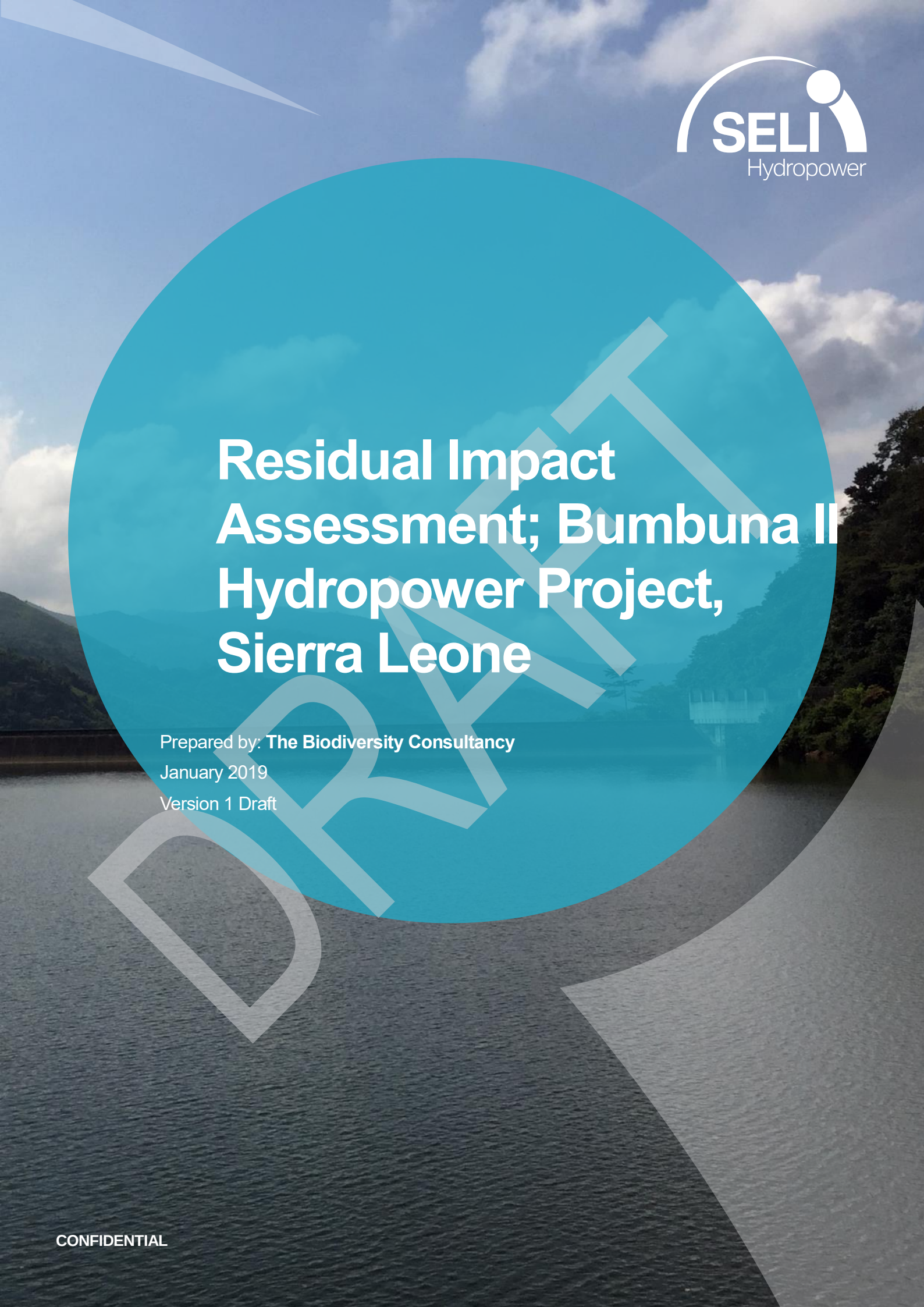

SELI Hydropower

Residual Impact Assessment; Bumbuna II Hydropower Project, Sierra Leone

Prepared by: **The Biodiversity Consultancy**

January 2019

Version 1 Draft

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TABLE OF ACRONYMS AND ABBREVIATIONS

Acronyms and abbreviations	
AC	Action Category
BCA	Bumbuna Conservation Area
CH	Critical Habitat
ha	hectare
IFC	International Finance Corporation
m.a.s.l.	Meter above sea level
MH	Modified Habitat
NH	Natural Habitat
PS	Performance Standard
QH	Quality Hectare
RAP	Resettlement Action Plan
RI	Residual Impact
RIA	Residual Impact Assessment
SRTM	Shuttle Radar Topography Mission
USGS	United States Geological Survey

1. Executive summary

Purpose of this assessment

This report provides a quantified assessment of the residual impacts of the Joule Africa Bumbuna Phase II project ('the Project') on biodiversity and identifies offset targets for delivering an overall net gain for biodiversity. To align with International Finance Corporation Performance Standard 6 (IFC PS6), the Project aims to achieve net gain for Critical Habitat-qualifying biodiversity and no net loss for Natural Habitat.

This residual impact assessment:

1. Quantifies residual biodiversity impacts[1];
2. Assesses the significance of residual impacts; and,
3. Provides biodiversity targets for offset design and implementation.

As it is not practical to quantify residual impacts for all biodiversity, the Project undertook a risk-based prioritisation exercise (TBC 2019a) to identify Critical-Habitat-qualifying biodiversity with a high likelihood and consequence of Project impacts. This residual impact assessment focuses on this biodiversity, comprising of three habitats (gallery forest, hillslope forest and freshwater habitat) and four species or subspecies (Western Chimpanzee, a species of aquatic plant *Ledermanniella yiben,* and two species of fish, *Enteromius* sp. aff. *trispilos* and *Chiloglanis* sp. OTU3). The assessment also estimates impacts to Natural Habitat in the Project area.

Impacts

Direct impacts are composed of:

- Project footprint, i.e. project infrastructure, roads and reservoir at full supply level;
- Habitat degradation or disturbance around project footprint; and
- Impacts from resettlement activities.

The main indirect impact is likely to be from the influx of economic migrants, resulting in habitat conversion for farmland and potentially in increases in hunting of species such as chimpanzees.

Results of the assessment

Table 1 presents a summary of residual impacts. It is estimated that a total of c. 24,900 ha will be impacted, mainly comprising of Modified Habitat (c. 17,450 ha). Terrestrial residual impacts also include 3,800 ha of Critical Habitat and 3,550 ha of other Natural Habitat. Freshwater habitat residual impacts include 39 km of main stem and 123 km of tributaries, which will impact priority fish species. It is predicted that the Project will result in the loss of 44-70 chimpanzees and the only known site of the aquatic plant *Ledermanniella yiben.*

Table 1: Summary of estimated residual impacts

Biodiversity	Direct impacts		Indirect impact	TOTAL	Section in the report
	Footprint	Resettlement	Influx		
Terrestrial Critical Habitat	1,659 ha	446 ha	1,705 ha	3,800 ha**	Section 3.6
Terrestrial Natural Habitat	1,584 ha	406 ha	1,552 ha	3,550 ha**	Section 3.6
Freshwater Critical Habitat (also used as a proxy for *Enteromius* sp. aff. *trispilos* and *Chiloglanis* sp. OTU3)	39 km of main stem 123 km of tributaries	Not yet known*	Not yet known*	> 39 km of main stem > 123 km of tributaries	Section 3.6
Western Chimpanzee	~25 individuals[2]	4 to 9 individuals	15 to 36 individuals	44 to 70 individuals	Section 5.1
Ledermanniella yiben	c. 250 m^2			c. 250 m^2	Section 5.3

* Impacts of resettlement and in-migration on freshwater habitats cannot yet be estimated as the locations of these activities are not yet known.

** these figures are rounded to the nearest 50 ha.

[1] Impacts to Critical Habitat-qualifying species that are not priority species are assessed through the use of habitat as a proxy for the species.

[2] Two groups are predicted to be lost and five groups are predicted to have reduced numbers.

Critical Habitat: residual impacts and offsets

Terrestrial

A net loss of 3,811 ha of terrestrial Critical Habitat is forecast as a result of the Project. This represents a loss of 12% of Critical Habitat within the Project area[3]. Project impacts are therefore considered significant at a local level. These habitats are important for several priority species, and therefore mitigation measures will focus on ensuring impacts are minimised to these habitats. In addition, terrestrial offsets will aim to compensate for residual impacts to achieve a net gain (Seli Hydropower 2019a). At a regional and national scale, these habitat types remain widespread, and therefore Project impacts are not anticipated to be significant at a larger scale.

Freshwater

In total, 39 km of main stem and 123 km of tributaries are estimated to be impacted. Within the Upper Seli catchment, the main rivers (the Mawaloko river and the Seli River above the Yiben reservoir) are approximately 82 km in length, meaning the Project impacts 32% of main rivers in the Upper Seli. Above the Yiben reservoir (i.e. not including the tributaries of the Mawaloko), there are approximately 1,540 km of tributaries, meaning the Project impacts approximately 7% of tributaries in the Upper Seli catchment. These are considered to be significant impacts. Freshwater habitats support a number of Critical Habitat-qualifying fish species which will be impacted by the changes in hydrology (among other impacts) as a result of the flooding of the Yiben reservoir. Mitigation measures are not possible for these species and so the Project proposes offset measures to protect and improve freshwater habitat quality upstream of the reservoir where the same suite of priority species can be found (Seli Hydropower 2019a).

Western Chimpanzee: residual impacts and offsets

It is estimated that between 44 and 70 chimpanzees will be lost due to the Project. The Western Chimpanzee is an emblematic Critically Endangered subspecies. Sierra Leone supports approximately 5,500 chimpanzees (Brncic *et al.* 2010). Whilst Project impacts represent a comparatively small loss (c. 1%) to the total estimated population in Sierra Leone, chimpanzee populations are threatened by habitat loss and, in some areas, by hunting. Project impacts are therefore an additional pressure on an already threatened population. The Project will focus mitigation actions on conserving Important Sites for Biodiversity with chimpanzee groups in the Project area, to minimise and monitor impacts. The Project is planning to compensate for residual impacts on chimpanzees, which will be used as a focal species to select offset sites and design conservation actions (Seli Hydropower 2019a).

Freshwater fish (*Enteromius* sp. aff. *trispilos* and *Chiloglanis* sp. OTU3): residual impacts and offsets

The loss of freshwater habitat that supports *Enteromius* sp. aff. *trispilos*, represents a loss of 25% of its global distribution range, which is a significant impact for the species. *Chiloglanis* sp. OTU3 distribution is not fully understood[4] but, based on expert opinion, a similar proportion of its global distribution range is likely to be impacted by the Project. As impacts cannot be mitigated, it will be important for the Project to ensure that remaining freshwater habitat in the Upper River Seli is protected from activities such as artisanal mining and removal of vegetation along the river banks that may degrade water quality and impact the species. Only the upper river Seli is suitable as a freshwater offset as the two species appear to be endemic to the Seli river. As an offset, the Project will undertake activities to reduce threats from artisanal mining activities that result in freshwater habitat degradation.

Freshwater plant (*Ledermanniella yiben*): residual impacts and offsets

As the population that will be impacted by the Project is the only known global location for the species, it is highly significant. The Project has been working on a net gain strategy for the species with actions to: search for new locations of wild populations; trial translocation of seeds and plants to new locations; and propagate the species ex-situ. To achieve a net gain for the species, the Project will need to establish new populations in secure locations (away from known threats, particularly artisanal mining). The Project aims to establish self-sustaining populations of *Ledermanniella yiben* in at least three new locations, to demonstrate a net gain. All actions that the Project will undertake for *Ledermanniella yiben* are outlined in the Biodiversity Action Plan (BAP: Seli Hydropower 2019).

Updates to the residual impact assessment

This assessment should be re-visited if there are significant changes to the Project design (e.g. new roads or infrastructure that are not accounted for in this assessment) or if resettlement of affected people is likely to result in greater impacts than predicted in this assessment.

[3] Compared to the total amount of terrestrial Critical Habitat predicted to remain in the Project area at the end of the Seli Hydropower concession period.

[4] The species was confirmed through genetic analysis but only one specimen of the species has been analysed; the distribution of the species is therefore not fully understood. However, expert opinion suggests that this species may also be endemic to the Upper Seli and have a similar distribution to *Enteromius* sp. aff. *trispilos* (Sonnenberg & Walsh 2018)

2. Introduction

This report provides a quantified assessment of the residual impacts of the Joule Africa Bumbuna Phase II project ("the Project") on biodiversity and identifies offset targets for delivering an overall net gain for biodiversity.

The Project identified biodiversity risks based on a Critical Habitat Assessment and through subsequent targeted survey work and risk-based prioritisation (TBC 2017, 2019). As a result, biodiversity is classified into four action categories (ACs) depending on the likelihood of a Project impact and the consequence of an impact on the Critical Habitat-qualifying feature (TBC 2019a).

Three species/subspecies and three habitats are classed as AC1, i.e. highest priority for habitat mitigation and/or species-specific actions. This biodiversity is a focus for the residual impact assessment and offset design (Seli Hydropower 2019a). For other Critical Habitat-qualifying features (in AC2-4), net gain is still required but can be achieved through habitat-focused actions. Residual impact for these features is thus assessed through the use of habitat as a proxy.

To achieve no net loss and net gain objectives, the Project will offset residual impacts via actions in selected offset sites. It will be important for the Project to measure changes in biodiversity in offset sites to demonstrate that an equivalent amount biodiversity has been gained through offset activities. To ensure there is uniform accounting for losses and gains across the Project area (area of losses) and offset areas (areas of gains), the Project has adopted a 'Quality Hectare' (QH) approach. The QH approach combines a measure of area and a measure of condition of the habitat to obtain an overall measure of loss (and gain) (ICMM & IUCN 2013).

2.1 Purpose and scope

To align with International Finance Corporation Performance Standard 6 (IFC PS6), the Project will aim to achieve net gain for Critical Habitat-qualifying biodiversity and no net loss for Natural Habitat. This residual impact assessment therefore:

1. Quantifies residual impacts to Action Category 1 habitats and species, and to other Natural Habitat;

2. Assesses the significance of residual impacts;

3. Provides targets for offset site selection, offset design and implementation.

This is a preliminary assessment and an update may be required if the Project design significantly changes and/or if there is greater overlap between resettlement areas and Important sites for Biodiversity[5] than is predicted by the scenario selected in Section 3.

2.1.1 SCOPE: BIODIVERSITY

The residual impact assessment focuses on a sub-set of biodiversity (Action Category 1 biodiversity), comprising:

1. Hillslope forest, gallery forest, and freshwater habitat (together called Critical Habitat, and all also being Natural Habitat);
2. Western Chimpanzee;
3. Two freshwater fish species (*Enteromius* sp. aff. *trispilos* and *Chiloglanis* sp. OTU3),
4. A freshwater plant species (*Ledermanniella yiben*).

Impacts to other Critical Habitat-qualifying species are assessed through the use of habitat as a proxy. This is considered appropriate as any impacts that may occur to these species are of lower significance (TBC 2019a) and will be broadly equivalent to impacts upon their habitats (rather than, for example, being separate such as through hunting). The residual impact assessment therefore includes an assessment of loss to all Natural Habitat types based on the Project's habitat map (see Table 2 for terrestrial habitats and Table 3 for freshwater habitat). As can be seen from Table 2, the majority of habitat in the Project area is already modified by human activities.

Table 2: Terrestrial habitat types present in the Project area and their area in hectares (ha) (Space Intelligence Ltd 2018)

Habitat type	Ha in the Project area
Natural Habitat (including Critical Habitat)	**86,381**
Gallery forest[6]	18,096
Hillslope forest	25,401

[5] Important Sites for Biodiversity have been identified in the Project area and are a focus for mitigation actions (Seli Hydropower 2019a)

[6] For the purpose of the assessment, 'lowland forest' (identified as an additional forest type in the habitat map: Space Intelligence Ltd 2018) has been incorporated into gallery forest. Gallery forests were identified, in the habitat map, as forest pixels located at less than 100 m from a river or a tributary. It is likely, however, that locations of all tributaries were unknown and thus that some forest pixels were inappropriately assigned to lowland forest (defined as forest pixels with slope lower than 7 degrees and located at more than 100 m from a river or a stream). Indeed, lowland forest is not a vegetation type identified as present in the Project area (Royal Botanic Gardens, Kew 2016).

Natural savannah/woodland	36,699
Swamp	2,815
Inselberg	2,836
Seasonal lake (i.e., Lake Sonfon)	534
Modified Habitat	**210,228**
Human modified savannah/recovering fallow (trees > 10m)	134,486
Agriculture and young fallow (trees < 10m)	60,553
Agriculture (no trees)	11,629
Settlements/roads	3,560

Table 3: Freshwater habitat within the Project area (based on GIS data provided by the Project's fish specialist)

Freshwater habitat type (based on stem size)[7]	Km in the Project area
Main rivers	122
Tributaries	2,131

2.1.2 SCOPE: PROJECT IMPACTS

The residual impact assessment includes the main direct and indirect impacts of the Project (ERM 2017a; Seli Hydropower 2019a), as listed in Table *4*. These are drawn from the Project ESIA (ERM 2017a) and/or more recent Project reports (e.g. the Resettlement Action Plan (RAP) phase 1, the RAP scoping report of phase 2, and the ecological flow assessment, SRK Consulting 2017a, 2017b; Ecotone 2018). As per the Biodiversity Action Plan (BAP), the residual impact assessment does not include transmission line infrastructure as this is being developed by the Ministry of Energy and details of its design have not been shared with the Project to date.

The stretch of river downstream of the extension tailrace has already been degraded by existing Bumbuna I operations. Hydrological changes caused by the operation of the Bumbuna extension may affect some fish species (TBC 2019a) but are unlikely to cause significant further degradation to river habitat quality (Ecotone 2018). Non-significant impacts are not included within this assessment.

Table 4: Summary table of Project impacts included in this residual impact assessment

Project impacts	Biodiversity associated with the impact			
	Terrestrial Natural Habitat	Chimpanzee	Freshwater habitat (and *Enteromius* sp. aff. *trispilos* and *Chiloglanis* sp. OTU3)	*Ledermanniella yiben*
1. Direct impacts				
1.1 Project footprint				
Habitat loss and degradation due to project infrastructure (at Yiben and the Bumbuna extension) and the construction/ upgrade of roads	✓	✓	✓	
Yiben reservoir	✓	✓	✓	✓
Operation of the Yiben reservoir (causing an increase in the footprint of the Bumbuna I reservoir)	✓	✓	✓	
Habitat fragmentation due to the Yiben reservoir		✓		
1.2 Resettlement of affected communities and associated farming activities				
Habitat loss from resettlement	✓	✓		

[7] A distinction is made between main rivers and tributaries as each supports a different suite of Critical Habitat-qualifying species. Impacts to main stem and tributaries are therefore separated in this residual impact assessment.

2. Indirect impacts				
Habitat loss due to influx of people	✓	✓		
Habitat degradation or over-exploitation of habitats resulting from influx of people		✓	✓	
Hunting/fishing as a result of influx of people		✓	✓	
Disease transmission		✓		

2.1.2.1 Direct impacts

Project infrastructure footprint

The Project infrastructure footprint is based on the ESIA design (ERM 2017a) and infrastructure data provided by Lahmeyer International (October 2018).

- For Yiben, the footprint includes: the dam, a powerhouse, a switchyard, power intake structures and spillway as well as a range of supporting ancillary facilities, a quarry and new access road.
- For the Bumbuna extension, the footprint includes: the power intake structure, a main headrace tunnel, a new powerhouse (consisting of two 41MW turbine units, a tailrace channel and a 4MW environmental flow power turbine located at the Bumbuna I Environmental Flow outlet), and a range of supporting ancillary facilities and the quarries.

Project footprint impacts include those from dust created by the operation of machinery and vehicles during construction. Dust will settle on vegetation causing habitat degradation.

Yiben reservoir footprint

The Yiben footprint is based on the full supply level of the reservoir, i.e. 320 m a.s.l. (metres above sea-level)[8]. Within the reservoir some islands may persist but, for the purposes of the assessment and as a precautionary approach, vegetation on islands is assumed to be lost.

Bumbuna reservoir extension

Once the Yiben reservoir is operational, the Bumbuna reservoir is predicted to extend up to the bottom of the Yiben dam (ERM 2017a). Under current operational conditions, the Bumbuna reservoir backs up to approximately the confluence of the Seli and Mawaloko rivers[9]. Only the additional "extension" of the Bumbuna I reservoir from the confluence to the base of the Yiben dam is included as part of this residual impact assessment.

Resettlement

Approximately 3,400 people, corresponding to 576 households, will be physically displaced from the Yiben inundation area and the Bumbuna extension area by the Project (RAP 1 and RAP 2 scoping estimates, SRK Consulting 2017a, 2017b). Land for housing and to replace agricultural activities will be provided to all affected people, resulting in loss of habitat.

2.1.2.2 Indirect impacts

Influx

Significant influx of economic migrants into the area is expected as people will be attracted to potential job opportunities created by the Project. Plans for managing this influx have not yet been developed. To support this influx, land will be cleared to grow food, resulting in habitat loss. Economic migration may also result in increases in activities such as fishing and hunting. Currently hunting of primate species (in particular chimpanzees) is considered to be low (Cathryn MacCallum, SRK Consulting, pers. comm. 2018) as it is against traditional customs. Migrants may not hold the same values and so hunting is likely to increase.

[8] Based on geo-referenced data provided by Lahmeyer International in October 2018.

[9] Based on ground visits to the area in February 2018.

3. Approach to assess habitat impacts

3.1 Use of a declining baseline

The Project area consists of a mosaic of agricultural land, fallow land (Modified Habitat) and Natural Habitat including gallery and hillslope forests (terrestrial Critical Habitat), woodland/savannah and swamp habitats. The majority (71%) of habitat has already been modified by human activities (Table 2). Natural Habitat that remains in the Project area is in small patches within a mosaic of Modified Habitat (Figure 1). These are under threat from further conversion to agriculture, and encroachment and degradation from logging activities, meaning that the area of Natural Habitat (gallery and hillslope forests, and natural savannah/woodland) is decreasing each year. It is therefore appropriate for the Project to use a declining baseline (or "counterfactual") in the estimation of terrestrial residual impacts, as a static baseline would be unrealistic and significantly overestimate Project impacts.

A declining baseline is also appropriate for freshwater habitat within the Project area as degradation of freshwater habitat is linked to the loss of gallery forest. Loss of gallery forest results in increased sedimentation, increases water temperature and reduces food availability and breeding success of priority species thus decreasing the quality of freshwater habitat. Presence of gallery forest is important for priority species as six of the fish species (five from the Nothobranchiid family plus *Rhexipanchax kabae*) require forest canopy along watercourses to survive because they are carnivorous/insectivorous and their main food source consists of arthropods that fall onto the water surface from the forest canopy. Their breeding success also depends on vegetation along rivers, as they deposit eggs on submerged vegetation and roots. Thermal change and sedimentation affects all Critical Habitat-qualifying fish species.

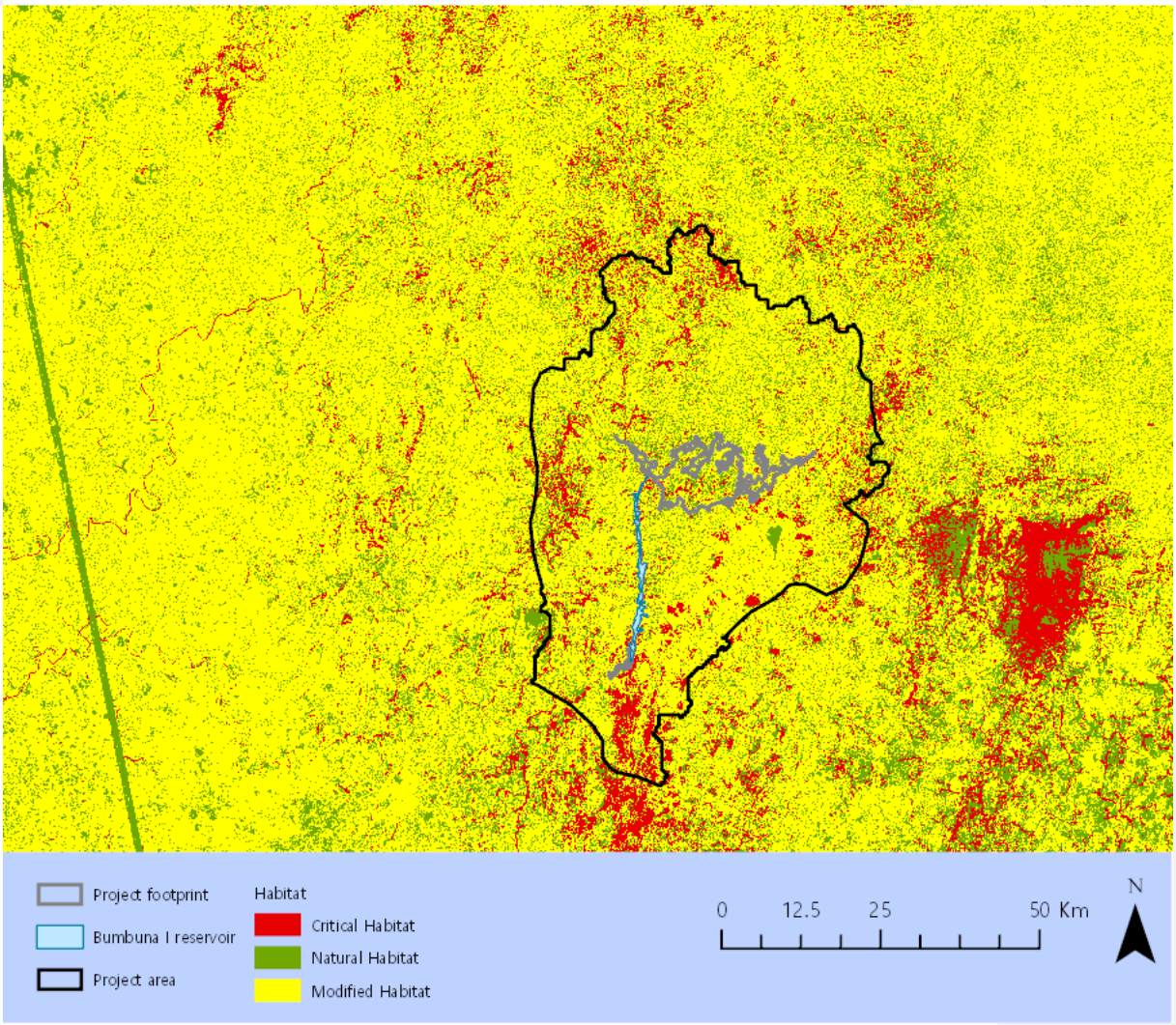

Figure 1: The Project area (area within the black line) is a mosaic of Modified Habitat with some Natural Habitat

Applying a declining baseline to assess habitat impacts

The Project baseline habitat map was created from satellite imagery and field data collected in 2017 (Space Intelligence Ltd 2018). To apply a declining baseline, a deforestation rate was applied to each habitat type to predict the changes that would have occurred without the Project over the next 25 years (the concession period of Seli Hydropower). The deforestation rate used was based on national deforestation rates. The national deforestation rate for Sierra Leone is increasing by 0.01% each year 0.63% in 2000, 0.68% in 2005 (Statistics: Sierra Leone 2006) and 0.73% in 2010 (FAO 2010). Projecting this deforestation rate forwards, the national deforestation rate would be 0.83% in 2020 (i.e.

the start of the construction period), 0.87% in 2024 (i.e. the start of the operational period) and 1.12% in 2049 (i.e. the end of the concession period). Using these projected deforestation rates, the without-project loss of each Natural Habitat type in the Project area can be estimated from the start of construction (2020) to the end of the Seli Hydropower concession period (2049).

Direct and indirect Project impacts (including footprint, resettlement and influx) have therefore been calculated as the difference between the estimate of full Project impacts (i.e., assuming a static baseline) and impacts that are predicted likely to occur anyway in the absence of the Project (i.e., assuming a dynamic baseline). This difference was considered to be the residual impact attributable to the Project.

3.2 Project footprint (infrastructure and reservoir) impacts to terrestrial habitats

The project footprint is calculated by compiling the infrastructure data provided by Lahmeyer International (October 2018), a dust buffer, the Yiben reservoir area and the "extension" area of Bumbuna I reservoir. Impacts are assessed by overlaying the footprint with the Project habitat map (Figure 2), and adjusting for a dynamic baseline (Section 3.1) – i.e., based on the area of each habitat type predicted to remain in the Project area at the end of the concession period in a without-project scenario.

A buffer was added to the infrastructure to account for the habitat degradation impact of dust on vegetation. Dust emissions during the construction period are expected to be high and climatic conditions within the Project area are likely to promote dust generation (during operations, dust impacts are predicted to be minimal, ERM 2017a). For people, dust emissions are estimated to have a significant impact for up to 200 m from the source (ERM 2017a). For vegetation, dust deposition on leaves will lead to a decrease in photosynthesis, and thus vegetation degradation. This is only likely to have a significant effect close to the road or construction areas. To quantify impacts for habitat, an assumption was made that habitat degradation within 200 m of project infrastructure would be equivalent to a 10% loss of habitat. To represent this, a 20 m habitat loss buffer was applied around infrastructure and roads. While such a buffer may underestimate impacts on habitats at 20-200 m from sources of dust, it is a reasonable representation of the rapid reduction in dust impacts away from sources (biggest impacts occur close to the sources).

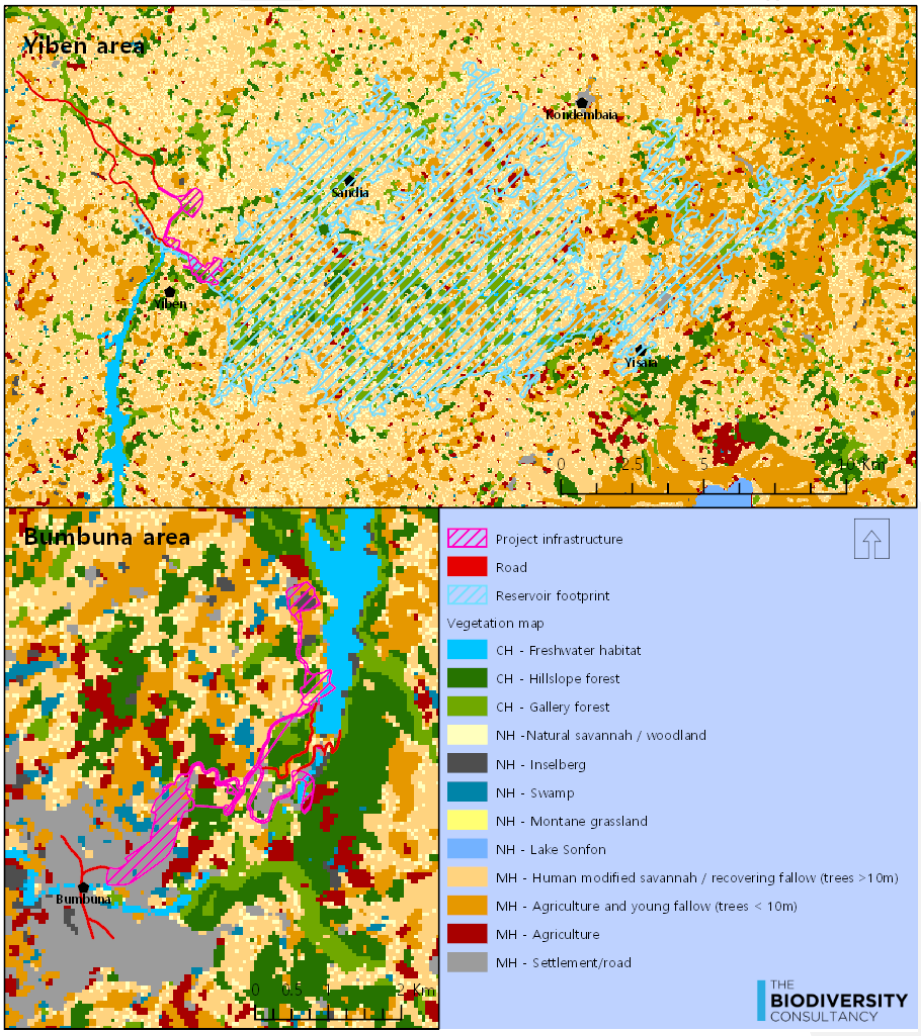

Figure 2: Direct impacts are assessed by overlaying the Project footprint with the Project habitat map. Critical Habitat (CH), Natural Habitat (NH) and Modified Habitat (MH) are all colour-coded.

3.3 Resettlement of affected communities

The area and types of habitat that will be impacted through the resettlement of affected communities is estimated based on the assumptions outlined below and an analysis of scenarios. Assumptions are made and a scenario assessment is undertaken as the RAP for affected people within the future Yiben reservoir has not yet been developed. Therefore, neither the exact number and size of agricultural areas farmed by affected communities within the Yiben reservoir, nor the locations for resettlement of affected people, are currently known.

Assumptions:

1. *Affected people will farm the same size area as they are currently farming and will apply the same farming practices (rather than pursuing alternative livelihoods).* More than 80% of villages within and immediately adjacent to the inundation area consider their primary livelihood to be agriculture (ERM 2017a) and, on average, each household cultivates 1 ha per household (ERM 2017b) over 1-3 years. Preferred habitat types for agriculture are gallery forests, swamps and hillslopes (ERM 2017b; SRK Consulting 2017a). After farming, areas are left fallow for 7-11 years depending on land pressure in the area, before being used again (ERM 2017b; SRK Consulting 2017b).

The total area of land (agriculture and fallows) per household is not known for affected people. It is estimated based on the average area of farmed land (1 ha) and the fallow period (7 to 11 years). The fallow period varies according to land pressure; if there is little land available, land is used more intensively but the overall area required does not change. In the Project area, there is a low population density and land pressures are likely to be low. Therefore, it is assumed that 1 ha is farmed for two years and then left fallow for approximately eight years, requiring **5 ha per household**.

2. *New housing will require clearance of land*. The footprint of new-housing is estimated to be **0.1 ha per household** (ERM 2017b). Although households are likely to be resettled into existing communities, this has not yet been decided and land clearance may be required.

- Each resettled household is therefore assumed to require a total of **5.1 ha of land.** In total resettlement is thus estimated to require **2,937.6 ha** for the 576 households.

Scenario assessment

The locations for resettlement are not currently known. Three scenarios were developed to assess alternative outcomes of resettlement on biodiversity. The scenarios are based on the effectiveness of mitigation measures, specifically: (i) effectiveness of avoidance of Important Sites for Biodiversity[10]; and (ii) effectiveness of resettlement management actions.

Table 5: Scenarios to assess impacts of resettlement on habitats

Scenario	Description of scenario; effectiveness of mitigation measures	Assumptions made and application of the scenario
Best-case	The resettlement action plan effectively avoids all Important Sites for Biodiversity and communities agree to conservation actions that protect these sites and remaining areas of terrestrial Critical Habitat (i.e. gallery and hillslope forests). Existing fallow land and savannah/ woodland areas are cleared instead.	Habitat loss is quantified by assuming that terrestrial Critical Habitat is not cleared. The areas cleared for resettlement and farming are assumed to be all other available habitat types and impacts to each type are calculated based on their availability and their proportion within the Project area, outside of the Important Sites for Biodiversity.
Intermediate	Communities are relocated adjacent to some Important Sites for Biodiversity resulting in some loss of terrestrial Critical Habitat within these sites. Existing fallow land and savannah/woodland areas are also cleared.	Habitat loss is quantified by assuming that all habitats have the same likelihood of clearance. The impact to each habitat type is based on their availability and proportion within the Project area.
Worst-case	Resettlement occurs within Important Sites for Biodiversity and people actively convert them for agricultural use leading to a total loss of terrestrial Critical Habitat within the sites.	Habitat loss is quantified by assuming only terrestrial Critical Habitat and swamps (i.e. the preferred habitats for agriculture) are cleared. The amount of loss for each habitat type is calculated based on their availability within Important Sites for Biodiversity and the wider Project area.

Selection of the most likely scenario

Although exact locations for resettlement is not known, potential villages that are likely to be used as focal areas for resettlement have been identified. Affected people will be relocated to one of the focal villages and/or to other, yet to be identified, villages. People are likely to try to locate their farms as close as possible to their housing. Although some of the focal villages are located close to Important Sites for Biodiversity, others are far away. It is therefore unlikely that resettlement will affect all Important Sites for Biodiversity. The worst-case scenario is therefore unlikely. However, it is probable that some conversion of priority habitats within Important Sites for Biodiversity and within the wider

[10] Important Sites for Biodiversity have been identified within the Project area based on the presence of chimpanzee groups, other Critical Habitat-qualifying species and terrestrial Critical Habitat (BAP 2019).

Project area will occur, as these habitat types are preferred for farming. The **intermediate scenario** is therefore considered the most likely scenario. Impacts henceforth are based on this scenario are calculated based on the area of Natural Habitat available in the Project area (outside the Project footprint) at the start of Project construction (in 2020), and adjusted for a dynamic baseline (Section 3.1) – i.e., based on the area of each habitat type predicted to remain in the Project area at the end of the concession period in a without-project scenario.

3.4 Project footprint (infrastructure and reservoir) impacts to freshwater habitats

Freshwater habitats are split into "main rivers" (Strahler Orders 5 and 6) and "tributaries" (Strahler Orders 1 to 4) as each supports different Critical Habitat-qualifying species. Direct impacts to each type of freshwater habitat were assessed by extracting the total length of the river and tributary systems provided by the Project fish specialist[11] under the Yiben reservoir and "extension" of Bumbuna I reservoir (Figure 3).

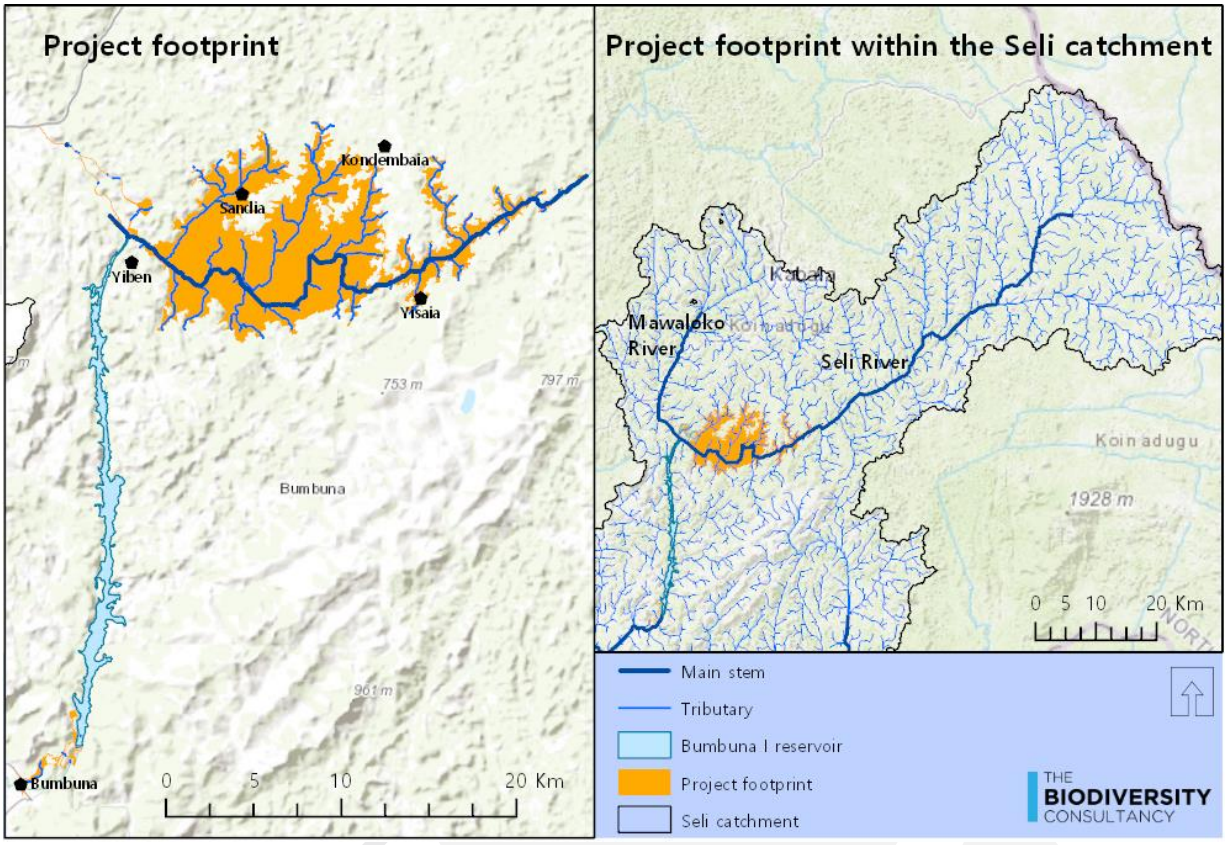

Figure 3: Freshwater impacts: Left figure: Impacts to main rivers and tributaries, Right figure: The Project footprint within the Seli catchment. For the purpose of this report, the Upper Seli catchment is considered to be upriver from the confluence of the Seli and Mawaloko rivers.

3.5 Indirect impacts to terrestrial habitats

Indirect impacts often have greater impacts to biodiversity than direct impacts but can be more difficult to measure (Tsunokawa & Hoban 1997; IFC 2009). The primary indirect impact pathway anticipated for this Project is via the influx of economic migrants into the Project area (also known as in-migration). Influx will lead to an increase in the conversion and/or degradation of habitats for agriculture and increased exploitation of natural resources such as fuel, and increased fishing and hunting. Migrants may not necessarily be the agents of increased biodiversity loss themselves (e.g., they may not clear vegetation for agriculture) but rather may be the drivers of increased biodiversity loss (e.g., they may create demand for food that causes an increase in the rate of clearance).

The residual impact assessment therefore (i) estimates the scale of influx that can be expected and (ii) estimates the impacts based on the forecast levels of influx. Such an approach is a prediction and is therefore uncertain. The aim of the assessment is to establish an order of magnitude estimate of the scale of indirect impacts from influx rather than a precise figure. Actual indirect impacts can be confirmed through monitoring.

[11] Gina Walsh provided data on the 'Strahler Orders' of the rivers. This is a globally recognised system of river classification based on river and stream size. The scale is from 1 to 12 for the most powerful river and 1 to 7 in the Project area. '1' is the smallest headwater tributary, and 7 is the largest river. Stream features from 30m-resolution SRTMs (Shuttle Radar Topography Mission) were downloaded from the USGS (United States Geological Survey) site. ArcMap 10.5 was used to run a Flow Direction and Flow Accumulation analyses using Spatial Analyst. Outputs were converted to a raster and a vector stream shapefile.

3.5.1 FORECAST OF THE SCALE OF INFLUX

The Project anticipates that the construction phase peak will employ a total of 2,000 people over the 3-4 year construction period[12] (Mark Goldsmith, Joule Africa, pers. comm., 2018). This number is used as a basis for forecasting associated influx numbers. The IFC Handbook for addressing Project influx presents three scales for estimating induced influx based on project workforce members (IFC 2009):

- Low (×3 in-migrants per workforce member);
- Medium (×6 in-migrants per workforce member);
- High (×10 in-migrants per workforce member).

The high in-migration scenario is considered by IFC to be reasonable for undeveloped countries where there is a high risk of influx. As Sierra Leone is underdeveloped and has a relatively high unemployment rate (9.1% on average and 9.4% for young adults: Central Intelligence Agency 2019), inter-regional migration is very common throughout the country (Diagne 2017). On average, 25% of the population migrates at least once during its lifetime (Diagne 2017). IFC's own guidance also cautions that in-migration is frequently much higher than its own "High" scenario would predict, with sustained population increases of 10% per year not unusual in situations where there are few comparable economic opportunities in the region of the project (IFC 2009).

- High influx rates are therefore applied to the Projects predicted workforce resulting in a forecast of **20,000 in-migrants to the Project area.**

3.5.2 ESTIMATES OF IMPACT FROM INFLUX MIGRATION

Actions to minimise biodiversity impacts from influx are outlined in the BAP, but the Project has not yet developed an Influx Management Plan. Therefore, to assess biodiversity impacts arising from influx, a scenario analysis was developed (Table 6) to assess the potential range of impacts based on:

1. The effectiveness of BAP avoidance and minimisation actions; and

2. The likelihood that migrants will remain in the area after the construction phase.

The following assumptions form the basis of the application of the scenarios presented in Table 6:

- Estimates of impact are based on the amount of land required to for food production. Migrants may or may not farm, but land will still be required to produce food for their consumption. It is assumed that migrant land requirements for food production will be the same as those of local people i.e. 1 ha per household effectively farmed each year and 5 ha of land in total (i.e. for the complete rotation cycle);
- As per the resettlement calculation, the area required to produce food is known per household. The area of land required to produce food per migrant was obtained by dividing the size of land by the average number of people per household (5.7 people, rounded to 5 people as migrants are likely to consume more food than an average household which includes young and old people: SRK Consulting 2017a), i.e. 0.2 ha of land effectively farmed each year to support each migrant and 1 ha of land in total per migrant for a complete rotation cycle (10 years);
- Migrants leaving after the construction phase require food and therefore agricultural land for four years only. As land is farmed for approximately two years before being left as fallow, it was assumed that two areas of 0.2 ha will be farmed to produce food for these migrants i.e. 0.4 ha per migrant. Migrants that stay in the area beyond the construction period will require agricultural land to produce food for a longer period; assumed to be a complete rotation cycle (10 years), i.e.1 ha of land;
- The area of habitat available for farming is calculated every two years (over the 10-year period, i.e. the complete rotation cycle) from the start of Project construction (in 2020), using the deforestation in the Project area but applying a declining baseline (Section 3.1) to discount impacts that are predicted to have occurred in the absence of the Project; and
- Migrants will also need land for housing (0.1 ha per household: (ERM 2017b); it was assumed that each migrant will need a fifth of 0.1 ha for housing, i.e. 0.02 ha, and that the land will be converted into housing at the start of Project construction (in 2020).

[12] of 600 'local' people at the Bumbuna I Extension, another 800 'local' people at the Yiben dam, and 600 Chinese expatriates

Table 6: Scenarios to assess impacts of influx on habitats

	Description of scenario		Application of the scenario to assess the scale of impact
Scenario	**Effectiveness of mitigation actions**	**Duration of impact**	
Best-case	Mitigation actions to control and manage influx (TBC 2019b) are implemented early to ensure influx is concentrated in designated towns; terrestrial priority habitats and Important Sites for Biodiversity are not exploited.	Influx is transient: 75% of migrants leave early in the operational phase.	▸ Migrants require 4,400 ha at the start of the construction period for housing and producing food, and an additional 4,000 ha to produce food each subsequent two years. 5,000 migrants remain after the construction period, requiring an additional 3,000 ha of land to produce food. In total, 11,400 ha of habitat is lost. ▸ Terrestrial Critical Habitat is not cleared to produce food for migrants; Modified and some Natural Habitat is cleared, based on their availability within the Project area (after accounting for direct impacts).
	Result: Land cleared to produce food for migrants is close to existing towns and mostly in areas of Modified Habitat (i.e. fallow areas). The rate of conversion of Natural Habitat in the Project area does not increase, and hunting pressure on priority species (particularly chimpanzees) remains low.		
Intermediate	Mitigation measures to control and manage influx are implemented later and/or are less effective. Important Sites for Biodiversity are avoided, but terrestrial Critical Habitat is used for agriculture in other areas.	Influx is transient: 75% of migrants leave early in the operational phase.	▸ Migrants require 4,400 ha at the start of the construction period for housing and producing food, and an additional 4,000 ha to produce food each subsequent two years. 5,000 migrants remain after the construction period, requiring an additional 3,000 ha of land to produce food. In total, 11,400 ha of habitat is lost. ▸ Terrestrial Critical Habitat and Natural Habitat are cleared. The amount of each habitat type that is cleared is based on their availability within the Project area (after accounting for direct impacts).
	Result: Land cleared to produce food for migrants happens in all habitat types even if Important Sites for Biodiversity are avoided. The demand for food decreases over time and fallow areas are left to convert back to Natural Habitat when migrants leave the Project area. Hunting pressure increases during the Project construction phase and priority species (e.g. chimpanzees) may be targeted.		
Worst-case	Mitigation measures to control and manage influx are implemented too late and/or are not effective. Important Sites for Biodiversity are not avoided when lands are converted for agriculture and terrestrial Critical Habitat is preferred to develop agriculture.	Influx is more persistent: only 50% of new households leave early in the operational phase.	▸ Migrants require 4,400 ha at the start of the construction period for housing and producing food, and an additional 4,000 ha to produce food every subsequent two years. 10,000 migrants remain after the construction period, requiring an additional 6,000 ha of land to produce food. In total, 14,400 ha of habitat is lost. ▸ Terrestrial Critical habitat and swamps are targeted for clearance. The amount of each habitat type that is cleared is based on their availability within the Project area (after accounting for direct impacts).
	Result: Land cleared to produce food for migrants happens mostly in habitat preferred for agriculture (terrestrial Critical Habitat and swamps) and migrants remain longer in the Project area. The rate of Natural Habitat conversion increases and remains high during the Project lifetime. Hunting pressure on priority species significantly increases and remains high over time.		

Selection of the most probable scenario

During the operational phase, the Project will only employ approximately 60 people. As migrants in Sierra Leone move for economic opportunities, it is likely that many people will not permanently remain in the Project area after the construction period as there will not be the same opportunities available. Prior to the Bumbuna I Project, in 2004 the population in Bumbuna was estimated at 4,000-5,000 (Nippon Koei UK *et al.* 2005). After the construction of the Project, in 2015 the figure was very similar, i.e. 4,051 people (ERM 2017a). It is therefore considered likely that migrants will only stay whilst work is available and will then leave. However, the Influx Management Plan has not yet been developed and therefore there is a risk that areas of Natural Habitat may be impacted if large numbers of migrants arrive in the Project area. On a precautionary basis, the **intermediate scenario** was therefore selected for the analysis.

3.6 Results of the residual impact assessment

Estimates of direct and indirect terrestrial habitat loss

An estimated 24,906 ha of land will be directly and indirectly impacted by the Project (Table 7).

The majority of the estimated impacts will be to areas of **Modified Habitat (17,387 ha).**

An estimated **3,680 ha of Natural Habitat** including **3,839 ha of Critical Habitat (i.e. hillslope forest and gallery forest)** will be impacted by Project development.

Table 7: Estimated areas of terrestrial habitat loss (all figures are rounded to the nearest hectare)

Habitat type	Direct impacts		Indirect impacts	TOTAL (ha)
	Footprint	Resettlement	Influx	
Critical Habitat	**1,659**	**446**	**1,705**	**3,811**
Hillslope forest	191	274	1,041	**1,504**
Gallery forest	1,468	174	665	**2,307**
Other Natural Habitat	**1,584**	**406**	**1,552**	**3,541**
Natural savannah/woodland	1,521	375	1,432	**3,327**
Swamp	33	31	120	**184**
Inselberg	30	0	0	**30**
Modified Habitats	**7,327**	**2,086**	**8,143**	**17,555**
Human modified savannah/ recovering fallow (trees > 10 m)	4,953	1,437	5,610	**12,000**
Agriculture and young fallow (trees < 10 m)	2,069	649	2,533	**5,251**
Agriculture (no trees)	191	0	0	**191**
Settlement/road	114	0	0	**114**
TOTAL	**10,570**	**2,938**	**11,400**	**24,906**

Estimates of freshwater habitat loss

The loss of freshwater habitat is estimated to be 162 km:

- 39 km of main stems; and
- 123 km of tributaries.

3.7 Significance of residual impacts to priority habitats

Terrestrial priority habitats

A total of 3,811 ha of terrestrial Critical Habitat is forecasted to be impacted by the Project (gallery and hillslope forest). This represents a loss of 12% of Critical Habitat within the Project area[13]. Project impacts are therefore considered significant at a local level. These habitats are important for several priority species, and mitigation measures therefore focus on ensuring impacts are minimised in these habitats (Seli Hydropower 2019a). At a regional and national scale, however, these habitat types are widespread, so project impacts are not anticipated to be significant at a larger scale.

Freshwater habitat

In total, 39 km of main stem and 123 km of tributaries are estimated to be impacted. Within the Upper Seli catchment the main rivers (the Mawaloko river and the Seli River above the Yiben reservoir) are approximately 82 km in length, meaning the Project impacts 32% of main river stem in the Upper Seli. Above the Yiben reservoir only (i.e. not including the tributaries of the Mawaloko), there are approximately 1,540 km of tributaries, meaning the Project impacts approximately 8% of tributaries in the Upper Seli catchment. These are considered to be significant impacts. Freshwater habitats support a number of Critical Habitat-qualifying fish species which will be impacted by the changes in hydrology (among other impacts) as a result of the flooding of the Yiben reservoir. Mitigation measures are not possible for these species and so the Project proposes offset measures to protect and improve freshwater habitat quality upstream of the reservoir where the same suite of priority species can be found (Seli Hydropower 2019a).

3.8 The Bumbuna Conservation Area (BCA)

Some of the predicted residual impacts will occur within the Bumbuna Conservation Area (BCA), a recognised protected area. Although the BCA is highly degraded (TBC 2019b), an area of 89 ha (including 28 ha of terrestrial Critical Habitat) will be lost due to the development of Project infrastructure for the Bumbuna extension. Mitigation actions to minimise and restore remaining areas of Critical Habitat within the BCA are therefore part of the BAP (Seli Hydropower 2019a).

Table 8: Project impacts to the Bumbuna Conservation Area

Habitat type	Total area in the BCA (ha)	Predicted Project impact to BCA (ha)
Terrestrial Critical Habitat	**560**	**28**
Hillslope forest	424	19
Gallery forest	136	9
Natural Habitat	**228**	**10**
Natural savannah/woodland	156	4
Swamp	37	1
Inselberg	35	5
Modified Habitats	**1544**	**51**
Human modified savannah/recovering fallow (trees > 10 m)	631	21
Agriculture and young fallow (trees < 10 m)	709	15
Agriculture (no trees)	143	2
Settlement/road	61	13
TOTAL	**2332**	**89**

[13] Compared to the total amount of terrestrial Critical Habitat predicted to remain in the Project area at the end of the Seli Hydropower concession period.

4. Offset target for habitats

4.1 Habitat condition

4.1.1 TERRESTRIAL HABITAT

In the Project area, the majority (71%) of habitat has already been modified by human activities. Natural Habitat is in small patches within a mosaic of Modified Habitat (Figure 1) and are under threat from further conversion to agriculture, and encroachment and degradation from logging activities. Ground truthing to support the development of the Project habitat map noted signs of degradation in all Natural Habitat visited, even larger patches of gallery or hillslope forest (SAR Sense Ltd. 2017). The condition of remaining Natural Habitat is therefore far from the best possible condition and area and condition are likely to continue to decline even without the development of the Project.

4.1.2 FRESHWATER HABITAT

As part of the Project's fish surveys, a semi-quantitative assessment of freshwater habitat was undertaken at each of the survey points. The assessment categorised riparian habitat quality and instream habitat quality at each survey point. Habitat quality classes were based on signs of disturbance, and ranged from "natural" to "critically disturbed". The quality of freshwater habitat in the upper Seli catchment is generally rated "moderately modified", i.e. it has lost some of its Natural Habitat qualities - mainly due to the loss of riparian vegetation[14] (Sonnenberg & Walsh 2018). As for terrestrial habitats, there is likely to be a background decline in habitat quality due to continued conversion of riparian habitats, which affects freshwater habitat quality.

4.2 Application of a Quality Hectare (QH) metric

The QH approach uses a combination of two measures: area and condition (or quality). In this metric, a theoretical "benchmark" habitat is considered the highest quality, at 100% condition. A degraded habitat is then considered at a lower percent condition. For example:

- 10 ha of highest possible condition habitat (100% quality) = 10 × 1 = 10 QH
- 10 ha of degraded habitat at 50% quality = 10 × 0.5 = 5 QH
- 10 ha of highly degraded habitat at 25% quality = 10 × 0.25 = 2.5 QH

Terrestrial habitat within the Project area is highly fragmented and has undergone historic, long-term degradation. Precautionarily, the quality of remaining habitat within the Project area is estimated to be **60% quality.**

Freshwater habitat within the Project area is degraded due to the loss of gallery forest and due to mining activities. Field surveys estimated the quality of freshwater habitat to be 73% in the Seli catchment (Sonnenberg & Walsh 2018), therefore the freshwater habitat is estimated to be **73% quality** (and applied using a declining baseline).

Table 9: Offset targets for all habitat types (incorporating a declining baseline)

Habitat types	Residual impact in ha	Residual impact in QH (area × 0.6)	Offset target
Critical Habitat			**Net Gain**
Hillslope forest	1,504	**902 QH**	**Greater than 902 QH**
Gallery forest	2,307	**1,384 QH**	**Greater than 1,384 QH**
Natural Habitat			**No Net Loss**
Natural savannah/woodland	3,327	**1,996 QH**	**Equal or greater than 1,996 QH**
Swamp	184	**110 QH**	**Equal or greater than 110 QH**
Inselberg[15]	30	**18 QH**	**Equal or greater than 18 QH**
Habitat types	**Residual impact in km**	**Residual impact in Qkm**	**Offset target**
Main stem	39	**21**	**Greater than 21 QKm**

[14] It should be noted that fish survey points deliberately avoided areas with artisanal mining activities which result in large amounts of sediment that significantly affect freshwater habitat quality ASM activities (as the surveys aimed to assess the presence and distribution of Critical Habitat-qualifying species) and so whilst the assessment provides a general gauge for freshwater habitat quality in the upper Seli catchment, the presence of ASM activities would significantly decrease habitat quality score for the section of river where they occur.

[15] During 2019 the Project will undertake additional surveys of the proposed quarry site (which is an inselberg habitat) to check for species that may qualify for Critical Habitat. If Critical Habitat-qualifying species are found, the Project will assess other potential quarry sites or undertake measures to avoid and minimise impacts to those species. The Project will undertake a species-specific residual impact assessment if it is required.

Tributary	123	**66**	**Greater than 66 QKm**

4.3 Use of offset multipliers

Additional multipliers are sometimes used to increase the scale of offsets required (Pilgrim & Ekstrom 2014).This may be in order to align offsets with national conservation goals in a few countries with well-developed national conservation plans (not yet the case in Sierra Leone). It may also be to account for lack of precision in data – we acknowledge this problem for this Project, but instead choose precautionary estimates and scenarios throughout. Multipliers are also sometimes used to account for temporal loss of biodiversity, but this only really addresses human time preference rather than biodiversity concerns, so is more appropriate when applied to ecosystem services (Pilgrim & Ekstrom 2014).

Another major issue for which offset multipliers are also sometimes (inappropriately) used is the inherent uncertainty of offset success (Pilgrim & Ekstrom 2014). Uncertainty of result is not usually reduced by quantity (e.g. the chance of flipping a coin twice and getting a "heads" the second time is not influenced by the result of the first flip), so multipliers are usually inappropriate to address this issue. Instead, a "bet-hedging" approach is more suitable – such as undertaking more than one offset across more than one site and in more than one context. In such circumstances, there is a much greater possibility that one offset will be successful. This Project is considering bet-hedging through funding to two offset sites with different contexts (Seli Hydropower 2019a, 2019b).

5. Species-specific assessments

Species-specific assessments are undertaken for priority species where habitats cannot be used as a proxy for assessing residual impacts. The Project has identified four AC1 priority species/subspecies (Section 2), of which two require species-specific assessment (Western Chimpanzee and *Ledermanniella yiben*). Habitat alone cannot be used as a proxy for chimpanzees as the Project may impact them indirectly through activities such as hunting and by disease transmission, rather than just habitat loss. Habitat cannot be used as a proxy for *Ledermanniella yiben* as the species is currently only known from one location and using freshwater habitat as a proxy would overestimate its distribution. Although the fish species *Enteromius* sp. aff. *trispilos* and *Chiloglanis* sp. OTU3 are likely endemic to the Upper Seli catchment, they are likely to be found in both tributaries and the main river. Freshwater habitat can therefore be used as a proxy to estimate impacts. For completeness, however, a species-specific assessment for *Enteromius* sp. aff. *trispilos* and *Chiloglanis* sp. OTU3 is provided in Section 5.2.5.

5.1 Western Chimpanzee

Western Chimpanzee is an emblematic subspecies, Critically Endangered across its distribution range. In Sierra Leone, more than 50% of the country's population is found outside protected areas (Brncic *et al.* 2010).

This assessment is based on results from field surveys undertaken in June 2017 and February 2018 (Ganas-Swaray *et al.* 2018) and known ecological and behavioural traits of the species.

5.1.1 SUMMARY OF SURVEY FINDINGS AND IMPLICATIONS FOR RESIDUAL IMPACT ASSESSMENT

Chimpanzee communities and social behaviour

- Chimpanzees live in communities which may split into smaller groups (or parties) to feed or sleep. Within the Project area, 13 chimpanzee groups were identified during surveys, based on evidence of chimpanzee nests and dung in close proximity (< 4 km apart from each other: Figure 4). It is unknown if each group is a separate community or if some of the groups may combine to form a community. ***For the purposes of the residual impact assessment, each of the 13 groups is assumed to represent a different chimpanzee community*** (as it is precautionary to consider the maximum likely number of groups rather than a lower number of larger groups)***.***
- Chimpanzees are territorial and will defend their territory against neighbours, which can lead to the death of one to several individuals during inter-community encounters (Boesch *et al.* 2008; Mitani *et al.* 2010). Inter-community encounters have not been studied in the context of hydroelectric development, nor in the context of forest-savanna mosaic habitat. However, research in areas of commercial logging has shown that communities move due to logging activities and that this has led to population declines of 40-90% due to inter-community conflicts (White & Tutin 2001; Morgan & Sanz 2007[16]). ***Project activities that may result in a movement of chimpanzee groups are therefore likely to have an inter-community impact***.

Chimpanzee home range and core area

- Chimpanzee home range is the total territory used by a chimpanzee community. The home range includes a core area (the area most often used and which usually includes a concentration of nesting sites: Kouakou *et al.* 2011) and foraging areas. Foraging areas vary over time (across season and year), depending on food availability. Generally, foraging areas are around the periphery of the core area and chimpanzees typically travel 3-4 km between food patches (Lehmann & Boesch 2004), usually not in a straight line. Surveys in the Project area have shown that chimpanzees prefer forest habitats (i.e. gallery and hillslope forests) for nesting (Ganas-Swaray *et al.* 2018); these forest habitats are therefore considered to be potential "core habitat". Loss or degradation of core habitats within home ranges will considerably reduce the likelihood of survival of a chimpanzee group. The core area for each known group of chimpanzees within the Project area was defined by drawing a polygon around nesting sites and forest patches that overlap with that polygon. Core areas range

[16] These studies were conducted in dense forested habitat with high ape densities. These figures are thus only indicative for this Project at this point.

in size from 0.16 to 10.9 km^2 depending on the size of the chimpanzee group. The total home range for each group is estimated by adding a 2 km buffer to each core area, resulting in home ranges of 12.6-59 km^2 in the Project area[17]. ***The likely core area and home range for each group of chimpanzees in the Project area is presented in Figure 4.***

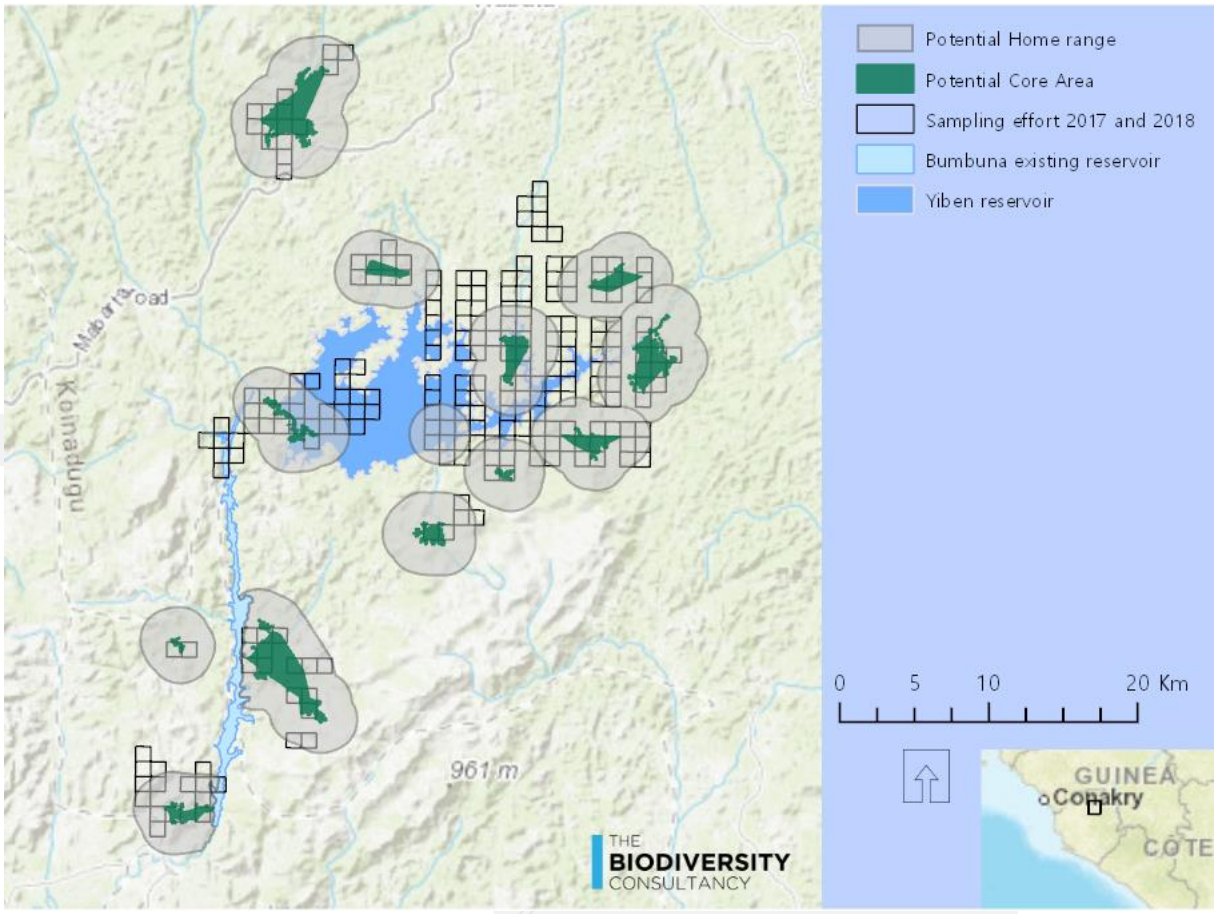

Figure 4: The 13 chimpanzee groups identified during 2017 and 2018 and their potential core areas and home ranges.

Number of chimpanzees per group

- Chimpanzee density varies throughout its range, depending on habitat type and condition and threats from humans. Based on nest presence along transects, chimpanzee density is estimated to be 0.13 ind./km^2 (95% CI 0.05 – 0.32 ind./km^2) in the Project area (Ganas *et al.* 2018). However, non-invasive genetic analysis conducted in one site, the Bumbuna Conservation Area, suggests that transect data in some instances can underestimate chimpanzee density[18]. ***The residual impact assessment therefore uses the mean and upper density estimate from the transect survey (i.e. 0.13 and 0.32 ind./km^2). The size of each group is estimated by multiplying the potential home range size by the chimpanzee mean and upper density estimates*** (Appendix 3).

[17] Chimpanzee home range size varies according to the habitat type, food availability and community size, but it has been estimated to range from approximately 25 km^2 in dense forest (Herbinger *et al.* 2001) to 60 km^2 in drier environments (for a community of 35 chimpanzees; Pruetz & Bertolani 2007). Therefore, most of these estimates fall within the lower end of this spectrum, which appear reasonable given the potentially small size of communities in this area (e.g. the Bumbuna community has a minimum size of 10 individuals, based on the non-invasive genetic analysis: Arandjelovic 2018).

[18] Based on transect surveys undertaken in 2013, six chimpanzees (95% CI: 2-17) are estimated to occur the Bumbuna Conservation Area. However, genetic analysis undertaken in 2018 estimated at least 10 chimpanzees (and potentially up to 25 chimpanzees) to be present in the area (Arandjelovic 2018).

5.1.2 PROJECT IMPACTS

A summary of identified Project impacts to chimpanzees is presented in Table 10.

Table 10: Summary table of direct and indirect impacts on chimpanzees

Impacts leading to a loss of chimpanzee home range and core areas and mortality	Associated impacts creating disturbance to chimpanzees
Direct impacts arising from:	
Project infrastructure at Yiben and at the Bumbuna extension	Noise, dust and vibration during construction and operation
Construction/upgrade of roads	Noise, dust and vibration during construction and operation
The Yiben reservoir	Habitat fragmentation
Operation of the Yiben reservoir (causing an increase in the footprint of the Bumbuna reservoir)	Habitat fragmentation
Disease transmission from staff and contractors	
Resettlement of communities and farming activities	Not yet included[19]
Indirect impacts arising from:	
Influx of people	Not yet included (footnote 19)
Hunting	To be monitored
Overexploitation of chimpanzee habitats	Planned roads and upgrades are included[20]

Direct impacts

1. **Project footprint**: Will result in a loss of chimpanzee home range, including core habitat (under the Yiben reservoir and infrastructure that will be built for the Bumbuna II extension).
2. **Noise, dust and vibration around project infrastructure and roads causing habitat disturbance**: Will result in chimpanzees avoiding these areas. For some groups this may mean a reduction in their home ranges or core habitats.
3. **Habitat fragmentation**: The Yiben reservoir will divide the Project area into a northern and southern area. This will reduce opportunities, for females from communities living in the reservoir vicinity, to move from one group to another when reaching maturity. However, the loss of core habitat for these groups from direct impacts is likely to be far more significant than any potential impact from fragmentation. Fragmentation is therefore not included in the assessment. The Yiben reservoir area is also an irregular shape, and may create barriers for chimpanzee groups living around the reservoir, cutting access to some sections of a group's home range and potentially creating inter-group conflict if groups try to move their home range. This impact is assessed as part of the risk of group conflicts.
4. **Disease transmission due to staff and contractors:** Disease transmission may increase during the Project construction period because of the increased risks of human-chimpanzee encounters. It is, however, considered to be negligible if mitigation measures are properly implemented and is therefore not considered further in this assessment (Seli Hydropower 2019a).
5. **Resettlement of affected communities**: Clearance of land for housing and agricultural activities may impact chimpanzee core habitat or foraging areas, leading to a reduction in the home range of chimpanzee groups and therefore a reduction in the number of chimpanzees that can be supported by the available habitat.

Indirect impacts

1. **Influx of people in search of employment opportunities**: A large number of economic migrants are anticipated to arrive to the Project area. Additional farm land will be required to feed these people which, like the clearance of land for resettlement, may impact chimpanzee core habitat or foraging areas – leading to a reduction in the home range of chimpanzee groups.
2. **Hunting**: Currently hunting of chimpanzees is considered to be very low or even absent from the area (Ganas-Swaray *et al.* 2018) as it is against traditional customs. However, migrants may not hold the same values and therefore hunting may increase. As chimpanzees are one of the last species of large mammals in the Project area, they are vulnerable to any increase in hunting pressure. However, changes in human behaviour as a result of influx are difficult to predict and therefore excluded from this residual impact assessment. The Project will monitor changes in hunting pressure in the Project area to assess if there is a change in hunting threat levels.

[19] Disturbance impacts from resettlement and influx cannot currently be estimated. Mitigation measures will be put in place to minimise impacts to Natural Habitat (and so chimpanzee habitat) and the outcome of mitigation measures will be monitored across the project area. If impacts become significant, the residual impact assessment and offset requirement will be updated.

[20] If new roads are constructed close to known groups of chimpanzees, the impacts will be assessed and included into the overall residual impact assessment and offset requirement.

3. **Overexploitation of chimpanzee habitats**: The construction of any new roads will increase access to chimpanzee habitats. This may in turn lead to an increase in hunting, disease transmission and degradation of chimpanzee habitat. Such overexploitation of habitat is included in estimates of impacts from influx for planned roads and upgrades.

5.1.3 APPROACH TO THE RESIDUAL IMPACT ASSESSMENT

The chimpanzee population in the Project area is believed to be declining due to impacts on habitat (e.g., the habitat within Bumbuna Conservation Area has been degraded over the last years: Ganas-Swaray *et al.* 2018). However, no information on the rate of population decline rate is available for the Project area. To be very precautionary, given high stakeholder concern over this subspecies, residual impacts on chimpanzees have thus been conducted using a static baseline (i.e. assuming that the chimpanzee population is stable).

Direct impacts

Project footprint (infrastructure, disturbance and fragmentation (direct impacts 1, 2 and 3 above)

Steps to estimate direct impact from the Project footprint, i.e. footprint, disturbance and fragmentation (1, 2 and 3 above).

1. *Addition of buffers around infrastructure to account for disturbance*

To account for disturbance and avoidance of habitat from noise, dust, and vibration, a 200 m buffer was placed around infrastructure and a permanent loss of any home range or core habitat was assumed. A 200 m buffer is based on:

- **Noise**: Chimpanzees are likely to avoid areas close to project infrastructure due to noise disturbance during project construction. Noise disturbance is estimated to have a significant impact for up to 400 m from the source for people (ERM 2017b), but this varies depending on the type of infrastructure. Chimpanzees living in the Project area are recorded living close to human settlements (~ 50 m) and are therefore used to a certain level of noise disturbance. A buffer of 200 m is considered precautionary.
- **Dust**: Dust deposited onto fruit and leaves near to infrastructure and roads will mean that chimps avoid these areas for feeding. For people, dust disturbance is estimated to have a significant impact for up to 200 m from the source (ERM 2017a).
- **Vibration**: Vibration impacts are likely to be concentrated to few areas, such as close to the quarries and at the dam during construction. Vibration disturbance is considered to be negligible at distance larger than 100 m from the source.

2. *Spatial assessment of impacts to each chimpanzee group*

The impact from the Project direct footprint (including disturbance) was assessed spatially by estimating the impacts to each known chimpanzee group. Impacts were estimated by assessing the degree of overlap between the direct footprint (and buffers) and the potential home range of each chimpanzee group living in or in the vicinity of the project footprint (Figure 5). These groups may be impacted by both habitat loss within their home range and the risk of inter-group conflict if the group shifts home range into a neighbouring group's home range. It was assumed that a risk of inter-group conflict exists when the home range of an impacted group is located within 2 km of the home range of another group.

The following rules were used to assess the loss of individuals in each known group:

- If > 50% of core habitat is under the Project footprint, the whole group is assumed to be lost as it will lose a significant area of food resources and nesting sites. If the group tries to move their home range, it would result in an intergroup conflict, and few other areas of suitable habitat are likely to be available in the largely modified landscape of the Project area;
- When ≤ 50% of core habitats are under the Project footprint, the group is assumed to persist in the area, although there is likely to be a reduction in the number of chimpanzees in the group. The reduction in number of chimpanzees is estimated by assuming that the reduction will be equivalent to the proportion of core habitat loss (e.g. if 30% of the core habitat within the home range of a group of 10 individuals is lost, it is assumed that the group size will be reduced by 30%, i.e. three individuals). This approach is precautionary as chimpanzees can adapt to some level of habitat change and may thus actually be able to adapt to the loss of a section of their core habitat. As chimpanzee loss will be monitored during Project implementation, offset targets can be lowered if monitoring reveals that chimpanzee loss is lower than forecast. Finally, if there is a likelihood of an intergroup encounter (i.e., the home range is located at less than 2 km of the home range of another group), the estimated number of chimpanzees lost based on core habitat loss was doubled to account for the conflict (in the example, six individuals will then be considered to be lost).

Resettlement of affected communities (i.e. direct impact 4 from above)

The total area of habitat lost related to resettlement was estimated in Section 3.3. As the exact location of resettlement is not yet known, the impact for known chimpanzee groups cannot be assessed spatially. Impacts were therefore assessed based on the loss of chimpanzee core habitat and home range; the area of home range lost was multiplied by the chimpanzee density estimate to estimate the number of chimpanzees potentially impacted. As per the habitat residual impact assessment, the intermediate scenario was used to estimate impacts.

Indirect impacts

The total area of habitat lost as a result of influx was estimated in Section 3.5. As the location of future influx migration is not known, the impact for known chimpanzee groups cannot be assessed spatially. Impacts were therefore assessed based on the loss of chimpanzee home range (calculated based on remaining home range after all direct impacts are accounted for); the area of home range lost was multiplied by the chimpanzee density estimate to estimate the number of chimpanzees potentially impacted. As per the habitat residual impact assessment, the intermediate scenario was used to estimate influx impacts.

5.1.4 RESULTS

It is estimated that between **44 and 70 chimpanzees** will be lost due to the Project (Figure 5 and Table 11)[21]:

- ~25 chimpanzees are estimated to be lost due to the Project direct footprint (and disturbance);
- 4-9 chimpanzees are estimated to be lost due to resettlement activities; and
- 15-36 chimpanzees are estimated to be lost due to influx of economic migrants.

Table 11: Estimated chimpanzee loss

Parameter	Direct impacts		Indirect impacts
	Footprint including degradation	Resettlement	Influx
Home range		2,937 ha 1% of home range lost	11,400 ha 3.8% of home range lost
Core Habitat		454 ha 1% of core habitat lost	1,705 ha 3.9% of core habitat lost
Number of groups and of chimpanzees	▸ Two groups are completely lost (>50% ▸ Two groups are significantly impacted (24-30% of core habitat loss) ▸ Three groups are slightly impacted (0.4-3.3% of core habitat loss) ▸ For six groups, no impacts are anticipated **~ 25 chimpanzees**	**4-9 chimpanzees**	**15-36 chimpanzees**

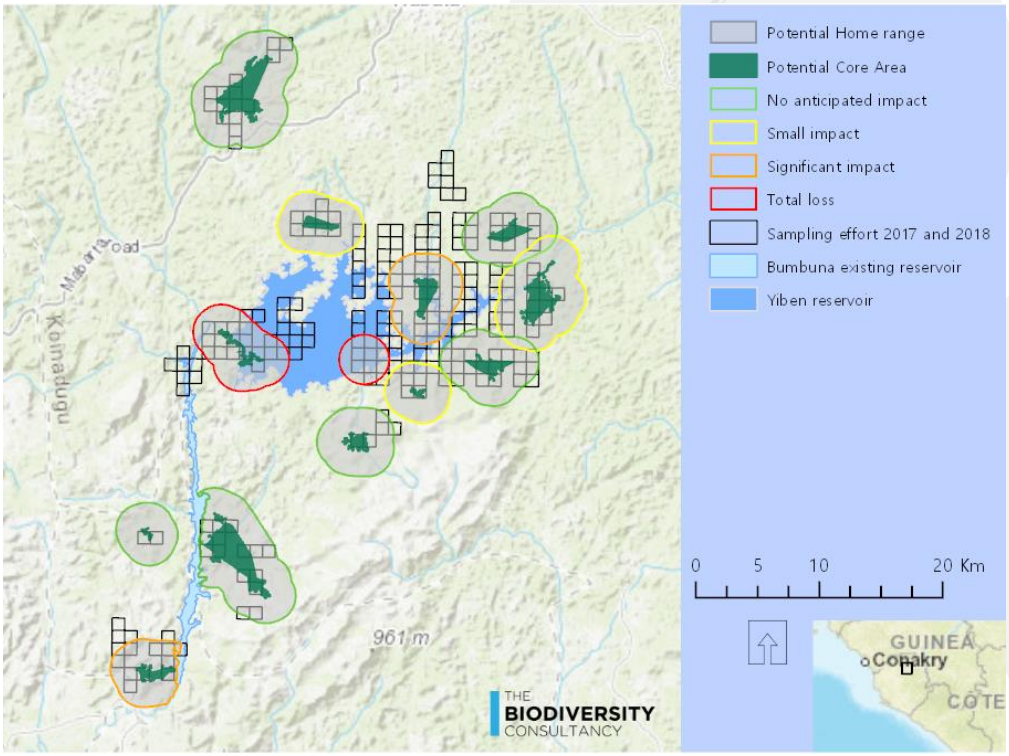

Figure 5: Results of the spatial assessment of direct footprint impacts on known chimpanzee groups

[21] The estimated impacts from all scenarios are provided in Appendix 2 for completeness

5.1.5 SIGNIFICANCE OF RESIDUAL IMPACTS TO CHIMPANZEES

It is estimated that between 44 and 70 chimpanzees will be lost due to the Project. The Western Chimpanzee is an emblematic Critically Endangered subspecies. Sierra Leone supports approximately 5,500 chimpanzee (Brncic *et al.* 2010). Whilst the Project impacts represent a comparatively small loss (c. 1%) to the total estimated population in Sierra Leone, chimpanzee populations are threatened by habitat loss and, in some areas, by hunting. Project impacts are therefore an additional pressure on an already threatened population. The Project will focus mitigation actions on conserving Important Sites for Biodiversity with chimpanzee groups in the Project area, to minimise and monitor impacts. The Project is planning to compensate for residual impacts on chimpanzees, which will be used as a focus species to select offset sites and design conservation actions (Seli Hydropower 2019a).

5.2 Priority freshwater fish: *Enteromius* sp. aff. *trispilos* and *Chiloglanis* sp. OTU3

5.2.1 ECOLOGY AND HABITAT

Enteromius sp. aff. *trispilos* and *Chiloglanis* sp. OTU3 are rheophilic, meaning they live in and prefer fast-flowing, clear water. The two species are found in moderate to large tributaries of the Seli and main river channels (Figure 6) and are considered unlikely to survive in lacustrine/lentic conditions (Sonnenberg & Walsh 2018).

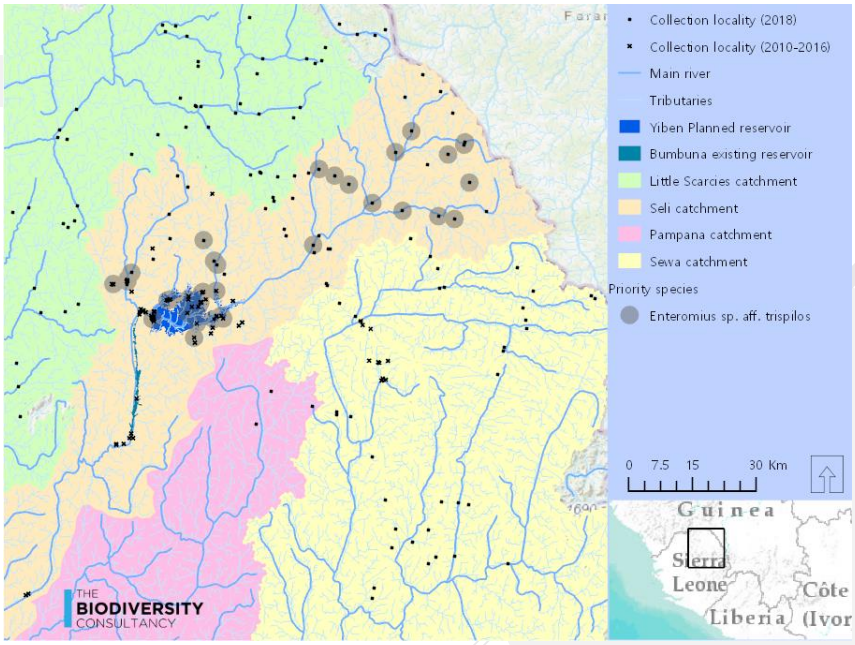

Figure 6: Freshwater fish distribution[22]

5.2.2 PROJECT IMPACTS AND OTHER THREATS

Direct

Habitat loss due to the Project footprint: Rivers and tributaries within the footprint of the Yiben reservoir and the "extension" of the Bumbuna I reservoir will be converted to lake conditions once the Project is operational. As these fish species are unlikely to survive in lake conditions, this loss of habitat represents a loss of these species in these areas.

Resettlement of affected communities: Affected communities that are resettled will require land for farming and other activities (Section 3.3) which may lead to the removal of vegetation along river banks and tributaries. Vegetation removal causes sedimentation and an increase in water temperature, degrading the quality of freshwater habitat and its suitability to support priority fish species.

***Habitat fragmentation*:** Connectivity between the Mawaloko River and the section of the Seli River upstream of Yiben reservoir will be lost once the Yiben reservoir is flooded, leading to two isolated populations (in the Mawaloko river and the Upper Seli river, above the Yiben reservoir).

Indirect

***Influx of migrants*:** Influx is likely to lead to increase conversion of habitats for farming (Section 3.5). If habitats are converted along rivers and streams, this will lead to freshwater habitat degradation (as per the resettlement of affected communities).

Other threats to the species in the Project area

[22] The distribution of *Enteromius* sp. aff. *trispilos* is currently only mapped as the presence of *Chiloglanis* sp. OTU3 is confirmed from only one location (in a tributary of Mawaloko River) but experts suggest that its distribution is likely to be similar to *Enteromius* sp. aff. *trispilos* (Sonnenberg & Walsh 2018)

Several existing threats in the Upper Seli catchment were identified by fish specialists:

- Agriculture along bank sides, inducing a removal of riparian areas that is causing sedimentation and an increase in water temperature;
- Artisanal mining activities, increasing sedimentation in the rivers and potentially toxicity;
- Logging, reducing gallery forest, leading to an increase in sedimentation and in water temperature.

Fishing is only likely to be a possible threat to *Enteromius* sp. aff. *trispilos* but it is not deliberately caught and instead is caught as by-catch when small-sized gill nets are used.

5.2.3 APPROACH TO RESIDUAL IMPACT QUANTIFICATION

As previously mentioned, surveys have shown that the fish species *Enteromius* sp. aff. *trispilos* is endemic to the Upper Seli catchment. *Chiloglanis* sp. OTU3 distribution is not mapped yet but experts suggest that this species has a similar distribution to *Enteromius* sp. aff. *trispilos* (Sonnenberg & Walsh 2018). Both species are likely to be found in both tributaries and the main river and so freshwater habitat can be used as a proxy to estimate impacts. The same approach and results as for impacts on freshwater habitat (Section 3.6) are therefore used for these fish species.

Quantification of residual impacts does not yet include quantification of degradation to freshwater habitat as a result of resettlement or influx of migrants. Instead of quantification, the Project will monitor the conversion of gallery forest habitat into agricultural lands and will monitor freshwater habitat quality in tributaries surrounding the Yiben reservoir to assess for any significant changes. If detected, the Project will undertake actions (in coordination with communities and authorities) to revegetate river and tributary banks.

5.2.4 RESULTS

The loss of *Enteromius* sp. aff. *trispilos* and *Chiloglanis* sp. OTU3 habitat is estimated to be 162 km:

- 39 km (or 21 Qkm) of main stems; and
- 123 km (or 66 Qkm) of tributaries.

5.2.5 SIGNIFICANCE OF RESULTS FOR *ENTEROMIUS* SP. AFF. *TRISPILOS*

The loss of freshwater habitat that supports *Enteromius* sp. aff. *trispilos*, represents a loss of 25% of its global distribution range, which is a significant impact for the species. *Chiloglanis* sp. OTU3 distribution is not yet confirmed but based on expert opinion, a similar proportion of its global distribution range is likely to be impacted by the Project. As impacts cannot be mitigated, it will be important for the Project to ensure that remaining freshwater habitat in the Upper River Seli is protected from activities such as artisanal mining and removal of vegetation along the river banks that may degrade water quality and impact the species. Only the Upper river Seli is suitable as a freshwater offset as this species appears to be endemic to the Seli river. As an offset, the Project will undertake activities to rehabilitate vegetation along river and tributary banks to improve freshwater habitat quality and it will aim to reduce threats from activities such as farming and artisanal mining that result in freshwater habitat degradation. Such actions will be undertaken in stretches of river and tributary that exceed the length of the impacts.

5.3 *Ledermanniella yiben* (freshwater plant)

5.3.1 ECOLOGY AND HABITAT

Ledermanniella yiben is a recently discovered species 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 classed as Critically Endangered (CR). It was considered CR as:

1. It is currently only known from one location (known as the Yiben site on the Seli River);

2. Other species of genus *Ledermanniella* have a highly restricted distribution e.g. *Ledermanniella keayi* and *L. sanagaensis* are known only from single waterfall sites. It was therefore considered that *Ledermanniella yiben* may also have very specific habitat requirements and limited distribution; and,

3. It is under imminent threat at its single known site (from the Project).

It is a priority species for the project because flooding as a result of the Yiben dam will impact the only known location of this species.

Subsequent to the publication of the species description, the author and top global expert on West African Podostemaceae, Martin Cheek, has undertaken further studies of collected specimens and seeds. The species is now considered to belong to the genus of *Sphaerothylax* as it has characteristics closely related to other species of this genus (specifically it has two types of leafy shoot), and will formally be renamed as *Sphaerothylax yiben* (Martin Cheek, pers comm. December 2017).

At the Yiben site, *Ledermanniella yiben* grows on gnessic rocks in a section of rapids where the majority of the rocks are exposed during the dry season, resulting in the plants drying out. A small number of plants remain perennial in the river channel where white water flows year-round; this behaviour makes it both an annual and a perennial plant depending on habitat conditions (Lebbie 2018). Plants are highly prolific, with each individual stem producing hundreds of capsules producing thousands of seeds at maturity which are released onto the surrounding rocks.

5.3.2 APPROACH TO RESIDUAL IMPACT QUANTIFICATION AND RESULTS

As the plant is currently only known from one location, surveys have been undertaken to estimate the area covered by the population and therefore the residual impact to the species once the Yiben reservoir is flooded. The plant covers an area approximately 75 m by 35 m. Within this area it grows in patches on some rocks and covers the entire surface of others. 1 m^2 quadrats, subdivided into 100 sub-quadrats were used to record the presence of plants on all exposed rocks within the site. On exposed rocks the plant is estimated to cover an area of 233.87 m^2. Further plants growing within the river channel could not be surveyed due to fast-flowing water. It is estimated that the area covered by plants in the river channel is less than 5% of the area covered on exposed rocks, i.e. 11.7 m^2, giving a total area of 245.57 m^2.

5.3.3 SIGNIFICANCE OF THE RESIDUAL IMPACT

As the population that will be impacted by the Project is the only known global location for the species, it is highly significant. The Project has been working on a net gain strategy for the species through actions to: search for new locations of wild populations; trial translocation of seeds and plants to new locations; and, propagate the species ex-situ. To achieve a net gain for the species, the Project will need to establish new populations in secure locations (away from other known threats, particularly artisanal mining). The Project aims to establish self-sustaining populations of *Ledermanniella yiben* in at least three new locations, to demonstrate a net gain. All actions that the Project will undertake for *Ledermanniella yiben* are outlined in the BAP (Seli Hydropower 2019a).

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7. Appendices

APPENDIX 1: SCENARIO RESULTS FOR HABITAT LOSS

Habitat loss for each scenario (the selected scenario is highlighted in blue)

Habitat type	Direct impacts (ha)				Indirect impacts (ha)			TOTAL (ha)
	Footprint	Resettlement			Influx			
		Best-case scenario	Intermediate scenario	Worst-case scenario	Best-case scenario	Intermediate scenario	Worst-case scenario	
Priority Habitats	**1,659**	**0**	**446**	**2,748**	**0**	**1,705**	**13,443**	**3,811**
Hillslope forest	191	0	272	1,675	0	1,041	5,236	**1,504**
Gallery forest	1,468	0	174	1,073	0	665	8,206	**2,307**
Natural Habitats	**1,548**	**478**	**406**	**190**	**1,825**	**1,552**	**957**	**3,541**
Natural savannah/woodland	1,521	442	375	0	1,684	1,432	0	**3,936**
Swamp	33	36	31	190	142	120	957	**184**
Inselberg	30	0	0	0	0	0	0	**30**
Modified Habitats	**7,327**	**2,459**	**2,086**	**0**	**9,574**	**8,143**	**0**	**17,555**
Human modified savannah/ recovering fallow (trees > 10 m)	4,953	1,694	1,437	0	6,596	5,610	0	**12,000**
Agriculture and young fallow (trees < 10 m)	2,069	765	649	0	2,978	2,533	0	**5,251**
Agriculture (no trees)	191	0	0	0	0	0	0	**191**
Settlement/road	114	0	0	0	0	0	0	**114**
TOTAL	**10,570**	**2,937**	**2,937**	**2,937**	**11,400**	**11,400**	**14,400**	**24,906**

APPENDIX 2: SCENARIO RESULTS FOR CHIMPANZEE LOSS

Summary of chimpanzee loss (the selected scenario is highlighted in blue)

Parameter	Direct impacts				Indirect impacts		
	Footprint and direct disturbance	Resettlement			Influx		
		Best-case scenario	Intermediate scenario	Worst-case scenario	Best-case scenario	Intermediate scenario	Worst-case scenario
Home range		2,937 ha 1% of habitat lost	2,937 ha 1% of home range lost	2,937 ha 1% of home range lost	11,400 ha 3.9% of habitat lost	11,400 ha 3.9% of habitat lost	14,400 ha 4.9% of habitat lost
Core Habitat		0 ha 0% of core habitat lost	449.5 ha 1% of core habitat lost	2,751.9 ha 6.3% of core habitat lost	0 ha 0% of core habitat lost	1,705 ha 9,1% of core habitat lost	13,443 ha 31% of core habitat lost
Number of groups and of chimpanzees	▸ Two groups are completely lost ▸ Five groups are impacted ▸ For six groups, no impacts are anticipated ~25 chimpanzee loss	Up to four chimpanzees	4-9 chimpanzees	Up to nine chimpanzees	Up to 15 chimpanzees	15-36 chimpanzees	At least 46 chimpanzees
Interpretation	10-25 chimpanzees will be lost based on habitat lost. As impacted areas are known to be used by chimpanzees, the mean density estimate is likely to underestimate chimpanzee numbers. Therefore, it is recommended to consider that 25 chimpanzees will be lost.	4-9 chimpanzees might be lost based on habitat lost. However, since no core habitat is impacted, the number of impacted chimpanzees is likely to be the smaller estimate or less.	4-9 chimpanzees might be lost based on habitat lost. Since core habitat is impacted, the number of impacted chimpanzees will be between both estimates.	4-9 chimpanzees might be lost based on habitat lost. Since more than 5% core habitat will be impacted, it is precautionary to consider that up to the higher estimate.	15-36 chimpanzees might be lost based on habitat lost. However, since no core habitat will be impacted, the number of impacted chimpanzees is likely to be the smaller estimate.	15-36 chimpanzees might be lost based on habitat lost. Since core habitat is impacted, the number of impacted chimpanzees will be between both estimates.	19-46 chimpanzees might be lost based on habitat lost. However, Impacts mainly occur in the core habitat of chimpanzees (more than 30% are lost). The number of impacted chimpanzees is likely to be higher than the estimate. This scenario clearly shows the importance of implementing mitigation measures to avoid worst impacts on chimpanzees.

APPENDIX 3: ESTIMATED SIZE OF CHIMPANZEE GROUPS IN THE PROJECT AREA

Group size is estimated by multiplying the potential home range size by the chimpanzee upper density estimate.

Group name	Home range (km^2)	Estimated size (ind.)
Temne Moria	32.7	4-10
Gbogoroma	27.8	4-9
Hut44	12.6	2-4
Konkoba	59.0	8-19
Kondembaia	34.0	4-11
Dukono	49.1	6-16
Kameron	35.1	5-11
Yisaia	20.4	3-7
Benekoro	28.3	4-9
Yiben	36.3	5-12
Kamasapi	19.3	3-6
Worowaia	54.9	7-18
Bumbuna	24.8	3-8

APPENDIX 4: SUMMARY OF EXCLUSIONS, LIMITATIONS AND ASSUMPTIONS

Exclusions

- The residual impact assessment does not include the Indim-Exim transmission line infrastructure within the assessment as this is being developed by the Ministry of Energy and details have not been shared with the Project to date.
- The assessment only includes road and transport infrastructure that was designed by Lahmeyer International and provided to TBC in October 2018, and were included in the ESIA. If additional infrastructure is added to the Project design, impacts will need to be quantified and added to the offset requirements, e.g. if access roads and replacement bridge for Badala are built upstream of the planned reservoir (ERM 2017a).
- Relocation of artisanal mining activities was not included in this assessment. If such activities are relocated by the Project, the residual impacts should be assessed and included into offset requirements.
- Impacts to any existing fisheries (e.g. downstream of the Bumbuna extension) are not part of this RIA as they are a social impact rather than a biodiversity impact and should therefore be considered by appropriate social specialists.

Limitations

1. To resettlement and influx estimates

- The locations of the areas for resettlement were not known when this RIA was undertaken and therefore resettlement impacts are not spatially explicit. Estimates of the numbers of people that will be resettled are based on the most recent estimates available from the Project's social consultants, SRK.
- If resettlement is planned to occur within Important Sites for Biodiversity (i.e. if scenario 3, the worst-case scenario, has the potential to occur), the RIA should be updated.

2. To chimpanzee estimates

- Primate surveys targeted parts of the Project area where direct and indirect impacts are considered to be most likely. All chimpanzee groups in the areas surveyed are likely to have been identified. It is, however, possible that there are additional groups in the wider Project area – in areas that have not been surveyed (as Project impacts were considered to be highly unlikely). If affected communities are relocated to areas that have not been surveyed for chimpanzees, further surveys and residual impact assessment is required.
- Influx can lead to hunting pressure on chimpanzees. However, since chimpanzees are currently not hunted in the Project area, it was not possible to quantify this threat and to model how it might increase with a population growth in the Project area. Hunting threat will therefore be monitored in the Project area and any hunting activity detected will require mitigation action.

3. To priority freshwater fish

- The fragmentation of fish populations due to the flooding of the Yiben reservoir may have long-term consequences for the species. It is excluded from this assessment since it is unpredictable, but changes in the distribution of priority species will be monitored within the Upper Seli catchment.

Assumptions

- Habitat loss from direct and indirect impacts were assessed sequentially, i.e. habitat loss from direct impacts will occur first and habitat loss from indirect impacts can thus only occur to habitats remaining after accounting for the loss from direct impacts.
- Not all habitat types can be used for farming by people that will be resettled or by economic migrants as they are either unsuitable for farming or already being used for farming; these habitat types were therefore excluded when assessing the impacts of agriculture. Habitat types that were excluded were: 'settlement/road'; 'inselberg'; and 'agriculture'.
- It is assumed that food for Project staff and contractors will not be produced in the Project area and will brought in from Freetown or other major cities outside the Project area. If food is not imported, habitat loss due to project construction impacts is likely to be higher and will require assessment.
- Deforestation due to agriculture and small-scale logging is already significant within the Project area (deforestation was estimated to be 58% between 2007 and 2017, Space Intelligence Ltd 2018). It is assumed agriculture is the predominant activity and that small-scale logging can be incorporated into the loss calculated for agriculture.
- Impact due to habitat fragmentation is not included in the habitat assessment, but is not expected to be significant for biodiversity in Action Categories (AC) 2 or 3. Species that may be impacted by fragmentation are AC1 species i.e. chimpanzees and some restricted-range freshwater fish species; species-specific residual impact assessments have been conducted for these species (Section 4.3).
- This assessment did not take into account cumulative impacts. There are however not expected to be significant, since no additional large industrial projects are happening in the Project area.