

Forest conservation and restoration in southwestern Costa Rica: The biological corridors COBIGA and AMISTOSA

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The southwestern parts of Costa Rica, especially the area around the Golfo Dulce and adjacent mountain areas such as the Fila Cal are hotspots of biodiversity and still boast a high proportion of forest cover. However, the natural ecosystems are increasingly affected by fragmentation and climate change. These have a strong negative impact on habitat diversity and biodiversity of flora and fauna. In order to improve this situation, the idea of biological corridors was developed: remaining patches of primary and secondary forest are protected and connected by reforestation of the pastures and wastelands in between. This allows plants and animals to disperse and migrate again over long distances, and promotes genetic exchange. An important aspect is to involve the local people in these projects. This article describes the organization and implementation of the COBIGA (Biological Corridor La Gamba) and AMISTOSA (Biological Corridor Amistad-Osa) corridor projects in southwestern Costa Rica.

WEISSENHOFER A., PICADO ZUÑIGA A., BARRRANTES RAMÍREZ W., ACEVEDO MAIRENA H. & HUBER W., 2019: Waldschutz und -restoration im Südwesten Costa Ricas: Die Biologischen Korridore COBIGA und AMISTOSA

Die Golfo Dulce Region und die angrenzenden Berggebiete im Südwesten Costa Ricas sind nach wie vor größtenteils bewaldet und weisen eine sehr hohe Artenvielfalt an Tieren und Pflanzen auf. Dennoch sind diese Ökosysteme durch Fragmentierung und Klimawandel sehr gefährdet, was eine negative Auswirkung auf die Diversität der Flora und Fauna hat. Die Etablierung von Biologischen Korridoren sollen der Fragmentierung entgegenwirken und primäre und sekundäre Wälder wieder verbinden. Dadurch wird Pflanzen und Tieren ein genetischer Austausch über größere Distanzen ermöglicht. Ein wichtiger Aspekt von Biologischen Korridoren ist auch die Einbeziehung des Menschen.

Keywords: Biological corridor, sustainability, biodiversity, conservation, reforestation, forest restoration, AMISTOSA, COBIGA.

Introduction

Human development has deeply changed and often destroyed the natural coverage of the planet. The natural ecosystems have been drastically reduced in area and are heavily fragmented. Consequently, the landscape has been transformed into a mosaic of human settlements and agricultural land, often interspersed with tiny and isolated fragments of natural vegetation (e.g., BENNET 1998, MORERA et al. 2007, MORENO & GUERRERO-JIMENEZ 2019).

Before this human impact, Costa Rica was covered – with the exception of a narrow band of sandy beaches and the highest mountainous regions – by a continuous layer of forests. According to elevation and regional climatic conditions, this forest cover could be differentiated into a variety of forest types (e.g., tropical lowland forest, hill forest, montane forest, subalpine forest), but together they formed an unbroken continuum.

Nowadays, natural vegetation remains only in the form of larger or smaller patches ('islands'). These patches are ± strongly isolated from each other, with distances ranging from just a few to many hundreds of kilometers.

Forest fragmentation poses a great problem to the animals and plants living in these habitat remnants. Many animals are bound to the forest and avoid crossing open land to reach another patch of forest. This not only holds true for ground-dwelling animals such as mammals, snakes, amphibians etc., but also for flightless birds and insects. In consequence, these animals are captured in small areas that are often too small for long-term survival. They cannot migrate to find appropriate food and proper sexual partners. Finding only relatives for reproduction, inbreeding is inevitable. Some animals such as tigers, leopards, jaguars etc. are in need of huge forest areas for survival and reproduction. They die out when their territories are scaled down.

It is not as obvious that this also holds true for plants, e.g. the forest trees. In a tropical forest, the individuals of many species often grow kilometers apart. Their survival and reproduction is only ensured if the area is large enough to contain many individuals, and if the appropriate pollen vectors (insects, birds, bats, etc.) and seed dispersers are present. Even species whose seeds are transported by birds over large distances are threatened. If they do not fall (with the faeces) on forest ground, they are lost. The seeds either do not germinate or the seedlings dry out in the sun.

In summary, human-caused habitat fragmentation is a significant threat to biodiversity. The more that plant and animal populations decrease and become increasingly isolated, the greater the threat.

How to counteract these problems? One way to diminish the effect of genetic degeneration is the establishment of biological corridors. A biological corridor is a connection between two or more forest patches, or more generally, between patches of similar natural vegetation. It allows for migration, expansion and genetic exchange of animals and plants and enables an exchange of individuals between different populations. It thus helps to maintain the genetic diversity and to prevent the negative effects of inbreeding. Corridors may also facilitate the re-establishment of animal/plant populations that have been reduced or eliminated due to events such as fires, animal/plant diseases or humans. Thus, they contribute to alleviating the worst effects of habitat fragmentation.

During the past few years, the establishment of biological corridors has received great acceptance among experts. A large number of associations and institutions, such as NGOs and universities, cooperate together in initiatives such as the Mesoamerican Biological Corridor Project (MBS). The vision of this specific project is a green corridor belt between North and South America, with the aim of re-establishing or increasing biological exchange between the two continents. The crucial meeting point is Central America. The countries here are challenged to establish corridors with different degrees of protection and restrictions of land use.

In Costa Rica, biological corridors are among the most important conservation strategies in terms of territory size and scope. They are promoted by the National Program of Biological Corridors (created on 30 May 2006, executive decree N°33106-MINAE), with local stakeholders and platforms forming so-called Local Committees of Biological Corridors (Consejos locales). So far, Costa Rica has 44 biological corridors, which represents about 33 % of the continental territory (Fig. 1).

In 2018, a management plan was established for the Biological Corridors in Costa Rica, entitled Plan Estratégico 2018–2025 del Programa Nacional de Corredores Biológicos de Costa Rica, Informe Final (SISTEMA NACIONAL DE ÁREAS DE CONSERVACIÓN 2018).

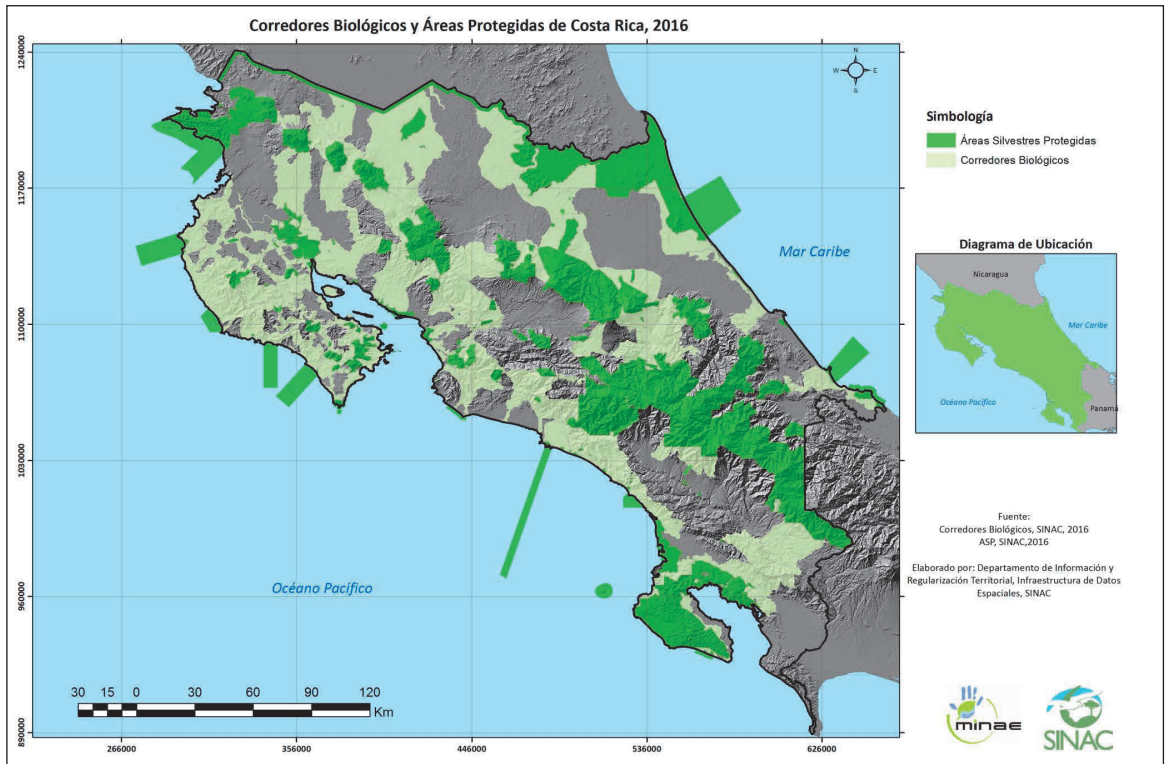


Fig. 1: Costa Rica's biological corridors (pale green) and National Parks (dark green). – Abb. 1: Biologische Korridore Costa Ricas (hellgrün) und Nationalparks (dunkelgrün).

Biological Corridors in the Golfo Dulce Region

The pristine forests of the Golfo Dulce region in southwestern Costa Rica harbor the most diverse ecosystems and encompass the most significant remaining areas of lowland Pacific tropical forest in Central America (see WEBER et al. 2001 and literature cited). The extraordinary level of biodiversity and endemism in the region resulted in one of the highest conservation priorities in Central America (ANKERSEN et al. 2006). The Piedras Blancas National Park (approx. 150 km²) and the Corcovado National Park (424 km²) includes protected lowland rainforests and is surrounded by agricultural land and unprotected forests.

The Biological Technical Coalition Biologica Corridor Osa (CTCBO), founded in 2001 by the National System of Conservation Areas (SINAC) and NGOs, aims at (1) generating and transferring technical and scientific information, (2) implementing conservation strategies and consolidating local capacities, and (3) setting up sustainable development and management in the region (GARCÍA 2008). As an example, the Osa Biological Corridor links different rainforest ecosystems including mangroves and cloud forests. Equally, it forms a connection between the Osa peninsula and the La Amistad International Park (PILA) in the Cordillera de Talamanca.



Fig. 2: A typical tree nursery run by Elias PADILLA at the Finca Alexis, 400 m a.s.l. – Abb. 2: Typische Baumschule die von Elias PADILLA auf der Finca Alexis auf 400 m Seehöhe aufgebaut wurde.



Fig. 3: View from the lowland forest near La Gamba up to the mountain forests of Fila Cal (1,700 m). Foto: Dennis KOLLARITS. – Abb. 3: Blick vom Tieflandregenwald Richtung Bergregenwald der Fila Cal in der Nähe von La Gamba (1.700 m). Foto: Dennis KOLLARITS.

The COBIGA project (Biological Corridor La Gamba)

The COBIGA project was initiated in 2006 by the first author and is guided by the Tropical Station La Gamba. The focus of the project is mainly on the connection of the lowland forests of the Piedras Blancas National Park with the 'Fila Cal', a largely unprotected area covered with montane rainforests. Local people in the villages of La Gamba, San Miguel and La Virgen are integrated in this project (Fig. 2 and 3).

The exchange of species of the lowland and mountain forests is thus facilitated and contributes to an enrichment of the flora and fauna in both ecosystems. Furthermore, the Fila Cal is an important transition corridor zone to the Talamanca mountains in the north.

On the basis of aerial photographs taken in 2003 (CARTA 2003), particularly important prospective corridor areas were identified (Fig. 4). Special importance was attached to (1) closing forest gaps in order to create – as far as possible – a continuous forest area, and (2) reforesting or restoring pastures and/or river banks for water protection and the formation of \pm compact corridors. MORERA & ROMERO (2008) analyzed the vegetation types in an area of 117.8 km² between the Piedras Blancas National Park and the Fila Cal based on aerial photographs taken in 1998. Around 54 % of the area proved to be covered with forest. The dominant use of the remaining area was for agriculture, particularly pastures (24 %) and timber plantations (9 %).

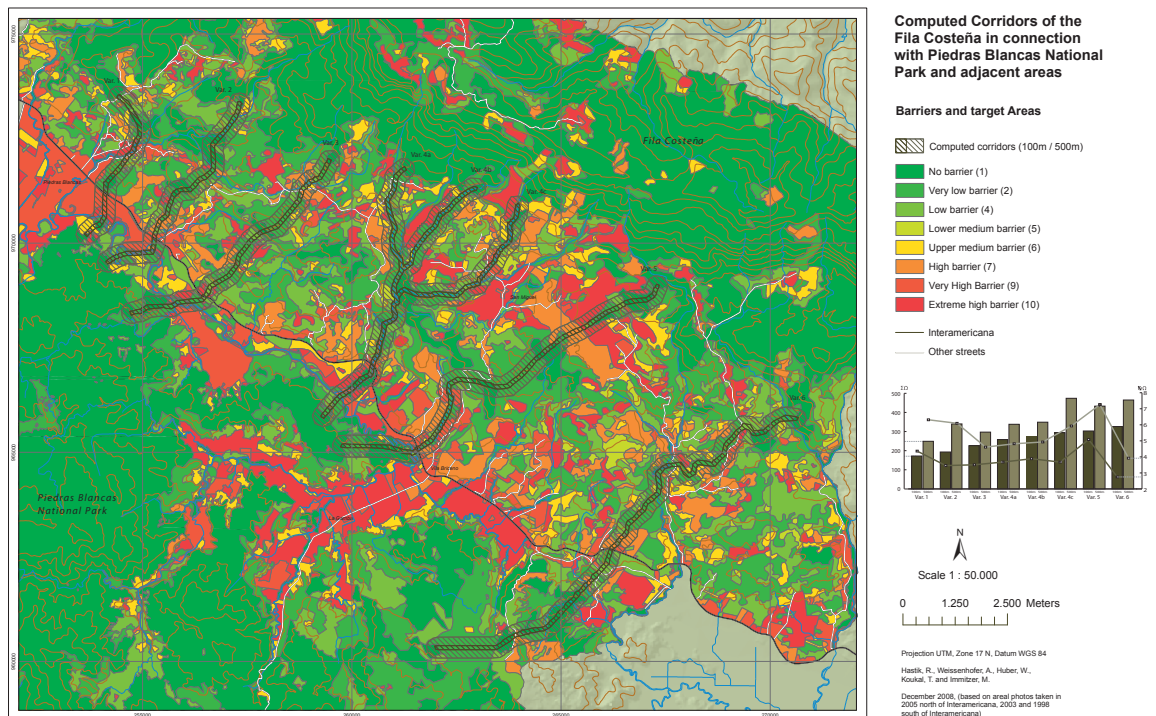


Fig. 4: Computed corridors in the COBIGA region around La Gamba and Fila Cal with different levels of barrier effects. – Abb. 4: Errechnete Korridorvarianten aufgrund von Barrierestufen in der COBIGA Region von La Gamba und Fila Cal.

At present, most of the sites envisaged for corridors are in private hands. The farmers are the first people that have to be convinced of the corridor idea. Since 2010, the Austrian association 'Rainforest of the Austrians' has taken an active part in the COBIGA project and engages mainly in purchasing suitable land areas, and in reforesting them. Examples that have been successfully reforested or are presently in the process of reforestation or natural succession are the Finca Amable (12.5 ha), Finca La Bolsa (16.5 ha), Finca Alexis (137 ha), and several smaller areas. The Fincas are then included into the FONAFIFO projects (Fondo Nacional de Financiamiento Forestal) for better visualization and protection of the forest areas.

Since 2015 the association Rainforest Luxemburg is a major sponsor. In 2017, the COBIGA project and Rainforest Luxemburg started working intensively together on the AMISTOSA biological corridor. The Tropical Station La Gamba is main actor in the local committee (consejo local) of La Gamba. It takes the lead in planning, managing and organizing local activities (see below), in association with national organizations (SINAC), NGOS and the involvement of the local people.

Reforestation of agricultural land and restoration of forests in COBIGA

Reforestation of agricultural land and restoration of forests with native tree species is an important step in the establishment of biological corridors, particularly in the COBIGA project. Moreover, agroforestry systems consisting of a mix of timber trees, fruit trees, short-lived crops and vegetables can be well utilized by the local people.

It is important to emphasize that reforestation with native tree species plays a fundamental role in environmental conservation, because it helps to recover certain species that face a particularly high risk of extinction, either because they are endemic or have very slow growth rates.

There is no doubt that trees play an important role in the history and economy of southern Costa Rica. One of the main problems is the over-exploitation of valuable species such as Cachimbo (*Platymiscium curuense*), Manú Negro (*Minquartia guianensis*) and Chirracó (*Caryodaphnopsis burgeri*). These species have been largely exploited without control and nowadays it is difficult to find trees of such species in their natural habitat.

There are many benefits of reforestation projects such as the COBIGA project. Along with the reforestation of areas, forest carbon storage areas are enlarged and safe zones for the dispersal of fauna and flora species are created. Such areas become central reservoirs both for common and endangered species. In addition, this allows study areas to be created for future research. Reforestation projects provide opportunities for collaboration in solving social issues, such as providing jobs directly and indirectly for the community of La Gamba and adjacent areas.

In total, between 2006 and 2019, more than 60 ha of pasture were reforested. More than 44,000 trees of 200 species were planted in the region of La Gamba, San Miguel and La Virgen. At present, the Finca Luis (La Gamba; approx. 1,000 trees, reforestation in patches, see Fig. 5) and the Finca Alexis 3 (San Miguel; species enrichment, 2,000 trees) are in the process of reforestation.



Fig. 5: Día de acción – Day of reforestation at Finca Luis, with students from the University of Vienna, volunteers of La Gamba and workers involved in the COBIGA project. – Abb. 5: Typischer Aktionstag – Wiederbewaldung auf der Fica Luis mit Studierenden der Universität Wien, Volontären aus La Gamba und Mitarbeitern von COBIGA.

Reforestation, forest restoration and species enrichment: explanation of terms and concepts

Reforestation projects are mainly conducted by or in cooperation with private farmers. In the case of the COBIGA project, up to 50 species of selected timber trees and species of high ecological value are used for reforestation. The private owners are allowed to use the wood after a certain period of time and have to replant the trees after cutting. In this way, a simple and sustainable forest management is established.

In contrast, restoration of forests means that there is no intention of using the planted trees after the forest has developed. In this case, one has to attach great importance to species selection for each individual site. Up to 200 different species have to be planted per Finca (e.g. Finca Amable). Such projects can only be realized in cooperation with national institutions, and only rarely with private owners. Restoration of forests is only practicable at sites where natural succession is hampered, due to soil conditions and/or lack of natural vegetation, e.g. pastures without contact to natural forest.

At sites where the seed bank is not disturbed and natural succession can take place successfully, we generally do not plant trees but rather promote growth of the spontaneous vegetation. In rare circumstances (e.g. Finca Alexis) we perform species enrichment. That

means that we select rare tree species of the region (e.g. species that were overexploited) and plant them in selected patches in the shade of the spontaneous vegetation. This is to avoid complete extinction of those species.

Tab. 1: List of the most important tree species used in the reforestation project. – Tab. 1: Liste der wichtigsten im Wiederbewaldungsprojekt verwendeten Baumarten.

Nr.	Family	Genus	species	Vernacular name
1	Anacardiaceae	<i>Anacardium</i>	<i>excelsum</i>	Espavel
2	Anacardiaceae	<i>Astronium</i>	<i>graveolens</i>	Ron ron
3	Anacardiaceae	<i>Spondias</i>	<i>mombin</i>	Jobo
4	Apocynaceae	<i>Aspidosperma</i>	<i>myristicifolium</i>	cara tigre
5	Apocynaceae	<i>Aspidosperma</i>	<i>spruceanum</i>	Manglillo
6	Bignoniaceae	<i>Tabebuia</i>	<i>guayacan</i>	Corteza
7	Malvaceae	<i>Ceiba</i>	<i>pentandra</i>	Ceiba
8	Clusiaceae	<i>Calophyllum</i>	<i>brasiliense</i>	Maria
9	Combretaceae	<i>Terminalia</i>	<i>amazonica</i>	Amarillon
10	Euphorbiaceae	<i>Hyeronima</i>	<i>alchorneoides</i>	Pilon, zapatero
11	Euphorbiaceae	<i>Croton</i>	<i>schiedeanus</i>	Colpachí
12	Fabaceae - Casalpinioideae	<i>Schizolobium</i>	<i>parahyba</i>	Gallinazo
13	Fabaceae - Casalpinioideae	<i>Copaifera</i>	<i>camibar</i>	Camibar
14	Fabaceae - Casalpinioideae	<i>Cynometra</i>	<i>hemitomophylla</i>	Cativo, guapinol negro
15	Fabaceae - Casalpinioideae	<i>Peltogyne</i>	<i>purpurea</i>	Nazareno
16	Fabaceae - Faboideae	<i>Platymiscium</i>	<i>curuense</i>	Cristobal, Cachimbo
17	Fabaceae - Faboideae	<i>Dussia</i>	<i>discolor</i>	Sangregao, targuayugo
18	Fabaceae - Mimosoideae	<i>Inga</i>	<i>oerstediana</i>	Cuajiniquil
19	Fabaceae - Mimosoideae	<i>Inga</i>	<i>spp.</i>	Guaba
20	Fabaceae - Mimosoideae	<i>Parkia</i>	<i>pendula</i>	Tamarindo, tamarindo gigante
21	Fabaceae - Mimosoideae	<i>Zygia</i>	<i>longifolia</i>	Sotocaballo
22	Humiriaceae	<i>Humiriastrium</i>	<i>diguense</i>	Chiricano alegre, lorito, nispero
23	Lauraceae	<i>Ocotea</i>	<i>sp.</i>	Ira
24	Lecythidaceae	<i>Couratari</i>	<i>guianensis</i>	Copo hediondo
25	Malvaceae	<i>Apeiba</i>	<i>membranacea</i>	Peine de mico
26	Malvaceae	<i>Apeiba</i>	<i>tibourbou</i>	Peine de mico
27	Malvaceae	<i>Luehea</i>	<i>semanii</i>	Guacimo colorado
28	Malvaceae	<i>Mortoniendron</i>	<i>anisophyllum</i>	Cuero de vieja
29	Meliaceae	<i>Carapa</i>	<i>guianensis</i>	Cedro bateo
30	Meliaceae	<i>Cedrela</i>	<i>odorata</i>	Cedro amargo
31	Meliaceae	<i>Guarea</i>	<i>grandifolia</i>	Caobilla
32	Moraceae	<i>Brosimum</i>	<i>utile</i>	Lechoso
33	Moraceae	<i>Brosimum</i>	<i>alicastrum</i>	Ojoche
34	Moraceae	<i>Ficus</i>	<i>insipida</i>	Chilamate
35	Myristicaceae	<i>Virola</i>	<i>koschnyi</i>	Fruta dorada
36	Olacaceae	<i>Minquartia</i>	<i>guianensis</i>	Manu, manu negro, palo de piedra
37	Salicaceae	<i>Tetrathylacium</i>	<i>macrophyllum</i>	Lengua de vaca, zapote
38	Verbenaceae	<i>Vitex</i>	<i>cooperi</i>	Manu platano
39	Vochysiaceae	<i>Vochysia</i>	<i>ferruginea</i>	Mayo
40	Vochysiaceae	<i>Vochysia</i>	<i>allenii</i>	Mayo

Species selection

In order to make a suitable selection of species for a given locality, it is necessary to know about factors such as soil type (acidity, prior use, fertility, presence of compacted layers etc.), weather conditions (precipitation) and topography, as well as the ecological characteristics of each species that is considered for planting. Unfortunately, very little information exists for most species of the area. The lack of knowledge about the ecological factors, paired with improper handling, led to the failure of many reforestation initiatives in the past. The selection of appropriate species is an indispensable prerequisite for successful reforestation. This step can best be achieved in close cooperation between forest engineers, botanists and local people with good knowledge of forest trees. Species of prime importance are those with a high ecological value. A selection of the most important species used for reforestation is given in Table 1. Practical information on reforestation and suitable tree species is presented in the book *Creating a forest – trees for biological corridors in the Golfo Dulce region, Costa Rica* (WEISSENHOFER et al. 2012).

The Finca Modelo

The Finca Modelo (*Escuela vieja*) is a model farm situated close to the Tropical Station La Gamba. It plays an important part in the COBIGA project. It is based at the site of a former primary school which was converted into a tree nursery for the permaculture pro-



Fig. 6: Seed exhibition at Finca Modelo: this is held once a year during the dry season. – Abb. 6: Die Samenmesse auf der Finca Modelo wird einmal jährlich in der Trockenzeit veranstaltet.

ject (agroforest system) in 2006. It has become an important communication and education center.

Since 2014, plant exhibitions (Feria de semillas, Fig. 6) take place annually in the dry season (February/March). People come from far away to exchange seed and plant material and learn about organic gardening. Courses on permaculture, forestry and cultivation of different plant species are held at the Finca Modelo as well. In 2019 the Finca Modelo was awarded – as the first Finca in southern Costa Rica – the so-called *Bandera Azul* by the Ministerio de Agricultura y Ganadería de Costa Rica MAG.

Practical and theoretical knowledge and experience in growing and planting trees, producing compost, and selection of tree species was collected during the years and compiled in the book *Creating a forest* mentioned above (WEISSENHOFER et al. 2012).

The AMISTOSA biological corridor

The aim of the AMISTOSA biological corridor is to integrate both the enlargement of forest areas and the connection between the Osa Peninsula and La Amistad International Park (PILA) in the Cordillera de Talamanca. Moreover, sustainable land management through projects of reforestation, agriculture and sustainable development is promoted.

For several years, various international, national and private organizations, such as the OTS (Organization for Tropical Studies), Tropical Research Station La Gamba (COBIGA Project), Association Rainforest Luxemburg, FUNDAOSA, SINAC, CATIE, local groups, etc. have sought to formalize the biological corridor AMISTOSA. In December 2018, the AMISTOSA project was accredited in the Programa Nacional de Corredores Biológicos (SINAC), which is a further step in the environmental conservation of the Golfo Dulce area.

The AMISTOSA biological corridor covers an area of 929 km² and is located in the Brunca region, in the cantons of Buenos Aires (5 %), Corredores (9 %), Golfito (39 %) and Coto Brus (48 %) (SINAC 2018). The AMISTOSA is a geographical and altitudinal bridge that connects the Parque Nacional Piedras Blancas and the Refugio Nacional de Vida Silvestre Mixto Golfito (ACOSA) with the Zona Protectora Las Tablas and the Parque Internacional La Amistad (ACLAP).

In total, 43 % of the AMISTOSA biological corridor are covered by forests (398 km²), while 32 % are dedicated to pasture cultivation (294 km²) and 21 % (194 km²) to annual and permanent crops, such as coffee and oil palm (Fig. 7). The three major problems of AMISTOSA are (1) the fragmentation of forests, (2) the lack of knowledge about the biological diversity of the corridor, and (3) the impact of climate change (SINAC 2018).

There are 1,017 forest fragments in the AMISTOSA biological corridor, of which 37 % have an area of less than 2 hectares. Because of their small size, these fragments are not legally recognized as forests by the Ley Forestal de Costa Rica (N° 7575). There are only four forest fragments with an extension of more than 1,000 hectares. These represent approx. 68 % of all AMISTOSA forests. The largest fragment covers an area of 18,186 hectares and is located in the southwest of the biological corridor, between the communities of La Gamba-Bajo, Cedros-Santo and Domingo-Kilómetro 29. The northern sector of AMISTOSA is the most fragmented one. Unfortunately, there is – as yet – a lack of concrete biological studies outlining the functional connectivity of AMISTOSA. Informa-

tion from local management elements or indicator species that would allow assessment of the current state of health of the biological corridor is also missing. Regarding climate change, the AMISTOSA biological corridor contains areas that act as ‘climatic shelters’, which were identified during formation of the Estrategia Nacional del Sector Biodiversidad ante el Cambio Climático (ENASB-CC).

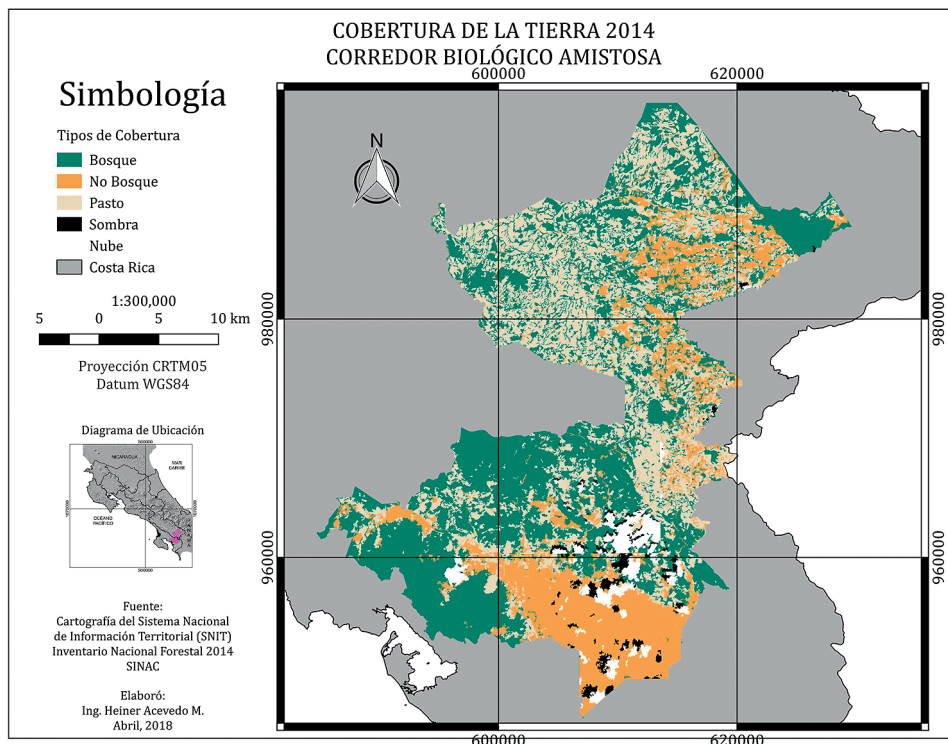


Fig. 7: Map of the AMISTOSA Biological Corridor. – Abb. 7: Karte des Biologischen Korridors AMISTOSA.

For this reason, the AMISTOSA management plan *Viveros Cuna del Corredor Biológico Amistosa* 2018–2027 (ACEVEDO 2018) identifies ‘promoting ecological connectivity and social articulation for conservation, recuperation and sustainable use of natural resources for the wellbeing of mankind’ as their primary mission goals. The management plan consists of seven strategical concepts: (1) planning, monitoring and evaluation; (2) governance; (3) connectivity, forests and natural spaces; (4) sustainable production; (5) climate change; (6) generation of economic resources and (7) communication and management of knowledge (SINAC 2018). This management plan has 18 goals that are stated for development within ten years. These goals are in line with at least five of the national goals outlined in the Estrategia Nacional de Biodiversidad 2016–2025 (ENB2).

The areas of highest priority for reforestation, production and restoration are areas containing water resources for the association of rural water providers ASADAS, routes of structural connectivity between select forest fragments, living fences or hedges of fruit trees.

Scientific work in the Biological Corridors COBIGA and AMISTOSA

The region around La Gamba is ideal for studying natural, semi-natural and anthropogenic habitats and organisms. Since the COBIGA project was established, many scientists have conducted their research on effects and impacts of biological corridors.

In 2013, the Association Rainforest of the Austrians bought a 13.7 ha Finca, called Finca Amable, in the vicinity of the village La Gamba. The Finca was used for banana production since the 1940s and was converted into a rice field in the 1980s. In the last years it was used for cattle breeding. When we purchased the Finca in 2013, vegetation was dominated by the introduced grass *Paspalum fasciculatum*. Many Fincas in the region have quite a similar history and Finca Amable is therefore an ideal model site for a long term study concerning reforestation and regeneration on agricultural land. A scientific design with 80 permanent plot replicates and different combinations of trees according to wood density and inclusion of legumes was established. The planted trees in the plots are monitored 1–2 times per year and should give exact data on growth and CO₂ sequestration (see HIETZ et al., this volume).

Other reforestation sites such as the Finca La Bolsa, Finca Amable, Finca Mundo, and Finca Alexis are ideal areas for studying regeneration as well as population ecology. Christian SCHULZE and his students have carried out scientific work on bats, birds, mammals and reptiles in natural habitats and in oil palm plantations (FREUDMANN et al. 2015, GALLMETZER et al. 2015, SEAMAN & SCHULZE 2010). Macroinvertebrates as indicators in tropical streams with different land-use are studied by Leopold FÜREDER and collaborators, University of Innsbruck (see DUSCHEK et al., this volume).

To get information on the diversity and migration of big mammals, Randy TEAL and Christian SCHULZE, University of Vienna, established a research project using camera traps (Fig. 8). In cooperation with the University of Natural Resources and Life Science, Vienna (BOKU), another new project was started by Ramon ENGUIDANOS REQUENA and Chris-



Fig. 8: Photo traps are crucial to study the success and routes of animal migration. Photo of *Puma concolor* taken near the Tropical Station La Gamba. – Abb. 8: Mit Hilfe von Kamerafallen kann der Erfolg von Biologischen Korridoren und Migrationsrouten der Tiere erforscht werden. Das Foto von *Puma concolor* wurde in der Nähe der Tropenstation La Gamba aufgenommen.

tian VOGL, dealing with the use of organic fertilizers under tropical climatic conditions. In total, around 20 master theses were conducted in the COBIGA area. They are referenced in the 'Scientific report' of the Tropical Station La Gamba (www.lagamba.at).

Research in the AMISTOSA biological corridor started only recently. The main focus is on migration of larger animals (Wendy BARRANTES, pers. comm.).

Conclusions

The establishment of biological corridors is important to connect isolated forest patches, thus enabling migration and genetic exchange of animals and plants. Nature conservation is impossible without involvement and support of the local people. Habitat protection or reforestation should be accompanied by educational programs to sensitize the local people. To guarantee attendance and success, the projects must be long-term. Success depends on the effective accomplishment of the guidelines, the monitoring processes and the time available to react and to correct mistakes. Scientific research is important and inevitable to gain data and information about migration, population ecology, carbon sequestration, etc.

Acknowledgments

We are grateful to all helpers working on the conservation of the Golfo Dulce rainforests. Special thanks go to the University of Vienna for supporting the scientific work and administration of the Tropical Station La Gamba since 1993. Furthermore, we are grateful to the associations 'Rainforest of the Austrians' and 'Rainforest Luxemburg' for financial support of our projects. Many thanks to all our private donors, especially to Günter and Christine STADLER for their financial support to buy Finca Luis and substantially enlarge the COBIGA project.

Without the help of many locals and international volunteers the COBIGA project could not be realized. Pura vida!

Literature

- ACEVEDO MAIRENA H., 2018: Viveros Cuna del Corredor Biológico Amistosa 2018–2027. Management plan AMISTOSA. Fundación Parques Nacionales.
- ANKERSEN T., REGAN K. & MACK S., 2006: Towards a bioregional approach to tropical forest conservation: Costa Rica's Greater Osa Bioregion. *Futures* 38: 406–431.
- BARRANTES-RAMIREZ W., 2018: Asambleas del Comité Local del Corredor Biológico. AMISTOSA. Palmar Note, Puntarenas, Costa Rica. (29 de Enero de 2018).
- BENNET A., 1998: Enlazando el Paisaje: el papel de los corredores y la conectividad en la conservación de vida silvestre. UICN. <http://www.iucn.org>
- CATIE & TNC, 2010: Corredor Biológico Amistosa Perfil Técnico. Informe, Programa de Investigación y Gestión de Corredores Biológicos, Turrialba.
- FREUDMANN A., MOLLIK P., TSCHAPKA M. & SCHULZE C., 2015: Impacts of oil palm agriculture on phyllostomid bat assemblages. *Biodiversity and Conservation*. Advance online publication. DOI: 10.1007/s10531-015-1021-6.
- GALLMETZER N. & SCHULZE C., 2015: Impact of oil palm agriculture on understory amphibians and reptiles: A Mesoamerican perspective. *Global Ecology and Conservation* 4, 95–109.
- GARCIA R., 2008: The Osa biological corridor in the context of the mesoamerican biological corridor. In: WEISSENHOFER A., HUBER W., MAYER V., PAMPERL S., WEBER A. & AUBRECHT G., *Natural and Cultural History of the Golfo Dulce Region*. *Stapfia* 88, 701–707.

- MORERA C., PINTÓ J. & ROMERO M., 2007: Paisaje, procesos de fragmentación y redes ecológicas: aproximación conceptual. In: Corredores Biológicos: Acercamiento conceptual y experiencias y experiencias en América. Imprenta Nacional, San José, Costa Rica.
- MORERA C. & ROMERO M., 2008: Conectividad entre el Parque Nacional Piedras Blancas y la Fila de Cal. In: WEISSENHOFER A., HUBER W., MAYER V., PAMPERL S., WEBER A. & AUBRECHT G., Natural and Cultural History of the Golfo Dulce Region. *Stapfia* 88, 707–714.
- MORENO R. & GUERRERO-JIMENEZ C., 2019: What about biological corridors? A review on some problems of concepts and their management. *BioRisk* 14, 15–24.
- SAN VICENTE M. & LOZANO P., 2008: Evidencias sobre la eficiencia de los corredores ecológicos: Solucionan la problemática de fragmentación de hábitats? *Observatorio Medioambiental* 11, 171–183.
- HIEZ P., KLEINSCHMIDT S., MALA B., WEST Z. & SCHWARZFURTNER K., 2019: Biomass accumulation and carbon sequestration in a reforestation project in La Gamba, Costa Rica. *Acta Zoobot Austria* (this volume).
- SEAMAN B. & SCHULZE C., 2010: The importance of gallery forests in the tropical lowlands of Costa Rica for understorey forest birds. *Biological Conservation*. 143/2, 391–398.
- SINAC., 2018*: Corredor Biológico Amistosa: Plan de Gestión 2018–2027. Sistema Nacional de Áreas de Conservación. La Gamba-Costa Rica: Estación Tropical La Gamba.
- SINAC., 2018: Perfil Técnico del Corredor Biológico Amistosa. Sistema Nacional de Áreas de Conservación, Área de Conservación Osa y Área de Conservación La Amistad Pacífico. La Gamba: Comité Local.
- SISTEMA NACIONAL DE ÁREAS DE CONSERVACIÓN, 2018: Plan Estratégico 2018–2025 del Programa Nacional de Corredores Biológicos de Costa Rica (Informe Final). Programa Nacional de Corredores Biológicos. San José-Costa Rica. 52 pp.
- WEBER A., HUBER W., WEISSENHOFER A., ZAMORA N. & ZIMMERMANN G., 2001: An introductory field guide to the plants of the Golfo Dulce rainforests, Costa Rica. *Stapfia* 78, 569 pp.
- WEISSENHOFER A., HUBER W., CHACÓN MADRIGAL E. & LECHNER M., 2012: Creando un bosque – Árboles para corredores biológicos en la región de Golfo dulce, Costa Rica / Creating a forest – Trees for biological corridors in the Golfo Dulce region, Costa Rica. Verein zur Förderung der Tropenstation La Gamba. Vienna. Austria.

Websites:

<http://www.sinac.go.cr/EN-US/correbiolo/Pages/default.aspx> (23.6.2019).

Received: 2019 09 23

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Jahr/Year: 2019

Band/Volume: [156](#)

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Artikel/Article: [Forest conservation and restoration in southwestern Costa Rica: The biological corridors COBIGA and AMISTOSA 47-60](#)