



## Harlequin Toad Press Release

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In December 2003, the existence of a remnant population of variable harlequin toads (*Atelopus varius*) was confirmed in a remote section of the Fila Chonta, within the boundaries of Rainmaker Conservation Project. Subsequent to this discovery a long-term monitoring program for the remaining harlequin toads was developed by Dr Twan Leenders of Yale University's Peabody Museum of Natural History and Sacred Heart University, in close cooperation with the management of Rainmaker Conservation Project and MINAE. Due to the uncertain status of the population and the overwhelming media attention at the time of the discovery, communication about the status of the project has been kept to a minimum until more information became available and to avoid drawing unwanted and possibly harmful attention to the surviving *Atelopus*. This long-term monitoring program was implemented in 2004, and field research on the population commenced in January of 2005. The main purpose of the project is to accumulate and analyze critical biological and abiotic information on the remaining harlequin toads and their habitat, assess the risks that this population faces and ultimately to develop a conservation strategy to ensure its survival into the future.

This study is designed to collect the maximum amount of information with minimal impact on the population. Visits to the *Atelopus* habitat are kept to a minimum and the site is only surveyed twice yearly for a period of no more than 7 consecutive days and with a very small crew of researchers. This low-impact approach appears successful as during the most recent population survey in January 2007, at the start of year three of the monitoring project, the *Atelopus varius* population appeared stable and healthy still and its habitat showed no visible signs of disturbance.

Since January 2005 a network of automated data loggers has been continuously documenting the specific micro climate in the habitat of the toads. In addition, a wide array of habitat parameters is measured during each survey to determine critical values required for the survival of *Atelopus varius*.

The accessible habitat for this population comprises only an 800 meter stretch of a single stream and a small tributary. Within that area, the toads have only been found clustered in small pockets of suitable microhabitats within a 300 meter section of the stream, between 300-425 m above sea level.

A total of 107 observations of *Atelopus varius* have been logged since January of 2005, representing 26 unique individuals. Each individual toad is recognized based on a unique color pattern which is recorded in a population database. Although age-related color changes have been observed in individuals that have been tracked for two years now, the uniqueness of each individual's color pattern still allows for positive identification. In addition to the 26 known animals recorded during the surveys, three more harlequin toads were identified based on photographs taken prior to the start of the population monitoring. Although only 29 individuals have thus far been identified in the area, new animals are still being found on each site visit. Several individual *Atelopus varius* have been monitored over repeated surveys, and over time life expectancy, population structure and other demographic data can be derived from repeat surveys. Based on the currently available limited data, total population size in the survey area is estimated to range between 60-95 individuals.

Although no eggs or larvae have been documented from the site, there are indications that reproduction does take place. A juvenile less than one year of age was recorded in January 2005, a gravid female full of eggs was found during a 2006 survey, and sexually active males (recognized by the presence of nuptial pads on their inner digits) have been seen on several occasions. The general behavior of the animals observed, including territorial interactions and calling activity appears characteristic for a healthy population and consistent with published accounts of historic populations.

The chytrid fungus *Batrachochytrium dendrobatidis* has been implicated in the demise of many amphibian species in Central and South America, including that of many species of *Atelopus*. Non-invasive sampling of skin cells from individual *Atelopus* and from sympatric amphibian has been taking place since the start of the monitoring project. These samples are screened using histological and molecular techniques to detect potential presence of the chytrid fungus. Laboratory analysis of the skin samples has shown no sign of chytridiomycosis in the area so far. The low elevation of the site may be advantageous to the harlequin toads as *Batrachochytrium dendrobatidis* appears more prevalent in cooler, middle to high elevation habitats. The vectors for this aquatic pathogen are unknown still, but several documented cases exist where humans inadvertently transported this fungus on clothing or field equipment. Strict decontamination protocols are followed during the site surveys to minimize risk of infection. Likely the biggest threat that *Atelopus varius* currently faces is the risk of chytridiomycosis after contamination through careless entry into the habitat. Since the transmission mechanism of *Batrachochytrium dendrobatidis* is still largely unknown the associated risks are still poorly understood and it is crucial that human contact with the population is kept to the absolute minimum.

Apart from chytridiomycosis, some of the other risks that potentially affect the survival of *Atelopus varius* in the Fila Chonta are predation, habitat alteration and inbreeding. Any extremely small population is inherently vulnerable to predation. Due to the potent skin toxins found in *Atelopus varius*, few vertebrate predators exist. However, the effects of *Atelopus* toxins on invertebrate predators are unknown and some large arthropods may prey on these toads. In particular, large land crabs that are prevalent in the harlequin toad habitat have been observed to prey on small lizards and a predation attempt on a *Atelopus varius* by one of these crabs was observed on one occasion. The toad escaped relatively unscathed.

Due to the very steep gradient in the terrain, landslides occur frequently within the harlequin toad habitat. It has been suggested that these landslides could jeopardize *Atelopus* survival. However, it is clear from analysis of successional stages of vegetation that many land slides have occurred in the past and that the habitat recovers relatively quickly. Succession and recolonization of a very large landslide (covering almost 7% of the total survey area) which occurred in July 2005 is being monitored and its effect on stream characteristics and harlequin toad occurrence downstream from the area is assessed. Analysis of water and microclimate data directly at and downstream from the landslide show only minor effects and harlequin toad distribution patterns downstream from the landslide appear unaffected. Recent observations indicate that opening of the otherwise closed canopy above the harlequin toad stream due to large tree falls during landslides in fact may be beneficial to creating suitable habitat conditions as toads were seen clustered in tree fall areas.

Preparations are currently underway to analyze genetic variation, degree of relatedness and levels of heterozygosity in this population to assess whether inbreeding is likely to cause long term problems in this small and genetically isolated population.

As we have entered the third year of monitoring this remnant population of *Atelopus varius* it is becoming increasingly clear that this species persists in a small but seemingly stable and healthy population in the Rainmaker Conservation Project. Additional research in future years will increase our knowledge of the population size and its demographic structure, as well as its specific (micro) habitat requirements. Future research will hopefully provide answers on reproduction and recruitment rates in this population as well as provide insight in the genotypic composition of the population, information needed to make educated long-term conservation plans. Initial data shows that the habitat and prevailing microclimate in the Fila Chonta differs considerably from that known for historic populations (which were typically found at much higher elevations). Its isolation in a lowland setting and remote, inaccessible habitat seems to have spared this population from the detrimental effects of habitat destruction, release of non-native fish in streams and chytridiomycosis, factors that likely decimated other *Atelopus varius* populations in Costa Rica in recent times. Nevertheless, the surviving harlequin toads are still in an extremely precarious situation due to their very small population size and the limited availability of suitable habitat. Continued low-impact monitoring and development of an in-situ conservation strategy appear to be the most sensible solutions at this point, while simultaneously securing the area from potentially detrimental intrusion by people.

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