

Stream ecosystems of Costa Rica

Corcovado National Park
Piedras Blancas National Park
,Regenwald der Österreicher'

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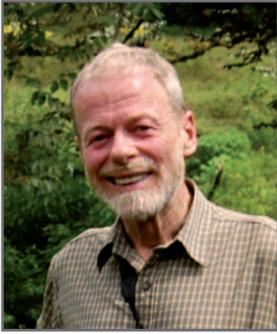
Peter Weish

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In Memoriam: Dipl.-Ing. Günther Matula

May 16th 1947 – October 11th 2010



We dedicate this volume to the memory of Günther Matula, an enthusiastic supporter of the field station at La Gamba from its inception. Günther was born in Wilhering in 1947, the youngest of five children. High moral values and an appreciation and love of nature – his father had a plant nursery – were a central part of his upbringing. He was multi-talented and was first drawn to music and mathematics, but eventually decided to study forestry at the University of Natural Resources and Life Sciences in Vienna.

In 1975 he took responsibility for customer service in his father's plant nursery, which included helping customers to plan their gardens. Interest in his garden designs increased, partly due to his technical knowledge, but mostly due to his gift for combining customers' wishes with the opportunities afforded by nature. He subsequently established his own business, as a pioneer of garden and pond design.

Günther first visited the La Gamba field station in Costa Rica in 1998. He was impressed both by the natural diversity of this unique forest, and by the conservation and scientific projects that were carried out there. He returned, and made a surprise visit a year later with his children Anna and Adam. The station was still very small at the time, so a bodega (small shop) that was still under construction was quickly converted into a building for the family to live in. Günther was so touched by this gesture that he financed the building work himself, and thereby laid the foundations for the "Cabinas Matula". The building was progressively enlarged, and now provides accommodation for large numbers of students and scientists. Günther was a keen supporter and sponsor of the station from the very first, and he would be delighted to see his influence continuing after his death in the form of projects and programs under his name.

Günther left a strong legacy and a deep impression in our hearts.



Preface

Fritz Schiemer

The original idea of producing a field guide to the streams of the Piedras Blancas National Park came from Julia Tschelaut and Christian Pichler, who were my first two students to work on the limnology of rainforest streams at La Gamba. As soon as they finished their degrees, however, like other excellent graduates they immediately became caught up in careers, and the project was put on hold. It was not until several years later, when the Limnology departments at the Universities of Vienna and Innsbruck (Austria) organised a limnological field course at the Tropical Research Station La Gamba, that the project was revived. This time, however, the field guide was to encompass rainforest streams, their riparian zones, and their estuaries and mangrove ecosystems.

Rainforests are a fascinating environment, and rainforest streams an intrinsic and functionally interlinked part of it. They serve as important migration corridors and major export routes for nutrients. They are home to a fascinating biota, both in the water, along the shoreline, and in the riparian zones. The rivers at La



Christian Pichler, Julia Tschelaut and Fritz Schiemer on an excursion in 2004

Gamba offer a chance to experience the rainforest's natural beauty, ecology and functionality.

Although this guide focuses on the La Gamba region and takes its examples from the Esquinas catchment, our intention was to outline the general features of rainforest rivers and their immediate environments. We therefore hope that the booklet will be useful as a general introduction for students and nonspecialists, as well as a field guide for anyone planning to hike along neotropical rainforest streams. We also hope that the guide will encourage future study of the ecology and biota of Costa Rican river systems.

I would like to thank my many colleagues who have made valuable contributions to this booklet in the form of texts and photographs, and in particular Bernd Pelster, Marlen Böttiger and Lucie Schiemer for proofreading the final texts.



Michaela Brojer searching for beetles in the middle reach of the Río Esquinas

The „Tropical Research Station La Gamba“

Roland Albert

The Tropical Research Station is located near the small village of La Gamba, on the border of the Esquinas forest. In 1991, Michael Schnitzler, a distinguished musician and professor at the University of Music and Performing Arts in Vienna, founded the “Association Rainforest of the Austrians” (“Verein Regenwald der Österreicher”). Over many years, he collected contributions in Austria and forwarded the funds to the Costa Rican government. With those funds, the government purchased large tracts of forest from landowners, thereby saving the Esquinas forest in south-eastern Costa Rica as part of the “Parque Nacional Piedras Blancas”. This protected forest is now a valuable link in the impressive chain of national parks in Costa Rica. The Tropical Research Station is located at the edge of this national park. With the support of Schnitzler’s foundation, as well as the Austrian Ministry of Science and Research and the University of Vienna, the Tropical Research Station has been enlarged and improved continuously during the last decade, and now comprises several buildings (including an air-conditioned laboratory) and a botanical garden. It provides comfortable living and research facilities for over 30 visitors. With this infrastructure, the field station is currently on the threshold of becoming an internationally established research institution and education center, focusing on

the exploration and conservation of Neotropical rainforests. Since its foundation, many scientists have used it to carry out field research in the Esquinas rainforest, while visitors have enjoyed its beautiful surroundings. The station is managed by a private association (“Verein zur Förderung der Tropenstation La Gamba”) since 2006 and we are particularly pleased that the former European Commissioner for Agriculture, Dr. Franz Fischler, functions as a patron.

Numerous scientific publications, including around 70 doctoral and diploma theses, have resulted from research conducted at the station. The scientific work initially focused on the flora and vegetation of the Esquinas forest but has now broadened to include a wide range of other topics, such as animal-plant interactions, herpetology, ornithology, entomology (in particular studies of butterflies), limnology, chemical ecophysiology, bio-geochemistry, geography and sociology. Around 60 field courses and excursions so far enabled students and scientists from universities all over the world to visit and study in the Piedras Blancas National Park. Much of the recently gathered biological data, together with older research, indicate that these lowland forests rank among the most highly diverse ecosystems in Central America.



As well as supporting research and teaching activities, the station helps the inhabitants of La Gamba through a series of applied projects aimed at improving their living conditions. These projects are partly run in collaboration with the nearby Esquinas Rainforest Lodge, another brainchild of Michael Schnitzler and an example of sustainable ecotourism.

The management of the station is particularly keen to provide all our visitors, as well as the many friends of the tropics abroad, with information about the biology and ecology of the local and regional rainforests and the adjacent cultivated land. Following the publication of a "Field Guide of Flowering Plants of the Golfo Dulce Rainforests" in 2001 a scientific monograph, "Natural and Cultural History of the Golfo Dulce Region, Costa Rica", was published in 2008. Alongside a series of colorful brochures has been published on amphibians and reptiles, birds, butterflies, dragonflies, bees and fruits. For further information see page 122. In contrast to many of our earlier booklets, which dealt with particular groups of organisms, the current volume focuses on an entire habitat type, i.e. aquatic rainforest habitats. It covers the general limnic relationships of tropical streams and rivers as well as the biology of particular aquatic organisms and life forms. Although based on the Esquinas forest systems and the nearby mangroves of the Golfo Dulce area, the authors have attempted to illustrate, in a comprehensive and integrative way,



Fritz Schiemer and Johann Waringer working in the laboratory

as many characteristic aquatic phenomena of the Neotropics in general as is possible in a limited space. This booklet could therefore also serve as a limnic field guide to tropical forests outside the Parque Nacional Piedras Blancas.

The primary aim of this booklet was to draw tropical travelers' special attention to aquatic habitats within the forests, which are usually rather neglected due to the overwhelming multiplicity of terrestrial life forms. This new field guide will open up a fascinating new tropical world! We hope that this booklet will be a source of information and joy to all those who love the tropics, to scholars and students, to teachers and researchers at the University and – finally – to all the friends of the Rainforest of the Austrians and the Tropical Research Station La Gamba.



A naturalist's walk along rainforest streams

Peter Weish

By walking along rainforest streams in Costa Rica like the Quebrada Negra, the Quebrada Gamba or the Rio Bonito, a large diversity of plants can be observed. Some of the species might be familiar from our indoor gardens at home, for example, *Dieffenbachia* and *Monstera* from the Araceae, ferns, and epiphytes such as orchids and bromeliads. The observant wanderer will also encounter an enormous variety of animals. The following paragraphs will describe some of the creatures we might find on a walk along a rainforest stream.

In the creeks are many fish whose close relatives we often find in aquaria at home. Among them are cichlids, which until quite recently were assigned to the broad genus *Cichlasoma* but today belong to several other genera. We

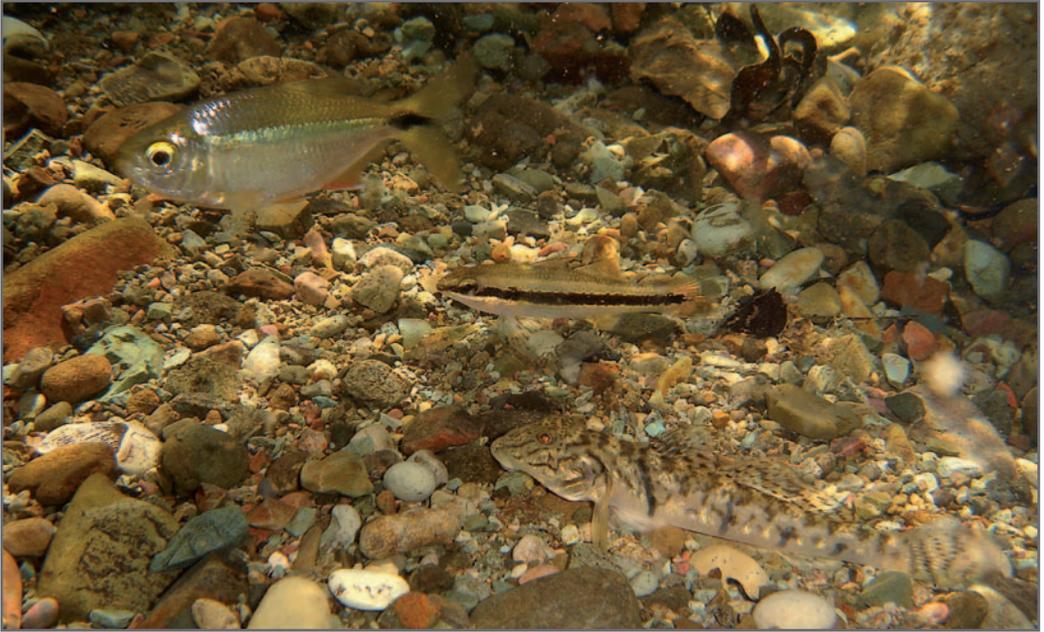


A flying jewel that is frequently seen is the Morpho butterfly

can also find characins (tetras), and several species of poecilids and catfish (for details see the chapter on fish, page 71). The water in the streams is clear (except during and shortly after rainfall), and many fish can be identified, even from above. But the best way to watch the exciting diversity and abundance of fish, especially



By immersing the lens half in and half out of the water, we can take some interesting shots



This picture with members of three families illustrates the high diversity of fish



Poeciliopsis paucimaculata feeding on algae

in potholes below the roots of fallen trees, is by snorkeling. A small, waterproof camera is all that is needed for taking pictures of fish in their natural habitat. With a little patience, we can even observe fish during feeding. Cichlids like *Tomocichla sieboldii* exhibit a characteristic coloration when guiding their offspring. This helps the young to distinguish their parents from the countless potential predators that surround the area day and night. We also find several crustaceans, such as large and small shrimps, prawns, and crabs.

The tadpoles of many anuran species develop in creeks. The tadpoles of toads are black and have rounded tails, whereas those of glass frogs are extremely slender and hide beneath leaves and stones during the day. Glass frogs deposit their eggs on leaves so that the tadpoles fall into the water immediately after hatching. It has been observed that they prefer to hatch during rainfall, which greatly reduces the danger of being discovered (and eaten) by fish. The small, diurnal poison-arrow frogs have become quite rare in recent years, so it is always exciting to find one. *Dendrobates auratus* and *Oophaga gran-*



The cichlid *Tomocichla sieboldii* guarding its brood



A hummingbird's nest with an egg and a nestling

ulifera are conspicuous because of their bright coloration, but "rocket frogs" of the genera *Allobates* and *Silverstoneia* lack such aposematic coloration. Both male and female *O. granulifera* care for their young. In *A. talamancae* the male looks after the tadpoles during their early development at a hidden, moist location below leaf litter, then carries them to a stream to release them.

Walks along the Río Bonito are also worthwhile for bird watchers. Creeks and streams, where the water is clear, make good hunting grounds for kingfishers, which we often see



Allobates talamancae male with tadpoles on the back



The salamander *Bolitoglossa lignicolor* is active during night

during the daytime. Hummingbirds also frequently hunt insects above the water; if we look carefully, we can find their elaborate nests and their chicks. Other species of birds that we often see include herons and the white ibis. Fig trees with ripe fruit attract many animals, among them Squirrel Monkeys. This endemic species, which lives in groups, is the most frequently seen monkey in the La Gamba region.

Night excursions

Streams also provide plenty of interesting opportunities for night excursions.

Since Costa Rica has such a tremendous biodiversity, with many species occurring in low abundance, even familiar paths can offer new surprises. For example, I often have walked at night along the bird-trail close to the Esquinas Rainforest Lodge, but only once have I seen a *Bolitoglossa* salamander.

In the La Gamba region, the most frequently heard frog calls are those of the Pug-nosed *Smilisca*, which we often find on night excursions. Their calling behavior



The Pug-nosed Smilisca (*Smilisca sila*) is commonly found at the edge of streams

is remarkable: several males call in perfect synchrony, thereby reducing the risk of being located by the frog-eating bat *Trachops cirrhosus*. They then all fall silent when a frog-eating bat flies by. This species is probably the prevalent prey of cat-eyed snakes. Males of *Bufo melanochlorus* choose elevated places for calling. The biggest frog is the South American Bullfrog *Lep-*

todactylus pentadactylus, which hunts for prey near the stream.

A torch can be used to find many animals, including shrimps, spiders, butterflies, frogs, and several reptiles and mammals, because their eyes reflect the light. Spiders are commonly found at night, sitting close to the water watching for prey. Many snakes are also active



Around La Gamba the venomous Lancehead (*Bothrops asper*) is the most common snake near rivers and streams



Young Caimans (*Caiman crocodylus*) are found even in small streams



Big spiders lurk for prey close to the water

at night, and we often see cat-eyed snakes of the genus *Leptodeira* and juveniles of the Lancehead, *Bothrops asper*. If we repeat the same walk at the same time on different nights, we can often observe the same individuals occupying the same places. It is rarer to encounter venomous coral snakes, although we have found *Micrurus allenii* and *Micrurus clarkii* on the banks of Quebrada Gamba and Quebrada Negra. Juveniles of the Common Basilisk (also known as “Jesus Christ

Lizard”) choose an exposed sleeping position on thin branches or roots, so that they can easily escape in case of danger. In the past, we have found young caimans of up to about 120 cm in the Quebrada Negra just behind the station. Caimans had previously bred in the nearby pond, and the young had taken the creek as a path in their search for a habitat, preferably in one of the nearby rivers. I once decided to pick up one of the caimans: the first attempt failed, when the



Male *Bufo melanochlorus* in calling position



A juvenile Common Basilisk (*Basiliscus basiliscus*) in sleeping position

caiman turned out to be stronger than my grip, but my second attempt with a smaller specimen was successful, and I was able to take the young caiman out of its pothole (see picture, page 12). It really was an exciting experience holding a wild caiman in my hands.

Only once have I met a common Gray Four-eyed Opossum (*Philander opossum*) close to a

creek. It is more usual to find Coatis (*Nasua narica*) and even Kinkajous (*Potos flavus*). We can often find peccary tracks, and on one occasion José Angel, our experienced guide from La Gamba, showed me the tracks of a Jaguar near a creek. I couldn't decide whether it was bad or good luck not to meet him or her personally!



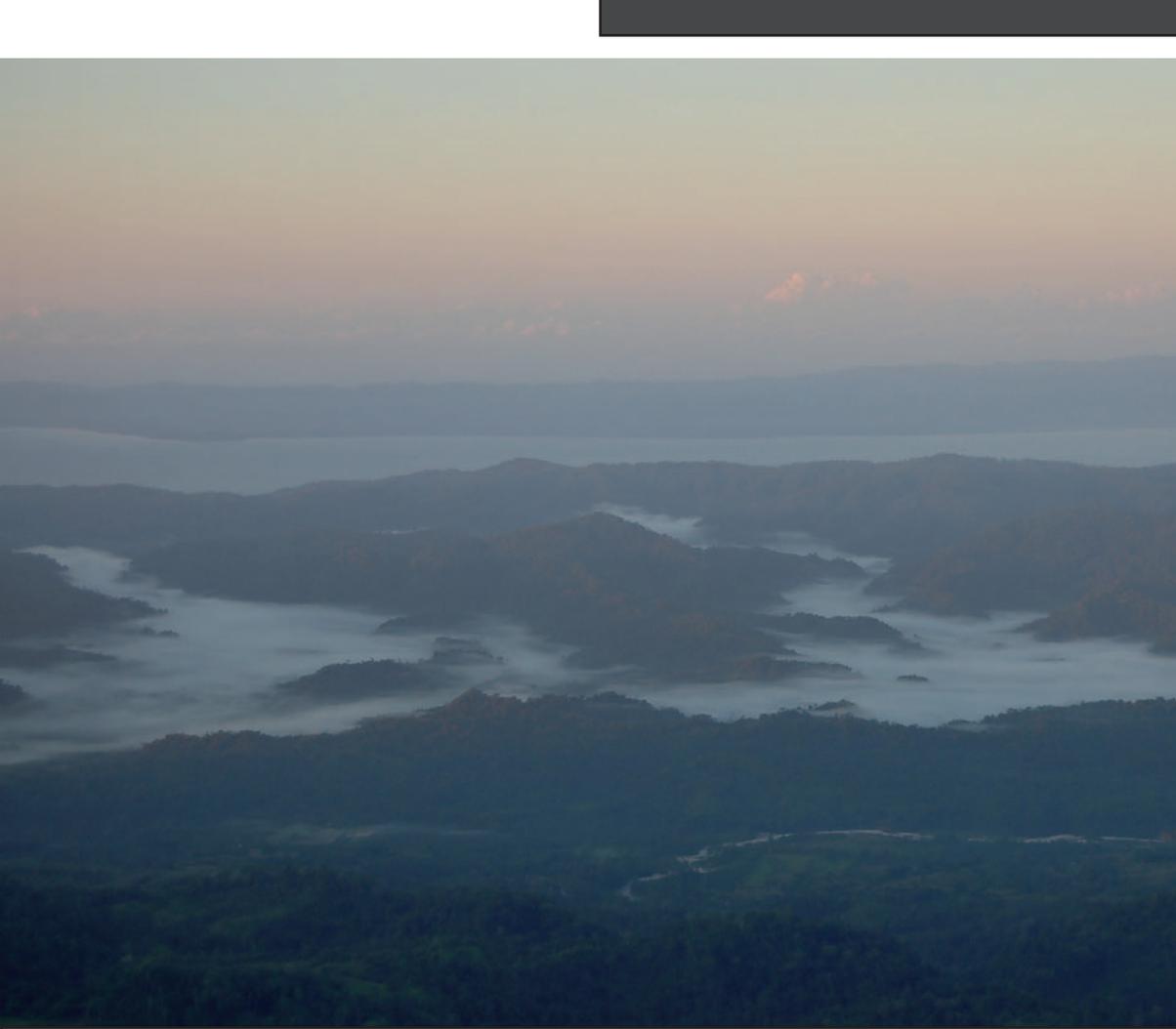
The South American Bullfrog (*Leptodactylus pentadactylus*)



The Gray Four-eyed Opossum (*Philander opossum*)



The Quebrada Negra behind the tropical research station



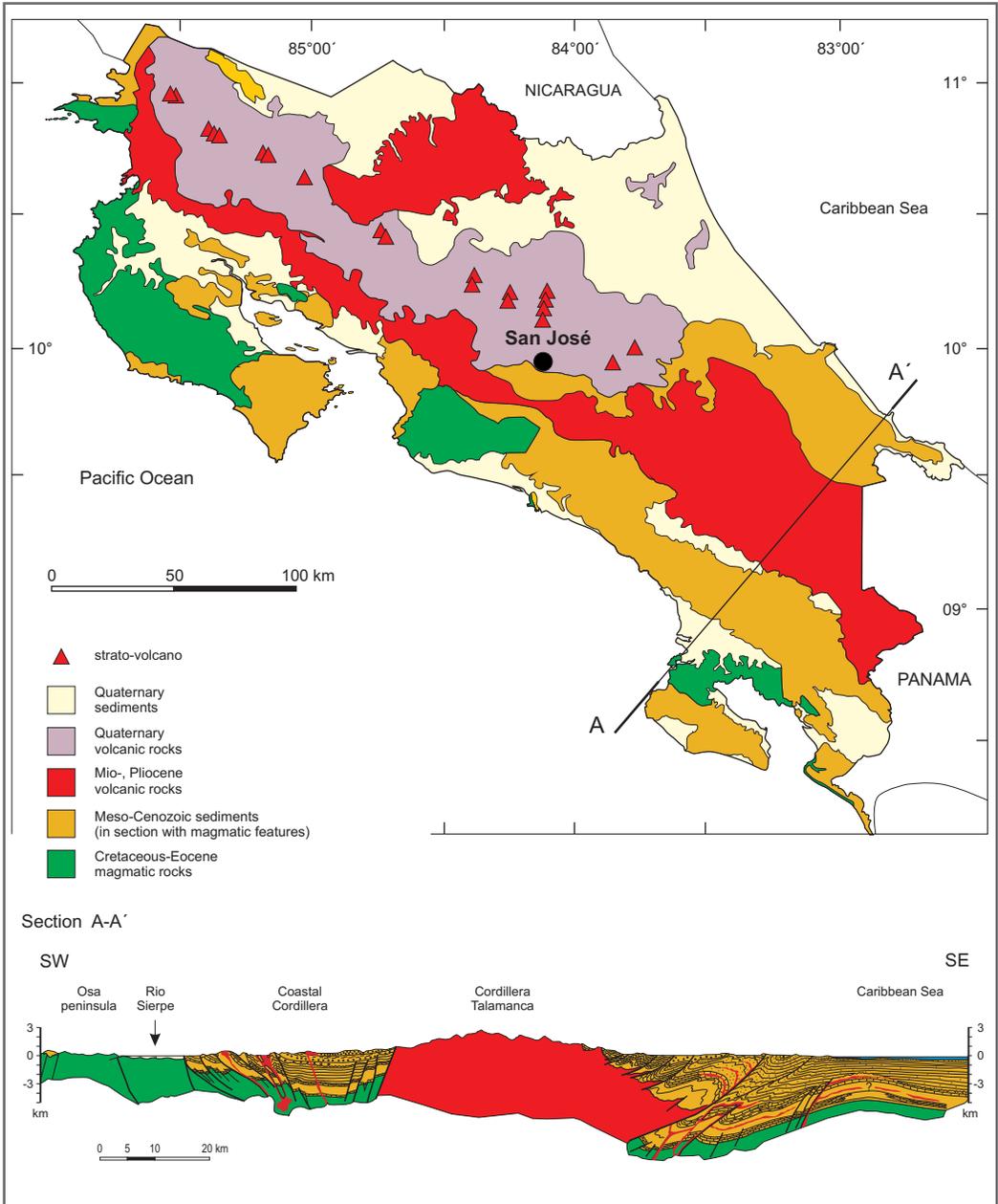
Geography, geology, climate and biodiversity

Werner Huber & Anton Weissenhofer

Costa Rica is a small country with an area of about 51,000 km² on the isthmus of Central America. It is topographically very diverse: the Cordilleras (Guanacaste, Tilaran, Central and Talamanca regions) form the Continental Divide, a backbone that divides the country into the Caribbean to the east and the Pacific slope to the west. The country contains about 68 volcanic cones or peaks, some of them very active. The highest peak is the Cerro Chirripó in the Cordillera Talamanca, at 3,820 m above sea level. The Valle Central (Central Valley), enclosed by the Cordillera Talamanca and Cordillera Central, contains the main cities San José (the capital), Heredia and Alajuela. Four major river systems (Río Reventazón, 2,950 km² catchment area, Río Sixaola, 2,330 km², Río Sarapiquí, 1,923 km², and Río Tortuguero 1,643 km²) and many small rivers drain the Caribbean slope, and several rivers flow into the Pacific (including Río Grande de Térraba, 5,076 km², Río Tempisque, 3,404 km², Río Tárcoles, 2,168 km², and Río Esquinas, 1,827 km²). Important wetlands include the marshy Corcovado Lagoon on the Osa Peninsula and the Lago Caño Negro close to the Nicaraguan border.

About 25% of the country is within protected areas such as national parks, biological reserves, forest reserves or private wildlife reserves. The Piedras Blancas National Park (also known as the Esquinas Forest) is located in the south of

Costa Rica in Puntarenas province. This national park is one of the last remaining virgin evergreen forests in the Pacific region of Central America. Its altitude ranges from sea level to 579 m at the peak of Cerro Nicuesa. The Golfo Dulce



Geological map of Costa Rica with cross-section (modified from Malzer and Fiebig (2008) following Denyer et al. (2003)). The map is divided into general lithological and chronological units which display more or less obvious affinity in the field. In the cross-section, the backbone of the Central American land bridge, consisting of Cretaceous to Eocene magmatites and Miocene-Pliocene volcanites, is clearly visible. The map illustrates the widespread occurrence of younger sediments and volcanites on top of the backbone.