Ecological and Social Impressions of the Middle Patuca River and Potential Consequences of the Patuca 3 Hydropower Project

18 September 2006

Peter C. Esselman, M.Sc., PhD candidate
Aquatic Conservation Biologist
School of Natural Resources and Environment
University of Michigan
Ann Arbor, MI 48109 USA
T. 734-769-0444
pesselman@hotmail.com

Executive Summary

The purpose of this report is to describe the outcomes of an 11-day field reconnaissance effort (starting 28 Aug 2006) in Honduras organized by the Empresa Nacional de Energia Electrica (ENEE) to capture and interpret knowledge from indigenous peoples within the Patuca watershed about ecological and social consequences the planned Patuca 3 hydropower project. A group of 12 researchers traversed 250 kilometers of the river in a large dugout canoe to conduct community meetings, interviews, and physical surveys of channel cross sections and water chemistry. Sixteen interviews were conducted with individual and small groups of fishermen in 11 communities (29 individuals total).

The livelihoods of indigenous and Mestizo communities situated along the river are intimately tied to the health of the river and floodplain ecosystems. Fishermen reportedly capture 26 species of fishes and 17 species of crustaceans and reptiles to use for food. The dominant species captured for food are 'tuba' (*Vieja maculicauda*), 'robalo' (*Centropomus undecimalis*), 'blanco' (*Centropomus ensiferus*), tilapia (*Oreochromis niloticus*), and catfish (possibly *Ictalurus furcatus*). At least 14 species migrate annually between the river and the sea, suggesting that upstream-downstream connectivity (which may be interrupted by the dam) is a crucial ecological factor relied upon by many species. Reproduction and migrations are strongly tied to annual patterns of flow.

The river currently exists in a state that is altered from its historical reference condition. Compound impacts including extensive deforestation, Hurricane Mitch, and sedimentation from upstream communities all currently influence the annual patterns of discharge and the ecosystems. Nonetheless, the river still provides many crucial services to communities, especially food, transportation, and fertility for their crops which are situated within the flood zone that receives flood sediments annually. Potential interruptions by Patuca 3 of key processes such as sediment delivery and the timing of floods are of concern to community members interviewed, though they commented that the predicted increase in dry season flow may be a good thing for navigation in the river.

From an ecological perspective, the greatest concerns about the predicted management regime of Patuca 3 are: (1) interruptions to the life cycles of migratory species caused by late onset of wet season; (2) extirpations of migratory species above the dam site caused by the physical barrier of the dam; (3) potential stresses (e.g., water contamination, decreased water flow) that may arise during the process of dam construction; (4) disappearance of important nesting habitats for reptiles caused by increased dry season discharges. Fortunately, these management conflicts are relatively few.

It is recommended that in the upcoming workshop that ENEE and its partners focus intensively on the following priority issues (in order of importance):

1. *Timing of wet season discharges* – if possible, the river must not lose the general pattern of its historical early wet season flows.
2. *Construction phase stresses* – should be identified and controlled very carefully.
3. *Dry season flow magnitude* – should represent a careful balance between electrical generation needs, navigational needs, and downstream habitat availability.
4. *Disrupted longitudinal connectivity* – threatens the character and function of the aquatic ecosystem *above* the reservoir. Engineering solutions should be considered and evaluated for feasibility.

Defining these issues and seeking possible management solutions should become major goals of the environmental flow workshop in November and in the management of Patuca 3.

Table of Contents

1. Introduction

The purpose of this report is to describe the outcomes of a field reconnaissance effort in Honduras organized by the Empresa Nacional de Energia Electrica (ENEE) to capture and interpret knowledge from indigenous peoples within the Patuca watershed about ecological and social consequences the planned Patuca 3 hydropower project. A group of 12 researchers traversed 250 kilometers of the river in a large dugout canoe to conduct community meetings, interviews, and physical surveys of channel cross sections and water chemistry. This report summarizes the process of information gathering, preliminary ecological observations, and recommendations for actions necessary to develop the most effective environmental flow recommendations possible given lessons learned and impressions made during the trip. These preliminary observations on the aquatic ecosystems of the scarcely-researched Patuca River—the longest river in Honduras—are meant to guide the development of environmental flow recommendations that will be incorporated into the Environmental Impact Assessment for the Patuca 3 project and, ultimately, into the design and operation of the dam itself.

This report is structured like a normal research paper with Methods, Results, and Discussion sections. Where possible, I have backed up my inferences with scientific literature, but I will also draw heavily on the results of formal interviews with 29 fishermen, and on personal experience as an expert in the region. To the greatest extent possible, I have tried to distill lessons learned into management recommendations, and to identify critical knowledge gaps.

2. Methods

2.1. *Travel route*

Rio Patuca is the highway into and out of the middle and lower reaches of the Patuca watershed. The ENEE field reconnaissance team hired a large dugout canoe or '*pipante'* (Figure 1) to penetrate the downstream areas to conduct interviews, community meetings, and to collect physical and chemical data. The ENEE team departed the village of Nueva Palestina on the morning of 29 August, went down river to the village of Kurhpa, and then worked our way slowly upstream stopping in villages along the way, finally returning to our start point on 8 September. This route allowed us to experience the river across a topographic transition from medium gradient rivers flowing through mountainous terrain, into the top of the coastal plain where the floodplain is more well-developed and the gradient of the river slackens. This route also gave us access to a diversity of ethnic groups, from recent Mestizo settlers (squatters) living on cattle farms along the river, to Tawahkan and Miskito amerindians living from a diversity of subsistence activities with some cash crops (e.g., cacao). We were able to conduct observations and interviews in settlements along a ~250 km portion of the river starting 7 river km downstream of the proposed site of Patuca 3, to within 150 km of the river's mouth with the Caribbean Sea (Figure 2).

2.2. *Data collection*

Data collection was conducted by 12 people total—9 employees from ENEE and 3 consultants (including myself). The 12 people were divided into 4 teams: a survey team that took cross section information at 12 points along our route; a water chemistry team that collected data at 18 points along our route; a social/geomorphology interview team; and a fishes/ecosystems team. I participated in the fishes/ecosystems team, and thus will present more detail on these aspects of the Patuca River.

The survey team used rod and transit to survey the morphology of channel cross sections up to the levels of reasonable flood magnitude. Along with the cross sectional information, a forester

Figure 1. Our vehicle to carry us down river and between communities was a 30' dug out ceiba tree with a 60 hp outboard engine.

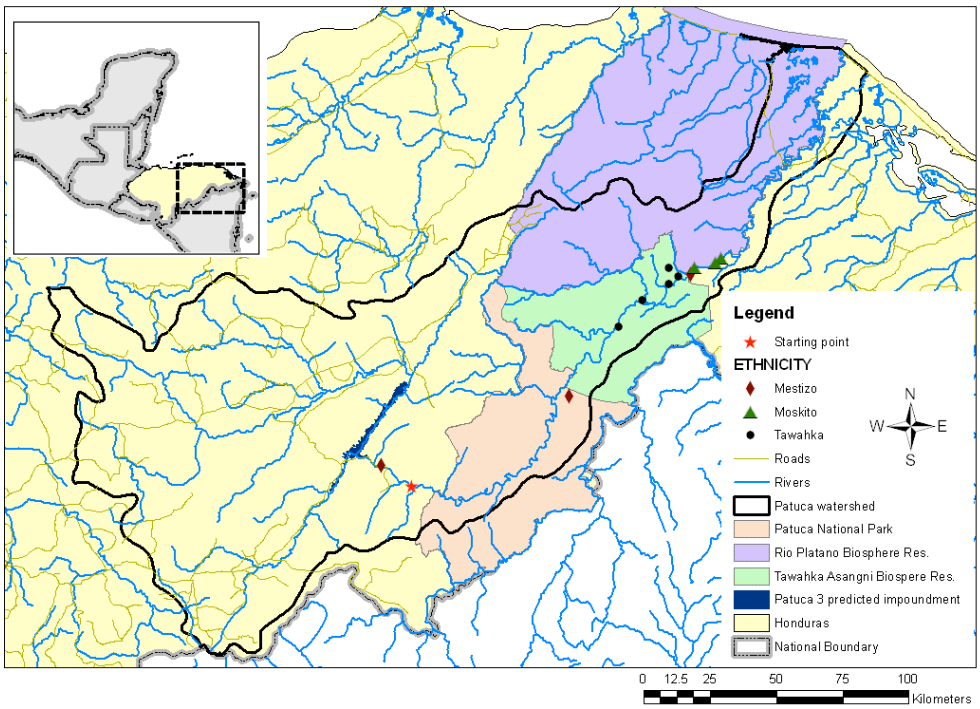

Figure 2. The travel route including the trip starting point, all communities visited to collect interview data, and the foreseen location of the Patuca 3 impoundment.

characterized vegetative communities in the floodplain area of these transects, and a soils expert characterized soils and land use. Findings of this team are not presented here.

The water chemistry team recorded dissolved oxygen, secchi depth, electrical conductivity, pH, and temperature at both banks of 18 points on the river, including all of those where transects were surveyed. These data are not presented here.

Both of the interview teams (social/geomorph and fishes/ecosystems) used similar approaches to identify respondents. Upon arriving at a village, we sought out community leaders to describe the purpose of our visit and our desire to interview community members. In most cases, leaders were able to direct us to suitable respondents. For the social/geomorph team, this generally meant meeting with community leaders and older community members with a well-founded knowledge of the history and socioeconomics of the community, and the history of flooding and river change through time. This team used two questionnaires, one devised by ENEE, and one devised by TNC for questions about river geomorphology. The fishes/ecosystems team sought out the individuals with the most experience capturing fishes and aquatic animals. This team used a questionnaire developed by TNC along with laminated pictures of fishes though to occur in the Patuca watershed. The fishes/ecosystems interview questions focused on detailing the composition and biology of aquatic assemblages with special focus on fishes. We also asked about the influence that Hurricane Mitch had on ecosystems only 8 years ago (29 Oct. 1998); how the changes predicted in preliminary IHA (conducted by Jeff Opperman with ENEE data) might influence important riverine process and species; and how a reduction in sediment in the river (from sediment trapping in the impoundment upstream) might influence ecosystems and human communities.

Interviews were done either with individuals or small groups of people. In general, once an interview began, other people in the vicinity would be drawn to the spectacle and would join in. Thus on many occasions our interviews represent information presented by up to 4 or 5 listeners.

3. Results

3.1. *Land use in the Patuca watershed*

It is important to situate the Patuca 3 project within a watershed context to understand how the effort to develop environmental flows for the Patuca River may be influenced by land cover patterns, and stresses associated with some of these activities.

The clear impression that I got driving and then floating through this landscape is that the upper Rio Patuca is severely deforested, with much of the landscape converted to cattle pastures and subsistence agriculture. Anecdotal conversations with other members of the ENEE group indicated that human immigration into the Patuca watershed has been heavy since the 1980's, and that population growth may also be a contributor to human high deforestation rates there. For the first 60 km of the float down river, I witnessed virtually no patches of high forest within a landscape that is more hillside than flat plain (Figure 3). Creek valleys occasionally would have small strips of secondary growth forest, but the riparian zone was generally pasture to the edge of the banks.

Moving downstream from Nueva Palestina we quickly entered the Patuca National Park, which then connects to Tawahka Asangni Biosphere Reserve, which in turn connects to the Rio Plantano Biosphere Reserve. The steep hill slopes along the river corridor are extensively

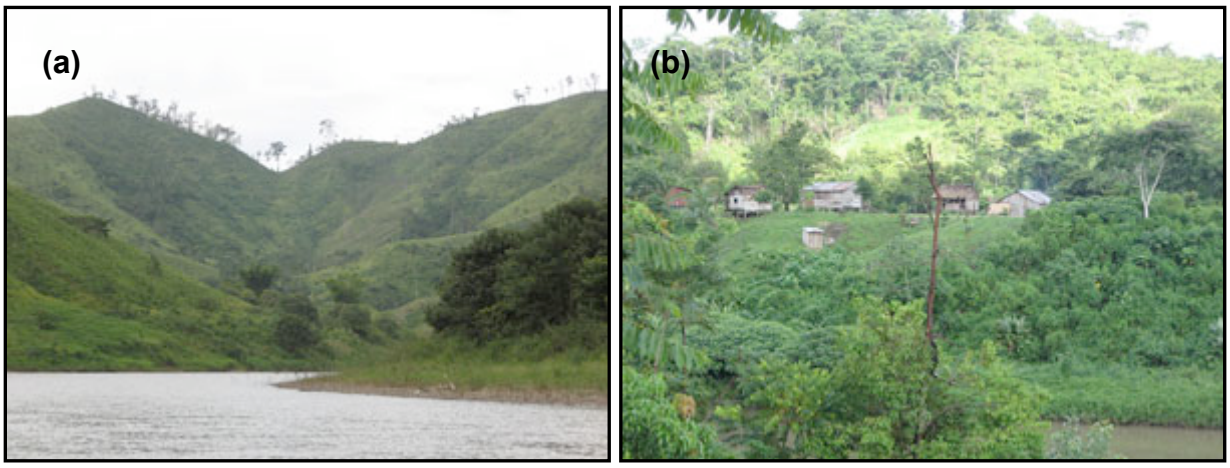

Figure 3. (a) Deforested hillslopes are more the rule than the exception in the Mestizo dominated parts of the middle and upper Patuca. (b) In Tawahkan and Miskito dominated areas, the landscape is generally used far less intensely.

cleared well into the Patuca National Park. Impoverished Mestizo settlers seem to be drawn to this area by the availability of land for cattle grazing (squatting seems to be a common form of land occupancy), and also because gold is present in the river sediments and is panned and dredged by many individuals[1].

As we moved further downstream into the northern extent of Patuca National Park and into the Tawahka and Rio Plantano Biosphere Reserves, the river was forested on both sides, and human communities were also well forested on their periphery. Clearing of steep hill slopes was almost non-existent in the Tawahka and Miskito areas we visited.

3.2. *The Patuca River*

The Patuca River is a large river by Central American standards. The approximate width of the river above the Rio Wampu confluence was approximately 50 m. Below this point, the river became closer to 80 m wide with more meanders. During our excursion, the river was swollen with wet season discharge, but not flooding. It is clear from the 35 years of data provided by ENEE for the IHA (Figure 4), that the river is strongly season with a dry season lasting from January to April, and a wet season from June to November. Dry season river flow is characterized by steadily declining river discharge with the lowest flows of the year in March and April. During the dry season, flooding almost never occurs though rainfall events can, and do, cause the river to rise. In May, the dry season begins to break and discharges increase with occasional flood events beginning in June, but with the largest floods generally occurring between August and November. In December the rains decline and the river begins to reduce its discharge as it heads into the next dry season.

For much of the reach we traversed, the river flowed through tight valleys, with very poorly developed floodplains, and multiple high floodplain benches. Rapids are frequent throughout the river as the river descends a fair gradient on its way to the sea. Only near the downstream-most extent of our trip did the hills leave the riverside and well-developed floodplain ecosystems form.

[1] The owners of the boat we hired to take us down river stated that they made more than 600,000 Limpiras (US$32,500) in one year prospecting for gold with a mechanical dredge. With this money they purchased a house in town, a boat and engine, and cleared land within the Patuca National Park to raise cattle and other livestock.

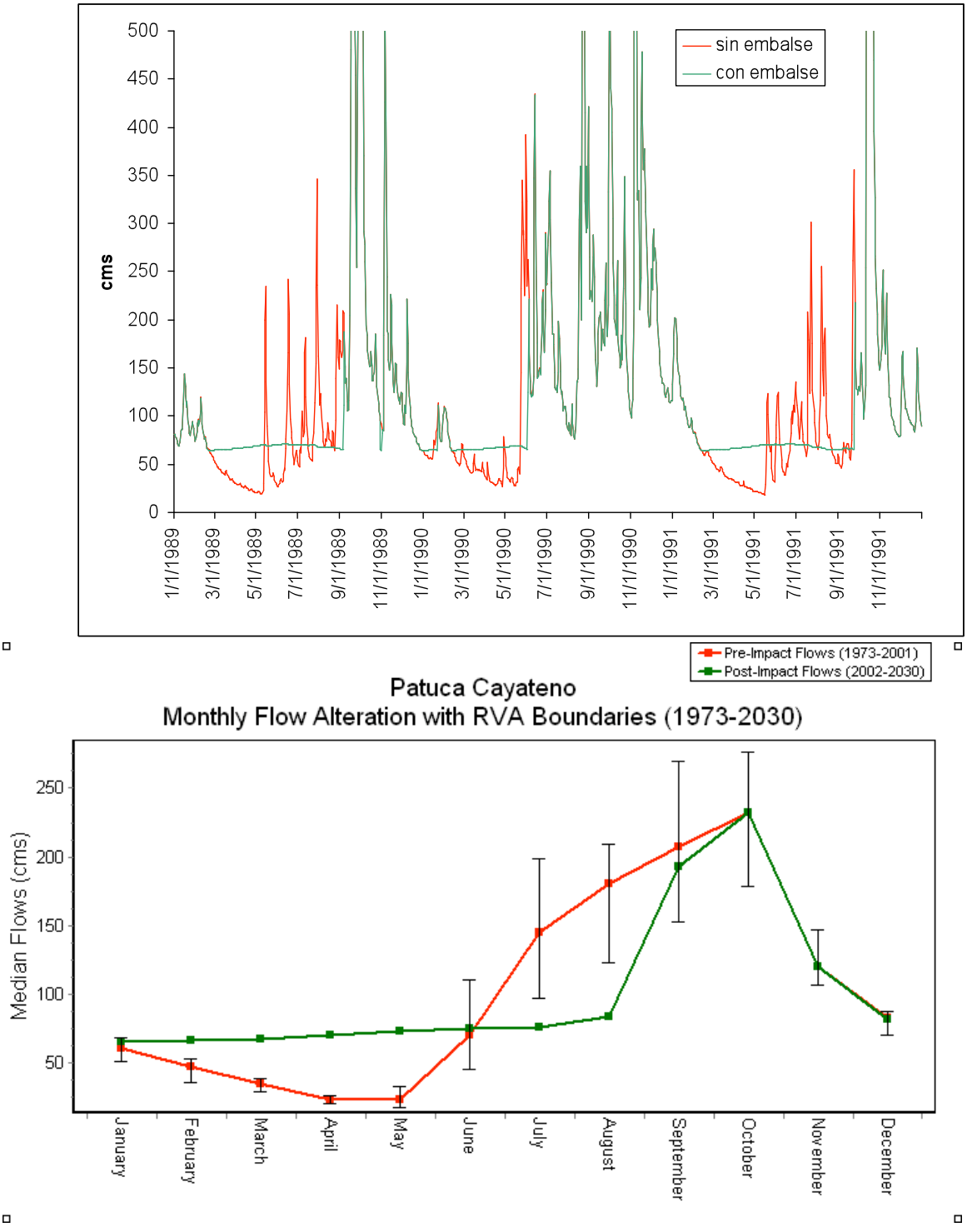

Figure 4. (top) Pre-dam flows at Cayetano (just below dam site), 1989 – 1991. Red line represents actual flow data; green line represents ENEE predictions of flow after construction of Patuca 3. (bottom) Median flows from the same site using 28 years of historical data (from IHA analysis of Opperman, 25 August 2006)

The river was running very brown with suspended sediment during this trip, but many respondents reported that the river clears up in the dry season. There were ample signs of bank failure and landslides, perhaps due to natural causes, but possibly also tied to the clearing of forests by humans and by Hurricane Mitch in 1998. The upper extent of Hurricane Mitch's flood waters was obvious on the forested slopes, because only young trees and shrubs grew within this zone (see Section 3.5 below). There were also signs of aggradation in some areas, despite the elevated wet season discharge (e.g., mid channel fine sediment bars, etc.). It was generally commented by older respondents that the river ran clearer in the past, but now attains an underwater visibility of only about 2.5 m in the dry season. The general impression I got from viewing the landscape and the river is that the sediment load is unnaturally high due to soil erosion from deforested slopes.

3.3. *Aquatic ecological communities*

During the eleven-day field trip, the fishes/ecosystems team conducted 16 interviews with individual and small groups of fishermen in 11 communities. In total, we administered the questionnaire to 29 individuals (Table 1). The species list that resulted from these interviews, was assembled from the positive identification of the fishes shown on the laminated fish cards, from prior experience in other rivers of the area (e.g., rivers in nearbye Belize), and from sources in the gray literature (Cruz et al. 2000). It is likely that the species reported as present by the respondents represents the cross section of the aquatic fauna from which the communities gain direct benefit in the form of food, meat, bait fish, etc., or which pose a threat to community well being (e.g., crocodiles, caimans). In other words, fishes with little utility or that are difficult to catch are likely not represented in our species list.

Fishing is accomplished by a variety of means throughout the human communities of the middle Patuca. The two most common methods of fishing in the Miskito and Tawahkan villages were hook and line (hand line) and the fishing bow and arrow ('flecha'), which was used from above the water to strike fishes seen near the banks or water surface, often times at night. Other methods used included underwater spear guns with snorkeling masks, cast nets, machete, and catching organisms by hand (e.g., shrimps, iguanas, turtles). Nets were more commonly reported by Mestizo respondents, particularly cast nets and seines. In the heavily used areas close to the dam site, some Mestizo fishermen reportedly also used agricultural chemicals and dynamite to capture fishes and shrimps.

3.3.1. Fish community composition

Twenty-six fish species in at least 17 families were reported to be present, and 17 non-piscine aquatic species were reported to be important to communities (Table 2). The majority of these species were used as food sources, indicating that the communities living in the middle Patuca River utilize a diversity of riverine animals for subsistence. The most speciose family of fishes reported by the communities was the cichlid family (Cichlidae), with 9 species reported present. The most important cichlids for the fishery were the blackbelt cichlid or 'tuba'(*Vieja maculicauda*), and naturalized African tilapia or "Kraha kna"(from photos, this appears to be the Nile tilapia, *Oreochromis niloticus*). Another important cichlid for food was the large, predacious wolf cichlid or 'sahsin' (*Parachromis dovii*). The cichlids reported in Table 2 were present throughout the entire study reach from Nueva Palestina to Kurhpa.

The next most speciose families were Centropomidae (the snooks) and Mugilidae (the mullets). Both of these families were reported to be important food fishes for communities. Species in these families were also reported to be present throughout the entire study reach. The snooks were represented by at least two (possibly three) species; the common snook or 'Mupi' (*Centropomus undecimalis*), which can grow to 45 lbs, and smaller snook species which are

Table 1. List of dates, locations, ethnic identities of villages, and respondents names, genders and ages. In total, 16 interviews with 29 individuals were performed. Twenty-one of the 29 respondents were male, and 20 of the respondents were older than 40 years of age.

Interview number	Date (2006)	Village	Ethnicity	Respondents (gender, age)
1	30 August	Kurhpa	Miskito	Lionel Flores (M, ~35)
2	31 August	Kurhpa	Miskito	Israela de Cayo (F, 40) Roman Cruz (M, 45)
3	31 August	Tukurun	Miskito	Alejandro Martinez Herrera (M, 63)
4	31 August	Tukurun	Miskito	Luis Martinez Herrera (M, 42) 3 other men
5	1 September	Pimienta	Miskito	Alberto Mena (M, ~65)
6	1 September	Pimienta	Miskito	Anastacio Honduras (M, 62) Iginio La Cayo-Coba (M, 49) Dionicio Honduras (M, 43)
7	1 September	Pimienta	Miskito	Ranulpa Vences Mendoza (F, 58) Rosa Cruz Verona (F, 61) Inez Vences Rosa(F, 35) Cristina Flores (F, 47)
8	1 September	Pansana	Mestizo	Marina Castillo (F, 38) Marcelino Sanchez (M, 32)
9	3 September	Krausirpi	Tawahka	Indalacio Sanchez (M, 56) Isidoro Sanchez (M, 54)
10	4 September	Krausirpi	Tawahka	3 anonymous respondents (M, 22, 31, 35)
11	5 September	Krautara	Tawahka	Teodoro Salvinas (M, 60)
12	6 September	Parahuas	Tawahka	Francisco Rosa (M, 25)
13	7 September	Boca del Cuyamel	Mestizo	Marvin Jeovany Duarte Sanchez (M, 30)
14	9 September	Aguas Calientes	Mestizo	Anonymous repondent (M, ~55)
15	9 September	Aguas Calientes	Mestizo	Ramon Hernandez (M, 53)
16	9 September	Arenas Blancas	Mestizo	Jose Acencio Rodriguez (M, 60)

likely to be juveniles of several species collectively called ‘callowah’, including the swordspine snook (*Centropomus ensiferus*; ID’d from photos of dried fish). The two mullet species reported are wide ranging species with migratory life cycles and pan-Caribbean distributions. Both mullet species—the bobo mullet or ‘cuyamel’ (*Joturus pichardi*), and mountain mullet or ‘tepemechin’ (*Agonostomus monticola*)—were reported to inhabit fast flowing currents and to be more common up the Rio Wampu than in the main river. Tawahkan and Miskito fishermen travel up the Wampu in the lenten season to catch ‘cuyamel’ and ‘tepemechin’ to sell and eat.

Several catfish species were reported to be important to the people of the middle Patuca, particularly because they are one of the only types of fishes that are easy to capture in the wet season. Several of these are as yet unidentified, but from fisherman reports that one of these fishes reaches sizes of at least 500 cm, it may be that the blue catfish (*Ictalurus furcatus*) is present, though this would represent a range extension from the presumed southern extent of its range in Belize. Another catfish that is sure to occur in the area (we captured it) is the filespine chulin or ‘Batchi’ (*Rhamdia guatemalensis*).