Final Evaluation Report

Your Details	
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Project Title	Ecological Diversity of Freshwater Fishes in Canje River, Guyana
Application ID	40787-1
Date of this Report	28th June, 2024

1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
What is the total fish composition of the Canje River?			X	To ensure that we collected maximum number of species in the Canje River, we set out to sample points along the Canje river up to the furthest possible point. However, while this object was achieved, loggers upstream informed us of an upper tributary of the river that is newly accessible by boat. This opportunity will allow us to unlock additional sites further upstream, possibly holding species that we have not collected yet.
Collect food web ecology data of all serrasalmids			X	Stomach samples were collected for all five species of serrasalmids from the Canje River. For species such as *Pygopristis denticulata,* we achieved our ideal sample while for *Myloplus* and *Metynnis,* we collected fewer individuals than expected. Overall, 80% of our ideal sample was collected. Sampling difficulties in certain areas (e.g., depth, steep bank, grass blockage, etc.) hindered our ability to collect certain fishes.
Educate students and Canje community about local biodiversity		X		Two student assistants from the University of Guyana were trained in methods of fish collection, species identification, preservation, ecological importance, and conservation needs. I also shared with the local indigenous communities the

				ecology of freshwater fishes found in their waters, while they provided valuable insights on the locations and seasonal occurrences of different fish species. Our discussions with these communities were very productive, as many of the residents were unaware of the different species of fish that inhabit their water ways.
Compare Canje fish diversity to neighbouring tributaries (e.g., Berbice, Corentyne)		X		We have created a comprehensive list of species found in most parts of the river. However, the entire river needs to be surveyed before an accurate comparison can be made. Nevertheless, we are in the process of comparing this list to species found in the Berbice and Corentyne Rivers.

2. Describe the three most important outcomes of your project.

- This survey yielded 63 freshwater fish species, representing 22 families. Our preliminary survey (in 2023) resulted in the identification of 44 species of freshwater fishes. Support from The Rufford Foundation expanded the list of fishes found in the Canje, an increase of 19 new species, representing four additional families. We now estimate that the Canje holds 77 species of freshwater fishes, with the very real possibility of new (i.e., undescribed) species requiring further investigation. Tissue samples were collected from fishes and will be sent off to a genetics lab for DNA barcoding (Examples of these fishes are attached in the appendix) – the PI (DHN) is currently engaged in analysing these data.

- This expedition enabled us to collect 80% of the serrasalmids (pacu and piranha) stomach samples needed for my 2nd dissertation chapter and 100% of the stomach samples required for my 3rd chapter.

- From talking with Canje residents living upstream from where our preliminary survey ended, we have been notified of a tributary that can extend our exploration further upstream. In part, this is because the main upstream tributary was unknown to us and has recently been cleared of debris by logging concessions. This provides a clear opportunity to find the headwaters

of the river and the species living there. The locals also confirm that besides the species we had collected, there are bigger species more upstream.

- We have completed the first scientific survey of fish fauna from the Canje River, yet we believe further upstream sampling is important because diverse habitats upstream likely support high species diversity. Our expedition recorded more species as we travelled further upstream, highlighting the importance of continued sampling. We were also limited in sampling far downstream due to blockage by floating grass mats (see below). Downstream sites merit more investigation given the possibility of brackish or estuarine species here (e.g., tarpon, stingrays, etc.).

3. Explain any unforeseen difficulties that arose during the project and how these were tackled.

- We lost several days of sampling due to clusters of invasive aquatic grasses blocking the downstream section of the Canje River (Figure 1). This grass is trimmed by the government to maintain navigability but can entangle and clog outboard motors (as well as block river passage outright). We lost one of our engines to this grass. To mitigate the impact of this unforeseen circumstance, we intensified our sampling efforts. We doubled the number of deployed gillnets and extended the time that each net was left out (i.e., increased soak time).

Figure 1. Heavy blockage of wild grass on the lower parts of the Canje River

- Our objectives were to sample the entire length of the Canje River to record total species diversity and collect food web data. This goal was fully achieved based on our initial plans; however, the far upstream portion of the river requires added attention based on the outcome from our expedition. Initially, our boat captain informed us of a narrow, shallow stream obstructed by substantial woody debris, which impeded access. Local fishermen suggested another route that would allow us to reach the river's terminus. However, our expedition could not extend our travel further upstream, as we had only sufficient fuel and provisions to return. In addition, we were unable to sample the lowest reaches of the river due to floating grass mats.

- The target species for my PhD dissertation are *Serrasalmus rhombeus, Pygopristis denticulata, Catoprion mento, Myloplus rubripinnis,* and *Metynnis hypsauchen, all* belonging to the serrasalmid family. Despite our extensive

sampling efforts, we were unable to collect enough samples for stomach content analysis of *Myloplus rubripinnis* and *Metynnis hypsauchen*. While we couldn't overcome this challenge, we have identified the specific sites where these species are found which will improve our ability of capturing these species in the next sampling period.

4. Describe the involvement of local communities and how they have benefitted from the project.

We set out to explore the uncharted waters of Canje River and document the river's freshwater fish diversity. Our trip presented the opportunity to exchange knowledge with the villagers, student assistants, and our local guide about the diverse species found in the Canje River. We were able to impart the biology and ecological importance of the species we encountered to our local colleagues, especially with respect to introducing new species of fishes they were unfamiliar with (e.g., weakly-electric knifefishes). This knowledge benefited the local community, by increasing their awareness of the species inhabiting their home and the role each species plays in their ecosystem. Student assistants from the university were trained to collect environmental data, the procedure of identifying fish species, collecting stomach content while understating the concept of niche partitioning, and collecting DNA tissues. These new skills not only provided the students with a competitive edge in job application or scientific research, but also serve as a strong qualification for graduate studies. Additionally, we supported a small local tourism business; Blackwater Adventures (operated by Dillon Ross) is an ecotourism and recreational fishing charter service on the Canje River. We trained Dillon in local fish identification and ecological knowledge, which will be passed on to his clients, friends, and neighbours. Finally, this expedition has contributed to Devya Hemraj-Naraine's dissertation, and samples collected (stomach contents & DNA) will form the basis of her instruction in molecular sequencing and bioinformatics.

***5.* Are there any plans to continue this work?**

The results of this expedition call for additional work in the Canje River. We have new information that requires sampling further upstream. Funding from Rufford (Table 1) enabled us to increase the species list by 24% (19 new species) (Figure 2). This survey also increased the amount of sampling points (48), ultimately unveiling a greater number of sampling sites along the length of the Canje River (Figure 2). While the number of sites added to the map is significantly higher than what was initially known, there are still tens of kilometres of the river that require sampling.

Table 1. Species collected during our preliminary survey (2023) in comparison to species collected with Rufford Support (2024).

Order	Family	Preliminary survey (2023)	Rufford Support (2024)
Cichliformes	Cichlidae	*Acarichthys cf. heckelli*	*Acarichthys cf. heckelli*
Cichliformes	Cichlidae	-	*Acaronia nassa*
Characiformes	Acestrorhychidae	-	*Acestrorhynchus falcatus*
Characiformes	Acestrorhychidae	*Acestrorhynchus microlepis*	*Acestrorhynchus microlepis*

Characiformes	Acestrorhychidae	*Acestrorhynchus sp.*	*Acestrorhynchus sp.*
Cichliformes	Cichlidae	*Aequidens potaroensis*	-
Siluriformes	Auchenipteridae	*Ageneiosus inermis*	*Ageneiosus inermis*
Siluriformes	Doradidae	-	*Amblydoras affinis*
Cichliformes	Cichlidae	-	*Apistogramma steindachneri*
Characiformes	Characidae	-	*Astyanax bimaculatus*
Siluriformes	Auchenipteridae	-	*Auchenipterus sp*
Gymnotiformes	Hypopomidae	-	*Brachyhypopomus sp*
Characiformes	Characidae	-	*Bryconops affinis*
Characiformes	Characidae	*Bryconops cf. melanurus*	*Bryconops cf. melanurus*
Siluriformes	Aspredinidae	-	*Bunocephalus sp*
Characiformes	Gasteropelecidae	*Carnegiella cf. strigata*	*Carnegiella cf. strigata*
Characiformes	Serrasalmidae	*Catoprion mento*	*Catoprion mento*
Siluriformes	Cetopsidae	*Helogenes villosus*	-
Cichliformes	Cichlidae	*Chaetobranchus flavescens*	*Chaetobranchus flavescens*
Characiformes	Characidae	*Charax gibbosus*	*Charax gibbosus*
Cichliformes	Cichlidae	*Cichla ocellaris*	*Cichla ocellaris*
Characiformes	Lebiasinidae	-	*Copella sp*
Cichliformes	Cichlidae	-	*Crenicichla alta*
Cichliformes	Cichlidae	*Crenicichla lugubris*	*Crenicichla lugubris*
Cichliformes	Cichlidae	*Crenicichla sp.*	-
Cichliformes	Cichlidae	*Crenicichla sp. 'gold spot'*	-
Cichliformes	Cichlidae	-	*Crenicichla wallaci*
Characiformes	Crenuchidae	*Crenuchus spilurus*	*Crenuchus spilurus*
Characiformes	Curimatidae	*Curimata cyprinoides*	*Curimata cyprinoides*
Characiformes	Curimatidae	-	*Curimatopsis cryticus*
Siluriformes	Doradidae	*Doras micropeus*	*Doras micropeus*
Characiformes	Erythrinidae	-	*Erythrinus erythrinus*
Characiformes	Gasteropelecidae	-	*Gasteropelecus sternicla*
Cichliformes	Cichlidae	-	*Geophagus sp*
Characiformes	Characidae	-	*Hemigrammus sp*
Characiformes	Characidae	*Hemigrammus stictus*	-
Characiformes	Hemiodontidae	-	*Hemiodus unimaculatus*
Characiformes	Erythrinidae	*Hoplias aimara*	-

Characiformes	Erythrinidae	*Hoplias malabaricus*	*Hoplias malabaricus*
Characiformes	Characidae	*Hemigrammus ocellifer*	-
Gymnotiformes	Hypopomidae	-	*Hypopygus lepturus*
Characiformes	Iguanodectidae	*Iguanodectes spilurus*	*Iguanodectes spilurus*
Cichliformes	Cichlidae	*Krobia cf. guianensis*	*Krobia cf. guianensis*
Characiformes	Anostomidae	-	*Leporinus agassizi*
Characiformes	Anostomidae	-	*Leporinus arcus*
Characiformes	Anostomidae	*Leporinus cf. friderici*	*Leporinus cf. friderici*
Characiformes	Anostomidae	-	*Leporinus fasciatus*
Cichliformes	Cichlidae	*Mesonauta guyanae*	*Mesonauta guyanae*
Characiformes	Serrasalmidae	*Metynnis hypsauchen*	*Metynnis hypsauchen*
Characiformes	Characidae	-	*Moenkhausia ceros*
Characiformes	Characidae	*Moenkhausia cf. collettei*	-
Characiformes	Characidae	-	*Moenkhausia lepidura*
Characiformes	Characidae	*Moenkhausia sp*	-
Characiformes	Serrasalmidae	*Myloplus rubripinnis*	*Myloplus rubripinnis*
Characiformes	Lebiasinidae	-	*Nannostomus harrisoni*
Characiformes	Lebiasinidae	*Nannostomus marginatus*	*Nannostomus marginatus*
Characiformes	Lebiasinidae	*Nannostomus unifasciatus*	-
Characiformes	Characidae	-	*Phenacogaster sp*
Siluriformes	Pimelodidae	-	*Pimelodus blochii*
Siluriformes	Doradidae	-	*Platydoras hancocki*
Perciformes	Polycentridae	*Polycentrus schomburgkii*	-
Characiformes	Characidae	*Poptella compressa*	-
Beloniformes	Belonidae	*Potamorrhaphis cf. guianensis*	*Potamorrhaphis cf. guianensis*
Characiformes	Characidae	-	*Pristella maxillaris*
Characiformes	Serrasalmidae	*Pygopristis denticulata*	*Pygopristis denticulata*
Characiformes	Lebiasinidae	*Pyrrhulina filamentosa*	-
Characiformes	Lebiasinidae	-	*Pyrrhulina stoli*
Siluriformes	Heptapteridae	*Rhamdia quelen*	*Rhamdia quelen*
Gymnotiformes	Rhamphichthyidae	-	*Rhamphichthys rostratus*
Siluriformes	Doradidae	*Rineloricaria fallax*	*Rineloricaria fallax*
Cichliformes	Cichlidae	*Satanoperca leucosticta*	-
Cichliformes	Cichlidae	-	*Satanoperca surinamensis*

Characiformes	Serrasalmidae	*Serrasalmus rhombeus*	*Serrasalmus rhombeus*
Gymnotiformes	Sternopygidae	*Eigenmannia limbata*	*Eigenmannia limbata*
Characiformes	Characidae	-	*Tetragonopterus sp*
Siluriformes	Auchenipteridae	*Trachelyopterus galeatus*	*Trachelyopterus galeatus*
Characiformes	Triportheidae	*Triportheus cf. brachipomus*	*Triportheus cf. brachipomus*
		44	**63**

Figure 2. Sampling sites during the preliminary survey in 2023 (purple diamonds) and sampling sites with the support of Rufford in 2024 (red dots). Blackwater Adventures is the home base of our local guide.

6. How do you plan to share the results of your work with others?
Results will be shared with the Guyana Environmental Protection Agency, the Centre for the Study of Biological Diversity (the national museum at the University of Guyana), and local and international researchers in the field of biodiversity, conservation, and fisheries. Additionally, data collected from pacu and piranha stomach content analysis will be presented at the Joint Meeting of Ichthyologists and Herpetologists (JMIH) in Pittsburgh (PA, USA) and to my dissertation committee members, as well as being shared to the international community as two published manuscripts: one on the diet and feeding behaviour of *Catoprion*, a parasitic piranha (*in preparation* for the journal Functional Ecology) and a subsequent paper outlining diet niche partitioning and seed dispersal by piranhas and pacus (*in preparation* for the journal Freshwater Ecology)(see images below).

7. Looking ahead, what do you feel are the important next steps?
Based on the channel information provided by the locals and the accumulated frequency curve indicating an increased species list (Figure 4), we observed that sampling further upstream resulted in the addition of more species to our list. The upstream regions of the Canje River exhibited significantly higher biodiversity compared to the downstream areas. We anticipate that as we continue our sampling efforts further upstream, we will encounter more microhabitats, potentially yielding additional new species.

Therefore, the next crucial step is to complete sampling of both the extreme upstream and downstream regions of the Canje River. Upon completion, we will finalise a comprehensive list of freshwater fish species. This list will serve as a baseline for comparing fish faunas of the Canje to adjacent coastal rivers such as the Abary, Mahaica, and Mahaicony, which also remain unknown, but have been substantially impacted by human activities (e.g., farming, channelisation).

Figure. 3. Species accumulated from 2023 to 2024

8. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?

The Rufford Foundation logo has not yet been used in this project. However, the foundation will be duly acknowledged upon the completion of the analysis and publication of the results. The environmental protection agency report (must be prepared and submitted within a year) will also bear the logo of Rufford. My presentation at the Joint Meeting of Ichthyologists & Herpetologists will feature the Rufford logo on my presentation.

9. Provide a full list of all the members of your team and their role in the project.

- Devya Hemraj-Naraine (DHN) - DHN assisted with drag netting, setting out gillnets and retrieving fish samples, eviscerate gut samples and collecting tissue samples.
- Matthew Kolmann (MK)- Dr. Kolmann's role on this trip was to ensure that all DHN's goals and aims were accomplished. MK also provided valuable advice during the expedition and when challenges arose. He also supervised and assisted with fishing, species identification, and data collection.
- Dillon Ross (DR)- the captain of our boat and the manager of Blackwater Adventures, was responsible for ensuring that our camp was set up, meals were provided, and our sampling sites were reached on schedule.
- Moses Rover (MR) - assisted with fish sampling and collection of tissue samples and gut samples.
- Chrislene Persaud (CP) - was responsible for all data recording and environmental/habitat sampling, including water chemistry and water quality, preparation of tags & labels, and databasing.
- Mikhel Naraine (MN) - assisted with dragnetting (seining), setting out & retrieving gillnets, and tagging & preserving fish specimens.

10. Any other comments?

The Rufford Foundation has been instrumental in advancing my research, enabling me to collect most of the samples needed for my dissertation and providing critical data on the diversity and distribution of Guyana's freshwater fishes. However, further surveys are essential along the remaining sections of the Canje River and other coastal rivers. These efforts are crucial for us to significantly make an appeal for the conservation of the pristine river system in Canje.

Appendix

Fish species collected

Myloplus rubripinnis (pacu)- These fish are herbivorous and key seed dispersers. They have long intestine that allows for long retention time of the seeds, this allows them to disperse seeds miles away from the parent plant.	***Leporinus fasciatus-*** algivorous and insectivivorous. Also a potential seed disperser.	***Catoprion mento-***the wimple piranha is ectoparasitic fish that scrapes scales from prey using its large lower jaw and stout teeth.
Triportheus cf. brachypomus	 ***Leporinus arcus*** ***Chaetobranchus flavescens***	***Geophagus sp.***

		Platydoras hancocki
Cichla ocellaris Most tourist explore the Canje river using Blackwater Adventures specifically to capture this game fish.		
Metynnis hysauchen These fish are herbivorous and another potential seed disperser. Part of DHN's research is understanding the role pacus (like this one) play in seed dispersal.	 ***Serrasalmus rhombeus*** The black piranha is a top predator. It usually consumed fins and scales as a juvenile and switches to whole small fish and chunks of fish flesh as an adult.	***Rhamphichthys rostratus*** Weak electric fish

All pictures were taken by Dillon Ross

Non-fish species sighted

Giant river otter (*Pteronura brasiliensis).* Conservation status- Endangered (Picture: Devya Hemraj-Naraine)

Canje pheasant (*Opisthocomus hoazin)*- the national bird of Guyana, (Picture: Devya Hemraj-Naraine)