

ECOLOGICAL SURVEY OF THE KAIHA 2 HYDRO-ELECTRIC POWER PROJECT



**LOFFA COUNTY
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EXECUTIVE SUMMARY

The general climate and vegetation of Liberia is primarily dependent on the biogeographic location of the country in west tropical Africa, and is determined by the movement of the inter-tropical air masses and high rainfall. The country occurs in the Upper Guinea forest zone, which according to historic sources was originally covered by closed canopy forest. Historic events over a couple of centuries such as high population density, diseases and war, which respectively led to forest clearance, low human population and vegetation regeneration is responsible for the current vegetation characteristic of the country. However, Liberia still remains one of the countries with the largest forest cover in West Africa and so its fauna and flora is expected to be more skewed towards forest species. The vegetation in the north of Liberia, encompassing the proposed Kaiha HPP, is generally tropical forest, largely interspersed by varying degrees and extent of degradation, farmlands and farmbush.

The distribution of mammals in Liberia may not be very different from that of birds as most of the avifauna is forest-dependent and so their presence and abundance follows the distribution of forests. The proposed Kaiha 2 HPP, located on the northern part of Liberia, is closely associated with the northwestern stretch of forest estate in the country and so could hold significant number of mammal and bird species. There are 150 species of mammals, including nine endangered, 12 vulnerable and nine near threatened, according to IUCN Red List (2015). Liberia supports 695 species of birds, including 21 species of global conservation concern, one of which Liberian Greenbul *Phyllastrephus leucolepis*, is endemic only to the country (Gatter, 1997; Demey 2006).

Herpetological studies in West Africa have a long history but present knowledge remains inadequate. In Liberia, despite the substantial efforts of some pioneering fieldworkers, current understanding of the number of reptile and amphibian species, and their distributions is based on results from a number of disparate sources, which together gives 58 amphibian and 77 reptilian species known to the country (Taylor et al., 1958, Hoke et al, 2007; Hiller et al., 2007). A checklist of fish species in Liberia from all sources, including specimens in major Rivers, suggests 205 fish species in total; 57 species are recorded from the Mano River (www.fishbase.org cited in Fermon and Gsegner, 2006). As in most African rivers, Cichlidae, Cyprinidae, Mormyridae, Characidae are the most important fish families (BHEP, 2004).

Ecological surveys were carried out in areas encompassing the construction of HPP at Kaiha-2, covering the following areas: Dam site, Access Road, Madina (Downstream), Irrigation Dam (Upstream), Transmission Line 1 (Mbaloma-Facunda axis), Transmission Line 2 (Foyah-Kolahun axis) and Transmission Line 3 (Kolahun-Voinjama axis). The survey covered four thematic groups: (i) Vegetation and Botanic assessment; (ii) Mammals and Birds; (iii) Amphibians and Reptiles; and (iv) Fish and Macro Invertebrates. Sampling methods follow standard methodologies applicable for each of the respective thematic groups. The GPS points of all sites surveyed were recorded.

The vegetation assessment shows that in the area to be affected by the Kaiha 2 HPP generally comprises as a mosaic of forest, farmbush, farmland and some bare/open areas of rocky

outcrops. The Dam site, Access Road and the Madina Area (downstream), accounts for most of the patchily distributed forests. One hundred and nine-three (193) species of vascular plants species belonging to 54 plant families were recorded during the survey, across the various ecosystems encountered, including 19 species of global conservation concern; 17 species are vulnerable (VU) and two are near threatened (NT). Trees were the most dominant growth form encountered across all survey sites with a total of 104 species, accounting for about 54% of the species growth reported.

A total of 38 species of mammals was recorded through interviews, signs and visual evidence. These include nine primates species among which are three endangered (Red Colobus Monkey *Colobus badius*, Western Chimpanzee *Pan troglodytes verus* and Diana Monkey *Cercopithecus diana*) and two vulnerable (Black and white Colobus Monkey *Colobus polykomus*, and Sooty Mangabey *Cercocebus atys*). For most of the mammal species presumed to be present, there was a general decline in their occurrence with increasing distance from the dam site, particularly in zones to be traversed by the transmission line.

A total of 176 species of birds belonging to 42 avian families was recorded over six days of surveys (Appendix A). These include six species with IUCN conservation status: Hooded Vulture *Necrosyrtes monochas* (EN), Yellow-casqued Hornbill *Ceratogymna elata* (VU), Green-tailed Bristlebill *Bleda eximius* (VU), Brown-cheeked Hornbill *Bycanistes cylindricus* (NT), Yellow-footed Honeyguide *Campaphega lobata* (NT) and Black-headed Rufous Warbler *Bathmocercus cerviniventris* (NT). Only two migratory species were recorded at the proposed Dam site: one Afro-tropical migrant White-throated Bee-eater *Merops albicollis*; and one Palearctic migrant, Common Sandpiper *Actitis hypoleucos*, which are the only species that may be affected by fast-flowing water.

The survey recorded 37 amphibians and 17 reptilian species. Of the 37 amphibian species, seven are of IUCN conservation concern with a Near Threatened (NT) status: These are *Hyperolius chlorosteus*, *Hyperolius zonatus*, *Kassina cochranæ*, *Leptopelis macrotis*, *Phrynobatrachus alleni*, *Phrynobatrachus liberiensis* and *Phrynobatrachus phyllophilus*). Three of the seven IUCN conservation concerned species (*Phrynobatrachus alleni*, *Phrynobatrachus liberiensis* and *Phrynobatrachus phyllophilus*) were recorded around the dam site whereas six, with the exception of *Leptopelis macrotis* were recorded in the upstream area and one (*Phrynobatrachus alleni*) was recorded within the downstream area.

In the case of reptiles, though many species have not been assessed by IUCN, one (Home's Hinge-back Tortoise *Kinixys homeana*), of the 17 species recorded is of IUCN conservation concern with a Vulnerable status. Further investigation through one-on-one interviews about the occurrence of macro reptiles within the survey area indicates the presence of 16 species of which three are of IUCN conservation concern. The three species include Slender-snouted Crocodile *Mecistops cataphractus* (Critically endangered), Dwarf Crocodile *Osteolaemus tetraspis* (Vulnerable) and Gray's Monitor *Varanus olivaceus*.

During this study, 12 fish species were recorded during sampling and about 25 additional species identified to exist in the Kaiha River by local communities. Six (6) of the species including those reported by the local communities are of global conservation concern and categorized as either Near Threatened (*Sarotherodon occidentalis* and *Tilapia walteri*), Critically Endangered (*Barbus carcharhinoides* and *Labeo curriei*) and Vulnerable (*Barbus eburneensis*, *Doumea chappuisi* and *Rhexipanchax nimbaensis*). However, the total number of fish species recorded during sampling only gives an approximate indication of abundance (Table 3). Species such as *Brycinus longipinnis*, *Chrysichthys johnelsi*, *Hemichromis fasciatus*, *Petrocephalus pellegrini* and *Barbus sacratus*, however, emerge as generally quite common whilst some, such as *Doumea chappuisi*, *Hemichromis bimaculatus*, *Tilapia louka*, *Sarotherodon occidentalis* and *Brycinus macrolepidatus* are only known from two or three specimens.

Of the species recorded so far, none possess the ability to move up the Kaiha-2 waterfalls (considering the slope and force of the waterfall) without being washed down. Despite the fact that the waterfall creates a natural barrier and as such has the tendency to produce distinct aquatic biota above and below these barriers (Rahel 2007), we are still far from a complete understanding of their influence on freshwater fish assemblages, especially in tropical aquatic environments (Bohlke et al. 1978). Besides, the capacity to migrate upstream requires that the fish swim faster than the water velocity, necessitating substantial energy cost (Blake 2004).

Some of the limitations include: limited time carry out seasonal assessment of the baseline biological condition of the project area, in order to account for a full complement of the biodiversity of the project area; time constraint and resource/equipment limitations also limited the number of sites visited and the type of sampling mechanisms used, respectively. The key conclusion is the areas to be affected by the Kaiha 2 HPP support a reasonable diversity of fauna and flora, based on the result of the survey and there is need for more scientific studies to provide detailed baseline for biodiversity assessment in Liberia. It is strongly recommended that the suitability of forest closer to the Kaiha 2 HPP area be assessed as offset for biodiversity conservation in the event of the displacement of species resulting from the construction and operation of the dam and related facilities.

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Glossary

Pelagic: Living and feeding in the open sea; associated with the surface or middle depths of a body of water; free swimming in the seas, oceans or open waters; not in association with the bottom. Many pelagic fish feed on plankton.

Benthopelagic: Living and feeding near the bottom as well as in mid waters or near the surface. Feeding on benthic as well as free swimming organisms. Many freshwater fish are opportunistic feeders that forage on the bottom as well as in midwater and near the surface, also pertaining to forms which hover or swim just over the floor of the sea.

Potamodromous: Migrating within streams, migratory in rivers, e.g. *Labeo spp.* Migrations should be cyclical and predictable and cover more than 100 km.

Catadromous: Migrating from freshwater to the sea to spawn. Sub-division of diadromous. Migrations should be cyclical and predictable and cover more than 100 km (eg. *Liza falcipinnis*)

SECTION I

INTRODUCTION

1.1 Background

1.1.1 Vegetation and Botanic Assessment

The general climate and vegetation of Liberia is primarily dependent on the biogeographic location of the country in west tropical Africa. The climate is determined by the movement of the inter-tropical front, which consists of a wedge of moist relatively cool air (the Equatorial Maritime Air Mass) which sinks under the lighter warm and dry air of the Tropical Continental Air Mass that forms over the Sahara. Rainfall is high with an average of over 4000 mm characterising the wet season across the West African coast. A combination of these factors is what shapes the vegetation of Liberia. It is country that occurs in the Upper Guinea forest zone, which according to historic sources was originally covered by closed canopy forest.

There are history evidences suggesting that the present vegetation of Liberia mainly comprises secondary closed canopy forest. Much of the original forest may have been cleared some three centuries ago due to high population density and rampant cut-and-burn agriculture (Cooper and Record, 1931; Gatter, 1984). The forests recovered because of the emergence of disease and the effect of inter-tribal war and the slave trade which is believed to have reduced the population, allowing the forest to regenerate resulting in the current state of the country's vegetation. These changes in forest cover is evidenced from occurrence of extensive, single dominant forest, the occurrence of forest whose secondary character is evident from their species composition and the presence of relics of human occupation such as graves, ancient roads and cultivated fruit trees (Gatter, 1997). Over the past century or so, the original continuous forest cover has been fragmented into a mosaic of forest, bush fallows, cleared land and human settlements. Currently, the larger forest tracks are now isolated from each other into effective islands, mainly concentrated in the north-northwest and central-southwest of the country.

Reduction in the forest cover has been accelerated by land development, road construction, timber exploitation and the introduction of rubber plantation within forest zone, thus opening the country to agriculture and mining. Though large in some cases, the forests have become isolated from each other and there is a gradual edging of savannah into areas, including the sandy coastal belt, and some inland zones. However, Liberia still contains some of the largest portions of the Upper Guinea forest cover in West Africa and remains the most important reservoir for all forest plant species that occur in the Upper Guinea Forest zone (Gatter, 1997).

1.1.2 Mammals and Birds

Liberia is one of the countries with the largest forest cover in West Africa and so its mammalian fauna is expected to be more skewed towards forest species. There are 150 species of mammals, including nine endangered, 12 vulnerable and nine near threatened,

according to IUCN Redlist (2015). The distribution of mammalian species, especially primates and large mammals is strongly correlated with the distribution of close forest ecosystems in the country. Areas that have relatively pristine forest cover support higher numbers of mammal species and accounts for greater proportions of threatened and rare species. The proposed Kaiha 2 HPP, located on the northern part of Liberia, is closely associated with the northwestern stretch of forest in the country and so could hold significant number of mammal species.

The distribution of mammals in Liberia may not be very different from that of birds as most of the avifauna is forest-dependent and so their presence and abundance follows the distribution of forests. Although site-based avifauna studies are rare in Liberia, yet studies done by Gatter (1997), Robertson (2001) and Demey (2007) have shown that Liberia is a strong hold for many endemic, rare and threatened birds in the Upper Guinea Forest and the Guinea-Congo forest biome. The Upper Guinea forest is considered among many others as one of the Endemic Bird Area, with the highest priority ranking for conservation based on the combination of its biodiversity importance and threat status (Strattersfield, et al, 1998).

Liberia supports 695 species of birds, including Liberian Greenbul *Phyllastrephus leucolepis*, which is endemic only to the country. There are 21 species of global conservation concern according to IUCN (2015) and Birdlife International (2015), 18 species of which are entirely forest dependent; these include two endangered, seven vulnerable, six near threatened and three data deficient species. A significantly large proportion of the species are resident, with 184 restricted to the Guinea-Congo biome and 15 (100%) of the species endemic to the Upper Guinea forest block. The few known savanna species are thought to be seasonal breeding visitors, but so far no Sudan-Guinea Biome Dependent species has been recorded.

1.3 Reptiles and Amphibians

Herpetological studies in West Africa have a long history but present knowledge remains inadequate. Many amphibian and reptile species are poorly characterized and their distributions are based on a limited number of records. Over the years, studies in West Africa have been mostly spurred by EIAs commissioned by industrial companies, while few were carried out by research scientists from abroad in the company of few locals as field assistants/guides. However, recent surveys in West Africa have begun to make substantial contributions to the knowledge of the West African amphibian and reptile faunas.

In Liberia, despite the substantial efforts of some pioneering fieldworkers, current understanding of the number of reptile and amphibian species, and their distributions is based on results from a number of disparate sources including Taylor et al (1958), stating that there are 58 amphibian and 77 reptilian species know to occur in Liberia, Hoke et al (2007) in a rapid survey of amphibians and reptiles of three National Parks including Lorma, Gola and Grebo, recorded 40 amphibian and 17 reptile species and Hiller et al (2007) in a rapid survey of three national parks of Liberia recorded 40 amphibian species. There is hardly a comprehensive and updated list of reptiles and amphibians of Liberia.

Outlined in this report are results of a field survey of amphibians and reptiles that inhabit the proposed dam site, downstream and the Upstream of the Kaiha River environ. Results include data collected from the field through day and night surveys, pitfall traps and interviews on some key herp species. The survey was conducted in forests, farm bushes, swamps, and plantations around the three key sites of the proposed dam.

1.4 Fish and Fisheries

The Kaiha River is a major tributary of Mano River which is a river in West Africa that originates in the Guinea Highlands in Liberia and forms part of the Liberia – Sierra Leone border.

A checklist of fish species in Liberia from all sources, including specimens in major rivers, suggests a number of 205 fish species of which 57 species are recorded from the Mano River (www.fishbase.org cited in Fermon and Gsegner, 2006). As in most African rivers, Cichlidae, Cyprinidae, Mormyridae, Characidae are the most important families (BHEP, 2004).

The present study, being a rapid survey, gives only a broad picture of the fishery that could be obtained through gill as well as scoop netting, making observations and assessment of catch by fishermen encountered during the survey.

1.2 The Impact Assessment Survey

This ecological survey was carried out along in the Lofa Country, northern Liberia in areas encompassing the development of a small Hydroelectric Power Project (HPP) along the Kaiha river. The proposed dam site is located at a point along the lower reaches of the river called Kaiha 2, and the HPP. The extent of the survey covered the following areas which have been used in the report for identification: Dam site, Access Road, Madina (Downstream), Irrigation Dam (Upstream), Transmission Line 1 (Mbaloma-Facunda axis), Transmission Line 2 (Foyah- axis) and Transmission Line 3 (Kolahun-Voinjama axis). Other areas visited included the Kaiha 1 point.

Four thematic groups constituted the ecological assessment, which potentially comprises eight biological components as follows:

- Vegetation and Botanic assessment
- Mammals and Birds
- Amphibians and Reptiles
- Fish and Macro Invertebrates

Each thematic team comprised of one expert, who was supported by a local field assistant. Local field guides were engaged at the village/town level to assist in the survey.

The main objective of the survey is to provide baseline ecological and biological information on the areas to be involved in the proposed Kaiha 2 HPP, including associated locations that may be directly or indirectly affected by the construction and operation of the project. The result of the survey will feed into the assessment of the impacts of the project on relevant

ecological systems and in the design and implementation of mitigation measures during the construction and operation of the Kaiha 2 HPP.

SECTION II

METHODOLOGY

2.1 Vegetation and Botanic Assessment

The survey was conducted to assess the botanical characteristic of the sites to be affected by the construction and operation of the Kaiha 2 Hydroelectric Power Project (HPP). Below is a Table 1 showing the names and location of the sites visited; these are consistent with the sites where the mammals and ornithological surveys were conducted:

Table 1 – Locations of sites surveyed for vegetation and botanic assessment. GPS UTM Datum (29 P). Transmission Line 1 – HPP-Kolahun; Transmission Line 2 – Kolahun-Foyah; Transmission Line 3 – Kolahun-Vojama.

| Date | Site visited | Eastings | Northings |
|---------------------|--|----------|-----------|
| 26 & 27 April 2016 | Mbaloma Village | | |
| 26 & 27 April 2016 | Access Road | 367243 | 888045 |
| 26 & 27 April 2016 | Dam Site | 366624 | 884707 |
| 28 April 2016 | Madina area (Downstream) | 367648 | 883057 |
| 27 to 29 April 2016 | Transmission Line 1 ➤ Bondowalahun | 368329 | 895104 |
| | ➤ Sosomalahun | 373793 | 913663 |
| | ➤ Kpengbemalahun | 370417 | 900941 |
| | ➤ Fagunda | 370838 | 908365 |
| | ➤ Kolahun south | 379156 | 915261 |
| 29 April 2016 | Transmission Line 2 ➤ Koindu Pombor | 368843 | 923154 |
| | ➤ Kortuhun | 374929 | 917505 |
| 30 April 2016 | Irrigation Dam (Upstream) | 375209 | 907586 |
| 29 & 30 April 2016 | Transmission Line 3 ➤ Kolahun east | 381011 | 918469 |
| | ➤ Sovasu | 387285 | 923487 |
| | ➤ Kpalu's Town | 396575 | 924274 |
| | ➤ Kabba's Town | 404328 | 925885 |
| | ➤ LPMC area | 413577 | 928677 |

The sampling methods applied for this aspect of the assessment is consistent with rapid botanical surveys, which mainly involves the determination of plant species distribution from observations along defined transects running through main habitat types. Transects were randomly placed (i) on the riverbanks (upstream and downstream of the proposed dam site), (ii) along the planned access road (5.5 km), and (iii) along the existing roads where the transmission line will be passing. All plant species encountered along such transects were recorded, and the species and family to which they belong, identified and noted. The plant composition in the area was used as indicators of the pristine nature of the habitat and conversely, the degree of disturbance and degradation in such plant communities. Where necessary, plant specimens were collected for further identification.

The broad vegetation categories encountered in the project area were classified based on the biogeographic representation of the country and/or sub-region (see Gatter, 1997). The recorded plant species were checked for conservation status by referring to the IUCN Red List and by considering their regional distribution.

2.2 Mammals and Birds Survey

The survey sites for Mammals and birds were consistent with the sites visited for vegetation and botanic assessment as given in Table 1.

2.2.1 Mammals

Due to the limited period of the survey, only primates and large mammals were considered in the survey, but data was also obtained for some species of small mammals. Data on mammals were obtained mainly through interviews with local people and hunters and through visual evidences, such as faecal droppings, footprints and nesting sites. No trapping was done because of the time allocated for the survey. Therefore the data is presented based on mere occurrence and status in the areas visited and not on abundance. At least two to five people, including hunters and farmers were interviewed in each of the settlements adjacent and associated with the project area. Some degree of triangulation was done to give credence to the information provided by the respondents. A field guide to mammals of Africa (Kingdon, 1997) was used as a reference material, particularly to show pictures to respondents of mammals that possibly occur in the area. This was to ensure that respondents are able to properly identify species they suggest occur in the area. There were some instances of mis-identification, but further discussions helped in ascertaining the correct species.

The recorded mammal species were checked for conservation status by referring to the IUCN Red List and by considering their regional distribution and abundance (e.g. asking local informants whether those species are confined to the project area or they also exist in other places). The population status of the species, particularly for primates and large mammals were assessed by asking respondent to compare frequency of encounter of the animals now and ten of more years ago.

2.2.2 Birds

Bird surveys were carried out by implementing methods prescribed by Bibby et al. (1998). Bird surveys mainly involved walking through defined transect up to 500 m long from either side of the main road or path; this was replicated in adjacent transects at least 100 m apart. The transects were placed along the Kaiha River (near the dam site) and the existing and planned road network. Transect surveys makes it possible to traverse various sub-habitats within a particular zone, and thus the probability of encountering a good representative of the species that occur in the area. Point surveys were employed for keen and focused observation at specific locations along transects, particularly whenever bird parties are encountered or in situations where several birds were calling from the same location.

No mist netting was done, but effort was made to identify species of global conservation concerns through visual evidence and calls, where possible. Recording and play-back techniques of bird calls were implemented to attract and identify shy and uncommon species, whenever necessary. A field guide (Borrow and Demey, 2008) was used to verify species identification in the course of the survey. Special emphasis was placed on recording water-dependent birds that prefer fast-running water (at the Kaiha waterfall/rapids).

2.3 Reptiles and Amphibians

A list of sites visited, GPS readings and descriptions are presented in the Table 2 below. Garmin 60Cx was used for recording site's GPS readings.

The methodology used for the survey of amphibians and reptiles was mainly a combination of visual and acoustic monitoring in all available habitats (Heyer et al. 1994, Rödel & Ernst 2004), which have been successful in numerous surveys in different habitat types all over West Africa. The survey was conducted during day and night searches to cover the varying active periods of different amphibian and reptile species. Night and day searches covered a wide range of habitats including rainforest and areas that are in close proximity to water bodies, e.g. swamps, tributaries and streams. Special emphasis was placed on recording amphibians that might depend on the fast-running waters at the Kaiha waterfall/rapids (i.e. proposed dam site). Visual monitoring also included a thorough screening of potential hiding places (lifting rocks, logs and branches, looking into holes, screening leaf litter, etc.).

Further technique to capture additional species (especially lizards and fossorial species) was the installation of a 40-meter drift fence with 10 pitfall traps in two locations including a wetland area about 2km from the dam site, and along the Kaiha River on the proposed transmission line within the Lahuma environ. The traps were monitored once a day in order to identify and release captured species. Additionally, amphibian call recordings were made and cross-checked with standard recorded calls to confirm species identification. Observed amphibian and reptile species were documented by photographs. No voucher specimen was collected because this was not necessary at the time. It is believed that the above methods are those internationally accepted and commonly used throughout herpetological surveys.

All species encountered from the searches and traps were identified by means of field guides. The guides included Rödel's herpetofauna of West Africa, (Rödel 2000), pdf files of Guide to

West African Amphibians and Reptiles (documents provided by M.O. Rödel and A. Hillers), Guide des Serpents d'Afrique Occidentale (Trape and Mané 2006) and the Tree Frogs of Africa (Schiotz 1999).

Table 2 – Locations of study sites for the Herpes (reptile and amphibian) studies.

| Site1: Dam Site Area | GPS Reading | | | Description of the site |
|---------------------------|-------------|---------|---------|---|
| Kaiha 2 | 29 P | 0366625 | 0884707 | This point of Kaiha is in a pristine forest with many rock outcrops. Many small tributaries from valleys empty into the river and at the proposed dam site (waterfall area). |
| Trap 1 Area | 29 P | 0367243 | 0888045 | This point is located towards the dam site, in a secondary forest with matured farmbrush. It is in a valley that drains water from the immediate mountains (tributary) that empties into the Kaiha river within the vicinity of the dam site. |
| Site 2: Up Stream | | | | |
| Kaiha 1, Trap 2 | 29 P | 0370427 | 0905098 | This site is along the transmission line and on the Kaiha River. The trap was installed in a secondary forest along the river. |
| Kaiha /Kolahun | 29P | 0381185 | 0915179 | This is in the Kolahun environ, along the Kaiha river. It is a degraded area with farm and swamp. The site is rocky on one side of the river and the other side is mined by locals for sand. |
| Facunda | 29P | 0370839 | 0908365 | This site is along the transmission line and on a tributary within mixed crop plantations. |
| Koindu Pormbor | 29P | 0368645 | 0923156 | This community is believed to be among the beneficiaries of the intended electricity supply. The survey was carried out in a mixed crop plantations, swamps and forests around the community. |
| Morgolor | 29P | 0378875 | 0914722 | This is in the Kolahun environ, along the tributary that empties into the Kaiha river. It is a degraded area with farms and swamps. The site also includes a cocoa/coffee plantation on the other side of the tributary. |
| Agricultural Dam Site | 29P | 0375212 | 0907572 | This is along the Kaiha River in a mixture of pristine and secondary forests. At this point, the river is dammed for agricultural purposes on the immediate established wetlands. |
| Site 3: Downstream | | | | |
| Madina | 29P | 0200012 | 1038215 | This area is at the confluence of two rivers Kaiha and Maonva rivers that occurs immediately below the proposed dam. The site is located in pristine forest with rock outcrops.it is a fishing ground for locals and foreign nationals from Guinea. |

Further probe into collecting data on reptile around the survey areas included one-on-one interviews with locals and presentation of photos of macro reptiles known to occur in the region. Result of the interviews can be found below in table given in the result, but are not used to ascertain the presence of the species by this study.

2.4 Fish and Macro-invertebrates

Table 3: Sampling locations for fish and mega-invertebrates at specific points along the Kaiha River

| | UTM(29P) | X | y |
|----------------------------------|------------------|--------|--------|
| | Above water fall | 366507 | 884755 |
| Kaiha-2 Dam Site(Upstream) | Below water fall | 366693 | 884695 |
| Madina | Down Stream | 368409 | 884304 |
| Agricultural Irrigation Dam Site | Up Stream | 375047 | 907580 |

Fish sampling was done within the stretch of the Kaiha River at a number of selected sampling stations upstream and downstream of the river.

Fish samples were collected through experimental fishing using gill nets and repeated attempts were made at each station

The most effective methods were:

- (i) Lightweight Monofilament gill nets of 2.5 cm and 3.5cm mesh sizes, set across River or in parallel to the current under faster flows to avoid them being swept away. They were laid alongside riverbanks at night to capture more nocturnal fish.
- (ii) Gill nets of 3cm and 7cm mesh sizes were also installed at key positions in the River. This was meant to catch larger sized fish species. Fishing nets were set, left overnight and checked in the morning. In the morning, catches were removed and recorded. The process was repeated for the period of 4 sampling days and involved locals who helped in the installation of the nets.
- (iii) Scoop net was used to catch small species in that attach to rock surfaces, swept by the fast flowing water or in pools of water along the river while some fishers contributed by allowing the team to glance at their catch from their hook and line. In case, there was any species left out from our sample, such specimens were obtained from fishermen.
- (iv) Surface observation in order to identify swimming fishes was also done at all sampling points along the river.
- (v) A photographic record of all species was done. The identification of fish species was accomplished with the help of the photo-ID guide of Wakeford and Payne (2007), Paugy et al, (2003) as well as that of Fermon and Gsegner (2006).

- (vi) A representative specimen of each species caught was preserved in a 96% alcohol for further identification.
- (vii) Interviews were also conducted with communities and fishers found at sampling areas on fisheries using a semi-structured questionnaire.

SECTION III

RESULTS AND DISCUSSION

3.1 Vegetation and Botanic assessment

3.1.1 Characterisation of the vegetation of the areas encompassing the Kaiha 2 HPP

The vegetation in the area to be affected by the Kaiha 2 HPP can generally be described as a mosaic of forest, farmbush, farmland and some bare/open areas of rocky outcrops. Most of the closed canopy forest occurs in areas encompassing the dam site and along the rivers as gallery forests. The rest of the forest is patchily distributed and occur in close association with communities, which in some cases use the forest for traditional practices and/or as sacred groves. These community forests are also characterised by extensive agroforestry practices, which involves the cultivation of cacao and/or coffee plantation in forest areas, and in some cases, monocultures of cacao, coffee and oil palm. The secondary forests bush fallows are inundated by stands of oil palm *Elaeis guineensis*. Some monoculture/plantations of oil palm, cocoa and coffee occur in places across areas to be affected by the transmission line. The following table summarizes the vegetation characteristic of the sites visited:

Dam Site

The site comprises mainly close canopy gallery forest with high tree density, tree heights ranging between 40 and 50 meters and a significant proportion of trees with diameter at breast height (dbh) of over 100 cm. The forest canopy is healthy. No form of recent agricultural activities observed, but there are signs of old timber and wood extraction. The common tree species are:

Albizia zigia, *Albizia adianthifolia*, *Cathormion altissimun*, *Cathomium rhombifolium*, *Pterocarpus santalinoides*, *Pentaclethra macrophylla*, *Pycnanthus angolensis*, *Uapaca heudelotii* and *Amphimas pterocarpoides*.



Access Road

This area is predominantly secondary forest, with the structure becoming more mature as one moves towards the dam site. The area is interrupted by farmbush and a few farmlands. There are a couple of locations with inland valley swamps, which were not under cultivation by the time of the survey. The



The main tree species include *Pentdesma butyracea*, *Albizia zygia*, *Albizia adiantifolia*, *Samanea dinklagei*, *Funtumia africana*, *Eremospatha macrocapa*, *Musanga cecropioides*, *Myrianthus*

serratus, *Myrianthus libericus*, *Myrianthus arborea*, *Phyllanthus discoideus* and *Smeathmannia pubescens*.

Downstream (Madina area)

In this site the gallery forest was mature with some trees over 50 meters high and dbh over 1 meter. Much of the upland vegetation was young secondary forest, farmbush, farmlands and open land. Many of the threatened species occurred here. Presumably, the large extent of gallery forest and secondary forest is as a result of the low population density and remoteness of the area. Tree species typical of the area are: *Cryptosepallum tetraphyllum*, *Chrysophyllum perpulchrum*, *Cathormion altissimum*, *Cathormion rhombifolius*, *Pterocarpus santalinoides*, *Amanoa bracteosa*, *Amphimas pterocarpoides*, *Carapa procera*, *Xylopia aethiopica*, *Calpocalyx aubrevillei* and *Nauclea diderrichii*



Upstream (Irrigation Dam)

The vegetation in the area seems to have undergone extreme levels of degradation or regeneration over the years. Whilst some areas, especially along the main road have been cleared and being used for commercial agriculture, the surrounding forest is secondary but less disturbed. Some portions of the gallery forest at the irrigation dam site forest has been degraded because of the presence of people engaged in the construction of the dam, which is expected to supply water to the agricultural project being set up. Common tree species included: *Nauclea diderrichii*, *Cathormion altissimum*, *Cathormion rhombifolius*, *Sterculia oblonga*, *Funtumia africana*, *Pentaclethra macrophylla* and *Pycnanthus angolensis*



Transmission Line 1 (HPP – Kolahun)

The areas to be directly affected by the transmission line comprises a mosaic of vegetation types derived mainly from close forest, including mature and young secondary patches, coffee and cocoa plantations, farmbush and farmland. A number of community sacred forest were encountered; it is worth mentioning that we were prevented from going near to the one at Facunda village because of the female cultural activity that was going on in the forest. Tree species that characterise the vegetation include:



Antiaris africana, *Sterculia tragacantha*, *Terminalia glaucescens*, *Coffea sp* *Theobroma cacao*, *Pseudospondias microcarpa* *Trichilia ornithothera* and *Ceiba pentandra*.

Transmission Line 2 (Kolahun – Foyah)

This area appears to show serious forest degraded with few remnants of forest vegetation in places. Much of the remnant forest vegetation is characterised by a mixed forest and coffee/cacao plantations. At some locations, the vegetation has been transformed into one dominated by grass species (particularly *Panicum maximum* and *Andropogon sp*) and invasive shrub (*Chromolaena odorata*). The limited forest cover is dominated by species such as *Cassia seiberiana*, *Ceiba pentandra*, *Theobroma cacao*, *Coffea sp*, *Terminalia ivorensis*, *Antiaris africana* and *Anthocleista nobilis*.



Transmission Line 3 (Kolahun – Voinjama)

The vegetation of this area is comparatively the most degraded portion of the area to be traversed by the transmission line. It is characterised by a mosaic of different plant communities and topographic features. There are small patches of forest, but the landscape is dominated by extensive farmbrush, cultivations, oil palm plantations in places, old/disused rubber plantations and large expanses of rocky pans covered in thin grass. Some of the young farmbrush are dominated by the invasive shrub *Chromolaena odorata* and the grass *Panicum laxium*. The main tree species are *Microdesmis puberula*, *Maniophyton fulvum*, *Mareya micantha*, *Macaranga barteri*, *Tetrorchidium didymostemon*, *Smeathmannia pubescens*, *Phyllanthus discoideus* and *Piptadeniastrum africanum*.



3.1.2 Plant diversity and status

One hundred and nine-three (193) species of vascular plants species belonging to 54 plant families were recorded during the survey, across the various ecosystems encountered. These include 19 species of global conservation concern as given in Table 4; 17 species are vulnerable (VU) and two are near threatened (NT). The distribution of threatened species across the different study sites as illustrated in Figure 1 which shows that the forests in the downstream area (Madina) accounts for the highest number of species listed in IUCN as vulnerable and near threatened, followed by the Dam site and Access Road respectively. However, all of the threatened species known to occur are widely distributed in the forest habitats where they occur.

Table 4 - Distribution of species listed as vulnerable (VU) and near threatened (NT) in IUCN (2015) in each site surveyed. TL – Transmission Line.

| Botanical name | IUCN Status | Growth Form | Dam site | Access Road | Down stream | Up stream | TL 1 | TL 2 | TL 3 |
|-----------------------------------|-------------|-------------|----------|-------------|-------------|-----------|------|------|------|
| <i>Afzelia africana</i> | VU | T | x | | x | | | | |
| <i>Cryptosepalum tetraphyllum</i> | VU | S | x | x | x | | x | | |
| <i>Gilbertiodendron limba</i> | NT | T | x | | x | | | | |
| <i>Terminalia ivorensis</i> | VU | T | | x | | | | | |
| <i>Amanoa bracteosa</i> | VU | T | x | | | | | | |
| <i>Garcinia afzelii</i> | VU | T | x | x | x | x | | | |
| <i>Irvingia gabonensis</i> | NT | T | x | x | x | | | | |
| <i>Trichilia ornithothena</i> | VU | T | x | x | x | | x | | |
| <i>Turraenthus africanum</i> | VU | T | x | x | x | | | | |
| <i>Entandrophragma candollei</i> | VU | T | | x | x | | | | |
| <i>Albizia ferruginea</i> | VU | T | | | x | | | | |
| <i>Milicia regia</i> | VU | T | x | x | x | x | | | |
| <i>Lophira alata</i> | VU | T | x | x | x | | | | |
| <i>Hallea stipulosa</i> | VU | T | | x | | x | x | x | x |
| <i>Nauclea diderrichii</i> | VU | T | x | | x | x | | | |
| <i>Zanthoxylum atchoum</i> | VU | T | x | x | x | x | | | |
| <i>Placodiscus oblongifolius</i> | VU | S | x | x | x | x | | x | |
| <i>Heritiera utilis</i> | VU | T | x | | x | x | | | |
| <i>Sterculia oblonga</i> | VU | T | x | | x | x | | | |

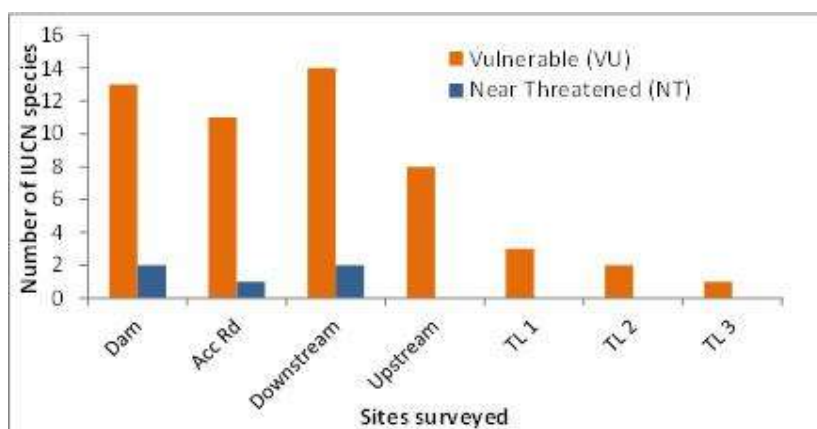


Figure 1 – Illustration of the number of threatened and near threatened plant species in survey sites

Plant community structure was determined by the number of species represented by the respective growth forms. Trees were the most dominant growth form encountered across all survey sites with a total of 104 species (Figure 2), accounting for about 54% of the species

growth form reported. This is followed in order of relative abundance by shrubs (42 species), herbs (25 species), lianas (10 species), and grasses (9 species). The Downstream site (Madina) accounts for the highest number of tree species recorded, followed by the Upstream site (Irrigation dam) and the Dam site. There is however, considerable overlap in the tree species representation across survey sites, even among species considered threatened by IUCN (Table 4 and Appendix A). With regards to grasses, whose abundance may indicate the degree of degradation in a forest ecosystem, a much larger proportion of grass species were recorded in areas that have experienced greater levels of deforestation (i.e. the sections to be traversed by the transmission line).

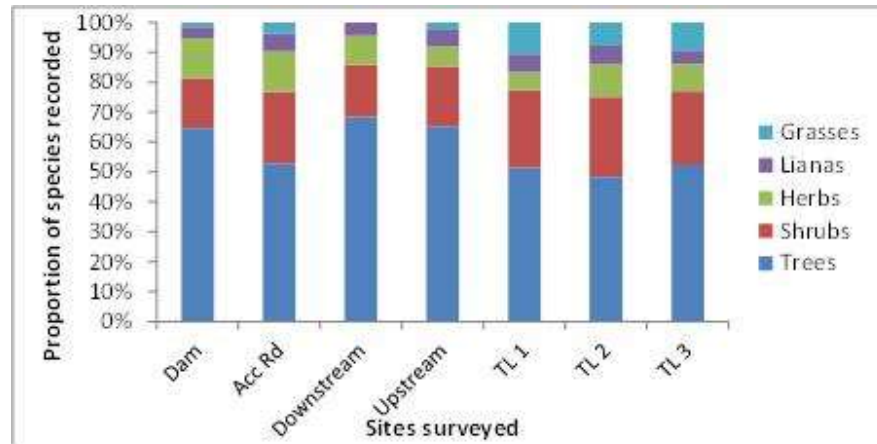


Figure 2 – Proportions of the different growth forms of plants recorded in each survey site.

3.2 Mammals and Birds

3.2.1 Mammals

A total of 38 species of mammals was recorded through interviews, signs and visual evidences. These include nine primates species among which are three endangered (Red Colobus Monkey *Procolobus badius*, Western Chimpanzee *Pan troglodytes verus* and Diana Monkey *Cercopithecus Diana*) and two vulnerable (Pied Colobus Monkey *Colobus polykomus*, and Sooty Mangabey *Cercocebus atys*). Four other large mammals occur, notably the endangered Pygmy Hippopotamus *Choeropsis liberiensis* and the vulnerable Leopard *Panthera pardus*. There were also ten species of antelopes, one of which is vulnerable (Zebra Duiker *Cephalophus zebra*), two are near threatened and one is data deficient. In addition small mammals of interest were identified; of particularly interest are the Giant, Long-tailed and Tree pangolins, all of which are considered threatened by the IUCN. Table 5 gives a full list of the mammals recorded in the area, their IUCN conservation status and their local relative abundance status. With the exception of Spot-nosed Monkey *Cercopithecus petaurista*, Royal Antelope *Neotragus pygmaeus*, Tree Pangolin *Phataginus truscipis* and the squirrel species, all other species were recorded through interviews with local hunters. The faecal matter of Maxwell Duiker *Cephalophus maxwelli*, Bushbuck *Tragelaphus scriptus* and a number of small mammals were encountered during the course of the survey, particularly in areas encompassing the proposed access road and dam site.

Table 5 – Mammal species that occur in the dam locations, access road and transmission lines. LC – Least concern; EN – Endangered; VU – Vulnerable; NT – Near threatened; R – rare; NC – Not common; C – Common; N – Not occurring in the area; (S) - Mammals that were seen during the survey; (F) Mammals whose faecal matter were seen.

| Species | | IUCN Status | AC RD/DM ST | Down STRM | Up STRM | TRNS LN 1 | TRNS LN 2 | TRNS LN 3 |
|-------------------------------|---------------------------------|-------------|-------------|-----------|---------|-----------|-----------|-----------|
| Western Chimpanzee | <i>Pan troglodytes verus</i> | EN | NC | N | N | R | N | NC |
| Red Colobus Monkey | <i>Procolobus badius</i> | EN | NC | N | R | R | N | N |
| Diana Monkey | <i>Cercopithecus Diana</i> | VU | NC | N | N | R | N | N |
| Pied Colobus Monkey | <i>Colobus polykomus</i> | VU | C | NC | N | C | C | C |
| Sooty Mangabey | <i>Cercocebus atys</i> | VU | C | C | NC | NC | NC | NC |
| Olive Colobus | <i>Poliochobus versu</i> | LC | R | NC | N | R | N | N |
| Mona Monkey | <i>Cercopithecus mona</i> | LC | C | NC | NC | NC | N | N |
| Spot-nosed monkey (S) | <i>Cercopithecus petaurista</i> | LC | C | C | C | C | C | NC |
| Senegal galago | <i>Galago senegalensis</i> | LC | C | C | NC | C | R | NC |
| Pygmy Hippo | <i>Choeropsis liberiensis</i> | EN | NC | NC | R | R | N | N |
| Bush Pig | <i>Potamochoerus larvatus</i> | LC | C | C | C | C | NC | NC |
| Red River Hog | <i>Potamochoerus porcus</i> | LC | R | NC | NC | R | NC | N |
| Water chevrotain | <i>Hyemoschus aquaticus</i> | DD | NC | NC | R | R | NC | N |
| Bushbuck (F) | <i>Tragelaphus scriptus</i> | LC | C | C | C | C | C | NC |
| Bongo | <i>Tragelaphus euryceros</i> | NT | R | R | NC | R | NC | N |
| Leopard | <i>Panthera pardus</i> | VU | R | R | R | N | N | N |
| Maxwell's Duiker (F) | <i>Cephalophus maxwelli</i> | LC | C | C | C | C | C | NC |
| Bush Duiker | <i>Sylvicapra grimmia</i> | LC | C | NC | NC | C | N | N |
| Red-flanked Duiker | <i>Cephalophus rufilatus</i> | LC | C | C | NC | R | N | N |
| Zebra Duiker | <i>Cephalophus zebra</i> | VU | R | N | N | R | N | N |
| Black Duiker | <i>Cephalophus niger</i> | LC | NC | NC | NC | NC | NC | N |
| Yellow-backed Duiker | <i>Cephalophus silvicultor</i> | LC | NC | N | N | R | N | N |
| Bay Duiker | <i>Cephalophus dorsalis</i> | NT | C | NC | NC | C | NC | N |
| Royal antelope (S) | <i>Neotragus pygmaeus</i> | NT | NC | C | NC | NC | N | N |
| Long-tailed Pangolin | <i>Uromans tetradactyla</i> | LC | NC | NC | NC | R | N | N |
| Tree Pangolin (S) | <i>Phataginus tricuspid</i> | NT | R | C | C | R | NC | NC |
| Giant pangolin | <i>Smutsia gigantea</i> | NT | R | R | R | R | N | N |
| Marsh Cane-rat (F) | <i>Thryonomys swinderianus</i> | LC | R | C | C | C | NC | C |
| Babary ground squirrel (S) | <i>Atlantoxerus getulus</i> | LC | C | C | C | C | C | C |
| Fire-footed rope squirrel (S) | <i>Funisciurus pyrrhopus</i> | LC | C | C | C | C | C | C |
| Gambian Sun squirrel (S) | <i>Heliosciurus gambianus</i> | LC | C | C | C | C | C | C |
| Crested porcupine | <i>Hystrix cristata</i> | LC | NC | NC | NC | NC | R | N |
| Brush-tailed porcupine (F) | <i>Atherurus africanus</i> | LC | C | C | C | C | NC | NC |
| Long-snouted mongoose | <i>Herpestes naso</i> | LC | C | NC | NC | C | R | N |
| Slender mongoose | <i>Herpestes sanguinea</i> | LC | R | R | R | R | R | N |
| Common Cusimanse | <i>Crossarchus obscurus</i> | LC | C | C | C | C | R | N |
| Common genet | <i>Genetta genetta</i> | LC | C | C | NC | C | NC | N |
| Blotched genet | <i>Genetta tigrina</i> | LC | C | NC | NC | C | NC | N |

For most of the mammal species presumed to be present, there was a general decline in their occurrence with increasing distance from the dam site, particularly in zones to be traversed by the transmission line. In fact, all mammalian species recorded from interviews with local hunters occurred in and around the areas closest to the dam site, which by observation, had more forest cover. This is consistent with the general concept that greater forest cover provides better habitat for wildlife in tropical ecosystems, because of abundant and diverse habitats therein. In some locations (with special reference to the access road, dam site and Madina forest), some of the mammals considered threatened by IUCN (e.g. Black-and-white Colobus Monkey, Red Colobus Monkey and Pygmy Hippopotamus) are said to be common by local hunters in these remote communities. For instance, based on information from respondents in Mbaloma and Madina, the Pygmy Hippo (which is generally very difficult to see) is fairly regularly encountered along their respective riverine forests.

Data from the interviews with hunters in areas closest to the large human settlements show a notable absence of most of the species of global conservation interest (see Table 5), where invariably the forest covers are thin and patchy. These areas, particularly settlements along the transmission line, such as the Foyah, Kolahun and Voijama axis, are characterised by intensive and extensive agricultural activities, open bush fallows, rocky outcrops and housing development, and so only small and degradation-tolerant mammals could survive in such degraded habitats. However, respondents indicated that there are occasional encounter of some of the relatively common primates (e.g. Spot-nosed Monkey and Sooty Mangabey) and duikers (e.g. Maxwell Duiker and Bush Buck) in the forest patches that occur around these large human settlements.

3.2.2 Birds

A total of 176 species of birds belonging to 42 avian families was recorded over six days of surveys (Appendix A). These include six species with IUCN conservation status: Hooded Vulture *Necrosyrtes monochas* (EN), Yellow-casqued Hornbill *Ceratogymna elata* (VU), Green-tailed Bristlebill *Bleda eximius* (VU), Brown-cheeked Hornbill *Bycanistes cylindricus* (NT), Yellow-footed Honeyguide *Campaphega lobata* (NT) and Black-headed Rufous Warbler *Bathmocercus cerviniventris* (NT). Table 6 shows the distribution of birds of global conservation interest in the various sites surveyed. The Access Road, Downstream (Madina area) and Transmission Line 1 area are most important in terms of the number of threatened species they support. Among the species of conservation interest, the Black-headed Rufous Warbler was the most widespread encountered, followed by Yellow-casqued Hornbill. Although Brown-cheeked Hornbill was recorded in only two locations, yet they accounted for the largest number of individuals recorded among IUCN Red List Species; about 10 individuals were seen in one location along Transmission Line 1.

A larger proportion (87%) of the birds recorded were resident species, among which are 83 species belonging to the Guinea-Congo forest biome (45% of the 184 species known for Liberia). Also, five (33.3%) of the 15 Upper Guinea forest endemic species were recorded during this survey. Of the migratory species encountered, 13 were of the Afro-tropical assemblage whereas only three Palearctic species occurred. Only two migratory species were recorded at the proposed Dam site: one Afro-tropical migrant White-throated Bee-eater

Merops albicollis; and one Palearctic migrant, Common Sandpiper *Actitis hypoleucos*. These two are the only species that may be affected by fast-flowing water, but there is no empirical data to ascertain this assumption. Many more may be recorded during the wet season, and at the peak of the Palearctic migratory season (November to February); however, there is no evidence that their activities are affected by the rate of flow of the water at the Dam site. In fact, more non-water dependent migratory birds were recorded across the survey sites, compared to their water-dependent counterparts.

Table 6 – IUCN Red List (2015) for threatened and near-threatened bird species recorded in various locations or sections to the affected by the Kaiha 2 HPP. The number of x indicate the number of times the bird was seen in the same location

| Threatened Species | IUCN Status | Dam Site | Access RD | Down Stream | Up Stream | TRMS Line 1 | TRMS Line 2 | TRMS Line 3 |
|-----------------------------|-------------|----------|-----------|-------------|-----------|-------------|-------------|-------------|
| Hooded Vulture | EN | | | x | | x | | |
| Yellow-casqued Hornbill | VU | | xx | | | x | x | |
| Green-tailed Bristlebill | VU | | x | | | | | |
| Brown-cheeked Hornbill | NT | | | x | | x | x | |
| Yellow-footed Honeyguide | NT | x | | | | | | |
| Black-headed Rufous Warbler | NT | | x | x | x | xx | | x |
| Total | 6 | 2 | 3 | 3 | 1 | 4 | 2 | 1 |

Table 7 provides detail data on the distribution of species recorded into various thematic and biogeographic categories. No Sudan-Guinea savannah biome species was encountered, although it is possible that these may occur in future judging from the level of degradation characterising areas closest to large human settlements and the apparent emergence of savannah conditions in a few locations. Liberia is generally a country with vegetation dominated by closed moist forest although there are some elements of Guinea savannah in places (Gatter, 2007). In effect, there are limited chances of encountering savanna-dependent species.

Table 7 – Species category data for birds recorded in various locations or sections to the affected by the Kaiha 2 HPP.

| Species category | Dam Site | Access RD | Down River | Up River | TRMS Line 1 | TRMS Line 2 | TRMS Line 3 | Total |
|-----------------------|----------|-----------|------------|----------|-------------|-------------|-------------|-------|
| Number of species | 40 | 68 | 52 | 48 | 115 | 41 | 30 | 176 |
| Number of families | 27 | 28 | 23 | 19 | 31 | 18 | 10 | 42 |
| Resident species | 47 | 62 | 47 | 42 | 109 | 40 | 30 | 153 |
| Afrotropical migrants | 4 | 5 | 5 | 4 | 4 | 1 | 0 | 13 |
| Palearctic migrants | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 3 |
| GC biome spp | 26 | 31 | 25 | 14 | 66 | 24 | 17 | 83 |
| UGF endemic spp | 1 | 3 | 2 | 0 | 3 | 1 | 1 | 5 |
| IUCN Threat status | 2 | 3 | 2 | 1 | 3 | 0 | 0 | 6 |
| Endangered (EN) | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| Vulnerable (VU) | 1 | 2 | 0 | 0 | 1 | 0 | 0 | 2 |
| Near Threatened (NT) | 1 | 1 | 1 | 0 | 2 | 0 | 0 | 3 |

The area occurs adjacent to the biogeographic location of the North Lorma and the Gola national forests and so its avifauna is influenced by the diversity that occurs in these important forests. However, these two national forest mentioned empirically have greater forest cover than areas covered in this survey (Gatter, 1997) and so have greater avifauna diversity (see Demey, 2007). Such large forest areas do serve as reservoirs for forest species that may suffer from the degradation accompanying the proposed HPP project. This is particularly true for species of conservation interest, which by comparison are more abundant in North Lorma and the Gola national forests than the area to be affected by the proposed project.

Notes on species of conservation interest recorded

Hooded Vulture *Necrosyrtes monochas*

Two birds were seen during the survey. One was encountered whilst flying over a farm in the Madina area (downstream). A second one was recorded whilst perching on a big tree the gallery forest overhanging a bridge along Transmission Line 1. A local hunter at Madina purported that the bird numbers have dropped over the couple of decades, but even a present, their numbers in that location fluctuates with season. The



photo was taken from a overhanging tree branch along the river at the Downstream site (Madina)

Yellow-casqued Hornbill *Ceratogymna elata*

Four pairs of birds were respectively encountered in three different locations during the surveys: two pairs were recorded at two locations above a forest along the Access Road, whilst the rest were encountered in two other forest locations along the transmission line. Photo was taken during this survey along Transmission Line 1.



Green-tailed Bristlebill *Bleda eximius*

This bird listed as Vulnerable by the IUCN (2015) is generally cryptic and very difficult to see. Only one individual was heard in a forest along the proposed Access Road on 27th April. The call of the bird was recorded and cross-checked with published recording (African Bird Sounds). The call was in deed that of the vulnerable Green-tailed Bristlebill. No photos available.

Brown-cheeked Hornbill *Bycanistes cylindricus*

This species is listed as Near Threatened by the IUCN (2015). It was the most abundant bird encountered among species of conservation interest listed by IUCN that occur across the project area. About 10 birds were seen perching on a the branches of a large tree at a location

along the Transmission Line 1 on April 27th and another 4 birds seen in the canopy of a forest patch along Transmission Line 2 on April 29th. The photo was taken along Transmission Line 1 during the survey.



Yellow-footed Honey Guide

This is a species that is listed as Near Threatened by IUCN (2015). A single bird was seen within 100 meters upstream of the proposed dam site on 26th April. No photos available.

Black-headed Rufous Warbler

This species was the most widespread of all the species of conservation interest; it is listed as Near-Threatened by IUCN (2015). The species was recorded in all, but two sites visited (see Table 2). A single bird was seen in one of the locations along the access road, but the rest of the evidence came from the calls of the bird. The bird is usually difficult to see, but its vocal ability makes it easy to identify. No photos available.

3.3 Reptiles and Amphibians

3.3.1 Amphibians

During the survey, a total 37 amphibians including seven species that are of IUCN conservation concern were recorded. The seven species are all Near Threatened and include *Hyperolius chlorosteus*, *Hyperolius zonatus*, *Kassina cochranæ*, *Leptopelis macrotis*, *Phrynobatrachus alleni*, *Phrynobatrachus liberiensis* and *Phrynobatrachus phyllophilus*. Three of the seven IUCN conservation concerned species (*Phrynobatrachus alleni*, *Phrynobatrachus liberiensis* and *Phrynobatrachus phyllophilus*) were recorded around the dam site whereas six, with the exception of *Leptopelis macrotis*, were recorded in the upstream area and one (*Phrynobatrachus alleni*) was recorded within the downstream area.

Of the seven species conservation concern recorded, none is known to be dependent upon fast flowing water or waterfalls for survival. The *H. chlorosteus* is arboreal and in normal situation occurs in primary rainforest, mostly by streams. It breeds exclusively in flowing water, laying its eggs on leaves above water into which the larvae fall and develop (Rodel et al, 2004).

The *H. zonatus* lives in primary forests (though due to habitat alteration, they can be found in unusual places), close to small temporary ponds and swamps. Its eggs are laid on vegetation above small stagnant pools (Schiotz et al 2004).

Kassina cochranæ is an arboreal, forest dwelling species that can also exist in secondary forests. It has also been recorded in secondary forest, moist and montane savannah area as

well as montane grassland. It seems to survive in fragmented habitats but unlikely to tolerate complete open habitats. According to Rodel et al (2004), it presumably breeds in both temporary and permanent waterbodies, favoring large well-vegetated pools.

Leptopelis macrotis depends on areas of undisturbed forest which are becoming gradually uncommon in Liberia. It is arboreal and lives along streams in rainforests. Its breeding biology is unknown but tadpoles are aquatic. It relies on good rainforest and does not occur in disturbed forest (M.O. Rodel pers. Comm. Jun 2012).

The *P. alleni*, *P. liberiensis* and *P. phyllophilus* depend on areas of undisturbed forest. Though the *P. alleni* and *P. phyllophilus* are widely distributed but their habitats are declining thus making them close to qualifying for Vulnerable. The *P. liberiensis* is confined to the upper Guinea forest zone of West Africa (Sierra Leone, southern Guinea, Liberia, Cote d'Ivoire and south-west Ghana). It is usually associated with swampy areas, breeding in small forest streams (Rodel, 2004). The *P. alleni* can survive in small forest fragments but at lower population density. It breeds in very small temporary puddles (Rodel, 2004), whereas the *P. phyllophilus* lives in swampy part of primary forest, and doesn't survive in secondary habitat. It deposits its eggs terrestrially close to water and the larvae develop in extremely small puddles (Rodel, 2004).

Among the amphibian species associated with fast flowing water are *Odontobatrachus natator* (formerly known as *Petropedetes natator*) and *Conraua alleni*. Both are known to occur in Liberia but the present survey did not record them. Hoke et al (2007) recorded the *C. alleni* in the Grebo and Gola National Park during a Rapid Assessment Program that covered Loma, Gola and Grebo National Forests. Hillers et al (2007) also recorded *C. alleni* and *O. natator* in a survey of three national forests including North Lorma, Gola and Grebo in Liberia. The species are found in forested hilly areas and lives in or near fast flowing streams. *Odontobatrachus natator* breeds in fast flowing streams with its eggs laid on land and the larvae attached themselves by means of suckers to rocks in waterfalls and rapids (Rodel, 2004), while the *C. alleni* breeds in streams and the tadpoles are usually found in slow-flowing or nearly stagnant sections of streams (Rodel et al, 2004). Table shows the list of species recorded within the surveyed areas.

The high number of forest-dependent species including *Phrynobatrachidae*, *Leptopelis spiritusnoctis*, *Leptopelis macrotis*, *Astylosternus occidentalis*, *Chiromatis rufescens* and *Cardioglossa leucomystax* indicate the extent of forest cover in Liberia amidst the much advancing trends in agricultural activities into forest zones.

Table 8 - List of amphibian species recorded during the survey.

Key: LC = Least Concern, NT = Near threatened. NA = Not Assessed and DD = Data Deficient

| | Common Name | Scientific Name | IUCN Status | Up Stream | Dam Site | Down Stream |
|----|----------------------------|-------------------------------------|-------------|-----------|----------|-------------|
| 1 | Banded Banana Frog | <i>Afixalus fulvovittatus</i> | LC | ♦ | | |
| 2 | Savanna Banana Frog | <i>Afixalus vittiger</i> | LC | ♦ | | |
| 3 | Striped Spiny Reed Frog | <i>Afixalus dorsalis</i> | LC | ♦ | | |
| 4 | | <i>Amietophrynus maculatus</i> | LC | ♦ | ♦ | ♦ |
| 5 | African Common Toad | <i>Amietophrynus regularis</i> | LC | ♦ | ♦ | |
| 6 | | <i>Astylosternus occidentalis</i> | LC | | ♦ | |
| 7 | | <i>Arthroleptis sp</i> | | ♦ | ♦ | |
| 8 | | <i>Cardioglossa leucomystax</i> | LC | | ♦ | |
| 9 | African Foam-nest Treefrog | <i>Chiromantis rufescens</i> | LC | | ♦ | |
| 10 | African Grove-crowned Frog | <i>Hoplobatrachus occipitalis</i> | LC | ♦ | ♦ | ♦ |
| 11 | | <i>Hyperolius concolor</i> | LC | ♦ | | |
| 12 | Sierra Leone Reed Frog | <i>Hyperolius chlorosteus</i> | NT | ♦ | | |
| 13 | Lime Reed Frog | <i>Hyperolius fusciventris</i> | LC | ♦ | ♦ | |
| 14 | | <i>Hyperolius picturatus</i> | LC | ♦ | | |
| 16 | | <i>Hyperolius nitidulus</i> | LC | ♦ | | |
| 17 | Nimba Reed Frog | <i>Hyperolius zonatus</i> | NT | ♦ | | |
| 18 | Chochran's Running frog | <i>Kassina cochranæ</i> | NT | ♦ | | |
| 19 | Big-eyed Forest Treefrog | <i>Leptopelis macrotis</i> | NT | ♦ | | |
| 20 | | <i>Leptopelis spiritusnoctis</i> | LC | ♦ | ♦ | ♦ |
| 21 | | <i>Leptopelis viridis</i> | LC | ♦ | ♦ | ♦ |
| 22 | | <i>Phrychmantis boulengeri</i> | LC | ♦ | | |
| 23 | Allen's River Frog | <i>Phrynobatrachus alleni</i> | NT | ♦ | ♦ | ♦ |
| 24 | | <i>Phrynobatrachus francisci</i> | LC | ♦ | | |
| 25 | | <i>Phrynobatrachus fraterculus</i> | LC | ♦ | | |
| 26 | Ahl's River Frog | <i>Phrynobatrachus latifrons</i> | LC | ♦ | ♦ | ♦ |
| 28 | Liberia River Frog | <i>Phrynobatrachus liberiensis</i> | NT | | ♦ | |
| 29 | Natal Dwarf Puddle Frog | <i>Phrynobatrachus natalensis</i> | LC | ♦ | ♦ | |
| 32 | | <i>Phrynobatrachus phyllophilus</i> | NT | ♦ | ♦ | |
| 33 | | <i>Phrynobatrachus tokba</i> | LC | ♦ | ♦ | ♦ |
| 34 | Broad-banded Grass Frog | <i>Ptychadena bibroni</i> | LC | ♦ | ♦ | ♦ |
| 35 | Mascarene Grass Frog | <i>Ptychadena mascareniensis</i> | LC | ♦ | ♦ | ♦ |
| 36 | | <i>Ptychadena pumilio</i> | LC | ♦ | ♦ | ♦ |
| 37 | | <i>Ptychadena oxyrhynchus</i> | LC | ♦ | ♦ | ♦ |

Photos of species of IUCN Conservation Concern recorded during the survey



Hyperolius chlorosteus – NT
(Photo from Kolahun environs)



Hyperolius zonatus – NT
(Recorded in a plantation at Koindu Pombor)



Phrynobatrachus alleni – NT
(Photograph from Kaiha River)



Phrynobatrachus liberiensis – NT
(Photograph from Access Road)



Phrynobatrachus phyllophilus – NT
(Photograph from Kaiha River)

Species Recorded from Calls

1. *Leptopelis macrotis* - NT (Recorded along the Kaihai River and Mongolor stream)
2. *Kassina cochranæ* - NT (Recorded in forest swamp along the Kaiha/Kolahun Environ)

3.3.2 Reptiles

A total of 17 reptile species were recorded during the six days survey (Table 9) while the one-on-one interviews with locals resulted in documenting 16 additional species.

Among the 17 species recorded by the survey team, one tortoise species (*Kinixys homeana*) is Vulnerable according to the IUCN redlist. This is due to habitat loss and hunting for various reasons including subsistence, traditional medicine and pet trade. It is likely that these threats will continue over the coming years due to human population growth, deforestation and industrial development in its range of occurrence.

K. homeana is a forest tortoise occurring within the range of the Guinea-Congo rainforest region, though its habitat use varies depending on the type of treatment by the indigenous people. The treatments largely include hunting and veneration. If it finds itself in veneration areas, the tortoises will be frequently found in habitats including dense dry bush, sparse dry bush, riparian vegetation, swamps, and plantations; whereas if in the hunting areas, the tortoises will be found almost exclusively inside dense bush, and always avoid plantations. It seems likely that the different habitat usage reflects extirpation from easier hunting areas (Luiselli et al 2006).

Table 9 shows the list of species recorded within the environs of the sites covered during the survey.

| Common Name | Scientific name | IUCN Status | Up Stream | Dam Site | Down Stream |
|------------------------------|----------------------------------|-------------|-----------|----------|-------------|
| | <i>Agama africana</i> | LC | ♦ | ♦ | ♦ |
| | <i>Agama agama</i> | LC | ♦ | ♦ | ♦ |
| Boulenger's Agama | <i>Agama boulengeri</i> | LC | ♦ | | |
| | <i>Atractaspis aterrima</i> | NA | ♦ | | |
| Keeled Water Skink | <i>Cophoscincopus durus</i> | LC | ♦ | ♦ | ♦ |
| | <i>Cophoscincopus simulans</i> | LC | ♦ | ♦ | |
| | <i>Dipsadoboa sp.</i> | | ♦ | | |
| | <i>Hemidactylus cf. muriceus</i> | NA | ♦ | | |
| | <i>Hemidactylus mabouia</i> | NA | ♦ | | |
| Serrated Hinge-back Tortoise | <i>Kinixys erosa</i> | DD | ♦ | ♦ | ♦ |
| Home's Hinge-back Tortoise | <i>Kinixys homeana</i> | VU | | ♦ | |
| | <i>Naja melanoleuca</i> | NA | ♦ | ♦ | ♦ |
| | <i>Naja nigricolis</i> | NA | ♦ | ♦ | ♦ |
| | <i>Pelusios niger</i> | NA | ♦ | ♦ | |
| | <i>Lepidothyris fernandi</i> | NA | | ♦ | |
| | <i>Trachylepis affinis</i> | NA | ♦ | ♦ | ♦ |
| | <i>Trachylepis paucisquamis</i> | LC | | | ♦ |

According to Luiseli (2006), this species is found throughout Liberia though there are no recent survey on the distribution of the species. However, during the current survey, *K. homeana* and allied *K. erosa* were recorded from two communities including Madina and Mbaloma. Both communities are within 5km distance from the proposed dam.

Species of IUCN Conservation Concern recorded during the survey - *Kinixys homeana* (VU).



Kinixys homeana (Vulnerable)

Four *K. homeana* were found in Mbaloma (2) and Madina (2), and one *K. erosa* from Mbaloma. The four *K. homeana* included two males and two females while the one *H. erosa* was a juvenile. Though the *H. erosa* is Data Deficient (IUCN, 2015), it is included in CITES Appendix II.

Result of Interviews with local people

Though the interview result is useful, the present survey team did not confirm the occurrence of the species, as no sign of the species were noted. It is hoped that future surveys will ascertain the occurrence of the species within the study area.

Of the 16 reptile species confirmed by locals, three including *Mecistops cataphractus*, *Osteolaemus tetraspis* and *Varanus olivaceus* are of IUCN Conservation concern (Table 10). All the three species are forest and stream/river environment dependent. They are classified into IUCN conservation concern categories based on habitat loss and population decrease mainly due to human activities. All three crocodile species known to occur in West Africa are classified under CITES appendix I while the *Varanus* species are under CITES Appendix II. Species under Appendix I include species threatened with extinction and provides the greatest level of protection, including restrictions on commercial trade whereas species under CITES Appendix II includes species that, although currently not threatened with extinction, may become so without trade controls. It also includes species that resemble other listed species and need to be regulated in order to effectively control the trade in those other listed species (USFWS, 2014).

Table 10 – List of reptile species recorded from interviews with communities

| | Common Name | Scientific Name | IUCN Status |
|----|---------------------------|--------------------------------------|-------------|
| 1 | | <i>Afronatrix anoscopus</i> | LC |
| 2 | | <i>Chamealeo gracilis</i> | NA |
| 3 | Nile Crocodile | <i>Crocodylus niloticus (suchus)</i> | LC |
| 4 | Western Green Mamba | <i>Dendroaspis viridis</i> | LC |
| 5 | | <i>Grayia smythii</i> | NA |
| 6 | Slender-snouted Crocodile | <i>Mecistops cataphractus</i> | CR |
| 7 | | <i>Natriciteres variegata</i> | NA |
| 8 | Dwarf Crocodile | <i>Osteolaemus tetraspis</i> | VU |
| 9 | | <i>Philothamnus semivariegatus</i> | NA |
| 10 | Northern Green Bush Snake | <i>Philothamnus irregularis</i> | LC |
| 11 | | <i>Psammophis elegans</i> | NA |
| 12 | | <i>Psammophis sibilans</i> | NA |
| 13 | Royal Python | <i>Python regius</i> | LC |
| 14 | | <i>Python sebae</i> | NA |
| 15 | | <i>Thelotornis kirtlandii</i> | NA |
| 16 | Gray's Monitor | <i>Varanus olivaceus</i> | VU |

The *M. cataphractus* occurs through West Africa though recent publications state that the distribution has changed due to local extirpations. *M. cataphractus* prefers forested rivers and other densely vegetated water bodies (e.g. reservoirs and freshwater lagoons) but they can also occur in sparsely vegetated gallery habitats (Shirley, 2014).

The females lay eggs in mound nests composed of organic matter at the edge of aquatic habitats. The nests are constructed at the base of trees at the edge of undisturbed forested wetland habitats. The nesting season of *M. cataphractus* overlaps with that of *Osteolaemus tetraspis*. *M. cataphractus* eggs are larger when compared to the female's size and the hatchlings are also larger than those of other crocodile species. The young crocodiles feed primarily on small fish and a variety of invertebrates (Shirley, 2014).

Notably, *Crocodylus niloticus* (now known as *Crocodylus suchus*), which was not reported in this study, is larger than the two other species known to occur in the region. Though common and considered as least concerned species by IUCN Redlist, it is classified under IUCN Appendix I.

Varanus spp are arboreal and can be found in both primary and secondary forests often with rocky outcrops. They lay eggs close to water bodies and juveniles have a diet of snails and crabs.

3.4 Fish and Macro-invertebrates

3.4.1 Fish species diversity

A total of 12 fish species and two macro-invertebrates (shellfish species) were recorded in this study. This constitutes about 6.8% of the total species recorded for Liberia and 25% of that recorded in the Mano River (www.fishbase.org cited in Fermon and Gsegner, 2006) which is a clear indication of low species diversity in this area. This is expected as Kaiha River is only a tributary of the Mano River, located in its upper catchment. Limited sampling days and season of the survey (early rains) could be contributing factors to low catch during this survey.

In the deeper pools with overhanging forest trees, typical calmer water species such as the predatory cichlid *Hemichromis fasciatus*, *H. bimaculatus* as well as the Characids *Brycinus macrolepidotus* and *B. longipinnis* (Payne et al., 2006) were recorded upstream and to a lesser extent downstream of the river as far as Madina (Table 11). However, *H. fasciatus* and *B. longipinnis* occurred almost ubiquitously along the river.

The list of fish species recorded per sampling area and the IUCN Red List status of all of the freshwater species identified by this survey is indicated in Table 11.

Table 11 - Fish and macro-invertebrate species recorded in the Kaiha River

| Family | Species | Dam site (Upstream) | Madina (Down stream) | Irrigation Dam (Upstream) | IUCN Red list Status |
|----------------------------|----------------------------------|---------------------|----------------------|---------------------------|----------------------|
| FISH | | | | | |
| Cichlidae | <i>Tilapia louka</i> | ✓ | | ✓ | LC |
| | <i>Sarotherodon occidentalis</i> | ✓ | | | NT |
| | <i>Hemichromis fasciatus</i> | ✓ | ✓ | ✓ | LC |
| | <i>Hemichromis bimaculatus</i> | ✓ | ✓ | | LC |
| Cyprinidae | <i>Labeo parvus</i> | | | ✓ | LC |
| | <i>Barbus sacratu</i> | ✓ | | ✓ | LC |
| Alestidae | <i>Brycinus longipinnis</i> | ✓ | ✓ | ✓ | LC |
| | <i>Brycinus macrolepidotus</i> | ✓ | | ✓ | LC |
| Mormyridae | <i>Petrocephalus pellegrini</i> | ✓ | ✓ | ✓ | LC |
| | | | | | |
| Bagridae | <i>Chrysichthys johnelsi</i> | ✓ | ✓ | ✓ | LC |
| | <i>Chrysichthys maurus</i> | ✓ | | | LC |
| Amphiliidae | <i>Doumea chappuisi</i> | ✓ | | | VU |
| MACRO-INVERTEBRATES | | | | | |
| Crab | <i>Potamon sp.</i> | ✓ | ✓ | | |
| Shrimp | <i>Macrobrachium sp.</i> | ✓ | | | |

Key: LC - List Concern; NT - Near Threatened; V - Vulnerable

Hemichromis fasciatus is considered as List Concern in the IUCN Red list category and inhabits inland waters of Permanent Rivers, Streams/Creeks (including waterfalls) (www.iucn.org). It is one of the most common and widely distributed species in West Africa and has been recorded in across the Sub Saharan Africa from Angola to Zimbabwe (www.iucn.org; Paugy et al, 2004). It is a Benthopelagic species (living and feeding near the bottom as well as in mid waters or near the surface) that can thrive in both fresh as well as brackish water. It occurs in mud-bottom and sand-bottom canals some distance inland from the coast associated with areas intact or recently disturbed forest cover. The migration behavior of *H. fasciatus* is mainly Potamodromous, thus migrating within streams, migratory in rivers, like the *Labeo spp.* Migrations should be cyclical and predictable and cover more than 100 km. In Liberia, this species is known from Farmington Lake, Mano, Loffa, St Paul, St John, Du, Nipoure and Cavally Rivers (Fermon and Gsegner, 2006).

Brycinus longipinnis, like *H. fasciatus*, is also considered List Concern by the IUCN Red List status. It is also a very common species with a wide range of distribution across West Africa from Benin to Togo (Paugy et al., 2004). This species inhabits both seasonal and permanent rivers, streams/creeks (including waterfalls). It could also inhabit intermittent saline or brackish waters (www.iucnredlist.org). It is the only *Brycinus sp* that can penetrate small rivers and stream and feeds on plants and invertebrates (Fermon and Gsegner, 2006). In Liberia, it occurs in Farmington Lake, Mano, Loffa, St Paul, Du and St John Rivers.

A further consistent feature of the species assemblage of fish in the Kaiha River was the presence of the Golden-coloured Barbel *Barbus sacratus* typical of fast-flowing rocky rivers (Payne, 2006) such as the Kaiha River and was recorded in low quantity at the Kaiha-2 Dam Site. Two(2) specimens of *B. sacratus* was recorded upstream of the Kaiha River below the water fall of the Kaiha-2 Dam Site, ten(10) specimens further upstream at the Agricultural Irrigation Dam site and four(4) specimen being recorded downstream of the River at Madina area, probably having being washed down by the water current (Table 11). *B. sacratus* is however, listed as List Concern in the IUCN Red List category. This species is distributed across Sub Saharan Africa including Liberia, Sierra Leone, Guinea, Cote d' Ivoire and Guinea Bissau and mostly inhabit inland waters of Permanent Rivers, Streams/Creeks (including waterfalls) (www.iucn.org; Paugy et al, 2004). The species is benthopelagic in terms of habitat and, in Liberia, it is known from the Loffa, St Paul and St. John Rivers including Vai River.

From a conservation perspective, two species, recorded only at the Kaiha-2 Dam site below the waterfall appeared quite interesting during this survey and are listed in the IUCN Red list classification as either Near Threatened (NT) or Vulnerable (V). These are *Sarotherodon occidentalis* (NT) and *Doumea chappuisi* (V) respectively.

S. occidentalis is distributed in some countries across West Africa including Guinea, Guinea Bissau, Liberia, Senegal and Sierra Leone (www.iucnredlist.org; Paugy et al., 2004). Record of this species has been made in the River Casamance in Senegal to the St John in Liberia (Paugy et al., 2004). It inhabits inland waters of Permanent Rivers, Streams/Creeks (Including waterfalls) (www.iucnredlist.org). It is a demersal (bottom dwelling) species and

recent studies in Liberia reveals that the species also occurs in the Loffa and St. Paul Rivers (Fermon and Gsegner, 2006).

Doumea chappuisi belonging to the family Amphilidae is a small catfish and a characteristic species of small fast-flowing streams. This species, though of no economic value, is comprised of suctorial mouthparts which enable it to cling onto the underside of rock surfaces. Judging by the body shape, these fishes are adapted to life in quick waters (Paugy et al 2004). It is a purely demersal species (Fermon and Gsegner, 2006). In fact, it was collected with a scoop net placed underneath the flow of water over small rocks while being washed away by the fast flowing water just above the waterfall of the Kaiha-2 Dam site. *D. chappuisi* is distributed in the Sub-Saharan Africa and particularly Liberia, Guinea Bissau, Cote d'Ivoire and Guinea(www.iucn.org) and has been recorded in rivers Cavally and Gbin(St. John basin, Liberia) and Corubai (Guinea Bissau) (Paugy et al,2004).

The number of catfish species in the samples was limited in the period of this survey. The most distinctive catfish groups below the falls were species belonging to the family Bagridae and of the genus *Chrysichthys* and include *Chrysichthys maurus* (recorded only at Kaiha-2 Dam site below the waterfall) and *Chrysichthys johnelsi*, largely recorded at Kaiha-2 Dam site and further upstream at the Agricultural Irrigation Dam area. The catch of the *Chrysichthys* spp (largely *C. johnelsi*) upstream of the Kaiha 2 waterfall may be due to the fact that catfish species move upstream to spawn during the rains in flooded areas when there is connectivity at the river flanks where current is less and away from the Kaiha-2 waterfall. The *Chrysichthys* spp are Potamodromous in terms of migration and are demersal (bottom-dwelling) species that inhabit freshwater systems. In terms of distribution, the species are known from the St John and St Paul Rivers in Liberia (Fermon & Gsegner, 2006).

Further fish species composition downstream and upstream of the Kaiha-2 waterfalls recorded during sampling was the presence of the mormyrid, *Petrocephalus pellegrini*. This species inhabits Inland Water/Wetlands-Permanent or Seasonal Rivers/Streams/Creeks (including waterfalls) as well as coastal waters and has been recorded in Cote d' Ivoire, Guinea, Liberia, Sierra Leone (www.iucnredlist.org; Paugy et al, 2004). It is a demersal species and its migration behaviour is poorly known (Fermon & Gsegner, 2006).

However, from the Fresh and Brackish Water Fishes of West Africa (Paugy et al, 2004), it is obvious that the fish species recorded during this survey (with the exception of *Barbus carcharhinoides* and *Labeo curreie*) are also found in rivers of the sub-region. Also, studies conducted by Fermon & Gsegner (2006) in the St John and St Paul Rivers revealed the existence of the species recorded during this survey. Therefore, the Kaiha River system cannot be considered as critical natural habitat for these species as the species are not endemic to the river. Also, the species recorded in the Kaiha River are not exclusive to the river and all species recorded for this survey (with the exception of *Barbus carcharhinoides* and *Labeo curreie*) could be regarded as Regional Endemics. The approximate abundances of each species recorded are given in Table 12. A descriptive comparison of the total abundances is shown in Figure 3, indicating that *Chrysichthys johnelsi* and *Brycinus longipinnis* were the most abundant species recorded.

Table 12 – Approximate abundance for fish species recorded at various survey sites

| Species | Kaiha-2 Dam Site | Madina (Downstream) | Irrigation Dam (Upstream) | Total |
|----------------------------------|------------------|---------------------|---------------------------|------------|
| CICHLIDAE | | | | |
| <i>Tilapia louka</i> | 1 | 0 | 2 | 3 |
| <i>Sarotherodon occidentalis</i> | 1 | 0 | 0 | 1 |
| <i>Hemichromis fasciatus</i> | 4 | 2 | 8 | 14 |
| <i>Hemichromis bimaculatus</i> | 2 | 0 | 0 | 2 |
| CYPRINIDAE | | | | |
| <i>Labeo parvus</i> | 0 | 0 | 5 | 5 |
| <i>Barbus sacratus</i> | 2 | 4 | 10 | 16 |
| ALESTIDAE | | | | |
| <i>Brycinus macrolepidotus</i> | 2 | 2 | 0 | 4 |
| <i>Brycinus longipinnis</i> | 5 | 8 | 16 | 29 |
| MORMYRIDAE | | | | |
| <i>Petrocephalus pellegrini</i> | 5 | 2 | 7 | 14 |
| BAGRIDAE | | | | |
| <i>Chrysichthys johnelsi</i> | 6 | 5 | 20 | 31 |
| <i>Chrysichthys maurus</i> | 2 | 0 | 0 | 2 |
| AMPHILIDAE | | | | |
| <i>Doumea chappuisi</i> | 3 | 0 | 0 | 3 |
| <i>Potamon Crab</i> | 3 | 1 | 0 | 4 |
| <i>Macrobranchium sp.</i> | 2 | 0 | 0 | 2 |
| Total Catch | 37 | 28 | 69 | 135 |

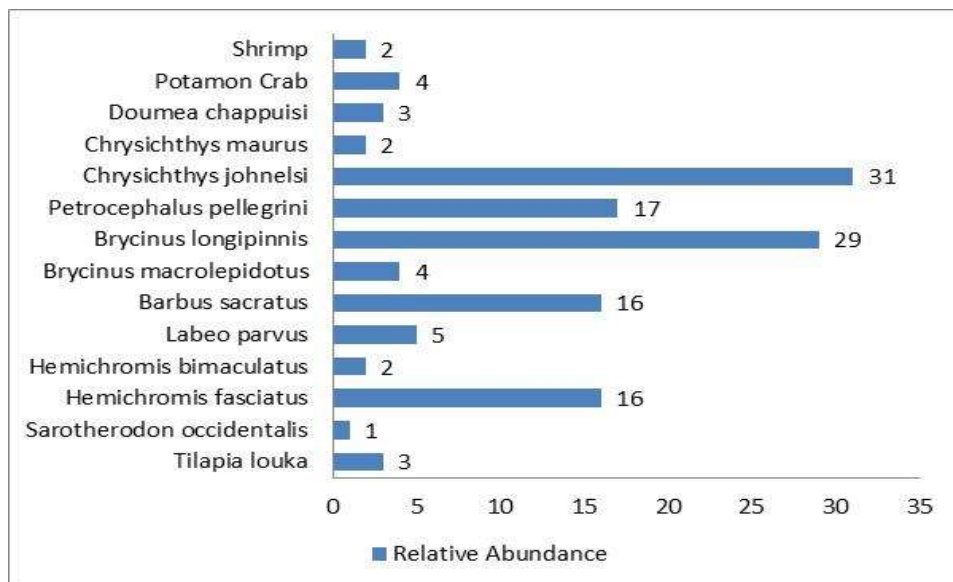








Figure 3 - Relative abundance of Fish species of Kaiha River

| | |
|---|---|
|  | <p><i>Sarotherodon occidentalis</i> Near Threatened (NT). Habitats: Wetland (Inland) – Permanent Rivers/Streams/Creeks (including waterfalls).</p> |
|  | <p><i>Potamon crab</i></p> |
|  | <p><i>Machrobranchium spp</i></p> |
|  | <p><i>Brycinus longipinnis</i> List Concern(L.C) Migration: Longitudinal up river migrations over long distances</p> |
|  | <p><i>Hemichromis fasciatus</i> Redlist status: List Concern(L.C) Migrates upstream at the beginning of the wet season</p> |
|  | <p><i>Doumea chappuisi</i> Red list status: Vulnerable. Habitat: Inland (Wetland)- Seasonal/Intermittent/Irregular Rivers/Streams/ Creeks. Found in fast flowing water on rocks at Mbaloma.</p> |

Photos of Some Fish Species Recorded

3.4.2 Macro-invertebrates

Two species of aquatic macro-invertebrates belonging to the class Crustacea (Decapod crustaceans) were recorded but were not identified to species level. These include one species of shrimp representing the genus *Macrobranchium* and one species of crab representing the family Potamonautidae.

One specimen each of both macro-invertebrates was recorded above the fall of the Kaiha-2 Dam site. Downstream of the Kaiha River, around Madina, another specimen of the Potamon crab was recorded.

3.4.3 Knowledge and perception of the local communities on fish species

Out of 37 fish species identified by the local communities to exist in the Kaiha River, seven (6) of these are of conservation concern, two of which were also recorded during sampling and include *Doumea chappuisi* and *Sarotherodon occidentalis* (Table 13); the full species list is given in Appendix D. Some characteristics of the species of conservation concern are discussed below.

Table 13 – List of species of global conservation concern recorded from interviews with local communities/fishers

| Species | Habitats | Location | IUCN Redlist Status |
|---|--|--|---------------------|
| <i>Barbus carcharinoides</i> (Stiassny, 1991) | Inland Water/Wetlands-Permanent or Seasonal Rivers/Streams/Creeks (including waterfalls) | Liberia | CR |
| <i>Barbus eburneensis</i> (Poll, 1941) | Inland Water/Wetlands-Permanent or Seasonal Rivers/Streams/Creeks (including waterfalls) | Cote d'Ivoire, Guinea, Liberia | VU |
| <i>Doumea chappuisi</i> (Pellegrin, 1933) | Seasonal/Intermittent/Irregular Rivers/ Streams/ Creeks | Cote d'Ivoire, Guinea, Guinea Bissau, Liberia | VU |
| <i>Rhexipanchax nimbaensis</i> (Daget, 1948) | Inland Water/Wetlands-Permanent or Seasonal Rivers/Streams/Creeks (including waterfalls) | Guinea, Liberia | VU |
| <i>Labeo Curriei</i> (Fowler, 1919) | Rivers/Streams/Creeks(including waterfalls) | Liberia | CR |
| <i>Sarotherodon occidentalis</i> (Diget, 1962) | Permanent Rivers/Streams/Creeks (including waterfalls)/Marine | Sub-Saharan Africa (Guinea, Guinea Bissau, Liberia, Senegal, Sierra Leone) | NT |
| <i>Tilapia walteri</i> (Van den Audenaerde, 1968) | Fresh water Lakes/Pools | Cote d'Ivoire, Liberia | NT |

(Source: www.iucnredlist.org; Fermon and Gseger, 2006; Paugy et al, 2004). Key: CR-Critically Endangered; NT- Near Threatened; V- Vulnerable; LC-List Concern.

The species, *Barbus eburneensis* is considered vulnerable according to IUCN Red List category and criteria. *B. eburneensis* is found from Guinean region of Mount Nimba in the basins of Cavally, Nipoué, Niger and St. Paul. It is native to Côte d'Ivoire; Guinea and Liberia (Paugy et al, 2004). The extent and quality of habitat is undergoing and continuous decline due to deforestation and past civil conflicts, and it is therefore assessed as Vulnerable. In terms of habitat and ecology, this is a benthopelagic species and inhabits fresh water systems (www.iucnredlist.org; Fermon and Gsegner, 2006). The migration behaviour of *B. eburneensis* is poorly known (Fermon and Gsegner, 2006).

Barbus carcharhinoides, is listed by the IUCN Red List category as Critically Endangered. This species is restricted to one location, the type locality, River Via, Saint Paul's River drainage, in Liberia. It is suffering ongoing decline in habitat quality due to siltation and pollution from deforestation and mining and is a pelagic species that is apparently endemic to Liberia. It inhabits freshwater systems (www.iucnredlist.org; Paugy et al, 2004; Fermon and Gsegner, 2006).

Labeo Curriei is also regarded as Critically Endangered and is native to Liberia and the current population trend tends to be decreasing. There are indications of continuing habitat degradation by deforestation, farming and mining with possible decline in population in Liberia. The species is reliably known from River Via, Saint Paul drainage, Loffa and Mano in Liberia (www.iucnredlist.org; Paugy et al, 2004; Fermon and Gsegner, 2006). In terms of habitat and ecology, the species is a **Benthopelagic** species (www.iucnredlist.org; Fermon and Gsegner, 2006).

Tilapia walteri is restricted to the Cavally and Nipoué (Cess) (Côte d'Ivoire/Liberia), Cavally and the St. John River in Liberia (www.iucnredlist.org; Paugy et al, 2004; Fermon and Gsegner, 2006). There is no information on any major threats to the species. Due to its restricted range, the species has been classified by IUCN as Near Threatened as any identified threat will trigger listing as a threatened species under the IUCN Red List Criteria. The current population trend or threat is unknown. It is also a benthopelagic fish (www.iucnredlist.org; Fermon and Gsegner, 2006).

Procatopus nimbaensis (*Synonyms-Rhexipanchax nimbaensis*), is a non migratory species that occurs mainly in small rivers, swamps and brooks in mountainous areas (Fermon and Gsegner, 2006). It is a benthopelagic species known from the St Paul and St. John Rivers in Liberia. Probably also in the adjacent part of Western Côte d'Ivoire (www.iucnredlist.org). According to the IUCN Red List Category & Criteria, the species is regarded as Vulnerable. There is no information on any major threats to the species in Guinea, but in Liberia the threats are from mining and deforestation. Due to its very restricted range and to the threats to this species in Liberia, the species is qualified as Vulnerable (www.iucnredlist.org).

Sarotherodon occidentalis is a demersal species known from Casamance River, Senegal to the Saint John River, Loffa and St Paul Rivers in Liberia (www.iucnredlist.org; Paugy et al, 2004; Fermon and Gsegner, 2006). The species has a wide range of distribution. But is

found in a limited number of locations (but more than 10) and native to Guinea, Guinea-Bissau, Liberia, Senegal and Sierra Leone (www.iucnredlist.org; Paugy et al., 2004), introduced in New Caledonia. It has widespread threats, particularly from drought, deforestation, overfishing and dams. The species is Near Threatened as it is close to meeting Vulnerable (www.iucnredlist.org).

Doumea chappuisi is threatened by deforestation, and agricultural development. The species is fragmented and is assessed as Vulnerable. It is known from rivers Cavally and Gbin (St. John basin, Liberia) and Corubal (Guinea Bissau) (www.iucnredlist.org). It is a demersal fish that inhabits fast flowing fresh water systems (Paugy et al, 2004).

However, the biology of most of the species recorded during this survey is poorly known for the area.

3.4.4 Migration of fish upstream of the Kaiha-2 waterfall

In spite of the fact that most tropical fresh water fish exhibit high downstream and upstream migration behaviour in more calmer river where there is little or no fall (e.g. *Hydrocyanus forskali* - Longitudinal up river migrations over long distances; *Clarias anguillaris*- Migrations upstream into swamps; *Hemichromis fasciatus* - migration upstream at the beginning of the wet season; *Tilapia brevimanis* - movement into flooded areas; *Liza falcipinnis* - catadromus migration from estuarine waters upstream into fresh waters) (Payne et al, 2006), fishes always tend to avoid high water currents in order to conserve energy for better purposes such as going in search of food or escape from predators. The capacity to migrate upstream requires that the fish swim faster than the water velocity, necessitating substantial energy cost (Blake 2004). Besides, fish movement within a river system can be restricted by various barriers. Even small waterfalls (1 – 3m high) are sufficient to stop upstream movement of many fish (Osborne, 2012).

Hence, the slope of the Kaiha-2 waterfall certainly does constitute a completely surmountable ecological barrier for fish. It certainly reduces the upstream dispersal movements of fish species as the energy needed by the fish to overcome the high current or rapids is too high which makes it practically impossible for any fish to move up across the fall, considering the height and force of the water fall without being swept down. Acknowledging the fact that these natural barriers (such as waterfalls) have produced distinct aquatic biota above and below them (Rahel 2007), we are still far from a complete understanding of their influence on freshwater fish assemblages, especially in tropical aquatic environments (Bohlke et al. 1978).

Notwithstanding, in Mbaloma, asked if fish could move up the falls, the community people responded by stating that the species *Barbus eburneensis* (Vulnerable) exhibits such characteristics (see descriptions above). However, *B. eburneensis*, in spite of the fact that some aspects of the biology and migration behaviour of *B. eburneensis* is poorly known, review of related literature reveals that the species is a benthopelagic species that inhabits mid and surface water in rivers and does not possess any form of suckoral or grasping mouth

part (Paugy et al, 2004). This literally suggests that it is very much unlikely that the species could possibly jump across the Kaiha-2 water fall without being swept down.

Despite the fact that *Doumea chappuisi* and *Labeo* spp. possess a suctional as well as grasping mouth parts respectively, none of these species could succeed on moving up against the water fall at the Kaiha-2 Dam site considering the height of the fall (approx. 1.5m high) and force of water. *D. chappuisi* is mainly known to move down along with water current flowing over rocks of minimal fall. They however, can fasten themselves on rock surfaces in order to prevent them being easily washed away the current. *Labeo* spp, like the barbs, is a benthopelagic species with a long distant migration and feeds on detritus and invertebrates with very rough-surfaced lower and upper lips used for picking its food materials on rock surfaces. The mouth part certainly does not provide sufficient ability for the fish to overcome the force of the Kaiha-2 water fall.

On the other hand, besides the difficulty of overcoming the Kaiha-2 waterfall by fishes, the effective establishment of fish populations would depend on their ability to access the few available flooded forests in that river stretch. Species adapted to floodplain environments, strongly dependent on food and shelter provided seasonally by the flooded forests and the large macrophyte stands (Goulding 1980; Saint-Paul et al. 2000). Also, it is likely that, increase in water volume during the rains could enhance connectivity between upstream and downstream of the waterfalls at the Kaiha-2 Dam Site along the river banks of those areas with minimal current away from the fall.

3.4.5 Fishery

Interviews with fishers and some nearby communities to the Kaiha River indicated that fishing practices and the fishery are similar throughout the river, and have not changed significantly in the past times. Fishing methods are essentially the same at all locations, and largely include the use of crude methods such as hook and line in the communities of Mbaloma and Madina. The fish obtained in these areas are purely for subsistence purposes.

However, at Madina, migrant part-time fishers from neighboring country, Guinea, using more efficient fishing gears are highly engaged in large scale commercial fishing in the Kaiha River using gill nets and long lines as fishing methods. The presence of the migrant fishers in this part of the river is mostly felt during the dry season. In the early rains, they tend to move out of their temporary base camp at Madina.

Madina is located downstream of the Kaiha River. Fish respond to the natural reductions in river flow in the dry season by moving into the centre of the channel as the margins dry, and many also migrate downstream in the late rains and early dry season, to areas where the changes in the water body are less extreme. This increases the chance of fishers catching more fish during the dries downstream of a river than during the rains when there is increased river flow and reduction in migration of species from other sources coupled with the high effects of current on fish movements and fishing gears.

At the Agricultural Irrigation Dam site around Mbolatahun, community people use kru-canoes as fishing craft and largely employ gill nets for fishing. Fishers interviewed at the irrigation dam site stated that catch is mostly dependent on the efficiency of their fishing gears (gill nets) in the area. Most of the catch at good times is marketed and some being used for consumption. The fishers were however not certain about the differences in catch per season.

Also, fishers were asked in a focused group discussion to identify fish species and some catch data. The responses of the fishers with comments are summarized and attached as annexure of this report.

SECTION FOUR

LIMITATIONS, CONCLUSIONS AND RECOMMENDATIONS

4.1 Limitations

The limitations outlined below are meant to indicate the constraints faced by the survey team in the course of carrying out the assignment. Some of them are inherent on the already existing conditions in the areas that were surveyed, but a few are actually issues that can be handled through planning. Whilst some of the limitations highlighted below specific to specific thematic group, some are generic.

- There is no plan to carry out seasonal assessment of the baseline biological condition of the project area, which ideally should have covered both the rainy season and the dry, in order to account for a full complement of the biodiversity of the project area.
- The length of the survey period is short, meaning that a longer period would have revealed more details on the biodiversity status of the area.
- Time constraint and resource/equipment limitations also limited the number of sites visited and the type of sampling mechanisms used, respectively. Additional methods like the use of camera trapping for mammals, mist netting for mammals and mash surber sampler for macro invertebrate could have revealed more data on biodiversity of the area.
- The Relative species diversity using a general relationship between the total number of species occurring in a basin and its area has been described for Africa by Welcomme (1985) as: $N = 0.449 A^{0.434}$, where N is species number and A is basin area (km²). This could not be calculated since there is no record of the Basin Area for Kaiha River.
- Absence of fishing craft (Kru-canoe) in most areas could not allow fishing nets to be set at certain locations or across river since water depth varied between 3-4m as one approach the centre of the river in all areas sampled.
- Limited literature on baseline data for some of the thematic groups such as herps (reptiles and amphibians), and lack of concise literature on fish migration and species diversity along sub-Saharan Africa, hampered the degree of comparison with the findings of this study.

4.2 Conclusion

From a general point of view, the areas to be affected by the Kaiha 2 HPP support a reasonable diversity of fauna and flora, based on the result of the survey. The area support

nineteen species of vascular plants considered threatened by the IUCN, a mosaic of ecosystem and a reasonable healthy forest cover in some areas. The primate/mammalian diversity is good particularly in the forest patches that occur in remote locations and along the river, according to local hunters.

The bird diversity mostly comprises species that are common and to a large extent depend on forest habitat, but less so for species of global conservation concern and Upper Guinea forest endemics in comparison forest entities like the North Lorma and the Gola National forests (see Demey, 2006).

There is very limited information on the diversity and distribution of herpes in Liberia, except for studies conducted on marine turtles. However, there is potential for exciting discovery of herpes species, especially amphibians if studies are conducted in biodiversity sensitive areas, particularly the forest. In fact, there is need for a wider scientific survey of herpes in Liberia to provide baseline data that would enhance comparison with subsequent studies.

The fish catch from Kaiha River constituted only 6.8% of the general figure and 25% when compared with species diversity of the Mano River. This is a clear indicator of low species diversity in the Kaiha River. This is however expected as the current survey is only a rapid baseline survey with limited sampling days per site.

Although there appear no unique elements to the sampling river system, fish assemblages, as recorded in the Kaiha River during this survey, however, share high level of endemism with the other rivers locally and regionally.

As the species recorded in the Kaiha River are not exclusive to the river is an indication that the species of conservation concern listed as Near Threatened (*Sarotherodon occidentalis*) and Vulnerable (*Doumea chappuisi*) are not endemic to the Kaiha River.

The presence of forests with rich cover and plant diversity in the vicinity of the area to the affected by the Kaiha 2 HPP, provides a basis for believing that there is adequate complementary and alternative habitat for species to be displaced by the project. However, because the project is small by comparison with other major HPP in the region, the likelihood of destroying a wide-range of habitats and displacing many species is obvious, but the extent would be limited.

4.3 Recommendations

- There is need to assess the suitability of forest closer to the Kaiha 2 HPP area to serve as offset for biodiversity conservation in the event of the displacement of species resulting from the construction and operation of the dam and related facilities;
- The Kaiha 2 HPP project implementers should identify viable forest patches within the vicinity of the project environs that can be maintained for the purpose of *in situ* conservation for species that may have limited dispersal options and small home-range sizes.

- Further and regular monitoring regimes should be planned and executed to assess the response of key biodiversity components and ecological systems to the changes associated with the construction and operation of the Kaiha 2 HPP dam and related facilities. For instance the effect of rise in inundation level along the upper reaches of the river relative to the dam on biodiversity, should be monitored.

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APPENDIX A

Plant species recorded at survey sites, their families, IUCN status and growth form

(1 – Dam site; 2 – Access Road; 3 – Downstream; 4 – Upstream; 5 – Transmission Line 1;
Transmission Line 2; Transmission Line 3)

| Botanical name | Family | IUCN Status | Growth Form | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|------------------------------------|------------------|-------------|-------------|---|---|---|---|---|---|---|
| <i>Pseudospondias microcarpa</i> | Anacardiaceae | | Tree | x | x | x | | x | x | x |
| <i>Spondias mombin</i> | Anacardiaceae | | Tree | | x | x | | x | x | x |
| <i>Trichoscypha arborea</i> | Anacardiaceae | | Tree | x | x | x | | | | |
| <i>Trichoscypha mannii</i> | Anacardiaceae | | Tree | x | x | x | | | | |
| <i>Trichoscypha bijuga</i> | Anacardiaceae | | Tree | x | x | x | | | | |
| <i>Lannea nigritanna</i> | Anacardiaceae | | Tree | x | | | | x | x | x |
| <i>Anisophyllea meniaudi</i> | Anisophylleaceae | | Tree | x | | x | | | | |
| <i>Xylopia aethiopica</i> | Annoaceae | | Tree | x | x | x | x | x | x | x |
| <i>Cleistopholis patens</i> | Annonaceae | | Tree | x | x | x | x | | | |
| <i>Xylopia quintasii</i> | Annonaceae | | Tree | x | | x | | | | |
| <i>Alstonia congensis</i> | Apocynaceae | | Tree | | x | x | | | x | |
| <i>Funtumia africana</i> | Apocynaceae | | Tree | x | x | x | x | x | x | x |
| <i>Rauvolfia vomitoria</i> | Apocynaceae | | Shrub | x | x | x | x | x | x | x |
| <i>Tabernaemontana glandulosa</i> | Apocynaceae | | Shrub | x | | x | | | | |
| <i>Tabernaemontana crassa</i> | Apocynaceae | | Shrub | x | x | x | | | | |
| <i>Tabernaemontana pachysiphon</i> | Apocynaceae | | Shrub | x | | x | | | x | |
| <i>Anubias afzelii</i> | Araceae | | Herb | x | | x | | | | |
| <i>Cercestis afzelii</i> | Araceae | | Herb | x | x | x | x | | | |
| <i>Cercestis angolensis</i> | Araceae | | Herb | x | x | | | | | |
| <i>Cercestis styriolata</i> | Araceae | | Herb | x | x | x | x | | | |
| <i>Newbouldia laevis</i> | Bignoniaceae | | Shrub | | x | | | x | x | x |
| <i>Ceiba pentandra</i> | Bombacaceae | | Tree | x | x | x | x | x | x | x |
| <i>Bombax buonopozense</i> | Bombacaceae | | Tree | x | x | | x | x | x | x |
| <i>Canarium schweinfurthii</i> | Burseraceae | | Tree | x | x | x | | | | |
| <i>Santiria trimera</i> | Burseraceae | | Tree | x | x | x | x | | | |
| <i>Afzelia africana</i> | Caesalpiniaceae | VU | Tree | x | | x | | | | |
| <i>Amphimas pterocarpoides</i> | Caesalpiniaceae | | Tree | x | x | x | | x | | x |
| <i>Cryptosepalum tetraphyllum</i> | Caesalpiniaceae | VU | Shrub | x | x | x | | x | | |
| <i>Dialum guineense</i> | Caesalpiniaceae | | Tree | x | | x | | x | | |
| <i>Dialum dinklagei</i> | Caesalpiniaceae | | Tree | x | x | x | | | | |
| <i>Dialum sp</i> | Caesalpiniaceae | | Tree | x | | x | | | | |
| <i>Distemonanthus benthamianus</i> | Caesalpiniaceae | | Tree | x | | x | | x | | x |
| <i>Gilbertiodendron limba</i> | Caesalpiniaceae | NT | Tree | x | | x | | | | |
| <i>Daniella ogea</i> | Caesalpiniaceae | | Shrub | x | x | x | | | | |
| <i>Chidlowia sanguinea</i> | Caesalpiniaceae | | Tree | x | | x | | | | |
| <i>Cassia sieberiana</i> | Caesalpiniaceae | | Shrub | | x | | | x | x | x |
| <i>Anthonota macrophylla</i> | Caesalpiniaceae | | Tree | x | x | x | | x | x | x |
| <i>Anthonota fragrans</i> | Caesalpiniaceae | | Tree | x | x | x | | | | |
| <i>Bussea occidentalis</i> | Caesalpiniaceae | | Tree | x | | x | | | | |
| <i>Salacia owabiensis</i> | Celastraceae | | Liana | x | x | x | | | | |
| <i>Cenestis ferruginea</i> | Connaraceae | | Shrub | | x | x | x | | | |
| <i>Parinari excelsa</i> | Chrysobalanaceae | | Tree | x | x | x | x | | x | |
| <i>Terminalia ivorensis</i> | Combretaceae | VU | Tree | | x | | | | | |
| <i>Terminalia glaucescens</i> | Combretaceae | | Tree | x | x | x | x | x | x | x |
| <i>Combretum grandiflorum</i> | Combretaceae | | Liana | | x | x | | | | |
| <i>Palisota hirsuta</i> | Commelinaceae | | Herb | x | | x | | | | |

| | | | | | | | | | | |
|------------------------------------|---------------|----|-------|---|---|---|---|---|---|---|
| <i>Chromolaena odorata</i> | Compositae | | Herb | | x | | | x | x | x |
| <i>Momordica silvatica</i> | Cucurbitaceae | | Herb | x | x | | | | | |
| <i>Rhynchospora corymbosa</i> | Cyperaceae | | Grass | | x | | | x | | x |
| <i>Scleria barteri</i> | Cyperaceae | | Grass | | x | | x | x | x | x |
| <i>Cyachea manniana</i> | Cyatheaceae | | Grass | | x | | | | | |
| <i>Tetracera alnifolia</i> | Dilleniaceae | | Liana | | x | | | x | x | x |
| <i>Tetracera potatoria</i> | Dilleniaceae | | Liana | x | x | x | x | | | |
| <i>Dracaena cerasifera</i> | Dracaenaceae | | Herb | x | | x | | | | |
| <i>Dracaena cristula</i> | Dracaenaceae | | Herb | x | x | x | | | | |
| <i>Dracaena phrynioides</i> | Dracaenaceae | | Herb | x | | x | | | | |
| <i>Dracaena surculosa</i> | Dracaenaceae | | Shrub | x | | | | | | |
| <i>Diospyros gabonensis</i> | Ebenaceae | | Shrub | x | x | x | x | | | |
| <i>Diospyros thomasii</i> | Ebenaceae | | Shrub | x | | x | | | | |
| <i>Diospyros sp</i> | Ebenaceae | | Shrub | | x | x | | | | |
| <i>Alchonea cordifolia</i> | Euphorbiaceae | | Shrub | | x | | | x | x | x |
| <i>Alchonea hirtella</i> | Euphorbiaceae | | Shrub | x | x | x | x | | | |
| <i>Amanoa bracteosa</i> | Euphorbiaceae | VU | Tree | x | | | | | | |
| <i>Hymenocardia lyrata</i> | Euphorbiaceae | | Tree | x | x | x | x | | | |
| <i>Macaranga bateri</i> | Euphorbiaceae | | Tree | x | x | x | | x | x | x |
| <i>Macaranga heterophylla</i> | Euphorbiaceae | | Tree | | x | | x | | | |
| <i>Macaranga sp</i> | Euphorbiaceae | | Tree | x | x | x | x | | x | x |
| <i>Mareya micrantha</i> | Euphorbiaceae | | Shrub | | x | | | | x | x |
| <i>Phyllanthus discoideus</i> | Euphorbiaceae | | Tree | | x | | | | | |
| <i>Uapaca guineensis</i> | Euphorbiaceae | | Tree | | x | x | x | | | |
| <i>Uapaca heudelotii</i> | Euphorbiaceae | | Tree | x | x | x | x | | | |
| <i>Tetrarchidium didymostemon</i> | Euphorbiaceae | | Tree | x | x | x | x | | | x |
| <i>Microdesmis puberula</i> | Euphorbiaceae | | Shrub | x | x | | | | | |
| <i>Maniophytum fulvum</i> | Euphorbiaceae | | Liana | x | x | x | x | x | x | x |
| <i>Drypetes chevalieri</i> | Euphorbiaceae | | Tree | x | | x | | | | |
| <i>Croton scarciesii</i> | Euphorbiaceae | | Herb | x | | | | | | |
| <i>Bambusa vulgaris</i> | Gramineae | | Grass | | x | | x | x | x | x |
| <i>Olyra latifolia</i> | Gramineae | | Grass | x | | | | | | |
| <i>Panicum laxium</i> | Gramineae | | Grass | x | | | | x | x | |
| <i>Panicum maximum</i> | Gramineae | | Grass | | | | | x | x | x |
| <i>Andropogon gabonensis</i> | Gramineae | | Grass | | | | | x | x | x |
| <i>Bambusa vulgaris</i> | Gramineae | | Grass | | x | | | x | | x |
| <i>Harungana madagascariensis</i> | Guttiferae | | Shrub | | x | | | x | | x |
| <i>Pentadesma butyracea</i> | Guttiferae | | Tree | x | x | x | | | | |
| <i>Vismia guineensis</i> | Guttiferae | | Shrub | | x | | | x | | x |
| <i>Garcinia afzelii</i> | Guttiferae | VU | Tree | x | x | x | x | | | |
| <i>Garcinia sp.</i> | Guttiferae | | Tree | x | x | x | | | | |
| <i>Anthocleista nobilis</i> | Gentianaceae | | Tree | x | x | x | | | | |
| <i>Anthocleista vogelii</i> | Gentianaceae | | Tree | | | | | x | | x |
| <i>Irvingia gabonensis</i> | Irvingiaceae | NT | Tree | x | x | x | | | | |
| <i>Klainedoxa gabonensis</i> | Irvingiaceae | | Tree | x | x | x | | | | |
| <i>Phyllacanthus africanus</i> | Ixonanthaceae | | Tree | x | x | | | x | x | x |
| <i>Napoleona heudelotii</i> | Lecythidaceae | | Shrub | | | x | | | | |
| <i>Strychnos afzelii</i> | Loganiaceae | | Liana | x | | x | | | | |
| <i>Strychnos densiflora</i> | Loganiaceae | | Liana | x | | x | | | | |
| <i>Hibiscus sterculiifolius</i> | Malvaceae | | Herb | | x | | | | | |
| <i>Sarcophrynium brachystachys</i> | Marantaceae | | Herb | x | x | | | x | x | x |
| <i>Thallia geniculata</i> | Marantaceae | | Herb | | x | | | | x | x |
| <i>Carapa procera</i> | Meliaceae | | Tree | x | x | x | | x | | |
| <i>Trichilia ornithothena</i> | Meliaceae | VU | Tree | x | x | x | | x | | |
| <i>Turraenthus africanum</i> | Meliaceae | VU | Tree | x | x | x | | | | |

| | | | | | | | | | | |
|-----------------------------------|----------------|----|-------|---|---|---|---|---|---|---|
| <i>Entandrophragma candollei</i> | Meliaceae | VU | Tree | | x | x | | | | |
| <i>Acacia pennata</i> | Mimosaceae | | Liana | | x | | | x | x | x |
| <i>Albizia adianthifolia</i> | Mimosaceae | | Tree | x | x | x | | x | x | x |
| <i>Albizia zygia</i> | Mimosaceae | | Tree | x | x | x | x | x | x | x |
| <i>Albizia ferruginea</i> | Mimosaceae | VU | Tree | | | x | | | | |
| <i>Cathornium altissimum</i> | Mimosaceae | | Tree | x | x | x | x | | | |
| <i>Cathornium rhombifolium</i> | Mimosaceae | | Tree | x | | x | x | | | |
| <i>Entada gigas</i> | Mimosaceae | | Liana | | x | | x | x | x | |
| <i>Parkia bicolor</i> | Mimosaceae | | Tree | x | x | x | | | | |
| <i>Pentaclethra macrophylla</i> | Mimosaceae | | Tree | x | x | x | x | x | x | x |
| <i>Piptadeniastrum africanum</i> | Mimosaceae | | Tree | x | x | x | | x | x | x |
| <i>Samanea dinklagei</i> | Mimosaceae | | Tree | x | x | x | x | x | x | x |
| <i>Newtonia aubrevillei</i> | Mimosaceae | | Tree | x | x | x | | | | |
| <i>Cylicodiscus gabonensis</i> | Mimosaceae | | Tree | x | | x | | | | |
| <i>Xylia evansii</i> | Mimosaceae | | Tree | x | | x | | | | |
| <i>Dichrostachys glomerata</i> | Mimosaceae | | Shrub | | x | | | x | x | x |
| <i>Calpocalyx brevibracteatus</i> | Mimosaceae | | Tree | | x | x | | | | |
| <i>Calpocalyx aubrevillei</i> | Mimosaceae | | Tree | x | | x | | | | |
| <i>Ficus exasperate</i> | Moraceae | | Tree | | x | | | x | x | x |
| <i>Ficus mucoso</i> | Moraceae | | Tree | x | x | x | | | | |
| <i>Ficus sp.</i> | Moraceae | | Tree | x | x | x | | | | x |
| <i>Milicia regia</i> | Moraceae | VU | Tree | x | x | x | x | | | |
| <i>Musanga cecropioides</i> | Moraceae | | Tree | x | x | x | x | x | x | x |
| <i>Myrianthus libericus</i> | Moraceae | | Tree | x | x | x | x | x | x | x |
| <i>Myrianthus serratus</i> | Moraceae | | Tree | x | x | x | x | x | x | x |
| <i>Myrianthus arboreus</i> | Moraceae | | Tree | x | x | x | x | x | x | |
| <i>Morus mesozygia</i> | Moraceae | | Tree | | x | | x | | | |
| <i>Antiaris africana</i> | Moraceae | | Tree | x | | x | | x | x | x |
| <i>Pycnanthus angolensis</i> | Myristicaceae | | Tree | x | x | x | x | | | |
| <i>Eugenia sp.</i> | Myrtaceae | | Shrub | | x | | | | | |
| <i>Ochna sp</i> | Ochnaceae | | Shrub | | | x | | | | |
| <i>Lophira alata</i> | Ochnaceae | VU | Tree | x | x | x | | | | |
| <i>Oratea flava</i> | Ochnaceae | | Shrub | x | x | x | x | | | |
| <i>Elaeis guineensis</i> | Palmae | | P | x | x | x | x | x | x | x |
| <i>Eremospatha macroparva</i> | Palmae | | P | x | x | x | | | | |
| <i>Raffia palma-pinus</i> | Palmae | | P | | x | x | x | | | |
| <i>Millettia thonningii</i> | Papilionaceae | | Tree | x | x | x | x | | | |
| <i>Millettia sp</i> | Papilionaceae | | Shrub | | | | | x | x | x |
| <i>Pterocarpus santalinoides</i> | Papilionaceae | | Tree | x | | x | x | | | |
| <i>Baphia nitida</i> | Papilionaceae | | Tree | x | x | x | x | | | |
| <i>Leptodarris miegei</i> | Papilionaceae | | Liana | | x | | x | | | |
| <i>Smeathmannia pubescens</i> | Passifloraceae | | Shrub | x | x | x | x | | | |
| <i>Carpolobia lutea</i> | Polygalaceae | | Shrub | x | x | x | x | | | |
| <i>Coffea arabica</i> | Rubiaceae | | Shrub | x | x | x | x | x | x | x |
| <i>Hallea stipulosa</i> | Rubiaceae | VU | Tree | | x | | x | x | x | x |
| <i>Nauclea diderrichii</i> | Rubiaceae | VU | Tree | x | | x | x | | | |
| <i>Nauclea latifolia</i> | Rubiaceae | | Shrub | | x | | | x | x | x |
| <i>Oxyanthus spinocoeus</i> | Rubiaceae | | Shrub | x | | x | x | | | |
| <i>Craterispermum laurinum</i> | Rubiaceae | | Shrub | | x | | | x | x | x |
| <i>Bertiara spicata</i> | Rubiaceae | | Shrub | x | x | x | x | | | |
| <i>Psychotria cornuta</i> | Rubiaceae | | Herb | x | x | x | x | | | |
| <i>Psychotria liberica</i> | Rubiaceae | | Herb | x | x | x | x | | | |
| <i>Psychotria sp</i> | Rubiaceae | | Herb | x | x | x | | | | |
| <i>Heinsia pulchelia</i> | Rubiaceae | | Shrub | x | | | | | | |
| <i>Morinda geminata</i> | Rubiaceae | | Tree | | x | | x | x | x | x |

| | | | | | | | | | | |
|----------------------------------|------------------|----|-------|---|---|---|---|---|---|---|
| <i>Morinda longiflora</i> | Rubiaceae | | Tree | x | | x | x | | | |
| <i>Ixora sp</i> | Rubiaceae | | Shrub | x | | | | | | |
| <i>Vangueriopsis discolor</i> | Rubiaceae | | Shrub | | x | | x | x | | |
| <i>Tarenna vignei</i> | Rubiaceae | | Tree | | | x | | | | |
| <i>Fagara sp.</i> | Rutaceae | | Tree | | | x | | | | |
| <i>Zanthoxylum atchoum</i> | Rutaceae | VU | Tree | x | x | x | x | | | |
| <i>Deinbollia gradifolia</i> | Sapindaceae | | Shrub | | x | | x | | x | |
| <i>Deinbollia cuneifolia</i> | Sapindaceae | | Shrub | | x | x | | x | | |
| <i>Placodiscus oblongifolius</i> | Sapindaceae | VU | Shrub | x | x | x | x | | x | |
| <i>Placodiscus sp</i> | Sapindaceae | | Shrub | x | x | x | x | | x | x |
| <i>Lecaniodiscus cupanioides</i> | Sapindaceae | | Tree | x | x | x | x | | | x |
| <i>Pancovia pedicellaris</i> | Sapindaceae | | Tree | | x | x | x | x | x | |
| <i>Allophylus africanus</i> | Sapindaceae | | Tree | x | x | x | x | | | x |
| <i>Blighia sapida</i> | Sapindaceae | | Tree | x | | x | x | | | |
| <i>Chrysophyllum pruniforme</i> | Sapotaceae | | Tree | x | | x | | | | |
| <i>Chrysophyllum perpulchrum</i> | Sapotaceae | | Tree | x | | x | x | | | |
| <i>Synsepalum afzelii</i> | Sapotaceae | | Tree | x | | x | x | | | |
| <i>Synsepalum brevipes</i> | Sapotaceae | | Tree | x | | x | x | | | |
| <i>Synsepalum sp</i> | Sapotaceae | | Tree | x | | x | x | | | |
| <i>Solanum sp</i> | Solanaceae | | Herb | | x | | | | x | x |
| <i>Cola lateritia</i> | Sterculiaceae | | Tree | x | | x | x | | | |
| <i>Cola nitida</i> | Sterculiaceae | | Tree | x | x | x | x | x | x | x |
| <i>Heritiera utilis</i> | Sterculiaceae | VU | Tree | x | | x | x | | | |
| <i>Sterculia tragacantha</i> | Sterculiaceae | | Tree | x | x | x | x | x | x | x |
| <i>Sterculia oblonga</i> | Sterculiaceae | VU | Tree | x | | x | x | | | |
| <i>Theobroma cacao</i> | Sterculiaceae | | Shrub | x | x | x | x | x | x | x |
| <i>Cyclosorus afer</i> | Thelypteridaceae | | Herb | | x | | | x | x | x |
| <i>Triumfeta tomentosa</i> | Tiliaceae | | Herb | | x | | | | x | |
| <i>Glypaea brevis</i> | Tiliaceae | | Shrub | | x | | | x | x | x |
| <i>Trema guineensis</i> | Ulmaceae | | Shrub | | x | | | x | x | x |
| <i>Vitex grandifolia</i> | Verbenaceae | | Tree | x | x | x | x | | | |
| <i>Vitex micrantha</i> | Verbenaceae | | Tree | | x | | | x | x | x |
| <i>Rinorea microdon</i> | Violaceae | | Herb | x | x | x | | | | |
| <i>Rinorea oblanceolata</i> | Violaceae | | Herb | x | x | x | | | | |
| <i>Rinorea sp</i> | Violaceae | | Herb | x | | | | | | |
| <i>Aframomum sp,</i> | Zingiberaceae | | Herb | x | | x | x | | | |
| <i>Costus afer</i> | Zingiberaceae | | Herb | | x | | | x | x | x |

APPENDIX B

Bird species recorded at survey sites, their families, IUCN status, Endemism, and Biome

(1 – Dam site; 2 – Access Road; 3 – Downstream; 4 – Upstream; 5 – Transmission Line 1; Transmission Line 2; Transmission Line 3; Rgn – Region; EBA – Endemic Bird Area)

| Family/species | English names | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Rgn | IUCN | EBA | Biome |
|----------------------------------|-----------------------------|---|---|---|---|---|---|---|-----|------|-----|-------|
| PODICIPEDIDAE | | | | | | | | | | | | |
| <i>Tachybaptus ruficollis</i> | Little Grebe | | | x | | | | | AM | | | |
| PHALACROCORACIDAE | | | | | | | | | | | | |
| <i>Phalacrocorax africanus</i> | Long-tailed Cormorant | | x | | x | | | | R | | | |
| ARDEIDAE | | | | | | | | | | | | |
| <i>Nycticorax nycticorax</i> | Black-crowned Night Heron | | | | | x | | | | | | |
| <i>Bubulcus ibis</i> | Cattle Egret | | | | | | x | | AM | | | |
| <i>Butorides striata</i> | Green-backed Heron | | | x | | | | | R | | | |
| SCOPIDAE | | | | | | | | | | | | |
| <i>Scopus umbretta</i> | Hamerkop | | x | | | | | | R | | | |
| CICONIIDAE | | | | | | | | | | | | |
| <i>Ciconia episcopus</i> | Woolly-necked Stork | x | | | | | | | R | | | |
| THRESKIORNITHIDAE | | | | | | | | | | | | |
| <i>Bostrychia hagedash</i> | Hadada Ibis | | | | | x | | | R | | | |
| ACCIPITRIDAE | | | | | | | | | | | | |
| <i>Milvus migrans</i> | Black Kite | | | | x | | | | AM | | | |
| <i>Gypohierax angolensis</i> | Palm-nut Vulture | | | | x | x | | | R | | | |
| <i>Necrosyrtes monachus</i> | Hooded Vulture | | | x | | x | | | R | EN | | |
| <i>Polyboroides typus</i> | African Harrier Hawk | x | | x | x | x | | | R | | | |
| <i>Urotriorchis macrourus</i> | Long-tailed Hawk | | | | x | | | | R | | | GC |
| <i>Buteo auguralis</i> | Red-necked Buzzard | | | | x | | x | | R | | | |
| <i>Stephanoaetus coronatus</i> | Crowned Eagle | | | x | | | | | R | | | |
| PHASIANIDAE | | | | | | | | | | | | |
| <i>Fringilla ahandensis</i> | Ahand Francolin | | | | x | | | | R | | | GC |
| <i>Fringilla bicalcaratus</i> | Double-spurred Francolin | x | | | | x | | | R | | | |
| RALLIDAE | | | | | | | | | | | | |
| <i>Sarothura pulchra</i> | White-spotted Flufftail | x | x | x | x | | | | R | | | GC |
| SCOLOPACIDAE | | | | | | | | | | | | |
| <i>Actitis hypoleucos</i> | Common Sandpiper | | x | | | | | | PM | | | |
| COLUMBIDAE | | | | | | | | | | | | |
| <i>Treron calvus</i> | African Green Pigeon | | | | x | | | | R | | | |
| <i>Turtur brehmeri</i> | Blue-headed Wood Dove | | x | | | | | | R | | | GC |
| <i>Turtur tympanistria</i> | Tambourine Dove | x | | | x | | | | R | | | |
| <i>Turtur afer</i> | Blue-spotted Wood Dove | | | x | | x | | | R | | | |
| <i>Streptopelia semitorquata</i> | Red-eyed Dove | | | | | x | | | R | | | |
| <i>Streptopelia vinacea</i> | Vinaceous Dove | | | x | | | | | R | | | |
| MUSOPHAGIDAE | | | | | | | | | | | | |
| <i>Corythaeola cristata</i> | Great Blue Turaco | x | x | | x | | | | R | | | |
| <i>Tauraco macrorhynchus</i> | Yellow-billed Turaco | | | | x | | | x | R | | | |
| <i>Tauraco persa</i> | Green Turaco | | | | x | | | x | R | | | GC |
| <i>Crinifer piscator</i> | Western Grey Plantain-eater | | | | | | | x | R | | | |
| CUCULIDAE | | | | | | | | | | | | |
| <i>Cuculus solitarius</i> | Red-chested Cuckoo | x | | | | | | | AM | | | |
| <i>Cuculus clamosus</i> | Black Cuckoo | x | | | | | | | AM | | | |
| <i>Cercococcyx mechowi</i> | Dusky Long-tailed Cuckoo | x | | | | | | | R | | | GC |
| <i>Cercococcyx olivinus</i> | Olive Long-tailed Cuckoo | x | | | x | | | | R | | | GC |
| <i>Chrysococcyx klaas</i> | Klaas's Cuckoo | x | | x | | x | | | AM | | | |
| <i>Chrysococcyx caprius</i> | Didric Cuckoo | | | x | | | | | AM | | | |
| <i>Ceuthmochares aereus</i> | Yellowbill | | | | | x | | | R | | | |
| <i>Centropus leucogaster</i> | Black-throated Coucal | | | | | x | | | R | | | GC |

| | | | | | | | | | | | | |
|------------------------------------|-----------------------------|---|---|---|---|---|---|---|----|----|-----|----|
| <i>Centropus senegalensis</i> | Senegal Coucal | x | | x | x | x | | | R | | | |
| STRIGIDAE | | | | | | | | | | | | |
| <i>Scotopelia peli</i> | Pel's Fishing Owl | | | | | x | | | | | | |
| <i>Strix woodfordii</i> | African Wood Owl | | | | | x | | | R | | | |
| CAPRIMULGIDAE | | | | | | | | | | | | |
| <i>Caprimulgus nigriscapularis</i> | Black-shouldered Nightjar | | | | | x | | | R | | | GC |
| <i>Caprimulgus inornatus</i> | Plain Nightjar | x | | | x | | | | R | | | |
| APODIDAE | | | | | | | | | | | | |
| <i>Rhaphidura sabini</i> | Sabine's Spinetail | | | | x | | | | R | | | GC |
| <i>Neafrapus cassini</i> | Cassin's Spinetail | | | | x | | | | R | | | GC |
| <i>Cypsiurus parvus</i> | African Palm Swift | | | | x | | | | R | | | |
| <i>Apus barbatus</i> | African Black Swift | x | | x | x | | | | R | | | |
| <i>Apus apus</i> | Common Swift | x | | | | | | | PM | | | |
| <i>Apus affinis</i> | Little Swift | x | | | | | | | R | | | |
| <i>Tachymarpis aequatorialis</i> | Mottled Swift | | | | x | | | | R | | | |
| ALCEDINIDAE | | | | | | | | | | | | |
| <i>Halcyon badia</i> | Chocolate-backed Kingfisher | x | x | | | | | | R | | | GC |
| <i>Halcyon leucocephala</i> | Grey-headed Kingfisher | | | | | x | | | AM | | | |
| <i>Halcyon malimbica</i> | Blue-breasted Kingfisher | x | x | x | x | x | x | | R | | | |
| <i>Halcyon senegalensis</i> | Woodland Kingfisher | | | | | x | | | R | | | |
| <i>Ceyx pictus</i> | African Pygmy Kingfisher | | | x | x | x | | | AM | | | |
| <i>Alcedo cristata</i> | Malachite Kingfisher | | | | x | | | | R | | | |
| <i>Alcedo quadribrachys</i> | Shining-blue Kingfisher | | | | x | | | | R | | | |
| <i>Megaceryle maxima</i> | Giant Kingfisher | | | | x | | | | R | | | |
| MEROPIDAE | | | | | | | | | | | | |
| <i>Merops gularis</i> | Black Bee-eater | | x | | x | | | | R | | | GC |
| <i>Merops albicollis</i> | White-throated Bee-eater | x | x | | | | | | AM | | | |
| CORACIIDAE | | | | | | | | | | | | |
| <i>Eurystomus gularis</i> | Blue-throated Roller | | | | x | | | | R | | | GC |
| <i>Eurystomus glaucurus</i> | Broad-billed Roller | | | x | x | | | | AM | | | |
| BUCEROTIDAE | | | | | | | | | | | | |
| <i>Tropicranus albocristatus</i> | White-crested Hornbill | x | | | | | | | R | | | GC |
| <i>Tockus fasciatus</i> | African Pied Hornbill | | x | x | | | x | | R | | | GC |
| <i>Bycanistes fistulator</i> | Piping Hornbill | | | | x | | | | R | | | GC |
| <i>Bycanistes subcylindricus</i> | Pied casqued Hornbill | | | | x | | | | R | | | GC |
| <i>Bycanistes cylindricus</i> | Brown-cheeked Hornbill | | | | x | | | | R | NT | UGF | GC |
| <i>Ceratogymna atrata</i> | Black-casqued Hornbill | | | | x | | | | R | | | GC |
| <i>Ceratogymna elata</i> | Yellow-casqued Hornbill | x | x | | x | | | | R | VU | | GC |
| CAPITONIDAE | | | | | | | | | | | | |
| <i>Gymnobucco calvus</i> | Naked-faced Barbet | x | | x | x | | x | | R | | | GC |
| <i>Pogoniulus scolopaceus</i> | Speckled Tinkerbird | | | | x | | | | R | | | GC |
| <i>Pogoniulus subsulphureus</i> | Yellow-throated Tinkerbird | | | x | x | x | x | | R | | | GC |
| <i>Pogoniulus bilineatus</i> | Yellow-rumped Tinkerbird | | | | | | x | | R | | | |
| <i>Buccanodon duchaillui</i> | Yellow-spotted Barbet | x | x | x | x | | | | R | | | GC |
| <i>Tricholaema hirsuta</i> | Hairy-breasted Barbet | x | | | x | | | | R | | | |
| INDICATORIDAE | | | | | | | | | | | | |
| <i>Melichneutes robustus</i> | Lyre-tailed Honeyguide | | x | | | | | | R | | | GC |
| <i>Indicator conirostris</i> | Thick-billed Honeyguide | | | | x | | | | R | | | |
| <i>Melignomon eisentrauti</i> | Yellow-footed Honeyguide | | x | | | | | | R | NT | UGF | GC |
| PICIDAE | | | | | | | | | | | | |
| <i>Campethera nivos</i> | Buff-spotted Woodpecker | | | | x | | x | x | R | | | GC |
| <i>Dendropicos gabonensis</i> | Gabon Woodpecker | x | | | x | | | | R | | | GC |
| <i>Dendropicos pyrrhogaster</i> | Fire-bellied Woodpecker | | | | | | x | | R | | | GC |
| <i>Dendropicos goertae</i> | Grey Woodpecker | | | | | | x | | R | | | |
| PITTIDAE | | | | | | | | | | | | |
| <i>Pitta angolensis</i> | African Pitta | x | | | | | | | AM | | | |
| HIRUNDINIDAE | | | | | | | | | | | | |
| <i>Psalidoprocne nitens</i> | Square-tailed Saw-wing | | x | x | x | | x | x | R | | | GC |

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|------------------------------------|--------------------------------|---|---|---|---|---|---|---|----|----|-----|----|
| <i>Psaldiprocne obscura</i> | Fanti Saw-wing | | | | x | | | x | R | | | GC |
| <i>Hirundo daurica</i> | Red-rumped Swallow | | | | x | x | | | AM | | | |
| <i>Hirundo preussi</i> | Preuss's Cliff Swallow | | | | x | x | x | x | R | | | |
| <i>Hirundo smithii</i> | Wire-tailed Swallow | | | | | x | | | R | | | |
| MOTACILLIDAE | | | | | | | | | | | | |
| <i>Motacilla aguimp</i> | African Pied Wagtail | | x | | | | | | R | | | |
| PYCNONOTIDAE | | | | | | | | | | | | |
| <i>Andropadus virens</i> | Little Greenbul | x | x | x | x | x | | x | R | | | |
| <i>Andropadus gracilis</i> | Little Grey Greenbul | | | | x | | | x | R | | | GC |
| <i>Andropadus ansorgei</i> | Ansorge's Greenbul | | | | x | | | | R | | | GC |
| <i>Andropadus gracilirostris</i> | Slender-billed Greenbul | x | x | x | x | x | | x | R | | | |
| <i>Andropadus latirostris</i> | Yellow-whiskered Greenbul | x | | | | | | x | R | | | |
| <i>Baeopogon indicator</i> | Honeyguide Greenbul | | | | x | | | x | R | | | GC |
| <i>Ixonotus guttatus</i> | Spotted Greenbul | | | | x | | | | R | | | GC |
| <i>Chlorocichla simplex</i> | Simple Leaflove | | | | | | x | | R | | | GC |
| <i>Thescelocichla leucopleura</i> | Swamp Palm Bulbul | x | x | | x | | | | R | | | GC |
| <i>Pyrhurus scandens</i> | Leaflove | | | | | | | x | x | R | | GC |
| <i>Phyllastrephus icterinus</i> | Icterine Greenbul | | | x | x | | | x | R | | | GC |
| <i>Bleda eximius</i> | Green-tailed Bristlebill | x | | | | | | | R | VU | UGF | GC |
| <i>Bleda canicapillus</i> | Grey-headed Bristlebill | x | x | | x | | | | R | | | GC |
| <i>Criniger barbatus</i> | Western Bearded Greenbul | | | | x | | | | R | | | GC |
| <i>Criniger calurus</i> | Red-tailed Greenbul | x | | x | x | | | | R | | | GC |
| <i>Pycnonotus barbatus</i> | Common Bulbul | x | | x | x | | | | R | | | |
| <i>Nicator chloris</i> | Western Nicator | | | | x | | | x | R | | | GC |
| TURDIDAE | | | | | | | | | | | | |
| <i>Stiphrornis erythrorhax</i> | Forest Robin | x | x | x | x | | | x | R | | | GC |
| <i>Cossypha polioptera</i> | Grey-winged Robin Chat | | x | x | | | | | R | | | |
| <i>Cossypha cyanocampter</i> | Blue-shouldered Robin Chat | x | | | | | | | R | | | |
| <i>Alethe diademata</i> | White-tailed Alethe | | | | x | | | | R | | | GC |
| <i>Alethe poliocephala</i> | Brown-chested Alethe | x | | | | | | | R | | | |
| <i>Neocossyphus poensis</i> | White-tailed Ant Thrush | | | | x | | | | R | | | GC |
| <i>Stizorhina finschi</i> | Finsch's Flycatcher Thrush | | x | | x | | | | R | | | GC |
| <i>Cercotrichas leucosticta</i> | Forest Scrub Robin | | | x | x | | | | R | | | |
| SYLVIIDAE | | | | | | | | | | | | |
| <i>Bathmocercus cerviniventris</i> | Black-headed Rufous Warbler | x | | x | x | | | | R | NT | UGF | GC |
| <i>Melocichla mentalis</i> | African Moustached Warbler | x | | | x | | | | R | | | |
| <i>Hippolais polyglotta</i> | Melodious Warbler | | | | x | | | | PM | | | |
| <i>Cisticola lateralis</i> | Whistling Cisticola | | x | x | x | | | x | R | | | |
| <i>Cisticola anonymus</i> | Chattering Cisticola | | | | | | | | | | | |
| <i>Cisticola brachypterus</i> | Short-winged Cisticola | | | | | x | | | R | | | |
| <i>Prinia subflava</i> | Tawny-flanked Prinia | | | | x | x | | x | R | | | |
| <i>Apalis nigriceps</i> | Black-capped Apalis | | | | x | | | | R | | | GC |
| <i>Apalis sharpii</i> | Sharpe's Apalis | x | | x | x | | | x | x | R | UGF | GC |
| <i>Camaroptera brachyura</i> | Grey-backed Camaroptera | x | | x | x | x | x | x | R | | | |
| <i>Camaroptera superciliaris</i> | Yellow-browed Camaroptera | | | x | x | x | | | R | | | GC |
| <i>Camaroptera chloronota</i> | Olive-green Camaroptera | x | x | x | x | x | x | x | R | | | GC |
| <i>Macrosphenus concolor</i> | Grey Longbill | x | | x | x | x | x | x | R | | | GC |
| <i>Eremomela badiceps</i> | Rufous-crowned Erememela | | x | | x | x | | x | R | | | GC |
| <i>Sylvietta virens</i> | Green Crombec | x | x | x | x | x | x | x | R | | | GC |
| <i>Sylvietta denti</i> | Lemon-bellied Crombec | x | | x | x | x | | x | R | | | GC |
| <i>Hylia prasina</i> | Green Hylia | x | x | x | x | x | x | x | R | | | GC |
| MUSCICAPIDAE | | | | | | | | | | | | |
| <i>Muscicapa cassini</i> | Cassin's Flycatcher | | x | x | x | | | | R | | | GC |
| <i>Muscicapa epulata</i> | Little Grey Flycatcher | | | | x | | | x | R | | | GC |
| MONARCHIDAE | | | | | | | | | | | | |
| <i>Muscicapa olivascens</i> | Olivaceous Flycatcher | | | | x | | | | | | | |
| <i>Trochocercus nitens</i> | Blue-headed Crested Flycatcher | x | | | | | | | R | | | GC |
| <i>Terpsiphone viridis</i> | African Paradise Flycatcher | | | | x | x | | | R | | | |

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|--------------------------------|---------------------------------|---|---|---|---|---|---|---|---|--|--|----|
| <i>Terpsiphone rufiventer</i> | Red-bellied Paradise Flycatcher | x | x | x | x | x | x | x | R | | | GC |
| PLATYSTEIRIDAE | | | | | | | | | | | | |
| <i>Bias musicus</i> | Black-and-white Flycatcher | | | | x | x | x | | R | | | |
| <i>Dyaphorophya castanea</i> | Chestnut Wattle-eye | x | x | x | x | | | | R | | | GC |
| <i>Dyaphorophya blissetti</i> | Red-cheeked Wattle-eye | | | | x | | | x | R | | | GC |
| <i>Platysteira cyanea</i> | Common Wattle-eye | | | | | x | | | R | | | |
| TIMALIIDAE | | | | | | | | | | | | |
| <i>Illadopsis rufipennis</i> | Pale-breasted Illadopsis | x | | | x | | x | | R | | | |
| <i>Illadopsis fulvescens</i> | Brown Illadopsis | x | x | | x | | | | R | | | GC |
| <i>Illadopsis cleaveri</i> | Blackcap Illadopsis | x | | | x | | | | R | | | GC |
| <i>Phyllanthus atripennis</i> | Capuchin Babbler | x | | | | | | | R | | | GC |
| PARIDAE | | | | | | | | | | | | |
| <i>Parus funereus</i> | Dusky Tit | | | | x | | | | R | | | GC |
| NECTARINIIDAE | | | | | | | | | | | | |
| <i>Deleornis fraseri</i> | Fraser's Sunbird | | | x | x | x | x | | R | | | GC |
| <i>Cyanomitra cyanolaema</i> | Blue-throated Brown Sunbird | | | x | x | | | | R | | | GC |
| <i>Cyanomitra olivacea</i> | Olive Sunbird | x | x | x | x | x | x | x | R | | | |
| <i>Hedydipna collaris</i> | Collared Sunbird | x | | | x | | x | x | R | | | |
| <i>Cinnyris chloropygius</i> | Olive-bellied Sunbird | x | | | x | | x | | R | | | |
| <i>Cinnyris venustus</i> | Variable Sunbird | x | x | | x | | | x | R | | | |
| <i>Cinnyris johannae</i> | Johanna's Sunbird | x | x | | x | | | x | R | | | GC |
| <i>Cinnyris superbus</i> | Superb Sunbird | | | x | | | | x | R | | | GC |
| <i>Cinnyris superbus</i> | Superb Sunbird | x | | | x | | | | R | | | |
| ZOSTEROPIDAE | | | | | | | | | | | | |
| <i>Zosterops senegalensis</i> | Yellow White-eye | | | | x | x | | | R | | | |
| MALACONOTIDAE | | | | | | | | | | | | |
| <i>Malaconotus multicolor</i> | Many-coloured Bush-shrike | x | | x | | | | | R | | | |
| <i>Laniarius leucorhynchus</i> | Sooty Boubou | | | | x | | | | R | | | GC |
| ORIOLIDAE | | | | | | | | | | | | |
| <i>Oriolus nigripennis</i> | Black-winged Oriole | | | | x | | x | | R | | | GC |
| <i>Oriolus brachyrhynchus</i> | Western Black-headed Oriole | x | x | x | x | | | | R | | | GC |
| DICRURIDAE | | | | | | | | | | | | |
| <i>Dicrurus ludwigi</i> | Square-tailed Drongo | x | | | x | | x | | R | | | |
| <i>Dicrurus atripennis</i> | Shining Drongo | | | | | | x | | R | | | GC |
| <i>Dicrurus modestus</i> | Velvet-mantled Drongo | x | | x | x | | x | | R | | | |
| CORVIDAE | | | | | | | | | | | | |
| <i>Corvus albus</i> | Pied Crow | x | | | x | | | | R | | | |
| PASSERIDAE | | | | | | | | | | | | |
| <i>Passer griseus</i> | Norther Grey-headed Sparrow | | | | | | | x | | | | |
| PLOCEIDAE | | | | | | | | | | | | |
| <i>Malimbus scutatus</i> | Red-vented Malimbe | x | x | x | x | x | x | x | R | | | GC |
| <i>Malimbus nitens</i> | Blue-billed Malimbe | x | | | x | | | | R | | | GC |
| <i>Malimbus rubicollis</i> | Red-headed Malimbe | | | | x | | | | R | | | GC |
| <i>Ploceus nigerrimus</i> | Vieillot's Black Weaver | | | | x | | | | R | | | GC |
| <i>Ploceus cucullatus</i> | Village Weaver | x | | | x | x | | | R | | | |
| ESTRILDIDAE | | | | | | | | | | | | |
| <i>Nigrita canicapillus</i> | Grey-headed Negrofinch | x | x | x | x | x | x | x | R | | | |
| <i>Nigrita bicolor</i> | Chestnut-breasted Negrofinch | | x | | x | | | | R | | | GC |
| <i>Estrilda melpoda</i> | Orange-cheeked Waxbill | | | | | x | | | R | | | |
| <i>Spermophaga haematina</i> | Western Bluebill | | | | x | | | | R | | | GC |
| <i>Lagonosticta senegala</i> | Red-billed Firefinch | | | x | | | | | R | | | |
| <i>Spermestes cucullatus</i> | Bronze Mannikin | | | x | x | x | | | R | | | |

APPENDIX C

Checklist of Freshwater Fishes of St. Paul and St. John Rivers in Liberia

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|---|---|--|
| <p>Polypteridae - (Bichirs) Polypterus palmas buettikoferi (Steindachner, 1891)</p> <p>Clupeidae Pellonula leonensis (Boulenger, 1916)</p> <p>Momyridae Mormyrus tapirus (Pappenheim, 1905) Mormyrus goheeni(Fowler, 1919) Isichthys henryi (Gill, 1863) Marcusenius thomasi (Boulenger, 1916) Gnathonemus thomasi Boulenger, 1916 Marcusenius ussheri (Günther, 1867) Mormyrus ussheri Günther, 1867 Brienomyrus brachyistius (Gill, 1863) Mormyrus liberiensis (Steindachner, 1894) Mormyrops breviceps (Steindachner, 1895) Mormyrops elongatus (Norman, 1935) Mormyrops bougouribaensis (Roman , 1966) Mormyrops anguilloides (Linnaeus, 1758) Mormyrops anguilloides voltae (Roman, 1966) Hippopotamyrus paugyi (Lévêque & Bigorne, 1985) Petrocephalus pellegrini (Poll, 1941) Petrocephalus simus (partim) non Sauvage, 1879</p> <p>Mochokidae - (Squeakers or upside-down catfishes) Chiloglanis occidentalis (Pellegrin, 1933) Chiloglanis niloticus waterloti (Daget, 1954) Microsynodontis polli (Lambert, 1958)</p> | <p>Notopteridae - (Featherbacks or knifefishes) Papyrocranus afer (Günther, 1868) Notopterus afer (Günther, 1868)</p> <p>Hepsetidae - (African pike) Hepsetus odoe (Bloch, 1794) Sarcodaces odoe(Günther, 1864)</p> <p>Alestiidae - (African tetras) Hydrocynus forskahlii (Cuvier, 1819) Brycinus longipinnis (Günther, 1864) Alestes longipinnis(Hubrecht, 1881) Alestes chaperi (Sauvage, 1882) Bryconalestes longipinnis longipinnis (Hoedeman, 1951) Brycinus longipinnis (bagbeensis Géry & Mahnert, 1977) Brycinus nurse (Rüppell, 1832) Alestes nurse (Müller & Troschel, 1845) Brycinus macrolepidotus (Valenciennes, 1849)</p> <p>Poeciliidae - (Poeciliids) Aplocheilichthys spilauchen (Duméril, 1861) Aplocheilichthys typus (Bleeker, 1863) Poecilia bensonii (Peters, 1864) Aplocheilichthys tschiloangensis (Ahl, 1928) Poropanchax normani (Ahl, 1928) Aplocheilichthys normani (Ahl, 1928) Aplocheilichthys gambiensis(Svensson, 1933) Micropanchax macrurus manni(Schultz, 1942)</p> | <p>Cyprinidae - (Minnows or carps) Raiamas steindachneri (Pellegrin, 1908) Barilius silex (Schultz, 1942) Varicorhinus wurtzi (Pellegrin, 1908) Barbus barryi(Daget, 1962) Barbus holasi (Daget, 1964) Barbus carcharhinoides (Stiassny, 1991) Barbus huguenyi (Bigorne & Lévêque, 1993) Barbus aliciae (Bigorne & Lévêque, 1993) Barbus macrops (Boulenger, 1911) Barbus francisci (Boulenger, 1916) Barbus weidholtzi (Holly, 1928) Barbus gambiensis (Svensson, 1933) Mannichthys lucilae (Schultz, 1942) Barbus deserti (non Pellegrin, 1909) Barbus ablabes (Bleeker, 1863)</p> <p>Claroteidae - (Bagrid catfishes) Chrysichthys auratus auratus (Geoffroy St-Hilaire, 1808) Chrysichthys macrops (Günther, 1864) Chrysichthys rueppelli (Boulenger, 1907) Chrysichthys filamentosus(Boulenger, 1912) Chrysichthys longifilis (Pfaff, 1933) Chrysichthys maurus (Valenciennes, 1839) Chrysichthys johnelsi Daget, 1959 Chrysichthys nigrodigitatus (Lacépède, 1803)</p> <p>Cichlidae - (Cichlids) Tylochromis jentinki (Steindachner, 1895) Pelmatochromis jentinki (Regan, 1920) Anomalochromis thomasi (Boulenger, 1915) Paratilapia thomasi (Boulenger, 1915) Pelmatochromis thomasi (Boulenger, 1915) Haplochromis thomasi (Boulenger, 1915) Hemichromis thomasi (Boulenger, 1915) Pelvicachromis humilis (Boulenger, 1916) Pelmatochromis humilis (Boulenger, 1916)</p> |
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| <p>Synodontis waterloti (Daget, 1962)</p> <p>Aplocheilidae - (Killifishes, Mosquito fish) 1.</p> <p>Epiplatys dageti dageti(Poll, 1953)</p> <p>Epiplatys sexfasciatus(Gill, 1862)</p> <p>Epiplatys olbrechtsi olbrechtsi (Poll, 1941)</p> <p>Epiplatys ruhkopfi (Berkenkamp & Etzel, 1980)</p> <p>Epiplatys fasciolatus fasciolatus (Günther, 1866)</p> <p>Epiplatys dorsalis (Mayer, 1936)</p> <p>Epiplatys sexfasciatus leonensis(Ahl, 1937)</p> <p>Epiplatys matlocki (Fowler, 1950)</p> <p>Epiplatys fasciolatus totoaensis (Romand, 1978)</p> <p>Epiplatys fasciolatus huwaldi (Berkenkamp & Etzel, 1978)</p> <p>Epiplatys lamottei(Daget, 1954)</p> <p>Callopanchax monroviae (Roloff & Ladiges, 1972)</p> <p>Roloffia monroviae (Roloff & Ladiges, 1972)</p> <p>Callopanchax occidentalis (Clausen, 1966)</p> <p>Scriptaphyosemion bertholdi (Roloff, 1965)</p> <p>Scriptaphyosemion brueningi (Roloff, 1971)</p> <p>Scriptaphyosemion liberiense (Boulenger, 1908)</p> | <p>Rhexipanchax nimbaensis (Daget, 1948)</p> <p>Haplochilichthys nimbaensis (Daget, 1948)</p> <p>Rhexipanchax schioetzi (Scheel, 1968)</p> <p>Aplocheilichthys monikae (Berkenkamp & Etzel, 1976)</p> <p>Aplocheilichthys terofali (Berkenkamp & Etzel, 1981)</p> <p>Latidae - (Lates perches)</p> <p>Lates niloticus (Linnaeus, 1758)</p> <p>Lates albertianus (Worthington, 1929)</p> <p>Amphilidae - (Loach catfishes)</p> <p>Amphilius platychir marmoratus (Günther, 1864)</p> <p>Pimelodus platychir(Günther, 1864)</p> <p>Amphilius grammatorphus (Pellegrin, 1913)</p> <p>Amphilius grammatorphus marmoratus(Daget, 1963)</p> <p>Amphilius atesuensis (Boulenger, 1904)</p> <p>Amphilius pictus (Nichols & La Monte, 1933)</p> <p>Doumea chappuisi (Pellegrin, 1933)</p> | <p>Hemichromis guntheri (Sauvage, 1882)</p> <p>Hemichromis voltae (Steindachner, 1887)</p> <p>Hemichromis tersquamatus (Günther, 1899)</p> <p>Pelmatochromis pellegrini (Boulenger, 1902)</p> <p>Pelmatochromis buettikoferi (Steindachner, 1895)</p> <p>Hemichromis « green » group = H. fasciatus (Peters, 1852)</p> <p>Hemichromis elongatus (Guichenot, 1861)</p> <p>Hemichromis « red » group = H. bimaculatus (Gill, 1862)</p> <p>Hemichromis guttatus(Günther, 1862)</p> <p>Hemichromis arasogaster (Boulenger, 1899)</p> <p>Hemichromis fugax (Payne & Trewavas, 1976)</p> <p>Hemichromis cristatus (Loiselle, 1979)</p> <p>Hemichromis paynei (Loiselle, 1979)</p> <p>Tilapia brevipinnatus (Boulenger, 1911)</p> <p>Tilapia sauvagei (Fowler, 1919)</p> <p>Tilapia buttkoferi (Hubrecht, 1881)</p> <p>Tilapia walteri (Thys van den Audenaerde, 1968)</p> <p>Tilapia zillii (Gervais, 1848)</p> <p>Tilapia guineensis (Bleeker in Günther, 1862)</p> <p>Oreochromis niloticus niloticus (Linnaeus, 1758)</p> <p>Sarotherodon caudomarginatus (Boulenger, 1916)</p> <p>Sarotherodon occidentalis (Daget, 1962)</p> |
|---|--|--|

(Cited in Fermon and Gsegner,2006)

APPENDIX D

Annex 1: Perception of Fishers/local communities on fish species occurring in Kaiha River and catch statistics.

| Species | Local Name | Mbaloma | | Mbolatahun Irrigation Dam | | Comments |
|--|-----------------|------------------|------------|---------------------------|-------|---|
| | | Rainy Season | Dry Season | Dries | Rains | |
| <i>Polypteruspalmas buettikoferi</i> | Loma | Yes | Yes | yes | yes | |
| <i>Isichthys henryi</i> | Ndabungi | Yes – Mostly | Yes | yes | yes | Abundant at night |
| <i>Marcusenius thomasi</i> | Mbowatan gi | Yes – Abundantly | | yes | yes | |
| <i>Mormyrops anguilloides</i> | Vugbai | Yes – Abundantly | | yes | yes | |
| <i>Petrocephalus pellegrini</i> | | Yes | Yes | yes | yes | Found abundantly in all seasons |
| <i>Hydrocynus forskahlii</i> | Fornai | Yes | | | | |
| <i>Brycinus longipinnis</i> | Garhong | Yes | Yes | yes | yes | Jumps up and down in water(Agric. Dam)) |
| <i>Brycinus nurse</i> | Pellee | Yes – Abundantly | | yes | yes | |
| <i>Brycinus macrolepidotus</i> | Polee | Yes | Yes | yes | yes | |
| <i>Micralestes occidentalis</i> | Lalangi | Yes | | | | |
| <i>Neolebias unifasciatus</i> | Gongi | Yes – Mostly | Yes | | | |
| <i>Raiamas steindachneri</i> | Mbolai | Yes | Yes | | | Found mostly in small creeks |
| <i>Barbus carcharhinoides</i> | Kolainea | Yes | Yes | | | Can get big |
| <i>Barbus eburneensis</i> | Bolohun | Yes | Yes | | | Found a lot at the waterfall Can jump up the waterfall in rainy season |
| <i>Chrysichthys maurus</i> | | Yes | | yes | yes | |
| <i>Chrysichthys nigrodigitatus</i> | Lowowoi | Yes | Yes | | | |
| <i>Doumea chappuisi</i> | Kpalanyen | Yes | | | | |
| <i>Heterobranchus longifilis</i> | Ndabai | Yes | Yes | | | Big Quantities in rainy season Found a lot at the waterfall |
| <i>Clarias salae</i> | Salangi | Yes | Yes | | | Found a lot in small creeks |
| <i>Rhexipanchax nimbaensis</i> | Ngoi | Yes | | | | Found in sandy areas |
| <i>Tylochromis jentinki</i> | Geletei | Yes | | | | |
| <i>Anomalochromis thomasi</i> | Family Planning | Yes – Abundantly | | yes | yes | |
| <i>Chromidotilapia guntheri guntheri</i> | Kpalai | Yes | | yes | yes | |
| <i>Hemichromis« green » group = H. fasciatus</i> | | Yes | | yes | yes | |

| | | | | | | |
|--|--|-----|--|-----|-----|---|
| <i>Hemichromis</i> « red » group = <i>H. bimaculatus</i> | | Yes | | | | Found in small creeks a lot |
| <i>Tilapia brevimanus</i> | | Yes | | yes | yes | |
| <i>Sarotherodon caudomarginatus</i> | | Yes | | yes | yes | |
| <i>Sarotherodon occidentalis</i> | | | | yes | yes | |
| <i>Labeo Currei</i> | | | | yes | yes | Move up against fall at Agric. Dam site |
| <i>Tilapia buettikoferi</i> | | | | yes | yes | |
| <i>Oreochromis niloticus</i> | | | | yes | yes | |
| <i>Ctenopoma kingslayae</i> | | | | yes | yes | Found in tributaries/small streams (Mbolatahun) |