INFLUENCE OF SUBSISTENCE HUNTING AND ENVIRONMENTAL VARIABLES ON THREE CAIMAN SPECIES AT MATSÉS NATIVE COMMUNITY AND MATSÉS RESERVE, LORETO, PERU.

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Subsistence hunting is steal an important activity for many rural populations of Latin America and specially for indigenous people; Matsés people, in the Peruvian Amazon steal depends in great amount on this activity to subsist. Even when this activity is mainly directed to mammals and birds, reptiles can be considered commonly used species.

During August and September 2012, I collected data at the Yavarí river basin in order to determine the current status of the population of three caiman species in the Matsés territory. I also registered variables in order to describe the influence of subsistence hunting and some environmental variables on the distribution, abundance and structure of these species. The three species subject of this study were *Caiman crocodilus*, known by the Matsés as "*cachita ushu"(which literally translates as white caiman)*; *Paleosuchus trigonatus,* locally known as "*cachita shëshë*" (which literally means black caiman); and, *Melanosuchus niger,* known by locals as "*cachita pianquid*" (which literaly means dangerous caiman).

For a better understanding, this research is divided into three parts and each corresponds to one of its specific objectives: the first part aims to determine the current status of the local population of these three species; the second part is referred to the importance that these species have in the diet of the matses people; the third part analyses the relationship between environmental and human variables and the abundance, population structure and distribution of *Caiman crocodilus* and *Paleosuchus trigonatus*.

Main Objective:
To analyze the influence of subsistence hunting and environmental variables on three caiman species at the study area.

Specific Objectives:

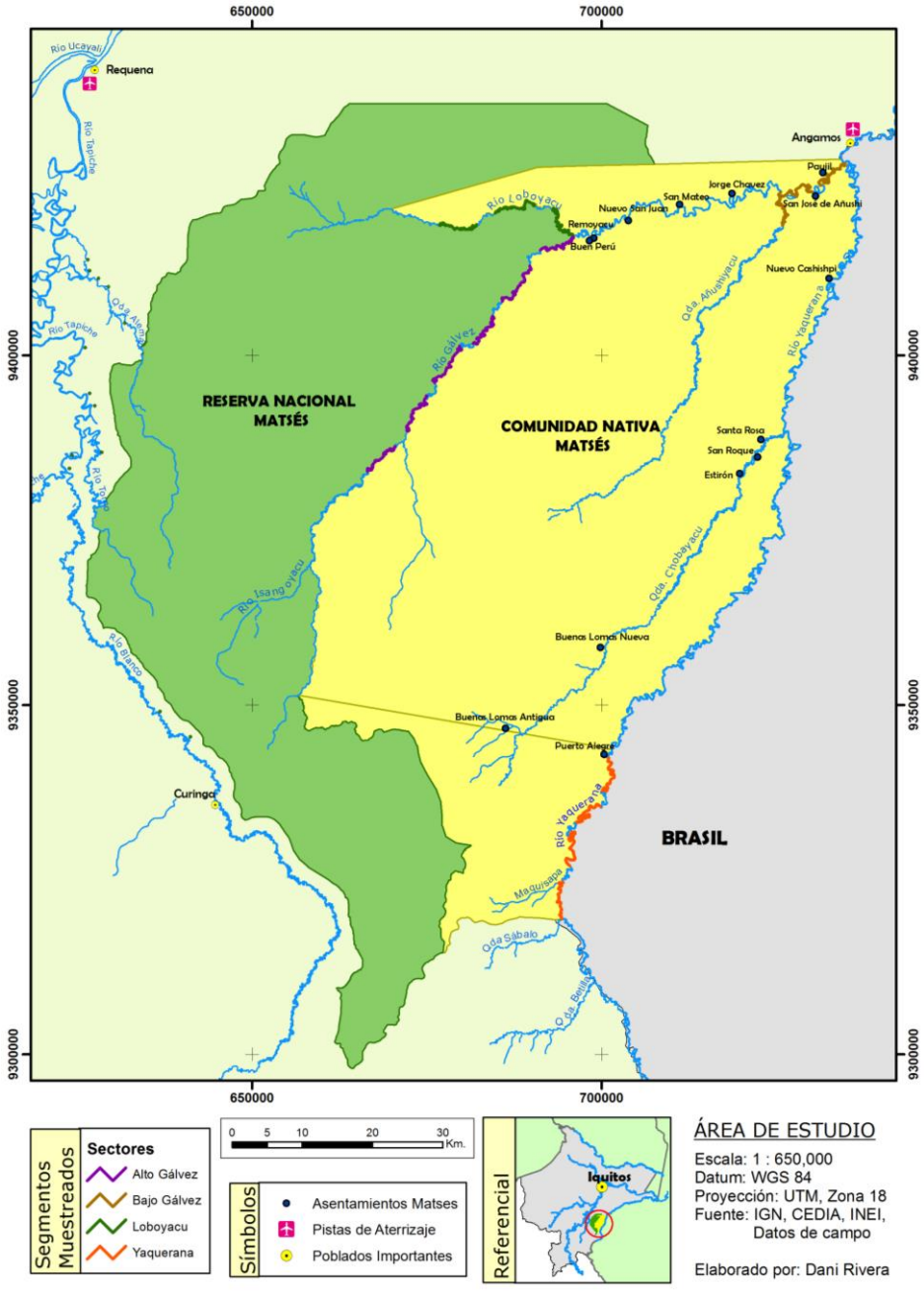
1. To estimate the abundance and structure of the population of three caiman species at the study area.
2. To characterize the current use of these species and the importance they have on the diet of this community
3. To determine the relationship between different variables, environmental and use, and the status of the populations of these species.
4. To propose management actions oriented to improve the harvest practices for the species that require them.

Methods

Study area

The study area corresponds to the ancestral territory of the Mátses people in Perú, currently the territory of the Matsés native community and the Matsés National Reserve.
Biological records were registered at the main streams of the Gálvez and Yaquerana Rivers, and also at the Loboyacu and Añushiyacu streams. In order to collect information on the importance of these species for the Matsés people, three workshops took place at different settlements of the community (Remoyacu, San José de Añushi and Puerto Alegre). Finally, I performed an interview to an old man from Puerto Alegre who has seen the changes experiences by the community in the last 40 years, since they established relationships with the rest of the national society.

In order to determine the abundance rate for these species, I performed nocturnal eye counts on 16 segments of the rivers and streams described above. I determined population structure from estimated longitude from nocturnal counts corrected by a correction factor established by capturing approximately 10% of total number of caimans registered. Sex ratio was also determined from the captured specimens. During nocturnal eye counts, I registered environmental variables. Other variables that can be understood as characteristics of the segment (river width, distance from closer settlement) were determined during segment recognition and from GPS information. As mentioned before, I collected harvest and importance on the diet information on three workshops performed in differend settlements, all of which were close to survey segments. From data collected during the night counts and with the use of statistical models (Generalized Linear Models), I measured the influence of different environmental variables and use variables (use intensity and distance to the nearest Matsés settlement) for *C. crocodilus* and *P. trigonatus* populations.



Results and Discusion

1. Population Status

Abundance

A total of 722 caimans were registered during night counts along 316 kilometers, which represents an abundance index of 2.28 caimans per shore kilometer (c/km). This total abundance index is considering the three caiman species and those records that could not be identified. From these three species the more abundant was *C. crocodilus*, with 476 records, which represents an abundance index of 1.50 c/km. The second species on abundance was *P trigonatus* with a total of 85 records wich represents an abundance index of 0.27c/km. *M. niger* was the rarest of all species with only 11 records.

C. crocodilus was more abundant on the segments of the high part of Galvez River closer to Remoyacu and Buen Peru settlements and on the segments of the high part of the Yaquerana River that are farther from Puerto Alegre settlement. They were rare at the low part of Galvez River (especially at Añushiyacu stream) and at Loboyacu stream. *P. trigonatus* were more abundant at the segments of the high part of Galvez River that are farther from the settlements and were rare at the low part of Galvez River and Yaquerana River. I only found *M. niger* at four out of the 16 segments sampled and it was always the rarest species.

The abundance indexes for *C. crocodilus* are similar to many others reported for similar areas, and even when other researchers have suggested that when *C. crocodilus* is common *M. niger* tends to be scarce due to competition or predation, it has not been probed. At this study, there is no evidence that might lead to that conclusion. *P. trigonatus* was also found in abundances similar to the ones reported for populations of similar areas under some protection, including Lago Preto Private Conservation Area at a lower part of the same basin. However, it is evident that this species was more abundant at the high Galvez River, where Matsés settlements are more distant, overlapping with an area they have preserved for tourism and that are not commonly visited by hunters. The rarest species found during the eye counts, was *M. niger,* but it does not necessarily means that this population is threatened or under any kind of pressure, it is possible that its abundance is related with habitat conditions and its abundance was always low.

Size structure

During eye counts I registered specimens of *C. crocodilus* between 40 and 220cm where small caimans were much more abundant. Most of records correspond to caimans between 50 and 60cm and more than 70% of observations correspond to caimans with lengths under 100cm in total length. Size distribution separated by sectors shows the same tendency were smaller individuals are much more abundant and bigger animal are less represented. This size distribution is common for this species and, even when some authors have suggested that it is product of past intensive harvesting; it is more likely to be a characteristic common in crocodilian species that share large reproduction rates, but also high predation rates on juveniles. This makes that, even when lots of caimans are born, just a few make it to adulthood.

In the other hand, *P. trigonatus* shows a different tendency on size distribution; for this species, individuals from 50-60cm are more abundant, but there is also an important part of population represented by bigger animals (between 110-150cm). Comparing different sectors, it is evident that bigger caimans are more common at the segments more distant to settlements in the Galvez River. This might be a consequence of differences on habitat use related to size (age related segregation), where bigger animals prefer places far from human settlements for they offer better habitat conditions (more food) or where they are less

disturbed, leaving less preferred places for smaller animals. Finally, I could not establish any tendency for size distribution for *Melanosuchus niger* for having few records for this species, however, it is important to mention that no animals under 100 cm of total length were found.

Sex ratio for the two most common species were clearly male biased. For *C. crocodilus* I found almost three males for every female (3.6:1), for *P. trigonatus* from the 13 animals captured, 12 were males and only one was a female. There were only 11 records for *M. niger* and from the two specimens captured, none was a female. In order to understand these results and any other related to habitat use, it is important to mention that this study was carried out only at rivers of different sizes, but other potential habitats for these and other crocodilian species like small streams and lakes, were not sampled. Probably an important part of these species populations, including young and females, can be found at habitats that were not surveyed. Different authors have reported sex related differences in habitat use for crocodilian species like *M. niger,* and this might also be the reason I have not found any female for this species and so little records for the other two.

2. Importance of caiman species for Matsés people

C. crocodilus and *P. trigonatus* were easily recognized for most of participants of the workshops for collecting information that took place at the settlements near survey areas; however, *M. niger* was recognized only for few people at the workshop that took place in Remoyacu, located near Alto Galvez and Remoyacu sectors. During this workshop they neither consider this species for the maps of the recognized distribution for these sectors. For this reason and because no individuals of this species were found at any of these two sectors, it is likely that this species is not commonly distributed at this part of study area.

On these workshops, participants were also asked to point out the places where caiman hunting is concentrated. Most of these places are located near Matsés settlements, except for Bajo Galvez sector, where main intensity of use corresponds to Añushiyacu stream, where San José de Añushi settlers have their farms and hunting camps. Use maps do not make any distinction between species, and because of this, some of the areas recognized as the most used and where caimans are intensely hunted like the segments near Remoyacu and Buen Perú settlements, are also the segments where *C. crocodilus* were more abundant. However they are also the zones were *P. trigonatus* are less represented. This can be explained by the preference of use for these species, because even when it is not the preferred meat, *P. trigonatus* is the preferred caiman species by the Matsés people.

In the other hand, *C. crocodilus* is one of the less consumed caiman species, because in all the meeting where consumption preference was consulted, it was always the second to last preferred meat type. If it is never or almost never consumed, it is understandable that this species is common in the areas of most intensive caiman hunting near the Matsés settlements, where *P. trigonatus* is rare or completely absent.

From the data collected in the workshops and from the information obtained in the interview to the Matsés elder, it is clear that the taboo over the consumption of *C. crocodilus* meat is turning more flexible at the Yaquerana river basin. Even when it is considered one of the less consumed meats by Puerto Alegre settlers, it is scarce near this settlement and turns more abundant at distant areas. In turn, the consumption of *M. niger* is non-existent or extremely rare in this community, eliminations caused by fear are also uncommon, and have only been reported for large animals located too close of Bajo Galvez settlements, which makes it unlikely that Matsés exploitation is one of the causes of this species scarcity.

3. Variables that influence the abundance and structure of caiman populations

The use of Generalized Linear Models (GLM), showed that none of the variables considered in this study, can adequately explain the abundance and distribution of *C. crocodilus. This is because the white caiman is* an opportunistic species, capable to survive and succeed at various environmental conditions as soon as it has enough food and space, and because it is not the main target of caiman hunting, it can be found at places with intensive hunting activity and near large settlements. For *P. trigonatus*, "distance to the nearest Matsés settlement", turned to be the variable with more influence on its abundance and distribution. The interpretation of this negative interaction is that this species is more abundant the farther from the settlements it is. The second most influential variable is water type, and its interpretation is that populations of this species are more abundant at black water[1], like the one present in most of Alto Galvez and Loboyacu segments.

With the use of these GLM, it was also determined that the different sizes of *C. crocodilus*, make a particular use of microhabitat. As an example, it is much more probable to find smaller animals inside water next to the shores, where they can easily receive parental care from their mothers. In turn, the biggest animals are more likely to be found on the shores, because having scarce natural predators, they can show their selves. For *P. trigonatus*, the variable with more influence over caiman size and distribution was "distance to the nearest Matsés settlement". The interpretation is that bigger animals are more likely to be found at the most distant places from Matsés settlements. This data support the thesis of differenced habitat use related to caiman size, which implies that bigger animals prefer more distant places, where they can find better resources (more food), and where they are less perturbed (no one is hunting them), leaving the less preferred places for smaller animals, where they get less resources and can be hunted at any time.

Probably a source-sink dynamic is supporting this *P. trigonatus* population, which means that reproduction takes areas located far from Matsés settlements and then, part of this population is migrating down the river, where they are consumed by Matsés people. In order to confirm this hypothesis, further studies should be made, related specially to caiman mobility.

[1] Black water: Common water type in the Amazon forest, characterized by its tea color and low pH level. It is relatively pour in sediments content and has a local origin.

General conclusions and recommendations

Even when *C. crocodilus* and *P. trigonatus* are not abundant enough to recommend commercial management, none of this species shows any evidence of being currently endangered. For both of them, the abundance of their population is similar to others reported for areas under diverse categories of protection, as in Lago Preto Conservation Concession and in Pacaya Samiria National Reserve. Also for both species, size structure shows a predominance of smaller animals which are much more common than big caimans. However, even though for *C. crocodilus* all sectors showed the same tendency, for *P. trigonatus* in some segments of the Alto Galvez sector, bigger animal were more abundant than smaller. This is evidence of differences in habitat use for this species.

Also, the evident male biased sex ratio for both species seems to be related to some kind of sex segregation. In order to completely understand the full structure (sex and size related) and dynamics of theses populations, further studies must include all potential habitats that were not registered during this research. For *M. niger* I could not establish any tendency in size structure or sex ratio, due to the small number of individuals registered.

Matsés people apply different pressures over the three caiman species considered in this study. Even when it is not one of the most preferred meats for the Matsés people, *P. trigonatus* is the most consumed caiman species because it does not have any cultural restriction over its consumption. In the other hand, there is a clear and present taboo onr the consumption of *C. crocodilus* and *M. niger meat.* Though, lately in some sectors of this community, people are starting to consume *C. crocodilus* meat, especially where *P. trigonatus* is scarce. I recommend establishing a monitoring plan for these three species in order to measure the changes in their use and to establish management interventions to prevent serious degradation of their populations.

During the workshops, it was established in the maps of use and known distribution, that *P. trigonatus* can also be found in small streams that were not surveyed during this research, but the use (hunting) of this species was concentrated in the rivers and main streams registered here. It is possible, then, that the pressure from subsistence hunting is being applied only over a fraction of this population (specially small and mid-size males). If further studies support the hypothesis of sex and size segregation, it would be a determining factor to establish a management strategy. From these preliminary results, my suggestion is to direct the subsistence use of this species to the rivers and main streams, in order to reduce the possibility of putting females in danger, because almost none was found at this environments. Another recommendation is to concentrate this activity on mid-size animals, because for this species it takes a long time to reach a large size that would have a chance of reproduction.

There is a clear interaction between the abundance and distribution of *P. triginatus* and the distance from the nearest Matsés settlement, where specimens are usually absent or extremely rear and small close to these settlements, and they tend to be bigger and more abundant in areas distant from the settlements. It does not necessary means that subsistence hunting from Matsés people is declining this species population. In order to establish the magnitude of the effect of their use, further studies including extraction rates and a periodical monitoring must be performed.

No interaction between the abundance of *C. crocodilus* and any of the use or environmental variables resulted from the statistical models. This is because this is an opportunistic species and at this moment, it is not the main target of subsistence hunting. Even when this species shows a relatively healthy population, at this moment, commercial management is not

recommended. Large animals, that normally support this activity, are not sufficiently represented. Further studies, considering a wider study area, may change this reality.

Commercial management for *P. trigonatus*, is not recommended either for two main reasons: 1) Currently there is not any market for the meat of this species, and 2) For a community like Matsés, whose key means of support depend on the products that nature offers, the subsistence use must be prioritized.

Alto Galvez segment overlaps with an area this community has reserved for Ecotourism, where harvest activities are restricted, this area might be the "source" for vertebrate species that are harvested in other areas of the community. I strongly recommend maintaining and reinforcing the protection of this area by communal agreements and coordination with Matsés National Reserve in order to guaranty the recruitment of this and other vertebrate species important for the community.

Finally, even when it is clear that caiman meat is not the preferred one by this people, and its consumption can be considered sporadic or marginal, this could change as soon as other vertebrate species, currently preferred, lessen their populations as has been reported for other species. In the same way, management plans directed to the recovery of more valued vertebrate species, will contribute to improve the conservation perspective for caimans.

Pictures:



Capture and handling of an adult male *Paleosuchus trigonatus*.
Alto Galvez Sector



Matsés guides holding a juvenile *Melanosuchus niger*.
Puerto Alegre Sector



Mapping caiman distribution and use. Workshop in Puerto Alegre



Local guide and Matsés Reserve Ranger learning the use of equipment for monitoring wildlife. Loboyacu stream