

***Ex situ* methodology building for Neotropical caudates, with a special emphasis on three species of Costa Rican Moss Salamanders of the genus *Nototriton*.**

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**Executive Summary**

This project's goal is to generate much needed information on the *ex situ* establishment and captive husbandry techniques surrounding Neotropical salamanders. In the recent years, following the global awareness of amphibian declines, many *ex situ* programs have been initiated in attempt to conserve amphibian species, but most of these efforts have been focused primarily on only one of the three living orders of amphibians, that of anurans. Very little work has been devoted to rearing and breeding any of the 11 genera and nearly 280 species of Neotropical salamanders. Our goal is to take a step forward in this poorly entered realm by generating captive husbandry guidelines for four species of Costa Rican caudates, three species of moss salamanders of the enigmatic genus *Nototriton* (i.e. *N. gamezi*, *N. major*, and *N. tapanti*), and an epiphyllous *Bolitoglossa* species (*B. colonnea*), which is commonly found within the Costa Rican Amphibian Research Center's private reserve. Our hopes are that, this information may be adopted and extrapolated to other taxa within Costa Rica and other countries in Latin America wanting to initiate *ex situ* management plans for their own salamander species of special concern.

**Introduction**

Costa Rica is world renowned for its exceptional biodiversity and pioneering methods of natural resource protection. Part of this impressive biodiversity is that of its amphibians, with 199 species having been documented to date from within the tiny 51,032 square kilometer national territory of the republic of Costa Rica ([www.AmphibiaWeb.org](http://www.AmphibiaWeb.org)). Of these 199 species, 49 are salamanders, which make up 25% of the countries' total amphibian diversity. Costa Rica stands out from the rest of the countries on the planet by having more described salamander species for its size than any other (Boza-Oviedo *et al.* 2012).

Part of this impressive caudate diversity is a poorly known group of tiny species known as moss salamanders (genus *Nototriton*). "Because they are small, secretive, and cryptic, they remain among the most poorly known elements of the Costa Rican herpetofauna" (Savage 2002). Costa Rica is home to eight species of *Nototriton* (*N. abscondens*, *N. gamezi*, *N. guanacaste*, *N. major*, *N. matama*, *N. picadoi*, *N. richardi*, and *N. tapanti*) all of which are known to be endemic to the country and from within very restricted geographic ranges. Of the eight species one is considered Least Concern (*N.*

*abscondens*), two are listed as Near Threatened (*N. picadoi*, and *N. richardi*), three are listed as Vulnerable (*N. gamezi*, *N. guanacaste*, and *N. tapanti*), one is listed as Critically Endangered (*N. major*), and the last (*N. matama*) has not been evaluated due to its recent description in 2012. Two of the eight species were only known from single specimens, their holotypes (i.e. *N. major* [collected in 1975] and *N. tapanti* [collected in 1986]), but during recent field surveys we (Brian Kubicki and Aura Reyes) were successful in rediscovering both species in a previously unexplored ridge system in the Talamancan mountains (*pub. in prep.*). The Costa Rican members of the genus *Nototriton* get their common name “moss salamanders” due to the fact that they are known to principally live in the moss found in cloud forest environments (Good and Wake 1993). Being that they are direct developers, their entire life history is likely confined to these humid mossy environments. Unfortunately more detailed aspects regarding their natural history and reproductive biology are basically unknown due to their secretive existence and general lack of detailed studies. This project also offers an extremely unique and important opportunity to learn a great deal about the poorly known biology of this genus by facilitating the observation of specimens and behaviors in captivity.

The genus *Bolitoglossa* has the highest species diversity among caudates not only in Costa Rica (26 species), but in the Neotropics (121 species). We will also be initiating exploratory efforts in establishing captive husbandry techniques with an epiphyllous species that is commonly encountered within the Costa Rican Amphibian Research Center’s private reserve, that of *Bolitoglossa colonnea*.

The Costa Rican Amphibian Research Center is known to have been successful in establishing pioneering methods and techniques regarding *in situ* and *ex situ* management of amphibian species native to Costa Rica since its start back in 2002. This project herein will be focused on establishing captive husbandry techniques with three species of *Nototriton* (i.e. *N. gamezi*, *N. major*, and *N. tapanti*) and *Bolitoglossa colonnea*. We are very excited to have this opportunity to establish knowledge regarding the *ex situ* management practices of Neotropical caudates. Information generated through *in situ* ecological research and *ex situ* management may provide the tools to further future efforts for Neotropical caudate conservation plans.

### **Anticipated Outcomes**

- Generate and publish much needed and lacking captive husbandry guidelines for Neotropical caudates, starting with a special emphasis on selected species of *Nototriton* and *Bolitoglossa* salamanders of Costa Rica. The husbandry guidelines created through this pioneering work may be adopted and used in forming *ex situ* management plans for other Neotropical caudates within Costa Rica and other Latin American countries.
- Form potential captive breeding groups of three species of moss salamanders (*Nototriton gamezi*, *N. major*, and *N. tapanti*), including two IUCN Red List species under the category of Vulnerable and one listed as Critically Endangered.
- Further the knowledge regarding the general biology of secretive and enigmatic Neotropical caudates.

## **Methodology**

### ***Field Work***

Field trips will be conducted to sites where we have previously discovered extant populations for the three species of *Nototriton* contained herein. The field trips will have two planned objectives. The first objective will be to obtain further information on the general ecology of the microhabitats in which these salamanders are found, especially the physical parameters to better allow us replicate the most optimal conditions in captive experimental systems. The second objective will be to collect a small quantity of individuals to begin *ex situ* husbandry research. Due to the fact that this project is focused on developing captive husbandry techniques in salamanders that have never been worked with in captivity we will limit potential population impact by restricting our collection to a maximum of 10 individuals per species.

### ***Ex Situ Program***

This *ex situ* project will be based at the Costa Rican Amphibian Research Center in Guayacán de Siquirres, Costa Rica. As mentioned above there is basically no information available regarding the general captive husbandry of Neotropical caudates, so we will be experimenting with the manipulation of different physical parameters and set ups to find the ones that provide us with the highest success in first managing *ex situ* groups of the proposed species, and second hopefully eventually allowing us to be successful in establishing captive breeding populations.

In order to have representatives from both clades of the genus *Nototriton* present within Costa Rica (*Nototriton picadoi* species group [species selected for this study include *N. gamezi* and *N. major*] and *Nototriton richardi* species group [species selected for this study include *N. tapanti*]), we are attempting to establishing *ex situ* groups with three species; *N. gamezi*, *N. major*, and *N. tapanti*. During previous explorations within the range of *N. gamezi* we have been successful in discovering numerous individuals. *Nototriton gamezi* will initially be our principal species of focus due to our confidence that we will be able to obtain sufficient individuals to initiate our *ex situ* methodology building, in addition to it being listed at a lower level of concern. We will also be making return visits to the sites we have rediscovered both *N. major* and *N. tapanti* in attempts to locate and collect founders of these species as well.

As mentioned above *Bolitoglossa colonnea* is a species commonly encountered during nocturnal surveys within the C.R.A.R.C. private reserve, so obtaining founders for *ex situ* studies should be possible during the first block in the proposed timeline below (July-December 2013).

### Budget

Category	Item/Amount	AARK	C.R.A.R.C.
Field Study/Collections	Field vehicle, \$10 per day/15 days		\$150
	Gasoline, \$15 per day/15 days	\$225	
	Temp Laser Gun	\$100	
	4 Data Loggers @\$50 each	\$200	
	Project Leader and Team Member salaries @\$100 per day for 15 days		\$1500
	Field Assistants 2@\$20/day 15 days	\$600	
	Collection containers/equipment		\$300
	Lodging, \$40 per day/15 days	\$600	
	Food, \$20 per day/15 days	\$300	
	Misc Field Equipment		\$500
<i>Ex Situ</i> Preparation	1/10 hp Chiller	\$500	
	Water circulation pump	\$125	
	Power heads		\$100
	Aqua Controller jr.	\$250	
	Wood for stands \$2 per inch/125 inches		\$250
	Glass and other misc. tank supplies	\$300	\$300
<i>Ex Situ</i> Management	Utilities, food colony supplies, and other <i>ex situ</i> maintenance costs over two projected years	\$1500	\$2500
<b>TOTAL</b>		<b>\$4700</b>	<b>\$5600</b>
<b>Percentage of Costs</b>		<b>45%</b>	<b>55%</b>

### Timeline

Activity	July-December 2013	January-December 2014	January-December 2015
Field Study	X	X	
Field Collection	X	X	
<i>Ex Situ</i> Preparation	X		
<i>Ex Situ</i> Management	X	X	X
Publications		X	X

### References

AmphibianWeb (2013) Information on amphibian biology and conservation. Berkley, California: <http://www.amphibiaweb.org> (Accessed: April 20<sup>th</sup>, 2013).

Boza-Oviedo, E., S. M. Rovito, G. Chaves, A. Garcia-Rodriguez, L. G. Artavia, F. Bolanos, and D. B. Wake. 2012. Salamanders from the eastern Cordillera de Talamanca, Costa Rica, with descriptions of five new species (Plethodontidae: Bolitoglossa, Nototriton, and Oedipina) and natural history notes from recent explorations. *Zootaxa* 3309: 36-61.

Good, D. A. and D. B. Wake. 1993. Systematic studies of the Costa Rican moss salamanders, genus *Nototriton*, with descriptions of three new species. *Herp. Monogr.* 7: 131-159.

Savage, J.M. 2002. *The Amphibians and Reptiles of Costa Rica*. The University of Chicago Press, Chicago, U.S.A. 934 pp.