Information Sheet on Ramsar Wetlands

1. Date this sheet was completed/updated: July 2000

2. Country: Nicaragua

3. Name of wetland: Río San Juan Wildlife Reserve

4. Geographical coordinates:

10º 09' 56" - 10º 58' 38" North latitude
83º 46' 38" - 84º 20' 25" East longitude

This wetland is defined by boundaries that begin at Río Bartola at 10º 58' 22" North latitude and 84º 20' 25" West longitude. The boundary continues downriver along Río San Juan on the shore that marks the border with Costa Rica to the Caribbean Sea at 10º 55' 56" North latitude and 83º 40' 02" West longitude. At this point, it continues north along the coast to 10º 09' 56" North latitude and 83º 50' 50" West longitude until meeting the Río San Juanillo at 10° 56' 28" North latitude and 83° 44' 53" West longitude. It then follows the edge of the wetland until reaching Lake Sílico at 10º 51' 58" North latitude and 83º 44' 53" West longitude and then along the contour line of 10 metres above sea level until reaching 10º 48' 50" North latitude and 83º 43' 58" West longitude. It then continues southwest, two kilometres from Río San Juan, along the southern bank of Río Bartola until 10º 58' 38" North latitude and 84º 20' 22" West longitude (where this description began) (MARENA, 1999).

5. Altitude: 20 metres above sea level

6. Area: 43,000 hectares

7. Overview: The Río San Juan Wildlife Reserve forms part of one of the two largest, best-preserved biological nucleuses of the Mesoamerican Biological Corridor and forms one of the most important wetlands in Central America because it is the final stage of the largest water basin in Central America on a low fluvial-marine plain with average elevations of 20 metres above sea level and slopes of less than 0.5 per cent. Its landscape is morphological deltas, low river dikes, marshes and beach bars, all moderately well-to-poorly drained. This combined with high precipitation in the area results in the soil remaining saturated with water.

The lacustrine complex is made up of several lakes that are interconnected by a multitude of small ponds through a tangled system of rivers that downstream supply the basin of freshwater populations and life cycles. All these bodies of water drain very slowly into Río San Juan, which then empties into the Atlantic Ocean. These characteristics are the logical consequence of the gradual slope of Río San Juan,

which begins in Lake Nicaragua at an altitude of 32 metres and flows for 200 kilometres until reaching Bahía de San Juan del Norte at sea level and then the Caribbean. At the point where the sea and freshwater join is one of the most productive ecosystems: the mangroves whose function and permanence are key to the stability of the life cycles of many aquatic species.

8. Wetland type: The Río San Juan Wildlife Reserve has a large variety of habitats, both marine/coastal and inland:

Marine/coastal wetlands: (In order of increasing importance)

K: Coastal freshwater lagoons; includes freshwater delta lagoons

A: Permanent shallow marine waters in most cases less than six metres deep at low tide; includes sea bays and straits

F: Estuarine waters; permanent water of estuaries and estuarine systems of deltas

H: Intertidal marshes; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes

I: Intertidal forested wetlands; includes mangrove swamps, nipah swamps and tidal freshwater swamp forests

E: Sand (guijarros), shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks

Inland wetlands (In order of increasing importance)

O: Permanent freshwater lakes (more than eight hectares); includes large oxbow lakes

M: Permanent rivers/streams/creeks

Y: Freshwater springs

Tp: Permanent freshwater marshes/pools; ponds (fewer than eight hectares), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season

W: Shrub-dominated wetlands; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils

Xf: Freshwater, tree-dominated wetlands; includes freshwater swamp forests, seasonally flooded forests, wooded swamps on inorganic soils

U: Non-forested peatlands; includes shrub or open bogs, swamps, fens

L: Permanent inland deltas

Sp: Permanent saline/brackish/alkaline marshes/pools

9. Ramsar criteria: 1, 2, 3, 4, 5, 7 and 8

Criteria that best characterize the site: The most significant criterion is criterion 1 because this wetland plays an important hydrological, biological and ecological role in the natural functioning of a water basin because of its diversity of preserved habitats with a rich biodiversity in excellent conservation status, including species that are vulnerable or endangered at other sites. It has a special value as habitat for plants and animals during critical periods of their life cycle. In addition, this wetland serves as a biological corridor because it is a cross-border site between protected areas in two countries and protects the survival of its inhabitants. Furthermore, this wetland is an example of the harmonious relationship between a wetland and fishing traditions in the area, which contribute significantly to the economic and social development of the local communities.

10. Map of site included? Please tick yes -or- no

11. Name and address of the compiler of this form:

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12. Justification of the criteria selected under point 9, on previous page: The wetland is considered of international importance because:

Criterion of representative wetlands

Criterion 1. Migratory marine species are of special importance because of the economy of the communities surrounding Río San Juan. Brackish water flows through this refuge to the freshwater lake. There are several species of fish: *tiburón toro* (*Carcharinus leucas*), tarpon (*sábalo real*) (*Tarpon atlanticus*), sea bass (*róbalo*) (*Centropomus parallelus*) and *gaspar* (*Antractosteus tropicus*), which provide food for the human populations that live there.

The natural functions of the Río San Juan Wildlife Refuge are also of great importance. This is the youngest geological area in Central America, functioning as an evolutionary bridge for the continent's fauna and flora. Its ecological importance lies in its diversity of ecosystems and habitats, forming part of one of the largest humid tropical ecosystems in Central America (Amigos de la Tierra, 1999).

This wetland plays a hydrological role of great importance by the fact that it is located at the mouth of a large river basin that allows this area to gather most of the sediments and nutrients from the two countries that share this basin. Likewise, the wetland acts as a regulator of streams, controlling flooding and extracting pollution from the water. It provides drinking water and a refuge for diverse wildlife and offers opportunities for transportation for several purposes (INETER, 1990).

Its ecological and biological importance is based on its wild state, which is important for two reasons, which reflect the diversity of the natural resources present: the diversity of ecosystems and species. This reserve still maintains natural resources in an excellent conservation status, although there are several natural spaces in regeneration because of previous human intervention (Amigos de la Tierra, 1999). Taking into account these considerations, we can deduce that the wetland is an especially good representative example because it plays an important hydrological, biological and ecological role and especially because it is cross-border.

General criteria based on fauna and flora

Criterion 2. Many of the terrestrial and aquatic species that are found in this wetland can be considered as the basis for its importance. Among them are fish such as the *tiburón toro* (*Carcharinus leucas*), tarpon (*sábalo real*) (*Tarpon atlanticus*), sea bass (*róbalo*) (*Centropomus parallelus*) and *gaspar* (*Antractosteus tropicus*) as well as large mammals such as the white-lipped peccary (*chancho de monte*) (*Tayassu pecari*), Baird's tapir (*Tapirus bairdii*), American manatee (*Trichechus manatus*), jaguar (*Panthera onca*) and giant anteater (*Myrmecophaga tridactyla*). Among the birds, there are the American harpy eagle (*Harpia harpyja*) and *pájaro campana* (*Procnias tricarunculata*) and two species of macaws considered to be endangered: the scarlet macaw (*Ara macao*) and Buffon's macaw (*Ara ambigua*). It is also important to mention the presence of sea turtles: the hawksbill turtle (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*), green turtle (*Chelonya mydas*) and loggerhead (*Caretta caretta*); all endangered species (Zúñiga et. al., 1996).

Among the local vegetation that justify the site's importance are communities of epiphytes, such as the orchids and bromeliads, as well as several palms and Araceae. It is important to mention large trees species sought after for their ecological and economic value, such as: *Carapa guianensis, Dipterix panamensis, Ficus* sp., *Manilkara zapota, Pentaclethra macroloba, Pterocarpus officinalis, Simarouba* sp., *Tabebuia* sp. and *Terminalia* sp.

This wetland sustains a diversity of important fauna. In a preliminary survey, 303 species of birds (24 migratory), 26 mammals, 15 reptiles, 3 amphibians and 61 species of insects were recorded. In addition, seven marine crustaceans and two freshwater species have been identified (Amigos de la Tierra, 1999). Just the presence of species extinct in other parts of the world justifies protection of many wildlife reserves in the world. An international agreement, ratified by Nicaragua in 1977 (La Gaceta, Diario Oficial No. 183), obliges us to take into account the species identified in the Appendices Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and regulate their trade. In this wildlife refuge, there are 46 of these species in significant numbers.

Criterion 3. Because it is a wildlife area in excellent conservation status and natural quality, this wetland has special importance for conservation of genetic and ecological diversity. It is of special importance for species endemic to Central America in general and the basin of Río San Juan in particular, such as the populations of orchids that are found in the area. Many of these orchids are endemic to the virgin forests of Central America, for example, *Epidendrum circinatum*, *E. hawkesii, Gongora* sp., *Maxillaria dresleriana* and *Stanhopea ecornuta* (Díaz, 2000).

Criterion 4. For migratory species, this wetland is of special importance as a habitat during a critical period of their life cycles, primarily because it provides sites for dispersion and reproduction for many species of fish and crustaceans that live there. A clear example is the lobster (*Panalirus argus*), which emigrates along the coast north of the wetland (the Caribbean coast) until reaching the continental platform at San Juan del Norte in search of breeding areas (Robleto, 1996). The wetland also provides refuge and feeding for a considerable community of migratory birds from North America. Up until now, a total of 22 species of marine birds have been identified, some of which remain in these ecosystems until their departure (Zúñiga et al., 1996).

Specific criteria based on waterfowl (It is important to mention that although there are still no studies that quantify these criteria, recent observations in field surveys support the veracity of these criteria.)

Criterion 5. Although there are no studies that support this criterion, it is known through rapid environmental assessments made in the area that the marine bird populations are stable, with a large expected variety of species still not surveyed. Among the most common marine bird populations are the *pato aguja* (*Anhinga anhinga*) and *pato chancho* (*Phalacrocorax olivaceus*). Kingfishers are also very common along the rivers. There are four species of kingfisher in the area: *Ceryle alcyon, C. torquata, Chloroceryle amazona* and *C. americana.* One species, *Chloroceryle inda,* has not yet been recorded, but it has been reported in southeastern Nicaragua, the northern limit of its distribution. Herons are very common in many bodies of water in the reserve. Among them are the *garceta azul* (*Egretta caerulea*), great egret (*Casmerodius albus*), *garza blanca pequeña* (*Egretta thula*) and *garza morena* (*Ardea herodias*) (a migratory bird). Two especially picturesque species are the *patito de agua* (*Heliornis fulica*) and Muscovy duck (*pato real*) (*Cairina moschata*). The swallows (*Tachicyneta albilinea* and *Notiochelidon cyanoleuca*) are migratory and are present along Río San Juan (Zúñiga et. al., 1996). This wetland regularly sustains a significant number of specimens of certain groups of aquatic birds such as those described earlier.

Specific criteria based on fish

Criterion 7. Preliminary results obtained through a rapid environmental assessment of the diversity of fish resources identified 32 species of fish and crustaceans in eight families that contribute to the world's biological diversity (Robleto, 1996). In this reserve, there is the freshwater shrimp *Macrobrachium carcinus*, which is one of the largest species of freshwater prawn in the world. As a result, it has a great export potential that is still little exploited. It reproduces in brackish waters and migrates for growth to several riparian environments. Until now, four species of Caribbean shrimp

(*Panaeus* spp.) have been identified, which also reproduce in the brackish waters of the mangroves in this reserve and serve as food for the local inhabitants. This exploitation still has little impact on the conservation status of the reserve. However, future population trends are alarming and could begin to have a negative impact on the wetland (Amigos de la Tierra, 1999).

Criterion 8. Among the migratory species that are captured during several months of the year in San Juan del Norte are sea bass (*róbalo*) (*Centropomus parallelus*), lobster (*Panalirus argus*), *calvas* (*Centropomus pectinatus*), *tiburón toro* (*Carcharinus leucas*), tarpon (*sábalo real*) (*Tarpón atlanticus*) and *gaspar* (*Antractosteus tropicus*). These species use Río San Juan as a migration route (Amigos de la Tierra, 1999).

13. General location: This wetland is located in the extreme south-eastern part of Nicaragua, bordering on Costa Rica. Administratively, the Río San Juan Wildlife Reserve forms part of the department of Río San Juan and the Región Autónoma Atlántico Sur (RAAS). This refuge is located in parts of three municipios: San Juan del Norte, El Castillo and Bluefields, of which two belong to the department of Río San Juan–the municipio of San Juan del Norte (85.67 per cent) and the municipio of El Castillo (13.21 per cent). Likewise, it is in a small portion of the municipio of Bluefields (0.67 per cent), belonging to the RAAS. These percentages have been calculated including the offshore strip of three nautical miles in the Caribbean (Amigos de la Tierra, 1999).

In the Río San Juan Wildlife Reserve, near the mouth of Río Indio, San Juan del Norte is the only populated centre within the refuge with a total population of 967 rural and urban inhabitants (INIFOM, 1998 in Amigos de la Tierra, 1999).

14. Physical features:

Geology: In terms of geology, this area belongs to the part of the continent that emerged relatively late. This determines not only its young geological origin but also its special biological richness. In general terms, its relief is rather flat because of tectonic orogenesis and its recent geological formation, emerging from the depression of Lake Nicaragua in the Quaternary. This area is the result of one of the last movements of the continental plates and is covered with volcanic material and fluvial-lacustrine sediments from the Quaternary (CATIE-UAW-MAG, 1995). According to the soil study of the Southeast by the Office of Land Registry and Natural Resources (Catastro, 1978 in INETER, 1990), there are the following four main geological formations:

(a) A colluvial-fluvial formation on the Atlantic coastal plain and to the north and south of El Castillo;
(b) The Machuca formation of sedimentary rocks from the Eocene Tertiary to the east of El Castillo and north of San Juan del Norte in the basins of the Indio and Maíz rivers;
(c) An undifferentiated pyroclastic and lava formation of volcanic rock from the Tertiary in a small area of the basin of the Río Indio (Cerro El Diablo) and the area of Río San Juan;
(d) The Pre-Machuca Eocene formation from the Tertiary of sedimentary rocks in the sector of Tambor Grande and Cerro El Diablo.

Geomorphology: From the point of view of geomorphology, this wetland is dominated by areas of fluvial origin. In addition, there are several low hills and coastal areas (Amigos de la Tierra, 1999). Because of the origin of the land in the Río San Juan basin, many of the observations that explain the origin of the Norte region of Costa Rica are applicable to the origin of the land in the Río San Juan Wildlife Reserve. Thus, in the middle Río San Juan there are sedimentary and volcanic rocks from the Tertiary, formed by marine and several continental sediments with alternations of volcanic rocks of the Machuca formation from the Oligocene. There are also sedimentary rocks from the Pliocene-Pleistocene that include materials of great heterogeneity in size and nature. These rocks are formed primarily by colluvial-alluvial and fluvial-lacustrine materials from the Pleistocene. The colluvial-alluvial material appears in the form of raised terraces. The Programa Zona Atlántica de Costa Rica (1995) identified two geomorphologic units: in the area of the Río San Juan Wildlife Reserve, alluvial fans, recent fluvial plains, Pleistocene dissected fluvial floodplain and in coastal areas, coastal bars and marshes (bogs) (CATIE-UAW-MAG, 1995).

Origin of the wetland: Natural

Hydrology: The Río San Juan Wildlife Reserve is a large hydrological network formed by the lower parts of the Nicaraguan basin of Río San Juan, the largest water basin in Central America. The most important hydrological characteristic of this area is the presence of Río San Juan, which begins in the extreme south-eastern part of Lake Nicaragua and empties into the Caribbean Sea, forming a shifting delta. Another series of wetlands runs parallel to the lower part of Río Indio joining with the *yolillales* of Río Colorado (Costa Rica) in the Río San Juan delta. There are two basic hydrological components that influence this reserve: Río San Juan and the Caribbean Sea. In addition, there is the system of lakes Ebo and Sílico and several smaller lakes, whose extraordinary beauty creates one of the most important ecological and scenic values of the area (Amigos de la Tierra, 1999).

Hydrological balance (annual averages) and total runoff of Río San Juan

Basin	1 Precipitation		2 Evapotranspiration			3 Total runoff (EST)			4 Infiltration		
	mm/y	$10^6 m^3/y$	mm/y	% P	$10^6 m^3/y$	mm/y	% P	$10^6 m^3/y$	mm/y	% P	$10^6 m^3/y$
R.S.J	1,860	55,472	924	50 %	27,557	780	42 %	26,262	156	8 %	4,652

Observations:

1 Average annual precipitation (INETER–IRENA)
2 Average annual real evaporation (INETER–IRENA)
3 Total runoff calculated on the basis of infiltration
4 Average annual infiltration, estimated from geomorphological, climatological and geological data.
I Infiltration
EST Total runoff
ETR Real evapotranspiration
P Average annual precipitation in millimetres per year
% P Coefficient of infiltration (considered inversely proportional to the precipitation)

Types of soil and depth of the water table: INETER (1990) carried out a survey of soil types in the area surrounding San Juan del Norte and on the edges of Río San Juan about 104 kilometres from San Carlos up to the two mouths on Río Indio, making the following observations.

Place	Texture	Colour	Depth of the water table (cm)
Viejo San Juan del Norte	sandy	brown	80–100
Nuevo San Juan del Norte (bank of the Río Indio)	sandy	brown	85–100
Dos Bocas (Río Indio)	Silty clay	grey	30
Boca del Sarapiquí	clay	brown	--

Supply and drainage of water: The average volume of Río San Juan is estimated at 1308 cubic metres/second at the mouth of Río Sarapiquí to which the contribution of Lake Nicaragua at the origin of Río San Juan is approximately 475 cubic metres/second. That volume increases up to the mouth of Río Sarapiquí to 833 cubic metres/second. Of the 833 cubic metres/second, 85 per cent (708 cubic metres/second) are supplied by the Costa Rican basins and the remaining 15 per cent (125 cubic metres/second) originate in Nicaragua.

The Río San Juan subsystem has an annual runoff in seasons of low water, from February to April, of 106 millimetres and a maximum of 295 millimetres in July and August. These values have been estimated based on precipitation and by extrapolating runoff to estimated areas. The volume increases considerably in Río Sarapiquí, reflecting the contribution of the large rivers of San Carlos and Sarapiquí. The maximum average monthly flow is almost three times the average minimum monthly. About 67 per cent of the volume is created in the portion of the basin between the stations of El Castillo and Sarapiquí and 74 per cent between San Carlos and Sarapiquí. In this part, runoff reaches 2400 millimetres, which indicates that average precipitation should be between 3600 and 3900 millimetres (OAS/UNEP, 1997).

Soils types and chemical characteristics: The soils in the region are characterized by their acidity, clay texture and low fertility. According to a study made by IRENA (1992 in Amigos de la Tierra, 1999), soils in the region can be divided into 11 types. The dominant types of soils (78 per cent of the area) are:

> Type A – *Vertic tripaquerps*: Deep with imperfect drainage, slopes between 0 and 4 per cent, medium to low fertility. They are found in 8 per cent of the region.
>
> Type D – *Dystropeptic tropodults*: These are deep, well-drained soils, with slopes between 2 and 15 per cent, with a moderate to strong degree of erosion and medium to low fertility. They cover 17 per cent of the area.
>
> Type E – *Typic tropodults* and *Typic tropohumults*: Deep or very deep well-drained soils, whose slopes vary between 15 and 50 per cent, with medium to low fertility. They cover 53 per cent of the region.

This study identified various levels of soil erosion through photo interpretation, finding light erosion in 48 per cent of the area in the form of laminate erosion and moderate erosion in 7 per cent of the soils in areas with slopes of 25 to 70 per cent. Finally, severe erosion (formation of furrows or rills) was identified in 18 per cent of the total area studied.

Water quality (physical and chemical characteristics)

Analysis of the water in the Río San Juan subsystem							
River	pH	Conductivity (μs/cm)	Turbidity (UNT)	STD	Iron	Total phosphorous	Hardness
Left bank of Río San Juan							
Melchora							
(a)	8.25	392	A	284.47	0.36	0.046	151.45
(b)	7.99	284	160	197.64	0.73	0.033	90.10
Bartola							
(a)	7.68	104	A	78.41	0.27	0.027	37.00
(b)	8.04	233	260	157.46	1.02	0.023	70.05
Right bank of Río San Juan							
Sarapiquí							
(a)	7.45	159	200	95.54	2.96	0.060	62.65
(b)	8.01	209	180	141.45	1.14	0.035	62.65
Delta							
(a)	7.63	166	400	117.09	4.46	0.076	52.05

Source: Report on the Physical-Chemical Characteristics of the Water of Río San Juan and Its Tributaries (CIRA/UNAN, 1994 in INETER, 1990).

( ) Sampling points; A: Abnormal data; Units of dissolved solids, iron, total phosphorous and hardness in mg/l.

INETER (1990) carried out a study of water quality with analysis physical and chemical characteristics. For this purpose, water samples were taken at two sites of interest: Point 1 - Well in the former San Juan del Norte and Point 2 - Río Indio (Current San Juan del Norte)

The following results were obtained.

Parameter	Point 1	Point 2
pH	7.03	6.40
(K) Potassium	9.00 mg/1	0.80 mg/1
(Na) Sodium	7.70 mg/1	5.00 mg/1
(Mg) Magnesium	2.61 mg/1	1.31 mg/1
(Ca) Calcium	28.85 mg/1	2.15 mg/1
(Fe) Iron	2.06 mg/1	0.98 mg/1
(NO_3) Nitrate	0.84 mg/1	0.84 mg/1
(NO_2) Nitrite	0.62 mg/1	0.05 mg/1
(Cl) Chlorine	7.71 mg/1	7.71 mg/1
(F) Fluor	0.01 mg/1	0.01 mg/1
(SO_4) Sulphate	1.16 mg/1	1.17 mg/1

(HCO_3) Bicarbonate	104.16 mg/1	14.22 mg/1
Conductivity	203 microhms	48 microhms
Dissolved solids	161.72 mg/1	34.28 mg/1
Total hardness	75.25 mg/1	10.75 mg/1
Alkalinity	85.35 mg/1	11.65 mg/1
Boron	0.05 mg/1	0.05 mg/1
Turbidity	27 UNT	18 UNT

Fluctuations in water level and permanence of water: Fluctuations in the water level are almost imperceptible in Río San Juan in the wetland. But there is a moderate difference in the flow of Río San Juan, primarily when compared with the dry season (March-May) and with the period of greatest rainfall in the area (October-December). Water always remains in the wetland because runoff is slow because of the bad drainage in the area, and the difference in altitude from one extreme to the other of the wetland (from west to east) is 32 metres in almost 200 kilometres.

Tidal regime of San Juan del Norte: The data provided are from July 1999 to December 1999 and from July 2000 to December 2000 (see annex 2, Mareas de San Juan del Norte 1999–2000).

The catchment area is 38,500 square kilometres. Because it is located at the mouth of a large water basin, this small refuge collects most of the sediments and nutrients of two neighbouring countries, including the force of the flow of the tributaries.

Runoff basin (especially in the case of important wetlands in controlling flooding): The real importance of wetlands, like that protected in this reserve, is regulation of streams, flood control, capturing of sediments, extraction of pollutants from the water, a source of food and natural products, supply of drinking water and a refuge for wildlife. The tributaries of Río San Juan are shared in two countries: those belonging to the Nicaraguan side that supply 15 per cent and those belonging to the Costa Rican side, which rise to elevations of up to 3,000 metres above sea level, with large drainage areas that supply approximately 85 per cent of the total volume of Río San Juan.

The following is a presentation of the lengths of the main tributaries of the Río San Juan basin on the Nicaraguan and Costa Rica sides. It is important to mention that little information was obtained about the tributaries in Costa Rica, although they supply 85 per cent of the flow.

BASIN R.S.J (Nicaragua)		BASIN R.S.J (Costa Rica)	
Tributary	Length (km)	Tributary	Length (km)
Río San Juan	180	Infiernito	12
Río Bartola	21	Crucitas	9
Trinidad	10.4	Río San Carlos	63
Agua Fresca	5.1	Cureñita	10
Las Cruces	7.2	Copalchi	18
El Sarnoso	10	Río Sarapiquí	60

San Francisco	8	Marías	30
Tambor	8	Tigras	8
Tamborcito	3.5		
La Danta	12		
La Tigra	5		
San Juanillo	47		
Río Indio	70		
Total	387.2		210
Total length of tributaries to the basin: 597.2 kilometres			

Climate: Perhaps the most important characteristic of the Río San Juan basin is its high rainfall. In the distance that separates Lago Cocibolca from the sea, precipitation suddenly increases enormously from west to east from 1,400 to 6,300 millimetres of annual precipitation at San Juan del Norte. This region has a wet tropical climate. The rainy season is from May to January, and the dry season varies from three to four months, between February and May, with a minimum of rains in March (Amigos de la Tierra, 1999).

Winds: Winds normally blow from north to southeast. The strongest winds occur between December and February. Relative humidity in the rainiest months is between 90 and 95 per cent, and in the months of less rain it is above 60 per cent. Average temperatures are hot and range between 24° and 27º C, with the monthly average varying by less than 3º C, without changing the pattern of the average temperature (Amigos de la Tierra, 1999).

15. Hydrological values:

The environmental factors that probably most influence the exuberant conditions in this reserve are topography and humidity. This is the part of Nicaragua where rainfall is heaviest. It rains practically all year round. Furthermore, it is in the part of the country of least altitude in the final part of the largest water basin in Central America (38,500 square kilometres). Both factors promote frequent flooding and severely restrict the farming potential of this area (Amigos de la Tierra, 1996).

It is important to mention the role played by the basin in capturing sediments, some pollutants and nutrients from the two countries that share its basin. At the same time, the basin regulates surges and controls flooding. Supplying drinking water is also important for wildlife.

In addition, the extraordinary beauty of Sílico and Ebo lakes and several other smaller lakes constitutes one of the most important scenic advantages that make this reserve attractive for tourism and for migratory birds that stop here, connecting these wetlands with others on their migratory route.

The importance of underground freshwater water pressure that circulates through this opening should not be ignored. It prevents salt water from intruding into the aquifers in the area. Restriction of the mouth of Río San Juan also decreases that

water pressure, which could invert the salinity gradient in relation to the underground drinking water available for humans at San Juan del Norte, which is at only one metre in depth (Amigos de la Tierra, 1999).

16. Ecological features:

The reserve is itself a real laboratory because of its rich biodiversity, a result of the concentration of migrations of wildlife from North America and the Amazon, and because it is the youngest region on the Central American isthmus (Saravia, 1996 in Amigos de la Tierra, 1999). Its condition as a biological bridge for the region has led to a high potential for a large biodiversity in the rich natural aquatic and terrestrial ecosystems.

Distribution of the ecosystems in the wildlife reserve depends on the relationship between rainfall and drainage in this sedimentary soil, including some marine influence, as well as specific geographical aspects of a transitional ecosystem and wetland (Amigos de la Tierra, 1999).

The ecosystems observed in the Río San Juan Wildlife Reserve are the following:

Lowland tropical rain forest, IA1a, “lowland forest”
Submontane tropical rain forest, IA1b, “upland forest”
Tropical rain forest of dicotyledons, IA1h (1), “lowland forest”
Tropical rain forest of palms, IA1h (2), “*yolillal*”
Alluvial riparian tropical rain forest associated with areas of freshwater, IA1f(1), “gallery woodlands”
Alluvial tropical rain forest, occasionally flooded, IA1f(2), “Gallery woodlands”
Alluvial tropical rain forest, seasonally saturated, IA1f(3), “Gallery woodlands”
Flooded wooded savannah, VA1e(1), “*llanos*”
Floating predominantly herbaceous grasslands, VIIA1, “*gamalotales*”
Marsh of Cyperaceae, mosses and similar with peat, VD1
Mangrove, IA5, “mangrove”

Classification of these ecosystems is based primarily on criteria of plant composition in the area and presence of several indicators of special environmental conditions (Ellenberg and Mueller-Dombois, 1974). Ecosystems in the Río San Juan Wildlife Reserve are visibly characterized by the following.

Lowland tropical rain forest, IA1a, “lowland forest”: Composed of numerous species of rapid-growth trees, some exceeding 50 metres in height, usually with smooth bark and tabular roots. Undergrowth is scarce and is made up of predominantly small replacement plants. The palms, shrubs and lianas are almost totally absent, although there are pseudo-lianas (plants that germinate in branches and later take root in the ground). Crustose lichens and blue-green algae are the most frequent life forms of epiphytes. Vascular epiphytes are less abundant. In the lowlands, vascular epiphytes are abundant where there is fog, for example near the coasts.

Submontane tropical rain forest, IA1b, “upland forest”: The growth of trees is similar to the previous case. The undergrowth is where there is the largest number

of herbaceous life forms. The most important difference is the greater frequency of vascular epiphytes.

Tropical rain forest of dicotyledons, IA1h(1), "lowland forest": This type has surface deposits of organic material, is poor in species and has a canopy at fewer than 20 metres. The trees are slow growing with small diameters and commonly with neumatophors and stilt roots. The broadleaf species are dominated by dicotyledons.

Tropical rain forest of palms, IA1h (2), "*yolillal*": Similar to the previous but with dominance of palms with neumatophorous shoots.

Alluvial riparian tropical rain forest associated with areas of freshwater, IA1f(1), "gallery woodlands": This type is located on the lower part of the riverbanks, often flooded. Dominated by trees of rapid growth, the herbaceous plants are almost absent in the undergrowth and there are rare epiphytes; poor in number of species.

Alluvial tropical rain forest, occasionally flooded, IA1f(2), "gallery woodlands": These are located on active high dry river terraces, similar to the life forms common in tropical alluvial rain forests, but with more epiphytes and many lianas.

Alluvial tropical rain forest, seasonally saturated, IA1f(3), "gallery woodlands": Located along rivers where water accumulates in wide plains for several months, there are trees with stilts. The canopy is not uniform, and undergrowth is poor, except in clearings.

Flooded wooded savannah, VA1e(1), "*llanos*": Periodically flooded in several patterns of mosaic with palms or groups of trees on the highest places.

Floating predominantly herbaceous grassland, VIIA1, "*gamalotales*": Made up of rooted or floating plants that tolerate or need a layer of water on the soil constantly or for a large part of the year. Densely interwoven grasses and mosses permanently covering accumulations of freshwater. Most of the Spermatophytes are heliophytes and not true aquatic plants. They are dominated by Cyperaceae or rhizomorph grasses. Camephytes and Spermatophytes can also be found.

Marsh of Cyperaceae, mosses and similar with peat, VD1: Open formations on land constantly or almost always flooded, with or without a few woody plants. Dominated by seasonally flooded Cyperaceae (gramineous, hemicryptophytes or geophytes).

Mangrove, IA5, "mangrove": Mangroves are found in the intertidal area and are composed almost entirely of trees and broadleaf evergreen sclerophyllous shrubs with stilt roots or neumatophors. Epiphytes are rare, except lichens on branches or algae attached to the lower parts of trees.

After determining the characteristics of the various areas included in the Río San Juan Wildlife Reserve and defining the most appropriate form of its distribution, we can observe that the zonification proposed in the management plan of that area is not defined only by aspects of the distribution of ecosystems. This can be explained by the fact that until now distribution of those ecosystems within the area was

unknown. For this reason, only a level of ecosystems of mangrove, *yolillal*, aquatic network, forest, riparian forest or marine coast have been used.

With additional information gathered in the field, we can now use new criteria to identify the following areas, which earlier were considered homogeneous (Díaz, 2000).

Area 1. Bahía de San Juan del Norte, with mangroves and vegetation in areas permanently flooded with brackish water, made up of open forest and vegetation with three strata. In sites where the soil is firmer, there is *Pterocarpus officinalis* within the tree stratum. The shrub stratum is dominated by *Montricardia arborescens*, and the herbaceous vegetation is made up of aquatic plants. These sectors are surrounded by *gamalotales*, and the bay is permanently flooded and slope is imperceptible.

Area 2. Caño El Cedro apparently forms the line of transition between the wetlands of San Juan del Norte and seasonally flooded forests with timber-producing species with a canopy of more than 20 metres. The forest is closed with an abundance of epiphytes primarily of the Araceae family. In this sector, the lowland forests of the Río San Juan basin begin with dominance of *Pentaclethra macroloba* in the sub-canopy and palms in the undergrowth. These areas are seasonally flooded and of sedimentary origin and slope is imperceptible.

Area 3. *Yolillales* along Río San Juan are formed by small patches of open forest formed mainly by *yolillos* scattered about in the lowland rain forest of Río San Juan. These areas are covered almost exclusively with *Raphia taedigera*. However, there are dispersed specimens of *Pentaclethra macroloba* in the tree stratum. In the shrub stratum, there are several scattered specimens of *Cyclanthus* sp. and *Tabernaemontana* sp. Among the herbaceous species, there are primarily *Dieffenbachia* sp. and *Spathiphyllum* sp, with several open areas dominated by Gramineae. These sites are seasonally flooded and are of sedimentary origin and unconsolidated substratum with imperceptible slope.

Area 4. *Yolillales* in the area of San Juanillo are formed by closed seasonally flooded forest with emergent trees (*Prioria copaifera*) and undergrowth dominated by trees in the genera *Tabernaemontana* and *Morinda citrifolia*. Herbaceous vegetation and epiphytes are not very abundant. These sites form a strip of sometimes flooded sedimentary land on unconsolidated substratum and with imperceptible slope.

Area 5. Permanently flooded *yolillales* to the west of San Juan del Norte, which are large areas of closed forest composed almost homogeneously of *Raphia taedigera* with several very dispersed specimens of other tree species.

Area 6. Tidelands of Río Indio, Caño El Pescador and Top House, composed of closed forest with a dominance of a canopy of *Raphia taedigera*. At several sites, the undergrowth has predominantly *Manicaria saccifera*. At other sites, there is *leche maría* (*Calophyllum brasiliense*) in relatively high densities, accompanied by *Symphonia globulifera* and *Pterocarpus officinalis*. At these sites, there are large areas for conservation of tidelands.

Area 7. The area around lakes Ebo and Sílico is permanently flooded with sediments and unconsolidated substrata. The area is formed by an open forest that includes a mosaic of ecosystems related to conditions of flooding. The vegetative cover includes *gamalotes*, *yolillos* and permanently flooded forests with scattered low trees with an impressive vascular and non-vascular epiphyte vegetation represented by several plant families, primarily Araceae, Bromeliaceae and Orchidaceae. This area connects on the west with part of the Indio-Maíz Biological Reserve, which in that area is an exuberant closed forest.

Area 8. The Indio-Maíz Biological Reserve to the west of Lake Sílico and Río Indio and contiguous to the Río San Juan Wildlife Reserve has a closed forest with a canopy dominated by *Pentaclethra macroloba* and lower strata with clear presence of shade-tolerant palms and non-flooded sites. There are many epiphytes in this area, primarily species in the Araceae and Cyclanthaceae families. In the northern part of the Indio-Maíz Biological Reserve, there are signs of recent human disturbance from selective cutting of timber. The reserve consists of hilly land with slopes of about 20 degrees. The soil is reddish in colour.

Area 9. Tertiary forest in the foothills of the Río San Juan Wildlife Reserve has areas with closed and open secondary forest, with several strata sometimes difficult to differentiate. The most frequent arboreal species in the canopy in these forests is *Pentaclethra macroloba*, in addition to several palms and other trees in the sub-canopy. The undergrowth is dominated by palms intolerant of shade. Slope ranges between 30 and 50 degrees, with several off-white incrustations in the soil. On the edge of Río San Juan, there are rocky outcroppings.

Area 10. *Tacotales* in the Río San Juan Wildlife Reserve along Río San Juan are made up of scattered specimens of heliophyte species, a shrub stratum composed of large herbaceous species in the *Costus* and *Heliconia* genera and *Calathea lutea* and abundant Melastomataceae. Among the grasses, there are Gramineae and ferns. There are also very abundant climbing species in several families. The substratum is sedimentary and sometimes flooded.

Area 11. Coastal shore forms an area made up of unconsolidated sand substratum. The original vegetation has been removed, and coconuts (*Cocos nucifera*) are now grown here. Despite this, we can identify the following subdivisions in the beach profile:

> Intertidal area, made up of the area influenced by the tides;
> Sandy beach, sandy beachfront without terrestrial vegetation;
> An area of herbaceous terrestrial plants and creepers with an area of herbaceous terrestrial vegetation;
> Areas of shrubs, shrub vegetation and heliophyte climbing plants;
> An area dominated by coconuts, coconut palms with the presence of plants of the underbrush and herbaceous species.

These abundant rivers, streams and coves form interesting sites for dispersion, feeding and reproduction for many species because of the abundant sub-aquatic vegetation and freshwater shrimp, the manatee, turtles, crocodiles, amphibians and numerous important fish. In addition, vegetation such as the *yolillo* palm (*Raphia*

taedigera) has abundant fruit and has a high nutritional value for several wild species such as macaws, the white-lipped peccary and *guardatinajas*. *Yolillo* also provides abundant organic material for the soil and feeds a large number of fish, aquatic invertebrates and insects, forming an extensive trophic network that includes amphibians, crocodiles, bats, etc. around this plant species.

17. Noteworthy flora:

Nicaragua is the southern limit of the distribution of several plant species that are present in the Río San Juan Wildlife Refuge, such as *ojoche* (*Brosimun* sp.)*, javillo* (*Hura poliandra*)*,* loquat (*Manilkara zapota*) and *zopilote* (*Vochisia hondurensis*) (Grijalva et.al, 1996). We also find important shade species (species that depend on others). By protecting the first, the second are also protected. This includes the red mangle (*Rhizophora mangle*), the only viviparous plant, which grows in an brackish environment. It is subject to flooding several hours a day where very few arboreal species can grow because of the poor supply of oxygen to the roots. The mangrove roots are arranged in a way that has no parallel in the plant kingdom. Among the roots live a multitude of living organisms, such as fish, molluscs and crustaceans (Amigos de la Tierra, 1999).

In this category of shade species, there are also the *cuajiniquil* (*Inga veraspuria*) and *sotacaballo* (*Pithecellobium latifolium*). Both trees are found on the edges of rivers, and their extensive branches touch the water. Their fruit and flowers are eaten by the manatee and attract many insects that are food for crocodiles, basilisks, fish and amphibians (Jiménez, 2000). The *yolillo* palm (*Raphia taedigera*) is of special importance in this reserve. Its fruit is abundant and has a high nutritional value for several wild species, such as macaws, white-lipped peccary and *guardatinajas*. The abundant organic material that the *yolillo* provides for the soil feeds a large number of fish, aquatic invertebrates and insects, forming an extensive trophic network that includes amphibians, crocodiles, bats, etc. around this plant species (Amigos de la Tierra, 1999).

Among the important plant species, epiphytes should be mentioned; epiphytes such as Bromeliaceae and Orchidaceae plus Araceae, Cycadaceae and Palmae of great ecological importance. Among the most important genera or species, there are *Anthurium* sp., *Bactris* sp., *Calathea* sp., *Costus* sp., *Cyclanthus* sp., *Desmoncus* sp., *Maxilaria* sp., *Oncidium* sp., *Philodendrun* sp., *Pleurothallis macrophylla*, *Sobralia* sp., *Spathiphillum* sp., *Synecanthus* sp., *Welfia georgil* and *Zamia* sp. There is a recent report of a species of orchid previously recorded only in Costa Rica and Panama: *Epidendrum circinatum* (Díaz, 2000).

It is also important to mention large arboreal species, appreciated for their ecological and economic value, such as *Carapa guianensis, Dipterix panamensis, Ficus* sp., *Manilkara zapota, Pentaclethra macroloba, Pterocarpus officinalis, Simarouba* sp., *Tabebuia* sp. and *Terminalia* sp. Several lianas used for handicrafts, such as the *bejuco del hombre* (*Heteropsis oblonguifolia*) and the *bejuco de la mujer* (*Philodendron rigidifolium*), also have an economic value. Several bromeliads and orchids whose commercial value is only just beginning to become apparent should also be included. There are species of alimentary importance such as the *palmito*, *maquengue* (*Iriartea deltoidea*) and other of industrial value such as the *zarzaparrilla*

(*Smilax* spp.), already used in neighbouring Costa Rica as a flavouring. In addition, there are plants with a pharmaceutical value, such as the *cuculmeca* (another species of *Smilax*) and *uña de gato* (*Uncaria tomentosa*), whose anti-cancer value is becoming known (Amigos de la Tierra, 1999). Most of these species have had an unknown value until now, but there is hope that scientific research will make available their benefits and the comparative advantages of the tropical characteristics of this part of Nicaragua.

18. Outstanding fauna:

The diversity of species is very broad in this reserve. During brief field surveys, 303 species of birds (24 migratory), 26 mammals, 15 reptiles, 3 amphibians and 61 species of insects have been recorded. In addition, there are 7 species of marine and 2 of freshwater crustaceans, 13 species of marine fish and 10 freshwater fish recorded (Amigos de la Tierra, 1999). From the delta of the Río San Juan and the basin of Río Indio, large areas of *yolillal* dominate, being one of the important habitats for several species of large mammals, such as the white-lipped peccary (*Tayassu pecari*) and Baird's tapir (*Tapirus bairdii*) (Zúñiga et. al., 1996).

Invertebrates also have a high value in this area. There is no abundance of land snails because of the acidic condition of the soil, which prevents crystallization of the calcium in their shells. The Río San Juan Wildlife Reserve has already provided important discoveries. Despite a scarcity of material collected in a short time, it can lead us to think that there is a large deposit of biodiversity still to be discovered. The value of several of these species is recognized for their economic and ecological importance and their beauty.

A. Symbolic value

In a nature area such as the wildlife reserve, each species plays a specific function, and as a result all are important. But here, there is an especially valuable species, which because of its singularity could alone represent the importance of the entire wildlife reserve. This is the manatee (*Trichechus manatus*). This inoffensive and little-known mammal can grow to more than three metres long and weigh more than half a ton. The females nurse their young similar to human beings. The early European explorers thought they saw in these aquatic mammals the legendary sirens. For this reason, zoologists included this species in the taxonomic order of the Sirenidae (Jiménez, 2000). There are only two species in this family in the world, both endangered. The species in this reserve is found only in the Caribbean Sea and is very rare. As a result, it attracts the attention of international organizations interested in their conservation. The largest populations of manatee in Nicaragua are in this reserve, primarily in calm water, where they find abundant herbaceous vegetation on which to feed. Just the presence of this species justifies protection of the area because of its international importance (Amigos de la Tierra, 1999).

B. Economic importance: The migratory aquatic species have an especially important value for the economy of the numerous fishing communities around Río San Juan, Lago Cocibolca and Caño Negro Lake in Costa Rica, which is connected to Río San Juan by Río Frío. Through the brackish waters of the Río San Juan Wildlife Refuge transit to the freshwater of the lake several species of fish such as the *tiburón toro*

(*Carcharinus leucas*), sábalo real (*Tarpon atlanticus*), róbalo (*Centropomus parallelus*) and *gaspar* (*Antractosteus tropicus*). The *tiburón toro* plays an irreplaceable role in aquatic environments by hunting ill or old fish, thus preventing the spread of epidemics among the fish populations that it helps to control. The *gaspar* is a true living fossil, as testifies its swimming bladder, which functions as a primitive lung (Amigos de la Tierra, 1999).

Through this reserve also transit the Caribbean spiny lobster (*Panalirus argus*), and the freshwater shrimp (*Macrobrachium carcinus*). The freshwater shrimp is one of the largest species of freshwater shrimp in the world. As a result, it has a still unexploited great potential for export. It reproduces in brackish water and migrates to grow in various riparian environments. There are four species of Caribbean shrimp (*Panaeus* spp.), which also reproduce in the brackish water of the mangroves in this reserve (Amigos de la Tierra, 1999).

C. Aesthetic value: Another group of species of great value in this reserve, primarily for tourism, is the waterfowl. They attract attention because of their contrasting colours and are very easily observed from moving boats. There are ten species of herons, two of storks, nine of plovers and three species of kingfishers. The *pato aguja* (*Anhinga anhinga*) and *pato chancho* (*Phalacrocorax olivaceus*) are also very visible. Neither is a true duck, but both dive quite well in search of fish and invertebrates on which they feed. It is common to see pairs of Buffon's macaw (*Ara ambigua*) and scarlet macaw (*Ara macao*) (Amigos de la Tierra, 1999).

D. Scientific value: The marine coast of this wildlife reserve has had a recognized historic importance since the seventeenth century because of the nesting of several species of sea turtle. There are only eight species in the world, and there is evidence that at least four of them lay eggs in these sands. They are the hawksbill turtle (*Eretmochelys imbricata*), leatherback (*Dermochelys coriacea*) and green turtle (*Chelonya mydas*) and quite possibly the loggerhead (*Caretta caretta*). The first of these has the most reduced population because of strong hunting pressure and the high commercial value of its shell. The second species is the largest in the world, also the rarest. And the last two are very appreciated for their meat. These species made possible the incursions of pirates in the Caribbean in the sixteenth and seventeenth centuries. Populations of all these species have decreased because of the almost total disruption of their nests, and recently because of disturbance caused by the boats used for industrial fishing of shrimp (Amigos de la Tierra, 1999).

Also of great scientific importance are the migratory birds. They migrate from North America in stages primarily to several wetlands where they rest before continuing their migration down the continent. These species attract international attention because of their annual migration from very distant places. Migration involves other forests and wetlands located in third countries, justifying a joint effort to guarantee the vitality of these itinerant bird populations (Amigos de la Tierra, 1999).

In this reserve, 24 species of migratory birds have been identified, outstanding among which are plovers and shorebirds. In the forested part of the reserve, there is one species of interesting bird: *Electron carinatum*. Its presence is relevant because it is considered endangered and is not included in the lists of birds in the neighbouring protected area of Barra del Colorado in Costa Rica. Likewise, the

Trogon massena, related to the quetzal, was sighted in forests in the reserve and is interesting because, based on the four specimens observed, it has coloration different from that described in the field guide for Costa Rica prepared by Stiles and Skutch (1995). It is possible that it is the case of a not-yet-identified subspecies. As a result, this species should be studied and a detailed description of this species made (Amigos de la Tierra, 1999).

E. Shade species: These are species that by protecting them and their habitats, other species that need smaller habitats are protected. In this wildlife reserve, there are several of these cases. One of them is the Central American condor (*Sarcoramphus papa*), also known as *zopilote rey*. Its territory covers several square kilometres and includes thousands of species of animals and plants, including the American harpy eagle (*Harpia harpyja*) and jaguar (*Panthera onca*) (Amigos de la Tierra, 1999).

19. Social and cultural values:

Two basic hydrological components that influence this wildlife reserve are Río San Juan and the Caribbean Sea, which connect the protected area to the neighbouring areas of Bluefields and El Castillo-San Carlos. This group makes up a territorial system that permits communication of persons and species and with neighbouring Costa Rica, thus promoting the exchange of persons, goods and services. The settlements of El Castillo and San Juan del Norte border on northern Costa Rica, with which strong social and commercial ties have traditionally been maintained (Amigos de la Tierra, 1999).

A significant value that might be overlooked is the historical importance of this area. The route across the isthmus (Ruta del Tránsito), which was of great relevance in the colonial period for the English and Spanish as an inter-oceanic route for navigation and of economic and geopolitical interest in the seventeenth and eighteenth centuries is found here (Rabella, 1995).

Formerly, there were several Indian populations in the area of San Juan del Norte, presumably descendents of the Macrochibcha tribes from South America, such as the Ramas, Zambos and Miskitos. They played a decisive role in European colonization. The only current surviving group in the area is a small population of Ramas (Ramaquís), as they are now called, which are very indifferent to other cultures in the area because of the marginalization to which they have been subjected during almost their whole history. There are also several Miskitos in the area most of whom have emigrated from the area of Bluefields and have settled in this area because of the abundant resources.

20. Land tenure/ownership of:

Like other protected areas in Nicaragua, there are several types of private and governmental property in the Río San Juan Wildlife Reserve. However, there is no clear knowledge about the proportions. Because of the problem of national and foreign settlements, it is necessary to increase economic activity in this area. Steps are being taken to establish a programme to clarify land tenure quickly (Amigos de la Tierra, 1999).

Legal instruments

Decree 66-99 (MARENA, 1999) declares inalienable the Areas Naturales Protegidas del Sureste (these areas include the Río San Juan Wildlife Reserve). These areas are land included within the limits of the protected areas.

Article 34 declares that land in the protected areas in the southeast retains the same inalienable character, and according to Article 54 of the regulations all government-owned land within these areas must be registered in the name of the government.

Article 35 declares that both private and government land within the Areas Protegidas del Sureste is subject to the management provisions of relevant laws for use and exploitation of natural resources. The same applies to any complementary dispositions that the Minister for the Environment and Natural Resources might decide.

21. Current land use:

The main human activities in the municipio of San Juan del Norte are small-scale fishing, production of coconuts, exploitation of the forest and tourism. Agriculture is limited to rice, beans and maize for substance and is restricted to a few areas because of a lack of soils apt for agriculture. Among the extractive activities of resources there is the important impact of traditional hunting of several very endangered species, although they are relatively abundant in the area (Amigos de la Tierra, 1999).

The hunting of wildlife occupies a large part of the activities of the local inhabitants of San Juan del Norte and forms part of the local diet (Jiménez and Altrichter, 1998). Lobster is exploited, with a catch of an estimated 500 to 1000 pounds per week per family during the fishing season. This product is sold in Barra del Colorado (Costa Rica) where there is a marketing centre (Robleto, 1996). Basic grains and comestible roots are grown for local consumption (Amigos de la Tierra, 1999).

Fishing in the area of San Juan del Norte is concentrated on two species of crustaceans: the Caribbean spiny lobster (*Panalirus argus*) and the freshwater shrimp (*Macrobrachium carcinus*), and a marine species, the sea bass (*róbalo*) (*Centropomus parallelus*) (Robleto, 1996).

Water is supplied to San Juan del Norte through a system of municipal wells to 80 per cent of the urban population. The rest of the population obtains water through individual wells (Amigos de la Tierra, 1999).

Currently, there is a low density of population in the reserve. However, the trend for the future is alarming. The local economy still has little impact on the reserve's conservation status. However, there has been no diversification in the economic activities capable of satisfying the needs of a growing population in the near future. If we exclude the incipient development of ecotourism, current opportunities are based exclusively on the use of still-abundant natural resources without any type of transformation. As a result, it is predicted that in a short time there will be greater pressure on natural resources (Amigos de la Tierra, 1999).

22. Factors (past, present or potential) adversely affecting the site's ecological character, including changes in land use and development projects:

One of the most serious threats is the pressure of colonization on the edges of Río San Juan. This pressure comes from Nicaraguans who have emigrated from other areas of the country to Costa Rica. They use the edges of the river for agriculture, grazing and forest exploitation, opening a new agricultural frontier towards the interior of the biological reserve and taking advantage of the favourable position for trading with northern Costa Rica (Amigos de la Tierra, 1999).

Based on an evaluation of environmental impact of activities in the area, we can point out that there is pollution from solid waste in the urban area of San Juan del Norte. There is a lack of treatment of solid waste. On the beaches, the interesting relationship of the nesting of turtles and biodiversity can be altered by the extraordinary amount of solid waste that tides deposit on the beaches.

In Haulover, there is a very small human population of workers on the coconut plantation. They complement their diet with exploitation of the nests of sea turtles on the coast. This would not be a serious problem if those species were not becoming extinct.

Associated with this, there is industrial-scale capture of shrimp from shrimp boats fishing very close to the coast. Turtles that approach the coast to nest are captured in dragnets, without any possibility of escaping for lack of turtle excluder devices (TEDs).

The gradual closing of the mouth of Río San Juan is a historical fact, first mentioned by travellers who used this route across the isthmus (Compañía del Tránsito) in the nineteenth century. If the mouth closes completely, the mangrove and all the species that need brackish water of the estuary will be affected, including shrimp and lobsters.

There is poaching of fauna and flora from Costa Rica, and there is excessive pressure from fishing at certain sites on the river that affects commercial fishing of migratory fish in the upper part of the river. The speed of boats is excessive in certain places, causing erosion of the banks of Río San Juan and affecting the only population of manatees in the border region with Costa Rica. There is also chemical pollution, mainly agrochemical, from tributaries in Costa Rica to Río San Juan. In addition, there is heavy pressure from colonization by small farmers on the banks of rivers and a population increase from immigration into San Juan del Norte. There is a proposal to build an eco-canal on Río San Juan, which would increase traffic on the river, with a still-unknown heavy impact on fish populations and greater erosion of riverbanks.

23. Conservation measures taken:

This is a protected area according to Decree 66-99 in the category of wildlife reserve and is part of the Reserva de la Biosfera del Sureste de Nicaragua. The Ministry for the Environment and Natural Resources (MARENA) has created an administration of

forest rangers in San Juan del Norte as a conservation measure in the area, in addition to posting forest rangers along Río San Juan at four border points (still insufficient personnel). There are restrictions on the use of species such as sea turtles and manatees and fish such as the *róbalo* and *sábalo real*. These measures are regulated by MARENA together with the army in the area. Recently revised and approved by the Ministry for the Environment and Natural Resources (MARENA), the management plan for the reserve was prepared by Amigos de la Tierra.

24. Conservation measures proposed but not yet implemented:

It is planned to implement the management plan with management and monitoring for coordination of other programmes. The sub-programmes planned include administration for protection and control of monitoring and evaluation and a programme for community management. In the programme for infrastructure and basic services, it is planned to develop sub-programmes for social and administrative infrastructure, protection and control, tourist infrastructure and research. The sustainable development programme will promote viable economic activities that improve the standard of living of the local inhabitants. This includes development of sub-programmes for agro-forestry, ecotourism and wildlife management. Another programme is environmental education and applied research (Amigos de la Tierra, 1999).

25. Current scientific research and facilities:

Research completed:

Preliminary survey of wildlife in the southern section of the Gran Reserva Biológica Indio-Maíz (Zúñiga et.al., 1996);
National survey of crocodiles (unpublished) (Buitrago, 2000);
Management plan for the Río San Juan Wildlife Reserve (Amigos de la Tierra, 1999);
Survey of the main aquatic ecosystems and aquatic biological resources in the area of San Juan del Norte (Gran Reserva Biológica Indio-Maíz) (Robleto, 1996);
Preliminary report on field trips to the Río San Juan Wildlife Reserve (Díaz, 2000);
Manatees of Río San Juan and the Canales de Tortuguero (Jiménez, 2000).

Infrastructure: A forest ranger post in San Juan del Norte and four border posts on Río San Juan have been established.

26. Current conservation education:

Activities in the context of environmental education have been carried out, including training of local inhabitants in fishing, education (professors) and ecotourist guides.

27. Current recreation and tourism:

Transportation and tourism are poorly developed in the area. There are few accommodations, and there still is a scarcity of trained personnel in the area of tourism. Primarily international tourists visit the municipio. For domestic tourism, costs are too high (Amigos de la Tierra, 1999).

There is an exponential increase in demand for tourism in Costa Rica leading to a situation of over-frequentation at the sites already integrated into a dynamic process of marketing and promotion. This opens potential opportunities for new sites, such as Río San Juan, with comparable ecotourist resources that can absorb this excess demand. However, Nicaragua is not yet currently in a position to take advantage of this possibility. The "tourist products" offered have usually been prepared spontaneously and unsystematically without equipment and minimum infrastructure and without proper training of personnel providing services (Amigos de la Tierra, 1999).

From Río Bartola to San Juan del Norte, there is no adequate accommodations or tourist facilities. A similar situation exists with regard to services for tourism in the form of restaurants, shops selling articles of interest to tourists and installations providing tourist information. In order to remedy the situation, sufficient tourist services and infrastructure should be created quickly. At the same time, there is an attempt to strengthen ecotourism with surveys of natural resources and cultural, scientific research and support of the policy of protected areas and wildlife reserves.

28. Jurisdiction:

Territorial jurisdiction over the wetland: This wetland covers parts of three municipios in two departments. The highest governmental authorities in the area are the municipal governments of the three municipios of San Juan del Norte (covering most of the wetland), El Castillo and Bluefields.

Administrative jurisdiction for conservation: MARENA through the Secretaría Ejecutiva de la Reserva de Biosfera del Sudeste is the administrative authority.

29. Management authority:

MARENA through the Secretaría Ejecutiva de la Reserva de Biosfera del Sudeste, which manages a park ranger station in the town of San Juan del Norte under supervision of MARENA.

30. References:

Annexes

1. Map of the Wetland

2. Tidal regime at San Juan del Norte

3. Preliminary List of Wildlife

4. Preliminary List of Vegetation

5. Photographs