



Species assemblages and niche separation of amphibians within the flooded and transitional forests of the Yarapa-Tahuayo river basins.

Emma Docherty, Katy Upton and Moya Burns

The Loreto region of the Peruvian Amazon contains a network of tributaries of the Amazon and seasonally flooded forest known locally as Varzea forest experiencing seasonal rise and fall in water levels of around 10m, as a result of rainfall in the Andes. Community-based conservation dominates the landscape of Loreto with large community-based reserves, community co-managed reserves and indigenous territories covering 98,800 km². During high water season, which runs from December to June, around 75% of the reserves land mass will be flooded leaving only small patches of land called levees above water. This highly variable ecosystem creates several unique, permanent and semi-permanent habitats for amphibians, resulting in very interesting species assemblages and high abundances of specialist species within the area. During the high-water season, floating meadows grow around the edges of oxbow lakes and along the channels and rivers forming a semi-permanent habitat exploited by many anuran species and during the low water as the floating meadows reduce in size, more terrestrial habitat becomes available as well as small inland pools perfect for some species breeding habits.

South America holds the largest diversity and density of amphibians worldwide with the Amazon Basin holding a great proportion of this. Peru currently has 574 amphibian species, of which 556 are anurans, 15 caecilians and 3 salamanders (AmphibiaWeb.org accessed 08/10/2016). In recent decades', scientists have observed a significant number of population declines and extinctions of amphibians, which suggests a general Global Amphibian Decline (GAD) is taking place. At present, almost one-third of the world's 7,000+ described amphibian species are threatened with extinction representing 1,856 species. Declines have spread geographically and the numbers of species affected are still increasing. Many factors appear to be contributing to this decline, including habitat loss, pollution, extreme climatic events and diseases such as chytridiomycosis, caused by a devastating infectious fungal pathogen.

As yet, there is no evidence of amphibian declines in undisturbed lowland forests of the Amazon Basin (Catenazzi and May 2014), however there is a severe lack of baseline data and ongoing studies in lowland sites (Ramalho, *et al.*, 2016). This is of concern as many of the factors mentioned above that are contributing to global declines of amphibians are also occurring within the Amazon Basin, specifically habitat loss and extreme climatic events. In recent years, climate change has been having a huge impact on Pacaya-Samiria National Reserve, resulting in extreme periods of flooding and drought. It is predicted that the western Amazonia will have increases in precipitation, temperatures, as well as height and duration of flood pulses with hydrological cycles across the Amazon Basin becoming more erratic (Gloor, M. *et al.*, 2015; Zulkafli, Z. *et al.*, 2016). This in turn will affect availability of certain habitats at different times of the year which could affect life cycles of certain specialist species of amphibian present.

Basic information on species assemblages and ecology of amphibians within varzea forests is vital to understand what is happening to populations over time and because of these varying erratic climatic conditions. This study aims to build on baseline data on-going since 2012 (Upton, K. 2015), to increase knowledge and develop a more accurate picture of the unique species assemblages present within the Samiria River basin and their ecology. Projects could consider how species assemblages differ across the

macro-habitats and try to determine specialist and generalist species. Another could look into more detail studying niche separation within each macro-habitat. Climate change could also be linked into a project to determine whether changing habitat availabilities is influencing species behaviour and presence. The information collected could be used in conjunction with previous surveys to aid long-term monitoring. In addition, a greater understanding of the ecology of the various amphibian species found in the reserve would benefit conservation efforts both *in situ* and *ex situ* and help us predict vulnerabilities to future climatic change.

Methods

Data will be collected in the Loreto region of the Peruvian Amazon Basin, specifically at the Lower Yarapa River basin in the extensive forest belonging to the indigenous Cocama Indians that connects two major protected areas: the Pacaya-Samiria National Reserve and the Tamshiyacu-Tahuayo Regional Community Reserve. Community-based conservation dominates the landscape of Loreto with large community-based reserves, community co-managed reserves and indigenous territories covering 98,800 km². This study will survey amphibians on both main macro-habitats (terrestrial and aquatic) in the forests of the Yarapa-Tahuayo rivers.

Terrestrial Surveys

Visual encounter surveys (VES) will be used to census the amphibians present in the reserve, with both day and night transects conducted to understand the ecology of the species found. Diurnal transects will be carried out between approximately 8am-12pm and nocturnal transects between approximately 8pm-1am.

Groups of 4-5 researchers and field assistants will traverse established 500m transects with the help of a local guide to direct the team through the forest and assist in amphibian detection. Each transect will take between 1-3 hours to complete, depending on the number of amphibians encountered. During the VES all possible microhabitats will be searched, which include leaf litter, tree trunks, decayed logs, fallen palm leaves and bromeliads. Due to the cryptic nature of anurans the most systematic method of detection during diurnal surveys is disturbance of the vegetation. This will be achieved by methodically probing through the area directly in front of the observers, including up to approximately 2m on either side of the trail. For nocturnal surveys, however, a visual search by torchlight rather than probing through the leaf litter will be used. This is to reduce the risk of disturbing other potentially dangerous animals that are also active at night.

For each anuran encountered, several data recordings will be taken. Firstly, the species, as well as some metamorphic measurements such as SVL and weight will be documented. Also, observations of age class, sex and any evidence of reproductive activity will be noted. Next, identification photographs will be taken of all individuals for future reference and the amphibian can then be released. Finally, microhabitat information (eg. Leaf litter, tree trunk, palm leaf etc.), as well as temperature and humidity, height from ground, perpendicular distance from transect, an estimated distance on the transect and a GPS weigh point from where the individual was first observed. For all surveys, auxiliary data will be taken at the start and end of transects. Including transect number, start and end time, weather and lunar observations and number of participants.

Aquatic Surveys

To survey the amphibians present on the floating meadows, a small motorised boat will be used to reach randomly selected floating vegetation mats present on the edges of rivers, channels and lakes. The boat will be wedged into the raft of vegetation, and the engine cut, then researchers will use a head torch to collect every frog present within two meters either side of the boat over the course of 15 minutes.

For each frog detected, microhabitat (e.g. emergent vegetation, water lettuce, water hyacinth, etc.), height from the water, distance from the water's edge, temperature and humidity will be recorded at the time of capture. The frogs will then be placed into small plastic pots and lined up in order of capture until the end of the search time, when each individual will be identified and information taken as in terrestrial surveys.

A crude habitat assessment will be taken for each point surveyed involving the estimation of percentages of different plant species present within two, one meter squared plots taken either side of the boat. Total number of plant species present, maximum height of plants and distance from the tree line will all be recorded, as well as auxiliary observations as in terrestrial surveys.

Statistical analyses will compare the frog diversity between macro and micro habitat types, using density, abundance and diversity analyses. Density will be determined using DISTANCE analysis, a software programme that estimates densities based on transect observation data. Morphometric data and body weights will be compared for common species found in different habitats, to look for ecological trends. Diversity indices will be used to combine species richness and abundance measures in a single analysis. In addition, data from previous years will be available and allow for a longitudinal comparison between years to look at changes in diversity and abundance.

Suggested reading

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