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SILVICULTURE AND BIODIVERSITY


Miriam Prochnow

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This publication is dedicated to Marcão, a former member of The Brazilian Forests Dialogue Steering Committee and Executive Secretary of the São Paulo Forest Forum. An environmentalist and coordinator of the Instituto Eco Solidário (Ecological Solidarity Institute), he has also been very actively involved with the Atlantic Forest NGo network and the FSC (Forest Stewardship Council), where he was a member of the Social Chamber. In addition to his work, Marcão provides an example to others through his cheerfulness and conciliatory spirit, which we hope will continue to be an inspiration to all.

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CONTENTS

Edegold Schaffer

FORESTS PLANTED FOR ECONOMIC PURPOSES CAN PROVIDE A CONNECTION BETWEEN FRAGMENTS OF NATIVE FOREST, TO FORM MOSAICS.

Miriam Prochnow

INTRODUCTION

Is it possible to reconcile production activities, such as commercial planted forests, with the conservation of biodiversity? Will the environmental impact of forestry activities affect the equilibrium of the remaining fragments of natural vegetation?

Does the forestry sector manage to efficiently reconcile its activities with maintaining the equilibrium of the natural fauna and flora? Can native species coexist with planted forests?

Such questions always arise when society discusses silviculture. Forest monoculture has even been described as a "Green Desert". Is this true, or just a myth?

This publication presents the opinions of biodiversity specialists, with a view to clearing up these and other questions relating to "Silviculture and Biodiversity".

Furthermore, there is also a chapter devoted to projects for the conservation and evaluation of biodiversity, carried out by institutions that participate in The Brazilian Forests Dialogue, including companies, third sector organizations and partnerships between the two.

WE HOPE YOU ENJOY THIS BOOK!

Giovana Baggio de Bruns
The Nature Conservancy

Ivone Satsuki Namikawa
Klabin

CHAPTER 1

BIODIVERSITY

NATURAL ENVIRONMENTS AND THE STUDY OF SPECIES DIVERSITY

Man's perception of nature has always thrown up more questions than answers. The interpretation of natural phenomena has often strayed far from logical reasoning, attributing more magical roots. For thousands of years, religions have played an important role in the link between mankind and nature. They have proffered reassuring explanations for many individual inquiries regarding biological observations, and both monotheist and polytheist religions are full of such examples.

Some Hawaiian peoples, for example, refer to the natural world as a living organism, in which all the space is filled (Mebratu, 1998). It is common also for religions to place mankind as a beneficiary, in intimate contact with nature (Palmer, 2006). Although the systematic empirical study of natural systems and the diversity of species only began in the 19th century, attempts were already being made to codify biological perceptions more than 10,000 years ago.

The birth of systematic study of biological diversity and its inter-relationships can be said to have occurred when Charles Darwin made his first notes after leaving the Galapagos Islands, in 1835. Darwin was impressed by the variations shown in birds that he had just collected from the different islands, and wrote, *"When I see these islands in sight of each other...tenanted by these birds, but slightly differing in structure & filling the same place in Nature, I must suspect they are only varieties."* (Macarthur& Wilson, 1967); 24 years later, in 1859, the "Origin Of Species", one of the most important works in the history of science, was published.

Following the publication of the "Origin Of Species", the German zoologist Ernst Haeckel thought it was necessary to come up with a term that could be used in refer-

Miriam Prochnow

THE ATLANTIC FOREST IS ONE OF THE ECOREGIONS WITH THE RICHEST BIODIVERSITY ON THE PLANET.

ring to the study of the various "struggles for survival" that Darwin alluded to. Consequently, in 1860, he coined the term Ecology, which literally means "study of the home" (Kingsland, 1991). The first step in the science of ecology is considered to have been the reading of the scientific paper "*The Lake as a Microcosm*", to the Peoria Scientific Association, in February 1887, by Stephen A. Forbes, and its subsequent publication. In his paper, Forbes addresses the complex relationship between the organisms and talks about the balance of births and deaths for each species.

With the passing of the years and the release of important publications, such as the studies on landscape preservation by Aldo Leopold, mainly in the 1940s, Rachel Carson's book "Silent Spring", in 1962, and the report "Limits to Growth", on behalf of the Club of Rome, in 1972, the problems facing natural systems started to gain prominence. As a result, ecology devoted to the understanding of biological diversity and its conservation was strengthened.

The year 1985, for example, was marked by the publishing of a landmark paper by Michel Soulé, describing the birth of a new science called Conservation Biology – the basic premise of which was the conservation of biological diversity. Spurred by the growing prominence of this new science, the Society for Conservation Biology was set up in 1986, followed in Washington D. C. by the first forum on the subject, in September of that same year. During the preparations for the forum, W. G. Rosen decided to coin a term that he considered better suited to all the relationships that were being studied, by shortening "biological diversity" to **BIODIVERSITY**. Subsequently, E. O. Wilson had several publications released that used this term, such as the book "Biodiversity" that resulted from the forum and was published in 1988, thereby consolidating the use of the term (Wilson, 1988).

THE PROBLEMS FACING BIODIVERSITY

In nature, billions of species have become extinct. Just to give you an idea, 99% of all the species that have ever lived on this planet are now extinct, and 99% of the species that exist today will be extinct thousands of years from now (Futuyma, 2002).

Wigold B. Schaffer

DEFORESTATION IS ONE OF THE MAIN CAUSES OF THE EXTINCTION OF SPECIES.

THE CASE OF THE EXTINCTION OF THE HEATH HEN

In the early part of the 18th century, the heath hen (*Tympanuchus cupido cupido*) could be found up and down the entire eastern seaboard of the USA and in southern Canada. Since it lived in accessible locations and was easy to catch, this bird was much used as a food. As a result, by 1830 it had completely disappeared from the mainland and could only be found on the island of Martha's Vineyard.

In 1908, in one of history's first conservation efforts, a reserve was set up on the island for the purpose of preserving the last 50 birds. Since they were not hunted, in less than 10 years the number of had risen to over a thousand. However, the situation changed in 1916, when there were several serious fires, a harsh winter, severe droughts and a disease spread amongst domestic fowl on the island. As a result, by 1928 there only 13 birds, only two of which were females. In 1930, only one bird remained, and in 1932, the last individual of this species died, thus marking the formal extinction of the heath hen (Begon et al., 2008).

THIS BROMELIA (*DYCKIA DISTACHYA)* NO LONGER EXISTS IN THE WILD FOLLOWING THE CONSTRUCTION OF THE BARRA GRANDE DAM.

THE POTENTIAL OF BIODIVERSITY FOR THE PRODUCTION OF MEDICINES IS STILL A VERY LONG WAY FROM BEING FULLY APPRECIATED.

Photos: Miriam Prochnow

However, unlike the vast majority of those species in the past, the biodiversity nowadays is being diminished mainly due to the direct or indirect impact of human activity.

Scientific estimates of the number of species extinctions that are directly linked to changes brought about by humans are very high. Based on fossil records and taking into consideration the estimated number of species within a given area and the rate of deforestation, mathematical models are produced in an effort to obtain an approximate assessment of the situation. In a study carried out by Pimm and Raven (2000), for example, it was estimated that if the deforestation rates in the tropical forests continue at the same level, in 100 years, roughly 40% of the existing species will have become extinct. In another estimate, Groom (2006) calculated that 5,000 species a year become extinct in the world's tropical forests. These are very rough estimates, however, because they rely on imprecise information, such as the number of species living in the tropical forests (He & Hubbell 2011).

Another estimate is provided by the IUCN (International Union for Conservation of Nature) Red List. This is an inventory of biological species that are threatened by extinction or have become extinct. The 2009 list showed 723 animal species and 86 plants species had become extinct. Between 1900 and 2000, roughly 100 species of birds and mammals became extinct. If one compares this with the total number of bird and mammal species in the world (15,333), it means that 0.65% of all birds and mammals became extinct during that period. In other words, one species per year (Groom, 2006).

However, these figures are also imprecise and are likely to be an underestimate of the number of species that have become extinct, because in order to be on the IUCN Red List a species needs to have been studied in detail, which considerably limits the candidates. Nevertheless, even if they have been underestimated, the extinction rates published by the IUCN are much higher than when man was not present. Again, using fossil records, we can compare the present annual extinction rates with those resulting from natural causes.

In the case of birds and mammals, for example, the average rate found in the fossil records is around 0.003 species a year. Compared to the present rate (1 species a year), that is 300 times lower. According to Raup (1994), the current extinction rate for coral reefs, for example, is equivalent to the natural extinction rate over a period of 10 million years. Some researchers say that the present extinction rates are close to, or even higher than, those of the major mass extinctions that have taken place during the course of the Earth's history, such as the one that wiped out the dinosaurs (Groom, 2006).

THE IMPORTANCE OF BIODIVERSITY

The loss of biodiversity on the Earth has direct and indirect consequences for the quality of life on the planet, and on the economy. For example, about 40% of all the prescribed and unprescribed medicines used around the world contain active ingredients that were extracted from or originated in plants or animals (Begon, 2007). Interesting examples include snake venoms, such as those obtained from the rattlesnake or pit viper, which have powerful healing properties and can prevent heart attacks; mammals such as the 9-banded armadillo, which has been used in studies of leprosy and preparation of a vaccine to treat the disease; and the Florida manatee, which has been used to develop a better understanding of hemophilia. Even more common are the barks, leaves and roots of plants that are used to cure a whole variety of illnesses, such as the medicine used in the treatment of leukemia, which is derived from a plant called the Madagascar periwinkle (*Catharanthus roseus*), and the bark of the Pacific yew (*Taxus brevifolia*), used to treat ovarian cancer. It should be remembered that the benefits are not limited just to human health. Pharmaceuticals for beauty care are continually being extracted and synthesized, such as the essence of the perfume Chanel n° 5, which comes from the rosewood (*Aniba rosaeodora*), an Amazon tree in the laurel family.

Another important factor is the ecological services provided by these species. Pollination, for example, is basically performed by insects. Bees alone pollinate 73% of the vegetable species that are cultivated all around the world. It is estimated that between 15% and 30% of the typical American diet is the direct or indirect result of pollination by animals. The monetary value of this service, worldwide, is estimated at US$ 117 billion (Costanza et al., 1997). In this context, it is worth citing a recent report, *The Economics of Ecosystems and Biodiversity* (TEEB), issued by the United Nations Environment Programme (UNEP) at the beginning of 2010. TEEB presents an integrated analysis of the ecological services provided by biodiversity and the ecosystems. Its conclusions are essential to the development of sustainability models. A whole range of other arguments about why we should conserve biodiversity are offered by scientists around the world. Certain regions, for example, may have specific functions that are outside the general context.

Wigold B. Schaffer

POLLINATION IS AN ENVIRONMENTAL SERVICE. BEES POLLINATE 73% OF THE VEGETABLE SPECIES THAT ARE CULTIVATED AROUND THE WORLD.

A DEFINITION OF BIODIVERSITY AND THE COMPLEXITY OF NATURAL SYSTEMS

Defining biodiversity is not an easy task. According to the definition provided by Groom et al. (2006), it is the "variety of living organisms, taking into consideration all levels of organization, including genetic, of species and the highest taxonomic levels; it is also the variety of habitats and ecosystems and all their processes". So, addressing biodiversity is not simply a matter of listing all the species living in a given area, but involves also understanding the different interactions taking place between them, their positive and negative relationships and how they change.

In ecological terms, we can say that the main variables affecting the biodiversity of a landscape are natural resources and conditions to be found there. In other words, the presence of species and their inter-relations within a region are largely related to the resources and conditions present in that location.

A good example of this occurred in the Netherlands in the 1980s, when two scientists (Drent & Woldendorp, 1989) noticed that the acid rain falling in the region had caused the periwinkles to practically disappear from the forests. Moreover, there were other species that depended on them for their own survival, such as the birds for which they were a source of calcium. Hence, with no periwinkles to eat, the birds began to produce eggs with very thin porous shells, which in turn drastically affected the chicks' chances of survival. The study concluded that, deprived of the necessary conditions (the soil ph was too acidic) the periwinkles were unable to survive in that region, and without suitable resources (periwinkles) the birds also found it hard to survive.

What we want to demonstrate is that, in any given place, there is a necessary combination of resources and conditions for each species to be present – what one might call an ecological niche. Therefore, the more combinations there are in the environment of resources and conditions, the greater will be the biodiversity. Landscapes with many combinations are called heterogeneous regions, meaning that they present more diverse environmental characteristics and can offer a greater number of different ecological niches, which leads to greater diversity of species.

Looking more deeply at this issue of resources and condition, according to Messier & Puettmann (2011), there are eight aspects of an area that must be taken into consideration to understand its biodiversity:

1. It is composed of many parts (e.g.: trees, insects, soil) and processes (e.g.: nutrient cycling, seed dispersal, tree mortality, decay);

2. These parts and processes interact with each other and with the external environment over multiple spatial and temporal scales (e.g.: competition, dispersal, disturbance);

3. These interactions give rise to heterogeneous structures and non-linear relationships;

4. These structures and relationships are neither completely random nor entirely deterministic, but instead represent a combination of randomness and order (e.g.: precisely predicting the development of even a single species is impossible);

5. They contain both negative and positive feedback mechanisms, stabilizing or destabilizing the system, depending on conditions (e.g.: nitrogen fixation, rainfall interception, density dependent mortality);

6. The system is open to the outside world, exchanging energy, materials and/or information (e.g.: nutrient, water cycling, albedo);

7. It is sensitive to the initial conditions following a major disturbance and subsequent perturbations (e.g.: rodent population that feeds on the seedbank);

8. It contains many adaptive components and subsystems nested within each other, giving rise to emergent properties (e.g.: carbohydrates that for minto trees).

Miriam Prochnow

RELATIONS BETWEEN SPECIES ARE BOTH COMPLEX AND FRAGILE, AND THEREFORE ANY ENVIRONMENTAL INTERVENTION MUST BE DONE WITH THE GREATEST CARE.

THE COMPLEX RELATIONSHIP BETWEEN THE HYACINTH MACAW, THE TOUCAN AND THE PANAMA TREE IN THE PANTANAL (PIZO ET AL. 2008)

The hyacinth macaw (*Anodorhynchus hyacinthinus*) is the world's largest parrot, reaching a length of 1 meter and weighing up to 1.3 kg. According to the IUCN (2012), it is estimated that there are only 6,500 individuals in the wild, of which 5,000 are in the Pantanal. Consequently, it is an endangered species. As they are such large birds, only a very limited number of trees are suitable for nesting. In the Pantanal, 95% of the nests are made in the trunks of the panama tree (*Sterculia apetala*), a tree which is also rare, occurring in just 6% of the Pantanal region. Moreover, the macaws only make their nests in panama trees that are more than 60 years old, since only then does the trunk attain the minimum size necessary to make a nest.

Among the species that spread the seeds of the panama tree is the toucan (*Ramphastos toco*) – one of the few legitimate dispersers and the one most frequently found performing this task. However, it is also the chief predator of the eggs and young of the hyacinth macaw. It is estimated that more than 50% of the mortality rate of hyacinth macaw chicks and eggs is attributable to predation by the toucan. In other words, while the hyacinth macaw depends on the toucan to sustain the population of the panama tree, where it makes its nest, the toucan is also a serious threat to its eggs and young. This is just one of the biodiversity puzzles that mixes positive and negative relations, in the struggle for survival of the hyacinth macaw, the toucan and the panama tree.

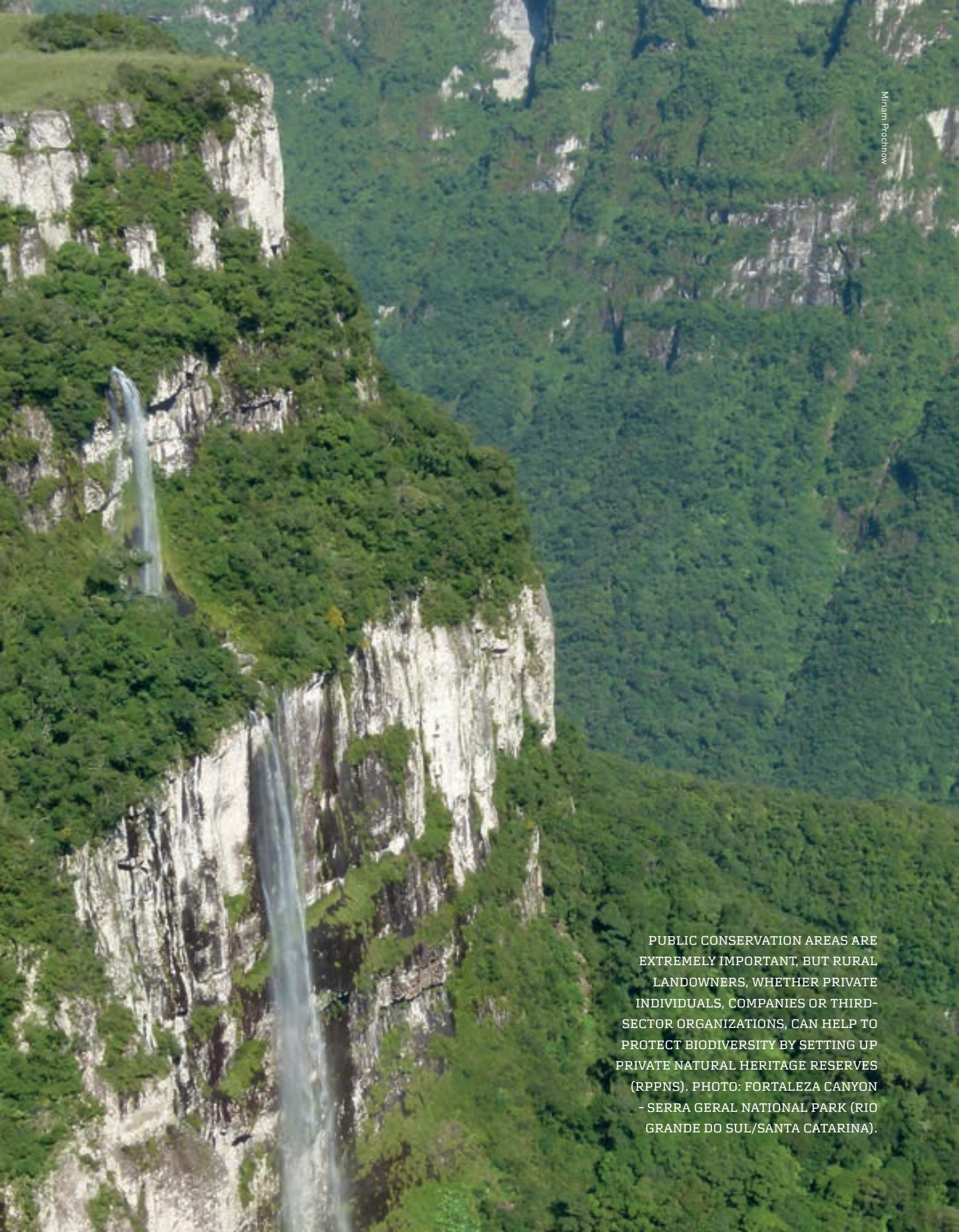
THE IMPORTANCE OF NATURAL FORESTS AND OF SUSTAINABLE MANAGEMENT IN SILVICULTURE AND THE CULTIVATION OF OTHER AGRICULTURAL CROPS

Because of this complexity of interaction, it is hardly surprising that natural forests are the principal refuge of biodiversity. They sustain about 65% of all the world's living organisms (Lindenmayer & Franklin, 2002). However, these refuges are rapidly being destroyed. According to a survey by Groom (2006), the destruction of natural habitats for agricultural production is the having a major impact on biodiversity and is a serious problem for more than 90% of the species currently threatened with extinction. Consequently, the main strategy for the protection of biodiversity is the creation of areas where land clearance is forbidden, known as Conservation Areas (CAs). In Brazil, for example, there are now 8,201 CAs throughout the country (Badialli & Paranaguá *in press*).

Even so, such action alone is not enough. Although the CAs represent an important part of any conservation strategy, they are not going to be able to protect all of the country's biodiversity, because around 92% of all the world's forests lie outside protected areas (Lindenmayer & Fischera, 2006). So, the solution to the conservation of biodiversity has to be connected to economic projects for agricultural development (Myers et al., 2000). Agricultural production must be aligned with the protection of biodiversity. In this context, silviculture may provide an important example of how we can achieve this sustainability.

Miriam Prochnow

THE PRINCIPAL STRATEGY FOR THE PROTECTION OF BIODIVERSITY IS THE CREATING OF CONSERVATION AREAS. NESTING HUMMINGBIRD IN THE CHAPADA DIAMANTINA NATIONAL PARK (BAHIA).



Miriam Prochnow

PUBLIC CONSERVATION AREAS ARE EXTREMELY IMPORTANT, BUT RURAL LANDOWNERS, WHETHER PRIVATE INDIVIDUALS, COMPANIES OR THIRD-SECTOR ORGANIZATIONS, CAN HELP TO PROTECT BIODIVERSITY BY SETTING UP PRIVATE NATURAL HERITAGE RESERVES (RPPNS). PHOTO: FORTALEZA CANYON - SERRA GERAL NATIONAL PARK (RIO GRANDE DO SUL/SANTA CATARINA).

CHAPTER 2

SILVICULTURE

SILVICULTURE IN BRAZIL

There is uncertainty regarding the precise date of the planting of the first silviculture seedlings in Brazil. The paper "Eucaliptos para o Brasil", by Armando Navarro Sampaio, which was published in the Forestry Service Archives magazine, v. 12, 1957, supplies some details about how this may have occurred. He tells us that the first eucalyptus was planted at the Chácara da Cachoeira, in the municipality of Amparo (São Paulo state). A seedling of the species *Eucalyptus globulus* was planted by the local priest, José Honório da Silva, sometime between 1861 and 1863. However, the author also mentions that, according to J. Barbosa Rodrigues, the eucalyptus had been introduced in Rio de Janeiro well before that time. In his work *"Hortus Fluminensis"*, published in 1894, Barbosa Rodrigues says that Brother Leandro do Sacramento, Director of the Rio Botanical Gardens between 1824 and 1829, had planted two specimens of the eucalyptus species *Eucalyptus gigantea*. That places the introduction of the eucalyptus in Brazil more than forty years earlier than the reference of any other author.

As far as planted forests are concerned, the first records of this form of cultivation in Brazil dates back to the early 20th century, or more precisely, 1903. The country was starting to build its first railways and Navarro de Andrade, technical advisor to the Companhia Paulista de Estradas de Ferro, decided to bring eucalyptus seedlings from Australia so that the adult trees could be used for laying down the tracks. Thus began the story of silviculture in Brazil.

The first plantations were established in Rio Claro (SP). But the production at that time was extremely primitive and it is now considered that the sector only really began to develop in the 1960s, when the government introduced a strategic policy of granting tax incentives for the establishment of plantations. This led to the forming of the first forest bases, between 1960 and 1980. One of the most notable projects of the period was that of the American billionaire Daniel Ludwig, who set up a huge area on the banks of the River Jari, in the Amazon region, for the production of wood pulp – which became known as the Jari Project. A second phase occurred between 1980 and 2000, when the sector in Brazil became truly professional, and the third (2000-2010) was one of consolidation and expansion of the plantation area. Today, Brazil is one of the world's leading cultivators of planted forests.

According to the most recent report (2010) by ABRAF (Brazilian Association of Forest Plantation Producers), professional advances during the last decade has enable Brazilian pulp production to rise to 5 times what it was 40 years ago. Between 1980 and 2008, the cultivation of eucalyptus and pine (the two principal products) increased by 80%. The total Brazilian pulp production in 2010 was 14.1 million tons, up 4.5% compared to the previous year. That puts Brazil in 4th place in the world pulp production ranking. The fiscal contribution of the forestry sector in 2010 was R$ 7.4 billion and it is estimated that the sector was responsible for providing 4.7 million jobs, counting direct jobs (640,400), indirect jobs (1.45 million) and jobs resulting from the income effect (2.60 million). The area of planted forest in Brazil probably exceeds 7 million hectares, but there is still plenty of room for growth.

Due to concerns about loss of national sovereignty, the federal government has placed restrictions on the purchasing of land by Brazilian companies that have more than 50% of their equity in foreign hands. As a result, various investment projects have been temporarily cut back or suspended. It is estimated that this has cost the sector more than R$ 37.23 billion in lost investment in new areas of planted forest and new installations for the transformation of the timber thus produced. Nevertheless, Bracelpa (Brazilian Pulp & Paper Association) considers that these are merely temporary and that there will soon be a new expansion cycle in the sector, which is predicting US$ 20 billion in investment over the next ten years. According to the BNDES (Brazilian Development Bank), there are projects being planned whose additional production capacity is predicted to raise the 2008 total by 180% in 2019. If they come about, Brazil will probably overtake Canada to become the world's 2nd largest pulp producer. And there is strong pressure to introduce a National Planted Forest Policy, in order to ensure that they do.

SILVICULTURE AND BIODIVERSITY

When a forest is cut down, all those eight aspects referred to above are effectively lost. For example, if a tree that was used for shelter by a species of primate is cut down, it will have to look for somewhere else. If all the trees in a given region are cut down, there is no more shelter, and the primate will become extinct in that region. In this context, it should be remembered that thousands of different species use the forests for food and shelter, and therefore, when one is cut down, it is not only the primates, but all the species that depended on its resources and the conditions provided that will become extinct there. In ecological terms, if there is any loss of heterogeneity in the landscape, there will also be a loss in terms of biodiversity.

On the other hand, when an area of forest is cleared, it is normal turned over to agricultural use, with the planting of crops or pasture for cattle. And these new plants will serve as food and shelter for some species. Even so, the heterogeneity of the planted grasses is much lower than that of the native forest. In other words, the replacing of a complex natural landscape with a homogeneous one, such as pastureland, will reduce the biodiversity of a region.

Thinking now in terms silviculture, eucalyptus trees, for example, are far more complex than grasses, and in some cases they are larger than the native trees. The questions is, will there be less biodiversity in areas of planted forest, compared to natural areas?

To answer this, we have looked at some studies that make this comparison, with a view to understanding the role played by planted forests in regard to biodiversity.

Methods for evaluating the relationship between biodiversity and silviculture

Studies showing the effects of silviculture on biodiversity are unfortunately scarce. As mentioned in the Writings of the Dialogue: "Sustainable Forest Mosaics", the methodologies employed in such evaluations often do not follow a clear standard, making it hard to compare areas and groups of species and invalidating any attempt at integrated analysis. It should be remembered that, in that same volume, based on the Sustainable Forest Mosaics Initiative (IMFS), a single methodology was proposed for the analysis of biodiversity in areas belonging to different companies in the south of Bahia and the north of Espírito Santo. Following the IMFS studies could lead to more precise and reliable analysis of the impact of silviculture in that region.

In our review, we sought to give priority to studies using scientific methodologies that had already been tested in a variety of different biomes and situations and that addressed the different biodiversity variables. Emphasis was also given to work using more detailed testing, given that increasingly sophisticated software has become available, particularly in relation to statistical and spatial analysis. We sought to focus more on work that did not merely evaluate biodiversity in terms of diversity indices (e.g.: Shannon, Margalef, Gleason) based on the abundance and variety of species within a given area, because as the theory has developed, it has been realized that biodiversity represented simply by numbers is unable to fully explain the landscape. Hence, we emphasized work that evaluated not only the vertical diversity but also the horizontal diversity. The main point is that, even if the wealth and abundance is similar, its organization may be different. So, biodiversity should also be assessed horizontally, looking into its composition, which is normally shown through a multi-variable representation using multi-dimensional scaling (MDS) (Quinn & Keough, 2002).

Another thing we try to take into consideration is analysis of the wealth of diversity through broad sampling, since the wealth found in a given region is often linked to the extent of the sampling effort. Looking harder, you often find more species. Hence, it may be that two areas show different or equal levels of abundance not because of their natural characteristics but because of the sampling effort made. Thus, use of the technique of rarefaction of collected wealth data is recommended, for more precise estimates that are independent of the sampling effort.

Results of the studies that have been assessed

FIBRIA CELULOSE S/A

OThe studies carried out in the Três Lagoas region (Mato do Grosso Sul) are part of an interesting program for monitoring the local fauna on behalf of Fibria Celulose S.A., the company that owns this land, which is coordinated by the Casa da Floresta team. The program has been running

Christine Drasigic

INTEGRATING THE METHODS FOR MONITORING BIODIVERSITY IN FOREST MOSAICS IS ESSENTIAL TO CONSOLIDATE ACTION FOR THE PRESERVATION OF SPECIES.

here since 2001 and has managed to compile valuable data on the fauna in the region (Table 1).

Studies involving species that are considered biological indicators are of great interest to this kind of analysis, since they tend to be highly sensitive to change and provide rapid responses to environmental modification. During the project at Fibria's Barra do Moeda farm, a study conducted by Uehara-Prado (2009) on fruit-feeding butterflies (considered a bioindicator) revealed that the wealth and abundance of the species in the region of eucalyptus forest is similar to that of the neighboring native forest, which bears the characteristics of scrubland (*cerrado*). However, the composition of species is different, leading the authors to conclude that areas of eucalyptus forest can shelter a population of fruit-feeding butterflies that is every bit as rich and abundant as that of the *cerrado*, but containing different species.

Another group considered to be a good environmental indicator of disturbances in the landscape is the amphibians and reptiles (Welsh & Ollivier, 1998). Hence, Givanelli (2009) conducted a second study under the same project, looking at the anurous amphibians, which yielded similar results. According to the author, the wealth and abundance was not significantly different, but there were differences in the composition. In the eucalyptus forest, for example, the predominant species was the Natterer's eyed frog (*Eupemphix nattereri*), a more general species that is a good indicator of environmental disturbance.

Mammals are a group through which it is very hard to make comparisons between landscape differences. The main issue is in the collection of data – which is a particular problem with regard to large and medium-sized mammals. Since they are relatively scarce and not commonly seen in the field the sampling size is usually small, making it harder to perceive patterns. It is felt that many of the methods for sampling the wealth and abundance of mammals lack precision and are not sufficiently reliable for accurate analysis (Tomas et al.,2006).

Table 1. RESULTS OF THE EVALUATION OF DIFFERENT BIODIVERSITY VARIABLES FOR DIFFERENT GROUPS OF SPECIES IN A COMPARISON BETWEEN EUCALYPTUS FOREST AND CERRADO SCRUBLAND IN THE TRÊS LAGOAS REGION OF MATO GROSSO DO SUL - BARRA DO MOEDA FARM.

GROUP STUDIED	AUTOR	VARIABLES	PLACES COMPARED	
			EUCALYPTUS FOREST	CERRADO
BUTTERFLIES	UEHARA-PRADO (2009)	WEALTH	=	
		ABUNDANCE	=	
		COMPOSITION	≠	
AMPHIBIANS	GIVANELLI (2009)	WEALTH	=	
		ABUNDANCE	=	
		COMPOSITION	≠	
BIRDS	GABRIEL (2009)	SPECIFIC ABUNDANCE INDEX [2]	≠	
BATS	TRAVELIN (2009)	WEALTH	=	
		COMPOSITION	=	
SMALL MAMMALS[1]	COLAS-ROSAS (2009)	WEALTH	=	
		ABUNDANCE	>	
LARGE MAMMALS[1]	COLAS-ROSAS ET AL (2009)	WEALTH	=	
		ABUNDANCE	<	

1 The authors emphasize the difficulty of the collection and evaluation methods and that for more precise conclusions to be drawn a greater sampling effort will be necessary.

2 This index shows the characteristics common to both habitats.

Arquivo Fibria

THE WHITE-EARED OPOSSUM (*DIDELPHIS ALBIVENTRIS*) IS FOUND IN FIBRIA'S PLANTATIONS.

As an example, a study performed by Travelin (2009), comparing the collection frequency of bats in areas of eucalyptus forest and *cerrado* showed that there is no difference between the two areas in terms of the wealth and composition of species. But, as previously mentioned, analysis of the wealth, abundance and composition of mammals is more difficult the larger the species in question, and this was the challenge faced in two studies under the project; one relating to small mammals and the other to large and medium-sized ones. In the first case, Colas-Rosas (2009) found equal wealth between the two environments, but when comparing the abundance, the eucalyptus forest showed higher numbers. In the second case, Colas-Rosas et al. (2009) found a greater number of species in the *cerrado* than in the eucalyptus forest. Nevertheless, in both cases, the author emphasized the difficulty of the collection methods and stated that for more accurate conclusions to be drawn, a greater sampling effort would be necessary.

On the macro scale, over the course of the monitoring project, the presence of 33 species of large and medium-sized mammals was recorded, with around 62% of the species found in the *cerrado*. However, it is important to emphasize, once again, the difficulty of working on data regarding mammals, especially since the data collection includes the use of faeces and spoor to identify species, which obviously involves a degree of uncertainty when confirming presence. For example, the project report identifies the presence of pampas deer (*Ozotocerus bezoarticus*), which is controversial, considering the physical characteristics of the region and the ecology of the species (Tiepolo & Tomas, 2006).

Birds are one of the groups that is most studied in tropical regions. Their relative ease of collection and identification makes them important elements in discussions about connectivity, the edge effect, ecological corridors and other issues relating mainly to landscape ecology (Uezuet al., 2008, Uezuet al.,2005). A study during the monitoring of the fauna at the Barra do Moeda farm showed the typical impact of eucalyptus forest on bird populations. Based on a Specific Abundance Index, the study showed that species that depend on forest vegetation are not found within a eucalyptus environment, which does not have any species that is specifically associated with it (Gabriel, 2009).

Another study relating to the monitoring of fauna on behalf of Fibria Celulose S.A. was conducted on the farms pertaining to the Capão Bonito and Vale do Paraíba units, in São Paulo state, under a program called *Conserv-Ação* (Conservation Action). As with that carried out in the state of Mato Grosso do Sul, monitoring of the local fauna has been conducted under this project since 2001 and has yielded some very interesting data on the relationship between biodiversity and silviculture in the Atlantic Forest biome. During more than 10 years studying the different farms, the researchers have managed to determine the presence of a number of different species. For example, there is the extremely rare bush dog (*Speothos venaticus*), a species that is classified as ecologically highly demanding. Other important information collected was the presence and absence of species over the years on the different farms, thereby providing an interesting historical database that could serve as a basis for more precise analysis in future. The results were very similar to those of the *cerrado* region, showing that the area planted with eucalyptus has a wealth and abundance of species that is only slightly inferior to that of the areas with natural vegetation, although the composition is significantly different. One interesting detail is that the plantations that have secondary vegetation show a composition of species that is more similar to that of native forests.

Another notable feature of this project is the Rapid Environmental Assessments. This methodology involves making an assessment based on an eight hour field survey of the vegetation, bird life and mammals, as well as evaluation of the landscape conditions. Using this approach, the *Conserv-Ação* program's team awards points for each farm, according to its biodiversity conservation status.

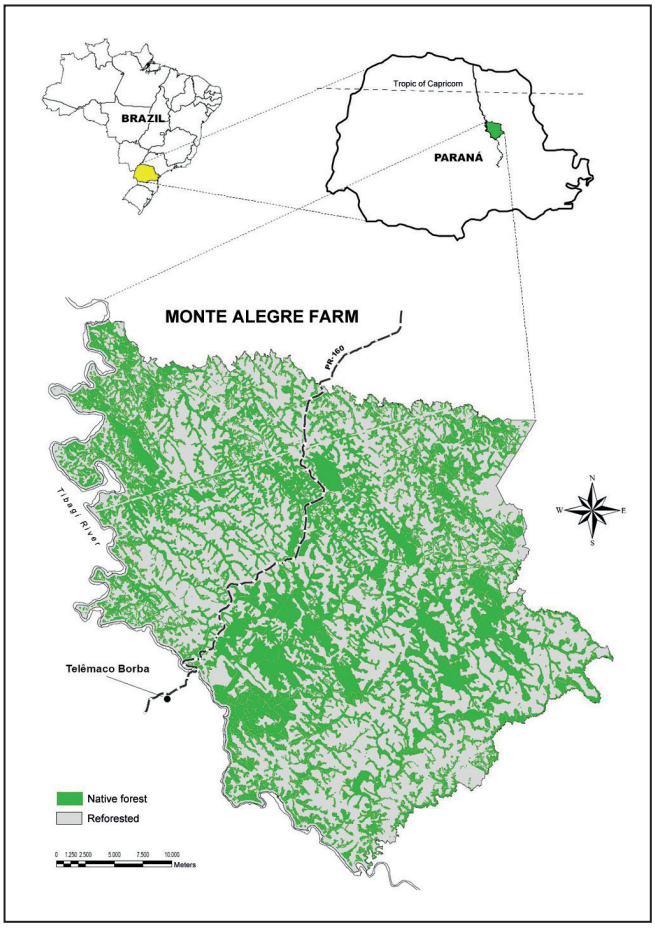
CENIBRA

Another long term project (since 2003) is being carried out with a view to understanding the relationship between biodiversity and silviculture in areas belonging to CENIBRA (Celulose Nipo-Brasileira), located mainly in the center of the eastern portion of the state of Minas Gerais, based on surveys of mammal and bird species.

Arquivo Cenibra

CAPUCIN MONKEYS ARE FOUND IN CENIBRA'S PLANTATIONS.

Figure 1
MONTE ALEGRE FARM



Up till now, within the regions that have been studied, a total of 297 bird species have been identified – 38% of the total bird species registered for the entire state of Minas Gerais. As for the mammals, 39 species have been identified, 12 of which are on official lists of species that are threatened by extinction in Minas Gerais and/or Brazil as a whole.

KLABIN

Finally, one must not forget the monitoring programs of Klabin, Brazil's oldest and largest company in the sector, particularly the one at the Monte Alegre farm, in Paraná state. This region contains areas of mixed umbriferous rainforest that, because they comprise roughly 40% Brazilian pine (*Araucaria angustifolia*), are also known as araucaria forests (Oliveira & Rotta, 1982).

The company has an area of 117,000 hectares, of which well over 40% is still in its natural state (see Figure 1). In other words, it contains an area of 52,000 hectares of native forest, of which 3,852 hectares are preserved in an RPPN (Private Natural Heritage Reserve) and 7,883 hectares are within an Ecological Park. Consequently, due to the fact that, over the years, the araucaria forests have been devastated, with only about 0.8% still intact (Castella & Britez, 2004), these protected areas on the Monte Alegre farm should be considered important havens of biodiversity.

Samples of species found in the area have been taken since the late 1980s, when researchers from nearby universities (notably the State University of Londrina) used the area for studying and understanding the biodiversity of the region. In this time, research has been conducted on virtually all the biodiversity groups, from crustaceans and aquatic insects (Bennemann et al., 2008) to large mammals (e.g.: Reis et al., 2005).

One of the most notable animals to have been found is the Estrella treefrog (*Hyla anceps*), which is listed as critically endangered in the state of Paraná. The only known sighting of this species in Paraná was on this farm. Consequently, a special 2.6 hectare reserve was created around the area of the sighting, in an effort to protect the species (Klabin, 2011).

The most complete study on biodiversity at the farm relates to the bird life. Up till now, a total of 402 species has been registered – representing 56% of the birds in the entire state of Paraná. Of these, 14% are considered to be endangered to some degree, important examples being the blue-fronted parrot (*Amazona aestiva*) and the king vulture (*Sarcoramphus papa*) (Volpato et al., 2009). Among the mammals, 83 species have been found – representing 44.62% of all the species in the state. Again, several endangered species have been found on the farm, such as the maned wolf (*Chrysocyon brachyurus*) and some species of felines, such as the puma (Puma concolor) and the ocelot (Leopardus pardalis) (Reis et al., 2005). Considering all species, by 2010 a total of 736 species of fauna and 1,146 species of flora had been registered, of which 642 are to some extent threatened by extinction (Klabin, 2011).

The studies of the Varanal creek, which passes through the Ecological Park, were also notable. Various species were found there, particularly arthropods, of which there were no previous records in the region, or they had not yet been described. Because of the high level of diversity revealed in the study, this stream has become a reference for biological diversity, for which it is outstanding compared to the other streams in the region (Bennemann et al., 2008).

As for comparative studies between the planted and native forests on this farm, one has to mention the one by Lima (2008) on bats. First of all, he discovered that native forest shows significantly greater diversity than areas planted with eucalyptus and pine. He also found significant differences when comparing the relative wealth (through rarefaction) and in the similarity indexes. An explanation of these results would be the differences in the availability of resources.

THE MOST COMPLETE STUDY ON BIODIVERSITY AT THE FARM RELATES TO THE BIRD LIFE. UP TILL NOW, A TOTAL OF 402 SPECIES HAS BEEN REGISTERED – REPRESENTING 56% OF THE BIRDS IN THE ENTIRE STATE OF PARANÁ

Zig Koch

AGOUTI FOUND IN AN AREA BELONGING TO KLABIN.

USE AND OCCUPATION

In order to better understand the results of the studies on biodiversity it is important to clarify two points in relation to the presence of a species in a landscape - the "use" and "occupation".

When one says that a region is occupied by a species, it means that it is constantly present in that place during a determinate period of time (or epoch). It is the same thing as saying that it lives in that region. However, if in that same period of time the species is only occasionally present in that area, one can say that it is using the location and not occupying it. In this case, it would be the same as saying the species is visiting that place.

There are certain cases that illustrate this difference. If a region under analysis lies outside the normal range of the species, or even at the limit of that range, the possibility of encountering the animal may be down to random chance. It would be more appropriate to say that the species is using the location, since it is certainly not there all of the time. On the other hand, if the region under analysis is within the normal range of the species, then it is more appropriate to say that the species is occupying the area, since it is found there on the vast majority of the occasions when the location is studied. When discussing the notion of living in or visiting a place, we can say that a species occupies/lives in a given region and simply uses other locations in transit or for other purposes.

It is important to note that the region used by a species is always.

larger than the region it occupies, and taking these variables into consideration is essential to understanding the biodiversity scenario. For example, if the objective is to determine the habitats that are being used within the landscape, the recorded presence of a species is already sufficient information for the results of the analysis. However, if the objective of the analysis is to understand which species live in and form part of the biodiversity of that location, it will be more useful to apply the concept of occupation to determine whether the species is merely passing through, or makes use of the conditions and resources of that location.

Arquivo Fibria

MANED WOLF (*CHRYSOCYON BRACHYURUS*) FOUND IN A FIBRIA PLANTATION.

Figure 2

(A) WEALTH OF BIRD SPECIES FOUND BY APPLYING THE TECHNIQUE OF RAREFACTION TO THREE ENVIRONMENTS UNDER STUDY (PRIMARY FOREST, SECONDARY FOREST AND EUCALYPTUS FOREST). (B) COMPOSITION OF BIRD SPECIES IN THE THREE ENVIRONMENTS UNDER STUDY. THE DIFFERENCES BETWEEN THEM ARE SIGNIFICANT. SOURCE: BARLOW *ET AL* (2007).

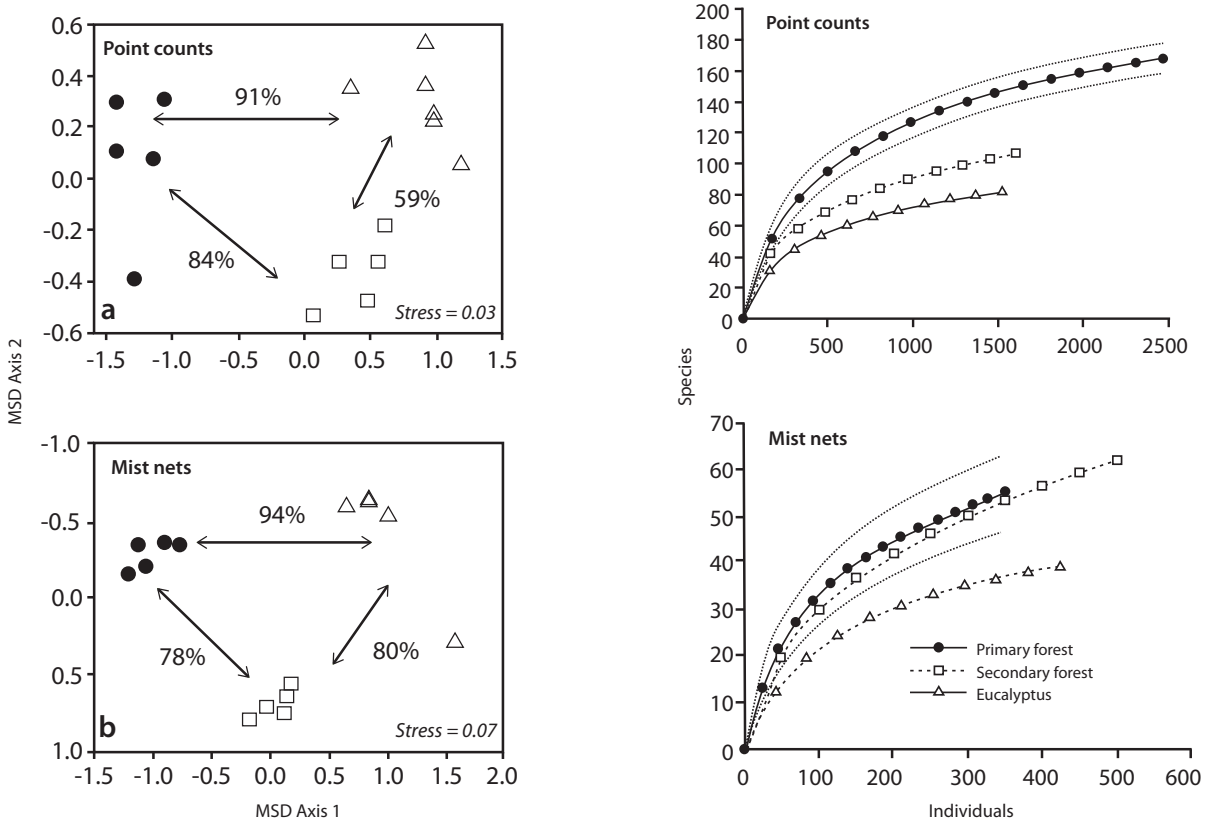
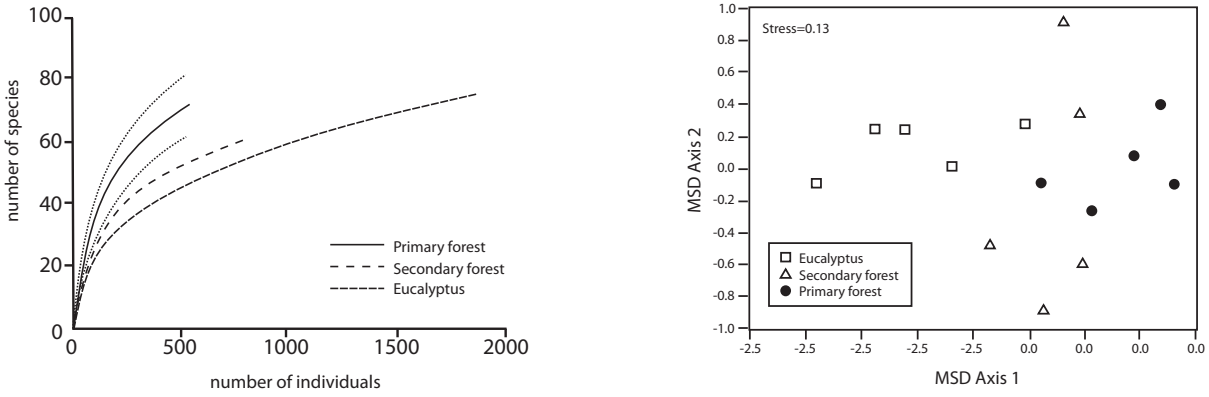


Figure 3

(A)) WEALTH OF BIRD SPECIES FOUND BY APPLYING THE TECHNIQUE OF RAREFACTION TO THREE ENVIRONMENTS UNDER STUDY (PRIMARY FOREST, SECONDARY FOREST AND EUCALYPTUS FOREST). (B) COMPOSITION OF BIRD SPECIES IN THE THREE ENVIRONMENTS UNDER STUDY. THE DIFFERENCES BETWEEN THEM ARE SIGNIFICANT. SOURCE: LO-MAN-HUNG *ET AL.*(2008).



OTHER STUDIES

The fullest and most important study carried out in the tropics to compare biodiversity levels in areas of eucalyptus and primary and secondary forest was conducted by Barlow et al. (2007) in the Amazon region. First of all, unlike all the papers reviewed herein, as well as those analyzed in an extensive bibliographical review, the region under study was free of any impacts that could influence the final results. The two most important factors that the authors were able to neutralize were the edge effect and the distance between the areas under study and the control group. If these two effects had not been neutralized, the results could have been skewed and any perceived differences or similarities in the biodiversity levels of the different areas might have been the result of the influence of these effects, and not an authentic landscape difference – as the authors point out. For this reason, the authors argue that many studies comparing areas under silviculture and areas of native vegetation overestimate the wealth and abundance of species in the areas of planted forest.

What this study showed is that although the areas under silviculture contained a certain wealth and abundance of species, the difference in relation to areas of primary and secondary forest is significant (Figure 2a). They also discovered, as confirmed in the results of most of the other papers, that the composition and structure of the bird communities is significantly different, and that eucalyptus forests have few specialized species (Figure 2b).

In a second very important study in the Amazon region, by Lo-Man-Hung et al.(2008), this time carried out in relation to spiders (arachnida), the authors discovered that the primary forests contained significantly more arachnid species than the secondary forests and eucalyptus plantations (Figure 3a). One interesting detail was that, within a specific group of species of spiders, the secondary forest showed a wealth similar to that of eucalyptus plantations; similar to the results obtained by other authors (e.g.: Gardner et al., 2007) in relation to the dung beetle, lizards and bats. When observing the composition of species, the secondary forest more closely resembled the primary forest and was significantly different to the eucalyptus plantations (Figure 3b).

WE CAN SEE THAT IN A BROADER ANALYSIS, ONE SHOULD SEEK TO UNDERSTAND THE IMPORTANCE OF THE AREAS UNDER SILVICULTURE WITHIN THE OVERALL LANDSCAPE CONTEXT.

Conclusions of the studies comparing biodiversity levels in areas under silviculture and natural areas

The first thing that needs to be cleared up is the notion that an area of planted forest is a *"green desert"* – as suggested in some journalistic articles. In summarizing the studies presented, we can say that eucalyptus forests show a reasonable level of biodiversity, although the wealth and abundance is normally less than is found in areas of natural vegetation. It is also important to note that the differences depend on the group that is being studied. More demanding groups will have more difficulty occupying such areas, while less demanding groups will find it easier.

From these same results, we come to our second important point, which tends to be common to nearly all the studies: the difference in the composition of the species. From the various papers, we may conclude that, usually, areas under silviculture have a composition and structure that is different to that of the native forests. In other words, there is one type of biodiversity related to native forests and another related to areas under silviculture. Nevertheless, despite the different composition, many species use the areas of eucalyptus to move between fragments of natural forest. So they could be an important means of furthering biodiversity in areas of natural forest, as shown by Barlow et al. (2007) in the Amazon region, Matlock et al. (2002) in Costa Rica and Rengifo (2001) in the Colombian Andes.

From this viewpoint, we can see that in a broader analysis, one should seek to understand the importance of the areas under silviculture within the overall landscape context. In other words, looking not at a comparison between native and planted forests, but at the size and arrangement of the neighboring forest fragments. Looking at the ecology of the landscape.

CHAPTER 3

LANDSCAPE ECOLOGY

To understand the alterations that silviculture makes to the landscape, one has to look at the landscape on a broader scale, as a whole. This is important to comprehending the impact on biodiversity of the introduction of agricultural cultivation. We need not only to understand how the biodiversity reacts within one environment or another, but to verify the importance of the different landscape elements within the broader context.

THE LANDSCAPE

Determining a given landscape is often not easy. In view of its importance, here are the definitions of the two principal ways of looking at a landscape. Geographically, we can say that it is: "a heterogeneous mosaic formed by interactive units" (Metzger 2001). From this perspective, a landscape can be a small area in the middle of a forest or an area of several square kilometers. There is always a matter of scale involved.

However, there is also an ecological approach to defining a landscape, which takes the point of view of the species in relation to the environment. In other words, how the environment affects its biological characteristics, and particularly its requirements in terms of living area, food, shelter and reproduction. From this perspective, a landscape may provide a function for one species, but not for another. So, to comprehend the effects on biodiversity of the introduction of agricultural crops, we must look at these two variables in the context of the landscape, the way it is organized and how each species regards this region (Figure 4).

THE BIODIVERSITY WITHIN A NATURAL AREA

The first characteristic is the size of the natural area. In simple terms, the less native forest there is, the fewer resources and conditions there will be in that region and, therefore, the fewer species it will be able to support. This concept was introduced through island biogeography, when researchers discovered that larger islands contained more species than smaller ones. As a result, scientists merely apply the same principle to areas in the landscape (Cullen Jr. et al., 2001).

To better illustrate this idea, we can take a simplified example, using three farms in the Atlantic Forest biome belonging to Fibria Cellulose S.A.. The Rosa Helena farm has 104.11 hectares of native vegetation, the Gaspar farm has 220 hectares, and the Conceição I, Nossa Senhora D'Ajuda, Nossa Senhora da Glória and São José I farms have a combined total of 634.63 hectares of native forest (Figure 5). A brief but consistent sampling effort on all the farms, during rapid environmental assessments, showed that the differences in the number and size of the natural areas were reflected by differences in the wealth of bird species encountered. On the first farm, 56 species were found, on the second there were 60 species and on the group of farms there were 68 (Table 2).

This is not a linear relationship and one would normally have to significantly increase the area of a forest in order for the number of species to double, for example. And the number also changes according to other environmental variables. There is a formula for handling this, called the species-area ratio: $S = c\ Az$ (where "S" is the number of species and "A" is the area). On this point, we once again emphasize the importance of Klabin's Monte Alegre farm, in Paraná, which has a preserved area of 52,000 hectares, one of the largest havens for the conservation of biodiversity in the Araucaria Forest.

The Edge Effect

As mentioned above, there are other variables that affect the biodiversity within areas of natural vegetation, such as the edge effect (Figure 4). The border areas tend to be areas of transition between agriculture and the area of natural vegetation, so they are the most strongly affected by the former. Consequently, the less the contact between them the more preserved the natural area will be. Numerous studies on the fragmentation of habitats point to forest borders as the main area of threat to various biological groups (Bierregaard et al., 2001; Cullen Jr. et al., 2003).

The border area of a forest fragment is affected by its shape. For example, if the fragment is round, the area

Figure 4
EXAMPLE OF A LANDSCAPE, SHOWING A EUCALYPTUS MATRIX, CORRIDORS AND PATCHES FORMING NATURAL HABITATS. CENIBRA, MACEDONIA PROJECT, IN IPABA (MINAS GERAIS).

Arquivo Cenibra

Table 2. FARMS BELONGING TO FIBRIA CELLULOSE S.A., SHOWING THEIR RESPECTIVE SIZES AND THE NUMBER OF SPECIES FOUND IN A RAPID ENVIRONMENTAL ASSESSMENT.

FARM	AREA (HA)	SPECIES
ROSA HELENA	104,11	56
GASPAR	220	60
CONCEIÇÃO I, NOSSA SENHORA D'AJUDA, NOSSA SENHORA DA GLÓRIA E SÃO JOSÉ I	634,63	68

in contact with the matrix will be less than if it were any other shape of the same size, such as an "S". This relationship between the shape and size of the fragment is very important and should be taken into consideration when looking for ways to foster biodiversity within a landscape. It is possible, for example, that the edge effect in an area of natural vegetation is so strong that the area loses its main characteristics and is no longer able to fully sustain its biodiversity (Cullen Jr. et al., 2003). Nevertheless, on the positive side, it is possible to increase the biodiversity without necessarily increasing the area of a natural forest, simply because, by altering its shape, one can reduce the border areas and thereby promote biodiversity.

To diminish the edge effect, it is recommended that a buffer area be established. It is a simple way of overcoming issues relating to the edge effect when planning the landscape with a view to promoting biodiversity (Laurance & Gascon, 1997). Buffer vegetation will provide a transition between the native vegetation and the agricultural crops, thereby ameliorating the environmental impact on the forest fragment (Figure 6). A very interesting project using this method, called "Abraço Verde (Green Embrace)", is being implemented in regard to a new settlement in the Pontal do Paranapanema region (Valladares-Padua et al.,2002).

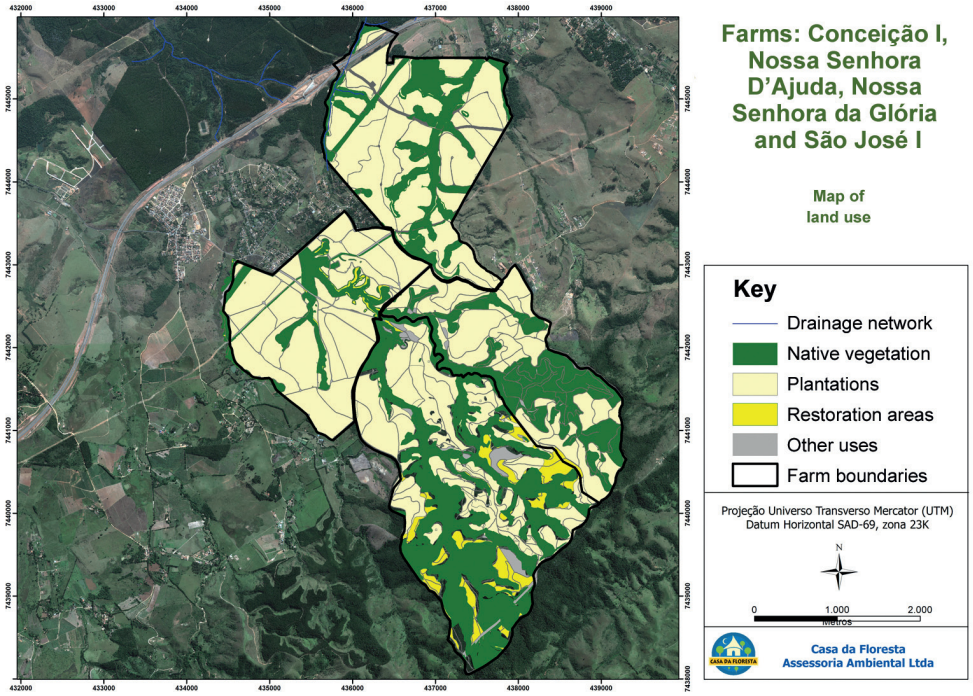
Small populations

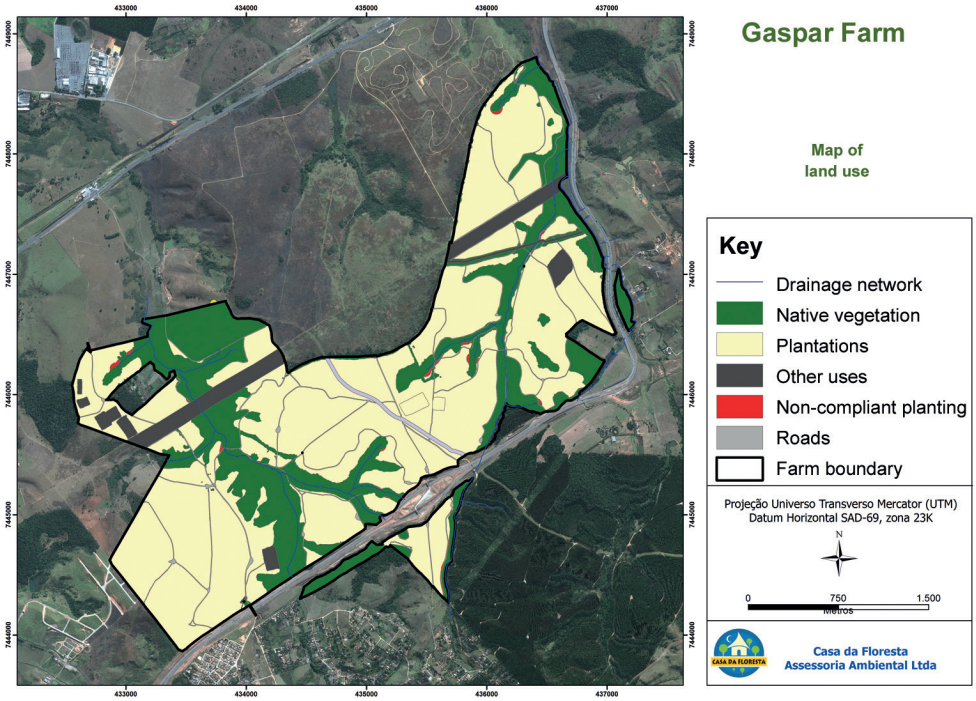
The species within a natural area may be affected even if there is no increase in human intervention, and this problem is mainly related to the matter of a minimum viable population. In forest fragments, populations of certain species, particularly those that depend on a lot of resources for their survival, may find the area too small and not viable for them in the long term.

The first problem with this type of population is the harsh reality of nature. Imagine, for the sake of argument, that there are 50 individuals of a certain species within a fragment of natural forest and in an atypical year there is a serious drought that kills some of the population. What might happen is that, because there are already so few, that reduction might prove critical, and lead to the local extinction of the species. Another factor is the balance between males and females in the population. For

Figure 5

FARMS CLASSIFIED ACCORDING TO THE AMOUNT OF NATIVE VEGETATION AND WEALTH OF SPECIES: (A) THE CONCEIÇÃO I, NOSSA SENHORA D'AJUDA, NOSSA SENHORA DA GLÓRIA AND SÃO JOSÉ I FARMS; (B) THE GASPAR FARM; AND (C) THE ROSA HELENA FARM.





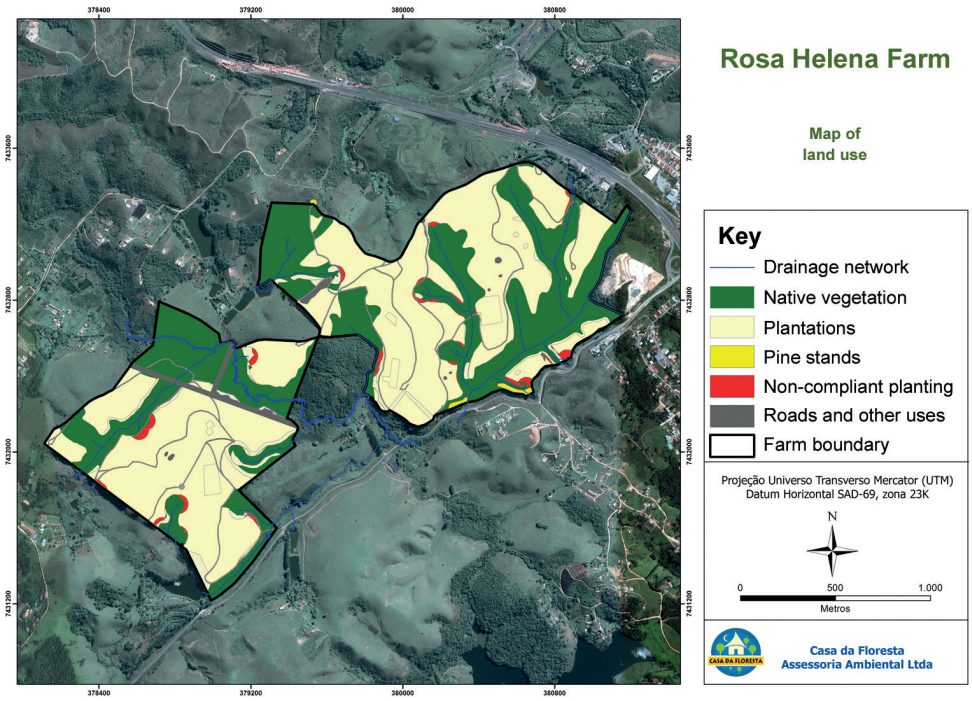


Figure 6

EXAMPLE OF A BUFFER ZONE TO DIMINISH THE EDGE EFFECT ON AN AREA OF NATIVE VEGETATION. ***ABRAÇO VERDE*** **PROJECT, CARRIED OUT BY IPÊ (INSTITUTE FOR ECOLOGICAL RESEARCH), IN PONTAL DO PARANAPANEMA.**

Rolex Awards

example, far more females than males might be born, or vice versa, making it more difficult for the population to maintain its numbers in the future.

Then there is the problem that, in small populations, there will tend to be inbreeding, or endogamy. As there are few individuals, they tend to be related to one another and their offspring may be born with problems that eventually lead that population to extinction. To understand the status of a population and its future viability, a Population Viability Analysis (PVA) is carried out. This tool is able to estimate the likelihood of a population or species becoming extinct. As a result of these studies, two cut-off points were determined: a population of fewer than 50 individuals is likely to become extinct in the short term, due to endogamy, and a population of fewer than 500 individuals is likely to lose evolutionary flexibility and become extinct in the face of environmental changes - a guideline that has been termed the "50 / 500". However, as previously mentioned, such "magic numbers" are merely a guide to managing biodiversity, and there are specific factors governing the future of each species.

AN INTEGRATED APPROACH TO SEVERAL FRAGMENTS OF NATURAL VEGETATION:

To improve the viability of biodiversity in the long term, we must necessarily look upon the landscape as an integrated whole. Nowadays, areas of natural vegetation mainly tend to be in the form of forest fragments, with few examples remaining of complete forests. Therefore, we must study how to promote conservation among a series of forest fragments. This approach to the landscape by addressing various fragments relates to the concept of metapopulation, something that was born of a rather different approach to promoting biodiversity.

The first authors to speak of the idea of integrated populations were Andrewartha and Birch, in 1954, in relation to the USA, when trying to find ways to combat agricultural pests. They were studying insects and realized that the application of pesticide functioned only for only part of the year, after which the population would grow again. A major discovery was the perception that, since there are various populations within the environment, if one becomes extinct, its place may be taken by a neighboring one - it only being necessary that there is some connection between the two. With the increasing problems facing conservation and the development of the concept of island biogeography, several authors began to use this idea to develop mechanisms for conservation in fragmented areas, and Richard Levins (1969) introduced the word metapopulation - which means the population of several populations (Hanski & Simberloff, 1997).

The key to implementing this concept in conservation biology is that, to take one example, if a fragment contains a population of birds, the impact on the number of individuals can be minimized if, occasionally, individuals from other populations move to this fragment. These new individuals can stimulate the reproduction rate while at the same time introducing genetic characteristics that were not already present - thereby reducing endogamy. Furthermore, if the original population becomes extinct for any reason, the area can be recolonized by individuals from neighboring populations.

Connectivity between fragments

For populations in a forest fragment to receive individuals from other populations, it is essential that there is a connection (enabling an individual to move from one fragment to another). Only in this way can the different fragments support a metapopulation. If the two fragments are not connected, new individuals will be unable to reinforce the population that is suffering some kind of impact and thereby minimize the possibility of local extinction, or perform recolonization. The problem of lack of connectivity may also affect pollinators and seed dispersers in the region, which would reduce the heterogeneity of the natural areas.

Promoting the connectivity between fragments

The most obvious method of promoting connectivity between forest fragments is by means of ecological corridors. These are fairly narrow strips that bear similar characteristics to the natural landscape and link the fragments of habitat that were previously one. They do not need to necessarily be continuous and, depending on the species, small patches could also fulfill this function, acting as stepping stones or ecological trampolines (Cullen *et al.*, 2003).

However, corridors also present some disadvantages. Because they are restricted areas, they may facilitate the predation of individuals, as well as suffering considerably from the edge effect, with ensuing modification of the landscape characteristics and reduction connectivity for some species. Hence, according to Tabarelli & Gascon (2005), and especially in the Amazon region, such corridors should be at least 300 to 1000 meters wide. According to CONAMA resolution No. 9, of 1996, the width of the corridor must be previously determined at 10% of its total length, with a minimum width of 100 meters. The National System of Conservation Areas (SNUC) also offers some guidelines on this subject, while leaving the definition of size open until the preparation of the management plan.

A second way for species to spread amongst forest fragments and further the metapopulation is through planted forests and other agricultural crops - called a landscape matrix. That is because, although they are not a habitat for many species, they facilitate transit. For example, according to Gascon et al. (1999), in the Amazon region, a matrix dominated by pasture worked almost as a barrier to birds and ants, yet for amphibians and smaller mammals it allowed them some movement. In general terms, the matrix is a barrier, especially for species living in the forest center, but for more flexible species this is not the case.

At this point, let us recapitulate on the notion of landscape use by some species. Several studies have found species that were "using" planted forests, such as the large mammals in Fibria's long-term projects for the cerrado and Atlantic Forest biomes and those of Cenibra (Celulose Nipo-Brasileira) and Klabin in the Atlantic Forest. Within broader studies, according to Barlow et al. (2007), in the Amazon, the eucalyptus can act as a corridor for birds, thus corroborating data from Matlock et al. (2002) in Costa Rica and Rengifo (2001) in the Colombian Andes.

Figure 7
CAYMAN IN A EUCALYPTUS STAND. SOURCE: CENIBRA (2011).

Arquivo Cenibra

Enhancing the permeability of planted forests, and their biodiversity

Analyses in the aforementioned papers are based on landscapes with homogeneous forest plantations with no diversification. To increase the permeability of these crops and enhance their biodiversity, a new way of carrying out silviculture is being adopted, which some people call "new forest", "close to nature forest ", "nature-oriented silviculture", and "diversity-oriented silviculture", among other terms (O'Hara, 2001). The idea is to strike a balance between economic gains and promoting biodiversity.

Various techniques and strategies can be effectively incorporated as part of an innovative silviculture system, including commercial production and the preservation of biodiversity. However, they are all based on the same principle: emulate the natural systems. They make the basic assumption that a forest is a complex and chaotic environment and silviculture models should try to find ways to reproduce this heterogeneity of natural environments (Missier & Puettmann, 2011; Lindenmayer et al., 2006). That would bring the composition of biodiversity in natural systems closer together and permit greater dispersion of species, thus promoting connectivity between fragments of natural vegetation and, consequently, of biodiversity.

The first technique for achieving this the heterogeneity is vertical stratification. According to some authors (e.g.: Missier & Puettmann, 2011; Franklin et al., 2002; O'Hara, 2001), simple differences between the heights of the trees can promote biological diversity. The greater the differences in height (vertical stratification), the greater the heterogeneity among the trees and similarity to natural systems will be (Figure 8).

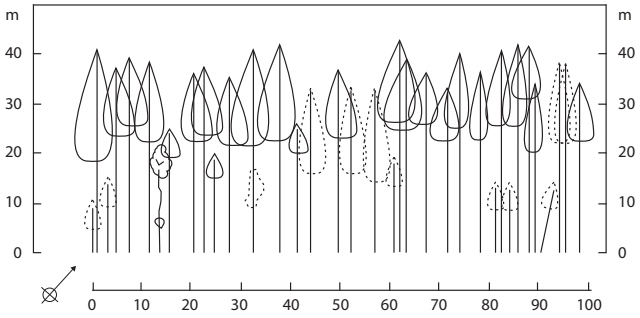
Vertical stratification can be achieved mainly from age differences. The method is based on planting trees over staggered periods of time. Thus, within the same environment, you will have two or more groups of trees at different growth stages. This system of tree rotation creates different strata in the landscape, thereby promoting a diversity of environmental conditions and enabling a wider range of species to survive in the region.

The use of different age groups is not something that can only be done during planting. Maintaining certain trees after the first cut and rotating the trees over the years can bring about the same age based stratification by simple means.

According to O'Hara (2001), structures with only two or three age groups are sufficient to generate most of the benefits that more complex systems would provide. An interesting piece of software for developing these scenarios is MASAM. It is based on a model that has proved very suitable for creating variability in planted forests. Three regions in the USA have been heavily tested: the central region of the state of Oregon, western Montana and the Black Hills in South Dakota and Wyoming (O'Hara et al., 2003; O'Hara & Nagel, 2004). The software can be accessed at the website: cnr.berkeley.edu/~ohara/downloads/.

Figure 8

FIGURE SHOWING AN EXAMPLE OF HOW TO ACHIEVE VERTICAL STRATIFICATION IN SILVICULTURE.



Another way to create age variation in silviculture is through the selecting of groups (Franklin et al., 2002). The cutting of small groups of trees creates areas of light

Miriam Prochnow

INCREASING THE HETEROGENEITY OF PLANTED FORESTS ALSO INCREASES THEIR BIODIVERSITY.

Wigold B. Schaffer

THE GREATER THE DIVERSITY OF THE FOREST MOSAICS, THE GREATER WILL BE THEIR CONTRIBUTION TO THE CONSERVATION OF BIODIVERSITY.

in the environment, allowing species that are not tolerant of shade to grow. Another advantage of group selection is that it facilitates the harvesting process since it is no longer necessary to cut specific trees. Harvesting can be done in patches within the environment. This method is very similar to the crop rotation carried out on a lesser scale on small farms.

A major concern amongst forest producers is the productivity of these kinds of systems, because they fear the economic losses could sometimes be so great as to make such action to promote biodiversity unviable. But according to a study by O'Hara (1996) in central Oregon and western Montana, in the USA, there is no significant difference in the cubic volume produced in an environment where the ages of the trees were homogeneous and another where there were age differences between the trees. In a review of other studies comparing these same scenarios, O'Hara & Nagel (2006) concluded that any productivity differences between these two types of production are usually small and insignificant.

There are several other ways to increase the heterogeneity of planted forests. Differences in horizontal strata, for example, can be one method. The technique is based on planting the trees in groups or spaced in an irregular way. One should bear in mind that the greater the diversity in the organization of the planted trees the greater will be the heterogeneity of the environment and, consequently, the closer it will be to natural forests, while the biodiversity will be greater, as will be the possibility of adequately connecting forest fragments.

CHAPTER 4

FINAL INTEGRATED ANALYSIS

The desire to preserve the biological diversity in nature existed long before the term biodiversity was coined. Various peoples and cultures developed tools and mechanisms that would make the relationship between mankind and the environment more harmonious. Some of these steps have been due to our basic dependence on natural resources. For example, many of the medications we use today would not exist if it weren't for the species they are derived from.

However, with the technological advances of human society, there has been an increase in the changes we produce in nature. So, if on the one hand we have made great improvements in the quality of human life, on the other, we are profoundly altering the natural resources that are necessary to preserving that quality of life. Through scientific progress we now realize that we have to find more sustainable of development (Chiaravalloti & Valladares Padua 2011).

In view of the expansion of silviculture in Brazil – with approximately 7 million hectares under cultivation – it may be considered an important factor in this new type of development. Add to this paradigm shift the sector's own willingness to adopt this type of action, illustrated by

Miriam Prochnow

APPROPRIATE PLANNING AND MANAGEMENT OF THE LANDSCAPE, INTEGRATING AREAS OF PRODUCTION AND AREAS OF NATIVE VEGETATION, NEEDS TO BE ADOPTED AS CURRENT PRACTICE IN ALL SECTORS.

the concern to reach beyond the usual models of planted forest management and investments made available for the technology and resources for this end. As a result, the managers of each unit nowadays find themselves constantly facing choices involving improving production and conserving biodiversity. Often, the decisions are simple and immediate, and the choices can be made without any worry. However, there are times when important decisions have to be made and a wrong choice can alter the future of an entire region.

To help in making important decisions, there is an extremely useful tool at our disposal; scientific know-how.

Making choices based on science can lead to measures that involve less physical effort and expenditure, while yielding more accurate results (Valladares-Padua & Chiaravalloti *in press*; Valladares-Padua, 2006).

Among the academic papers and reports analyzed, one can see that the changes brought about by planted forests have an environmental impact. However, it is much less than has been portrayed in some journalistic and environmentalist texts, which have called these areas a "green desert", given that, although not many native species appear to occupy the planted forests, they use these areas to move between the fragments of native forest.

In this respect, management of the landscape is essential. Through understanding of the concepts governing the landscape, we can work towards finding a balance between productivity and the conservation of biodiversity. To begin with, the more natural areas there are, the better the biodiversity will be preserved, as demonstrated for certain areas under silviculture using the ratio species-area. One must also bear in mind that small areas may be unable to sustain native populations over the years, resulting in forests lacking in biodiversity.

The efforts should, nevertheless, be focused not only on increasing the natural areas, but also on optimizing the situation of the existing areas. Hence, the importance of thinking about the landscape in an integrated manner – conserving the fragments and the metapopulations. First, one has to think about the shape of the fragments, bearing in mind that the smaller the area of external contact, the less will be the environmental impact on its interior. It is important to emphasize here the advantage of minimizing the edge effect by creating a buffer area, which will boost the protection of the fragment simply by reducing its contact.

MANAGING THE LANDSCAPE IS ESSENTIAL. BY UNDERSTANDING THE CONCEPTS GOVERNING THE LANDSCAPE, WE CAN SEEK A BALANCE BETWEEN PRODUCTIVITY AND CONSERVING BIODIVERSITY.

The most important issue with regard to the integrated landscape is the connecting of the forest fragments. Simply by enabling some individuals to move amongst the different populations, we can ensure the viability of the species and of the local biodiversity. In this context, ecological corridors play a fundamental role, even if they are not continuous, since islands within the landscape can also contribute to dispersal (sometimes referred to as the trampoline effect). It is worth noting that, although less effective, such a pattern can function as a jumping off point for the spread of some species. To promote this function, the managers have the option of increasing the heterogeneity of the planted forests. We emphasize that, in addition to promoting dispersal, this sustainable silviculture will also promote biodiversity within the plantations, since they will provide an environment that is more similar to that of a natural forest. The production areas should be organized in the form of forest mosaics.

Finally, not all the tools recommended for the promotion of biodiversity can be used in all environments. So it is important to have a variety of options (corridors or ecological trampolines, different fragment shapes and sizes, buffer areas and other instruments developed by means of scientific testing) that can be applied according to the situation and make it possible to simultaneously further agricultural/forest production and conservation of biodiversity. It is important to think outside the box, because a successful entrepreneur is one who is able to innovate, integrating the environmental, social and economic aspects: the triple bottom-line.


Wigold B. Schaffer

CHAPTER 5

PROJECT PORTFOLIO

Biodiversity and Climate on the Paraná Coast

SOCIETY FOR WILDLIFE RESEARCH AND ENVIRONMENTAL EDUCATION (SPVS)

Over the course of more than 10 years, in the south of Brazil, SPVS has been developing important projects that combine biodiversity conservation and climate change mitigation. These projects stand out for their demonstrative character and ability to generate multiple benefits and engage other players in the challenge to help reverse the current biodiversity loss scenario.

In the Guaraqueçaba Environmental Protection Area (APA) of the Paraná coast, SPVS developed projects that aim to capture the CO_2 from the atmosphere, conserve biodiversity and increase incomes within local communities. For its development, three RPPNs were created, along with strategies that contribute to the maintenance of ecosystems, development of the region and management of other conservation areas. The projects include partnerships with TNC, as well as American Electric Power, GM and Chevron.

Lucas Pontes

AREA ADOPTED BY THE "DEFORESTATION PREVENTION" PROGRAM.

MORE INFORMATION/CONTACT
www.spvs.org.br

RESULTS

- 18,600 ha of protected areas (11,400 hectares of RPPN)
- Increased revenue to regional municipalities, through ICMS Ecológico tax
- 650,000 native species seedlings produced and planted
- Restoration of 1,500 hectares
- 100 research projects carried out
- Ensuring water supply to approximately 16,000 people
- 28 jobs created to date
- Support for the Community-Based Ecotourism Cooperative (COOPERGUARÁ) and the Native (stingless bee) Apiculture Association (ACRIAPA)

In the Araucária Forest region, SPVS has developed the "Deforestation Prevention" program. Due to degradation of the Araucaria Forest region, in January 2003, a methodology was created to allow areas to be adopted, which identified owners of remaining sections of the forest that were in good condition. To support these areas, SPVS sought out partnerships with companies, which to-date has included the involvement of Posigraf, Souza Cruz, JTI and HSBC. The experience had a very positive influence on Paraná's new State Law for the Payment of Environmental Services, which was promulgated by the state government in April 2012.

RESULTS

- 29 adoptions (4,281.2 ha)
- 496 mil t/CO_2 stored
- Over R$ 2 million transferred to property owners for conservation work in their areas
- As per the Management Plan, approximately 58.75% of the funds were invested in the areas
- 219 plant species, 156 birds and 28 mammals identified

Conserving Biodiversity in the Pantanal

WCS BRASIL/PANTANAL/CERRADO

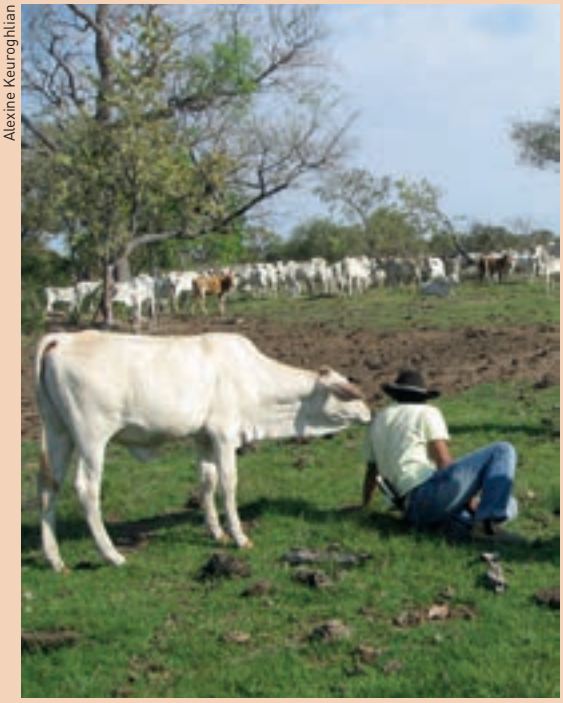
Deforestation and the conversion of natural habitats in exotic grasslands, coupled with inadequate management, are responsible for negative pressures on the natural resources of the southern Pantanal and the surrounding tableland. To prevent deforestation and protect biodiversity, areas considered productive could be managed more efficiently and profitably. To this end, WCS Brasil works with the farming communities to promote best practices to optimize the utilization and profitability of productive areas, minimizing pressures on natural resources.

Each of the project's partner farms is evaluated. Then, a management plan is developed with the aim towards reducing negative impacts on the environment. Sustainable management practices that offer profitable alternatives to deforestation are encouraged. The work of WCS/Pantanal/Cerrado is the first to scientifically document the consequences of good and bad management practices across an immense variety of environmental and socioeconomic indicators (publication: http://tropicalconservationscience.mongabay.com/content/v4/11-03-28_39-52_Eaton_et_al.pdf).

The study presents scientific data that support a profitable alternative that does not require deforestation. Forests preserved as a result of this project will benefit the entire region through the maintenance of environmental services, such as CO_2 sequestration and water balance regulation.

The project also offers courses for farm communities to teach the practice of pasture ecology, best practices in cattle husbandry and environmentally friendly cattle management.

Alexine Keuroghlian



GRASSLAND ECOLOGY PRACTICES CONTRIBUTE TO BIODIVERSITY MAINTENANCE.

Miriam Prochnow

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http://programs.wcs.org/brazil/pt-br/início.aspx

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Biodiversity Conservation

ARCELOR MITTAL BIOFORESTS

ArcelorMittal owns areas that lie within two important Brazilian biomes – the Cerrado (tropical savanna) and the Atlantic Forest. Since biodiversity is an essential component for the sustainability of all human endeavors, including economic activity, the company has adopted a biodiversity management system for the areas in which it operates, with an emphasis on the activities listed below.

Management of Private Natural Heritage Reserves (RPPNs) and conservation of Permanent Preservation Areas (APPs) and the Legal Reserve, identifying them as being of significant environmental interest, particularly in the monitoring, prevention and control of forest fires.

Environmental Education programs aim to offer subsidies to train and educate Brazilian citizens, helping them with their professional development and awareness of biodiversity demands and obligations.

Flora Monitoring, whose objective is the continuous monitoring of communities and plant populations to determine what biodiversity maintenance activities are necessary as a platform for sustaining the activities of ArcelorMittal Forests.

Fauna Monitoring, whose objective is to promote the study and monitoring of species of birds and medium and large mammals, in line with the principles and criteria established in the Forest Certification (Forest Stewardship Council) guidelines. In partnership with the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA), the company also participates in a project that is reintroducing wild birds into company-operated areas.

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www.arcelor.com.br

Photos: Arquivo Arcelor Mittal

CAMERA TRAPS CAPTURE ANIMALS IN ARCELOR MITTAL AREAS.

Sustainability Corridors

V & M FLORESTAL

On its 23 farms, V & M FLORESTAL (VMFL) cultivates 113,000 hectares of eucalyptus trees that were planted to provide charcoal, a renewable energy source, for steel production. Concern for sustainability is reflected not only in the production of charcoal, but also in the proper management of the entire planted area. VMFL's planting model, adopted in 1985, has been very important for preservation of the local biome. Ecological corridors consist of 25-meter width rows of native vegetation that are arranged in parallel formations, with the plantations being interspersed every 500 meters. These are interconnected at their ends and through the Legal Reserve areas, thus displaying a mesh-like configuration.

This conservation model arose from several studies that sought to reconcile the implementation of forestry activities and conservation of the Cerrado biome.

The corridors contribute to preservation of native fauna, while offering greater ease in regard to food, shelter and travel. They also serve as a biological control of pests and offer greater environmental stability to the forest plantations. The importance of the corridors has been confirmed in the results of fauna monitoring conducted by the company over the last 12 years. They confirm the presence of wild animals transiting through these areas.

Besides fauna conservation, the corridors offer greater control over fires and help in the management of forest soils, as they minimize the risk of erosion. This conservation model contributes to the sustainable management of eucalypt forests.

Arquivo V&M

PUMA ON THE HUNT IN AN AREA BELONGING TO V & M FLORESTAL INSET, THE COMPANY'S CORRIDOR MODEL

Thiago Fernandes

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Sustainable Forest Mosaics Initiative

CONSERVATION INTERNATIONAL

Extensive areas of the Atlantic Forest biome are occupied by planted forests, which are the most efficient way to produce wood for various uses and fibers for the production of pulp and paper. Continuous forest cover that is comprised of forestry plantations interspersed with native forests, in their many different stages of succession, constitutes a grand forest mosaic, which ensures the production of capital and environmental services, the protection of soils, ecological landscape permeability and the generation of job opportunities and income. The obvious importance of pulp and derivatives production for the economic, social and cultural development of society is accompanied by the ever more pressing need to adopt advanced sustainable practices throughout the supply chain.

Christine Drasigic

SAMPLE AREA IN SOUTHERN BAHIA MONITORED BY THE SUSTAINABLE FOREST MOSAICS INITIATIVE.

Based upon its responsibility to disseminate sustainable production practices among its suppliers, Kimberly-Clark, the world's largest corporate purchaser of cellulose, accepted a proposal made by Conservation International to adopt a global-scale initiative to develop and test methodologies, procedures and practices that could lead to the creation of models to improve the management and sustainability of forestry production, expand ecosystem services and increase income generation in local communities.

The initiative has brought together several companies – Veracel, Suzano and Fibria – as well as civil society organizations – CI-Brasil, IBio and The Nature Conservancy – with the following specific objectives:

- Identify, construct and validate models for sustainable forest mosaics in different pulp producing regions.
- Develop tools for planning, communication and exchanging experience to reconcile land use planning, forestry management, biodiversity conservation and environmental services protection.
- Disseminate these successful models to all pulp suppliers.

MORE INFORMATION: Sustainable forest mosaics: Integrated biodiversity monitoring and forest restoration guidelines. Writings of the Dialogue. Vol 3. 2011. Available at www.dialogoflorestal.org.br/publicacoes/

MORE INFORMATION/CONTACT
www.conservation.org.br

Biodiversity Monitoring

KLABIN

The Biodiversity Monitoring Project in Klabin forestry units is comprised of several activities, including a technical-scientific survey with specialist firm and initiatives with partner universities, as well as records that are kept by company employees.

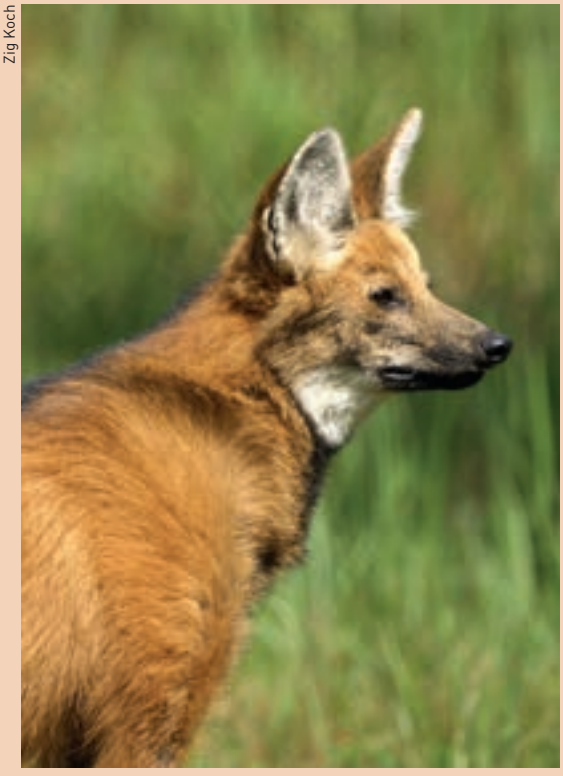
Maintained internally, the fauna log is kept by employees who are encouraged to record their sightings of wild animals. This data is compiled, thereby enabling an analysis of the presence of different species in areas where forestry operations are being carried out.

As for the technical-scientific survey of fauna and flora, this is being periodically performed by a specialist firm in the forestry units, which includes already identified high conservation value areas. The objective of this work is to perform a species diagnosis, assessing the successional dynamic for the regeneration stratum and designing measures to reduce the impact of forestry operations.

The first step of this work is to identify different landscape units by means of physical and biotic evaluation, starting with a biodiversity inventory and defining monitoring periodicity as long-term (over 14 years) to evaluate changes in fauna and flora inserted into the productive system and short-term (1-2 years) to evaluate specific management practices or the use of specific inputs.

To date, the following has been reported:

Zig Koch



MANED WOLF IN A KLABIN AREA.

ANIMAL SPECIES	PARANÁ (717)	SANTA CATARINA (304)
BIRDS	408	251
MAMMALS	132	42
FISH	60	-
AMPHIBIANS	52	6
REPTILES	40	5
INSECTS	22	-
CRUSTACEANS	3	-

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Herpetofauna Monitoring in Mussununga Areas of Southern Bahia and Northern Espírito Santo

SUZANO PAPEL E CELULOSE

In 2011, the Mucuri facility of Suzano Pulp and Paper monitored herpetofauna in five areas of the Mussununga in southern Bahia and northern Espírito Santo to identify amphibian and reptile species that live in these fragments, considered "High Conservation Value Forests (HCVF)." The study indicated a high level of amphibian and reptile species preservation, with the variety on display exceeding that of some environmentally protected parks located in southern Bahia and northern Espírito Santo. During this research, 28 amphibian and 10 reptile species were identified by researchers from the Federal University of Viçosa (UFV).

Photos: João Augusto Alves Meira Neto

SPECIES MONITORED IN SUZANO AREAS.

Much of the territory of southern Bahia and northern Espírito Santo is classified as high priority for conservation and diversification of animals and plants, and is considered the largest bioclimatic shelter for amphibians within the Atlantic Forest. However, knowledge about the regional fauna is still immature and studies to diagnose their diversity and explain species distribution patterns across this territory is lacking.

Therefore, this study has contributed to a greater understanding of the local fauna. One of its highlights was the monitoring of the Scinax juncae amphibian species, which is found in areas of the Mussununga that are preserved by the company. Until this study, none of the monitoring conducted in the state of Espírito Santo had found any evidence of this species. The discovery confirms that good forestry management is being practiced in the region.

Suzano maintains large eucalyptus cultivation areas that are interconnected with fragments of natural vegetation, which allows for the transit of fauna and flora species within the forests and ensures biodiversity conservation and sustainability of the company's activities.

MORE INFORMATION/CONTACT
www.suzano.com.br

Monitoring and Preservation of Red-Spectacled Parrots in the Mountains of Southeastern Rio Grande do Sul

CMPC CELULOSE RIOGRANDENSE LTDA

Biodiversity monitoring in Rio Grande do Sul indicated the importance of Celulose Riograndense areas that are located within an IBA (important bird area) of the Médio Camaquã for preservation of the red-spectacled parrot (*Amazona pretrei*). Located in the mountain region of southeastern Rio Grande do Sul, this IBA was created for the red-spectacled parrot, an endangered species that is typical of southern Brazil.

This species preservation project is being carried out by the Carazinho branch of the Friends of the Environment Association (AMA) and Passo Fundo University, initially coordinated by the Pro-Nature Foundation (FUNATURA) and, currently, by Celulose Riograndense itself. They have evaluated 97 tree nurseries in and around the IBA, of which 78% had a high or good potential for the presence of the species, which was effectively verified on 12 farms. Nests were found in 4 of these areas.

The species resides in Rio Grande do Sul from June through February, during their breeding period. Thereafter, they begin migrating to the southeast of Santa Catarina, where there is a greater supply of araucaria (Araucaria angustifolia) seeds. In the mountains of the southeast of Rio Grande do Sul, they feed on the seeds of another conifer, known locally as the pinheiro-bravo (*Podocarpus lambertii*), flower buds of the trumpet tree (*Tabebuia* sp.) and the fruit of the bead-tree (*Melia azedarach*).

The results of the survey led to these areas being included among high conservation value areas and changes in the definition of plantation management, including alterations to the time and maximum area of harvest in places where nests are present. In the second stage of the project, in partnership with the AMA, beyond continued monitoring, 80 nest boxes are being installed to increase the supply of breeding locations for the bird.Knowing that one of the threats to the species derives from the habit of capturing nestlings for pet breeding, the project is also investing in environmental education, with the expectation that in the medium and long term, it can discourage the practice of keeping wildlife as pets, interrupting the cycle of capture and illegal sales.

Aroldo Palo Junior

ONE OF THE SPECIES MONITORED BY CMPC IS THE RED-SPECTACLED PARROT (*AMAZONA PRETREI*).

MORE INFORMATION/CONTACT

http://www.celuloseriograndense.com.br/responsabilidade/#meio-ambiente-florestal

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Independent Monitoring of the Forest Cover of the Northern Basins of the Deep South of Bahia

VERACEL CELULOSE

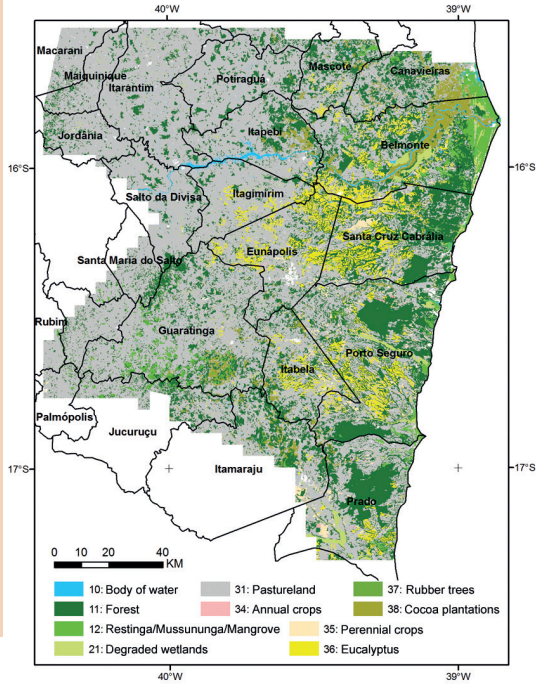
During 2009, the Forestry Forum of the South and Extreme South of Bahia called attention to the fact that no detailed information existed about the temporal evolution of the forest cover in the northern basins of the deep south of Bahia. This lack was hindering a quantitative understanding of landscape dynamics and planning for biodiversity conservation activities.

The matter was brought before the Subcommittee on the Atlantic Forest Biosphere Reserve of the Deep South of Bahia and the Management Committee for the Mosaic of Protected Areas of the Deep South of Bahia, resulting in a resolution on the importance of carrying out a study of this nature.

In 2010, through a public tendering process, Veracel Celulose selected the BioAtlantic Institute consortium (IBio, ECONAMFI and the Laboratory for Landscape Ecology and Conservation at the University of São Paulo - LEPAC/USP) to carry out the first phase of a study monitoring the temporal evolution of the forest cover in one contiguous area of 2.3 million hectares that includes the current and anticipated areas in which the company is/will be active (Fig. 1). To make the study possible, Veracel offered its database of satellite images from SPOT 5 (2006), Formosat (2007) and Landsat (1990, 2001-2), as well as orthophotos (1995-6), to allow detailed mapping for the different dates, as well as comparisons between different time periods.

Throughout 2011, the work of visually interpreting these images was conducted by two local teams, one in Ilhéus and the other in Porto Seguro, who were trained at the start of this initiative. A field campaign was conducted to collect records from 3,700 points in the region, producing an extremely detailed legend, with 28 different types of cover.

A key outcome of the project was mapping of the vegetation cover and soil use in the area of interest for the period 2006-2007, on scale of 1:20,000, which is significantly more detailed than previous mappings of the same region. The set of products generated represents the most extensive mapping at this spatiotemporal resolution ever conducted in the Atlantic Forest (Fig. 2).



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Public Housing in Indigenous Areas of Bahia

GRIN9 EDUCATION AND ENVIRONMENTAL MANAGEMENT

Awareness of the socio-environmental and economic reality of southern Bahia mobilized the NGO GRIN9 to participate in a public call to tender by the State of Bahia for the construction of public housing in Amerindian villages in the municipality of Porto Seguro, in 2010.

The proposal was presented to and discussed with the leadership of the Patáxo people, which agreed to a sustainable construction model that was based on the use of eucalyptus as a substitute for wood from native trees, thus reducing the strain on remnants of the Atlantic Forest in the region. Eucalyptus is being used in all stages of home construction – foundation, scaffolding, window frames and roof.

The concept was developed after extensive research was conducted in the region and, in a purposeful way, encourages the urgent need for all – planners, government leaders, business people and citizens – to effectively contribute to the triple bottom line of sustainability (economic, social and environmental). In other words, the proposal has a socio-environmental vision that will guide the economic investments and financing.

The construction of 230 units with appropriate technical support has been of great help to those natives who intend to become professionals and pursue future work in construction.

The Public Housing Project has completed construction of 83 houses for the Pataxó tribe and has trained 230 families. Indigenous communities have spontaneously built their own social network and this has been strengthened through the partnership with GRIN9 in cooperation with the state of Bahia, with support from manufacturers and suppliers.

Photos: Hugo Gaudino

HOUSE BUILT UNDER THE PROJECT (LEFT).
PLANNING WITH THE COMMUNITY (RIGHT).

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The Role of Planted Forests in Conservation

WWF-BRASIL

Estimates suggest that, by 2050, the world's population will exceed 9 billion people. Accordingly, demands for natural resources will increase. Hence, one of the challenges over the coming decades will be ensuring that people have a sufficient supply of natural resources. The forest is one of the main sources of natural resources. Humanity is extremely dependent on it as a source of food, energy, shelter and raw materials for various industries. In some of these industries, the cultivation of forests (a process that involves planting, managing and harvesting, such as occurs with agricultural crops) has become essential to supplying, for example, the paper and pulp industries, as well as steel mills, which use charcoal as raw material for steel production.

The expansion of cultivated areas is threatening local livelihoods and altering natural ecosystems, which are important for maintaining biodiversity. WWF Brasil seeks to influence the forestry sector, ensuring that this increase in demand for natural resources does not cause irreversible impacts on natural resource conservation. In this regard, the forestry sector can promote increased protection of biodiversity through the recovery and maintenance of native forests, important natural remnants that can assure the formation of vegetation mosaics in forest production areas.

On small farms, including the planted forest component can guarantee investment security for producers, by diversifying production. Moreover, considering the issue of climate change, forests promote the capture of CO_2 from the atmosphere, reducing the concentration of greenhouse gases (GHG). Of course, none of these benefits are achieved by simply planting forests, especially in the case of a monoculture forest. In this sense, it is important to evaluate the complexity of the sector, taking into consideration social, economic and, especially, environmental aspects.

Having a landscape vision that considers the impacts of a dense forest in a given region is the main concern of WWF Brasil. In this regard, WWF Brasil aims to guide the expansion of the Brazilian forestry sector, taking into consideration landscape planning elements; to participate in and lead initiatives for dialogue between companies and civil society organizations; and to support forest certification, orienting the consumer market for forests to consume products responsibly.

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Eduardo Aigner/WWF-Brasil

EUCALYPTUS PLANTATION IN THE CERRADO OF MINAS GERAIS' CHAPADA GAÚCHA REGION.

Morro da Pescaria Municipal Nature Park and "Our river, our life"

GREEN FORCE ASSOCIATION

The Green Force Association develops biodiversity conservation projects in the municipality of Guarapari, in the state of Espírito Santo. One of these is the management of the Morro da Pescaria Municipal Nature Park and the other is the "Our river, our life" project.

Guarapari's Morro da Pescaria Municipal Nature Park is a municipal conservation unit that contains 73 hectares of Atlantic Forest along a rocky shore and a surrounding hinterland. The Força Verde (Green Force) is the principal manager of this park, which receives thousands of visitors each year, including students from public and private school districts. Currently, the main concern is with recovery and enrichment of the Atlantic Forest, elimination of invasive and alien species and protection of terrestrial and marine fauna.

The "Our river, our life" project, conducted in partnership with Band FM and TV Guarapari, with sponsorship from Samarco Mineração, is a diagnostic initiative that presents proposals for the revitalization, protection and elimination of negative impacts on the Conceição River, the main source of drinking water for the city of Guarapari. In addition to diagnostics, the project encompasses environmental education activities, engagement of and involvement with local communities and landowners, and especially coming up with proposals intended to increase the purity and flow of the river. This first project will be the basis for future projects, where specific actions will be proposed to the sponsor and project partners.

Photos: Celso Maioli

ENVIRONMENTAL EDUCATION ACTIVITIES DEVELOPED AS PART OF "GREEN FORCE" PROJECTS.

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Biodiversity Conservation Plan

THE NATURE CONSERVANCY - TNC

In 2010, The Nature Conservancy (TNC) and Suzano Papel e Celulose established a partnership seeking to focus on the preparation of a Biodiversity Conservation Plan for all of the states in which the company's forestry areas are located.

This plan seeks to guarantee that the native areas owned by Suzano are recognized for their importance, are managed appropriately and have biodiversity monitoring programs that follow the detailed suggestions for the company's forestry areas in the Atlantic Forest, Cerrado, Caatinga and Amazon biomes (associated ecosystems and transition zones) in the states of São Paulo, Bahia, Minas Gerais, Paraná, Espírito Santo, Piauí, Maranhão and Tocantins.

Photos: Marcelo Matsumoto

SUZANO AREA IN THE STATE OF SÃO PAULO. BELOW, PLANNING PROJECT ACTIVITIES.

The biodiversity management and monitoring suggestions defined in this plan are generated based on an international methodology developed by the TNC known as Conservation Area Planning (CAP). This method takes into consideration that not all of the information necessary to guide conservation actions is always available and that planning must be flexible so that the best possible management actions can be conducted efficiently.

According to the CAP methodology, conservation targets are decided upon in the natural areas that have been evaluated (which could consist of species, habitats, etc.). The targets are assessed regarding their feasibility (ecological "health") and the threats that the region is subject to are determined — such as, for example, poaching, wood theft, forest fires and others. Next, strategies are defined to mitigate these threats and to decide which indicators and measures for improving feasibility of the conservation targets are to be chosen. The objective is that the ecological processes that sustain these targets should be maintained in good condition over the long-term, and to this end the company is committed to implementing the suggested management actions.

Furthermore, the state of conservation of natural fragments is analyzed through the geographical information system (SIG in Portuguese), using tools such as LandFrag, Corridor Designer, CARGEO, and others. Suggested restoration and landscape management actions are developed through these analyses, with particular attention on High Value Conservation Areas (HVCAs).

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Rio Negro Pantanal State Park Management Plan and Carbon Stock Estimate In Five Private Natural Heritage Reserves In Mato Grosso do Sul

FORPUS INSTITUTE

The Forpus Institute (IF) was created in 2004 by a group of researchers and university and research center professors to develop environmental and social-economic projects focused on biodiversity conservation and the sustainable use of natural resources, with the engagement of society. Until now, the IF has supported the conducting of biological inventories and the preparation of conservation area management plans.

The management plan for the Rio Negro Pantanal State Park was delivered by the IF in 2008, the result of an agreement between the institute and Conservation International in Brazil. Created in 2000, the park is the largest fully protected conservation area in the state of Mato Grosso do Sul, encompassing parts of the municipalities of Aquidauana and Corumbá, protecting 78,302 ha of different environments in the region as well as species that are threatened with extinction.

Currently, the IF acts in partnership with the Mato Grosso do Sul Association of Private Natural Heritage Reserve Owners (REPAMS) in the "BRPPN: Generating Environmental Services" project. The main objective of the IF in the project is to estimate the amount of carbon stored in the above-ground vegetable biomass within the Private Natural Heritage Reserves (RPPNs) of Gavião de Penacho, Buraco das Araras and Fazenda São Geraldo, located in the Cerrado and the Fazenda Rio Negro and Dona Aracy RPPNs on the Pantanal plain.

The existence and maintaining of these forest reserves avoids the emission of carbon dioxide into the atmosphere, representing an essential environmental service for climate maintenance, the conservation of biodiversity and assistance against global warming. Moreover, the quality of carbon that is stocked or in the process of being fixed can be traded in the form of carbon credits, generating income for the forest property owners in a near-term future.

Jalina Casarin

CHECKING THE FOREST CARBON STOCK IN THE RPPNS.

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Biodiversity Conservation Program

THE ASSOCIATION FOR THE PRESERVATION OF THE ENVIRONMENT AND OF LIFE – APREMAVI

The creation and implementation of Conservation Areas (CAs) represents one of the most efficient strategies for the conservation of biodiversity. With this objective, Apremavi has been developing its Biodiversity Conservation Program, designed to expand in situ conservation in Atlantic Forest remnants that exist in the state of Santa Catarina through support for the creation, installation and management of Conservation Areas — especially fully protected areas. A number of different activities are being carried out through the program.

The establishment and management of the Atlantic Forest Natural Municipal Park (54 ha) and the setting up of a steering committee are steps that have been taken. Created in 2000, the park is in the municipality of Atalanta and contains beautiful landscapes and a wealth of biodiversity. Currently, Apremavi is managing it.

Then there is support of the creation and establishment of the Area of Significant Ecological Interest (ARIE) located in Serra da Abelha (4,251 ha) in Vitor Meireles. The ARIE, which is one of the last remnants of Araucaria Forest in the region of the upper Itajaí valley, came into existence as a result of a motivational campaign run by the association in 1990. Ever since, the entity has been working to ensure its continuance. The program also supported the creation of the Trilha dos Bugres Municipal Nature Park in Imbuia and conducted studies for the creation of two new municipal CAs in Vitor Meireles.

Apremavi owns the Serra do Lucindo Private Natural Heritage Reserve (RPPN - 316 ha) in Bela Vista do Toldo and is creating its second RPPN, Irmãs Grimm (about 200 ha), in Papanduva. Both areas contain important Atlantic Forest remnants.

The organization was an important player in the creation of the Araucarias National Park (12,842 ha) in Passos Maia and the Mata Preta Ecological Station (6,563 ha) in Abelardo Luz. With the creation of the CAs in 2005, Apremavi was instrumental in the preparation of the Management Plan for the Araucarias National Park and the Conservation Action Plan for the Mata Preta Ecological Station. It also helped constitute the Steering Committees for these CAs and currently is training their managers, as well as members of the surrounding communities.

Now underway are campaigns for the creation of the Campo dos Padres National Park and the Rio da Prata Wildlife Refuge in the Pelotas Corridor.

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PERAU DO GROPP WATERFALL, IN THE ATLANTIC FOREST MUNICIPAL NATURE PARK OF ATALANTA (SC).

Asas (Wings) Project

MINAS GERAIS ASSOCIATION FOR ENVIRONMENTAL PROTECTION - AMDA

The number of wild birds seized by Ibama reveals that the capturing and trafficking of wild animals continues to be the second most important threat to biodiversity in Brazil. Seeking to guarantee the survival of the birds that are recovered from traffickers, Ibama signs up rural properties that are willing to receive them and are equipped with suitable infrastructure, as defined by the entity. One of these is the Fazenda dos Carvalhos, a farm of about 200 ha, of which nearly 90% is covered by natural habitat, located in the municipality of Brumadinho, in the metropolitan area of Belo Horizonte.

Miriam Prochnow

In a partnership with this property, at the beginning of 2012 AMDA established its Asas Project ("Asas," or "wings," is also the Portuguese acronym for "Wild Animal Release Area"). Veterinarian João Paulo Mourão Vasconcelos, one of the owners, is its voluntary coordinator.

Three adaptation enclosures were built: one for small passeriformes, another for medium-sized birds and a third for psittacines (parakeets and parrots). The passeriformes undergo an adaptation period of 30 days before they are released. The psittacines remain in the enclosure for approximately six months, in view of the fact they have more difficulty in re-adaptation.

The adaptation of the birds is monitored and species that are unable to adapt must be recaptured and maintained in the enclosures to receive environmental education. The project also calls for the reintroduction in the region of the Blue-fronted Parrot (Amazona aestiva), in a pioneering initiative.

The project has the formal and financial support of local condominiums and business people and action is being taken regarding local farmers, rural schools and visitors to the district to inform them and seek their participation. As a result, the association expects to have.

João Paulo Mourão Vasconcelos

ONE OF THE OBJECTIVES OF THE PROJECT IS THE REINTRODUCTION OF THE BLUE-FRONTED PARROT (*AMAZONA AESTIVA*).

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The Ilhas Verdes (Green Islands) Project

ÁGUAS DA SERRA DA BODOQUENA INSTITUTE – IASB

Ilhas Verdes (Green Islands) is a forest recovery demonstration project developed in the municipality of Bonito (Mato Grosso do Sul state). Recovery is conducted based on a technique whose main principle is to reduce the need for combatting brachiaria grasses in planted areas. Without the need for constant maintenance, the cost of recovery can be cut by up to 50%. Another important action in this project is the involvement of the population of the municipality of Bonito, including young people, adults, the government and farmers, in environmental activities.

Besides these actions, many others have been implemented since the project, which has the support of Petrobras, was kicked off in January 2011.

On the forestry recovery project, taking into account the high cost of recovering degraded forests, the project emerged as a result of the need to seek a new recuperation alternative that would reduce such costs.

The elevated cost is mainly related to the constant need for maintenance to keep down brachiaria grasses. These grasses inhibit or retard the development of the native species seedlings, leading to high rates of plant mortality. The forest recovery technique used is not designed to eliminate brachiaria grass, but rather to make it possible for the tree seedlings to develop, without incurring extra costs. Because the technique is new to the municipality of Bonito, the IASB is testing its efficacy from the ecological and economic point of view, analyzing the soil, climate and vegetation conditions encountered in the region.

As for the environmental education project, it is increasingly important that the population learns about the natural wealth that Bonito possesses. The work is conducted in order to protect and conserve these riches. Thus, the project has been implementing a series of Environmental Education actions designed to instruct members of the population regarding environmental and social matters in the region in which they live and encourage them to practice nature conservation.

Photos: Liliane Lacerda

THE ILHAS VERDES PROJECT PROMOTES ALTERNATIVE WAYS TO CONTROL BRACHIARIA GRASSES.

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Biodiversity Conservation Projects

FIBRIA CELULOSE S.A.

The conservation of biodiversity is one of the priorities of Fibria's sustainability strategy. The company operates in three Brazilian biomes: the Atlantic Forest, the Cerrado and the Pampa; the first two of these are among the richest biomes in the world in terms of numbers of species, even though remnants of their native vegetation are very fragmented due to the historical process of the occupation of Brazilian territory.

On Fibria's properties, some 352,000 ha (about 37% of the total area) are set aside for biodiversity conservation and ecological processes. These conservation areas represent different types of ecosystems and are distributed along rivers and in large blocks, forming a landscape mosaic where the eucalyptus tree plantations are intertspersed with native vegetation, which is the subject of protection, restoration, management and integration with the forest plantation matrix.

Fibria's projects can be grouped as follows: studies for monitoring flora and fauna; landscape management practices for biodiversity purposes; conservation of threatened species; restoration of native areas; environmental education programs; management of conservation areas; and joint initiatives for conserving biodiversity.

The data from the field collection of flora and fauna are stored in the company's Biodiversity Database. The presence of 680 bird species, 132 mammal species and 1,355 plant species has already been recorded on Fibria's land. All of the accumulated knowledge regarding the existing relationship between eucalyptus plantations and native flora and fauna makes it possible to develop a number of initiatives that help improved management practices.

The company's policy and procedures have been determined to identify and control environmental factors, in order to minimize negative environmental impacts and to enhance the positive ones. Because Fibria's forest plantations are certified, the prohibition of converting habitats and the combat of invading species, together with protection of rare and endemic species, are management practices of the company.

Photos: Arquivo Fibria

DEER AND GIANT ANTEATERS ARE FOUND ON FIBRIA'S LANDS IN MATO GROSSO DO SUL.

MORE INFORMATION/CONTACT
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The Mutum (Currasow) Project

CELULOSE NIPO-BRASILEIRA S.A. – CENIBRA

Now in its 22nd year, the result of a technical-scientific cooperation agreement between CENIBRA and the Society for Research on Wildlife Management and Reproduction (CRAX), the pioneering reintroduction of endangered birds under the MUTUM PROJECT has been carried out on a Private Natural Heritage Reserve (RPPN), the Fazenda Macedônia, located in the municipality of Ipaba,in the state of Minas Gerais. The project has made it possible to reintegrate into their natural habitat birds such as the red-billed curassow (*Crax blumenbachii*), solitary tinamou (*Tinamus solitarius*), spot-winged wood quail (*Odontophorus capueira*), yellow-legged tinamou (*Crypturellus n. noctivagus*), brown tinamou (*Crypturellus obsoletus*), dusky-legged guan (*Penelope obscura*) and black-fronted piping guan (*Pipile jacutinga*).The basis for CRAX's efforts is its research center, located in Contagem (Minas Gerais), where suitable preparation and management is carried out to make it easier for the birds to be re-adapted before they are reintroduced into their natural habitats.

Jacinto Moreira Lana

João Marcos Rosa

FEMALE CURASSOW (TOP) AND BLACK-FRONTED PIPING GUAN IN CENIBRA'S FORESTED AREAS.

The reintroduced species are regularly monitored in order to obtain data regarding their adaptation, dispersion, reproduction and losses of reintroduced individuals. This monitoring registered a total of 98 red-billed curassow chicks born at Fazenda Macedônia. It is estimated that the actual number is significantly higher, due to the fact that the RPPN's forests are connected to other areas of native vegetation preserved by CENIBRA, which allows the curassows to disperse into other regions.

The curassow population at the RPPN is estimated to be 200 individuals, including those that were released and their descendents. This number is very high, considering that the world population of the species is about 1,000 individuals, including those that live in captivity or in the wild, according to data from Red-billed Curassow Action Plan (IBAMA, 2005). The Mutum Project is an example that reintegration of endangered species into their natural ecosystems can be a solution for preventing their extinction in nature.

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Protection of Threatened Birds on the Pampa

STORA ENSO FLORESTAL RS

Stora Enso has expanded its areas for protecting biodiversity on the western border of Rio Grande do Sul. In 2012, the company adopted the recommendations of a fauna monitoring team and set aside areas on two farms in the municipality of Rosário do Sul. As a result, about 50 hectares of fields previously used as pastureland were transformed into High-Value Conservation Areas to protect a number of bird species at differing levels of threat of extermination.

According to agronomist Gilberto Deprá, in 2010 the presence of ten endangered bird species was registered at Fazenda Tarumã and Estância Tarumã, properties owned by Stora Enso. Four of the species are included on the official list of endangered birds in the state: sedge wren (*Cistothorus platensis*), marsh seedeater (*Sporophila palustris*), chestnut seedeater (*Sporophila cinnamomea*) and rusty-collared seedeater (*Sporophila collaris*). Another two species are rare and, thus, considered vulnerable: rufous-rumped seedeater (*Sporophila hypochroma*) and Zelich's seedeater (*Sporophila zelichi*).

The birds inhabit wetlands or shrubby grasslands with tall weeds, migrating after spring/summer. They arrive on the Rosário do Sul properties as of November. According to the Red Book on Fauna Threatened with Extinction (MMA 2010), the main threat to the species derives from loss of habitat and suppression and alteration of the vegetation. Other influencing factors include drainage of wet environments and loss of feeding and resting spots on the migratory routes, among others. "Due to the isolating of these areas and the resulting improvement in the conditions of the habitat for feeding and nesting, we believe that we will see an increase in the populations of these birds," in the opinion of Stora Enso Environmental coordinator Julio Medeiros.

Gilberto Deprá

Miriam Prochnow

SEDGE WREN MONITORED IN AN AREA OF *PAMPA*.

Of the 4,348 ha at Estância Tarumã, 53.3% are permanent preservation areas (APPs), Legal Reserves(RL) and other native vegetation remnants. The eucalyptus plantations occupy only 38% of the property. At Fazenda Tarumã, with 2,075 ha, 52.4% are earmarked for protection and another 42.5% are for plantations. The forest plantations on the two farms represents 0.58% of the Rosário do Sul land area.

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PRIVATE NATURAL HERITAGE RESERVES

Native Forest Conservation Strategy in Mato Grosso do Sul

MATO GROSSO DO SUL ASSOCIATION FOR OWNERS OF PRIVATE NATURAL HERITAGE RESERVES - REPAMS

REPAMS has been working for the past nine years in partnership with rural property owners and private enterprise to generate information that would stimulate the creation of new Private Natural Heritage Reserves (RPPNs) in the state of Mato Grosso do Sul. Currently, there are 43 RPPNs in the state, and together they protect more than 139,000 ha. The association runs projects designed to expand the private reserve segment in partnership with Conservation International of Brazil, through its "Pantanal RPPN Incentive Program," with WWF-Brasil through institutional support initiatives under the "Pantanal Cerrado Program" and, currently, is involved in a project entitled "BRPPN: Generating Environmental Services," financed by the "Petrobras Environmental Program."

An RPPN is a type of private conservation area, where the rural property owner voluntarily creates a reserve on his lands, taking on a permanent commitment and guaranteeing in perpetuity the existence of locations with unique characteristics, preserving the flora and fauna species of the region. Through four separate official public tendering procedures, the Pantanal RPPN Incentive Program offered support to 42 projects of RPPNs located in the upper Paraguai river basin, with action that helped landowners create their RPPN (such as organization of documents, geo-referencing, protocols and monitoring of the creation process until final publication in the State Official Gazette), as well as actions involving reserve management, management plan preparation, equipment acquisition, fire fighting, construction of firebreaks and fencing off the RPPN to limit access of domestic animals, among others.

Also through the Pantanal RPPN Incentive Program, REPAMS has developed new projects and understandings, such as the construction of the Alliance Fund for the Pantanal and Cerrado RPPNs (FAPACE). In 2010, REPAMS approved, through the Petrobras Environmental Program, the BRPPN: Generating Environmental Services project. This work involves: i) the calculation of the carbon stock; ii) a survey of environmental services for possible evolution of the Environmental Services Payment (PSA); iii) education/communication that seeks to provide clear and objective information to stakeholders; and iv) the recovery of degraded areas, involving action such as the construction of seedling nurseries and planting of native Cerrado and Pantanal species on the borders of the reserves.

Cyntia Cavalcante Santos

RESERVA DO SACI RPPN – BONITO (MS).

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SOS SERRA VERMELHA

The Last Semi-Arid Brazilian Forest

PIAUÍ ENVIRONMENTAL NETWORK - REAPI

Located in the extreme south of the state of Piauí, Serra Vermelha — with an area of approximately 200,000 ha — is one of those rare places we can call paradise on Earth. There, nature did its best to put on a display of rich biodiversity of rare beauty, present in the lush Atlantic Forest, in the singular Cerrado and in the majestic Caatinga. On top of this is added an infinite variety of surprising and precious animal and vegetable species. This is the last great forest of Brazil's northeastern bush country, known as the Sertão.

This veritable "Garden of Eden" remained intact until 2005, when the "Green Energy" project was established in the region, designed to produce charcoal from native forests to supply steel companies in Brazil and abroad.

Action by environmental NGOs, with the support of the Federal Prosecutors Office, succeeded in stopping the project and a strong campaign was initiated to create a conservation area in the region. The promise was that Serra Vermelha would be included in the expansion of the Serra das Confusões National Park, but this never happened.

In view of this, the Piauí Environmental Network (REAPI), with the help of a number of other organizations, such as Fundação Rio Parnaíba (FURPA), SOS Mata Atlântica, the Atlantic Forest NGO network, the University of São Paulo Zoology Museum, Fundação Cultural Raízes do Piauí and many others, decided to continue organizing campaigns to demand the creation of the Serra Vermelha National Park.

The most recent of these campaigns now has a new poster (the fifth in a series over the past seven years), whose theme is: "Save the Serra Vermelha," showing through images how important the creation of the park would be for protecting the last semi-arid forest in Brazil.

André Pessoa

TOP, VIEW FROM THE AIR OF THE SERRA VERMELHA. BELOW, THE CAMPAIGN POSTER.

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CONSERVATION OF BIODIVERSITY MUST BE A COMMITMENT OF ALL SECTORS OF SOCIETY.

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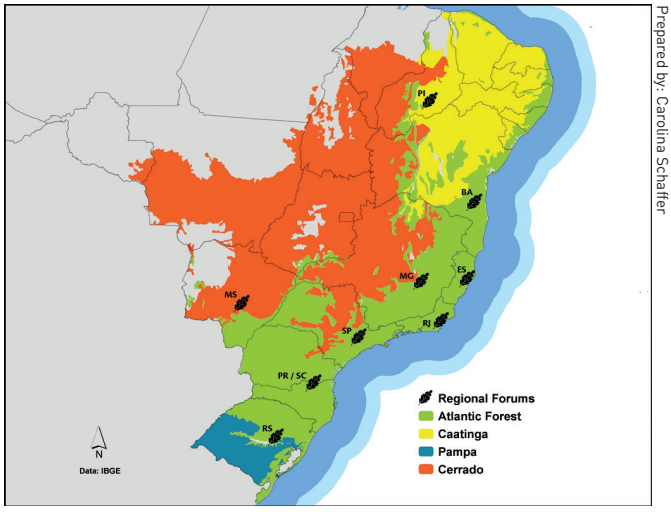

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