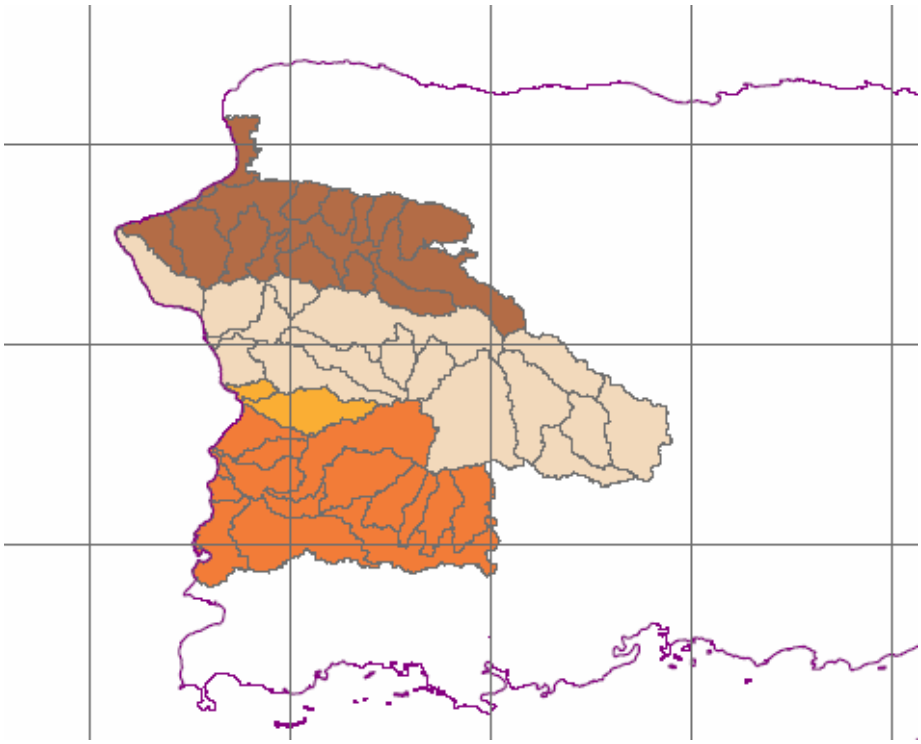
CONSERVATION SECURITY PROGRAM

2007

Culebrinas-Guanajibo Watershed – Puerto Rico

8-Digit HUC: 21010003



Culebrinas River

Añasco River

Yagüez River

Guanajibo River

Watershed Name: Culebrinas-Guanajibo Puerto Rico (NRCS Caribbean Area)
HUC number: 21010003

Introduction

The Culebrinas-Guanajibo Puerto Rico 8 – Digit Hydrologic Unit: 21010003 has an extension of about 504 sq. mi. (322,560 acres), which covers about 14.5 percent of the main Island of Puerto Rico. The watershed encompasses 16 municipalities extending from Aguadilla in the northwest to Cabo Rojo in the southwest, and to Adjuntas in the west-central interior (see Figure 1). This watershed represents a large diversity of land uses such as: urban land, grazingland, cropland, wetland, recreational land and forest land. Soil erosion, water quality, and wildlife are major concerns in the watershed. Many studies have been completed and others are under the supervision of federal and local entities. Data regarding agricultural, social and water concerns was gathered from federal and local sources and a compendium of applied conservation practices is included. The appendices include information in maps and tables of the watershed.

Figure 1. Culebrinas-Guanajibo Watershed and its Municipalities

Physical Description

There are 163,863 acres of farm land in this watershed. The slopes range from near leveled land to over 60%. Most of the farming is performed in small farms in the mountainous areas. The economy of these municipalities is based on agriculture, manufacturing industries and tourism. From the 16 municipalities within the watershed, 2 are not considered for statistical purposes as most of their lands do not drain to the watershed. Fifty three percent of the total farmland is devoted to cropland and grassland, and 47% is under woodland, forestland, idle or used for cropland conservation. Eighty

five percent of the total farms and 65% of the total acreage have full ownership. Only 5% of the farms have part owners or tenants.

Crops and livestock are common within the area. Coffee production and grazing lands are important resources for the economy and welfare of Puerto Rico. There are about 10,000 farms and 60,000 acres devoted to coffee orchards in this area with an average production of 14,000 tons (280 hw), and an approximated market value of $42 million. (2002 PR Census of Ag.). Coffee production provides about 38,000 direct and indirect jobs. Most landusers are considered limited resource farmers. About 40 dairies are concentrated in the interior of the watershed and beef cattle is dispersed through the entire area with a higher concentration in the coastal plains. Estimates for livestock are: dairy and beef cattle 39,100 units; hogs 12,575; horses 1,865; and small ruminants 10,000. (USDA Census of Ag. 2002).

Other farmland is devoted to crops such as: yams, tanniers, sweet potatoes, avocado, cassava, pigeon peas, bananas, plantains; hay production; vegetables and fruit orchards; hogs and poultry. Home gardens are very common through the area.

Table 1 shows the total acreage of cropland and pastureland, and other land uses.

Table 1. Farms, Land in Farms, and Land Use by Municipality in the Culebrinas-Guanajibo Watershed YR 2002.[1] (Source: 2002 Census of Agriculture-Puerto Rico. Released on February 3, 2004 by the National Agricultural Statistics Service. USDA).

Municipality	**No. Farms**	**Land in Farms** (acres)	**Cropland** Acres	**Grassland** Acres	**Other land**[2] Acres
Adjuntas	1498	25864	10633	2724	12507
Aguada	247	3557	1051	1176	1330
Añasco	250	9934	1691	2187	6056
Cabo Rojo	178	15449	3562	7753	10190
Hormigueros	40	1743	535	739	469
Lares	1209	19432	9874	606	9421
Las Marías	693	12149	4620	336	7193
Maricao	439	9911	4211	74	5626
Mayagüez	384	10923	2926	992	7005
Moca	266	8987	1860	2240	4887
Rincón	71	3416	250	2365	801
Sabana Grande	134	6138	1693	1979	2466
San Germán	344	12638	3228	3501	5909
San Sebastián	784	23722	7969	5665	10088
TOTAL	6537	163863	54103	32337	77423

[1] Municipalities of Aguadilla and Yauco are excluded for statistical purposes.
[2] Idle cropland, woodland, forestland, underbrush, and cropland conservation: used for cover crops, legumes and soil improvement grasses not harvested and not pastured.

Table 2 shows number of farms, land in farms by tenure of operation.

The most important surface-water bodies are: Río Grande de Añasco with about 143 square miles. This river has the highest drainage area of the watershed with 91% of the watershed with slopes greater that 20%, including the lake areas in the upper land. Lakes Yahueca, Guayo, Prieto and Toro, with a total drainage area of 45 square miles, were

constructed by the Puerto Rico Water Resources Authority (PRWRA), presently the Puerto Rico Electric Power Authority, during the decade of the 50's. These were constructed to supply water to the Luchetti Lake for energy production and irrigation. The average discharge of the Río Grande de Añasco exceeds 300 cubic feet/sec (USGS, 1994). The Añasco River is the main supplier of sediment when compared with the rest of the Island rivers (González, 2005). Río Culebrinas has a drainage area of about 105 square miles. The Río Yagüez with 13.7 square miles drains urban areas of Mayagüez. The discharge was estimated to be less than 5 cubic feet/sec (USGS, 1994). Seventy percent of this basin area has slopes of 20 to 60%.

Table 2. Farms, Land in Farms by Tenure of Operation. Source: 2002 Census of Agriculture-Puerto Rico.[1/2] (Released on February 3, 2004 by the National Agricultural Statistics Service. USDA).

Municipality	Total		Full Owners		Part Owners		Tenants	
	Farms	Acres	Farms	Acres	Farms	Acres	Farms	Acres
Adjuntas	1498	25864	1366	19323	74	4039	58	2503
Aguada	247	3557	197	1821	36	1438	14	298
Añasco	250	9934	207	5414	29	2924	14	1596
Cabo Rojo	178	15449	51	3929	64	5901	63	5620
Hormigueros	40	1743	12	300	21	1404	7	39
Lares	1209	19432	1086	16604	79	1847	44	981
Las Marías	693	12149	631	10058	47	1694	15	398
Maricao	439	9911	409	8818	22	1047	8	46
Mayagüez	384	10923	343	7034	28	1123	13	2765
Moca	266	8987	188	5223	54	2990	24	774
Rincón	71	3416	43	2023	13	688	15	704
Sabana Grande	134	6138	97	2258	21	3117	16	763
San Germán	344	12638	273	7699	59	3986	12	954
San Sebastián	784	23722	636	15402	111	6471	37	1850
TOTAL	6537	163863	5539	105906	658	38669	340	19291

[1] Municipalities of Aguadilla and Yauco are excluded for statistical purposes.
[2] Includes farms managed by salaried managers.
[3] NA Data not available.

The Río Guanajibo, basin has 127 square miles of flat and mountain terrain with slopes from 20 to 60% covering about 50% of the basin. According to USGS, the river discharge is characterized by nickel and chromium-rich sediment.

All these rivers drain to the Mona Passage. For characteristics of water bodies see Appendix I.

The island of Puerto Rico is divided into five ground water areas: North Coast, South Coast, West Coast, East Coast, and East Central (USGS 1996). The most important aquifers are in the north and southern parts of the island. Most of the waters in the western watershed are surface waters.

Conservation assistance is provided by four NRCS Service Centers, one Soil Survey office, and one Resource Conservation and Development (RC&D) office. The soils are digitized and the offices have the ability to use RUSLE2.

Physiographic Description according to Major Land Resource Areas

Puerto Rico is part of an island arc that largely consists of faulted and folded volcaniclastic and sedimentary rocks that have been locally intruded by igneous rocks. Sedimentary rocks, which are mostly limestone of Oligocene to Pliocene age, overlie the volcaniclastic and sedimentary rocks in isolated areas, and thick alluvial deposits of Quaternary age formed of material eroded from the volcaniclastic and sedimentary rocks are along many stream valleys, especially in coastal areas. (USGS 1996).

270—Humid Mountains and Valleys-4,910 km² (1,895 mi²)

Elevation and topography: Elevation ranges from 50 to 1,340 m. Three distinct mountain ranges are in the area. The Central Ridge, Cordillera Central as it is known locally, is the highest and largest of the three. It is oriented in a general east-west direction. Cerro de Punta is the highest peak with 1,338 m. asl. Slope ranges from level to very steep lands.

Climate: The average annual precipitation ranges from 2,075 to 2,150 mm. Maximum precipitations occurs in May and September. Average annual temperature is 24° C. There is little difference between the temperature in summer and that in winter.

Water: Surface water from precipitation, perennial streams, and lakes are abundant. Ground water is limited to water that seeps into the soil and is stored in the dense and massive underlying volcanic rock.

Soils: Most of the soils are Udepts and Humults. Shallow and moderately deep, medium textured Eutrudepts (Caguabo, Múcara, Morado, and Quebrada series) have an isohyperthermic temperature regime and mixed mineralogy. The Humatas series, a deep, fine textured Haplohumults has an isohyperthermic temperature regime. The Los Guineos series is an Isothermic Humic Hapludox. They are on steep side slopes in the west-central part of Puerto Rico. Soils of minor extent are the deep, extremely weathered Anionic Acrudox (Nipe series) in the western.

271—Semiarid Mountains and Valleys Puerto Rico-960 km² (369 mi²)

Elevation and topography: Elevation in ranges from 50 to 400 m. Slopes range from moderately steep to very steep; near-vertical slopes occur in the northernmost part of the area. These semiarid mountains are in the southern slopes of the central mountain chain that runs east and west of the island.

Climate: The average annual precipitation is 1,150 mm. Maximum precipitation is in May and in September. The average annual temperature is 26° C. The difference between the temperature in summer and that in winter is less than 5° C.

Water: The source of surface water is about 1,143 mm of rainfall a year. Because of high evaporation rates in this area, much of this precipitation is lost in the atmosphere before reaching the small streams and rivers. The few man-made lakes are used for storing water for human consumption and for irrigation. Ground water is scarce because the steep

topography and the high evaporation rates prevent sufficient quantities of water from entering the soil and establishing underground deposits.

Soils: Most of the soils are Ustolls. They are shallow and moderately deep and medium textured. They have an isohyperthermic temperature regime and mixed mineralogy on volcanic rocks. The well drained, shallow Typic Haplustolls (Descalabrado series) are dominant throughout the area and are on the steep southern side slopes of the east-west central ridge of mountains. The well-drained, moderately deep Vertic Haplustolls (Jácana series) are on side slopes and foot slopes. Of minor extent are shallow Typic Haplustalfs (Guayama series) on steep side slopes.

272—Humid Coastal Plains-2,420 km^2 (933 mi^2)

Elevation and topography: Elevation ranges from sea level to 700 m, rising gradually from the beaches on the Atlantic Ocean to the hilly karst area to the south. This area is divided into two distinct zones - the flat alluvial plains and terraces along the coast and the irregular features of the karst limestone inland. Streams generally flow to the north, but most of the drainage in the karst zone is underground.

Climate: The average annual precipitation is 1,600 mm. Maximum precipitation is in May and August. Average annual temperature is 25° C. There is little difference between the temperature in summer and that in winter.

Water: Surface and ground water are plentiful. Surface water consists of runoff from rainfall in the humid uplands. Some large manmade lakes are used for hydroelectric power and as a source of water for human consumption. Ground-water supplies are derived from water in the joints and fractures of the underlying volcanic rock and the contiguous limestone aquifers of this humid coastal area.

Soils: There are four distinct geomorphic areas--coastal plains, river flood plains, small lagoon-like depressions, and limestone karst areas. All the soils have an isohyperthermic temperature regime. In the coastal plains, the dominant soils are deep, well drained, acid Plintic Hapludox (Almirante series) and Typic Hapludults (Vega Alta series) and Typic Hapludox (Bayamón series) and Typic Eutrustox (Coto series). On the flood plains, the poorly drained Endoaquolls (Bajura series), the somewhat poorly drained Endoaquepts (Coloso series), and the well-drained Hapludolls (Toa series) are the main soils. Poorly drained Haplosaprists (Tiburones and Saladar series), Fluvaquents (Martín Peña series), and swamps and marshes are dominant in small depressions. In the extensive limestone karst, Haprendolls (Colinas and Soller series), Argiudolls (San Sebastián series) and Hapludalfs (Tanamá series) are major soils.

Common Resources Areas (CRA)

The CRA represent agro ecologically areas where landscapes resource concerns and treatment needs are similar. The CRA for the Caribbean basin are based mainly on soil classification and soil surveys already published and ongoing updates, other resources

information such as geology, climatic data and geography land use, life zone areas, and social and economic factors are related to set groups of similar agroecosystems.

About 80% of total CRA acreage in the watershed is humid upland, 41.7% of it is deep reddish clayey soils and 16.7% is in shallow clayey soils. Less than 12% is in humid alluvial land, which comprises the highest productive soils in the watershed. The remaining acreage is of low agricultural value such as coarse sandy soils, and rock outcrops and other lands as urban land. There are 23,842 acres of agricultural land in Coloso, Añasco and Guanajibo valleys. (see Appendix II for CRA distribution in the watershed).

CRA's in the Culebrinas-Guanajibo Watershed

270.1 Deep, Reddish, Clayey Soils in the Humid Volcanic Upland

This area includes soils that are highly leached and have low base saturation in the subsurface that contains a significant amount of illuvial clay accumulation and high organic content in the surface horizon. The soils are deep, well drained, very strongly acid and moderately permeable. These soils are on side slopes, and narrow ridge tops of the humid uplands. They formed in residual material weathered from volcanic rock. Slope, runoff, past erosion, and hazard of further erosion are limitations. Natural fertility is medium. The Humatas, Consumo, Los Guineos, Naranjito, Alonso, Maricao complex is suitable for use as native pasture and woodland and for wildlife food and cover. Most of the life zone is classified as Subtropical Wet Forest, with few areas under Lower Mountain Wet Forest. Most of these lands are devoted to coffee and forest.

270.2 Shallow Clayey Soils in the Humid Volcanic Upland

This area includes soils exhibiting initial stages of soil formation. Soils are shallow to moderately deep, steep to very steep, and well-drained soils to poorly drained in the higher areas of the volcanic humid upland. Soils formed on foot slopes, side slopes, and rounded hilltops of strongly dissected humid volcanic upland. Reaction in the surface layer and subsoil is very strongly acid. Natural fertility range from low to medium. The hazard of erosion is the major concern of management. Some areas severely eroded exposed bedrock. The life zones comprised are Subtropical Wet Forest and Lower Mountain Wet Forest.

270.3 Shallow Sandy and Gravelly Soils in the Humid Volcanic and Plutonic Upland

This area includes soils exhibiting initial stages of soil formation, consisting of shallow to moderately deep gravelly, steep to very steep and well-drained soils. These soils formed on foot slopes, side slopes, ridge and hilltops of strongly dissected humid volcanic and plutonic upland. Some areas formed in residual material weathered from serpentine rock in the western part of the island of Puerto Rico. Erodibility is higher in granitic soils such as Pandura and Pellejas. Natural fertility is low and acidity is strong. Shallow to mixture of weathered and partially weathered volcanic rock. Slope, shallowness to bedrock, rapid runoff and erosion hazard are the major concerns of management. The life zone is Subtropical Moist Forest.

270.4 Shallow Soils in the Humid Calcareous Upland

This area includes moderately deep to deep to limestone rock with nearly black, organic rich surface horizon and high supplies of bases in karst areas of northern Puerto Rico. These sloping to very steep soils formed on foot slopes, side slopes and ridge tops of limestone hills. They have moderate permeability, high available water capacity and medium natural fertility. Runoff is moderate to very rapid. Slopes, runoff, past erosion, hazard of further erosion, and shallowness to soft limestone are the major resource concerns. The life zone is Subtropical Moist Forest.

270.6 Deep Dark Clayey Soils in the Humid Alluvial Land

This area includes gently sloping to sloping soils with a relative high base saturation and a subsurface horizon that contains a significant content of illuvial clay accumulation. These soils formed in fine textured sediment of mixed origin that is somewhere underlain by coarse textured, gravelly or cobbly sediment on humid alluvial fans and terraces. They are deep, moderately well to somewhat excessively drained, slow to rapidly permeable soils. Runoff is slow to medium. Soils formed from coarse fraction sediment, are excessively drained and have low fertility. These soils have moderate limitation for farming because of slope and the hazard of erosion. The life zone is Subtropical Moist Forest.

272.1 Deep Gleyed Soils in the Humid Alluvial Land

This area includes soils formed in alluvium deposits of sediment weathered from volcanic, plutonic or limestone rocks. These areas are on river flood plains and coastal lowlands. Soils are deep and nearly level. Drainage range somewhat poorly drained to poorly drained. Soils in the eastern part of Puerto Rico, which are formed in sediment derived from granitic rock, are excessively drained and rapidly permeable. Wetness, frequent flooding, and seasonal high water table are the major concerns of management. The life zone is Subtropical Moist Forest.

272.2 Deep Dark Friable and Fertile Soils in the Humid Alluvial Land

This area includes moderately deep to deep soils with nearly black, organic rich surface horizon and high supplies of bases in humid climates. These nearly level soils are on river flood plains and terraces. They formed in stratified moderately fine textured, fine textured and coarse alluvial sediment from the volcanic or granitic rock and limestone hill. Areas located in the eastern part of Puerto Rico have been receiving influence from the volcanic rock. They have moderate to rapid permeability, moderate to high available water capacity and high natural fertility. Runoff is slow. Hazard of flooding is the major resource concern. The life zone is Subtropical Moist Forest.

272.3 Deep and Moderately Deep Reddish Clayey Soils in the Humid Alluvial Land

This area includes highly weathered and exceedingly leached soils. The soils are deep to moderately deep, well drained and moderately permeable. They formed from serpentenite

in the southwest, along the northwestern coast; they also developed from pre-weathered blanket deposits and small areas on remnants of old erosion surfaces on the St. John Peneplain in the Barranquitas area in the east-central Puerto Rico. Runoff is slow to medium on gently to strongly sloping slopes on foot slopes, marine terraces, and low rounded hills where they are found. Soils in the western area of the blanket deposits show a high base saturation which makes it much more fertile, for cropland production, but high infiltration and evapotranspiration rate, in addition to low water holding capacity required the use of irrigation system to increase production. Nutrient management is very important to increase productivity. Soil complexes are restricted to grazing, woodland or wildlife habitat because of the large number of out crops, stones and cobblestones. Some patches of soils are used for subsistence crops, but they are cultivated by hand. The life zone is Subtropical Moist Forest.

272.4 Deep Sandy and Gravelly Soils in the Humid Alluvial Land

This area includes soils that are highly leached and have low base saturation in subsurface. The soils are deep, have low fertility, medium runoff and are excessively drained. They are formed mostly in sand underlain by clay and plinthite on gently to sloping landscape. Others soils formed in the Arecibo area have stratified layers of accumulation of organic matter, usually in conjunction with aluminum and/or iron. They are on foot slopes, terraces and alluvial fans in humid to sub humid alluvial lands and blanket deposits. Slope, low fertility and available water capacity are major resource concerns. The amount of rainfall and distribution are not optimum for farming. The life zone is Subtropical Moist Forest.

272.5 Poorly Drained and Mucky Soils in the Humid Alluvial Land

This area includes dominantly nearly level soils on flood plains, adjacent to the sea, and in saline marshes, flats and ponds. These mineral and organic soils are very deep, somewhat poorly to very poorly drained, slowly permeable soils formed from alluvium from adjacent volcanic and limestone hills and mountains, in marine sediments and in organic materials. The climate is tropical semiarid. Most areas are used for wildlife. The life zone is Subtropical Moist Forest.

Resource Concerns

Soil erosion, agricultural water management and wildlife concerns predominate over the region. Soil and water management consists of measures to conserve these resources in rural areas, to improve and conserve soil quality, and water quality impaired by nonpoint source pollutants.

Major factors and activities affecting agricultural lands in this watershed include:

- Steep to very steep topography
- Flooding
- High stocking rates

- Pressure over the land and water quantity for real state development and other uses having over 1,200 persons/m^2 in the Island
- Agricultural activities
- Urban runoff
- Sand extraction
- Rural and isolated community waste waters
- Industrial discharges
- Municipal waste water discharges, and coffee processing plants

These factors have had a significant adverse environmental impact on the ecosystem such as soil erosion, fragmentation, change in wildlife habitat, and degradation of water quality and quantity. In general, runoff is greatest during two periods that coincide with periods when precipitation is greatest - in August through November and April through May. Average annual evaporation in Puerto Rico is estimated from pan evaporation to range from about 64 inches in the coastal areas to about 50 inches in the interior.

Soil Erosion Concerns

Soil erosion decreases soil quality and condition. Hurricanes and tropical storms that pass over or near the island produce great runoff that transports large volumes of sediment-rich waters to the coast and shelf (Gupta, 1988, 2000; Ahmad and others, 1993; Soler-López, 2001). These atmospheric disturbances have an adverse effect on land, coast and marine life. The coastal waters are influenced by discharge from the western watershed and torrential rains induce large discharge volumes of turbid water to the coast. (IN: Andrew, et. al.).

Figure 2. Satellite image of Puerto Rico showing hypopycnal sediment plumes at river mouths of (A) Río Guanajibo, and, (B) Río Grande de Añasco, (Source: USGS NED 2005)

In the mainland United States, about 10 percent of the sediment eroded from uplands is transported directly to the oceans by rivers. Some of the eroded sediment is trapped in reservoirs, but most is stored on hill slopes, flood plains, and other parts of stream

valleys. In Puerto Rico, where stream lengths are relatively short, channel gradients are high, stream valleys are steep and narrow, and where intense rainfall and high runoff are common, it is likely that more than 10 percent of the sediment eroded from uplands is discharged to the coast. (Meade and Parker, 1985; Meade and others, 1990) (IN: Andrew et. al.). Figure 2 shows hypopycnal sediment plumes at river mouths of Río Guanajibo and Río Grande de Añasco.

The potential annual average soil losses for bare soils in the Culebrinas-Guanajibo watershed range from 40 to 60 tons/acre/yr according to RUSLE2. With proper conservation systems these tonnages can be reduced to, or close to the soil loss tolerance level (T) for most soils in different farming systems. As an example soils such as Humatas, which is the most common in the coffee zone have an erosion potential of 77 tons/ac/yr in bare conditions. In a conservation system the erosion potential of Humatas can be reduced to 2.2 tons/ac/yr, which is less than T=5. Predominant soils in the watershed are: Humatas, Consumo, Coloso, Toa, Caguabo, Voladora, Nipe, Rosario and Múcara.

Water Quality Concerns

According to the Environmental Protection Agency *Safe Drinking Water Information System (SDWIS*, June 2006), the total population served by groundwater and surface water is about 527,198 persons. Only the municipality of Aguada is served 100% of groundwater sources. Table 3 shows a distribution of the population served by municipality.

Table 3. Population served by Community Water Systems, Non-Transient Non Community Water Systems and Transient Non Community Water Systems in the Culebrinas Guanajibo Watershed. The municipalities of Aguadilla and Yauco are excluded.

Municipality	Population served
Adjuntas	16,111
Aguada	42,082
Añasco	28,348
Cabo Rojo	84,775
Hormigueros	16,614
Lares	35,472
Las Marías	11,061
Maricao	6, 449
Mayagüez	98,434
Moca	39,697
Rincón	14,767
Sabana Grande	25,935
San Germán	37, 105
San Sebastián	70,348

According to USEPA 2004, pollutants and stressors impacting rivers in the watershed are: fecal coliforms, metals, cyanide, low dissolved oxygen, mercury and surfactants. The sources of pollutants can be described as: on site wastewater systems, agriculture (crop production, and animal feeding operations), urban runoff/storm, municipal point sources, industrial point sources, collection systems failure, landfill, and resource extraction.

Corvera R. (2005) found that average values for Total Phosphorus exceed the limits of 0.1 mg L^{-1} for eutrophication in two micro-watersheds of the Añasco River, with values ranging from 0.34 to 0.48 mg L^{-1} and suggests that these discharges are influenced by lack of residential sewage systems and small animals.

The Mayagüez Bay is one of the largest estuarine systems of the Puerto Rico. Coral reefs off Mayagüez Bay show a marked trend of deterioration toward the coastline, but the shelf-edge reef systems are in good condition. Farther north along the west coast is Rincón and coral reef systems are established throughout the relatively narrow shelf off Tres Palmas, including an elkhorn coral (*Acropora palmata*) biotope fringing the coastline that is probably the largest remaining stand in Puerto Rico. A series of patch reefs are distributed throughout the Rincón mid-shelf and there is a "spur-and-groove" coral reef formation at the shelf-edge. Off the northeast coast of Aguadilla, several small marginal coral reef systems are associated with rock outcrops at depths between 15-25 m. These reefs are strongly affected by intermittent discharge of the Culebrinas River. East of Aguadilla, the influence of large river plumes, a prominent feature of the coastline, constrains coral reef development, but hard ground and rock reefs with live corals are present throughout (Garcia-Saís 2005).

The western coast has an extension of 34.5 miles. Water was monitored for recreational and aquatic life. From thirty-tree water samples obtained from 12 segments and analyzed following the EPA guides, only 5% were threatened or impacted by onsite disposal systems and urban runoff. River waters monitored and analyzed for Total Maximum Daily Loads (TMDL's), present parent impairments for use. Those impairments include: metals, pathogens and mercury. (EQB 2001-2003). TMDL's are listed in Appendix III.

Wildlife Concerns

Shade grown coffee and residue management play an important role in habitat maintenance. Although conservation practices in coffee farms located in the upper part of the watershed have been applied for years, fragmentation still is of concern for wildlife species.

The western area, from Cabo Rojo towards Aguadilla, has a fringed coast with sand beaches, estuaries and some rocky littoral. Wetlands of special value such as the Bloodwood Forest (*Pterocarpus officinalis*) are present. A compendium of endangered species present in the area is included in Table 4.

Table 4. Endangered Animal and Plant Species Present in the Culebrinas-Guanajibo Watershed. (Taken in part from: Threatened and Endangered Species: Puerto Rico and the US Virgin Islands-Draft. Municipality List. US Fish and Wildlife Service. Caribbean Area).

Animal species	
Common Name	**Technical Name**
Golden coquí	*Eleutherodactylus jasperi*
Greeen Sea Turtle	*Chelonia mydas*
Hawksbill Sea turtle	*Eretmochelys imbricata*
Leatherback Sea turtle	*Dermochelys coriacea*
Puerto Rican Boa	*Epicrates inornatus*
Puerto Rican Broad Winged Hawk	*Buteo platypterus brunnescens*
Puerto Rican Crested Toad	*Peltophyrene lemur*
Puerto Rican Nightjar	*Caprimulgus noctitherus*
Puerto Rican Plain Pigeon	*Columba inornata wetmorei*
Puerto Rican Sharp Shinned Hawk	*Accipiter straitus venator*
Roseate Tern	*Sterma dougallii*
West Indian Manatee	*Trichenchus manatus*
Yellow Shouldered Black Bird	*Agelaius xanthomus*
Plant Species	
Common Name	**Technical Name**
Bariaco	*Lyonia truncata var. proctori*
Cobana negra	*Stahlia monosperma*
Higuera de sierra	*Crescentia portiricensis*
Manaca Palm	*Calytronoma rivalis*
Nigua Tree	*Cornutia obovata*
Nogal	*Juglans jamaicensis*
Palo de rosa	*Ottoschulzia rhodoxylon*
St. Thomas Prickly Ash	*Zanthoxylum thomasianum*
Three awn	*Aristida portoricensis*
Valh's Boxwood	*Buxus vahlii*

Figure 6. The endangered Puerto Rican boa (*Epicrates inornatus).*

There are several areas of conservation in the watershed. Three state forests, two agricultural reserves, wetlands, and areas of critical concern comprise part of the important areas of conservation. These have been identified by the PR Department of Natural and Environmental Resources as important wildlife habitat. These include: Caño Boquilla and La Cipiana Swamps in Mayagüez and Añasco; Caño Corazones in Mayagüez, Maricao State Forest, Susúa State Forest in Sabana Grande, Cayures Swamp in Aguada; Guilarte Forest in Adjuntas; Joyudas Lagoons in Mayagüez-Cabo Rojo, part of the Karstic Zone in Moca-Aguadilla; and three valleys of special value for agriculture: Coloso, Añasco and Guanajibo.

The local seashore is ideal for nesting of the endangered sea turtles; the endangered West Indian Manatee has also been sighted close to the seashore. The humpback whale (*Megaptera novaengliae*) uses the Mona Passage, during their annual migration.

Located at Mayagüez, the Caño Boquilla natural system consists of mangrove and brackish estuarine swamp forest. The latter—a rare coastal ecosystem in Puerto Rico—is dominated by Bloodwood (*Pterocarpus officinalis*). Caño Boquilla is home to 29 bird species, as well as reptiles, amphibians, fish, and crustaceans of commercial and recreational value, mollusks, and marine mammals. Caño Corazones is threatened by the government flood control plan. An important point of this area is the feasibility to develop an educational area. The Maricao State Forest encompasses the municipalities of Maricao, Mayagüez, Sabana Grande and San Germán. The forest was created in 1919 by the government of Puerto Rico. It has an extension of 10,569 acres. Some of the endemic species identified in this forest are: Jaguey Colorado (*Ficus sintenesii*), Jaguilla (*Magnolia portoricensis*) and Roble Cimarron (*Tabebuia haementha*). The Susúa State Forest has 3,174 acres and includes the municipalities of Yauco and Sabana Grande.

A NRCS general habitat assessment tool will be used to evaluate habitat conditions for wildlife species. Copy of this tool is attached in the Appendix IV.

Wildlife resource concerns will focus in Tier II.

For a map showing areas of conservation within the Culebrinas-Guanajibo Watershed see Appendix V.

Conservation measures applied and properly maintained by landusers have alleviated these factors in several farmlands.

Relevant Studies or Assessments in the Watershed

There are several studies made in the watershed by federal, state and local agencies or institutions regarding the performance of different resources in the watershed. A compendium of these studies is listed in Table 5.

Table 5. Compendium of projects or studies conducted in the Culebrinas-Guanajibo Watershed

Watershed Surveys and Planning (PL-06)		
Río Culebrinas	Coloso Valley Watershed Assessment	FY 2003
Environmental Statement	Añasco River Watershed	March 1976
Supplemental Watershed Work Plan	Añasco River Watershed	July 1973
Watershed Protection and Flood Prevention Operations (WF-08)		
Environmental Statement	Añasco River Watershed	March 1976
Supplemental Watershed Work Plan	Añasco River Watershed	July 1973
Watershed Rehabilitation (WRHB-07)		
Assessment Report Añasco River Watershed Ajíes and Dagüey Dams	Añasco River Watershed	2003
University of Puerto Rico		
Nitrogen and Solid Sediments present in two micro watersheds of the Añasco River Great Watershed.	Añasco River Watershed	2005
Validación del Índice de Fósforo del Caribe y Evaluación de Prácticas de Manejo de Desechos Orgánicos en Fincas de Producción Animal de Puerto Rico. Research completed in the Culebrinas Watershed.	Culebrinas River Watershed	2005
Population Ecology and Reproductive Behavior of the Endangered Buxus vahlii Baillon (Buxaceae).	Culebrinas River Watershed	2001
Characterizing Zooplankton and Microkekton Diel Vertical Migration at the Western Puerto Rican Shelf/Slope Break.	Añasco River Watershed	2005
Estudio de Márgenes de Mercadeo en la Empresa de Carne de Res en la Región Agrícola de Mayagüez, Puerto Rico	Culebrinas-Guanajibo Watershed	2005
Special Characterization of Sandy Beaches in Western Portion of Puerto Rico	Culebrinas-Guanajibo Watershed	2005

P Balance in Puerto Rico. Study completed in the Culebrinas Watershed. UPRM	Culebrinas Watershed	2005
Water Use, Management and Limnology of the Lower Rio Culebrinas, PR. Jorge R. Ortíz Zayas, CSA Group.	Culebrinas Watershed	2004
Qualitative Study of Phytoplankton in Lower Grande de Añasco River and Tributaries. Martha Espinoza Lucero, Department of Biology, University of Puerto Rico at Mayagüez	Añasco River Watershed	2005
Field Validation of Rural Community Water Treatment Plant in San German, PR.	Guanajibo River Watershed	2005
Development of TMDL's in Rio Yagüez and Rio Guanajibo Watersheds	Yagüez and Guanajibo Watersheds	2006
Land Use Classification of the Mayagüez Bay Watershed	Guanajibo, Yagüez, Añasco Watersheds	2005
Nutrient Discharge from Mayagüez Watershed	Mayagüez Watershed	2004
Monitoring the Water Quality Parameters of Mayagüez Bay	Yagüez Watershed	2004
Hydrologic/Hydraulic Study for the Design of a Bridge over the Rio Yagüez and Quebrada Lavat in Mayagüez	Yagüez Watershed	2004
Development of a Comprehensive Integrated Management Plan for the Mayagüez Bay Watershed	Guanajibo, Yagüez, Añasco Watersheds	Ongoing
Comprehensive Approach for Flood Hazard Mitigation in Rio Grande de Añasco	Añasco Watershed	Ongoing
Nutrient Discharges from Mayagüez Bay Watershed	Yagüez Watershed	Ongoing

Census and Social Data

A. Land and Social Data

There is an estimated population in the Culebrinas-Guanajibo Watershed of 457,185 persons and 190,472 housing units (2000 U.S. Census Bureau). With a total of 322,560 acres within the watershed, and about 163,900 acres are in farmland, representing about 50% of the land use. From about 6,500 farmers, close to 82% (or 5,360), persons are considered limited resource farmers (2002 US Census of Ag.).

B. Archaeological Features of Special Concern

Studies reveal that it was in the western coast that Christopher Columbus disembarked in what he named the island of San Juan Bautista in 1493. Many Taíno-Indian artifacts play grounds or *bateyes*, conch yards or *concheros* and stone carving or *petroglifos* (see Figure

7); have been found across the entire western part of Puerto Rico. According to genetic analyses, it has been demonstrated that few close descendents of the Taíno Indians still live in the western part of the island. Taínos are recognized as the very first Native American Indians to greet and meet Christopher Columbus in the new world. Some of the most known English words with Taíno language roots are: hurricane, tobacco, mays, and hammock.

Other features of archaeological importance include: ruins of a Franciscan friars monastery built in Aguada by 1516; a lighthouse that is still being used built in 1893 in the coast of Rincón; an active old colonial Spanish city called San Germán, founded in 1574; the Church of Porta Coeli built during the fist decade of 1600; a Catholic church in Hormigueros where people claim the apparition of Virgin Mary in 1874; the old Columbian wells in Aguada, which constitute artisan wells where colonizers used to obtain fresh water for their ships and voyages; and many old sugar mills or *ingenios azucareros* built by the 17th through 19th centuries by colonizers, Indians and slaves from Africa.

Figure 7. Some of the "Petroglifos" (stone carving), found in the watershed.

Resource Conservation-Progress Data

Resource conservation has been applied and managed through the watershed science the creation of the Conservation Districts in Puerto Rico under Public Law 211 of March 26, 1946. Districts within this watershed include: Culebrinas, Noroeste, Oeste, Sur and Suroeste. Practices applied and managed that account for this watershed during 2003-2005 includes: 78,000 acres in erosion reduction; 6,000 acres of nutrient management; 3,800 acres in prescribed grazing; 4,100 acres in conservation buffers; 3,100 acres in pest

management; 3,100 acres in wildlife habitat; and over 1,000 acres in other conservation practices such as residue management-no till, besides over 10 total comprehensive management plans and waste management plans, and about 15 ecological coffee processing plants (PRMS FY04 & FY05).

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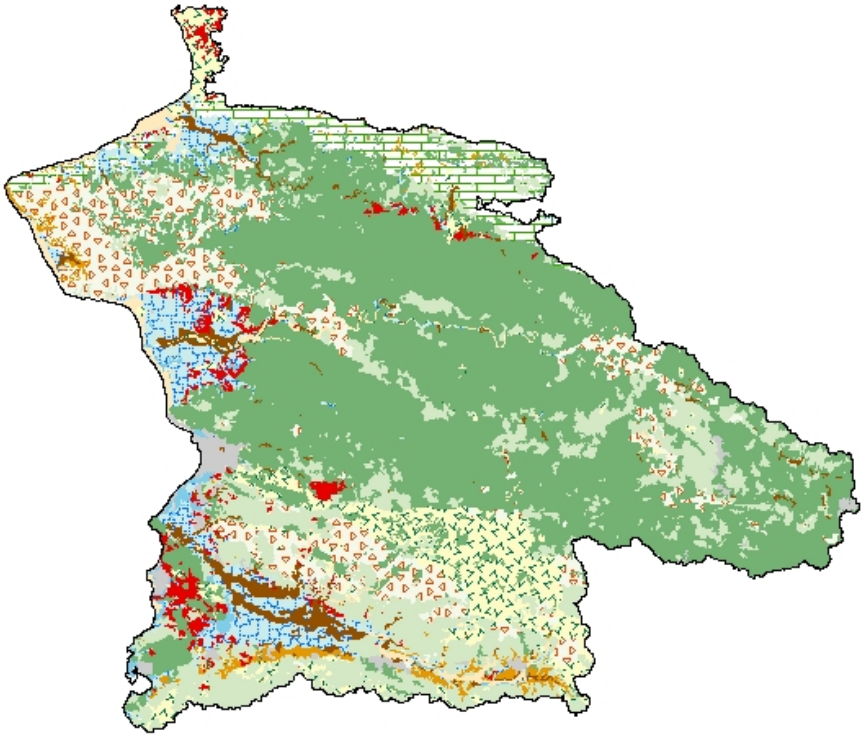
APPENDIX I

Characteristics of Water Bodies in the Culebrinas-Guanajibo Watershed

Water Body	Drainage Area (sq. miles)	Municipalities	Length (km)	Outlet
Río Grande de Añasco	143	Añasco, Mayagüez, Las Marías, San Sebastián, Lares, Maricao, Yauco, Adjuntas	64	Añasco Bay
Río Yagüez	13.7	Mayagüez	20	Mayagüez Bay
Río Guanajibo	127	Sabana Grande, Cabo Rojo, Maricao, San Germán, Hormigueros, Mayagüez, Las Marías	38	Mayagüez Bay
Río Culebrinas	105	San Sebastián, Moca, Aguadilla, Aguada	40	Aguadilla Bay

APPENDIX II

Common Resource Areas: Culebrinas-Guanajibo Watershed



Legend

- Deep Redish Clayey Soils in the Humid Volcanic Upland
- Shallow Clayey Soils in the Humid Volcanic Upland
- Shallow Sandy and Gravelly Soils in the Humid Volcanic and Plutonic Upland
- Shallow Soils in the Humid Calcareous Upland
- Deep Dark Clayey Soils in the Humid Alluvial Land
- Rock Outcrop
- Deep Gleyed Soils in the Humid Alluvial Land
- Deep Dark Friable Soils in the Humid Alluvial Land
- Deep and Moderately Deep Reddish Clayey Soils in the Humid Alluvial Land
- Deep Sandy and Gravelly Soils in the Humid Alluvial Land
- Poorly Drained and Mucky Soils in the Humid Alluvial Land
- Other Land
- Water

APPENDIX III

Total Maximum Daily Loads Section 303(d) for Culebrinas-Guanajibo Watershed. (Source: USEPA 2004).

2004 Section 303(d) List for PUERTO RICO

Waterbody Name	Total Size acres	Impairment acres	State Impairment	Parent Impairment
LAGO GUAYO	285	285	LOW DISSOLVED OXYGEN	OXYGEN DEPLETION
EUTROPHIC DUE TO NUTRIENTS FROM UNKNOWN				
STREAM/CREEK/RIVER				
Waterbody Name	**Total Size miles**	**Impairment miles**	**State Impairment**	**Parent Impairment**
RIO YAGUEZ	43	22	ARSENIC	METALS (OTHER THAN MERCURY)
			FECAL COLIFORM	PATHOGENS
			SURFACTANTS	OTHER CAUSE
RIO GUANAJIBO	328	60.2	ARSENIC	METALS (OTHER THAN MERCURY)
			LEAD	METALS (OTHER THAN MERCURY)
			CYANIDE	TOXIC INORGANICS
			FECAL COLIFORM	PATHOGENS
		23.6	ARSENIC	METALS (OTHER THAN MERCURY)
			FECAL COLIFORM	PATHOGENS
		17.4	ARSENIC	METALS (OTHER THAN MERCURY)
			COPPER	METALS (OTHER THAN MERCURY)
			FECAL COLIFORM	PATHOGENS
RIO CULEBRINAS	313	37.9 MILES	ARSENIC	METALS (OTHER THAN MERCURY)
			FECAL COLIFORM	PATHOGENS
		28.3 MILES	ARSENIC	METALS (OTHER THAN MERCURY)

			COPPER	METALS (OTHER THAN MERCURY)
			MERCURY	MERCURY
			FECAL COLIFORM	PATHOGENS
RIO GRANDE DE AÑASCO	432	26.9	ARSENIC	METALS (OTHER THAN MERCURY)
			COPPER	METALS (OTHER THAN MERCURY)
			FECAL COLIFORM	PATHOGENS
		24.4	ARSENIC	METALS (OTHER THAN MERCURY)
			CADMIUM	METALS (OTHER THAN MERCURY)
			COPPER	METALS (OTHER THAN MERCURY)
			LEAD	METALS (OTHER THAN MERCURY)
			FECAL COLIFORM	PATHOGENS
		20.6	COPPER	METALS (OTHER THAN MERCURY)
			FECAL COLIFORM	PATHOGENS

APPENDIX IV Wildlife Assessment Criteria that will be used in the Watershed

CONSERVATION SECURITY PROGRAM _ WILDLIFE HABITAT EVALUATION WORKSHEETS

Instructions

1. In order for a producer to receive an enhancement payment(s) above the 0.5, someone trained in using the habitat assessment procedure MUST go to the field. The Self Assessment can get a producer to the 0.5 level but a field visit is required for any enhancement payments based on 0.6, 0.7,.1.0. The person going to the field does not have to be a NRCS Biologist but they must be trained in using the habitat assessment procedure.

2. Fields must be assessed individually. Weighted averages are NOT allowed. Producers are being paid for land that meets CSP requirements. If a producer has a large field that meets 0.5 (or higher) and then some smaller fields that do not meet 0.5, you cannot average them together to get all fields to the 0.5 level. You can use some common sense when you are doing this. For example, if you have 2 fields separated by a drainage ditch, then I would consider them as one field. But if there is land (a block of woods for example) separating 2 fields submitted for CSP, then each field must be assessed.

3. Land used for habitat assessment MUST be under the producers control and needs to be adjacent to the land being offered for CSP. For example, land a ½ mile away cannot be used in the habitat assessment process - even if the producer owns it. Adjoining landowners (another producer) land may NOT be used in seeing if a landowner meets 0.5 on the assessment procedure. The exception to this is if the land adjacent to the producers land is in permanent protection. Land such as State Natural Reserve, State Forest, National Wildlife Refuges, etc. can be used.

4. Select the appropriate worksheet for the habitat type (land use management system) on which one or more wildlife practices will be applied.

• Use one worksheet per management system, which may include one or more fields.
• Crop fields with the same crop rotation and management practices should be grouped for habitat evaluation.
• Fields which are managed primarily as permanent hayland should be evaluated on a separate worksheet from fields managed primarily for pasture.

5. Evaluate the benchmark condition (existing conditions without the proposed wildlife practices) and the planned condition (with the proposed wildlife practices).

• Record the point score that most closely fits each item.
• Add up the points for the benchmark condition and the planned condition.
• Divide by the maximum possible score to get the benchmark and planned index values for the system.

6. If you are evaluating more than one system, record the results from each worksheet on the summary worksheet.

Use the summary worksheet to calculate the net effect of the wildlife management plan (overall planned index minus the overall benchmark index).

CROPLAND HABITAT INDEX

Name: _____ Tract No._____
Date: _____ Field No. _____
Evaluated by: _____ Acres: _____

	POINTS	BENCHMARK	PLANNED
Crop Residue Management			
Residue >30	10	○	◉
Residue 10 - 30%	5	○	○
Residue <10%	2	◉	○
Crop Rotation (For coffee plantation use coffee or alley cropping criteria)			
Coffee or alley cropping	0	○	◉
Row crop (2 crops - 2 years or more idle)	10	○	○
Rotation (2 crops - 1 year idle)	7	○	○
Rotation (2 different crops)	5	○	○
Continuous row crops	1	◉	○
Coffee or other alley cropping (For clean crops use the crop rotation criteria)			
Crop rotation	0	○	○
21% - 30% of shade and diversified farmer	10	○	◉
10% - 20% of shade and diversified farmer	3	○	○
Sun and monoculture plantation	1	◉	○
Crop Management			
>10% unharvested crop	10	○	◉
1-10% unharvested crop	5	○	○
Total crop harvested	2	◉	○
Adjacent to Important Ecological Area (IEA) or woody vegetation (close canopy and open understory), border not mowed			
> 20 feet wide or not adjacent to woody vegetation	20	○	◉
11 - 20 feet wide	10	○	○
5 - 10 feet wide	5	○	○
No border	0	◉	○
Pesticide management and use			
Integrate Pest Management	10	○	◉
Implement Pesticide Management	5	○	○
Lack of Pesticide Management	0	◉	○
(A) Total Cropland Habitat Points (60 maximum)		6	60
(B) Cropland Habitat Index (Total Points/60)		0.10	1.00

GRASSLAND/HAYLAND HABITAT INDEX

Name: _____ Tract No._____

Date: _____ Field No. _____

Evaluated by:_____ Acres: _____

INDICATOR	POINTS	BENCHMARK	PLANNED
Composition			
Two forage grass species with 11-30% of legume species or single forage grass species with >30% of forage legume species	10	○	◉
Two forage grass species with 5-10% of legume species or single forage grass species with 11-30% of legume forage species.	6	○	○
Two forage grass species with <4 of legume species or single forage grass species with 5-10% of forage legume species.	3	○	○
Single forage grass species with <4 % forage legume species.	1	◉	○
Fence (includes at least 2 species important for wildlife)			
Living fencepost around 100% of the field	10	○	◉
Living fencepost around 50-75% of the field	8	○	○
Living fencepost around 25% of the field	3	○	○
No living fencepost or no important wildlife species	0	◉	○
Percent of herbaceous cover			
≥ 80%	10	◉	◉
71 - 80%	5	○	○
≤70%	1	○	○
Adjacent to Important Ecological Area (IEA) or woody vegetation (close canopy and open understory), border not mowed			
> 20 feet wide or not adjacent to IEA or woody vegetation	20	○	○
11 - 20 feet wide	10	◉	○
5 - 10 feet wide	5	○	○
No border	0	○	◉
Pesticide management and use			
Integrated Pest Management (IPM)	10	○	◉
Implement Pest Management	5	○	○
Lack of Pest Management	0	◉	○
Livestock excluded from streams and other waterways			
Yes or Not applicable	10	○	◉
No	0	◉	○
(A) Total Grassland/Hayland Habitat Points (70)		21	50
(B) Grassland/Hayland Habitat Index (Total Points)		0.30	0.71

RIPARIAN CORRIDOR HABITAT INDEX

Name: _____ Tract No._____

Date: _____ Field No. _____

Evaluated by: _____ Acres: _____

	POINTS	BENCHMARK	PLANNED
Condition of stream channel and banks			
Minimally disturbed: generally stable channel & banks; mostly natural conditions and vegetation consists of a mix of vegetation types and ages, suggesting the absence of any recent disturbance.	10	○	◉
Moderately disturbed: some streambank erosion, poor vegetation suggesting a recent disturbance.	5	○	○
Significantly disturbed: severe bank erosion/gullies, streambanks not vegetated, trash.	0	◉	○
Water quality			
Good: water clear with not significant algal or microalgae, rock may be slimy but algae not obvious, minimal pollution by sediment, nutrients, contaminants, etc.	10	○	◉
Fair: large clumps of macroalgae present, or distinctive green/brown scums visible on bottom or sides of stream, moderate sediment loading & turbidity during storm events; some algae during low flows.	5	○	○
Poor: water distinctly green or channel chocked with grasses; pollution by sediment, nutrients, contaminants is evident (e.g., heavy sedimentation, excessive algae, chemical spills).	0	◉	○
Plant composition in the riparian buffer			
Predominantly trees and/or shrubs, diverse vegetation.	10	○	◉
Predominantly herbaceous plants (60%) cover.	5	○	○
Predominantly crops, bare ground, dirt-lined or fully channelized and lined.	0	◉	○
Riparian Buffer width			
> 30 feet wide	30	○	◉
21- 30 feet wide	20	○	○
15 - 20 feet wide	10	○	○
<15 feet wide or no permanently vegetated buffer.	0	◉	○
Livestock or domestic animals excluded from streams and other waterways			
Yes	10	○	◉
No	0	◉	○
Pesticide use in the buffer zone			
No	10	○	◉
Yes	0	◉	○
Trash/litter (indicator of urban/human influence			
No litter or trash is present	10	○	◉
Litter or trash evident but not predominant	5	○	○
Abundant trash, unsanitary waste (animal carcass or excrement), diapers, or dead fish	0	◉	○
(A) Total Riparian Corridor Habitat Points (90 maximum)		0	90
(B) Riparian Corridor Habitat Index (Total points/60)		0.00	1.00

FORESTLAND HABITAT INDEX

Name: _____ Tract No._____
Date: _____ Field No. _____
Evaluated by:_____ Acres: _____

	POINTS	BENCHMARK	PLANNED
Livestock are excluded from forestland?			
Yes	5	○	◉
No	2	◉	○
Diversity			
>7 tree species; several size (dbh) classes present	10	○	◉
3-6 species and several size classes present	5	○	○
2 species and only 1 size class present	3	◉	○
Bird diversity			
> 3	10	○	◉
1-3	5	◉	○
Understory composition			
Cover with vegetation and leaf litter	10	○	◉
Cover with vegetation	8	○	○
Primarily bare ground	0	◉	○
Native/naturalized tree			
> 25%	10	○	◉
<25 %	5	◉	○
Pesticide use			
No	10	○	◉
Yes	0	◉	○
(A) Total Forest Habitat Points (55 maximum)		15	55
(B) Forest Habitat Index (Total points/55)		0.27	1.00

UPLAND WILDLIFE HABITAT MANAGEMENT EVALUATION

WORKSHEET

SUMMARY

Name: _____ Tract No._____
Date: _____ Field No. _____
Evaluated by: _____ Acres: _____

(a) Habitat Type (Land Use)	(b) Field No.	(c) Acres	Benchmark (Before) Condition			Planned (After) Condition		
			(d) Habitat Index	(e) Weighted Index (Column c x Column d)	(f) Overall Index (Total Column e/Total Column c)	(g) Habitat Index	(h) Weighted Index (Column c x Column g)	(f) Overall Index (Total Column h/Total Column c)
		12	0.5	6		12	0.8	
		0	0	0		0	0	
		0	0	0		0	0	
		0	0	0		0	0	
		0	0	0		0	0	
		0	0	0		0	0	
		0	0	0		0	0	
		0	0	0		0	0	
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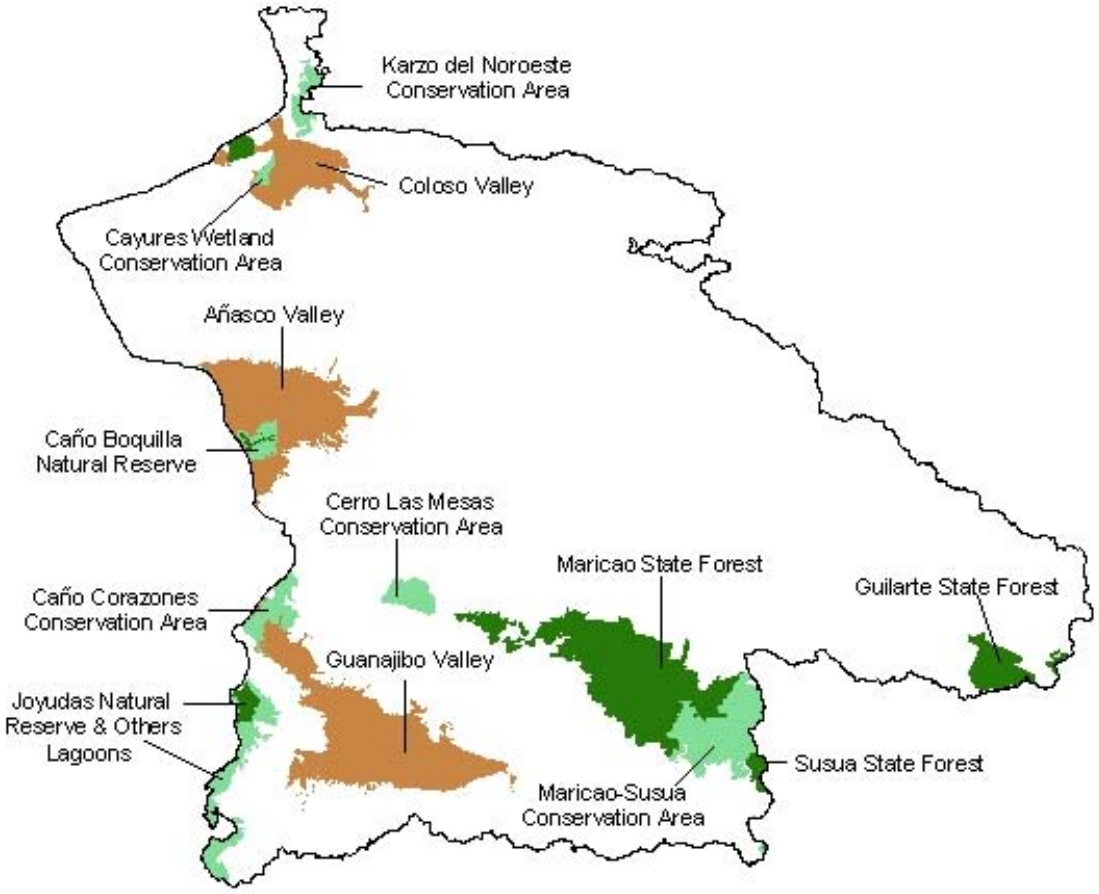
		0	0	0		0	0	
		0	0	0		0	0	
		0	0	0		0	0	
		0	0	0		0	0	
		0	0	0		0	0	
Totals		12		6	0.50		0.8	0.07

APPENDIX V

Reserve Areas within the Culebrinas-Guanajibo Watershed



I certify that the soils are digitized in this watershed and the offices in the watershed have the ability to use RUSLE2.

JUAN A. MARTÍNEZ
Director, Caribbean Area

July 13, 2006
Date