

The Frog Logger System  
Anuran Species Call Identification Protocol and the Baseline Assessment of Anuran Biodiversity, Community Composition and  
Community Activity at the  
Firestone Center for Restoration Ecology

Kelly Janes  
Baru, Costa Rica

## Abstract:

The overall purpose of this study was to create a protocol for analyzing baseline anuran biodiversity and community composition using the Frog Logger System. A secondary aim in this research was to look at nocturnal community activity. Anuran calls were recorded over a two-month period at several different sites within the Firestone Center for Restoration Ecology and an analysis protocol was developed using the Audacity music-editing program. Species calls were identified in the field and compared to the data collected over one night at a site observed to have a high level of anuran activity, the Duck Pond. Twelve different calls were identified and designated a number. Of these, eight calls, matching six species, were identified and confirmed in the field. Although results proved to be insignificant, as time limitations did not allow for replicate data collection, initially it appears that, at the Duck Pond habitat site of the reserve, the red-eyed tree frogs (*Agalychnis callidryas*) are the dominant anuran active in the early evening. This species is replaced by the hourglass tree frog (*Hyla ebraccata*) and the small-headed tree frog (*Hyla microcephala*) as the dominantly active anuran at this site later in the evening. Also abundant are the giant toad (*Bufo marinus*), the Smokey Jungle Frog or Central American bullfrog (*Leptodactylus pentadactylus*), and the common tink frog (*Eleutherodactylus diastema*).

## Introduction:

Located on the southwest coast of Costa Rica, the Firestone Center for Restoration Ecology (FCRE) is a 60 hectare reserve and field station originally made up of lowland moist rainforest until it was cleared in the 1950's and 1960's for cattle farming, leaving only a few patches of forest in riparian areas. After the 1990's when restoration began, the FCRE has become covered in mostly secondary tropical moist forest, bamboo and small areas of overgrown pastureland. The goal of the center is to restore the property to primary forest while giving undergraduate students research and fieldwork opportunities.

Due to a greater degree of vulnerability than many other creatures, amphibians are considered a "canary in the coal mine" for environmental damage. Amphibians are potential bioindicators of environmental health because they have both terrestrial and aquatic life stages, they are first herbivores and then become carnivore, and they have permeable skin. [1] By monitoring the diversity and relative abundance of anuran species, one can get an overall indication of environmental health.

Previously unknown populations of various species of frogs have been recently discovered with help from an electronic portable automated recording system. The system, dubbed "frog logging" by researchers, is a self contained, portable and weather resistant device that uses a timer to automatically turn on and off a Mp3 recorder. This recorder logs animal vocalizations, which usually occur at night, at field research sites. It uses a voice clock to audibly time stamp the beginning of each sampling interval. Dr. Michael Dorcas, a postdoctoral fellow at Savannah River Ecology Laboratory near Aiken, S.C, designed the "frog logger" with help from his father, Eugene Dorcas, an electrical engineer. He believes that due to their decline, amphibian populations need to more closely monitored. [1]

In this research project, protocol for anuran (frog and toad) species identification and species activity analysis was established using the Frog Logging System in conjunction with the Audacity music-editing program. Nocturnal anuran calls were recorded by the System over two months in six locations of the property.

Methods and Materials:

Site Selection and Data Collection:

Frog Logging jumpstarts with the placement and commencement of the Frog Logging System (hop to Appendix I for detailed instructions on the use of The System.) Field observations made during initial night frog safaris helped to discern where to set up the system for data collection. Data collection was started approximately at dusk between 1700 and 1900 hours and recording took place for ten minutes every hour for 6 hours. This was done to get a range of anuran activity from dusk to early morning allowing for a full spectrum of anuran activity over a night. To get an idea of the variation in anuran population composition and activities across habitats of the FCRE, six locations were chosen as sites for data collection. The four ponds including: the lower Dorm, Duck, Basilisk, Frog and Upper ponds were chosen as collection sites because water is an important part of the reproductive life cycle of these animals and anuran vocalizations are used exclusively for mating and territorial purposes. It was observed that all the locations had substantial anuran activity. The Bamboo Forest was chosen as another site to represent an ecologically disturbed habitat made up of exotic vegetation. Lastly, as it is regularly cleared and consists mainly of cropped exotic grasses, the Yoga Pavilion, which basically has a monoculture make up of its vegetation and has regular instances of intense human activity, was chosen to represent a habitat that is permanently disturbed. The time, date, weather conditions, and moon phase were recorded.

Initial frogging expeditions showed the Duck pond, located on the upper property, to be buzzing with anurans. For this reason, this site was chosen as the primary site for initial frog logging action. The System was commenced on July 14, 2006 at 1800 hours and preceded until 1200 hours. There was light cloud cover with a few light showers late in the evening and the moon was bright, waning three days past full, an average night as experienced by the researchers. Most importantly this night is one of the few in which six full recordings were completed by the System's recorder. Due to regular malfunctions of the controller, only one to three recordings were made on any other night making the Duck Pond (Fig. 1) recordings to be the most valuable for analysis.



**Fig 1.** The Duck Pond at dusk, FCRE upper property

#### Data Analysis:

##### Developing the Analysis Protocol:

Analysis began by looking at, and listening to, an entire ten-minute recording. This proved near impossible due to the explosive numbers of vocalizations. After extensive work, analysis metamorphosed into a protocol where by five random five- second intervals were chosen from each ten minute recording. Within each interval every distinct and different call was marked and labeled with a number. Identifying these calls was done in several ways: identifying audio and visual cues such as call frequency (the interval between calls), duration (the length in time of the call) and amplitude (the intensity of the call or, varying with distance and orientation of the anuran from the mic, how loud the call is). The frequency analysis provided by Audacity, which gives approximate Hz frequencies for selected calls in graphical and numerical form, was also used to compare known calls to unknown similar calls (refer to Appendix II for full details on analysis protocol). Examples of distinct calls found were compared to recordings of known species vocalizations recorded manually (refer to “troubleshooting for portable recorder” in Appendix I for full manual recording details).

##### Analysis of June 14<sup>th</sup>, 2006 Duck Pond Data Collection:

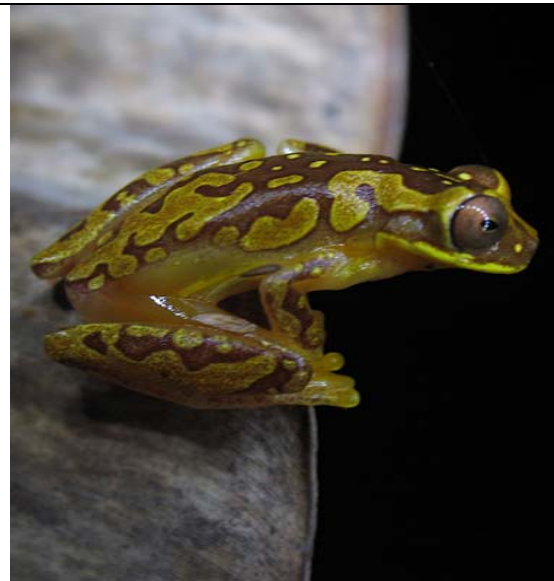
From the June 14<sup>th</sup> collection, twelve distinct calls were identified in the thirty (five-second) randomly chosen intervals of the six ten-minute recordings. A correlation coefficient Pearson’s test was done to test statistically the observation that the red-eyed tree frog is the most active anuran early in the evening to be replaced mostly by the hourglass and small-headed tree frog.

## Results and Discussion:

The analysis of nocturnal anuran activity recorded by the System established the identification of twelve unique frog and toad calls. Through regular frogging expeditions, and consequent field observation, manual recordings were made of known species vocalizing and these recorded calls were compared with established calls. Of these, eight calls were matched with six corresponding species where two species were found to have two distinct calls. The calls of the red-eyed tree frog (*Agalychnis callidryas*, Fig. 2), the hourglass tree frog (*Hyla ebraccata*, Fig. 3), the small-headed tree frog (*Hyla microcephala*, Fig. 4), the giant toad or cane toad (*Bufo marinus*, Fig. 5), the Smokey Jungle Frog or Central American bullfrog (*Leptodactylus pentadactylus*, Fig. 6), and the common tink frog (*Eleutherodactylus diastema*, Fig. 7) were identified. *Agalychnis callidryas* was found to have two distinct calls starting early on with four to five rapid chirps developing into one to two louder, sharper chirps. *Hyla ebraccata* was seen to have a slightly varied call depending on the individual's orientation to the microphone. In addition, the call of the diurnal species *Dendrobates granuliferus* (common name granulated poison-dart frog, Fig. 8) was also identified and manually recorded.



**Fig. 2** Red-eyed Tree Frog



**Fig. 3** Hourglass Tree Frog



**Fig. 4** Small-headed Tree Frog



**Fig. 5** Giant Toad (Cane Toad)



**Fig. 6** Central American Bullfrog (a.k.a. Smokey Jungle Frog)



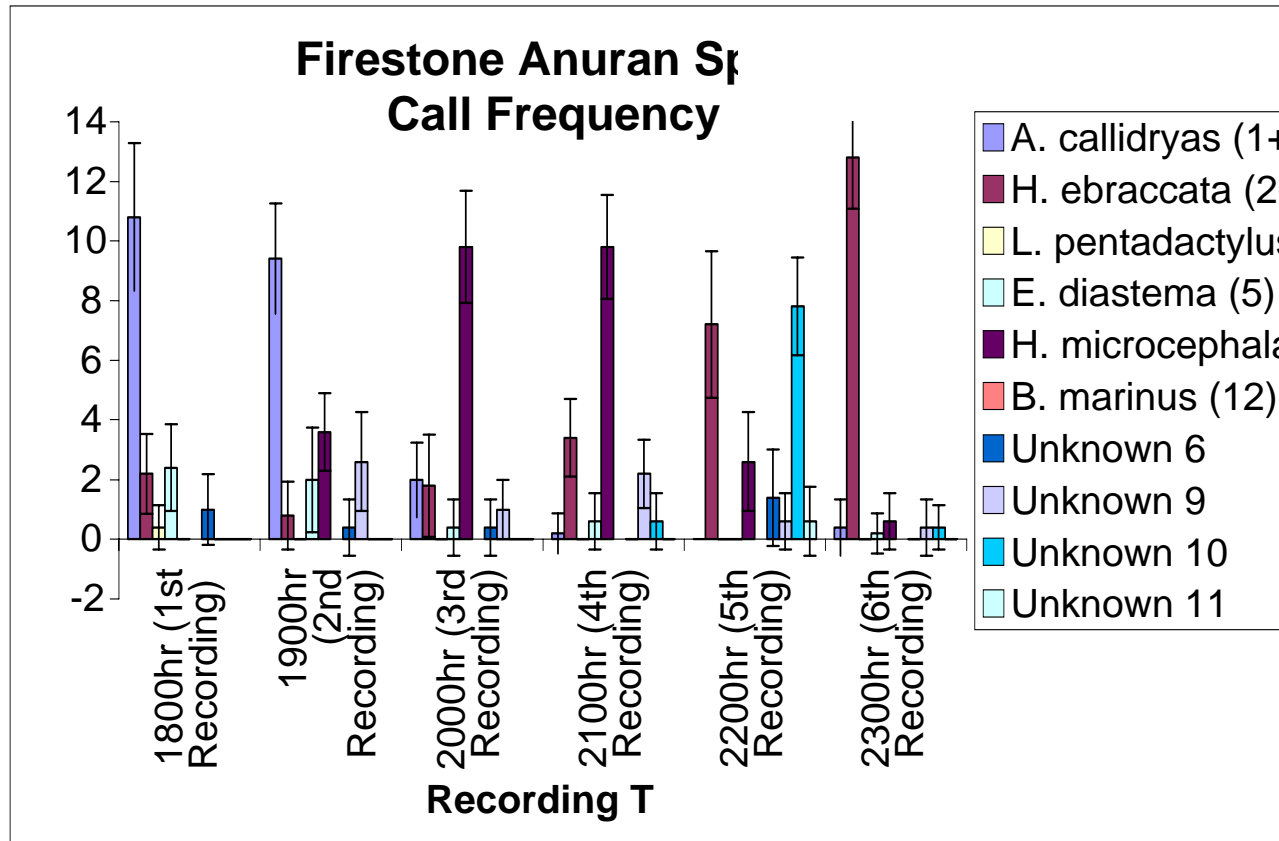
**Fig. 7** Common T/Dink Frog



**Fig. 8** Granular Poison-dart Frog

Examples of known calls were used in analyzing Frog Logging data collected on June 14 of 2006 from 1800 hours to 1200 hours at the Duck Pond. It was found, ostensibly, that *Agalychnis callidryas* are the most active anurans by leaps and bounds at this

local, early in the evening starting at dusk. This species was replaced as the most hopping caller with in a few hours of dusk by *Hyla ebraccata* and *Hyla microcephala* (Fig.9)



**Fig 9.** Average call density per species of anurans identified July 14, 2006 at the Duck Pond, FCRE Costa Rica.

Also accomplished during this study was a species list (Table. 1) that developed over the two months of research done at the FCRE. This includes not only the species recorded by the System but also those species captured and photographically documented.

Identification of species was done using the library of the FCRE. Identification keys were not used; do to our limited knowledge of amphibian anatomy. For the full catalogue of the anuran species identified and photographically documented, refer to Appendix III.

Scientific Name	Common Name	Location			Call Identified	Pictures: See Appendix III
		Observed	Captured	Day/Night		
Family: Bufonidae (Toads)						
<i>Bufo haematiticus</i>	Smooth-skinned toad	Visually and audibly at Program House, Dorm and ponds. They hang out on the patios.	1 captured on Waterfall Trail	Day	No	Yes
<i>Bufo Marinus</i>	Giant Toad (aka Cane Toad)		Captured at program house, dorm and ponds	Night	Yes	Yes: two variations
<i>Bufo valliceps</i>	Gulf Coast toad	Visually along all trails	3 - one on access road, two on North Fork Trail	Day	No	Yes
Family: Dendrobatidae (Poison-dart Frogs)						
<i>Dendrobates auratus</i>	Green and black poison-dart frog	Daily seen along trails	Often	Day	No	Yes: one juvenile



<i>Dendrobates granuliferus</i>	Granular poison- dart frog	Daily seen along trails. Our friend, Herpert, lives outside the dorm kitchen window and serenades us all day.	Often	Day	Yes	Yes
Family: Hylidae (Tree Frogs)						
<i>Agalychnis callidryas</i>	Red-eyed leaf frog	Visually and audibly at all ponds. They love the banana trees. Guaranteed to see them in the banana tree next to the Duck pond especially at dusk	Often	Dusk into late evening	Yes	Yes: multitudinous individuals, mating

<i>Hyla ebraccata</i>	Hourglass tree frog	Visually and audibly at all ponds. Guaranteed to see them calling in the grass along Duck Pond and in the plants right on the waters edge	Often	Night (start calling at or a little after dusk)	Yes	Yes: multitudinous adult individuals, one juvenile
<i>Hyla microcephala</i>	Small-headed tree frog	Visually and audibly at all ponds. Guaranteed to see them calling in the grass along Duck Pond and in the plants right on the waters edge		Night (start calling a little after dusk)	Yes	Yes: multitudinous individuals, female and males individuals, mating
<i>Scinax elaeochroa</i>	Olive tree frog	Visually on Program House walls, outside.	Often	Night	No	Yes: two variations

<i>Smilisca phaeota</i>	Masked tree frog	Adult observed visually on Program House wall, outside. Juvenile observed visually and audibly in grass along Access Road between the Yoga Pavilion and the Duck Pond	2 captured outside Program House, juvenile captured in grass next to Access Road	Night	No	Yes: three variations, one juvenile
Family: Leptodactylidae (Leptodactylid Frogs)						
<i>Eleutherodactylus brandfordii</i>	Brandford's litter frog	Visually along trails and throughout bamboo forest	Often	Day	No	Yes: three variations
<i>Eleutherodactylus diastema</i>	Common tink frog	Audibly from dusk until late night throughout property	1 captured in tall grass next to Duck Pond by J.A.Z.	Night	Yes	Yes
<i>Eleutherodactylus Fitzingeri</i>	Common rain frog	Visually along North Fork Trail and on path between the Program House and the Dorm	1 captured on the North Fork Trail, 1 captured on path between the Program House and the Dorm	Night	No	Yes: two variations

<i>Leptodactylus pentadactylus</i>	Central American bullfrog (aka The Smokey Jungle Bullfrog)	Visually along Waterfall Trail and Visually and Audibly at the Duck Pond.	It is not recommended to hold this species as the secrete copious amounts of mucus making them very slippery and which is known to be an irritant of the eyes and mucus membranes	Night	Yes	Yes
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**Table. 1** Anuran species list compiled in the summer of 2006 (June and July) at the FCRE, Baru, Costa Rica

The goal for future projects will be to continue collecting baseline data of anuran activity using the Frog Logging system. Further goals may include but are not limited to continued research on the progression of species activity over a night as well as other possible experiments. Other research topics that may be of interest may include looking at the way weather and/or moon phase effect anuran activity. Another possibility would be to look at community diversity and activity levels when comparing the different sites. All though all ponds are man made, each has varying degrees of ecological disturbance and recovery levels in the surrounding habitat. It may be interesting to compare the degree of disturbance and what consequently makes up the surrounding vegetation, soil composition, etc. to the community composition of the anuran populations. The Bamboo is made up of mainly exotic plant species and it would be interesting to see which species of anuran decide to makeup the community composition in such an exotic environment. The Yoga Pavilion provides a location in which to test if smaller populations of anuran with reduced community species diversity will be found in severely ecologically disturbed areas when compared to recovering areas of disturbed forest. This may include further data collection in a more diverse array of habitats found on the FCRE such as throughout the trail systems and in riparian areas. This would also include further frogging expeditions in order to collect manual vocalization recordings of species yet unidentified. Many species were caught, identified, photographically documented and released in the summer of 2006. Many were diurnal such as *Dendrobates granulifarris* but there are still many nocturnal species that have yet to be recorded and to have had their calls identified and

catalogued. The data collected in the summer of 2006 may be useful in addressing some of these questions but it would be beneficial to continue collecting frog logging data in future summer research projects. Happy Frogging!

Resources:

1. AIKEN, S.C. High tech device helps ecologists monitor locations of frogs and birds. UNIVERSITY OF GEORGIA SAVANNAH RIVER ECOLOGY LABORATORY NEWS RELEASE. <http://www.uga.edu/srel/logger.htm>. accessed August, 2006