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# Safeguarding the Pantanal Wetlands: Threats and Conservation Initiatives

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**Abstract:** *The Pantanal, one of the largest wetlands on the planet, comprises 140,000 km<sup>2</sup> of lowland floodplain of the upper Rio Paraguai basin that drains the Cerrado of central Brazil. The diverse mosaics of habitats resulting from the varied soil types and inundation regimes are responsible for an extraordinarily rich terrestrial and aquatic biota, exemplified by the bird richest wetland in the world—463 birds have been recorded there—and the largest known populations of several threatened mammals, such as Pampas deer (*Ozotoceros bezoarticus*), marsh deer (*Blastocerus dichotomus*), giant otter (*Pteronura brasiliensis*), and jaguar (*Panthera onca*). Until recently, deforestation of the adjoining Brazilian central plateau was considered the major threat to this area, but now deforestation is a critical problem within the floodplain itself. More than 40% of the forest and savanna habitats have been altered for cattle ranching through the introduction of exotic grasses. And there are other threats that lead to large-scale disruption of ecological processes, severely affecting biodiversity. Although the Pantanal wetland is a Biosphere Reserve and is considered a Wetland of International Importance, only 2.5% of the upper Paraguai River basin is formally protected. To date, protected areas have been created opportunistically and as such, although of undoubted value, protect only a fraction of the Pantanal's wildlife and habitats. Among the conservation initiatives in the area, the private sector is increasingly participating in the establishment of private reserves. The prospects are far from optimistic, however, and the major challenge is to find alternative socioeconomic models that allow for conservation and economic uses of the land in association with the development of specific environmental legislation that reflects the unique characteristics of the region.*

Protegiendo a los Humedales del Pantanal: Amenazas e Iniciativas de Conservación

**Resumen:** *El Pantanal, 140,000 km<sup>2</sup> de llanura inundable de la cuenca alta del Río Paraguai que drena el Cerrado en el centro de Brasil, es uno de los humedales más extensos del planeta. Los diversos mosaicos de hábitats que resultan de diversos tipos de suelo y regímenes de inundación son responsables de una biota terrestre y acuática extraordinariamente rica, ejemplificada por el humedal con mayor riqueza de aves en el mundo - se han registrado 463 especies de aves - y las mayores poblaciones conocidas de varios mamíferos amenazados, como el venado de las Pampas (*Ozotoceros bezoarticus*), el venado de pantano (*Blastocerus dichotomus*), la nutria gigante (*Pteronura brasiliensis*) y el jaguar (*Panthera onca*). Hasta hace poco, la deforestación de la meseta central Brasileña adyacente era considerada como la mayor amenaza a esta área, pero ahora la deforestación es un problema crítico dentro de la misma llanura inundable. Más de 40% de hábitats de bosque y sabana han sido alterados para producción de ganado mediante la introducción de pastos exóticos. Y hay otras amenazas que conducen a la disrupción de los procesos ecológicos a gran escala*

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que afectan severamente a la biodiversidad. Aunque el humedal del Pantanal es una Reserva de la Biósfera y es considerado un Humedal de Importancia Internacional, solo 2.5% de la cuenca alta del Río Paraguai está protegido formalmente. A la fecha, las áreas protegidas han sido creadas oportunísticamente y por lo tanto, aunque de valor indudable, solo protegen a una fracción de la vida silvestre y hábitats del Pantanal. Entre las iniciativas de conservación del área, el sector privado está incrementando su participación en el establecimiento de reservas privadas. Sin embargo, las perspectivas están lejos de ser optimistas y el mayor reto es encontrar modelos socioeconómicos alternativos que permitan la conservación y utilización económica de tierras en asociación con el desarrollo de legislación ambiental específica que refleje las características únicas de la región.

## Brazilian Pantanal Wetlands

The Pantanal is one of the largest continuous wetlands on the planet, covering approximately 140,000 km<sup>2</sup> of low-elevation floodplain of the upper Rio Paraguai and its tributaries, which drain the Cerrado of the central plateau of Brazil. The vegetation is heterogeneous and influenced by four biomes: Amazon rainforest, Cerrado (predominant), Chaco, and Atlantic Forest (Adámoli 1981). Different habitats, soil types, and inundation regimes are responsible for the great variety of vegetation formations and the patchy landscapes, which harbor a rich terrestrial and aquatic biota (Pott & Adámoli 1999). Sixteen vegetation classes based on phytophysiology have been identified (Silva et al. 2000), the most important being grassland (31%), cerrado woodland (*cerradão*) (22%), cerrado (bush savanna) (14%), marshes (7%), semideciduous forest (4%), gallery forest (2.4%), and floating mats (2.4%). Summers (November–March) are hot and rainy and winters (April–October) are warm and dry, except for occasional cold spells (Soriano 1997).

The main ecological factor that determines patterns and processes in the Pantanal is the flooding pulse (Junk & Silva 1999; Oliveira & Calheiros 2000), which follows an annual, monomodal cycle with amplitudes from 2 to 5 m and a duration of 3 to 6 months. There is a delay of about 4 months before the peak water level passes through the Pantanal from north to south (Heckman 1999). The dry season is already under way in the northern Pantanal when water levels reach a peak in the south. Water levels in any one season in the north are extremely variable, rising and falling in close response to rainfall. Water levels in the south, on the other hand, rise and fall more smoothly during the year because natural flood retention dampens the fluctuations caused by heavy rainstorms (Heckman 1999). The Pantanal is also subject to a multiyear variation of flooding intensity, with an alternation of high-flood years and significantly drier ones (Mourão et al. 2000; Cunha et al. 2002).

Although species diversity is not particularly high (greater in the south than in the north) and endemism is practically absent (probably related to the geomorphological youth of the floodplain—a desert in the Pleistocene), the region is notable for its extraordinary concen-

tration and abundance of wildlife (Heckman 1999; Swartz 2000). About 124 species of mammals occur there, and the Pantanal has the largest known populations of several threatened species, such as the Pampas deer (*Ozotoceros bezoarticus*), marsh deer (*Blastocerus dichotomus*), giant otter (*Pteronura brasiliensis*), and jaguar (*Panthera onca*) (Alho & Lacher 1991; Mourão et al. 2000; Tomas et al. 2000; Sanderson et al. 2002). Mittermeier et al. (2003) report 423 birds in the Pantanal, but a recent review by Tubelis and Tomas (2003) resulted in a list of 463 species, making it the richest single wetland site for birds in the world. From this total, 117 species are included on at least one state, national, or international list of threatened species; the best-known is the Hyacinth Macaw (*Anodorhynchus hyacinthinus*) (Tubelis & Tomas 2003; Tomas et al. 2004). The Pantanal is also an important migratory route, with more than 130 species arriving there from the southern continent (Pampas), the Northern Hemisphere, and the Atlantic Forest (Antas 1994; Nunes & Tomas 2004). A large number of species are seasonal (Cintra & Yamashita 1990) and transient. Generalist species are favored within the temporally variable and patchy habitats (Figueira et al. 2005). Forty-one amphibians, 177 reptile species (Médri & Mourão 2004), and more than 260 fishes have been recorded in the Pantanal (Britski et al. 1999).

The Pantanal wetland is recognized as a “National Heritage” in the 1988 Constitution of Brazil and as a Wetland of International Importance in the Ramsar Convention. In 2000, it was designated a Biosphere Reserve by the U.N. Educational, Scientific, and Cultural Organization, and part of it is also a World Heritage Site, affording a unique opportunity for biodiversity conservation in conjunction with sustainable development. Referring to its biological distinctiveness, conservation, and priority status, Olson et al. (1998) concluded that the Pantanal is a region that is “globally outstanding, vulnerable and with highest priority for conservation at regional scale.” Despite this, the available data on its biological diversity are still poor and fragmentary (Silva et al. 2001; Silva 2002).

The fragile equilibrium of the Pantanal ecosystems, defined by the dynamics of the periodic flooding, is threatened by recent tendencies in economic development. The traditional models of fishing and cattle ranching are

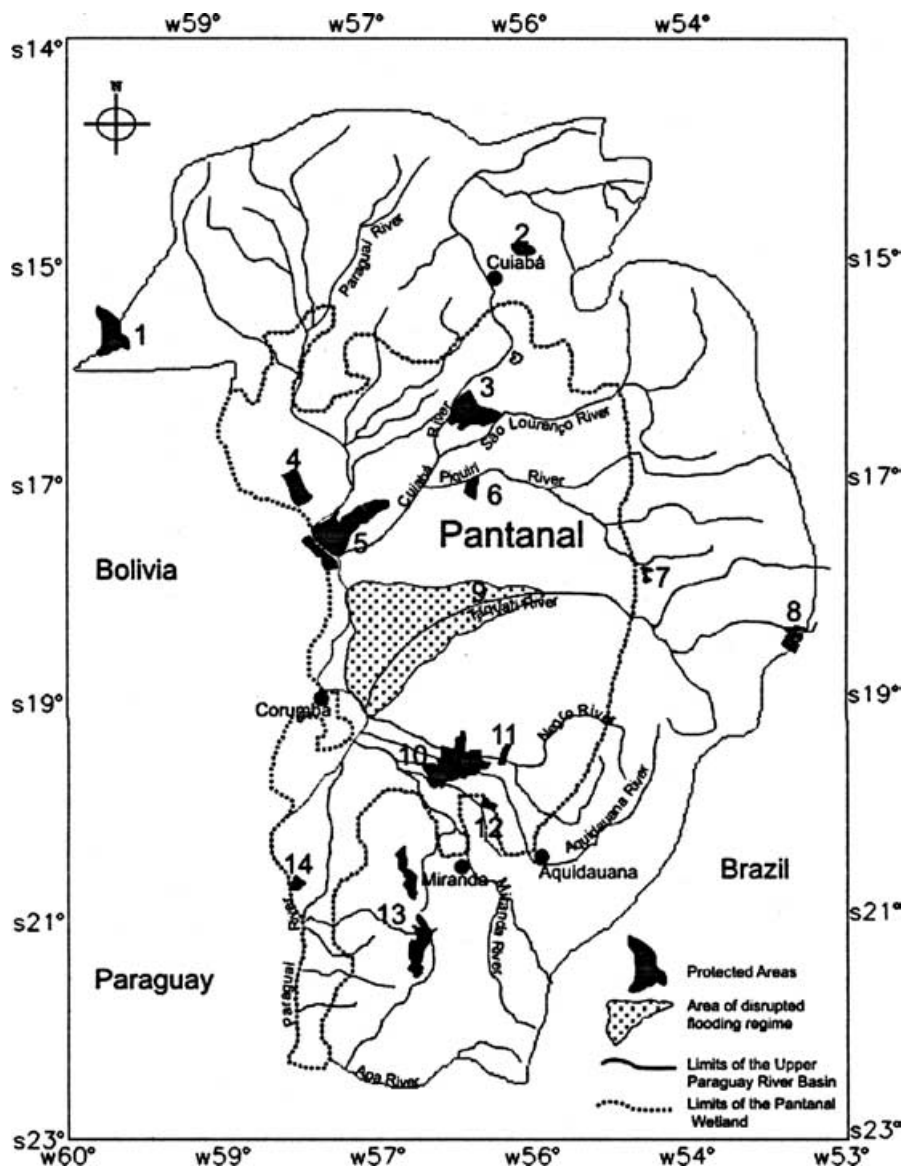


Figure 1. Map of the Upper Paraguay River basin and the Pantanal, showing the area where the flooding regime of the Rio Taquari has been disrupted. Also shown are some of the existing federal, state, and private protected areas: 1, Serra de Ricardo Franco State Park; 2, Chapada dos Guimarães National Park; 3, Serviço Social do Comércio Pantanal Private Reserve; 4, Guira State Park; 5, Complex of the Pantanal Matogrossense National Park and the Private Reserves of Acurizal and Doroche; 6, Fazenda Poleiro Grande Private Reserve; 7, Serra de Sonora State Park; 8, Nascentes do Rio Taquari State Park; 9, Fazenda Nhumirim Private Reserve; 10, Complex of the Pantanal do Rio Negro State Park and the Private Reserves Fazendinha and Santa Sofia; 11, Fazenda Rio Negro Private Reserve; 12, Dona Aracy Private Reserve; 13, Serra da Bodoquena National Park; 14, Fazenda Rancho Seguro and Tupaciara Private Reserves.

being rapidly replaced by intensive exploitation, accompanied by deforestation and the degradation of the natural vegetation and watercourses.

## Major Present and Future Threats

### Habitat Loss

Until recently, the major threat to the region was deforestation of the surrounding plateau. Today, however, this is a critical problem within the Pantanal itself. By 2000, the total area where the original vegetation had been removed and replaced with exotic grasses was estimated at 12,182 km<sup>2</sup> (Padovani et al. 2004). More than 40% of the forests and savanna habitats have already been altered for cattle ranching through the introduction of exotic grass species (Padovani et al. 2004). Burning—a practice to re-

new pasture and control weeds and cattle pests such as ticks—is on the increase, and frequently leads to uncontrolled fires. The effects of introduced grasses (and herbicides) are still poorly known, although reduced densities and species richness of small mammals in areas that are heavily grazed have been documented (Lacher & Alho 1989).

Conversion of natural habitats in the neighboring Cerrado has led to severe erosion, causing sediment deposition in the lowlands of the Pantanal and altering the patterns of water flow and hydrological regimes. In the last 30 years, for example, the Rio Taquari has been overflowing and permanently flooding extensive areas that previously flooded only seasonally (Fig. 1). Unsustainable development practices in the upper reaches of the rivers are creating severe and long-lasting environmental impacts and even bankruptcy for those living in the lower reaches.

## Development Projects

Large infrastructure projects also threaten the Pantanal. The Manso hydroelectric dam, completed in 2000, is the largest of the nine reservoirs in the area and has altered natural hydrological patterns throughout the basin of the Rio Cuiabá. The immediate effect on fish populations appears to have been substantial, but the long-term effects are as yet unknown (Resende 1994).

In the mid-1990s, Argentina, Bolivia, Brazil, Paraguay, and Uruguay began collaborating on the construction of the Paraguay–Paraná waterway, or *Hidrovia*. The project, supported by the Inter-American Development Bank, aims to dredge and change the course of the Rio Paraguai to allow for fluvial transport of mainly agricultural produce. Models have already indicated that the proposed changes would alter the flow of the Rio Paraguai and cause the loss of large areas of wetland in the Pantanal (Hamilton 1999), with subsequent large-scale disruption of the fragile ecological processes that determine the spatiotemporally variable mosaic of habitats so vital for the enormous wealth of wildlife. The Brazil–Bolivia natural gas pipeline will intensify the mining of iron and manganese in the Urucum Mountains in the state of Mato Grosso do Sul. As a result, projects for the installation of large steelworks and petrochemical plants are already under way. These projects will be significant sources of pollution, and their effects will pose unpredictable challenges to the Pantanal and its surroundings.

## Hunting

Hunting was a major concern in the past. Species such as the Paraguayan caiman (*Caiman crocodilus yacare*) were extensively harvested before Brazil imposed a ban in 1967. Although the state government made efforts to enforce the law, extensive caiman poaching diminished only when it coincided with a drop in the prices of skins on the international market (Mourão et al. 1996). Giant otters were hunted until they almost disappeared from the Pantanal in the late 1960s. From 1960 to 1969, records indicated a regional harvest of 12,390 giant otter skins—over 24% of the Brazilian production in that period. Currently, the population is recovering and appears to be sparking a new threat for the species: conflict with fishers (Tomas et al. 2000; Zucco & Tomas 2004). Overall, poaching pressure is not a major issue in the Pantanal. Exceptions are the jaguar and puma (*Puma concolor*), which are persecuted by cattle ranchers because they prey on cattle (Alho & Lacher 1991; Crawshaw 2002; Dalponte 2002).

## Exotic Species

Three of the world's 100 worst invasive alien species (Lowe et al. 2000) already occur in the Pantanal. The Chinese golden mussel (*Limnoperna fortunei*) and the African giant snail (*Achatina fulica*) are of major concern for biodiversity conservation, public health, and economic development in the Pantanal (Darrigan & Pastorino

2003). Feral pigs, introduced more than a century ago, are now widespread and abundant in the Pantanal, but their effects on the native peccaries (*Tayassu tajacu* and *T. pecari*) are still unknown (Mourão et al. 2002a).

Two fishes have been introduced from the Amazon basin: the tucunaré (*Cichla cf. ocellaris*) and the tambaqui (*Colossoma macropomum*). Both were released into the Rios Itiquira and São Lourenço. The tucunaré is a voracious predator, and its introduction elsewhere (in southeastern Brazil) has resulted in widespread local extinctions. Other exotic fishes are still farmed in the Rio Paraguay river basin and pose a serious threat to the fish communities of the Pantanal.

Water buffalo (*Bubalus bubalis*) were introduced to the Pantanal as an alternative to the Nelore cattle (*Bos indicus*), the most common breed of the region. At least four populations of feral buffaloes have now been established in the wetland (W.M. Tomas & G.M. Mourão, unpublished data), the Taboco marshland, the Forte Coimbra, the Rio Taquari, and the region of Ilha de Taiamã. They trample and consume vegetation along riverbanks with evident but poorly understood impacts, and the idea that water buffalo decrease the risks of jaguar predation on cattle (Hoogesteijn et al. 2002) is highly controversial.

## Pollution

Pesticides are a major threat because of the enormous areas of agricultural land surrounding the Pantanal and along the headwaters of the main rivers that feed the floodplain (Alho et al. 1988). Distilleries for producing alcohol from sugarcane produce toxic stillage that is frequently dumped in nearby streams and fields. It is a significant source of pollution, killing fish and cattle (Alho et al. 1988). Traces of pesticides from soybean plantations have been found in the Rios Taquari and São Lourenço (Mourão et al. 2002b). Mercury was used in gold mining in the Poconé region until around 1994, when the mining was forbidden, but contamination of the food web has been detected (Vieira et al. 2004).

## Current Conservation Status

Only 2.5% of the Upper Paraguai River basin is formally protected in national and state parks and in private protected areas (Fig. 1). The first protected area in the Pantanal was the Pantanal Matogrossense National Park, created with the Taiamã Ecological Station in 1981 (Table 1). The Serra das Araras Ecological Station was created in 1982, the Chapada dos Guimarães National Park in 1989, and finally the Bodoquena National Park in the state of Mato Grosso do Sul in 2000. These areas total 264,300 ha of federal strictly protected areas in the Pantanal and the surrounding Cerrado. There are five state parks totaling 245,320 ha, and two environmental protection areas with a combined area of 725,157 ha. Finally, there are five highway parks that cover a distance of 294

**Table 1. Federal and state protected areas in the Pantanal region of Brazil in the states of Mato Grosso (MT) and Mato do Grosso do Sul (MS).**

<i>Name</i>	<i>State</i>	<i>Date of decree</i>	<i>Area/length</i>
Pantanal Matogrossense National Park*	MT	1981	135,000 ha
Chapada dos Guimarães National Park*	MT	1989	33,000 ha
Taiamã Ecological Station	MT	1981	11,200 ha
Serra das Araras Ecological Station	MT	1982	28,700 ha
Águas Quentes State Park	MT	1978	1,487 ha
Serra de Ricardo Franco State Park*	MT	1997	158,621 ha
Gruta da Lagoa Azul State Park	MT	2000	12,512 ha
Aguas do Cuiabá State Park	MT	2002	10,600 ha
Dom Osório Stofell State Park	MT	2002	6,421 ha
Guirá State Park*	MT	2002	100,000 ha
Cachoeira da Fumaça Highway Park	MT	1998	20 km
Transpantaneira Highway Park	MT	1999	140 km
Santo Antônio-Porto de Fora Highway Park	MT	2000	74 km
Poconé-Porto Cercado Highway Park	MT	2000	45 km
Cuiabá-Mirante Highway Park	MT	2000	60 km
Chapada dos Guimarães State Environmental Protection Area	MT	1995	251,847 ha
Cabeceiras do Rio Cuiabá State Environmental Protection Area	MT	1999	473,410 ha
Serra da Bodoquena National Park*	MS	2000	76,400 ha
Várzeas do Rio Ivinhema State Park	MS	1998	73,345 ha
Pantanal do Rio Negro State Park*	MS	2000	78,303 ha
Nascentes do Rio Taquari State Park*	MS	2000	35,000 ha
Matas do Segredo State Park	MS	2000	178 ha
Serra de Sonora State Park*	MS	2001	7,913 ha
Prosa State Park	MS	2002	135 ha
Rio Cênico Rotas Monçoeiras State Environmental Protection Area	MS	2000	-

\*Shown in Fig. 1.

km (Table 1). These areas were established opportunistically and protect only a fraction of the diversity of the upper Paraguay River basin fauna and flora. Some areas of unique landscape features are still poorly protected, such as the brackish and freshwater pools of Nhecolândia.

Cattle ranching has long been the predominant human activity in the Pantanal, and the rich and abundant fauna has persisted in large part because of the low human population and the lack of hunting (Alho & Lacher 1991). Feral pigs are hunted as an alternative source to beef, diverting the hunting pressure from native species. A more intensive use of the Pantanal habitat has been limited by cultural factors (the traditional way of raising cattle) and the lack of technology and low capital input. Until recently, agriculture was limited in its extent because of the seasonal flooding, resulting in the preservation of vast areas of natural habitats (Alho & Lacher 1991). This situation is changing rapidly, however, with cattle ranching becoming increasingly competitive and intensive and irrigated agriculture spreading inside the floodplain.

### Major Conservation Initiatives

The Brazilian Agricultural Research Corporation (Empresa Brasileira de Pesquisa Agropecuária [Embrapa]) established a research center in the Pantanal in the mid-1970s (Embrapa Pantanal), focusing on alternatives and strategies for the sustainable development of the region. Besides its support for the principal economic activities of the region, over the years it has made enormous contri-

butions to our understanding of the ecological dynamics and conservation of the floodplain, besides wildlife and fish management and monitoring. Long-term research on the ecology of the Paraguayan caiman, for example, supported the removal of the species from the U.S. Endangered Species Act (Mourão et al. 2000). This allowed for the export of skins of caimans bred on ranches in the Pantanal. In the face of increasing threats from industry and potentially prejudicial changes in land use, in 1997 the Ministry of the Environment set up the Program for the Sustainable Development of the Pantanal—Pantanal Program to improve the sustainability of resource use in the upper Rio Paraguai basin, directly or indirectly affecting approximately 80 municipalities, and 39 Indian villages (MMA 1997). Although as yet incipient, components of this program include research and measures directly related to protected areas, urban environments, sustainable economic activities, and the management of hydrographic basins. A collaborative venture between the federal government and the state governments of Mato Grosso and Mato Grosso do Sul, it was formally implemented in 2001, and financed by the Brazilian government, the Inter-American Development Bank and the Japan Bank for International Cooperation.

A Government Center for Conservation Data focusing on species and ecosystems in the Mato Grosso was established in 1989 with the support of the World Wildlife Fund and The Nature Conservancy, to support conservation planning for the Pantanal in the Upper Paraguai river basin (Brito et al. undated). This resulted in Law

5993 of 1992, which indicated 19 priority zones for environmental conservation in the region. The incentives for the implementation of this law came later, in 1993, with the establishment of the Mato Grosso State Program for Environmental Development and the creation of 10 state-protected areas in the Mato Grosso portion of the Upper Paraguai river basin (Table 1).

In 1998 the government-sponsored Cerrado-Pantanal Conservation Priority-Setting Workshop (Fundação Pró-Natureza et al. 2000) resulted in the delineation of an initial corridor design for the Pantanal. This addressed the need for a more extensive and connected protected area system and later supported the creation of two state parks (Rio Negro and Nascentes do Taquari) and a national park (Serra da Bodoquena) in Mato Grosso do Sul. In collaboration with the U.S. Agency for International Development and in partnership with local organizations, Conservation International has embarked on an initiative to establish a biodiversity corridor that links the Pantanal and the Cerrado, covering 800 km from the swamps of the Pantanal's Rio Negro to the cerrado of Emas National Park in Goiás.

Two projects with flagship species in the Pantanal deserve mention. Since 1991, the Hyacinth Macaw Project has been monitoring the populations of this species and conducting environmental education initiatives for local communities. The Hyacinth Macaw population has begun to recover since the project began and is currently estimated at 5000 individuals in the wild (Guedes 2002). The second is the Jaguar Conservation Fund, a project promoting environmental awareness among local communities and providing compensation to ranchers from cattle losses. For the first time ranchers are coming to accept recovery of the jaguar population, and at least those engaged in tourism now recognize the potential of the species as a source of income. Benefiting from federal and state legislation, numerous landowners have already protected 2618 km<sup>2</sup> of the Pantanal, and the creation of the Private Protected Areas Association (REPAMS) in 2002 will further stimulate what is seen as a most important tool for the conservation of the region. The change in attitudes of the cattle ranchers in the Pantanal exemplifies the gradual increase in the participation of the private sector. The prospects are far from optimistic, however, the continuous engagement of the private sector in addition to effective government actions are necessary measures to ensure both conservation and the sustainable economic use of the land.

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