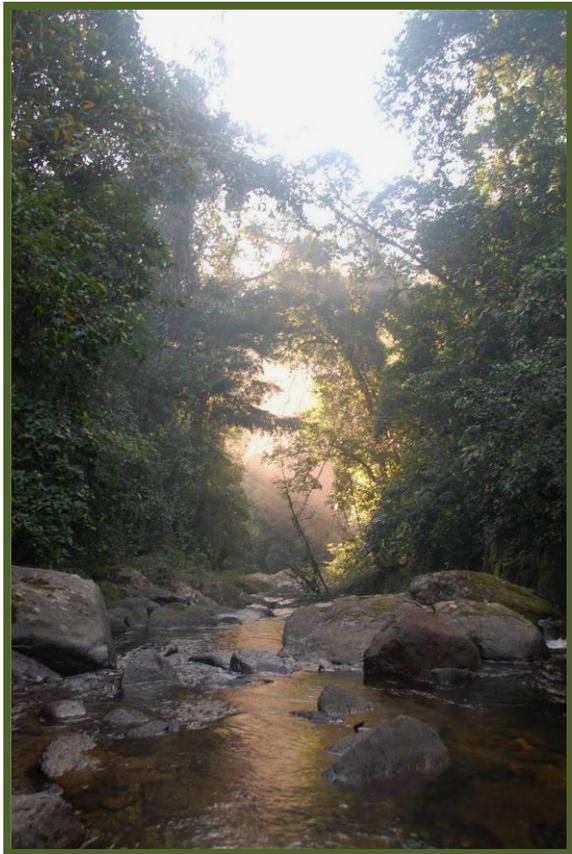


**Rapid Ecological Assessment of Central River
Bladen Nature Reserve & Columbia River Forest Reserve
Toledo District, Belize
February 2010**



Supported by:



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The coordinating agency for this Rapid Ecological Assessment was the Ya'axché Conservation Trust¹, working in partnership with Wildtracks², the University of Southern Mississippi³, Critical Ecosystem Partnership Fund and Friends for Conservation and Development.

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A special mention must be made of the Columbia River Forest Reserve and Bladen Nature Reserve's buffer communities who have been very supportive of the work that the authors and their respective organisations are trying to achieve in safeguarding the natural resources of the area for current and future generations of local people. In particular, the various team members that hailed from San Pedro Columbia, San Miguel, Golden Stream, Indian Creek and San Jose, not only worked tirelessly to accomplish the field work within the projects narrow timeframe but enhanced the Assessment's success through their wealth of knowledge about the local area.

Executive Summary

This report documents the results of a Rapid Ecological Assessment of the fish assemblages, herpetofauna and avifauna of Central River in the Bladen Nature Reserve and Columbia River Forest Reserve. The assessment will provide an overview of the biodiversity of this Maya Mountain riparian and riverine corridor and will establish a partial baseline for any future assessment of the environmental and social impacts associated with the construction and operation of a hydroelectric facility on Central River.

Central River lies within Belize's Maya Mountain Massif, a biodiversity-rich landscape of fourteen contiguous protected areas that supports at least thirty-seven globally threatened species. Four of these species are considered 'Critically Endangered' and thirteen classified as 'Endangered' by IUCN (2008). To date, eighteen endemic species have been identified in the rich matrix of ecosystems (Walker *et al*, 2008).

The initial findings of the Rapid Ecological Assessment indicate very high amphibian and reptile species richness for the Central River corridor which is likely to support over a hundred herptile species, including critically endangered, endangered and endemic amphibians. Additionally, it is quite likely that Belize's other critically endangered terrestrial vertebrate – the Coffeus Rain Frog will occur here too. A low diversity of fish species was recorded during the assessment, but this might be a consequence of the relatively high altitude or the geographic isolation caused by the unique limestone geology of the Maya Mountain Massif. Even with the low diversity of fish species there are many other ecological processes that depend on the conservation of the natural flow of the river. Countless species of fauna and microorganisms as well as downstream communities currently benefitting from the provision of environmental services are dependent on the well-being of Central River's high-quality water supply.

Currently it is difficult to assess any potential effect of the proposed hydroelectric facility on the ecosystem, flow regime and downstream environmental services of the Central River watershed without having any specific siting and design detail of the development (i.e. engineering information of any impoundment measures). However, the findings of this Rapid Ecological Assessment do reinforce the acknowledgement of Central River's unique ecosystem and rich biodiversity status within Belize.

The report concludes with recommendations of immediate follow-up actions, further complimentary research work and suggested management activities for Central River area, to be included in the management plan of Bladen Nature Reserve.

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Acronyms

BHD	Belize Hydroelectricity Development and Management Company Ltd
BNR	Bladen Nature Reserve
CPZ	Core Preservation Zone
CR	Critically Endangered Species
CRFR	Columbia River Forest Reserve
EN	Endangered Species
IUCN	International Union for the Conservation of Nature
MMM	Maya Mountain Massif
REA	Rapid Ecological Assessment

Introduction

This Report

This report documents the results of a Rapid Ecological Assessment (REA) of the fish assemblages, herpetofauna and avifauna of Central River in Bladen Nature Reserve (BNR). The REA will provide an overview of the biodiversity of this riparian corridor and will establish a partial baseline for any future assessment of environmental and social impacts of a proposed hydroelectric facility on Central River.

The upper reaches of Central River lie in the heart of the most biologically diverse area of Belize (Meerman, 2007), forming the western boundary of BNR from the Columbia River Forest Reserve (CRFR). The upper reaches drain both Little Quartz Ridge and the Main Divide of the Maya Mountain Massif (MMM).

The Study Area

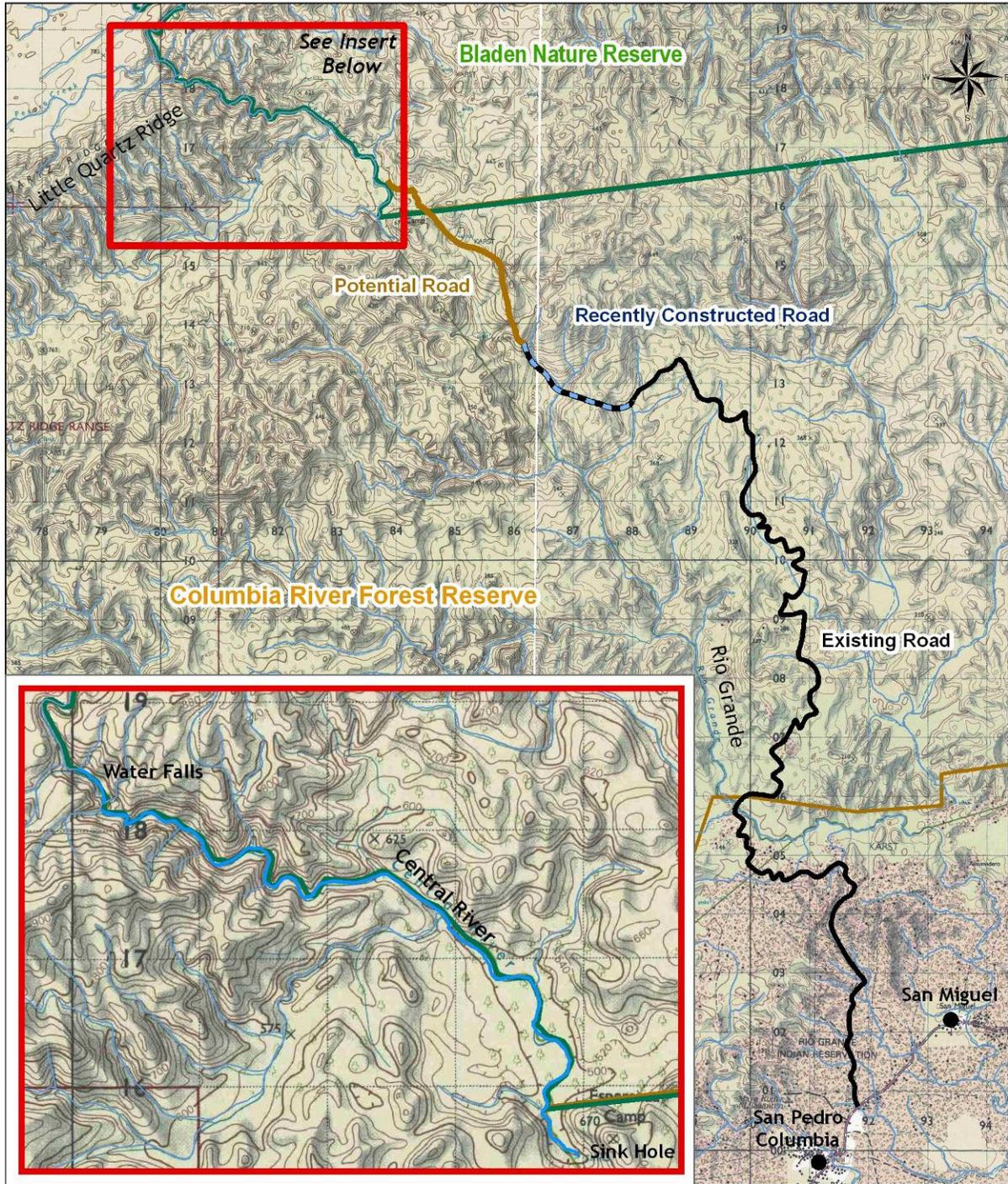
The REA was undertaken in the Central River watershed located in Toledo District's Bladen Nature Reserve and the Columbia River Forest Reserves. The study area is limited in the north by the upper reaches of Central River that flow through a system of waterfalls and cascades (UTM NAD27 E283754 N1815535). The southern limit is a sink hole where the river plunges into a limestone cave system (UTM E279956 N1818480) and is believed to re-emerge to join the Rio Grande in the lower foothills. Rio Grande empties into the Port Honduras Marine Reserve which is located approximately 30 miles to the west of the southern Belize Barrier Reef System. The river flows through pristine forest for several kilometres between its upper reaches and the southern sink hole (see Figure 1).

Development Activities to Date

In July 2009 the Belize Hydroelectric Development and Management Company Limited (BHD) illegally entered both the CRFR and BNR in order to conduct feasibility studies for a hydroelectric facility on Central River; an area of core conservation within the MMM and the National Protected Area System of Belize. After bulldozing access roads and clearing helipad and camping areas the BHD team was removed from the Reserves.

However, in October of 2009, BHD was granted a research permit from the Belize Forest Department and restarted work, again violating the law by breaching the terms and conditions of their permit. The research permit is intended to allow ecological research, not development feasibility studies.

Figure 1 REA Study Area within the Rio Grande Watershed



REA Study Area

Legend

- Settlements
- Rivers
- Potential Road
- Recently Constructed Road
- Existing Road
- ▭ Study Area
- ▭ Bladen Nature Reserve
- ▭ Columbia River Forest Reserve



0 0.5 1 2 3 4
Kilometers
Projected Coordinate System: D:\NAO_1927_UTM_Zone_18N
Projection: D:\Transvoro's_Mercator
False_Easting: 500000.00000000
False_Northing: 0.00000000
Central_Meridian: -87.00000000
Scale_Factor: 0.99960000
Latitude_Of_Origin: 0.00000000
Linear Unit: Meter



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Topographical & Geological Overview

The geology of the region is highly complex but consists predominantly of limestone and associated karst features. A unique feature of the CRFR is Little Quartz Ridge, an isolated mountainous ridge that extends a distance of approximately fifteen kilometres, trending northeast to the banks of Central River and lying near the northern limit of the karst foothills (Holland in Meerman & Masola, 2007).

Watercourses formed in the high elevations (>1000 meters) of Little Quartz Ridge and the Maya Mountains flow into the surrounding carbonates 300 meters below, penetrating a few kilometres before disappearing in the karst (Holland in Meerman & Masola, 2007).

The meandering stretch of Central River providing the focus for this REA flows from the approximate elevation of 700m to 500m (above sea level) over 6km and then disappears into a subterranean fluvial system where it is believed to flow for almost 8km before re-emerging within the Rio Grande to the southeast. This geographical isolation from the lower reaches of the watershed might be a key factor in promoting a unique ecosystem for genetically distinct species of fish or amphibians.

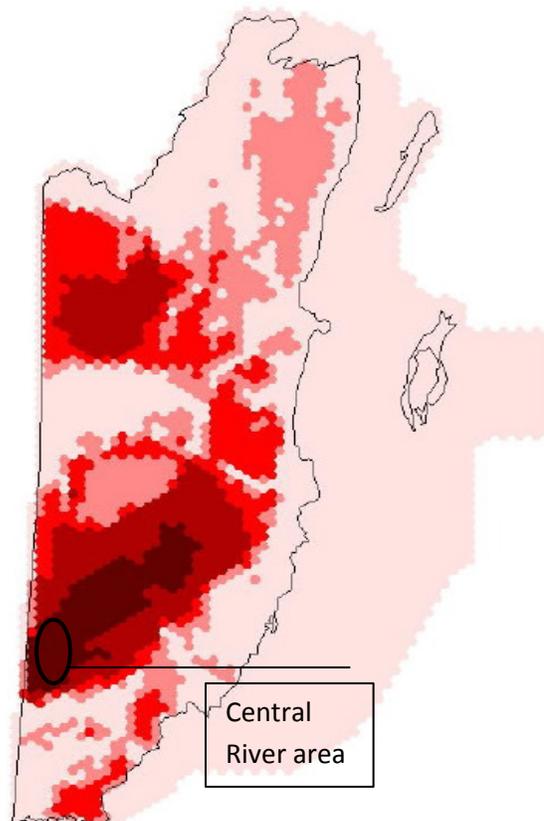
Figure 2. Key biodiversity areas (Meerman, 2007)

Ecosystem & Biodiversity Overview

In 2007, the Critical Ecosystem Partnership Fund sponsored Jan Meerman to identify Key Biodiversity Areas within Belize. A Marxan analysis of predicted ranges of Critically Endangered (CR) or Endangered (EN) species was conducted and the areas that are likely to hold the highest richness of these species were determined.

Figure 2 demonstrates the results of using only species listed as CR or EN on the IUCN Redlist where the greatest richness of these endangered species are indicated by the darkest colours.

From this analysis, it can clearly be seen that the high elevation areas of the Maya Mountains, including the Central River area, have the highest concentration of endangered species in Belize.



A Technical Assessment of the Maya Mountains and its biodiversity, cultural heritage, threats, opportunities, socio-economic and management capacity was conducted by Walker *et al* in 2008 and has since been endorsed by the Belize Forest Department (H. St-Luce, Per. Comm.). This study noted that:

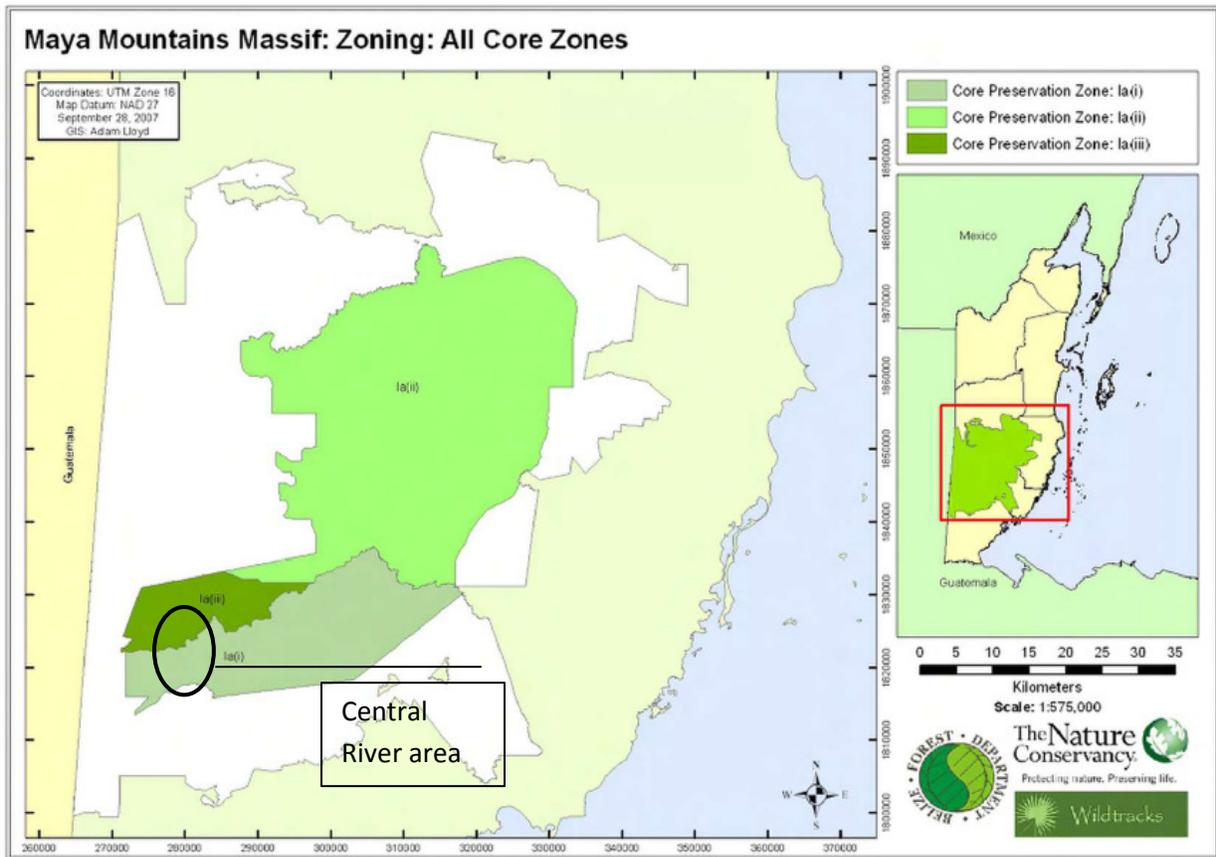
- current ecosystem mapping of the vegetation in the MMM indicates a complex mosaic of 44 tropical broadleaf, pine forest and aquatic ecosystems under the UNESCO system of classification and that nationally, thirteen of these ecosystems are found only within the MMM;
- the MMM is regionally important in its role of maintaining viable populations of at least 30 species of international concern (rated as Critically Endangered, Endangered or Vulnerable under the IUCN, 2007); and that
- the species diversity of the Maya Mountains may be significantly higher than has been presumed to date.

The Technical Assessment of the Maya Mountains (Walker *et al*, 2008) developed system level management zones based upon factors such as watershed protection and functionality, biodiversity and cultural values, accessibility, and threat distribution. The importance of the ecosystem and biodiversity assets of the Central River area are highlighted through this zonation, with the area straddling two of the Core Preservation Zones (CPZ) as illustrated in

Figure 3:

- Strict CPZ (i) – areas recommended for restricted use in core biodiversity and cultural resource protection, with critical management activities (including prioritized surveillance and enforcement) and research; and
- CPZ (iii) – areas recommended for restricted use open to management activities, researchers, with enhanced surveillance and enforcement activities.

Figure 3 Maya Mountain Massif Zoning: All Core Preservation Zones (Wildtracks, 2008)



A report commissioned by Ya'axché (Meerman, 2006) details the history of research within the Columbia River Forest Reserve and to some extent the Bladen Nature Reserve. Most notably of these were the: 1987 rapid assessment conducted through an expedition to Doyle's Delight (Matola, 1989), followed by a rapid ecological assessment in 1991 (Matola, 1991); a detailed multi-disciplinary assessment of the biodiversity conducted in 1992 under the Conservation International Rapid Assessment Program (Parker et. al, 1993): followed by another multi-disciplinary expedition to the Little Quartz Ridge area in 1997 (Meerman et. al., 2003). For amphibians, Hillis and de Sá (1988) conducted studies in the southwest end of little quartz ridge whilst Meyer (1993) worked primarily on the central southern portion and in the lands south and east of CRFR.

Studies conducted on fish assemblages throughout Belize particularly by Greensfield and Thomerson (1997) and more recently by Esselman et al. (2006) have tended not to sample the waterways within the core biodiversity zone of the Maya Mountains, primarily due to its geographical isolation. The upper reaches of Central River are a prime example of such an isolated waterway that has not previously been subject to a detailed ichthyologic assessment.

Methodology

Herpetofauna

The rapid assessment of the amphibian (and reptilian) fauna of the upper reaches of the Central River watershed encompassed approximately 36 man-hours of transect search, as well as opportunistic sightings, and follows up on a brief assessment of the lower reaches that was undertaken in August '09.

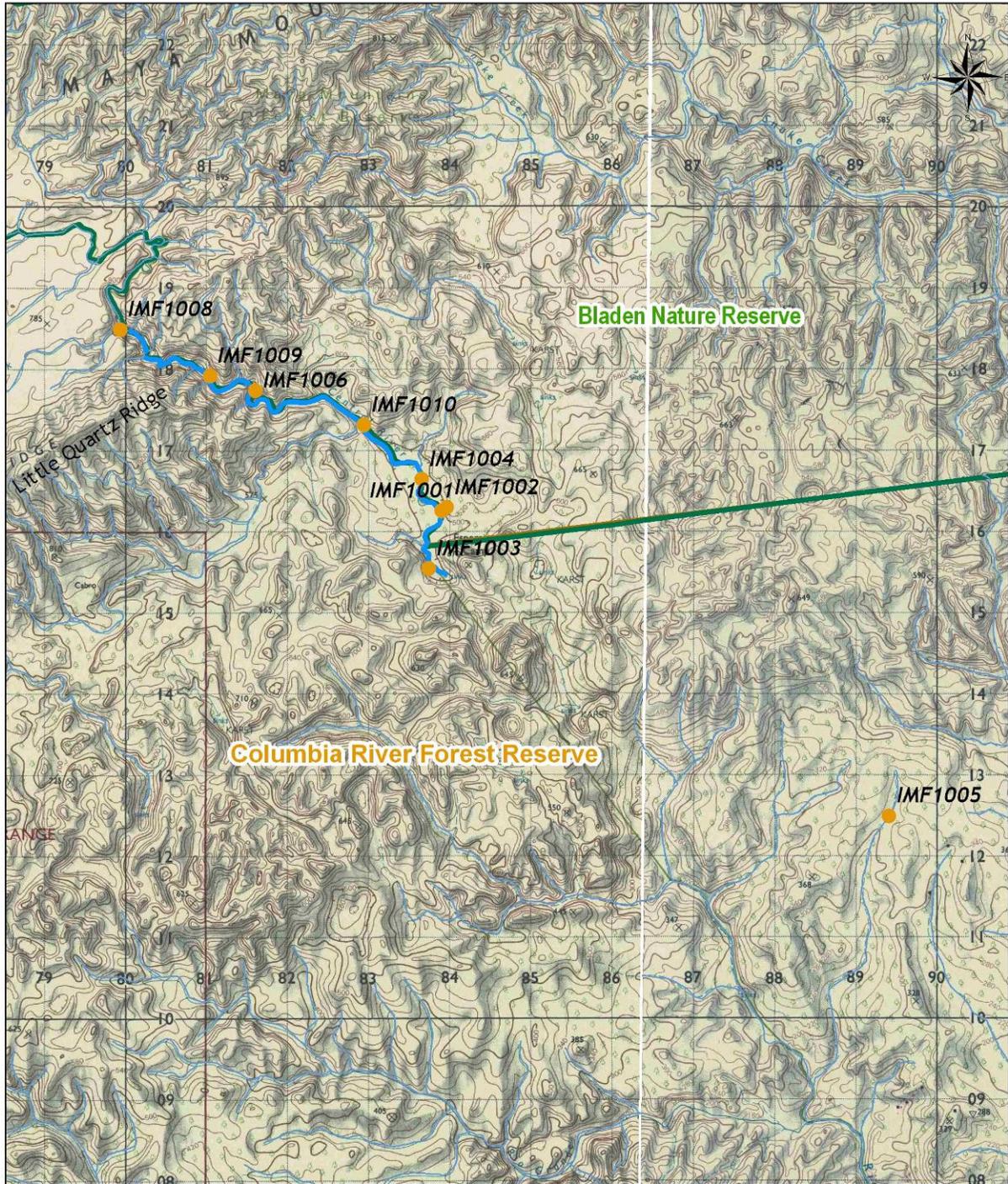
Ichthyofauna

Fish assemblages at ten sites across the mid and upper reaches of the Central River watershed were assessed using a combination of electro-fishing, netting and hook & line methods (refer to **Table 1** and **Figure 4**). Five localities were surveyed between 4th and 6th February, 2010, and the remaining five localities were surveyed between 11th and 14th February, 2010.

Table 1 Ichthyofauna sampling sites

Date	Time		Field number	Site	Coordinates
	Begin	End			
04/02/10	(1) 08:15 (2) 19:00	(1) 10:05 (2) 21:00	IMF1001	Central River - Esperanza base camp	283909 1816245
04/02/10	11:30	14:16	IMF1002	Central River - 200mt Downstream of base camp	283976 1816290
04/02/10	15:38	16:30	IMF1003	Central River - Water Sheet, toward sink hole	283754 1815535
05/02/10	(1) 08:45 (2) 19:00	(1) 09:38 (2) 21:00	IMF1004	Central River - 1/2 Hour Upstream from base camp	283666 1816637
06/02/10	14:28	15:30	IMF1005	Susill-ha	289418 1812486
11/02/10	10:30	11:25	IMF1006	Central River - 1/2 Downstream from third camp	281619 1817731
11/02/10	00:25	13:01	IMF1007	Central River - third camp	281720 1876461
12/02/10	12:30	13:45	IMF1008	Central River - Below last waterfall	279956 1818480
12-13/02/10	19:05	21:30	IMF1009	Central River - Station 52	281061 1817910
14/02/10	10:12	11:10	IMF1010	Central River - Station 7	282953 1817303

Figure 4 Ichthyofauna sampling sites on Central River



Ichthyofauna Sampling Sites

- Sampling Sites
- Bladen Nature Reserve
- Central River
- Columbia River Forest Reserve
- Rivers



0 0.5 1 2 3
Kilometers

Projected Coordinate System: DNAD_1927_UTM_Zone_18N
 Projection: D_Treosvors_Mercator
 False_Easting: 0.0000000000000000
 False_Northing: 0.0000000000000000
 Central_Meridian: -87.00000000000000
 Scale_Factor: 0.9996000000000000
 Latitude_Of_Origin: 0.0000000000000000
 Linear Unit: Meter



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A transect of between 50 to 140 meters was surveyed at each locality (the length of transect was established based on the average width of the river at the sampled site). Physical parameters of the channel and physicochemical properties of the water were recorded at each locality, such as: channel width and depth; type of substrate; water velocity; vegetation cover and type; dissolved oxygen; conductivity; salinity and pH. All wadeable habitats were sampled by making one pass through each habitat type (riffle, run, pool, and backpool) shocking and dip-netting fish near cover (e.g., boulders, woody debris, undercut banks), from open areas free of cover, and from within the water column.

Electrofishing is a common scientific survey method used to sample fish populations to determine abundance, density, and species composition. When performed correctly, electrofishing results in no permanent harm to fish, which return to their natural state in as little as two minutes after being stunned. A battery powered, backpack electrofisher was used which employs a transformer to pulse the current before it is delivered into the water. The anode is located at the end of a 2 metre long pole and is usually in the form of a ring. The cathode is a three metre long braided steel cable that trails behind the operator. Extreme care was taken to ensure the welfare of both the survey team and non-target organisms within the sampling sites. Importantly, a highly experienced ichthyologist operated the electrofisher, using it to temporarily stun the fish while two other team members scooped the fish from the water with four-foot dip nets.

The collected fish were put in a bucket with water with each species being identified, counted, recorded and then selected specimens euthanized and fixed in a solution of 10 % formalin. The taxonomic key of Greenfield and Thomerson was used later to make identifications. Samples of genetic material were taken by a clip from the right pectoral fin of the fish with the use of scissors and forceps and the preserving the tissue in a 2 ml vial with a solution of absolute ethanol. Fish were tagged with the correlative number of the vial. Forceps and scissors have to be carefully cleaned between samples to avoid contamination from one specimen to the next.

Avifauna

The rapid assessment of the avifauna of the mid and upper reaches of the Central River corridor was undertaken by a local ranger trained in the visual identification and audible calls of the native birds of Belize. Opportunistic sightings and calls were recorded throughout the five-day period in the study area. Some photographic records were also taken.

Findings

Herpetofauna

Within the upper reaches, a total of 11 amphibians and 10 reptile species were recorded, including the Critically Endangered Morelet’s Tree Frog, the Endangered Sanderson’s Stream Frog, and the endemic Maya Mountains Frog. Two unusual salamanders that were found are provisionally identified as being a juvenile specimen of extremely rarely encountered *Bolitoglossa dofleini* (or, is otherwise a new species for Belize), and *Bolitoglossa odonnelli* – a species only once previously found once in Belize.

The findings add further validation to the categorization of the area as being the most biodiverse in Belize (Holst, et. al., 1997), highest priority within the Key Biodiversity Areas Assessment (Meerman, 2007) and its zonation within the CPZ of the MMM (Walker *et al*, 2008). Amphibians found in this pristine submontane palm forest and on immediately adjacent slopes have been found nowhere else in Belize, and may qualify the area for recognition as an Alliance for Zero Extinctions Site. It is also likely that the unique amphibian fauna is indicative of overall uniqueness of biodiversity in the area: several predominant tree species were not readily identifiable by team members, and have not been observed by them elsewhere – and suggest an extremely uncommon flora.

Amphibian and Reptile species recorded during the assessment of the upper reaches of Central River (refer to Annex C – Plates 1 - 6 for photographic records collected):

Amphibia

Plethodontidae

Bolitoglossa dofleini (provisional identification)

Bolitoglossa odonnelli (provisional identification)

Bolitoglossa rufescens Northern Banana Salamander

Leptodactylidae

Craugastor chac Chac’s Rain Frog

Craugastor sandersoni Sanderson’s Stream Frog

Bufo

Ollotis campbelli Campbell’s Rain Forest Toad

Hylidae

Agalychnis moreletii Morelet’s Tree Frog

Smilisca cyanosticta Blue-spotted Tree Frog

Centrolenidae

Hyalinobatrachium fleischmanni Fleischmann’s Glass Frog

Ranidae

Lithobates juliani Maya Mountain Frog

Lithobates vaillanti Vaillant’s Frog

Reptilia

Polychrotidae

Anolis biporcatus

Neotropical Green Anole

Anolis capito

Bighead Anole

Anolis uniformis

Lesser Scaly Anole

Scincidae

Mabuya unimarginata

Central American Mabuya

Sphenomorphus cherriei

Brown Forest Skink

Teiidae

Ameiva festiva

Middle American Ameiva

Colubridae

Drymobius margaritiferus

Speckled Racer

Imantodes cenchoa

Blunthead Tree Snake

Elapidae

Micrurus diastema

Variable Coral Snake

Viperidae

Bothrops asper

Fer-de-Lance

Ichthyofauna

Three species were identified in the watershed, *Xiphophorus helleri* (Green Swordtail), *Heterandria bimaculata* (Two-spot Livebearer), and *Rhamdia laticauda* (Rock Catfish). The three species are ubiquitous, with broad watershed distribution. These preliminary results are in agreement with other high altitude fish fauna assemblages in other areas of Mesoamerica. It is important to mention the prevalence of a population of melanistic *Xiphophorus helleri* in some localities; sometimes the melanistic morph was more abundant than the normal morph. This may be an indication that some important evolutionary processes may have been taking place in the region.

Fish species recorded during the assessment of the mid and upper reaches of Central River were:

Heptapteridae

Rhamdia laticauda

Rock Catfish

Poeciliidae

Heterandria bimaculata

Two-spot Livebearer

Xiphophorus helleri

Green Swordtail

The abundance of the three identified fish species recorded at each sampling site is detailed in Table 2. Annex C - Plates 7 to 10 contain photographic records of the species collected.

Table 2 Fish Species Abundance

Sampling site	Poecilia sp	Heterandria sp	Rhamdia laticauda	Xiphophorus helleri	Machrobranchium sp	Total
IMF1001	6	43	11	18	16	94
IMF1002	11	38	4	56	27	136
IMF1003	2	38	0	38	25	103
IMF1004	15	32	18	90	12	167
IMF1005	0	0	0	114	37	151
IMF1006	0	12	0	33	44	89
IMF1007	0	3	0	37	7	47
IMF1008	0	23	1	19	43	86
IMF1009	0	0	8	0	0	8
IMF1010	1	36	2	0	6	45
Total Ind.	35	225	44	405	217	926

Table 3 details the species and abundance of invertebrate encountered at Esperanza Base Camp and Station 52 & 54 sampling sites.

Table 3 Invertebrate Species

Phylum	Order	Family	Common Name	Esperanza Base Camp	Station 52 & 54
Insecta	<i>Ephemeroptera</i>	<i>Heptageniidae</i>	Flathead Mayflies	11	0
		<i>Leptophlebiidae</i>	Pronggills	1	0
	<i>Megaloptera</i>	<i>Corydalidae</i>	Saddlecase Makers	4	5
		<i>Caenagrionidae</i>	Damselflies	3	6
	<i>Odonata</i>	<i>Lybelullidae</i>	Dragonfly	3	5
		<i>Gerridae</i>	Water striders	6	18
	<i>Hemiptera</i>	<i>Naucoridae</i>	Creeping Water Bugs	0	2
		<i>Plecoptera</i>	<i>Perlidae</i>	Stonefly	4
<i>Trichoptera</i>	<i>Glossomatidae</i>	Saddlecase Makers	4	0	
<i>Coleoptera</i>	<i>Gyrinidae</i>	Whirligig Beetle	0	1	
<i>Lepidoptera</i>	<i>Pyralidae</i>	Aquatic Pyralid Moths	0	11	
Mollusca	<i>Pulmonata</i>			34	102

Avifauna

Whilst the avifauna was not the primary focus of this assessment, there were several noteworthy findings from the five-day survey. Overall, there was a fairly high diversity with 73 species from 37 families and 17 Orders (see Annex B for full records). Most impressively, a juvenile Ornate Hawk-eagle (*Spizaetus ornatus*) was spotted, a rarely recorded species for Belize (refer to Annex C - Plate 11 for photographic record). The presence of Bat Falcons (*Falco ruficularis*) within CRFR, which was suspected previously, can now be confirmed as a result of the survey.

Table 4 Species of Conservation Concern found within CRFR

Common Name	Species Name	IUCN Status¹	Belize Status²
Vulnerable			
Cerulean Warbler	<i>Dendroica cerulea</i>	Vulnerable	Vulnerable
Keel-billed Motmot	<i>Electron carinatum</i>	Vulnerable	Vulnerable
Great Curassow	<i>Crax rubra</i>	Vulnerable	Vulnerable
Crested Guan	<i>Penelope purpurascens</i>		Vulnerable
King Vulture	<i>Sarcoramphus papa</i>		Vulnerable

¹IUCN Redlist, 2008 (downloaded, October, 2009)
²Species of National Concern (Provisional). Meerman, 2005 (NPAPSP output);

Importantly, the Central River area and its access route is an important area for many species of conservation concern, both at national and international level, as indicated in Table 4 below. Moreover, the area appears to be an important overwintering site for North America-Neotropical migratory birds, including the Louisiana waterthrush and Wood thrush which are listed on the United States Fish and Wildlife Service list of Species of Concern, as well as a large number of other migratory bird species such as the American redstart (*Setophaga ruticilla*), Hooded warbler (*Wilsonia citrina*) and Common Yellowthroat (*Geothlypis trichas*). These findings support those of Parker et al (2003) who concluded that during surveys of the Little Quartz ridge the area was “unusually rich”, with 224 species being recorded. He noted that the lower montane forests were especially important migratory habitats for species such as the Cerulean Warbler (*Dendroica cerulea*), of which over a hundred were counted during the expedition and indicating that the area is likely to be a very important staging area for the species, and supporting a large percentage of the species during late March and early April. Overall, the avian survey findings serve to reinforce the overall conservation importance of the site.

Discussion

It is clear that the total species richness, especially for amphibians and reptiles is very high in the study area – and is likely to include 100+ species for these two groups, including the above-mentioned critically endangered, endangered and endemic amphibians that were recorded during this survey. Additionally, it is quite likely that Belize’s other critically endangered terrestrial vertebrate – the Coffeus Rain Frog, recently found to occur adjacent to Little Quartz Ridge, will occur here too. Taxonomic uncertainty remains regarding a bright yellow toad found now on both sides of Little Quartz Ridge – uncertainty as to whether it is a colour morph unique to this area, whether it is the male of the new toad species record for Belize (*Ollotis macrocristatus* – recorded in 2008), or is a new species within this complex. The presence of this previously unknown variant / species in good numbers in the upper reaches of Central River further demonstrates the exceptional biodiversity of this submontane palm forest.

Water quality data collected indicated a very healthy aquatic environment within the watershed:

- dissolved oxygen readings at all sampling sites were within acceptable ranges;
- no signs of eutrophication were noted at any of the samples sites; and
- all other parameters (i.e. pH, TSS) were well within acceptable international water quality standards for human consumption and good conservation.

Although Central River maintains a healthy aquatic environment, the diversity of fish species recorded was low. This might be a result of the relatively high altitude¹ or the geographic isolation caused by the unique limestone geology of the MMM (discussed earlier in this report). Even with the low diversity of fish species there are many other ecological processes that depend on the conservation of the natural flow of the river. Many other species of fauna as well as the maintenance of numerous ecological and environmental services, including downstream communities utilizing the currently, high-quality water supply, are dependent on the well-being of Central River.

Hydrological data has been collected to model a preliminary ecological flow regime. However, in order to fully assess flow requirements to maintain ecological and environmental services of the Central River system, life history data from the three fish species present (*X. helleri*, *H. bimaculata*, and *R. laticauda*) and the key amphibian species identified is also required. This data is currently being collated and will be presented in an Addendum Report detailing the ecological flow assessment.

Without specifications of the precise location and type of hydroelectricity facility being considered for the Central River, it is not possible to accurately determine the likely impacts on the endemic fauna and flora. If a significant impoundment reservoir is not envisioned, a run-of-

¹ The low species diversity is no different to other high altitude localities in Mesoamerica; a similar species-richness has been collected in analogous sites in Honduras (Matamoros et al. 2009).

the river facility might not cause extensive direct habitat loss, but would potentially impact stream flow considerably (including tributaries) - which would significantly impact not only the critically endangered, endangered and endemic amphibian species recorded in this assessment, but the wealth of biodiversity that is intricately dependent upon the hydrology and micro-climate within this pristine habitat.

Construction / service / maintenance access to any facility (and associated power transmission lines) would be a major cause of concern in a habitat such as this – with inevitable impacts on the micro-climate, as well as increased risk of storm damage, erosion, impaired water quality, hunting and agricultural incursions. Additionally, the extremely rugged topography would pose an enormous logistical challenge to development in this location, a protected area of the MMM, and would further increase the ‘collateral environmental damage’ associated with it. The protected areas of the MMM, such as BNR, including Central River, are *“considered to contain significant valuable resources – plants and animals of economic and cultural value... and all have significant ecosystem services, such as providing protection to the headwaters of the majority of the watersheds of Belize”* (Walker et al, 2008).

There can be no question that the ecological costs of a development within the upper reaches of Central River would be exceptionally high, and the question remains as to whether the river flow volumes would be sufficient to supply a large enough facility to merit any serious consideration of whether the national and regional biodiversity losses could be justified and sanctioned.

Recommendations

Immediate Follow-up Actions

- Disseminate findings of REA to stakeholders (local communities, Government of Belize) and regional, national and international media.

Further Research Work

It is recommended that the following research work be considered:

- Gather more detailed data on the ecology of Central River. It has previously been demonstrated that watershed conservation affects fish conservation and many other taxa dependant on a healthy aquatic environment and riparian corridor. For instance, amphibians suffer greatly from changes in hydrological regimes. Therefore any further taxa assessments should, again be coordinated to encompass an integrated ecological approach. This should include determining the exact re-emergence point of the River.
- Conduct similar analyses across all the rivers of the Maya Mountains to determine whether watershed segments isolated by the permeable geology of the region have created unique freshwater habitats and endemic biodiversity and to enable informed advocacy for the protection of this key biodiversity area.
- Conduct a national river resources inventory. Local capacity building and training should be a key aim to undertake such a project. Training should include all project processes; experimental design, data collection, data processing and analysis, report writing, field techniques and sampling, lab work and taxa ID.
- Collate more detailed social and economic research on the benefits that the Central River provides to the communities downstream, the benefits/impacts that the current dam at San Miguel has had and the likely benefits/impacts that the proposed dam will have on the communities.
- Further enhance inventories of the plant and invertebrate diversity of the Central River and Maya Mountain Massif Key Biodiversity area through active engagement with academic institutions.

Management Activities

It is recommended that the following management activities are undertaken:

Reduce Ease of Access and Increase Security of CRFR and BNR

- Install a gate at or near the entrance of CRFR on Colombia Farmer's Road. Ideally a post would be established there as well, but even a gate will deter tractors, trucks and ATVs all of which are penetrating CRFR currently.
- Post signage at CRFR entrance points including Farmer's Road and "shortcut" trail from Colombia's dry creek into CRFR.
- Post signage at the entrance of BNR at Esperanza Camp.
- Increase monitoring and enforcement activities and streamline into Ya'axché's, Belize Defence Force's and the Forest Department's work plans:
 - Conduct monthly patrols to Esperanza Camp with reconnoitre radius of 4 miles from the camp (re-evaluate frequency after first 6 months).
 - Map existing trails now utilized by Guatemalan Xateros within BNR.
 - Identify, map and monitor existing archaeological sites, including those recently illegally excavated.
 - Investigate potential for permanent conservation post, warden classroom or research facility in CRFR or western BNR.

Mitigate Environmental Damages from BHD Incursion

- Reopen all water blockages placed within creeks during the construction or re-opening of roads to reduce the amount of sediment entering waterways -and restore normal hydrologic regime.
- Install water bars across reopened road and trails in CRFR to reduce the overall speed of surface water run-off thereby reducing soil loss and stabilizing bare slopes.

Improve Adaptive Protected Area Management through Facilitation of Future Research Activities, Capacity Development, and Strategic Partnership

- Build management capacity of Maya Mountain Massif protected area manager units to assist in assessments of key biological areas through targeted trainings as mentioned in recommended research activities.
- Conduct adaptive management exercise to internalize research results into protected area management plans of CRFR and BNR.
- Strengthen partnerships with key researchers and fundraise to facilitate recommended research work.
- Promote watershed stewardship within local communities.

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Annexes

Annex A Terms of Reference for Central River Ecological Assessment

INTRODUCTION

In July of 2009, the Belize Hydroelectric Development and Management Company Limited (BHD) illegally entered Colombia River Forest Reserve and Bladen Nature Reserve to conduct feasibility studies for a hydropower dam on the Central River, an area of core conservation within the Maya Mountain Massif and the National Protected Area System of Belize. After bulldozing roads and clearing many camping areas the BHD team was removed from the Reserves. In October of 2009, BHD was granted a research permit from the Belize Forest Department to continue their work on Central River.

Ya'axché Conservation Trust is currently launching efforts to:

1. advocate for the payment, to the Government of Belize, of damages and restoration efforts needed in Colombia River Forest Reserve and Bladen Nature Reserve.
2. monitor and deter the increased number of illegal activities within the newly threatened area of Bladen Nature Reserve.
3. build public support for protected areas and protected area law through an outreach campaign.
4. rapidly assess the hydrology and ecology of the Central River as an initial step towards understanding the true environmental and social impacts of a small hydropower dam on Central River.

This consultancy seeks to achieve objective 4 (above), as there is an urgent need and call of action from the buffer communities of Central River to better understand potential environmental and social implications of this development activity.

CONSULTANCY TITLE

Rapid Ecological Assessment of the Central River

TYPE

Team

LOCATION

Central River in Bladen Nature Reserve and Colombia River Forest Reserve; Punta Gorda Town, Belize

REPORTING TO

Ya'axché Sustainable Land Use Manager, Nicholas Wicks

DURATION

60 working days between three month period of December 1st 2009 and February 28th 2010

OBJECTIVE

To conduct a rapid assessment of the fishes, amphibians and hydrological processes of the Central River in Bladen Nature Reserve in order to assess this core protected area and project potential environmental and social impacts of hydropower development.

GENERAL RESPONSIBILITY

Plan and conduct field assessments making all arrangements in coordination with Ya'axché to ensure activities are completed and deliverables are fulfilled in a timely manner.

SPECIFIC ACTIVITIES

1. Assess the fish assemblages of the lower, mid and upper reaches of the Central River in at least the first, second and third order streams.
2. Assess water quality parameters at fish sampling sites of the Central River.
3. Assess the ecological flow requirements to maintain ecological and environmental services of the Central River system.
4. Collect genetic samples of fish and amphibian fauna within the Central River.
5. Assess the national context of the fish fauna and hydrology of the Central River.
6. Assess the amphibian fauna of the upper reaches of Central River, developing an initial baseline and identifying which endangered or endemic species occur there.
7. Characterize the habits of the amphibian species of concern within the upper reaches of Central River, including an assessment of conditions and threats.
8. Assess the importance of this area in the national context of conservation of endangered amphibian species in Belize.
9. Develop suggested management activities for Central River area, to be included in management plan of Bladen Nature Reserve

MAJOR DELIVERABLES

1. Detailed work plan indicating timeline of logistics, activities and deliverables
2. Documented assessment of fish assemblages, water quality, flow requirements, and amphibian species contributing towards projections of potential environmental and social impacts of a small hydropower dam on the Central River.
3. Proposed management activities for Central River area of Bladen Nature Reserve.
4. Final Report detailing principal results, analyses of study, and suggested further research.

Annex B Avian Data Records

TAXA	COLLOQUIAL NAME
ORDER: APODIFORMES	
Family: Trochilidae	
Amazilia candida	White-bellied Emerald
Amazilia tzacatl	Rufous-tailed Hummingbird
Florisuga mellivora	White-necked Jacobin
ORDER: CAPRIMULGIFORMES	
Family: Caprimulgidae	
Nyctidromus albicollis	Common Pauraque
ORDER: COLUMBIFORMES	
Family: Columbidae	
Patagioenas nigrirostris	Short-billed Pigeon
ORDER: CORACIIFORMES	
Family: Alcedinidae	
Chloroceryle americana	Green Kingfisher
Family: Motmotidae	
Electron carinatum	Keel-billed Motmot
Momotus momota	Blue-crowned Motmot
ORDER: CUCULIFORMES	
Family: Cuculidae	
Piaya cayana	Squirrel Cuckoo
ORDER: FALCONIFORMES	
Family: Accipitridae	
Spizaetus ornatus	Ornate Hawk-Eagle
Family: Cathartidae	
Sarcoramphus papa	King Vulture
Falco ruficularis	Bat Falcon
ORDER: GALLIFORMES	
Family: Cracidae	

TAXA	COLLOQUIAL NAME
Penelope purpurascens	Crested Guan
Family: Odontophoridae	
Odontophorus guttatus	Spotted Wood-Quail
ORDER: PASSERIFORMES	
Family: Cardinalidae	
Caryothraustes polioaster	Black-faced Grosbeak
Family: Formicariidae	
Formicarius analis	Black-faced Antthrush
Family: Fringillidae	
Automolus ochrolaemus	Buff-throated Foliage-gleaner
Euphonia hirundinacea	Yellow-throated Euphonia
Glyphorhynchus spirurus	Wedge-billed Woodcreeper
Sclerurus guatemalensis	Scaly-throated Leaf-tosser
Sittasomus griseicapillus	Olivaceous Woodcreeper
Family: Furnariidae	
Xiphorhynchus flavigaster	Ivory-billed Woodcreeper
Family: Icteridae	
Psarocolius wagleri	Chesnut-headed Oropendola
Family: Incerta Sedis	
Lipaugus unirufus	Rufous Piha
Schiffornis turdina	Thrush-like Schiffornis
Family: Mimidae	
Dumetella carolinensis	Gray Catbird
Family: Parulidae	
Dendroica magnolia	Magnolia Warbler
Geothlypis trichas	Common Yellowthroat
Seiurus motacilla	Louisiana Waterthrush
Setophaga ruticilla	American Redstart
Wilsonia citrina	Hooded Warbler
Family: Pipridae	
Pipra mentalis	Red-capped Manakin

TAXA	COLLOQUIAL NAME
Family: Sylviidae	
Polioptila plumbea	Tropical Gnatcatcher
Family: Thamnophilidae	
Microrhopias quixensis	Dot-winged Antwren
Family: Thraupidae	
Cyanerpes lucidus	Shining Honeycreeper
Piranga rubra	Summer Tanager
Tangara larvata	Golden-hooded Tanager
Family: Troglodytidae	
Thryothorus maculipectus	Spot-breasted Wren
Family: Turdidae	
Hylocichla mustelina	Wood Thrush
Family: Tyrannidae	
Attila spadiceus	Bright-rumped Attila
Contopus cinereus	Tropical Pewee
Elaenia flavogaster	Yellow-billed Elaenia
Megarynchus pitangua	Boat-billed Flycatcher
Myiarchus tuberculifer	Dusky-capped Flycatcher
Myiozetetes similis	Social Flycatcher
Tolmomyias sulphurescens	Yellow-olive Flycatcher
Vireo flavoviridis	Yellow-green Vireo
Vireolanius pulchellus	Green Shrike-Vireo
ORDER: PICIFORMES	
Family: Galbulidae	
Galbula ruficauda	Rufous-tailed Jacamar
Family: Picidae	
Celeus castaneus	Chestnut-colored Woodpecker
Dryocopus lineatus	Lineated Woodpecker
Melanerpes pucherani	Black-cheeked Woodpecker
Family: Ramphastidae	
Aulacorhynchus prasinus	Emerald Toucanet
Pteroglossus torquatus	Collared Aracari

TAXA	COLLOQUIAL NAME
Ramphastos sulfuratus	Keel-billed Toucan
ORDER: PSITTACIFORMES	
Family: Psittacidae	
Amazona farinose	Mealy Parrot
Aratinga nana	Olive-throated Parakeet
Pionus senilis	White-crowned Parrot
Pyrilia haematotis	Brown-hooded Parrot
ORDER: STRIGIFORMES	
Family: Strigidae	
Ciccaba virgata	Mottled Owl
ORDER: TINAMIFORMES	
Family: Tinamidae	
Crypturellus boucardi	Slaty-breasted Tinamou
Crypturellus soui	Little Tinamou
Tinamus major	Great Tinamou
ORDER: TROGONIFORMES	
Family: Trogonidae	
Trogon Massena	Slaty-tailed Trogon
Trogon violaceus	Violaceous Trogon

Annex C **Photographic Records**

Plate 1 Campbell's Rainforest Toad



Plate 2 A rare variant of the Campbell's Rainforest Toad



Plate 3

Fleischmann's Glass Frog



Plate 4

A juvenile Dofleini's Salamander (*provisional identification*)



Plate 5

O'Donnell's Salamander (*provisional identification*)



Plate 6

Juvenile Neotropical Green Anole



Plate 7

Green Swordtail



Plate 8

Melanistic Green Swordtail



Plate 9

Two-Spot Livebearer



Plate 10

Rock Catfish



Plate 11

Juvenile Ornate Hawk-Eagle

