat, composition of freshwater</p> | | | | | |



| Offset: ID, measure and outline of action required | Applicability | Timeframe | Frequency | Responsibility for ensuring action is implemented | Means of verification |
|--|---|-----------|-----------|---|-----------------------|
| | species and presence of priority fish species at, and downstream of, ASM sites (state indicators). Key response and pressure (and if appropriate state) indicators will have thresholds associated with them to trigger an adaptive management response if targets are not met. | | | | |

9 Monitoring and evaluation strategy

As outlined in the Project biodiversity strategy (Seli Hydropower 2018b), the Project will use the State-Pressure-Response framework to develop indicators and methods to track losses and gains and adaptively manage mitigation and offset actions. An overarching Project monitoring approach will be developed in a biodiversity monitoring and evaluation plan (BMEP) prior to the construction phase of the Project (GMA5). The BMEP will capture the methods for monitoring pressure, state and response indicators within the Project area (losses) and biodiversity gains at offset sites. Specific monitoring plans will be developed for terrestrial offset sites and freshwater offset actions (TOA4 and FOA3) but both plans will share common state indicators with the BMEP to ensure that losses and gains in priority biodiversity can be compared.

Thresholds will be developed for key pressure and response indicators e.g. forest cover in the BMEP and in the offset monitoring plans, to trigger an adaptive management response and enable the Project to change the level of mitigation or offset effort. For example, if remote sensing data indicates that the area of Natural Habitat is declining faster than predicted in the Project area (and, in particular, in the Important Sites for Biodiversity) this would trigger an investigation into the causes of the change and, where required, increased or altered mitigation or conservation measures.

The potential indicators and approaches outlined Table 12 will be confirmed in the BMEP²¹. Early in the construction period, the monitoring approaches will be trialed, any gaps in the monitoring baseline filled and the BMEP updated as required. The Project has collected extensive biodiversity data to inform mitigation actions but ongoing monitoring will likely adopt approaches that are more efficient and effective for tracking long-term changes. For example, for priority fish species, a thorough inventory of species presence and distribution within the upper Seli catchment is available from baseline data collection. However, the monitoring approach will likely involve Environmental DNA (eDNA²²) monitoring (as well as complementary periodic surveys) as this will be a more efficient monitoring approach over the operational phase of the Project; this will require some additional genetic analysis of specimens of priority species already collected by the Project and the development and trial of a monitoring design.

The indicators and methods in the BMEP will be periodically reviewed, based on biodiversity data collected, to ensure that this plan remains fit for purpose and enables the Project to demonstrate progress towards no net loss and net gain targets.

Preliminary indicators and thresholds for *Ledermanniella yiben* have been developed, as net gain actions for this species are already underway and monitoring is therefore required to track and adaptively manage these actions (Table 13). The preliminary thresholds will be evaluated with species experts once multiple years of data are available.

²¹ Indicators are described as 'potential' as they may need to be refined once the Project has developed a full suite of management plans.

²² eDNA monitoring refers to DNA deposited in the environment through excretion, shedding, secretions, etc. This can be collected in water samples and used to identify the species present within the sample. The Project has begun developing a genetic database of priority species and is well placed to apply this approach as part of freshwater monitoring.

Table 12: Overview of potential key indicators and approaches for the monitoring and evaluation plan

| Priority biodiversity | Response Indicator (and related GMA) | Pressure Indicator | Pressure Approach | State indicator | State Approach |
|---|---|--|---|---|--|
| Critical Habitat: Gallery forest, hillslope forest | % of communities adjacent to Important Sites for Biodiversity actively engaged in conservation of the sites (GMA3.1) | Encounter rate of signs of threat (agriculture activity, timber extraction) | Surveys in Important Sites for Biodiversity | Area of Critical Habitat in Important Sites for Biodiversity and the wider Project Area | Remote sensing |
| Natural Habitat: Natural savannah/woodland | % of activities implemented to avoid and minimise influx in the Influx management plan (GMA3.2) | Number of people in key towns and villages in the Project Area of Influence (Aoi) | Local census | Quality of Critical Habitat in Important Sites for Biodiversity and the wider Project Area | Ground surveys |
| Freshwater habitat and priority fish species | Area of gallery forest with rehabilitation activities (GMA4) Growth of forest in areas that have been rehabilitated Number of invasive species awareness campaigns undertaken for the reporting period (GMA3.3) | Records of invasive fish or aquatic plant species from Yiben or Bumbuna reservoirs Oxygen levels (and other variables) at different depths in Yiben and Bumbuna reservoir | Observation/eDNA Water sampling | Presence and distribution of priority species Area of gallery forest along main Seli river and tributaries | eDNA and periodic surveys Remote sensing |
| Western Chimpanzee, <i>Pan troglodytes verus</i> | % of communities adjacent to Important Sites for Biodiversity undertaking joint patrols with the Project in Important Sites for Biodiversity (GMA3.1 and 3.2) | Encounter rate of signs of threat (snares, gun cartridges, etc.) | Surveys in Important Sites for Biodiversity | Chimpanzee population size in Important Sites for Biodiversity (State habitat indicators for Critical Habitat relevant here) | Transects for density and surveys to enable DNA analysis in Important Sites for Biodiversity |

9.1 Thresholds and adaptive management

Evaluation of monitoring data compared to expected trends is an essential step in implementing adaptive management. An important part of evaluation is to establish thresholds that, if crossed, trigger further review and – where necessary – corrective action. Two types of threshold will be established:

- ▶ Early warning or “orange” thresholds that suggest that mitigations/offset actions may be deviating from expected trends such that corrective action may be necessary;
- ▶ Alert or “red” thresholds that suggest significant deviation from expected trends and a comprehensive review and urgent and extensive corrective action may be required.

9.2 *Ledermanniella yiben* monitoring

Preliminary indicators and thresholds for *Ledermanniella yiben* have been developed to monitor the outcome of translocation trials. As more information is known about the species’ lifecycle, thresholds may be altered. Orange and red thresholds indicate risks to the Project achieving its targets, and require intervention to assess the causes and potentially establish further translocation trials. Green and gold thresholds indicate success, and that the translocation site is on track to being a self-sustaining population of *Ledermanniella yiben*.

Table 13: Indicators and thresholds for *Ledermanniella yiben* translocation sites

| Indicator | Red threshold | Orange threshold | Green threshold | Gold threshold |
|---|---|--|---|---|
| Trend of population at location | 50% decrease in number of plants compared to previous year | 10% decrease in number of plants compared to previous year | 10% increase in number of plants compared to first year | 25% increase in number of plants compared to first year |
| Percentage of plants with evidence of flowering | No signs of flowering over five consecutive years monitoring | No signs of flowering over three years consecutive years of monitoring | 10% of plants flowering over three consecutive years | 40% of plants flowering over three consecutive years |
| | 25% of plants that were recorded flowering stop flowering over four consecutive years of monitoring | 25% of plants that were recorded flowering stop flowering over two consecutive years of monitoring | | |
| Percentage of plants with evidence of seed production | No signs of seed production over six consecutive years of monitoring | No signs of seed production over four consecutive years of monitoring | 15% of plants seeding over five consecutive years | 35% of plants seeding over eight consecutive years |
| | 25% of plants that were recorded producing seeds stop producing over three consecutive years | 25% of plants that were recorded producing seeds stop producing over two consecutive years | | |

References

- Brcic, T.M., Amarasekara, B. & McKenna, A. (2010) Sierra Leone National Chimpanzee Census 2010. Tacugama Chimpanzee Sanctuary, Freetown, Sierra Leone.
- Cheek, M. (2017) *Vepris felicis*. *The IUCN Red List of Threatened Species 2017*. <http://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T65064584A65064590.en>
- Ecotone (2018a) Ecological Flow Assessment (Draft) - Bumbuna Reservoir II, Sierra Leone (Prepared for Joule Africa).
- Ecotone (2018b) Pilot Forecasts of Likely Trophic Status and Eutrophication Risk of Yiben Reservoir – a Proposed Hydro-power Impoundment on the Seli River (Sierra Leone) - A predictive Eutrophication Risk Assessment (Draft version).
- Ecotone (2018c) *Sphaerotherylax yiben*: Habitat Assessment and Potential Distribution Model (Draft) (Prepared for Joule Africa).
- ERM (2017a) Environmental and Social Impact Assessment for the Bumbuna II Hydroelectric Power Project Volume 1 – ESIA Report (Unpublished report prepared by Environmental Resources Management for Joule Africa).
- ERM (2017b) Environmental and Social Impact Assessment for the Bumbuna II Hydroelectric Power Project Volume 2 – Technical Annexes (Unpublished report prepared by Environmental Resources Management for Joule Africa).
- Fahr, J. (2008) *Rhinolophus ziama* (Ziama Horseshoe Bat). *The IUCN Red List of Threatened Species 2008*. <http://www.iucnredlist.org/details/44786/0>
- Forest Division (2012) Loma Mountains National Park: Preliminary Management Plan 2013-2017. Ministry of Agriculture, Forestry and Food Security, Sierra Leone.
- Ganas-Swaray, J., Arandjelovic, M., Casado, N., Garriga, R. & Serckx, A. (2018) Primate and large mammal targeted surveys, Phase II Bumbuna Hydroelectric Dam, Sierra Leone: Priority species.
- IFC (2012) Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources. International Finance Corporation, Washington DC, USA.
- Jenness, J., Klimpt, J.-E. & Oates, J. (2013) Bumbuna Dam Environmental and Social Advisory Panel (Sixth Mission Draft Report. Prepared for the Project Management Unit, Ministry of Energy, Sierra Leone).
- Kleynhans, C.J. & Louw, M.D. (2007) Module A: EcoClassification and Ecstatus determination in River EcoClassification: Manual for EcoStatus determination (version 2). Joint Water Research Commission and the Department of Water Affairs and Forestry, Pretoria, South Africa.
- Lévesque, C., Paugy, D., Teugels, G.G. & Romand, R. (1989) Inventaire taxinomique et distribution des poissons d'eau douce des bassins côtiers de Guinée et de Guinée Bissau. *Revue d'Hydrobiologie tropicale* 22: 107–127.
- Ministry of Energy (2018) Electricity Sector Reform Roadmap Update (2018-2030) (Report written with the support of the Millennium Challenge Coordinating Unit from the Millennium Challenge Corporation (United States of America)).
- Payne, A.I., Wakeford, R.C. & Ndomahina, T.E. (2010) Fish distribution and zonation along a tropical African river, the Rokel/Seli River, Sierra Leone, West Africa. *Smithiana Bulletin* 12: 25.
- SAR Sense Ltd. (2017) Habitat Report and classification Joule Africa Bumbuna Phase II. Spate Intelligence, Edinburgh Centre for Carbon Innovation, Edinburgh.
- Seli Hydropower (2018a) Net gain Strategy for *Sphaerotherylax* (*Ledermanniella*) *yiben* for the Bumbuna II Hydropower Project, Sierra Leone (Version 2 Draft).
- Seli Hydropower (2018b) Biodiversity Strategy for the Bumbuna II Hydropower Project, Sierra Leone (Prepared by TBC).
- Seli Hydropower (2019a) Residual Impact Assessment; Bumbuna II Hydropower Project, Sierra Leone (Prepared by TBC).
- Seli Hydropower (2019b) Biodiversity Offset Strategy; Bumbuna II Hydropower Project, Sierra Leone (Prepared by TBC).
- Seli Hydropower (2019c) Biodiversity Action Plan; Bumbuna II Hydropower Project, Sierra Leone (Prepared by TBC).
- Sonnenberg, R. & Walsh, G. (2018) Bumbuna Phase II Priority Fish Species Survey. Freshwater fish baseline survey in the hydrographic systems of the Little Scarcies, Seli and Sewa Rivers surrounding the proposed Bumbuna Hydroelectric Dam Phase II project area, Sierra Leone. Draft Report.
- SRK Consulting (2017) An ecosystem services and livelihoods assessment of the early works area, Bumbuna II, Hydropower RAP, Sierra Leone (Prepared for Joule Africa).
- TBC (2017) Bumbuna Phase II Project: Critical Habitat Assessment (Report prepared on behalf of Joule Africa). The Biodiversity Consultancy Ltd, Cambridge.
- TBC (2018) Bujagali Project: Biodiversity Action Plan. Report prepared on behalf of BEL by The Biodiversity Consultancy Ltd, Cambridge, U.K.
- TBC (2019a) Prioritisation of biodiversity for management actions. Report to Joule Africa for the Bumbuna Phase II hydro-electric project, Sierra Leone (Report prepared on behalf of Joule Africa). The Biodiversity Consultancy Ltd, Cambridge.

TBC (2019b) Bumbuna Hydropower Project Phase I (BHP1) biodiversity management legacy issues, with lessons learned to inform Bumbuna Hydropower Project Phase II (Bumbuna II) (Report prepared on behalf of Joule Africa). The Biodiversity Consultancy Ltd, Cambridge.