

Ichthyofauna Survey in Amazonian Terra Firme streams in Finca Las Piedras, Madre de Dios, Perú

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Introduction

The Peruvian Amazon rain forest in the Madre De Dios region is considered to be an incredibly biodiverse hotspot (Myers et al., 2000), and within this incredibly diverse forest, palm swamps and small streams with a large array of aquatic life can be found. Fresh and brackish water ecosystems such as lake, rivers, marshes, and streams make up approximately 5% of Peru's total surface area (Leon et al., 1995). While a significant amount of research has been done on large aquatic ecosystems such as rivers and lakes, less is known about the ecology of small forest streams and palm swamps in the Madre De Dios region of Peru. The Madre De Dios region is also a hotspot for slash and burn agriculture, which causes a severe amount of deforestation and degradation. There is also a significant amount of selective logging, and illegal gold mining. All of the previously mentioned human interventions are having significant impacts on the forest ecosystem (Giam, 2017; Webster, 2012). While small forest streams might not take as much area as large rivers and lakes, they are an important ecosystem for a large variety of ichthyofauna. It has been found that across lakes, rivers and streams in the Amazon, streams contain 38% of fish species, and only 5% of species found across these three habitats are shared (Albert

et al., 2001). While small Amazonian streams are often overlooked, they actually contain an astounding amount of diversity. The conservation and monitoring of these ecosystems is incredibly important especially in the Madre De Dios region where deforestation, selective logging, and illegal gold mining are all very prevalent, and without knowing what these habitats hold, it is impossible to know what the effects of changing ecosystems is having on these small yet diverse aquatic ecosystems.

While aquatic ecosystems within national parks and reserves are studied at a good level, it is just as, if not more important to study and understand aquatic ecosystems outside protected areas. As stated above the forest within the Madre De Dios region is rapidly changing due to human influence. It is known that in museum collections of Neotropical fish, about 25% are undescribed species (Albert et al., 2001). The fact that so little is known about Neotropical fish is unsettling. How can it be known what is being lost if it was never known what these aquatic ecosystems contained in the first place?

Aim and Hypothesis

The aim of this study is to create an inventory, and expand the field guide of Finca Las Piedras' ichthyofauna, which is the

field site for Alliance for a Sustainable Amazon. The first step in preserving Neotropical aquatic ecosystems is to figure out what species inhabit said ecosystems. Knowing this will allow for further research and monitoring to take place. Because Finca Las Piedras is a research station, understanding the ecosystem within palm swamps and streams that are on the property will encourage further research to take place so we can understand how this ecosystem could be changing as well as demonstrate the value of sites outside protected areas such as this one. In this study, two sites will be sampled. It is predicted that because the two sites are significantly different in terms of depth, width, flow, surrounding vegetation, and the fact that they are geographically isolated, there will be different fish species assemblages within the two sites. It is also predicted that because site two has never been sampled previously, it is more likely that species that have not previously been found at Finca Las Piedras will be found in it.

Methods

This study was conducted during the summer of 2019 at Alliance for a Sustainable Amazon's field site Finca Las Piedras. Data collection occurred June 3rd to June 19th. Sampling was conducted by me Quincy Knowlton with assistance from Jose Cueva, Riccardo Mattea, Lindsey Cathcart and Naeem El-Choufy. Fresh and brackish water ecosystems such as lake, rivers, marshes, and streams make up

Field Site

The field site Finca Las Piedras is located in the Madre de Dios region of Peru

near the city of Puerto Maldonado (S 12°13.570'; W 069°06.850'). The field site which is approximately 54 hectares contains a variety of habitats such as terra firme forest, palm swamp (Aguajal), and grassland. Finca Las Piedras is located within a humid tropical rainforest that has a wet and dry season. This study was conducted during the dry season, when water level in the palm swamps is comparatively low. Despite the fact that the forest has been the victim of selective logging in the past, which resulted in the loss of much of the big trees such as mahogany (*Swietenia macrophylla*) Spanish cedar (*Cedrela odorata*) and most of the ironwood (*Dipteryx micrantha*), and that the grasslands occupies abandoned agricultural fields, where forest once stood Finca Las Piedras is a relatively intact ecosystem, with a remarkable amount of biodiversity which is worth studying.

Sampling Sites and Time

To conduct this study, we sampled two separate sites within the Finca Las Piedras property. The majority of our sampling was conducted at site one which is characterized by palm swamp containing a stream with fairly large pools, housing a large variety of aquatic species (reptiles, amphibians, fish and invertebrates). Site one is located on the south end of the property. This was sampled by fishing in three main pools, all of which were slightly different from each other but contained most fish species.

Site two, which is on the opposite side of the property, was sampled two times, all of which occurred after sunset. Site two is characterized by a small stream that during this time of the year (dry season) presents muddy-dry stretches as well as slow flowing

ones. Even in the deepest parts of the stream, its depth never exceeds more than 30 cm. The majority of the sampling was conducted at night (between 8 and 10PM) because it was easier to fish as many species would sleep in the shallows which made them much easier to catch as well as because in addition to diurnal species, nocturnal species were present after sunset.

Fishing Gear and Specimen Collection

Due to limited resources, fishing equipment had to be crafted using available materials. The first couple days consisted mainly of tool construction followed by trial and error. Due to the presence of small minnows, a sieve was created by attaching two sticks to the ends of a piece of mesh about 110cm long and 70cm wide. This was used by placing it in the water and throwing some bait (crackers on mashed insects) in the water above the sieve. As fish gathered to eat the bait the sieve was slowly lifted up and out of the water in order to catch the fish. The second tool crafted to trap small fish, were two large plastic bottles (2l) which have been modified by cutting the top off (at about 4-5cm) and successively secured it by placing it in the bottle with the neck pointed into the bottle. Bait (grinded crackers) were added to the traps which were placed in the water for a few hours, tied on a tree to prevent it from drifting away. The most conventional method we used was a line and hook. This was used by placing bait on the hook (generally insects) and immersing it into water. Once fish ate the bait, they were safely hooked and pulled out of the water. The last method used was a homemade dipnet. In order to craft the net, six 3mm metal wires

were twisted together to provide a strong structure that would host the net. The coiled wire measured a diameter of 40cm. The circular coil of wire was then attached to the end a 180cm wooden pole by wrapping additional wire to the stick. In order to provide extra stability to the rim, another stick of smaller diameter was placed across the whole diameter of the metal structure and until half way down the main pole. This was then secured by tying it to the top part of the rim and to the main pole. This adjustment was made so that the net's structure would not bend when opposed to resistance under water. A 43cm long net (2mm mesh) with the same rim's diameter, was then carefully adapted to the metal structure. The hook was used to catch larger species while the net was used to catch both small and large fish at site one. We also found that by using the dipnet to scoop up mud or leaves you could find different kinds of fish. Due to the shallowness, and lack large species in site two the net was most effective, and because there was only one net and several people sampling some of the fish were caught with bare hands. All collected specimen were temporarily stored into 20L buckets filled with fresh water from the stream.

Photographing and Preparing Specimen

Once the fish were caught they were placed in a bucket and brought back to lab at the field site to be photographed and collected. Photographing involved the use of a soft box setup. Having one flash firing underneath the soft box (in order to remove shadows), and one box paced above the set up to diffuse light. The fish were placed individually at the base of the soft box with a

10cm ruler and photographed in RAW format. Pictures were taken directly from above. Some fish were photographed with lateral view, and dorsal view depending on morphology. Each specimen was then prepared for collection. This was done by euthanizing the individual in 50/50 alcohol 70% and water solution. This was found to be the most effective and humane way for the euthanizing process. Once the fish were they were then injected with a 5 mm syringe containing 90% alcohol in order to better preserve tissues. Alcohol was used instead of formalin, as it was the readily substitute available.

Results

Throughout the 14-day sampling period of this study, a total of 21 different species were caught, 12 of which were new to Finca Las Piedras. Of the new species found, 8 were caught at site one while 4 were

caught at site two. Site one was sampled a total of 14 times (over 14 days). Seven of these sampling periods occurred during the day while 7 occurred after sunset some of which occurred on the same day. Site two was sampled twice, both of which occurred at night. One species was found both at sight one and sight two, and had previously been found at Finca Las Piedras. The new species were sorted into morphological groups due to the limited resources in order to identify species and information on fish taxa at Finca Las Piedras.

Table 1 below describes what group each species is in, where they were caught, how they were caught, and when they were caught.

Figure 1 below contains information on how many species were caught at each site and what group (morphospecies) they were put in. We can see eel/knife fish dominated site 1, while catfish dominated site 2.

Table 1: List of species, group, sampling site, sampling method, and collection time.

Species	Morpho Group	Sight	Sampling method	Day/Night
SP01	Cichlid	1	line and hook	Day
SP02	Eel/knife fish	1	dipnet	Day
SP03	Minnow	1	dipnet	Night
SP04	Minnow	1	dipnet	Night
SP05	Cichlid	1	dipnet	Night
SP06	Eel/ Knife fish	1	dipnet	Night
SP07	Minnow	2	Hands	Night
SP08	Miscellaneous	2	dipnet	Night
SP09	Catfish	2	dipnet	Night
SP10	Eel /knife fish	1	dipnet	Night
SP11	Eel/Knife fish	1	Line and Hook	Night
SP12	Cattish	2	dipnet	Night

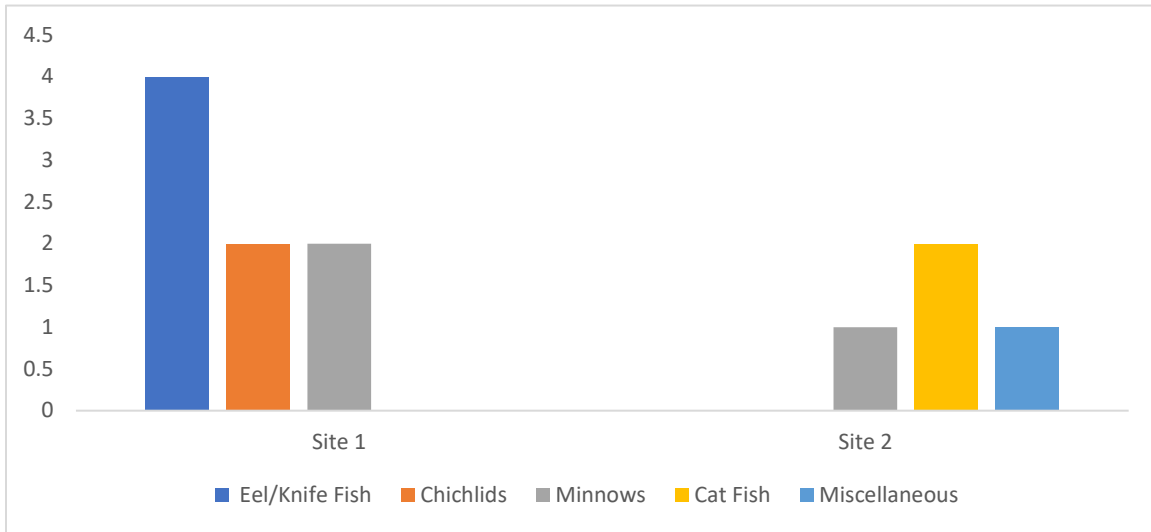


Figure 1: Number of new species caught at each site, and the group each species was placed in.

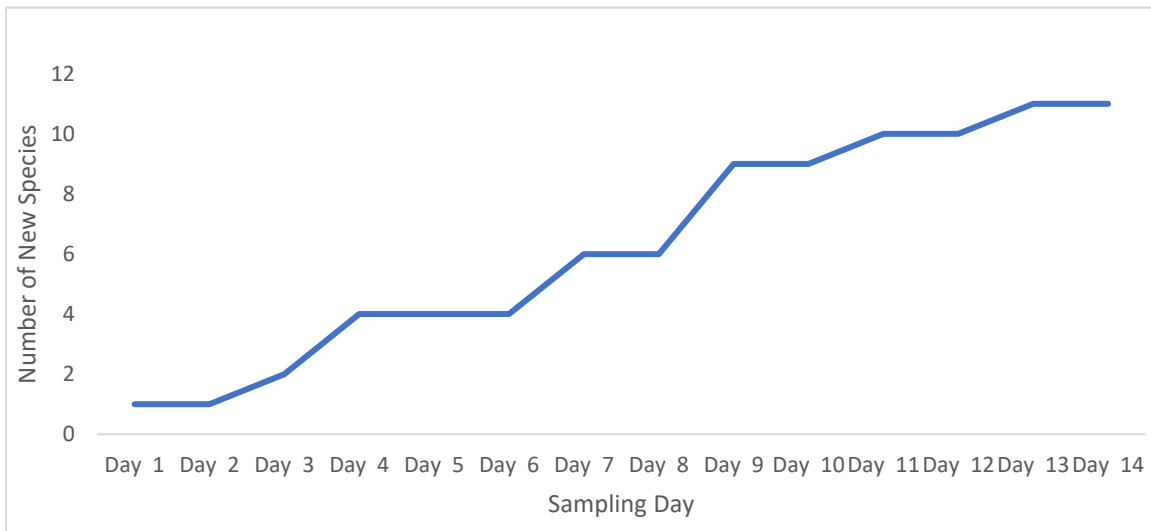


Figure 2: Number of new species acquired over time.

Figure 2 above shows the species accumulation curve over the course of this study. We can see a steady increase throughout the sampling period. Notice that the species accumulation does not approach asymptotic values.

Discussion

Neotropic aquatic ecosystems are incredibly diverse and contain an astounding

amount of ichthyofauna (Myers et al., 2000). As the results of this study, we have shown that there is an outstanding number fish species within the stream and palm swamp of Finca Las Piedras. With the species documented in this study and the species that have previously been found there is a total 27 possible species of fish. The species accumulation curve does not show signs of approaching an asymptote (see figure 2) as an exponential growth is still shown between

day 12 and 14. This means that there is likely a significant amount of new species yet to be sampled at Finca Las Piedras. This is highlighted by the fact that there was basically no decrease in the rate of species discovery over time. The species accumulation curve also shows that the first couple of days there was very little new species discovered. This can be explained by the trail and error process that took place in order to discover what sampling method was most effective. Of the sampling tools created, the dipnet was by far the most successful. The hook and line was also useful as it helped catch the larger fish. The minnow sieve and traps were only successful in catching a single species that had already been discovered at Finca Las Piedras. The net was probably most effective because it was mobile and had a long reach, allowing the researcher to collect fish from a distance and with relative control. The sieve was unsuccessful due to the fact that it was slow when retrieving and hard to control, and the bottle traps might have worked better with a different bait but they also may just not be as effective.

Site Comparison

Table one shows that over the course of this study more species were discovered at site 1 than at site 2, however this does not necessarily mean that there is greater diversity at site 1. On one hand, more species were discovered at site one which was sampled for 14 days; while on the other hand, site 2 was only sample twice and yet still yielded 4 new species. This is obviously due to that fact that site 2 had never been sampled before meaning that there was a greater

chance to find new species in the least amount of time. It also shows that even though site 1 and site 2 are relatively close to one another the Ichnofauna is quite different, this is likely because they are significantly different ecosystems (site 1 being a palm swamp with deep pools created by a stream, and site 2 being a very shallow stream). Considering the differences between the sites, the difference in fish is quite outstanding and is great example of the incredible diversity within the rainforest. It also a good example of why it is important to keep studying small aquatic ecosystems. If the variety of ichnofauna can vary so greatly just at Finca Las Piedras one can only imagine the amount diversity throughout all the small aquatic ecosystems in the Amazon.

Conclusion

It was predicted that the Ichnofauna found at site 1 and site 2 would be significantly different due the the differences in the ecosystem such depth, width, flow, and vegetation found within the stream. It was also predicted that a significant amount of previously uncollected species would be found at site due to that fact had not yet been sampled. According to the results of this study it can be said that these predictions have been supported although no statistical analysis was carried out. As stated in the results four new species were found at site 2 and only one species was shared with site 1. This shows that that the two habitats are significantly different, and considering that site 2 was only sample twice, four new species is a good starting sample.

To conclude, we can say that this has been a successful study. The goal of it was to

expand the inventory of species at Finca Las Piedras and we can say that this has been met considering that we found 11 possible new species to add to the existing 16. While there are definitely species yet to be sampled at Finca Las Piedras having an expanded inventory will allow for the aquatic ecosystems to be better understood, so that we can know how the effects of anthropogenic actions are changing these incredibly diverse ecosystems. To further the understanding of the aquatic ecosystems of Finca Las Piedras it is recommended that a study is done to determine abundance, species composition assemblage and that can be included in a statistical analysis.

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