

COSTA RICAN AMPHIBIAN
RESEARCH CENTER



Costa Rican Amphibian Research Center



**“Dedicated to the Conservation and Biological
Research of Costa Rican Amphibians”**



A male Crowned Tree Frog (*Anotheca spinosa*) peering out from a tree hole.

Text by: Brian Kubicki

Photography by: Brian Kubicki

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Mailing Address: Apdo. 81-7200, Siquirres, Provincia de Limón, Costa Rica

Telephone: (506)-8889-0655, (506)-8841-5327

Web: www.cramphibian.com

Email: crarc@yahoo.com

Cover Photo: Mountain Glass Frog (*Sachatamia ilex*), Quebrada Monge, C.R.A.R.C. Reserve.

Costa Rica is internationally recognized as one of the most biologically diverse countries on the planet in total species numbers for many taxonomic groups of flora and fauna, one of those being amphibians. Costa Rica has 190 species of amphibians known from within its tiny 51,032 square kilometers territory. With 3.72 amphibian species per 1,000 sq. km. of national territory, Costa Rica is one of the richest countries in the world regarding amphibian diversity density.

Amphibians are under constant threat by contamination, deforestation, climatic change, and disease. The majority of Costa Rica's amphibians are surrounded by mystery in regards to their basic biology and roles in the ecology. Through intense research in the natural environment and in captivity many important aspects of their biology and conservation can become better known.

The Costa Rican Amphibian Research Center (C.R.A.R.C.) was established in 2002, and is a privately owned and operated conservational and biological research center dedicated to studying, understanding, and conserving one of the most ecologically important animal groups of Neotropical humid forest ecosystems, that of the amphibians.

IT IS THE FIRST OF ITS KIND IN COSTA RICA.



A male Red-eyed Stream Frog (*Duellmanohyla rufioculis*), a species endemic to Costa Rica.

The C.R.A.R.C. was started to further biological studies and conservation efforts directed specifically at the Costa Rican amphibian fauna, and one of their most vital habitats, that of the low-mid elevation rainforests of the Atlantic slopes of the Talamanca Mountain Range. Such research and conservation is crucial for many species that are currently struggling to survive in the ever-changing environment.

The C.R.A.R.C. is nestled in the Caribbean foothills of northeastern Talamanca, near the small town Guayacán de Siquirres. It is located nine highway kilometers from Siquirres, right on the National Highway 10, which leads from the Caribbean lowland town of Siquirres to Turrialba. It is easy to get to the center, being only two hours from the Costa Rica capital of San José, ten minutes from Siquirres, 45 minutes from Turrialba, and less than an hour from Puerto Limón. Access from these towns is along blacktopped highways. Sorry, there are no dusty pothole-filled dirt roads.



Image showing the location of the C.R.A.R.C within the Republic of Costa Rica. Image courtesy of NASA.

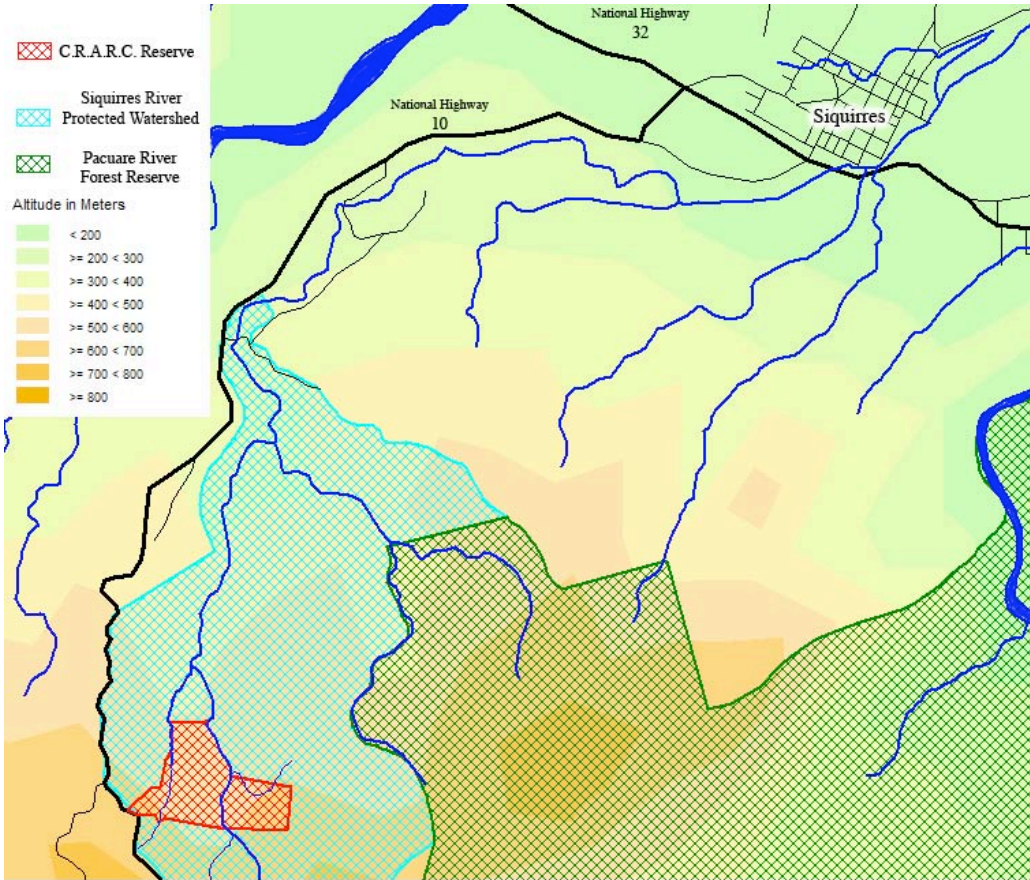


Image showing the proximity of the C.R.A.R.C. and its private reserve to the town of Siquirres.

The Role of Natural Reserves in the Future of Biological Conservation.

Small to medium-sized reserves owned and operated by private individuals or small organizations can play a crucial role in the conservation of critical ecosystems and endangered species due to more flexibility in land management policy and a better utilization of financial resources.

The C.R.A.R.C. owns and operates two biological reserves; one is located in Guayacán de Siquirres, and the second in Altos de Pacuarito. The two reserves have a combined total area of 77 hectares, or 191 acres. The properties were bought and dedicated as private reserves because of their biological diversity and conservation importance. Both reserves are connected to large sections of forest, which is crucial for the continued survival of the flora and fauna. It is vital that a reserve connects to larger sections of healthy forest for metapopulation support and continued genetic diversity by gene flow dynamics.

Private Reserves of the Costa Rican Amphibian Research Center.

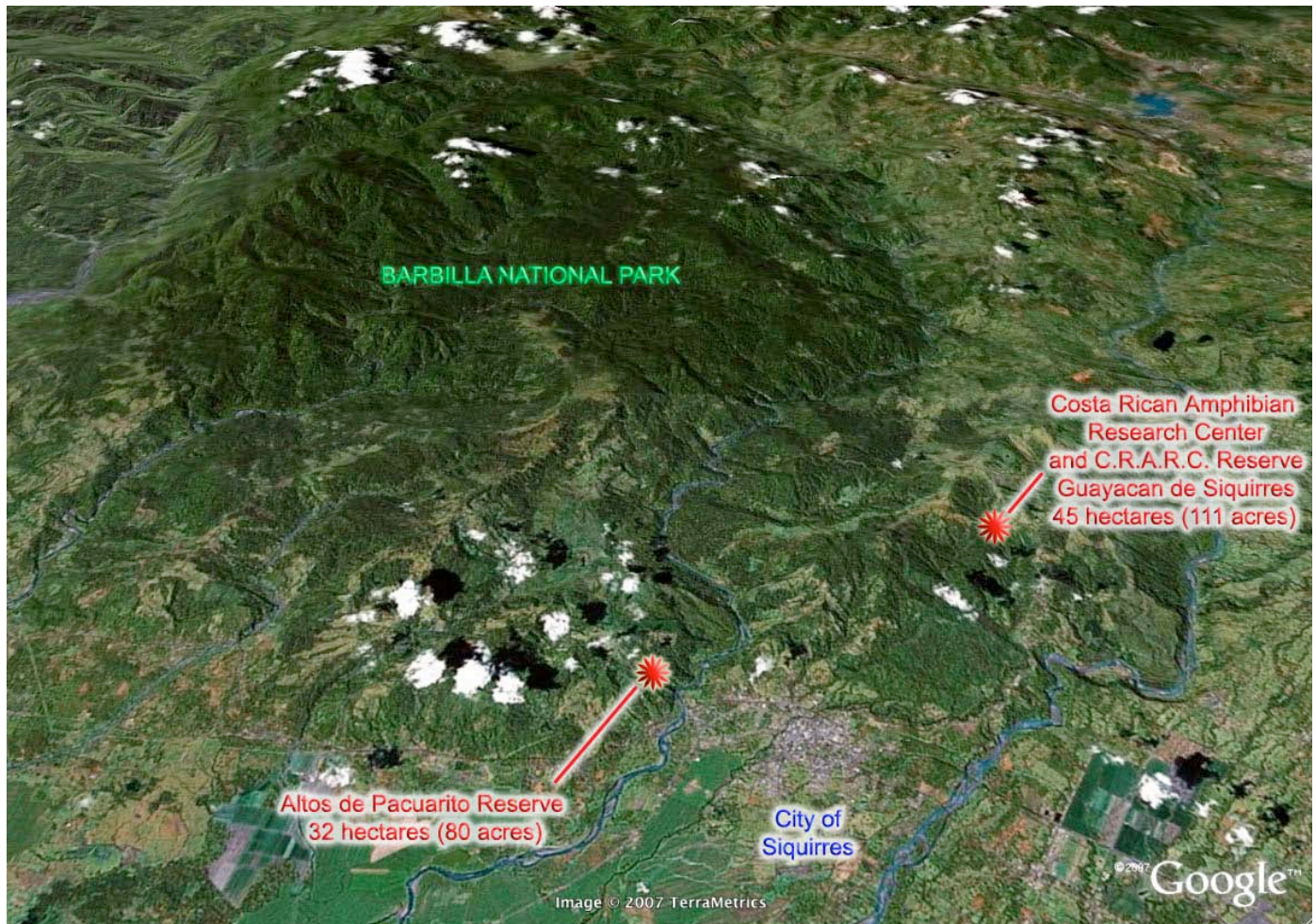
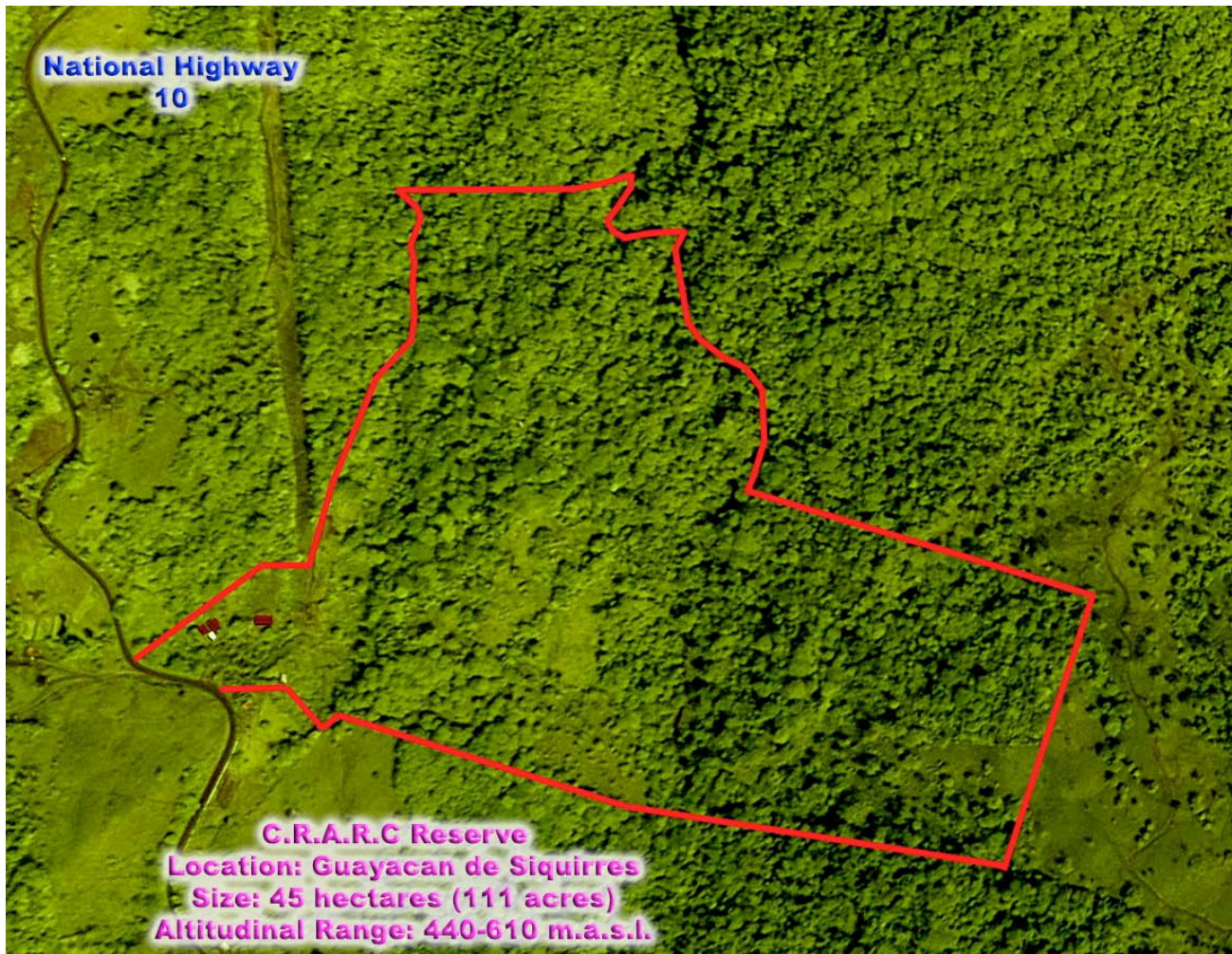


Image showing the location of the two private reserves owned and operated by the C.R.A.R.C. Image courtesy of Google Earth.

C.R.A.R.C. Reserve

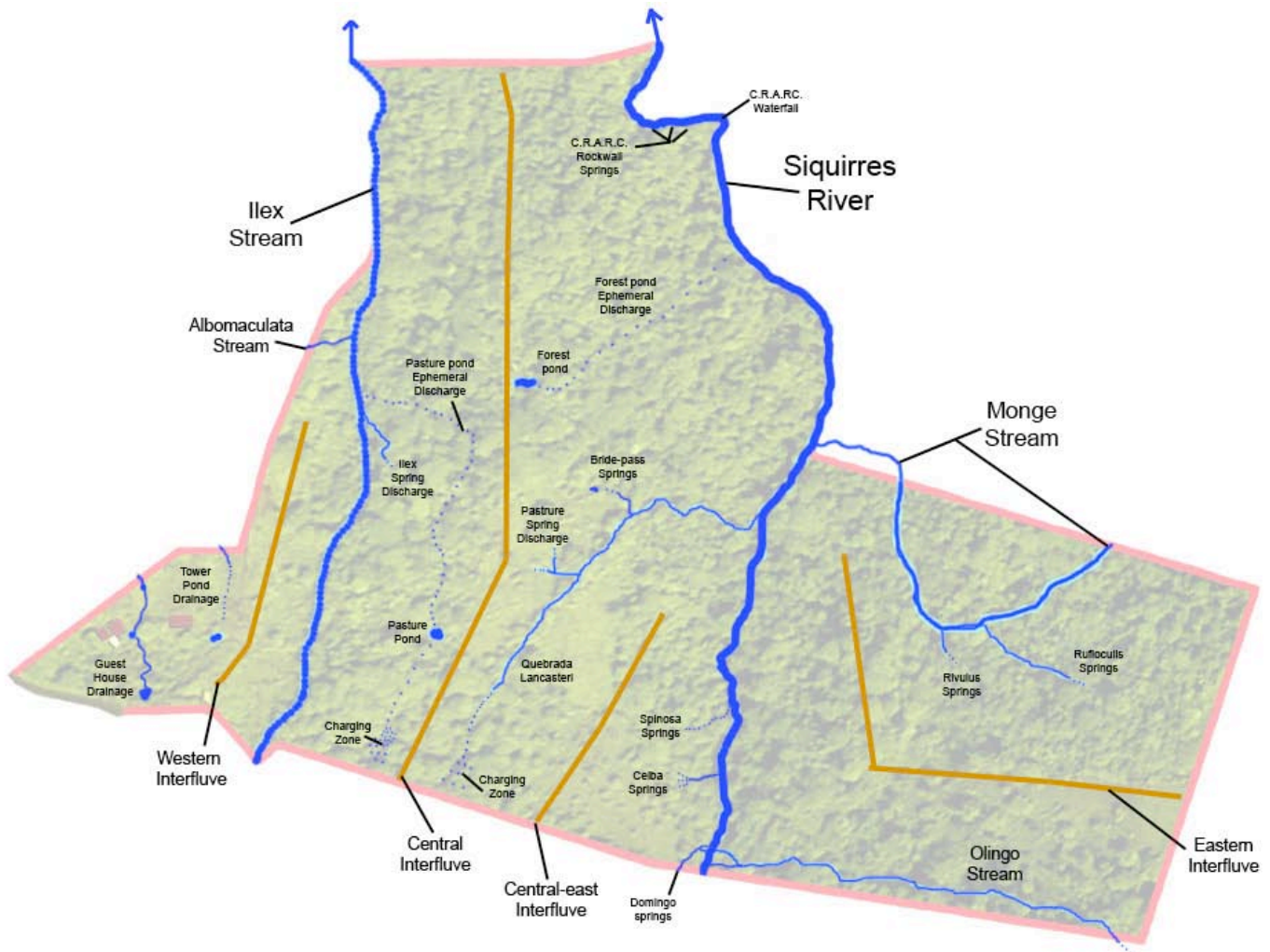


The original 35 hectares property of the C.R.A.R.C. was purchased in September of 2002. In March of 2008, we were able to purchase an additional property that borders the C.R.A.R.C. directly to the south and has a total area of 10.6 hectares.

Prior to being purchased in 2002, the land that made up the original 35 hectares of the C.R.A.R.C. had a mixture of land use. Roughly 5000 sq. meters (half a hectare) bordering the highway was planted with coffee and bananas. To the east of the coffee and bananas there was a small section of pasture, roughly 2 hectares in size, which was inhabited by four cows. Along the southern border, towards the center of the property there was an additional section of roughly 2.5 hectares of pasture. The remaining 30 hectares were covered in mixture of secondary and old growth forest. After purchasing the property in 2002, the cattle were removed, along with the majority of coffee and banana plants. We immediately began the task of replanting native species of trees and herbaceous plants on much of the disturbed areas of the property. The previous owner had a permit to log a section of forest, but we were able to obtain the property before any logging took place, and as a result save that section of forest.

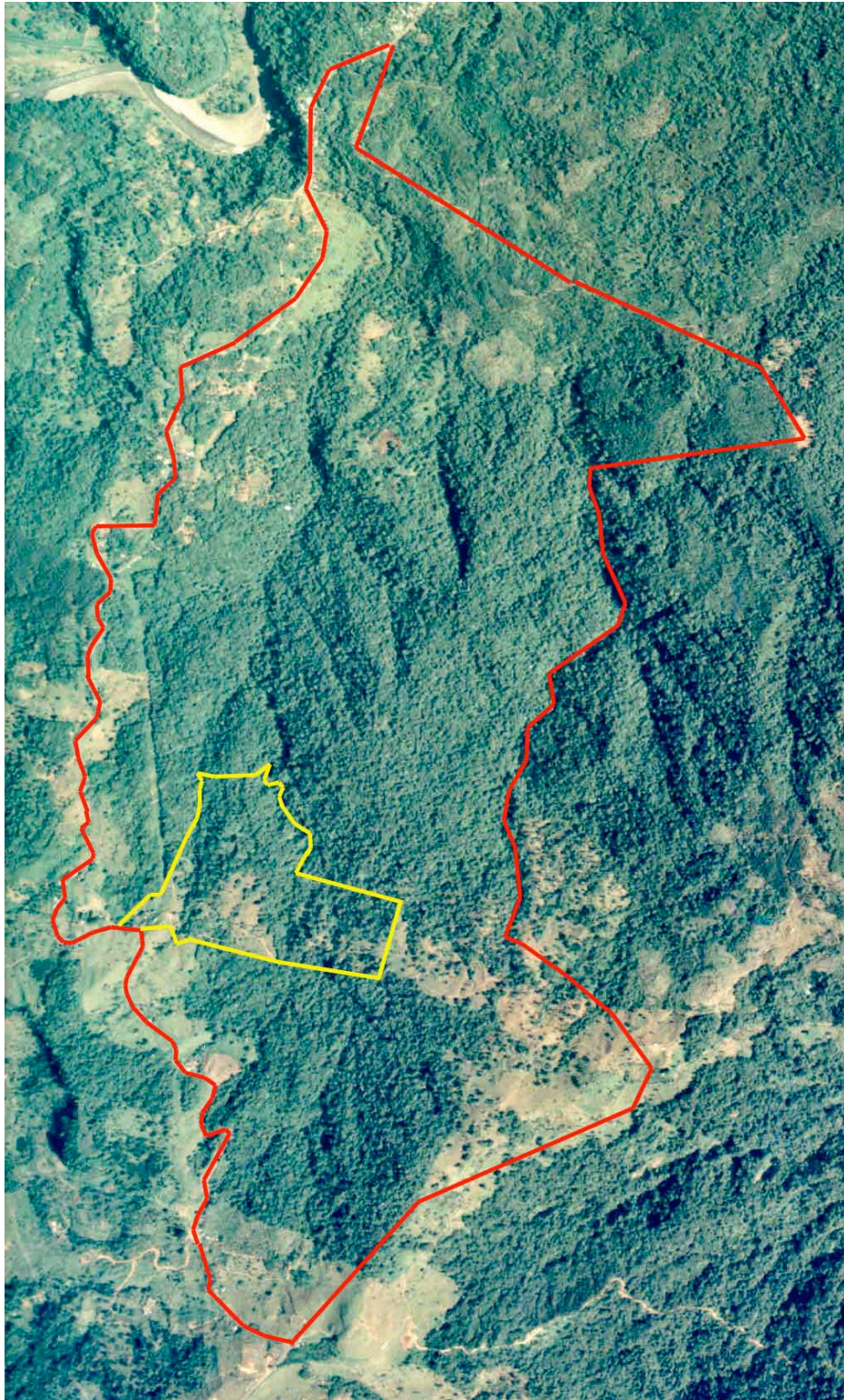
The 10.6 hectares piece bought in March of 2008 is primarily abandoned pasture and secondary forest. There is a small strip of old-growth riparian forest along the Siquirres River. This property has some important hydrology aspects, which include two small streams that originate within its boundaries, and a catchment basin of a small stream that starts on the original C.R.A.R.C. reserve.

Hydrology of the C.R.A.R.C. Reserve

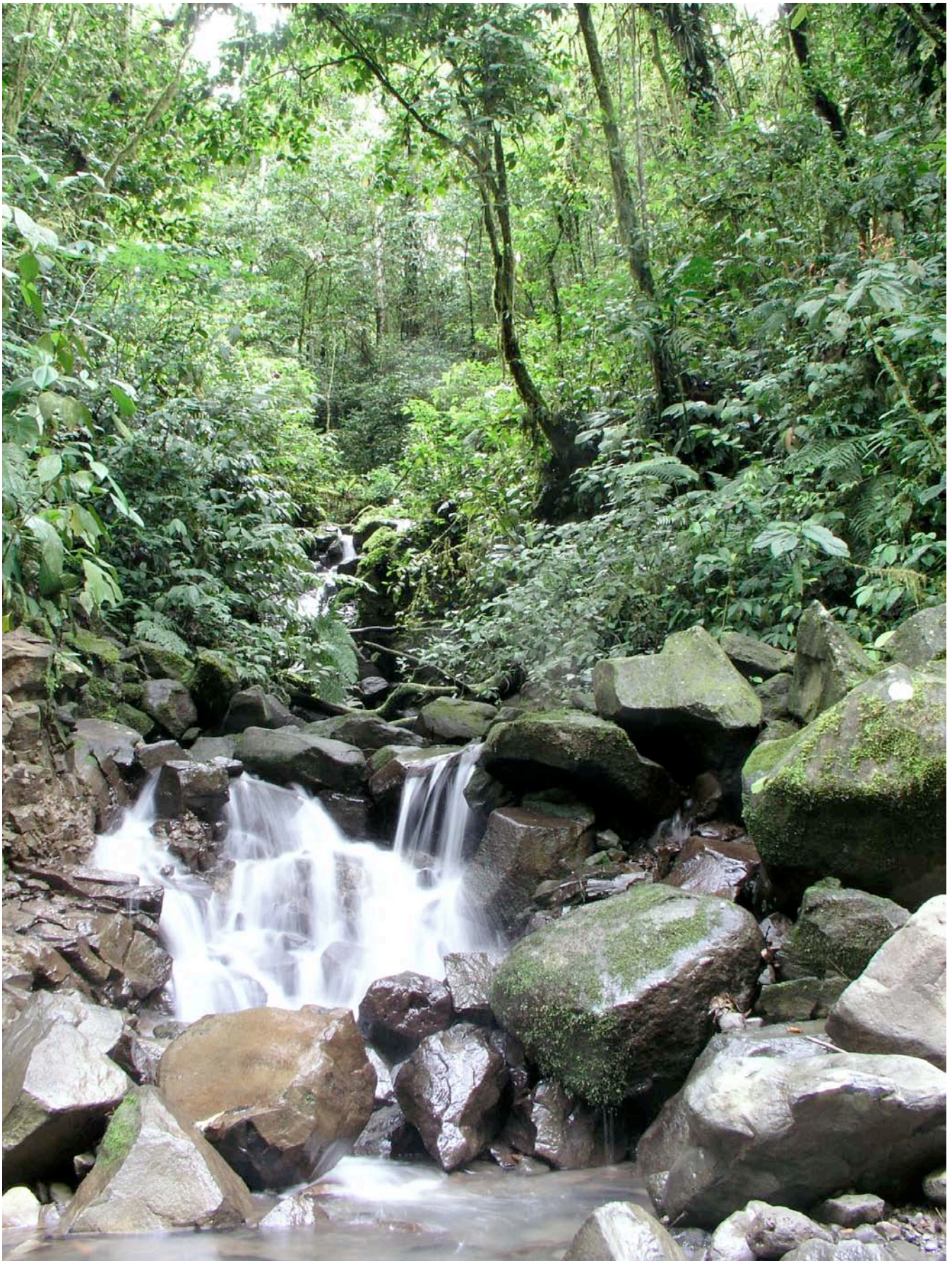


The C.R.A.R.C. reserve has numerous streams and the Siquirres River flowing through it. Several of the smaller streams actually originate within the reserve's boundaries. The upper section of the Siquirres River Valley is a very important watershed, and in 1995, the Costa Rican government declared 681 hectares in the headwater region as a protected area, named the "Zona Protectora Cuenca Río Siquirres".

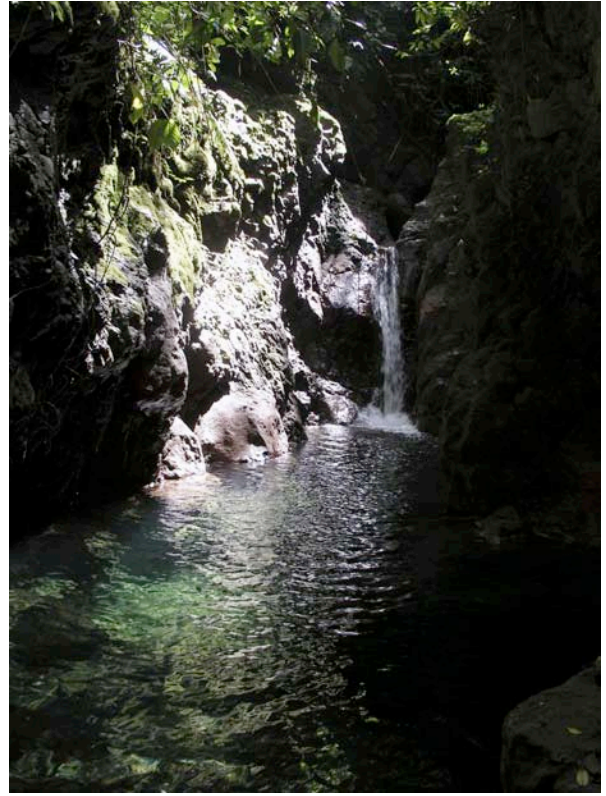
The Siquirres river has very clean high quality water, low in dissolved solids and nutrients, this is the main reason it was chosen to supply the drinking water for the city of Siquirres. The majority of the Siquirres river's tributaries originate in forested areas, including the Siquirres River itself.



Aerial photo (1998) showing the Z.P. Cuenca Rio Siquirres (red), and the location of the C.R.A.R.C. reserve (yellow).



Quebrada Monge at the union with Río Siquirres.



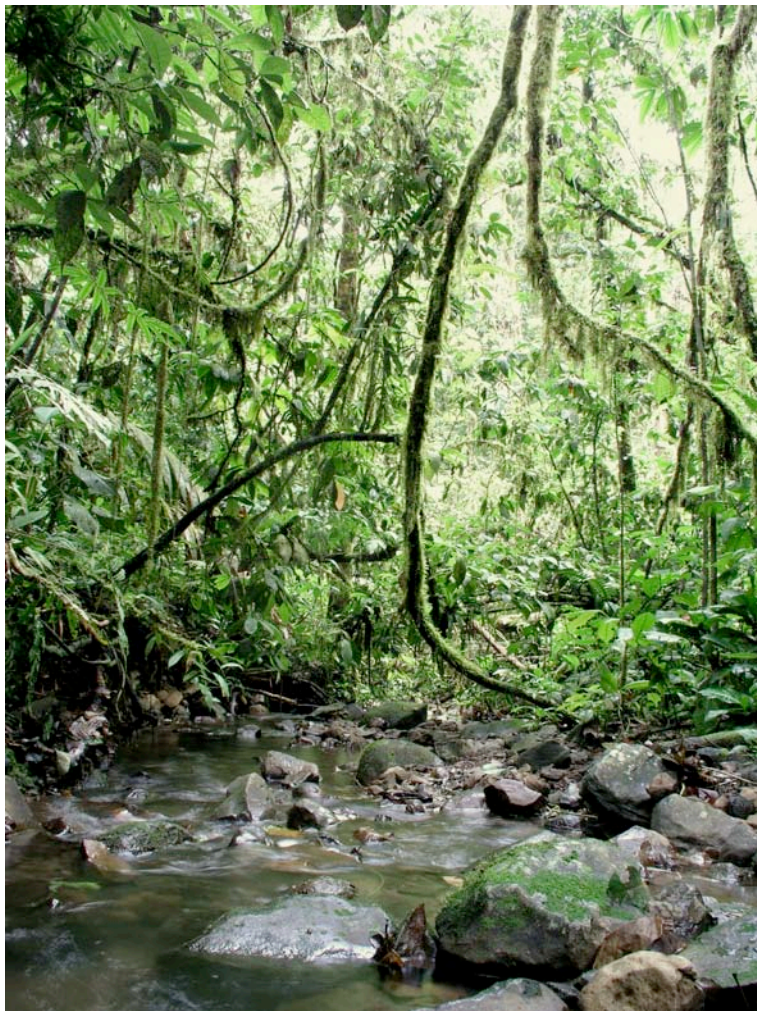
A waterfall in the Siquirres River during normal conditions (left) and dry conditions (right).



Small cascade in Quebrada Ilex. This stream is home to 6 species of glass frogs, and the very rare *Hyloscirtus palmeri*



Cascade in Quebrada Albomaculata.

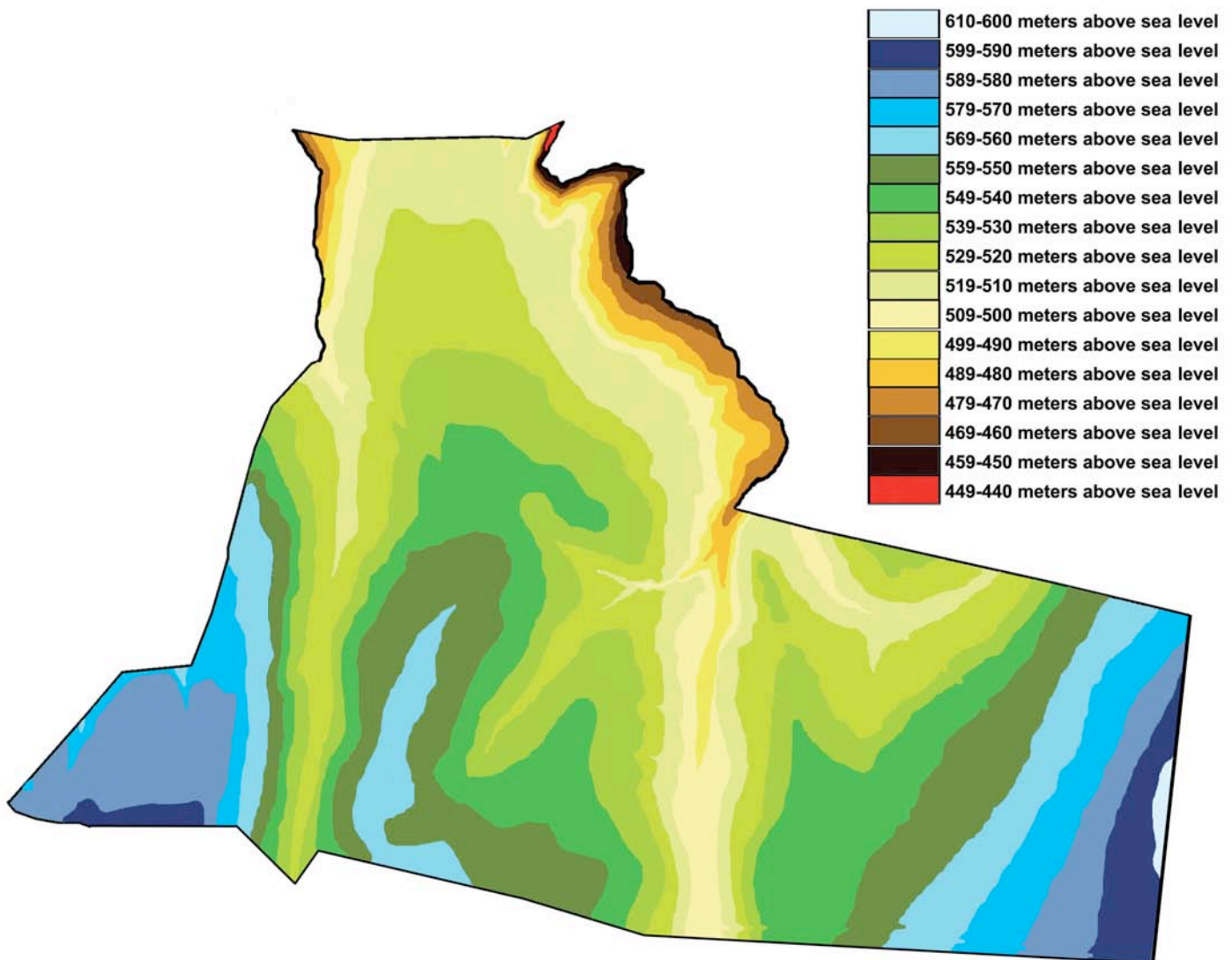


Photos of Quebrada Monge.

Topography of the C.R.A.R.C. Reserve

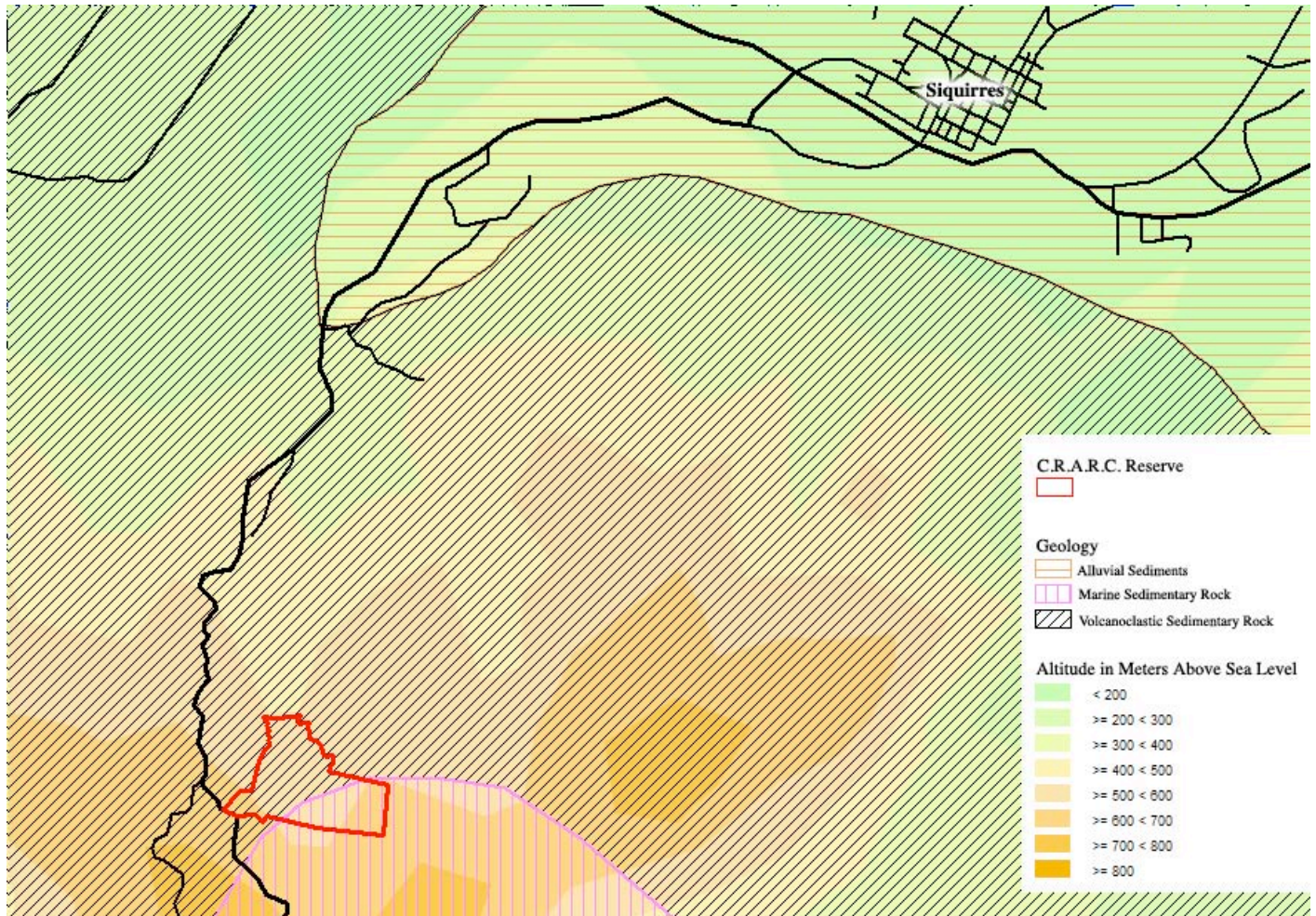
The C.R.A.R.C. Reserve is situated on the northeastern edge of the Talamancan Mountain Range, and due to this location at the base of such a significant massif it has a varying topography. The reserve's overall altitude ranges from 440-610 meters above sea level (m.a.s.l.). Most of the extreme variation is due to the hydrologic history of the area, with the roughest terrain being found along the riparian areas of the Siquirres River and the Ilex Stream. Even with the moderately erratic terrain of the reserve much of the area is still easily navigable by foot due to careful planning of our trail network.

The trail system was designed to use the contours of the reserve in one's favor. We have built our trails using the gradual contours to the best of our ability, but there are still some sections of the reserve that will require a little sweat to arrive at. Several of the reserve's most popular sites are easily accessible.



Topographic map of the 45 hectare C.R.A.R.C. Reserve. (Topo map made by Brian Kubicki, 2008)

Geology of the C.R.A.R.C. Reserve



Map showing the Geology of the region.

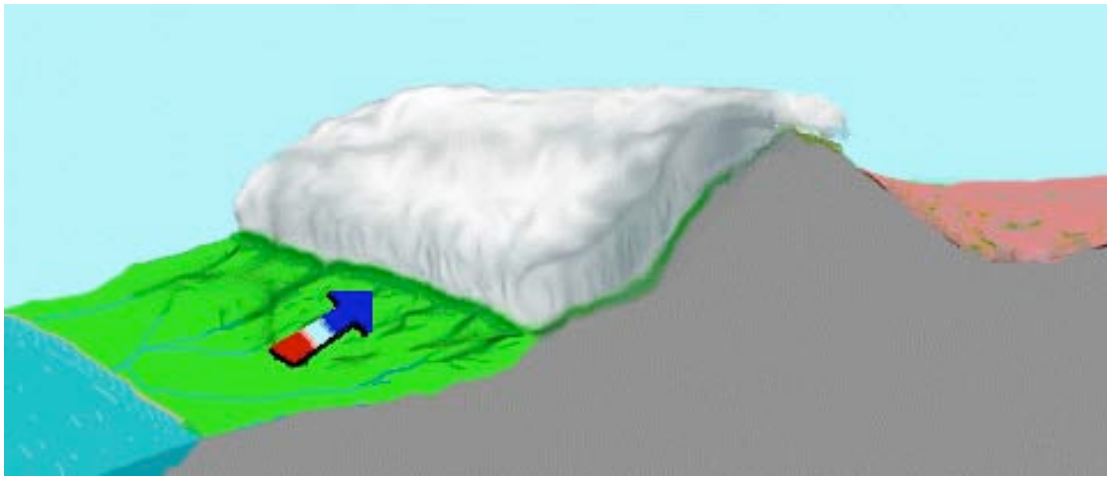
The C.R.A.R.C. reserve is located in a geologic transition zone. The northwest half of the reserve has a dominant make-up of volcanoclastic sedimentary rock, provided by historical eruptions from the Turrialba volcano. The southeastern half of the reserve is considered to be within the range of marine sedimentary rock, which is common in many parts of the Talamancan Mountain Range.

Climate of the C.R.A.R.C. Reserve



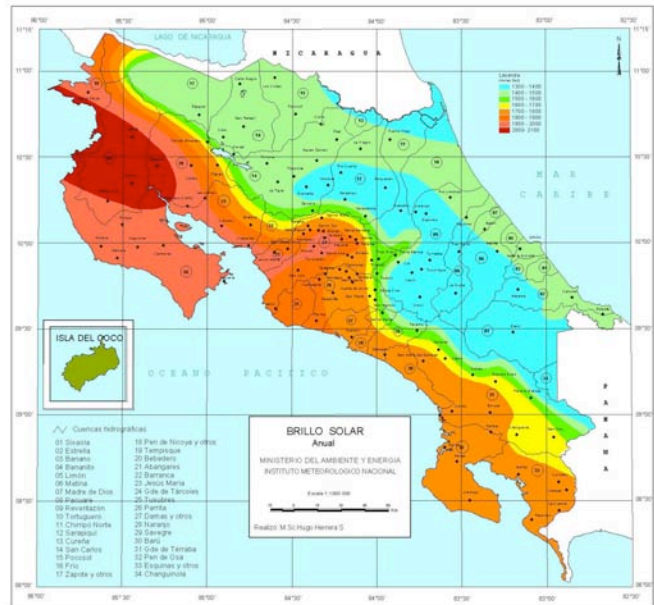
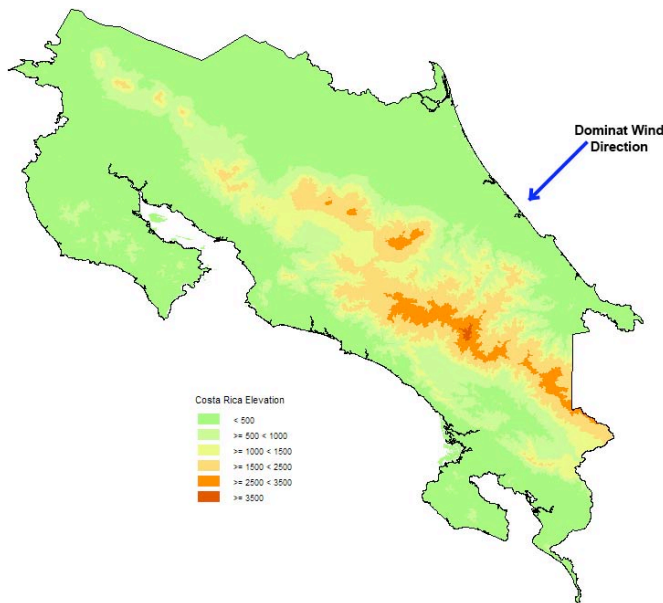
The C.R.A.R.C. has a mild temperature range, with very little seasonal variation. The average temperatures range between a high of 25-28°C, and a low of 17-19°C. The diurnal temperatures can vary within the reserve depending on forest coverage. The highest temperatures are felt in the open areas on sunny days, where the increased solar energy causes higher terrestrial heat radiation. During the daylight hours there can be as much as a 5°C difference between the under story of dense forest and open areas.

The C.R.A.R.C. is located in one of the rainiest areas of Costa Rica; this is mainly due to its position on the windward Caribbean slope, and what is known as the Orographic Lifting Effect. The process of orographic lifting that affects the C.R.A.R.C. takes place in the following simplified manner. A warm humid air mass comes off the Caribbean Sea and travels inland, towards the Talamancan Mountain Range. As the warm humid air hits the foothills it is forced upward. This upward movement causes the air to expand due to decreased levels of atmospheric pressure. As the air expands its temperature decreases, this is a process known as cooling by expansion. As the air mass rises further the cooling continues, and eventually the air hits its humidity saturation point and forms clouds. With the cooling increasing further the air gets supersaturated with moisture and precipitation is the result. Once the air crosses the mountain divide it begins to sink and in doing so heats up. This process is known as heating by compression, and it is the opposite of cooling by expansion. When the air heats up it loses its moisture-saturated state, which causes the leeward mountain slope to be drier by what is known as the rain shadow effect. This orographic lifting phenomenon can easily be seen in Costa Rica by the climate differences between the Caribbean and Pacific versants.

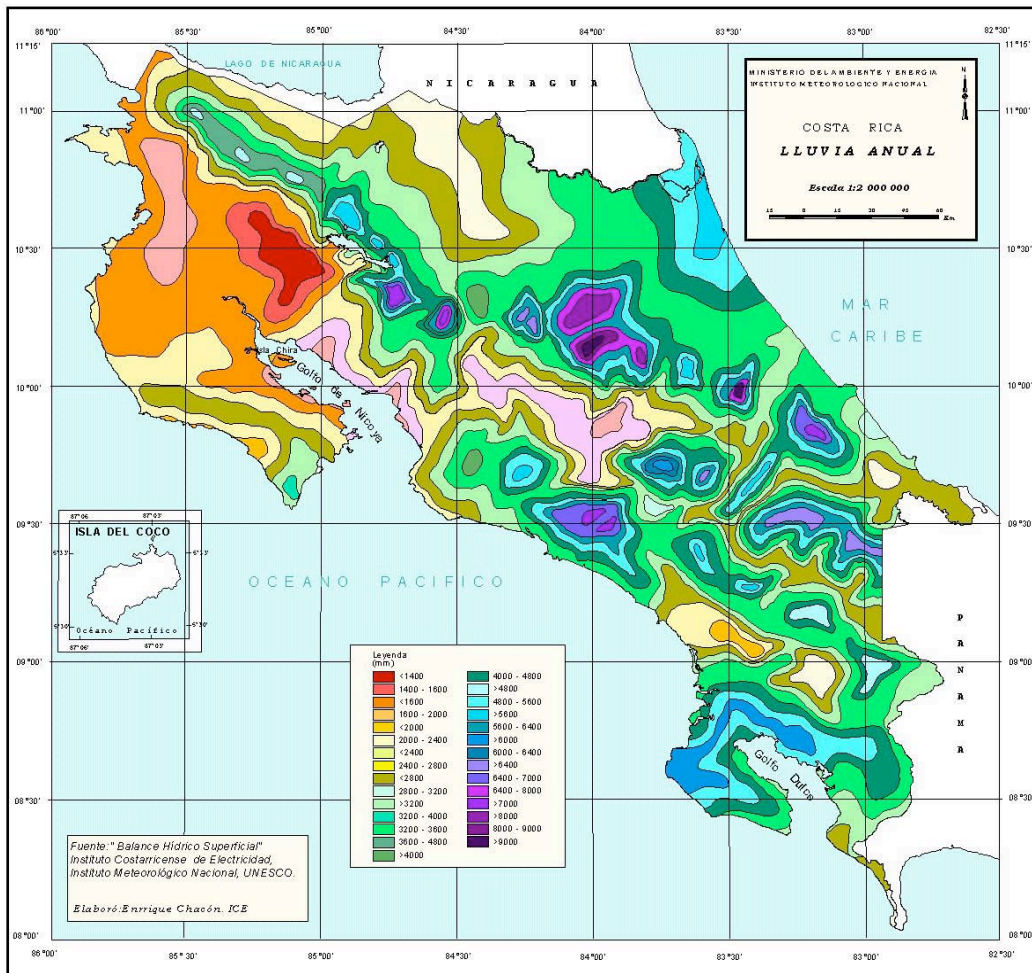
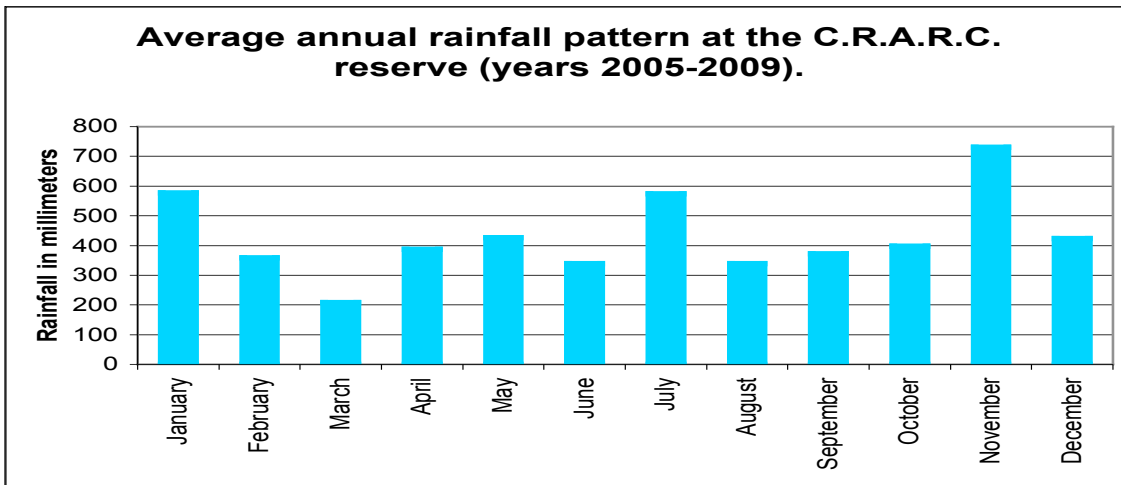


This simplified drawing shows the process of "Orographic Lifting". Image by: Brian Kubicki.

The two maps below show the overall topography of Costa Rica (left) and the annual sunshine hours (right). Notice the direct correlation with the cloudiest area (blue) on the map to the right and how it relates to the topography. This is another example of orographic lifting and its affect on Costa Rica. "Annual Sunshine Hours" map (below right) courtesy of the Instituto Metereologico Nacional.



The C.R.A.R.C. receives an abundant supply of rainfall due to orographic lifting conditions and convectional showers and storms. Guayacán gets an average annual rainfall of 5000-6000 mm (rain gauge at the Costa Rican Amphibian Research Center, 2004-2009). The area lacks a prolonged dry season, but typically during the months of February, March, June and August the monthly precipitation drops compared to the other months of the year, averaging less than 350 mm. The rainiest months are typically January, May, July, and November. During these months the total precipitation averages 450 mm or greater. In the months of April through October strong convectional showers and thunderstorms occur with greater frequency. Storms producing lightning and thunder are for the most part uncommon during the rest of the year. During the months of November, December, January, and often lasting into February the rainfall can be much more continual. During this time of year frequent precipitation and overcast conditions are common, and at times continual rainfall can last a week or more. These prolonged rainy and overcast conditions are caused by cold fronts coming off the Caribbean Sea and are known locally as "temporales".



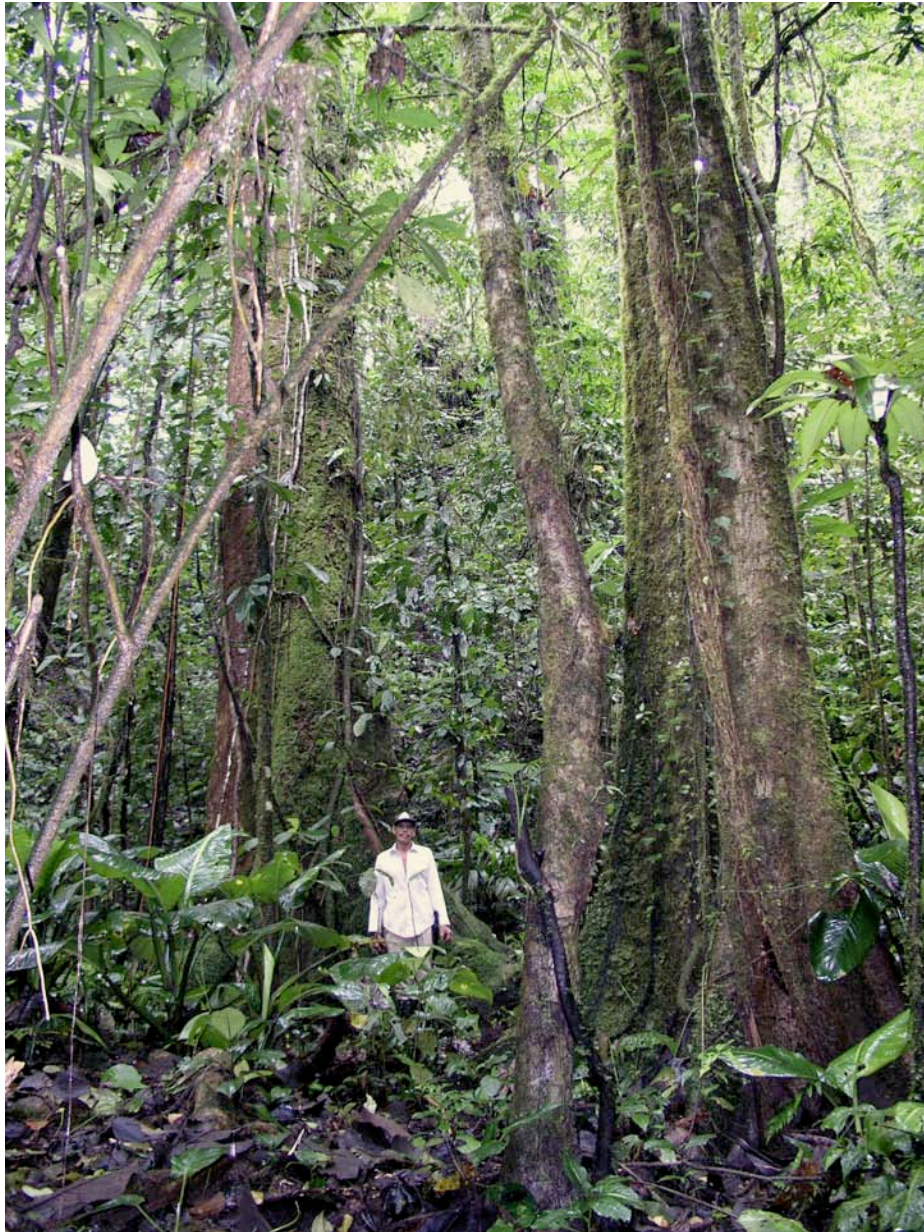
This map shows the average annual rainfall for Costa Rica. Courtesy of I.C.E. and the Instituto Meteorológico Nacional.

The relative humidity in the region is high, and seldom drops below 65%. The average relative humidity ranges from 75-100% throughout the day and evening, but in forested areas the humidity rarely drops below 80%.

Strong Wind conditions are unusual to rare in Guayacán, but light breezes between 1-10 km/hour are common, especially in the afternoons or during changing weather fronts. The sections of Guayacán that receive the highest air movement are the upper ridges, where slight breezes are commonly present.

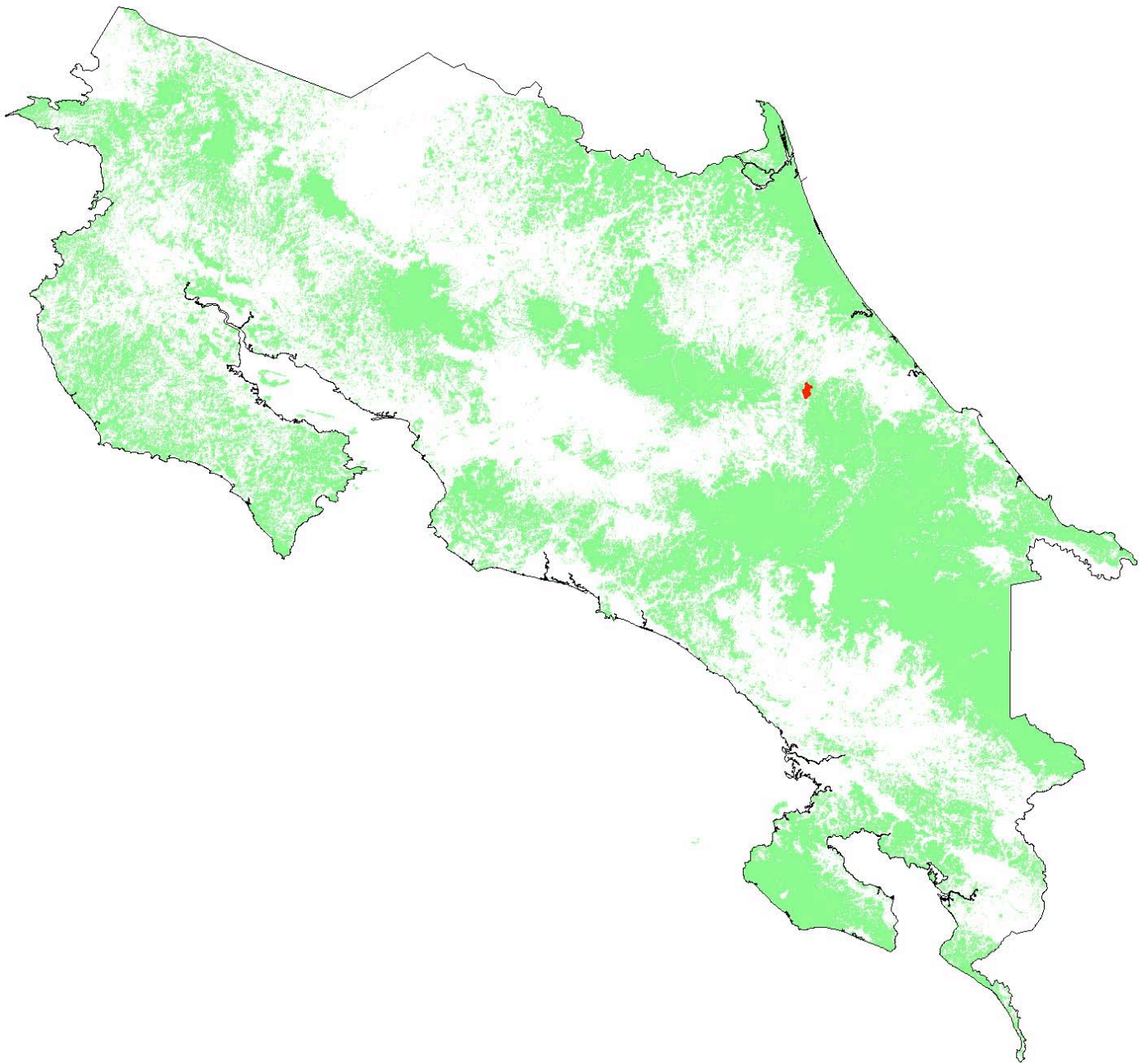
Flora and Fauna of the C.R.A.R.C. Reserve

In the C.R.A.R.C. reserve two life zones are represented, that of Tropical Wet Forest, and Tropical Premontane Rain Forest (Holdridge 1967). The areas within the reserve recognized as Tropical Wet Forest are those with an altitude less than 500 m.a.s.l., whereas the areas with an altitude greater than 500 m.a.s.l. are classified as Tropical Premontane Rain Forest.



Section of old-growth forest on the C.R.A.R.C. reserve.

The abundant rainfall, stable intermediate temperatures, high relative humidity, and varied topography at the C.R.A.R.C. create conditions that are favorable for a rich diversity of flora and fauna. To date, few detailed surveys of the flora and fauna have been carried out in the region of Guayacán, but such work is needed for biological and conservational awareness. Having a low to intermediate altitude (average from 400-650 m.a.s.l.) Guayacán presents an interesting assemblage of biological diversity. At these altitudes many plant and animal assemblages of lowland, mid-elevation, and highland species overlap, and this plays a key role in the rich biological diversity of the region. 66 species of amphibians have been documented in Guayacán, making it the richest known site in Costa Rica for amphibian diversity (Kubicki 2008).



The above image shows forest coverage in Costa Rica (light green), and the location of the Z.P. Rio Siquirres (Red).

The region of Guayacán has an impressive coverage of secondary to old-growth forest communities. Large sections of relatively undisturbed old-growth forest are very accessible, and this helps facilitate the area's natural history exploration. Guayacán is located on the northeastern edge of one of the largest intact sections of forest in lower Central America, that of the Talamancan Mountain Range of Costa Rica, and Central Mountain Range of northwestern Panama. Another interesting aspect of Guayacán is that it is one of the few accessible mid-elevation regions of the Atlantic versant of Talamanca, which is likely the most biologically diverse region of Costa Rica, but thus far remains mostly unexplored.

Some Interesting Examples of Fauna Found on the C.R.A.R.C. Reserve



Two very rare species of scorpions have been found on the C.R.A.R.C. reserve, *Chactus exsul* (left) and *Tityus cerroazul* (right). The species *C. exsul* was recently rediscovered after nearly 50 years since its last collection, and *T. cerroazul* was documented for the first time in Costa Rica in 2005.



These interesting creatures, known as velvet worms, have their own unique phylum (Onychophora). These prehistoric animals are believed to have remained relatively unchanged for millions of years. The velvet worms are restricted to scattered regions throughout the tropical latitudes of the world. Three morphologically distinct forms have been found on the C.R.A.R.C. reserve, and it is assumed that all three represent separate species, but unfortunately there exists very little literature regarding the identification of Costa Rican velvet worms. The above images show two of the three that have been found within the reserve. The red velvet worm, measuring up to 15 cm in length, is at times seen foraging among the mossy rocks on the edges of streams at night. This red velvet worm is currently in the process of being described as a new species. The velvet worm to the upper right is occasionally seen on the low-lying vegetation at night. The third species (or morphotype) that has been found on the reserve is solid brown, and it is occasionally seen while looking through the leaf litter or searching through the organic remains of rotten logs.



There is an incredible diversity of other types of invertebrates on the reserve, such as this interesting curculionid beetle and terrestrial snail.

The diversity of vertebrates is equally impressive. Nearly 200 species of birds have been observed on the reserve, with the possibility of dozens more to be found. Numerous species of mammals inhabit the Siquirres River Valley; among them are ocelots, margays, white-faced and howler monkeys, collared peccary, sloths, taryas, olingos, and kinkajous. The region of Guayacán is also well known for its diversity of reptiles, especially snakes, including many rare species such as the bushmaster (*Lachesis stenophrys*).



Male Bay-headed Tanager (*Tangara gyrola*)



An unidentified Hummingbird species sitting on its nest at night.



An Ocelot track



Male green basilisk (*Basiliscus plumifrons*)



Bushmaster (*Lachesis stenophrys*)



Eye-lash Viper (*Bothriechis schlegelii*)



Northern Ringed Snake (*Rhinobothryum bovallii*)



Speckled Blunthead (*Imantodes inornatus*)



Rhinoclemmys annulata

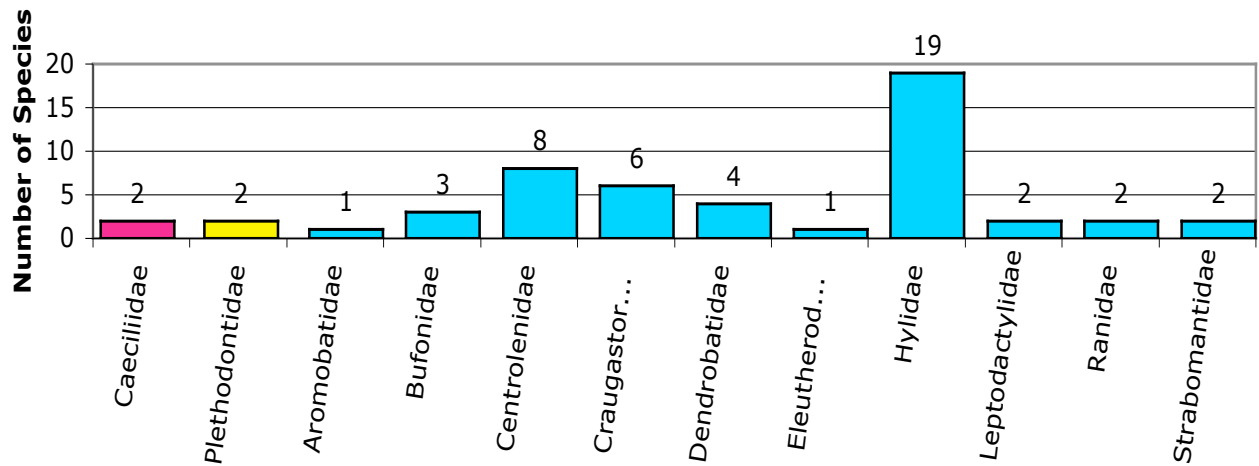
Amphibians of the Costa Rican Amphibian Research Center Reserve:



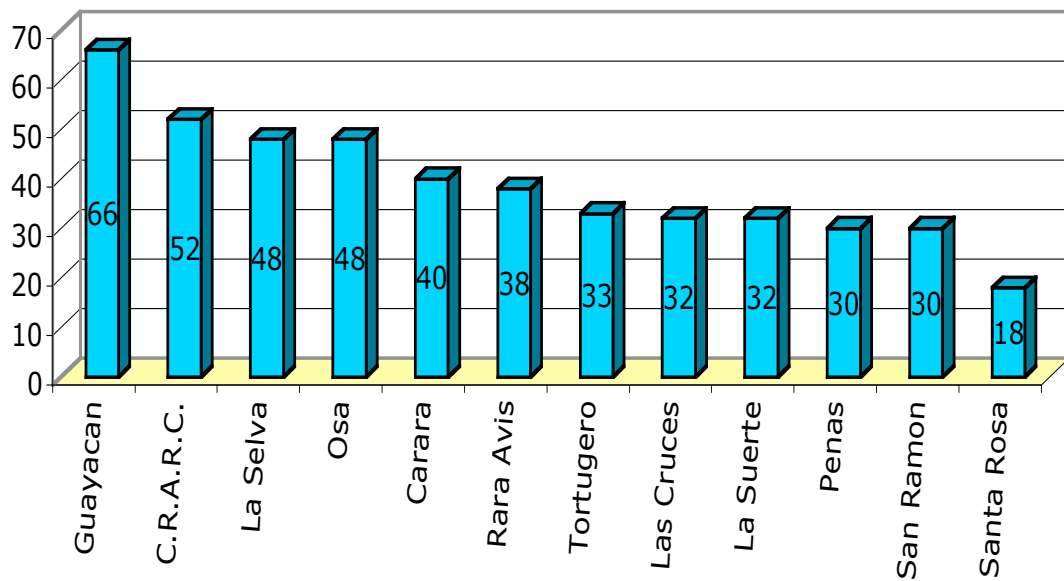
Cochranella granulosa



Bolitoglossa striatula



Representation of Species Diversity per Family for the Class Amphibia at the C.R.A.R.C. Reserve.



Amphibian diversity at various sites in Costa Rica.

Amphibian Species of the C.R.A.R.C. Reserve:

Order: Gymnophiona

Family: Caeciliidae

Dermophis parviceps
Gymnopsis multiplicata

Order: Caudata

Family: Plethodontidae

Bolitoglossa colonnea
B. striatula

Order: Anura

Family: Aromobatidae

Allobates talamancae

Family: Bufonidae

Incilius melanochlorus
Rhaebo haematiticus
Rhinella marina

Family Centrolenidae

Cochranella granulosa
Hyalinobatrachium fleischmanni
H. talamancae
H. valerioi
Teratohyla pulverata
T. spinosa
Sachatamia albomaculata
S. ilex

Family: Craugastoridae

Craugastor bransfordii
C. crassidigitus
C. fitzingeri
C. megacephalus
C. noblei
C. persimilis

Family: Dendrobatidae

Dendrobates auratus
Oophaga pumilio
Phyllobates lugubris
Silverstoneia flotator

Family: Eleutherodactylidae

Diasporus diastema

Family: Hylidae

Agalychnis callidryas
A. saltator
A. spurrelli
Anotheca spinosa
Cruziohyla calcarifer
Dendropsophus ebraccatus
D. phlebodes
Duellmanohyla rufioculis
D. uranochroa
Ecnomiohyla miliaria
Hylomantis lemur
Hyloscirtus palmeri
Isthmohyla lancasteri
Scinax boulengeri
S. elaeochrous
Smilisca baudinii
S. phaeota
S. sordida
Tlalocohyla loquax

Family: Leptodactylidae

Leptodactylus melanonotus
L. savagei

Family: Ranidae

Lithobates vaillanti
L. warszewitschii

Family: Strabomantidae

Prisitmantis cerasinus
P. ridens

Total Species: 52

Amphibians of the C.R.A.R.C. reserve, Guayacán, Limón Province, Costa Rica



Dermophis parviceps
Order: Gymnophiona
Family: Caeciliidae



Gymnopsis multiplicata
Order: Gymnophiona
Family: Caeciliidae



Bolitoglossa colonnea
Order: Caudata
Family: Plethodontidae



Bolitoglossa striatula
Order: Caudata
Family: Plethodontidae



Allobates talamancae
Order: Anura
Family: Aromobatidae



Incilius melanochlorus
Order: Anura
Family: Bufonidae



Rhaebo haematiticus
Order: Anura
Family: Bufonidae



Rhinella marina
Order: Anura
Family: Bufonidae



Cochranella granulosa
Order: Anura
Family: Centrolenidae



Hyalinobatrachium fleischmanni
Order: Anura
Family: Centrolenidae



Hyalinobatrachium talamancae
Order: Anura
Family: Centrolenidae



Hyalinobatrachium valerioi
Order: Anura
Family: Centrolenidae



Teratohyla pulverata
Order: Anura
Family: Centrolenidae



Teratohyla spinosa
Order: Anura
Family: Centrolenidae



Sachatamia albomaculata
Order: Anura
Family: Centrolenidae



Sachatamia ilex
Order: Anura
Family: Centrolenidae



Craugastor bransfordii
Order: Anura
Family: Craugastoridae



Craugastor crassidigitus
Order: Anura
Family: Craugastoridae



Craugastor fitzingeri
Order: Anura
Family: Craugastoridae



Craugastor megacephalus
Order: Anura
Family: Craugastoridae



Craugastor noblei
Order: Anura
Family: Craugastoridae



Craugastor persimilis
Order: Anura
Family: Craugastoridae



Dendrobates auratus
Order: Anura
Family: Dendrobatidae



Oophaga pumilio
Order: Anura
Family: Dendrobatidae



Phyllobates lugubris
Order: Anura
Family: Dendrobatidae



Silverstoneia flotator
Order: Anura
Family: Dendrobatidae



Diasporus diastema
Order: Anura
Family: Eleutherodactylidae



Agalychnis callidryas
Order: Anura
Family: Hylidae



Agalychnis saltator
Order: Anura
Family: Hylidae



Agalychnis spurrelli
Order: Anura
Family: Hylidae



Anotheca spinosa
Order: Anura
Family: Hylidae



Cruziohyla calcarifer
Order: Anura
Family: Hylidae



Dendropsophus ebraccatus
Order: Anura
Family: Hylidae



Dendropsophus phlebodes
Order: Anura
Family: Hylidae



Duellmanohyla rufiocolis
Order: Anura
Family: Hylidae



Duellmanohyla uranochroa
Order: Anura
Family: Hylidae



Ecnomiohyla miliaria
Order: Anura
Family: Hylidae



Hylomantis lemur
Order: Anura
Family: Hylidae



Hyloscirtus palmeri
Order: Anura
Family: Hylidae



Isthmohyla lancasteri
Order: Anura
Family: Hylidae



Scinax boulengeri
Order: Anura
Family: Hylidae



Scinax eleaochrous
Order: Anura
Family: Hylidae



Smilisca baudinii
Order: Anura
Family: Hylidae



Smilisca phaeota
Order: Anura
Family: Hylidae



Smilisca sordida
Order: Anura
Family: Hylidae



Tlalocohyla loquax
Order: Anura
Family: Hylidae



Leptodactylus melanonotus
Order: Anura
Family: Leptodactylidae



Leptodactylus savagei
Order: Anura
Family: Leptodactylidae



Lithobates vaillanti
Order: Anura
Family: Ranidae



Lithobates warszewitschii
Order: Anura
Family: Ranidae



Pristimantis cerasinus
Order: Anura
Family: Strabomantidae



Pristimantis ridens
Order: Anura
Family: Strabomantidae

<u>Order:</u>	<u>Family:</u>	<u>Species:</u>	<u>Habitat:</u>	<u>Activity:</u>	<u>Breeding Mode:</u>	<u>C.R.A.R.C. Status:</u>
Gymnophiona	Caeciliidae	<i>Dermophis parviceps</i>	S, P, F	U	U (L?)	U
		<i>Gymnopsis multiplicata</i>	S, P, F	N	L	U
Caudata	Plethodontidae	<i>B. colonnea</i>	S, P, L	N	Lld	O
		<i>B. striatula</i>	D, S, P, L, A	N	Lld	U
Anura	Aromobatidae	<i>Allobates talamancae</i>	S, P, T	D	Lla	U
	Bufonidae	<i>Ollotis melanochlora</i>	S, P, T	N	As	O
		<i>Rhaebo haematiticus</i>	S, P, T, Rs	D, N	As	O
		<i>Rhinella marina</i>	D, S, T	N	Ap	C
	Centrolenidae	<i>Cochranella granulosa</i>	S, P, L, A	N	Sv	C
		<i>Hyalinobatrachium fleischmanni</i>	D, S, P, L, A	N	Sv	C
		<i>H. talamancae</i>	S, P, L, A	N	Sv	R
		<i>H. valerioi</i>	S, P, L, A	N	Sv	O
		<i>Teratohyla pulverata</i>	S, P, L, A	N	Sv	O
		<i>T. spinosa</i>	S, P, L	N	Sv	C
		<i>Sachatamia albomaculata</i>	S, P, L, A	N	Sv	O
		<i>S. ilex</i>	S, P, L, A	N	Sv	C
Craugastoridae		<i>Craugastor bransfordii</i>	D, S, P, T	D, N	Lld	C

	<i>C. crassidigitus</i>	S, P, T, L	N	Lld	C
	<i>C. fitzingeri</i>	D, S, P, T, L	D, N	Lld	C
	<i>C. megacephalus</i>	S, P, T	D, N	Lld	O
	<i>C. noblei</i>	S, P, T, L	D, N	Lld	O
	<i>C. persimilis</i>	S, P, T	D, N	Lld	O
Dendrobatidae	<i>Dendrobates auratus</i>	D, S, P, T	D	Lla	C
	<i>Oophaga pumilio</i>	D, S, P, T	D	Lla	C
	<i>Phyllobates lugubris</i>	D, S, P, T	D	Lla	O
	<i>Silverstoneia flotator</i>	S, P, T,	D	Lla	O
Eleutherodactylidae	<i>Diasporus diastema</i>	D, S, P, L, A	N	Lld	C
Hylidae	<i>Agalychnis callidryas</i>	D, S, P, L, A	N	Pv, Tt	C
	<i>A. saltator</i>	S, P, L, A	N	Pv	O
	<i>A. spurrelli</i>	S, P, L, A	N	Pv	O
	<i>Anotheca spinosa</i>	S, P, L, A	N	T, Tt	R
	<i>Cruziohyla calcarifer</i>	S, P, L, A	N	Tt	C
	<i>Dendropsophus ebraccatus</i>	D, S, P, L	N	Pv	C
	<i>D. phlebodes</i>	D, S, L	N	Ap	O
	<i>Duellmanohyla rufioculis</i>	S, P, L, Rs	N	As	C
	<i>D. uranochroa</i>	S, P, L, Rs	N	As	U
	<i>Ecnomiohyla miliaria</i>	S, P, A	N	U (T?)	R
	<i>Hylomantis lemur</i>	D, S, P, L	N	Pv	C
	<i>Hyloscirtus palmeri</i>	S, P, L, Rs	N	As	C
	<i>Isthmohyla lancasteri</i>	S, P, L, Rs	N	As	O
	<i>Scinax boulengeri</i>	D, S, P, L, A	N	Ap	R
	<i>S. elaeochrous</i>	D, S, P, L, A	N	Ap	C
	<i>Smilisca baudinii</i>	D, S, P, L, A	N	Ap	U
	<i>S. phaeota</i>	D, S, P, Aq, L	N	Ap	C
	<i>S. sordida</i>	D, S, P, L, Rs	N	As	O
	<i>Tlalocohyla loquax</i>	D, S, P, L, A	N	Ap	C
Leptodactylidae	<i>Leptodactylus melanonotus</i>	D, S, Aq	D, N	Af	O
	<i>L. savagei</i>	D, S, P, T	N	Af	C
Ranidae	<i>Lithobates vaillanti</i>	D, S, P, Aq, T	D, N	Ap	C
	<i>L. warszewitschii</i>	D, S, P, Aq, T, Rs	D, N	As	C
Strabomantidae	<i>Pristimantis cerasinus</i>	S, P, T, L	D, N	Lld	C
	<i>P. ridens</i>	S, P, L	N	Lld	C

KEY TO SYMBOLS INCLUDED FOR EACH SPECIES

HABITAT:

D= Disturbed open habitats
S= Secondary forest
P= Primary forest
T= Terrestrial
R= Rotting trunks, and under moss mats
L= Low-lying vegetation (0-5 meters)
A= Arboreal (5+ meters)
F= Fossorial
Aq= Aquatic
Rs= Rocks in or near streams

Activity:

D= Diurnal
N= Nocturnal
U= Unknown

Breeding Mode:

Af= Aquatic foam nests
Ap= Eggs laid in the water of ponds
As= Eggs laid in the water of streams
Sv= Eggs laid principally on the vegetation overhanging streams
Pv= Eggs laid principally on the vegetation overhanging ponds
Lld= Eggs laid in the leaf litter, rotting trunks, or vegetation, and having direct development
Lla= Eggs laid in the leaf litter, and tadpoles are later carried to water
U= Unknown
T= Eggs laid in the water of tree holes
Tt= Eggs laid on the bark, wood, or vegetation above a water-filled cavity in a tree or trunk
L= Bearing live young

Status in the Reserve:

C= Common; sightings are frequent, and normally expected while visiting a species living or breeding habitat
O= Occasional; sightings are not expected on every visit to the species living or breeding habitat
U= Unusual; Sightings are unusual on a visit to the species living or breeding habitat
R= Rare; Sightings are exceptional

Pro-active Conservation, Research, and Experimentation

In view of the existing conditions of natural areas in our world today it is obvious that an active approach to conservation is needed. Most natural areas have been greatly influenced by humans for tens, hundreds, or even thousands of years. The C.R.A.R.C. reserve has a large percentage of its area in “healthy” old-growth forest, but upon a closer look one can find evidence of invasive species, and human disturbance.

At the C.R.A.R.C. we are actively involved in trying to restore certain parts of the reserve, and in doing so increase the vigor of the flora and fauna. The activities include things such as planting native plant and tree species to increase not only biological, but also genetic diversity, which is vital for long term survival; recovering or increasing the abundance of certain tree and herbaceous plant species that are an important natural food source for animals in the area; rehabilitating key terrestrial and aquatic ecosystems that have been damaged by human activity prior to being a biological reserve; creating terrestrial and aquatic habitats that have become rare or were naturally rare due to specifics; eliminating non-native invasive species; and reforesting severely damaged areas such as pasture or other historically mono-specific agricultural zones. We would like to thank the National Reptile Breeders Expo for their donation from the 2009 silent and live auction to support habitat and population management projects on the C.R.A.R.C. reserve.

Some examples of research projects, habitat creation, and habitat rehabilitation being conducted by the Costa Rican Amphibian Research Center.



These photos show an experiment involving the augmentation of a reproductive habitat for *Cruziohyla calcarifer*. This species normally utilizes water-filled cavities in fallen or standing trees for reproduction. Their highly specialized reproductive mode targets a very limited reproductive resource in natural conditions. We are trying to synthesize and augment this reproductive habitat in hopes to increase the vigor of native populations of *C. calcarifer*. This area of the reserve was chosen due to a high concentration of natural tree holes (photo upper right). This experiment was started in January 2004, and we are proud to call it a success, with egg masses and dozen of tadpoles being seen on any visit to the site. New generations of frogs are now breeding at the site.

We had an unexpected surprise with the critically endangered *Hylomantis lemur* reproducing in these artificial sites as well.



A male *C. calcarifer* from an experimental reproduction site on the C.R.A.R.C. reserve.



A clutch of *C. calcarifer* eggs overhanging one of the artificial reproductive sites.



We have created numerous ponds on the C.R.A.R.C. reserve, and this is just one example. These photos show the before (upper left) and after (upper right and below) of a cleaning and rehabilitation of a natural wetland. This wetland became filled in with sedge-peat by grass growth when this site was cleared years before for cattle grazing. Before the forest was cut this wetland was most likely an open-water forest pond community. We have attempted to restore this wetland's original state by removing nearly a half-meter of sedge-peat from the aquatic area. This peat removal was done with shovels and wheel barrels. We planted native aquatic and terrestrial plants that are typically found in or near forest ponds in the region. We are also selecting plants that are utilized by amphibians and other animals for habitat or reproductive sites.

We made one large irregular shaped pond in this swampy area. This habitat was first modified in November 2003, and since that time 13 species of frogs have been observed at the site

(*Agalychnis callidryas*, *A. saltator*, *A. spurrelli*, *Hylomantis lemur*, *Tlalocohyla loquax*, *Dendropsophus ebraccatus*, *D. phlebodes*, *Smilisca baudinii*, *S. phaeota*, *Scinax elaeochrous*, *Leptodactylus melanonotus*, *L. savagei*, and *Lithobates vaillanti*). The majority of these species were not observed at the site prior to the habitat modification. Amphibians are not the only animals that are using this new habitat. Various species of mammals, birds, and reptiles are now commonly seen, including a sighting of a rare margay cat.



The above photo shows one result of this pond's rehabilitation. Hundreds of *Agalychnis spurrelli* eggs are visible on the vegetation. This is just a small section of vegetation surrounding the pond. During such breeding events hundreds of *A. spurrelli* adults can be seen at the site, and the

following day thousands of eggs are often found hanging from literally every available leaf surrounding the pond.



A pair of *A. spurrelli* approaching the pond.

COSTA RICAN AMPHIBIAN RESEARCH CENTER'S Native Amphibian Species Preservation Laboratory

This lab was built in part to the thanks of the generous donations of the Atlanta Botanical Garden, Henry Vilas Zoo, Bronx Zoo, Catocin Wildlife Preserve and Zoo, funds raised through Amphibian enthusiasts at the Midwest Frog Fest, International Amphibian Days, North American Amphibian Conference, plus additional groups and private individuals.



Photo showing the front of the laboratory.



Some of the terrariums in the laboratory.

In addition to field research and habitat conservation, captive studies are of extreme importance for the conservation of many species of amphibians. With many species of amphibians there is basically nothing known about their biology. In terrariums that closely resemble a particular species' natural habitat many important biological discoveries might await, discoveries that could be the key in their conservation. The C.R.A.R.C. is investigating techniques to increase the captive husbandry methodologies of rare and endangered species.



A male *Hyalinobatrachium valerioi* guarding two egg masses in a terrarium at the C.R.A.R.C.



Photo showing some tadpoles of *Hyalinobatrachium fleischmanni* bred and raised at the C.R.A.R.C.



Captive bred tadpoles of the critically endangered *Hylomantis lemur*



Juvenile *Anotheca spinosa* that were bred and raised and later released on the C.R.A.R.C. reserve.
In 2008 we released 118 juvenile *A. spinosa* that were bred and raised in our lab.



Our Goal: *To create and maintain an internationally recognized and supported project dedicated to the research and preservation of Neotropical glass frog species.*

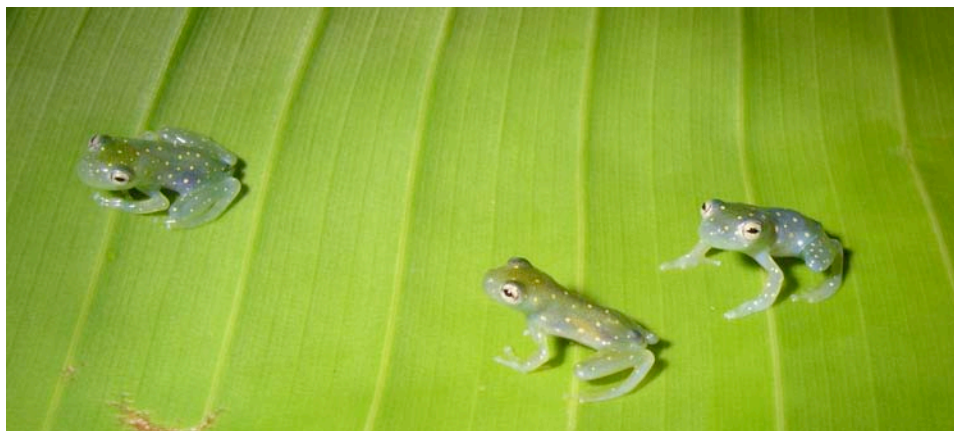
Objectives:

To conduct continuing ecological research of glass frogs in their natural environment and captivity.

To undergo in-depth studies to clarify the taxonomic and biogeographic status of Costa Rican glass frogs.

To use this knowledge in creating methodologies and guidelines to support glass frog in-situ and ex-situ programs.

To provide additional resources to other conservation programs in other institutions working with amphibian conservation.



Three neonate *Cochranella euknemos* bred and raised at the C.R.A.R.C.

The C.R.A.R.C. has been working on additional conservation projects with three species of special concern native to the region of Guayacán, two of which are critically endangered.



The crowned tree frog (*Anothea spinosa*)

Anothea spinosa was historically more abundant in the area of Guayacán, but due to over collecting for the black market pet trade this species has become increasingly rare. We bred this species in captivity, and released 118 metamorphs on the reserve in 2008 in hopes to increase the genetic diversity and overall numbers in the small remnant population.



A male *Anothea spinosa* peering out of a tree hole on the C.R.A.R.C. reserve.

Conservation of the Critically Endangered Green Red-eyed Stream Frog



The critically endangered Green Red-eyed Stream Frog (*Duellmanohyla uranochroa*)

Not too long ago this species was considered to possibly be extinct, but recently herpetologists have found a few surviving populations. In February of 2009 we discovered an existing population in Guayacán. This population of *D. uranochroa* is at an altitude of 550 meters above sea level, which is one of the lowest altitude sites known for this species. This site is located less than 2 kilometers distance from the C.R.A.R.C. reserve. The unfortunate situation is that this remnant population of *D. uranochroa* in Guayacán is found in a section of unprotected forest, and is highly endangered due to illegal hunting and lumber extraction. We have decided that it is very important to try to translocate a limited number of tadpoles to a nearly identical habitat and altitude within the C.R.A.R.C. reserve. Our goal is to establish a population of *D. uranochroa* within the protected habitat of the C.R.A.R.C. reserve.



Conservation of the Critically Endangered Lemur Leaf Frog



The C.R.A.R.C. has a wild population management project for the Lemur Leaf Frog (*Hylomantis lemur*) on the reserve. This species is currently only known to exist at a handful of sites in Costa Rica and Panama. There are only two known populations *H. lemur* remaining in Costa Rica, and one of them is within the C.R.A.R.C. reserve. The second site where *H. lemur* is known to exist in Costa Rica is located in a section of unprotected forest, and its future is not secure. We need to do all that we can to preserve this Costa Rican *H. lemur* genetic pool on the C.R.A.R.C. reserve. We are undergoing habitat management to increase the population sustainability of this beautiful and extremely rare species.



A pair of *H. lemur* in amplexus on the reserve (left), and a couple *H. lemur* egg masses on a leaf overhanging one of the reserve's tubs (right).

This project involves creating and augmenting the reproductive habitat for *H. lemur* on the C.R.A.R.C. reserve. We have created numerous small ponds and placed more than a dozen 30 gallon tubs at two strategic points on the reserve. Since the start of this project new generations are now using the ponds and tubs for reproduction. We have had great success thus far, but feel it is vital to increase metapopulation support by creating new reproductive habitats on other parts of the reserve.

Reforestation at the C.R.A.R.C.



Several of the hundreds of treelets of the endangered Manú Negro (*Minquartia guianensis*) that were raised in our greenhouse.

We have collected seeds and seedlings from the rarest and most endangered timber species from the region of the C.R.A.R.C. for the purpose of reforestation and species preservation. There are numerous native tree nurseries in Costa Rica, but rarely do they stock the most endangered species, due to economical reasons and difficulty in obtaining seeds. The reason many of the endangered timber species have become so rare is the demand for their fine tropical wood characteristics. We are concentrating on the rarest and most ecologically valuable species native to the central Caribbean foothills of Costa Rica. These species are not only valuable for their precious wood, but also their importance in the ecosystem. We are trying to obtain the highest genetic diversity in the trees we are working with, but this has proven difficult at times due to knowledge of only a single adult tree in the overall region for some species. We continue trying to obtain localities of rare species to ensure the highest genetic diversity, which will lead to the healthiest populations. The species we have worked with thus far are the following; Manú Negro (*Minquartia guianensis*), Guayacán (*Tabebuia guayacan*), Cristóbal (*Platymiscium pinnatum*), Cóbano (local tree with this common name, which is currently being investigated to obtain true identification), and Cola de Pavo (*Hymenolobium mesoamericanum*) just to name a few. Fortunately, we have been able to find at least one adult individual of all the above mentioned species within the reserve's limits, but it is important to try to increase the genetic diversity for future species preservation. In addition to these rare species we are also working with more common forest trees that play an important ecological role such as a food source for birds and mammals, or shelter for a variety of animals and epiphytes. We are also working with other plants such as heliconias and arrowroot (Families: Heliconiaceae, Marantaceae) Palms (Families: Aracaceae, Cyclanthaceae), Aroids (Family: Araceae), Orchids (Family: Orchidaceae), bromeliads (Family Bromeliaceae), and an assortment of other epiphytes and herbaceous plants.



The two photos above show examples of extremely rare and endangered trees from the central Caribbean slopes that were raised in the greenhouse. The upper photo shows a young specimen of the critically endangered tree known locally as “Cola de Pavo” (*Hymenolobium mesoamericanum*), and the lower photo shows numerous seedlings of “Corteza” (*Tabebuia chrysantha*).



Brian Kubicki holding a pot with a critically endangered 2-year-old “Cola de Pavo” (*Hymenolobium mesoamericanum*), which is nearly ready to join its ancestors in the C.R.A.R.C. forest (Photo by Aura Reyes).



Aura Reyes (Brian’s wife) showing the size of a critically endangered Guayacán (*Tabebuia guayacan*) two years after being planted in an open area on the reserve.

Building Trails



We have built kilometers of trails on selected parts of the reserve. These trails are important to reduce the impact of continuously walking through the forest. In areas of old-growth forest the under-story plants are extremely fragile, and can take years or even decades to reach a mere meter or two. The trails were also created to facilitate conducting transects, which are used for biological surveys. Transects can generate quantitative data in areas such as reproductive phenology, diversity, abundance, and habitat preference of the study subjects. We are currently in the process of making detailed maps of the reserve and trail specifics such as important plants and ecosystems found along their course, in addition to birds eye views, and cross-sectional topographical information.

Cabin in the Rainforest...



This photo shows the forest cabin located at the large forest pond site. This cabin was built completely out of wood from the property. We did not cut down any trees, but simply utilized wind fallen trees for the lumber. This cabin was created for the purpose of having a place to sleep while conducting research at the pond or surrounding forest. The cabin is three meters wide, by six meters long. There is an outhouse down a trail, approximately 25 meters behind the cabin. The outhouse has a flushing toilet, and a running waterspout for washing purposes. The water is collected from the roof when it rains, and is held in two 55-gallon tanks. The cabin sleeps up to three people with the choices of a bunk bed or a mattress on the floor, all with mosquito netting. The photo below shows the proximity of the cabin to the pond.



IN RETROSPECT....

It may be hard to image what the C.R.A.R.C. started out like, especially for those visiting in the recent years. When the property was originally purchased it was an abandoned finca (farm). The yard area was grown over with tall grass, weeds, banana and coffee plants, not to mention lots of garbage. Even though the guest house was built less than two years prior to purchasing the property it, too, was in need of serious repairs. The amount of work over the years has been extensive to say the least. I saw the potential of the property, you could say a diamond in the rough.....



The above photos show the guest house and yard after nearly a month of chopping and cleaning in October 2002. These photos show an improvement, but the real work was just beginning...



This photo shows the front garden before the small pond was made and before planting the vegetation. Notice the pile of garbage (right-center) that was from just the small area shown in this photo.



The front porch after some cleaning and just prior to beginning the process of pouring cement.

The following photos show the transformation of what is now the guest house. I lived in this house from December 2002 to April 2006. Little by little over the years I made repairs and improvements as time and finances would allow. For the first year the house stayed pretty similar to the photos on the following page from October 2002.

The guest house was completely remodeled in November of 2007. It now has three bedrooms, one with a double bed, the second with a single-sized bunk bed, and the third with a bunk bed having a double bed below and a single above. The guest house is complete with a kitchen, living room, and bathroom. The shower and sinks have hot water. There are two porches for enjoying the view and the comfortable year round outdoor weather conditions. It is the perfect option for anyone looking to enjoy the natural beauty Guayacán and the C.R.A.R.C. has to offer, comfortably sleeping up to 7 people.



The living room (above, October 2002) and (below, December 2007).





Another view of the living room (above, October 2002, photo by Alberto Ballar) and (below, December 2007)



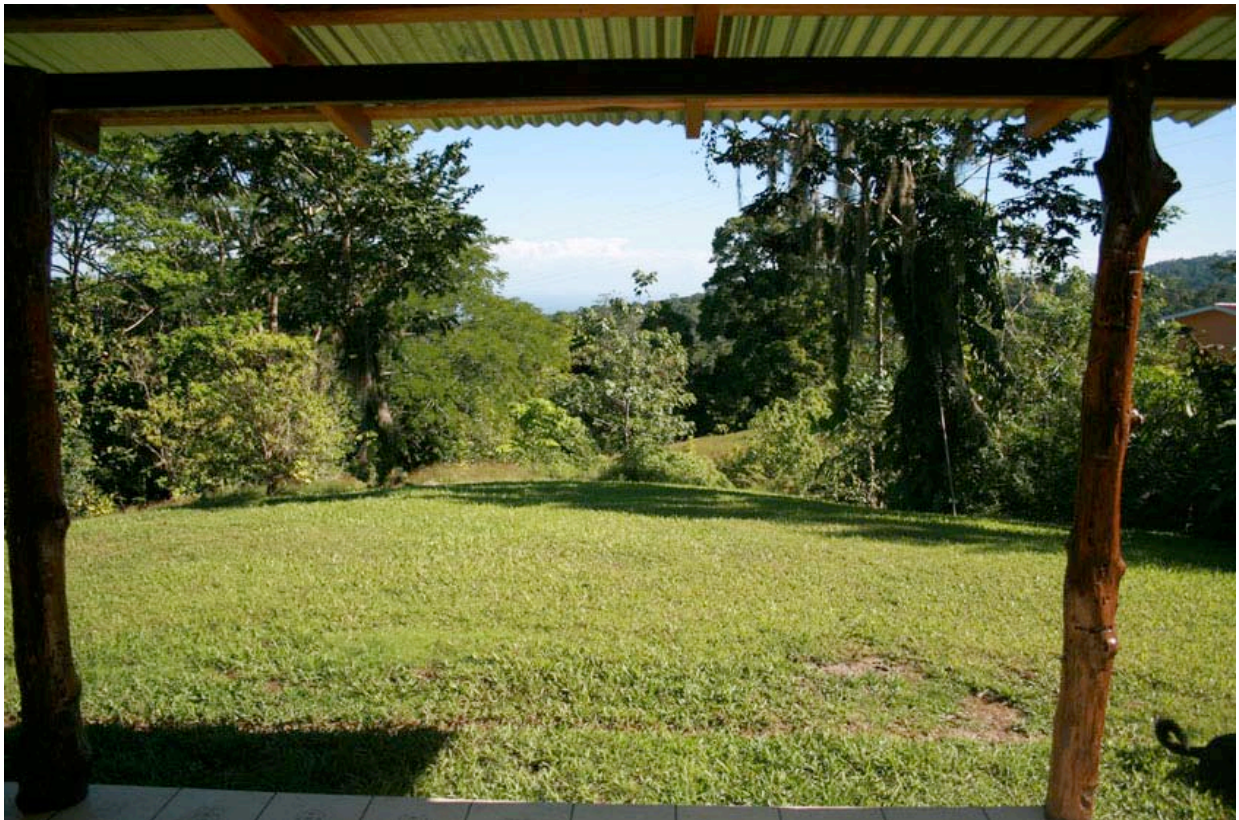


The main bedroom (above, October 2002) and (below, December 2007)





Outside the guest house (December 2007).



View of the forest from porch # 1.



View of the garden and pond from porch # 2.



Sunrise over the reserve.



Rain clouds rolling in over the reserve, looks like rain again.....

Altos de Pacuarito Reserve



A nice thing about doing fieldwork is that you get to know some really interesting sites. One particular area I have always found special is located along the small road that leads to Barbilla National Park. This region has a lot of biodiverse forest patches bordering the Pacuare River. These forest patches form a crucial biological corridor along the Pacuare River valley.

During the spring of 2007 we found an impressive property that needed to be conserved. After a couple of weeks of negotiation with the owner we arrived at a price that we could not pass up. We were able to purchase it in April of 2007 and dedicate it as an additional private reserve of the Costa Rican Amphibian Research Center. This land was obtained for its conservational importance, and to be used as an extension for future research projects through the Costa Rican Amphibian Research Center.

The Altos de Pacuarito Reserve is located 3 kilometers (1.8 miles) off National Highway 32 (San José to Limón), on a gravel road that leads to Barbilla National Park. We were especially interested in this region due to a combination of its biological richness, conservational importance, and its proximity to the C.R.A.R.C. reserve, being less than a half hour by car. The altitudinal zonation of this property (200-350 meters above sea level) has been heavily deforested due to human development and resource encroachment. Old-growth forest areas at this altitudinal range are rare. This is a shame because these altitudes presents an interesting biological assemblage of species due to the transition of humid lowland low-gradient forests to high-gradient foothills wet forests.

The property has about 25% of its area covered in old-growth forest, 25% of its area covered in mature secondary forest, and about 50% of its area covered in young to mature secondary growth and open habitat. This area is of great conservational importance due to its abundant forest coverage, especially at this particular altitudinal range.

Another very important aspect of this reserve, and a key element that was considered regarding its purchase, is its richness in springs and streams. This property is located in the headwater region for this area, and numerous small streams originate within its boundaries. At the C.R.A.R.C. we place stream stewardship at the top of our list of priorities. There is no natural resource more precious on this planet than clean freshwater, especially mountain spring streams. This source of freshwater is vitally important to all animal species, including humans. This property is indeed very special, even for this high rainfall region, due to its density of hydrologic richness.

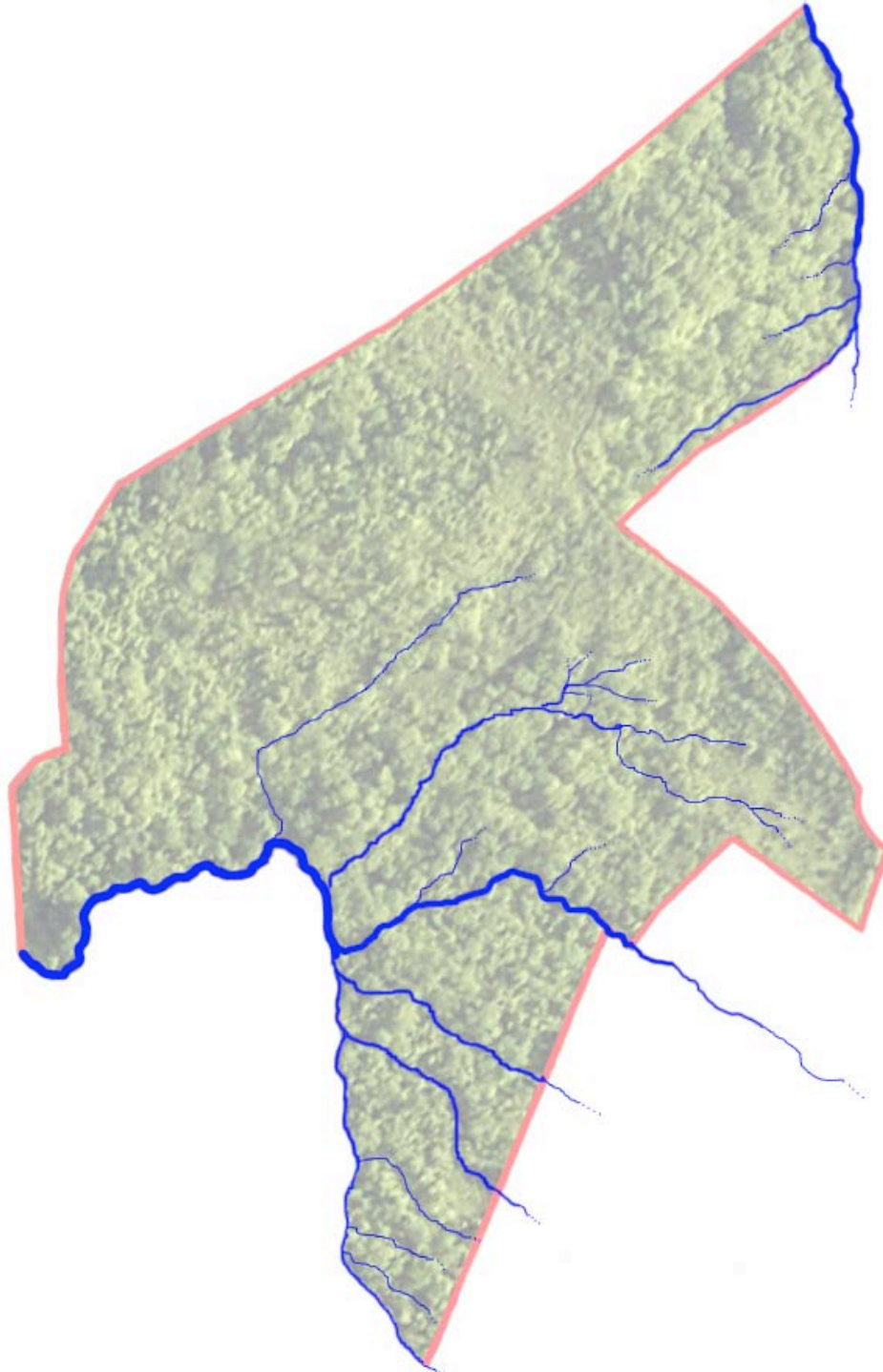


Image showing the hydrologic richness of the Alto de Pacuarito Reserve



A cascade during dry conditions in one of the numerous mountain-spring streams that originate within the Altos de Pacuarito Reserve.

Due to the recent acquisition of this property, and to limited time, we unfortunately have not had a schedule that allows us to conduct detailed biological inventories, but during some preliminary explorations we have found numerous plant and animal species that are of conservational importance.



One example of a species of conservation importance is *Cruziohyla calcarifer*. This species has been found in a section of old growth forest on the Altos de Pacuarito Reserve.



This photo shows the scale of the base of a large "Espavel" tree (*Anacardium excelsum*) in a section of old-growth forest on the Alto de Pacuarito Reserve.



This photo shows a small part of the numerous panoramic views of the Caribbean lowlands of Costa Rica that are abundant from the Altos de Pacuarito Reserve.



Numerous species of amphibians, such as this tiny species of dendrobatid (*Silverstoneia flotator*), greatly appreciate the concern of the C.R.A.R.C. for the dedication to the future conservation of their specific reproductive habitat within the C.R.A.R.C. and Altos de Pacuarito Reserves.

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Oophaga pumilio



Hyloscirtus palmeri



Agalychnis saltator



Hyalinobatrachium talamancae

Costa Rican Amphibian Research Center



Telephone: (506)-8889-0655, (506)-8841-5327

Mailing Address: Apartado Postal 81-7200, Siquirres, Limón Province, Costa Rica

Email: crarc@yahoo.com **Web:** www.cramphibian.com