

# *Leptocereus grantianus*

*The Unique Cactus Endemic to Culebra*



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# **Leptocereus grantianus<sup>1</sup>**

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## **Introduction:**

A significant new population of the **Leptocereus grantianus** cactus, an endangered species that is both federally and locally listed, was first identified on the morning of September 26, 2003 in the **Villa Mi Terruño (VMT)** proposed project site on the island of **Culebra**, Puerto Rico. On that fateful morning, field biologists of the Environmental Consulting Group (ECG) were performing an investigation of the **VMT** site for the Environmental Impact Statement's **Flora & Fauna Survey**. During the investigation, they noted the possibility of having found the endangered cactus in two separate transects on the southern side of the central hill and on the southern hill facing **Playa Cascajo** and the Caribbean Sea. Only one highly exposed population of 50 individuals was previously known to grow in the **Punta Melones** area of **Culebra** on a rocky, exposed shoreline cliff next to a public beach.

**Leptocereus** was originally described as a subgenus of the **Cereus** genus in 1905 by Alvin Sargent. It was raised to full genus status in 1920 by Nathaniel Britton and Joseph Rose.<sup>2</sup>

**Leptocereus** is a bushy, treelike but generally sprawling vine-like or arching shrub, with spiny areoles, thin ribbed with notched margins, many jointed segmented cacti with tubular to bell shaped flowers usually white or pale green. It is native of Cuba, Hispaniola, Puerto Rico and Culebra with 15 species, many native to Cuba.<sup>3,4</sup> The **Leptocereus** name is derived from the Greek "*leptus*" which means thin from the ribs or slender blades of the stems and "*cereus*" meaning waxy or waxy for its luster. It is generally rare to encounter these species in cultivation.

There are four keys to differentiate **Hylocereus trigonus** from the **Leptocereus grantianus** cactus genus. Growth habit, spines, spine areoles location and flowering and fruiting, **Hylocereus trigonus** is a sprawling, climbing cacti that needs support from trees or sturdy mature vines or bushes in dry tropical forest while the **Lepto cactus is self supporting**. **Hylocereus trigonus** many jointed elongated stems, without leaves, are thin **three ribbed** or thickly three angled, strongly undulated marginally, with areoles with spines borne **at the tip of the undulations**. The **Lepto cactus'** areoles with tiny fuzzy spines when very young seem spineless and the areoles are located **at the base of the undulations**. The stems have a mix of three to five ribs. The flowers of the **Lepto cactus are smaller**, white-yellow or cream colored,

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<sup>1</sup> Britton, N. L., 1933. **An Undescribed Cactus of Culebra Island, Puerto Rico**, Cactus and Succ. Soc. Amer. 5:469.

<sup>2</sup> Britton, N.L. and Rose, J.N., 1919-1923, **The Cactaceae**, 4 Vols., Carnegie Institution, Washington, D.C.

<sup>3</sup> Britton, N.L. and Rose, J.N., 1919-1923, **The Cactaceae**, 4 Vols., Carnegie Institution, Washington, D.C.

<sup>4</sup> Edward F., **The Cactus Family**, 2001, The Timber Press, Portland Oregon

oblong-ovate, obtuse and about 8 millimeters long with many stamens and yellow anthers. The stigma lobes are several and small. The *Hylocereus cactus*' flowers are the largest in the cacti family. It is best known for producing exotic, large fruits, known as Dragon Fruit. The fruits are larger than an orange, with pinkish-red skins accentuated by green scales.



*Hylocereus trigonus*

*Hylocereus trigonus*

*Leptocereus grantianus*

The early observations of the three possible cactus populations in the **VMT** property from November 2002 to August, 2003 were later only confirmed on the upper southern hill site facing **Playa Cascajo** and discharged in the other two locations on the central hill. The confirmed site was an extraordinary find of the second known mature population of an endangered natural flora species that is only found in **Culebra**. It was significant because of the species' extension over several areas of the southern hill, the size of the population and number of individuals cacti plants found, and its relatively isolated location on protected private property that could better guarantee the survival of the species. Since late 2003, **VMT** management and personnel have been protecting the new population and the author has been investigating and, since June 2006, identifying additional sites on the coastal cliff of Playa Cascajo as well as photographing and observing the life cycle of the plant. All photographs included in this article are protected by copyrights rights of the photographer, Manuel H. Dubón, and its licensee, **Fundación Mi Terruño, Inc. (FMT)**, a non-profit educational, scientific foundation that discharges the conservation and educational functions and acts as title holder of the set aside lands and protective easement rights.

### The VMT Ecological Corridor:

**Villa Mi Terruño** is a *model sustainable project of advanced master planning*, proposed on a **104 cuerdas**<sup>5</sup> land site. It is located on three hills at the center of the **Playa Sardinias II Ward** in the **Punta Soldado** southeastern peninsula extension of the island of **Culebra**.

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<sup>5</sup> One (1) cuerda = 0.971 acres.

VMT is a sustainable development that sponsors a non-profit foundation, **Fundación Mi Terruño Inc. (“FMT”)** dedicated to sustainable community development and improvement and the ecological, scientific and educational research and conservation of the local marine and land flora and fauna. The proposed project’s Master Plan will only **gradually develop 33.7 cuerdas of land over a period of 15 years. P.R. {Panning Board Regulations do not permit fragmented proposed Master Plans and require the entire site to be master planned regardless if the original long term plan will be entirely developed for financing or economic demand reasons.**

**Due to its sustainable and conservation design goals, the developer will set aside 70 cuerdas to protect the tropical Caribbean island dry forest.** Included in the 70 non-developed cuerdas is a **38 cuerda contiguous corridor** that sets aside the most undisturbed dry tropical forested areas of the site to protect and conserve for future generations significant endemic vegetation. **Such an extensive set aside to protect the natural environment is unique to VMT and generally unknown in propose development projects of this type.**

*The ecological reserve is referred to as the **VMT Ecological Corridor** which includes the **Leptocereus grantianus cactus habitat areas.***

VMT is not a 104-cuerda development, as incorrectly alleged by some. **As a matter of fact, the 28-cuerda portion of the site where the *Leptocereus grantianus* cactus grows is currently zoned R0–1-C, which permits the construction of two (2) homes per cuerda or 56 homes in total. All but three (3) of these 56 homes were “relocated” from the Playa Cascajo drainage basin to the less sensitive areas of the property, thereby extending the VMT Ecological Corridor to protect the endangered cactus species and the Cascajo Beach coastal area drainage basin.**

#### **Species Status:**

***Leptocereus grantianus, Britton*** (no known common name), is a sprawling, nearly spineless cactus, endemic and found only in **Culebra**. Only one population, consisting of approximately 50 individuals, was known to exist on the island in the area of **Punta Melones**. This first identified population is designated as **Culebra Natural Population One**. This population is threatened by intense pressure for residential and tourist development, as well as by its location on a rocky, unstable shoreline, approximately 8 to 10 meters from high tide. The species’ endangered classification has not changed since 1993. The USF&WS is currently performing the required 5-year review under Section 4(c)(2) of the Endangered Species Act (ESA), as amended.



*Leptocereus grantianus* was listed as an endangered species on February 26, 1993 in accordance with the Endangered Species Act of 1973, as amended.<sup>6</sup> “Critical habitat has not been designated for this species because of the risks of vandalism as well as its potential for over-collection for use as an ornamental.”<sup>7</sup>

Three new population areas are known to exist in the **VMT** site. **The second population site** was first identified on the morning of September 26, 2003 in **Villa Mi Terruño** during the EIS Flora and Fauna survey work on the proposed project site and subsequently confirmed. This second identified population is designated as **Culebra Natural Population Two**. In flora investigation and photographic work carried out by the author during June 2006, two additional sites were identified on the coastal cliff of Playa Cascajo in the **VMT** site. These two coastal cliff identified new populations are designated as **Culebra Natural Population Three**.

During the construction in 2012 of a new home in a ridge top in the **Punta Soldado** beachfront area a new population consisting of four plants was discovered in an isolated area of some forty square feet of the hilltop ridge saddle. This fourth identified new population is designated as **Culebra Natural Population Four**. This population is later additionally described.

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<sup>6</sup> 58 FR 11550, 11552, February 26, 1993.

<sup>7</sup> U.S. Fish and Wildlife Service, 1994, *Leptocereus grantianus* Recovery Plan, U.S. Fish and Wildlife Service, Atlanta, Georgia.

## The Geographic Location and General Description of Culebra island

**Culebra, Puerto Rico** is a small **Caribbean** tropical island located to the east of **Puerto Rico**. It forms part of the island archipelago of the eastern platform belt of the **Greater Antilles Arc** in the **West Indies**. **Culebra** has of one inhabited main island and 23 smaller uninhabited offshore cays of exceptional beauty and natural attractions. **It is located 18 degrees and 19.01 minutes north of the Equator and 65 degrees and 17.24 minutes west of the Prime Meridian.** The island enjoys a temperate tropical climate refreshed by the northeastern trade winds. Its seasonal and limited rainfall establishes **Culebra** as a **dry tropical forest ecosystem**. Only certain plants could naturally establish themselves in the specific life zone or selective microclimates.

**Culebra** island is located approximately 27 km (17 miles) east of the “big” island of **Puerto Rico**, approximately 19 km (12 miles) west of **St. Thomas, U.S. Virgin Islands (USVI)**, and approximately 14 km (9 miles) north of the island of **Vieques** all on the **Eastern Puerto Rico Geologic Platform Foundation** of the **Northeastern Geologic Platform Bank of the Greater Antilles Arc**. The **Puerto Rico Platform** extends from the western end of the island of Puerto Rico to the USVI and British Virgin Islands (BVI) to the East. Like all islands in the **Puerto Rico Platform, Culebra** and its adjacent keys form part of an arc of island underlain by volcanic and intrusive rocks formed during the **Pleistocene period**. Its three largest keys are **Culebrita, Cayo Norte** and **Luis Peña**. In appearance they resemble **Culebra** in that all have rugged coastline, cliff and gentle to steep hills, sandy beaches and vegetation cover in moderate to extreme dense coverage. The smaller keys have none or sparse vegetation covers and is primarily solid rock all around a rugged coast and in a few tiny beaches may be found. The island is very scenic with integrated views of the sea, land and sky and beautiful coves and beaches.

The dominant topographic features of the **Isla de Culebra** are the two hill ranges in the north side and south side of the island, one wider and trending northwest-southeast and the other trending east-west. The two dominant scenic ranges are separated by a large navigable inner inlet designated as **Ensenada Honda** that divides it into a north side and south side. These features allow that the **Isla de Culebra** be described as a Maine Lobster claw or lobster claw shaped. The northwestern lower hill range of the Flamenco Peninsula form the base and the two dominant hill ranges in the north side and south side of the island form the claw and the water inlet provides the open space between the claws.

**Culebra** is approximately seven miles long by five miles wide (11 km by 8 km) and occupies an area of approximately 11.6 square miles or 28 square kilometers (6,741 *cuerdas*). It has some of the most beautiful beaches of the world. It predominantly has shallow shoreline coastal zones behind its beaches and rapidly rises from coastal cliffs to a hilly topography. Its highest hills are **Monte Resaca** with an elevation of 650 feet (198 m) and **Cerro Balcón** with 541 feet (134 m) on the north side. The central hill of the **VMT** parcel is the highest elevation point on the southern side of the island, in the Playa Sardinias II Ward, with an elevation of 350 feet (107 m).

The island is divided into six wards; **Dewey, Flamenco, Fraile, Playa Sardinias I, Playa Sardinias II and San Isidro**. The island and its cays have an approximate area of 7,700 acres of which 6,747 acres are located in the main **Island of Culebra** and the remaining in the surrounding islands and cays. **Cayo Luis Peña** has 315 acres, **Cayo Norte** 303 acres and **Culebrita** 266 acres and 69 in the smaller cays. Including **Cayo Luis Peña** and **Culebrita** the Federal Government had title to 34.7 % of the lands in **Culebra** until the **US Navy** ceased operations. In 1977 the **US Navy** declared in excess of its needs **1.346 acres**, these included the Island of **Culebrita** a, 286 acres around the airport and 177 acres on the southern end of **Fulladosa Peninsula**, and the coastal strip around the northeastern, eastern and southern coast of **Culebra**.<sup>8</sup>

**Culebra** was discovered by **Columbus** on his second trip to the new world. It was the last offshore island of Puerto Rico to be colonized and inhabited during the Spanish colonial period. It was originally inhabited by the **Táino Indians**. The Indians were displaced and the island remained uninhabited during most of the European colonization period. It was occasionally used by pirates who found shelter in its protected harbor, as well as by fisherman and sailors. During this period, it was known as the “**Isla del Pasaje**” (Passage Island). **In October 1880, Culebra was finally settled by means of land grants**. After its first settlements it became known as “**Isla de San Idelfonso**” in honor of the **Bishop of Toledo, Spain**. It later became known as **Culebra** one of the last names of the first administrator. From the early 1900s until 1975, most of the northwestern half of the island including the world ranked **Flamenco Beach** and its cays were used by the U.S. Navy for target practice and naval exercises. Its remoteness, limited water supply and use by the Navy during the first three quarters of the twentieth century protected the island from development other than the limited grazing agricultural use in the southern and eastern ends.

**Culebra** is of volcanic origin and characterized by steep mountains, sandy beaches, reefs, small islands, bays, and coves or “ensenadas” like “**Ensenada Honda**” and “**Ensenada Fulladosa**”. **Culebra** has a Marine Reserve known as “**Canal Luis Peña Reserve**”, located to the west coast between the **Flamenco peninsula** and **Punta Melones**.

**Culebra’s** local environmental and species habitat conditions reflect the island’s **West Indies** location along gradients of elevation, longitude, and latitude and the multitude of micro-scale physical and chemical factors that vary within these gradients. Moreover, the local environmental and land contour conditions of the site constrain the patterns of land use and plant establishment and habitation.

Alternatively, the constraints of local conditions provide opportunities to use existing ecological patterns and processes as models for efficient and sustainable land use. The different rates of key ecosystem processes, such as primary production and decomposition, are limited by soil nutrients, temperature, and water availability. The temporal pattern of availability of these factors, as mediated by climate and weather, are

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<sup>8</sup> Culebra, A Plan for Conservation and Development, October 29, 1973, US Department Department Of Interior, DNRA,PRPB



presented in another section that follows below entitled **Zone of Life (Humidity, Elevation and Diversity)**.

Thus, its geographic and geology locale and reality will only allow certain ranges of natural ecological-process rates without artificial continued management inputs. External and human intervention may broaden these ranges but cannot entirely evade the constraints of place. For instance, the proposed interaction with the sustainable development proposed on the site maintains the undisturbed green areas and ecosystem process by enhancing productivity on the more sensitive vegetation covered areas and improving the evapotranspiration rates and filtration of water and nutrients to the soil.

Through programmed reforestation more plant species are planned to be planted in the area. Proposed additional reforestation with current established dry forest species enhances and increases the number of species and their long term survival. Exotic species introduced in the area could affect the natural count of species, so it should be taken under consideration when planning the planting layouts and with the introduction of restrictive covenants.

Agricultural (seeding and other modification on the plants, landscape or others) production requires favorable conditions of temperature, soil, nutrients, and water, key limiting factors for plant growth and productivity. The temporal pattern of these factors is a consequence of climate and weather, restricting the location of agriculture and the suitability of particular crops. Using plants appropriate for a particular place and situating agricultural and natural patches of vegetation in an appropriate landscape context can allow sustainable communities land use, reduce the impacts of developments on adjacent areas, and permit more efficient use of resources. Many uses of land have failed because species composition and ecosystem processes have not been appropriately matched with the local physical, chemical, and climatic conditions.



## Description of Species:

*Leptocereus grantianus* was discovered in **Culebra** in 1932 by Major Chapman Grant, whose cultivated specimen was later described by **Nathaniel Britton in 1933**.<sup>9</sup> Copy of the short Britton article is attached as Annex A. It belongs to the **Cactaceae** family to a genus of, today, some 15 known species first discovered in Cuba. It was more common in the early 20th century before land clearing for cattle grazing and human habitation occurred in its known habitats.

*Leptocereus grantianus* is a shrubby cactus, with ascending and erect branches both at the base and above, that generally grows to about 1.5 to 2 meters in height and 3 to 5 centimeters in diameter. The cactus bases of mature specimens are rounder and light gray-brown in appearance up to 4 inches wide. It has no aerial roots.



The many jointed elongated stems, without leaves, are thin ribbed or angled and at times appear cylindrical. The stems have 3 to 5 prominent ribs in separate stems, distinctly notched and with broadly rolling scalloped edges. Ribs of the young joints are thinner and appear pointed at the tip. At the base of the rolling scalloped edges, small brown-felted areoles bear spines when young. At this stage, areoles exhibit 1 to 3 nearly black/dark brown spines that are less than 1 millimeter long. The spines are non-persistent and disappear as the ribs become thicker and the joints older. The cactus can appear vine-like in mature spread out specimens but it is not dependent on support of other plants or small trees. It has been observed free standing to at least 1.5 meters.

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<sup>9</sup> Britton, N. L., 1933. *An Undescribed Cactus of Culebra Island, Puerto Rico*, Cactus and Succ. Soc. Amer. 5:469.



The upper tips of the younger stems have brown areoles up to the stem tip that are closer in distance and curved in the tip edges from where flower cephalia tubes develop. Flowers are borne singly on terminal cephalia tubes. The tubes are three 3 to 6 cm long and about 1 to 1.5 cm wide. The terminal cephalia can be singly borne or form part of several flower stems borne at the edges of the tips of the 3 to 5 rib stems. More than one flower tube can be borne from a single rib. The outer perianth segments of the flower tube are yellow-green, linear, and have similar smaller areoles like those of the rolling scalloped-edged top of the ribs. The flower tube opens to a campanulate ovary crown corolla that also displays the brown-felted spot areoles around the crown.

The flower is white-yellow or cream colored, oblong-ovate, obtuse and about 8 millimeters long with many stamens and yellow anthers. The stigma lobes are several and small.

The inner perianth segments of the flower have a circular row of numerous white short corona filament hairs that radiate around the ovary crown and additional cream pollen anthers at the perianth's central base with the two white taller styles having three radiating stigma all joined together in the ovary and surrounded in the corolla by two light yellow, cream-white concentric rows of 8 to 10 wider petals and about 8 to 10 petaloid sepals calyx of the same color that combine around the crown at full flower opening.



The solitary flower is referenced as nocturnal with an extended early diurnal period of daily flower opening. The flower emerges from the obconic (about 1 cm wide) ovary tube and opens at night from about 10 p.m. and remains open to about 10 a.m.<sup>10</sup> This nocturnal flowering mechanism of the young flower, as well as the brown-felted spot areoles around the crown, having 1 to 3 black/dark brown spines less than 1 millimeter long, is a protective mechanism of the cactus against bird and animal predations of the flower and of the terminal cephalic tubes, as observed below. Bees and other insects provide the fertilization functions to the flower and ovary.

Note also below, that the receptacular tissue of the rolling scalloped edges of the stem has been chewed off and half of the flower and ovary tube have brownish edges to the tissue after being bitten away by a predator. A letter report of March, 2002 of Robert Ross to the USFWS<sup>11</sup> contains comments that at the original and three transplant sites, one in *Culebrita* and two



<sup>10</sup> See Britton, *supra*, note 1.

<sup>11</sup> Letter Report with Comments to USFWS of March, 2002 from Robert Ross

in **Luis Peña**, the bite damage to the flower and ovary tuber was noted at all four population sites and attributed by Ross to rats. It was also noted by R. Ross that the flowers do not continue to develop and that rat damage to the vegetative tissue is very rare. Ross reported in 2002 that most flowers were blackened by winds of Hurricane Hortense on September 1996.

Fruits develop as an oblong, subglobose to ellipsoid pod in the ovary of the flower-tube as the fertilized ovary shrinks the campanulate flowering crown, and grows and expands inside the cephalia tube to about 4 to 5 centimeters (1.5 to 2 inches) in diameter with a few of the original spine areoles of the flower-tube remaining around the fruit. The fruit produces numerous black seeds. Ross reported in 2002 that fruit was collected on July 19, 1996 from flowers cross pollinated in June 29, 1996. It has been reported in the USFWS Recovery Plan Action Status summary table that fruits collected by the UPR (RP) (2008-2011) show a high degree of germination at greenhouse conditions.



### Reproductive Status:

The species' **Recovery Plan** states that little is known about the reproductive status of **Leptocereus grantianus**. **Flowering** has been observed to occur both in the field and while in greenhouse cultivation both in **Boquerón** and **Culebra**. **A controlled study in a nursery is needed to observe and document in more detail seed reproduction.** No observations have been published as to flowering in the known natural populations or the frequency of flowering. It has also been reported and observed that independent stem fragments that fall to the floor after a storm will root into a plant. Digital photographic records by the author over several years evidence flowering from April through mid July. Observation efforts need to be expanded to determine presence of flowering during other months of the year.

## Ecosystems and Ecological Associations or sub-ecosystem:

**Culebra** enjoys a warm humid subtropical climate and its ecosystem may be described as a **Subtropical Dry Forest**, the driest life zone of the six zones present in the platform. **Culebra** has a dry season that extends from early spring to summer, except for hurricane events, and a wetter fall and winter with occasional rain events. There are no rivers or streams in **Culebra**. The island has dry drainage basins that activate during significant rain events. **Culebra**, contrary to sections of **Vieques, St. Thomas, and St. John and well as in some of the BVIs**, does not have a subtropical moist forest area. Water and moisture has a significant impact on flora habitat composition.

Three distinct ecological associations or life zones are clearly identified within the **VMT** site. They are described as *(i) the cliff association, (ii) the dry forest association* and *(iii) the grassland association*. The three associations are interconnected as an ecosystem whole.

The *cliff association* is found in the extreme southern area of the property where steep seashore cliffs roll down to **Playa Cascajo**.



A particular characteristic of the **dry forest association**, that prevails throughout the interior hillside of **VMT**, is the low density and high separation between the small trees found in such terrain. Trees of some size and higher tree density may be noted generally in limited areas on the northern side of the site, particularly in drainage basins of the northern central hill and in some areas of the basin that drain southwest toward Fulladosa Bay in the southern half of the central hill of the **VMT** property.

A notable characteristic of the **grassland association** is the fact that it is manifested throughout a significant portion of the property; not only on top of the hills, throughout the central hill and southern and northern hill saddles and flat hilltop areas where the local vegetation was removed for cattle grazing, but also in areas where some trees have developed.

The coastal area of **Playa Cascajo**, in **VMT's** southern boundary, provides a proper habitat for coastal vegetation of the **Subtropical Dry Forest** zone of life. This coastal habitat is limited by the seashore's short depth and the immediate rocky cliff associations that are characteristic of the geography of the southern extension of the **VMT** site. The **Playa Cascajo** beach area is not deep or sandy and is covered by rocks or dead coral and crush shells ("cascajo").

The "*Cascajo*" designation for the beach area describes its fractured stone, dead coral and seashell ground cover in Spanish. Other areas of **Culebra** provide wider coastal habitat extensions allowing for better development of coastal habitat plants within such areas and also allowing, in some sandy beaches, turtle nesting areas.

### **Meteorology and Climatology:**

*(Adapted and expanded from VMT's Final EIS (DIA-F, by its Spanish acronym))*

#### **Winds:**

In general, the island of **Culebra** is subject to three wind patterns: (1) the **Caribbean trade winds** from the east-northeast, (2) the **sea breeze** from the prevailing direction and (3) the **land breeze** that blows generally from the Caribbean Sea from the southeast, but is also known to blow from the south. Hurricane events produce changing counter-clockwise circular movements of wind of varying strengths, depending on the event, its speed, intensity, proximity and the direction of storm movement. The Hurricane season extends annually from July to October.

According to the wind rose available in the former Roosevelt Road Naval Base Airport and the St. Thomas Airport, the nearest official data published by the U.S. Weather Bureau, the wind in the proposed development site of **VMT** blows predominantly from **the east around 40%** of the time and from **the east-northeast 20%** of the time. These two wind vectors represent the predominant wind direction **60%** of the time. Windy days can produce wind bursts of up to 32 knots.

The trade winds generally blow from the east during the winter and from the southeast during the summer and in the evenings. The trade winds tend to refresh and cool the island surface and ambient temperature both during daylight and at night. The sea breeze and the land breeze generally blow in opposite directions. The counter movement from the southwest and the easterly counter flow cause inductive flows. Sea breezes are produced during the day due to the faster heating of the earth's surface on the island, which causes the cooler sea breezes to rise due to the inductive flow. During the evening, as the land cools, the circulation pattern is inverted. Limited precipitation ensues due to the lower elevation of the hills.

#### **Temperature:**

Temperatures in Puerto Rico generally become cooler with the elevation as we travel up to the central mountain range with slight temperature variances. In **Culebra**, the hills don't enjoy such

microclimate differences due to their low heights. The **Culebra** hilltops will generally feel cooler due mainly to stronger breeze patterns and not real temperature differentials. During the winter season, the average temperature is 74 degrees Fahrenheit with November through April being the cooler months. During the summer season, from June to September, temperatures average 90 degrees Fahrenheit. Relative humidity averages 67% during the year but can fluctuate to above 80% during the wet seasons or during significant rain events.

### Historical Precipitation or Rainfall:

There is general consensus that the late Pleistocene, Wikipedia defines it as “the geological [epoch](#) which lasted from about 2,588,000 to 11,700 years ago, spanning the world's recent period of repeated [glaciations](#)”<sup>12</sup> was much dryer and as much as 8°C cooler than today<sup>13</sup>.” Relying on data from Curtis et al.2001<sup>14</sup> Lazell summarizes the last 8,000 years of precipitation as follow:

“Precipitation increased dramatically to a peak about 8,000 ybp [years before present], when sea levels was about 20 m. below its current level. There followed a dry spell, with precipitation falling off to today’s levels for about 800 years, then increasing to set the highest Holocene, Wikipedia defines Holocene as “the geological epoch which began at the end of the Pleistocene (around 12,000 to 11,500C years ago) and continues to the present.”<sup>15</sup>, record of about 7,200 ybp (ca. 8,200 radiocarbons ybp). There was another drop to today’s precipitations levels at about 6,000 ybp (ca. 7,500 radicarbons ybp). Then rainfall increased and continued to be high, right through the hypsithermal<sup>16</sup> maximum, 6,000-4,000 years ago. The dramatic raise in sea level that brought the ocean up very close to today’s levels, ca. 4,000 ybp, was not complemented by changes in precipitation: Conditions remained much wetter than they are now. About 1,680 ybp, a 500-year spell of rainfall (similar to ours today), a relative draught, began. Following the 500 year draught, rainfall increased sharply after 1,200 ybp and peaked in a brief pluvial-period centered about 1,000 ybp with conditions as wet as they were during the long Holocene span of 6,800 to1,680 ybp – and much wetter than now. Since that time climate has died down to what we live with today.”<sup>17</sup>

### Precipitation or Rainfall:

Precipitation on the island of **Culebra** is mostly of (1) **orographic nature**. When masses of air in sea breezes containing moisture pushed by **Trade Winds** are swept from the ocean onto land up the side of a higher hill, adiabatic cooling results and, ultimately, condensation and precipitation of short duration follows. The higher hilltop range in the north side of the island

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<sup>12</sup> <http://en.wikipedia.org/wiki/Pleistocene>

<sup>13</sup> Lazell,2005, Ibid. p. 108

<sup>14</sup> Curtis, J.,Brenner, M., and Hodell, D, Climate Change in the circum-Caribbean (late Pleistocene to Present) and Implication for regional biogeography. In Biography of the West Indies, 2<sup>nd</sup> Ed., 2001, Woods, C.A. & Sergile,F.E., eds. Pgs. 35-54, CRC Press, Boca Raton, Fla.

<sup>15</sup> <http://en.wikipedia.org/wiki/Holocene>

<sup>16</sup> A climatic phase in the early to middle part of the Holocene (q.v.)-lasting several thousand years-when conditions were appreciably warmer than today, is called *hypsithermal*. <http://www.springerreference.com/docs/html/chapterdbid/4549.html>

<sup>17</sup> <sup>17</sup> Lazell,2005, Ibid. p. 108-09



seems, by visual appreciation of cloud cover and precipitation events, seems to enjoy more rainfall during the year.

I have observed over the years that moisture clouds arrive to **Culebra** predominantly from the neighboring St Thomas and during stronger easterly fronts or hurricane events from both the USVI and BVI. The masses of air in sea breezes contain moisture collected as they travel over the warmer ocean. Pushed by the **Caribbean trade winds** the air masses are first swept from the ocean onto land on the neighboring higher elevation St Thomas where they are cooled and produce rain events. This additionally leaves moisture laden clouds that are pushed again by the same **trade winds** and continue to travel south westerly over **Culebra**. **Culebra's** highest hills are **Monte Resaca** with an elevation of 650 feet (198 m) and **Cerro Balcón** with 541 feet (134 m) on the north side of the island. The higher elevation of the northern hills of **Culebra** have a cooler condition that allows them to receive slightly more *orographic* rain than the lower elevations of the southwestern side but during the rainy season, in May and September to November, many *orographic* rainfall events reach the **Punta Soldado** side and southwestern shores of the island dropping some rain and moisture.

There are two additional mechanisms responsible for rainfall in the Northeastern Caribbean: the (2) **tropical wave currents coming from the east** and the (3) **cold fronts (or "troughs") coming generally from the northeast from the North Atlantic area of the North American Continent**. **Caribbean trades winds** are refreshing and **the cold fronts (or "troughs") from the North Atlantic area** generate more winds and cooler temperatures in **Culebra** and its surrounding waters. The cold fronts events create a northwesterly wind pattern over the island pushing the moisture laden clouds from the neighboring **Caribbean** islands and **St. Thomas** away from **Culebra**. The cool air and ocean wave action that accompanies the front, cool both the island's ocean water and land. This cooler climate and coastal water temperature annual climate period coincides with its dry season from January to April.

It appears that a phenomenon similar to the one that occurs in the **Galapagos Islands** in the Pacific is repeated in **Culebra** annually. In **Galapagos** the prevailing climate effect of the cool Humboldt Current causes the shores of the southern islands to be bathed in cool waters, chilling the air and creating unusually cold conditions for equatorial islands. During this period, rain is scarce on the coastal regions. Only plants that can survive long periods of time without water can establish and develop in these climatic conditions. In **Galapagos**, every seven years the pattern is reversed, when the cooler Humboldt Current is interrupted by the **El Niño** climate phenomenon, which drives warm waters that are normally sent westward by wind and the Earth's rotation, toward the shores of South America and the **Galapagos Islands**. The **El Niño** induced warm seas bring very heavy rainfall to the **Galapagos**. In **Culebra** the rain pattern impact of the cooler waters and **cold fronts (or "troughs") from the North Atlantic area** appears to occur annually. The **El Niño** phenomenon changes wind and temperature patterns that warm the waters of the **Caribbean Sea** and **South Atlantic Ocean** around the Equator with consequent changes in weather and climate patterns in the **Caribbean Sea** area and the southern **Atlantic Ocean** to the north. The **El Niño** induced warmer climate and ocean waters

also change the intensity, direction and frequency of annual Hurricane events from July to October in the West Indies and the Gulf of Mexico.

**Culebra's** rainy season extends from September to November. Rainfall also usually occurs during the month of May, as well as during the hurricane or tropical storm season that lasts from July to October. **Culebra**, however, is considered to have a dry tropical island climate due to extended dry seasons from January to April and low total annual accumulated rainfall. The mean annual precipitation in **Culebra** averages 842 mm (84.2 cm) or 33.55 inches of rain annually.<sup>18</sup> In 1994, the **USFWS' Recovery Plan** estimated mean annual precipitation was 975 millimeters (or 38.38 inches).<sup>19</sup>

A 2009 book, ***Climatología de Puerto Rico***, by Dr. Jose A Colón, who served as Director of the San Juan Office of the U.S. Weather Service for 23 years, provides a higher annual rainfall estimate. The publication indicates that “the data for a period of 19 years of the island of **Culebra** – located some twenty five miles from **Fajardo** – **indicates an annual rainfall of 41.5 inches or 1,054.1 mm**. The rainy season extends from May to November with less rain in June and July and a dry season from January to April.”<sup>20</sup> (Translated from the original in Spanish) Last year [2013] we did an informal measure at VMY of some 39.5 inches.

### **Zone of Life (humidity, elevation and diversity):**

*(Adapted and expanded from VMT's Final EIS (DIA-F))*

The **VMT** site has been classified as **subtropical dry forest**.<sup>21</sup> However, the site's vegetation can be described as a more open, semi-evergreen seasonal forest. In instances, taller trees and large shrubs are widely spaced, growing between large boulders, on ridges, or within drainage basins. The prevalent small tree and large shrubs vegetation zones form a canopy of about 3 to 5 meters. Note that references to “forest” are made only in the context expressly used by Holdridge<sup>22</sup> and do not intend to characterize the ecosystems within the area of study as a developed forest.

The vegetation of the life zone tends to form a complete ground cover. In this life zone, few tree species have adapted to the seasonally dry climatic conditions. Trees are usually less than 15 meters tall with broad-spreading flatter crowns. Many trees become leafless during the dry season. Plants are generally small, succulent and predominantly leathery, many with thorns and spines and generally bisexual to allow self-pollination and ensure survival. Vegetative debris of dry leaves accumulates on the ground during the dry season, helping to enrich the soil but increasing fire hazards. The dry leaf cover also helps retain soil moisture. Agriculture is

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<sup>18</sup> Geoffrey M. Bonnin, Deborah Martin, Bingzhang Lin, Tye Parzybok, Michael Yekta, David Riley, 2006: *NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, Volume 3 Version 4.0: Puerto Rico and U.S. Virgin Islands*. Silver Spring, Maryland, p. A.4-20.

<sup>19</sup> 1 inch = 24.5 mm

<sup>20</sup> Colon, José A. (2009). *Climatología de Puerto Rico*. La Editorial, Universidad de Puerto Rico: San Juan, p. 123 and Figure 43.

<sup>21</sup> Holdridge, L.R. 1967. *Life Zone Ecology*, Revised Edition. Tropical Science Center: San José, Costa Rica, pp. 206.

<sup>22</sup> *Ibid.*

marginal and requires irrigation to a level generally not available in many islands such as **Culebra**. Grazing of cattle and goats is possible but requires a water trough.

Six principal (dominant) species are present in this **subtropical dry forest** stratum in the **VMT** site: (1) *Acacia farnesiana*, (2) *Prosopis pallida* (an invasive species), (3) *Bursera simaruba* and (4) *Bucida buceras*, (5) *Croton astroides* and (6) *Cordia dentata*. Also present within this stratum in well-distributed amounts, is the cactus *Pilosereus royenii*.

The second, and only other stratum present in the **VMT** site, is the **herbaceous** one, composed of species that grow on the humus, which accumulates on the top of boulders, and also on the bare ground. This stratum represents the matrix of the overall area of study.

Dominant species within this stratum include *Sida acuta*, *Commelina elegans*, *Jatropha gossypifolia*, *Mimosa casta*, and *Portulaca pilosa*.

Note that dominant species are listed herein to provide a characterization of the habitat within the area of study. Although many more species, particularly wayside plants and vines, populate the site, the mentioned species establish the overall ecological values of the site and provide a clear indication of the nature of the **subtropical dry forest** ecosystems within.

### **Area Geology:**

*(adapted and expanded from VMT's Final EIS (DIA-F, by its Spanish acronym))*

**Culebra** is the smallest and most arid of the three large Puerto Rico outlying islands, that is, **Vieques** and **Culebra** on the eastern shore, and Mona on the western shore. **Culebra** and its adjacent islands and cays are underlain by volcanic and intrusive rocks of the Upper Cretaceous period, primarily andesite lava. The lava is overlain by andesite tuffs with intrusions of diorite in north-central **Culebra**. In some areas such as hilltops, drainage basins and valleys, the intrusive rocks have weathered to form rounded boulders.

The terrain where the **VMT** proposed action is contemplated is located in a geologic formation identified as **TKa ("andesite dikes")** as described in the geologic maps of Puerto Rico, prepared by the U.S. Geological Survey (USGS).<sup>23</sup>

**TKa** consists of a **Karaisali** geologic formation belonging to the oscine period, such as paleozoicene cretacic rocks like andesite, toba, brequia with lower content of limestone rocks.

The Karaisali geologic formation is mainly composed of reefal carbonates and dolomitic limestone at the investigated area.<sup>24</sup> It is generally white to pale grey, medium to thick bedded and it contains coralline algae, echinoderms, bryozoa, corals, mollusca and foraminifera.<sup>25</sup> Karaisali formation accumulated on the pre-Miocene topographical highs and in the adjacent

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<sup>23</sup> See Final EIS, **Appendix 5**, Geologic Map.

<sup>24</sup> Cavit Demirkol. (1989). *The Stratigraphy and Geological Development of the Carbonate Platform in the Pozanti-Karsanti-Karaisali (East Taurus) Area*, Mineral Res.Expl. Bull., 109, 25-36, 31.

<sup>25</sup> *Ibid.*

areas it formed reef and associated deposits.<sup>26</sup> The unit has a lateral and vertical facies relationship with Kaplankaya and Gildirli formations at the base, and Güvenç, Cingöz formations at the top.<sup>27</sup> According to the related fossil descriptions, Karaisalı formation might have been deposited during Burdigalian-Langhian time space.<sup>28</sup>

### **Soil Formations:**

The predominant soil formations at the **VMT** site, like most soils in **Culebra**, are classified into two (2) series: **Descalabrado clay loam (DeE2)** and **Rock land (Rs)** as defined by the Soil Survey of the Humacao area of Puerto Rico prepared by the U.S. Department of Agriculture's Soil Conservation Service. The description of the two series follows:

#### **Descalabrado clay loam (DeE2):**

This series of soils is found on the steep hillsides or cliffs and on the hilltops of **VMT's** three hills. This soil series is shallow and can be found to the depth of 1 foot to 1 ½ feet over the mother volcanic fractured rock base layers. This soil series is also found with greater topsoil depth in limited areas that can accumulate natural historic soil runoff from higher elevations, such as the two small saddle areas on top of the northern lower hill and near the base of the northern central drainage basin before the municipal road.

This **DeE2** soil series is not adequate for farming due to its shallow depth and steepness of the hill contours that makes the terrain propitious to fast runoffs, less accumulation of precipitation and a tendency to cause erosion.

The unit capacity of **DeE2** soils in **VMT** is **Vlls-4**. The unit capacity is divided in class, subclass and unit. The unit of capacity of **DeE2** soils is **VII**, which describes those soils that have very limited capacity or value to support farming. The subclass of unit capacity is **Vlls**, which describes those soils that have severe limitations due to their rocky nature, shallowness and for their limited capacity to retain water. The unit category of unit capacity is **Vlls-4**, which describes the ground of this soil series as steep or very steep, with good drainage and of a moderate to fine texture.

#### **Rock land (Rs)**

**Rs** soils consist of areas where rocks or rock formations may crop out on top of the soil by weathering on 50 to 70 percent (50-70%) of the surface. Loose single stones are also very common on the surface. Very shallow soil material lies between the outcrops and stones. This **Rock land (Rs) soil series** is predominant in the central, higher and lower steeper hillsides of the site. Slopes can be as steep as 60 to 70 percent (60-70%). The vegetation is mainly brush and small trees.

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<sup>26</sup> *Ibid.*

<sup>27</sup> *Ibid.*, Fig. 5,6.

<sup>28</sup> *Ibid.*, p. 31.

Rock land has little value for farming or production uses. Its use is restricted mainly to xerophitic vegetation flora and only provides a limited wildlife habitat in **Culebra** for the small wildlife population.

### Watersheds, Streams and Surface Waters:

According to an evaluation of the site topography (based upon evaluation of the USGS 7.5 minute topographic map) the site has six distinct watersheds, each with its own natural drainage patterns.



### Aerial View of Punta Soldado and VMT Proposed Site

According to the USGS' Topographic Map of Culebra, **VMT's** general topography is accidental with elevation contours ranging from approximately 5 meters MSL to 100 meters MSL. It consists of three hill ranges dominated by a central hill with 100 meters of elevation. The lower northern hill site range is first subdivided into two hill ranges separated by a central drainage basin area that feeds into the **Ensenada Honda Inlet** bay, and a smaller drainage valley basin in the western midsection off the saddle that drains northwest and feeds **Laguna Lobina**. The second contour feature is the central higher (350 ft) hill range with a western saddle area wrapping southeast in the western end into the lower southern hill. Portions of the lower north hill and saddle area and northern side of the central hill both also drain to the northeast into the **Ensenada Honda Inlet** bay.

The south side of the central hill, its western saddle and south hill all wrap around a green central drainage basin referred to in **VMT** as "**The Green Valley or Valle Verde**" that drains into the **Fulladosa Sound** to the southeast. The western section of the southern saddle wraps and continues into the lower southern hill.

Lastly, the south hill has two separate watersheds, one on the eastern southern half draining southeast into "**Playa Cascajo**" and the "**Sonda de Vieques**" and the other on the western southern side draining to a small retention pond watershed area close to **Dátiles Beach** on the Caribbean Sea. The **Leptocereus grantianus** habitats are found in the upper southern hillside in the center of the south hill and in the southern coastal cliff in two locations.

The drainage basins and watersheds at the site are a consequence of the site's ridge, saddle and steep elevation contours. The areas immediately adjacent or within the drainage catchment areas typically harbor the most undisturbed, dense and diversified ecosystems.

Also, these areas include the least stable soils of the site. The drainage basins are not permanent streams but dry drainage systems that functions upon the occurrence of major rains. Creeks and streams in drainage basins are generally dry and only collect rainwater during rain events and storms. A number of generally manmade retention ponds exist throughout the island. Some are used for irrigation of gardens and limited agricultural use. Many of them dry out during the dry rain season. There a limited number of natural springs and seeps, about a dozen, that dry out and need to be recharged during the next rainy season. Most rainfall during the dry season is quickly absorbed by the dry land and vegetation. The flora and fauna ecosystem that inhabit these drainage systems enjoy the benefit of receiving more water during the intermittent rain events and some concentration and accumulation during smaller events.

Some wells had been used during the early years of habitation of depths of 10 to twenty feet in areas away from the saline coastal seepage, but these wells are also high in **chlorine concentration** and **salinity** making them not suitable for human consumption. Most of these water supply and catchment systems are no longer in use. Some home continue to operate with rain water wells for aqueduct public water supply distribution to some more isolated areas was slow in developing. **VMT's** sustainable design calls for collection of rain water for showers, toilets and gardens. **PRASA** historically operated 11 water wells in **Culebra** with 6 wells in the **San Isidro ward** until the desalination and undersea water pipe was laid from **Vieques** to the south coast of **Culebra**. . Before the construction of the Desalination Plant 5 Municipal wells field of 5 wells was the mayor source of water for public supply.

An inventory of water wells was carried out from May to June 1991 by the USGS <sup>29</sup> and a Report was published in 1995. The report described 77 wells of which two are found in the **VMT** property. They were dug by the Fishbach family prior owners of the property to water cattle. Of the 77 historical well only two (2) were operating for household use and four (4) for agricultural use in 1991. Most are probably close today or use for garden or non-potable use.



**VMT Upper South Hill Cacti Population**

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<sup>29</sup> Cherry, Gregory & Ramos, Juan, **Water Wells on Isla de Culebra**, PR, 1995, USGS Open-File Report 95-369

## New Population of *Leptocereus grantianus* Discovered in 2012

A new cactus population consisting of four plants was discovered in an isolated area of some forty square feet of the hilltop ridge saddle during the construction in 2012 of a new home in a ridge top in the **Punta Soldado** beachfront area. This small population is the fourth natural population of the *Leptocereus grantianus* species that has been discovered and known to be growing well in **Culebra** during the last three decades. The habitat area has been cordoned off to protect the new population. The property owner is aware of the significance of the find and has requested the assistance of a noted biologist to learn how best not to interfere with the population's habitat and protect and conserve the species. The general area of the rest of the hilltop and beachfront ridge have been searched and observed with no additional population having been discovered to date on the property.



A site visit was made by the author to the new species population during September and again in November, 2012 to confirm the species designation and observe the cacti plants.

Photographs were taken in November to document the new population. The population by the brownish tint observed on many of its bases and older stem segments appears to be mature population. New growth was observed in some twenty stem segments and one of the new stems was observed in flower. The population seems supported by the stems and branches or braces of leafless trees. The upper stems of a couple of the cacti plants are growing to six to seven meters with the aid of the support.

The new population find is both significant and welcomed news. The find has confirmed the observation and belief that there are probably additional population areas existing in the isolated ridges and hilltops of **Punta Soldado** as well as possibly in other ridges and hilltops areas of **Culebra** but as yet undiscovered.

### Ecological Value:

The **hillside cliff association** of the **VMT** site provides the conditions for nesting, breeding and feeding for most of the birds, reptiles, insects, certain crustaceans and other fauna. It also provides the habitat for the **Leptocereus grantianus** cactus. **Culebra** has a small local population of birds, biased toward seabirds, a migratory bird population and a small fauna density. The lack of larger mammal habitation is typical of **Tropical Dry Forest** life zones. Trees and larger shrubs provide a place for nesting and feeding and provide support and protection from wind erosion. Most of the species stay within the area of the cliff because it provides the major life support necessities. Birds move along the site to other forested areas.

Many areas on top of the hills are flatter and were cleared for cattle grazing during the early to mid-1900s. The grass and shrub area upon repopulation has been significantly covered by Aroma – Cassie (*Acacia farnesiana*) and the invasive Bayahonda – Mezquite (*Prosopis juliflora*). Few reptiles use the site area as a natural habitat due to feral cats.

The coral and grass areas in the **Playa Cascajo** oceanfront area lie outside of the proposed project site but they are additionally being protected by the relocation of home sites from the **Playa Cascajo Coastal Cliffs** area to be able to establish and expand the **VMT Ecological Corridor**. The residential home sites allowed by the current R0-1-C zoning on the oceanfront of the southern hill are being relocated to other less environmentally sensitive and disturbed areas of the site to protect the **Playa Cascajo** coastal area.

### Recovery Plan & Efforts:

#### Leptocereus grantianus Recovery Plan:

In 1994, the U.S. Fish and Wildlife Service prepared a **Recovery Plan** for **Leptocereus grantianus**, which was approved on July 26, 1995 (**USFWS Recovery Plan**) to provide for the preservation and recovery of the endangered cactus.



On February 20, 2009, the USFWS issued a Notice, under Section 4(c)(2) of the ***Endangered Species Act of 1973*** (the Act), as amended, that it was initiating and conducting a 5-year species review under Section 4(c)(2)(A) of the Act of ten Caribbean plant species, including ***Leptocereus grantianus***.<sup>30</sup>

A draft report of the review has already been submitted to the Regional Office of the USFWS for comments. On the basis of such review, under Section 4(c)(2)(B) of the Act, the USFWS will make recommendations and a determination whether or not the species should be delisted or reclassified, or down listed, from endangered to threatened status. The results of such review have not yet been published.

Among the most relevant aspects of the **USFWS Recovery Plan** are the following:

### **Recovery Objective:**

The **Recovery Plan's objective** is to reverse the decline of ***Leptocereus grantianus*** and to restore the species to a self-sustaining status, permitting its removal from the Federal Endangered Species List.

According to the USFWS Recovery Plan, ***Leptocereus grantianus*** may be considered for down listing when (1) an agreement between the USFWS, the municipality of ***Culebra***, and the Puerto Rico Department of Natural and Environmental Resources (DNER) is reached and implemented for the protection of the species, and (2) new populations capable of self-perpetuation have been established within units of the ***Culebra National Wildlife Refuge***. The USFWS Recovery Plan called for the establishment of two new populations within protected areas, such as offshore ***Culebra*** cays (***Cayo Luis Peña and Culebrita***) that are titled and managed by the USFWS. If propagation proves to be insufficient and *ex situ* populations prove to be insufficient, these minimum requirements could be expanded. Alternatively, if new populations of the species are found, it may be preferable to place greater emphasis on protection instead of propagation in order to achieve the minimum number of plants necessary for recovery.

### **Actions Needed:**

The USFWS Recovery Plan provided for the following actions:

1. Protect the existing population and its habitat through an agreement with private landowners, the municipality of Culebra, and the DNER.
2. Develop a management plan for the species in cooperation with these entities.
3. Monitor known populations.
4. Enforce existing Commonwealth and Federal endangered species regulations.
5. Educate the public on conservation values and regulations.

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<sup>30</sup> 74 FR 7914, 7915, February 20, 2009.

6. Conduct research on the life history of the species and evaluate propagation techniques.
7. Conduct propagation and enhance existing populations or establish new ones on lands within the Culebra National Wildlife Refuge.

### Protecting the Existing Population:

Only fifty (50) individuals plants were are known to exist in a single mature population. It is located among competing vegetation on a rocky, unstable slope of a shoreline cliff, with slopes



exceeding 60% gradients, and approximately 8 to 10 meters from high tide off **Punta Melones**. The competing population other species while offering protection and camouflage do not seem to have displaced the cacti population.

It is threatened by its closeness to the shoreline. Some individual cacti plants have been recently observed by the author as close as 4 to 5 meters from the shore. Damage to the first known population by the passage of Hurricane Hugo in 1989 was not documented. Other close hurricane and storm events have apparently not adversely affected the original known population but the threat of a high storm surge is an annual event during the Hurricane Season.



The attractiveness and spineless character of the species increases its potential for use as an ornamental plant and makes collection efforts a potential future problem in this exposed population. It should also be noted that there is very little general knowledge among the residents and visiting tourist population of the endangered character of the species and its attributes. This lack of notice and knowledge might permit innocent or uninformed removal and collection of the endangered cactus for ornamental uses. The USF&WS Recovery Plan indicates it was threatened by intense pressure for agricultural activities as well as rural, municipal development and infrastructure needs and improvements for tourist residential development.

The Plan also states that as reported by Britton (1933),<sup>31</sup> the *Leptocereus grantianus* species was more common and abundant back then. Coastal areas of *Culebra* have been historically deforested for agricultural grazing uses as well as rural and tourist development. It is also reported that the cacti may have been used as cattle feed due to its spineless nature. (G. Proctor, DNRA, pers. comment).

The original population in the **Punta Melones** area was observed in both in July 2011 and May 2012 as continuing to do well. It is a mature population as can be observed from the color and size of many of its base stems and newer upper plant segments. It is, however, more exposed and threatened today, 18 years later, than in 1995, when the USFWS Recovery Plan was approved.



**Punta Melones Population base and stem segments**

The population may also be protected by the large boulders of the rocky shoreline and by a large overgrowth of the spiny bush *Pithocellobium inguis-cati* (Guama – Uña de Gato – Beefsteak).

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<sup>31</sup> See Britton, *supra*, note 1.



### **Punta Melones Population Protected by spiny Uña de Gato – Beefsteak**

The original population continues to be subject to intense development pressures. According to the USFWS Recovery Plan, in 1995, the Municipality of Culebra proposed construction of a coastal road. During the past 10 years, this road has been built up to the base of the **Melones Beach Area** with limited parking facilities and increased tourism use of the shoreline. The hillside area behind the **Melones** population has been substantially developed for tourism residential second homes. The aerial photos below show an uphill extension of the public road to give access to the residential area up the hillside behind the cliff. The developer of the adjacent uplands of the cliff has been aware of the presence of the species.



### **Management of Existing Population at Punta Melones:**

The USFWS Recovery Plan indicates that a 14 meter setback from the maritime zone at the base of the coastal cliff that is subject to DNER jurisdiction was ceded to the Municipality for the

express purpose of building a coastal road through the upper area of the cliff. According to the Recovery Plan, DNER jurisdiction extends over the maritime zone coastal watch area where the cactus population occurs within the 14 m setback from the shoreline ceded to the Municipality. The aerial photos above show that a surfaced uphill extension of the municipal road to provide access to the residential tourism homes in the uplands of the cliffs. A new construction and maintenance non-surfaced rustic road has been additionally built on the immediate top of the cliff along the coastline to give access to the lower area of the residential lots and home sites.

### Protection of VMT Population:

Immediately upon the discovery of the new population in the **VMT** site, **VMT's** property owners' management, **Culebra Resort Associates, S. en C. por A., S.E. (CRA)**, issued guidelines and directives to its designers, consultants, working maintenance supervisors and crews of the significance of the find and the importance of keeping it protected and not interfering with its habitat during trail maintenance activities.

In **2003**, a pedestrian path was built on the upper hillside area of the site to assist in surveying and contour plotting work and to facilitate the natural use and enjoyment of the property. The consulting biologist used the pedestrian path as one of the survey-transects while conducting the **Flora and Fauna Study** of the south hill on morning when he discovered the endangered species.

Upon confirmation of the species find, protective warning tape was installed. Soon thereafter, a light wooden protection barrier with "**Prohibido El Paso**" signs was installed to protect the cacti habitat. Due to limited use, the Nature Trail retains its vegetative grass-like cover throughout the year minimizing the potential for erosion and soil loss from the cacti habitat area. The path also offers a protective barrier against spurious wild fires known to occur in Culebra. A "**Do Not Enter**" sign at the entrance of the path restricts vehicular access to emergency or limited maintenance requirements.



Two suspect additional sites on the south side of the central hill of the **Green Valley (or Valle Verde)** were dismissed by 2005 after the sites and species were observed and studied more closely. The cactus found in those two other areas of the property on the central hill were determined to be *Hylocereus trigonus* with some similarity in its stem systems but with significant differences in flowering, spines stem structure and growth habit.



After confirmation of the presence of the *Leptocereus* species in **VMT**, **CRA** consulted with the USFWS, both through informal communications and formally during NPDES consultations, and with the DNER during the preparation, submission and discussion of **VMT's** Preliminary Environmental Impact Statement (DIA-P, by its Spanish acronym), including the proposed project and **Flora and Fauna Study** required by the DIA-P. Both agencies were informed of the presence of the federally and locally listed endangered species on the property.

### Research and Observation of Plants:

Since late **2003**, we have been identifying, studying and mapping the additional population sites on the **VMT** beachfront cliff, photographing and observing the life cycle of the plant and protecting its habitat.

Observations by the author of the *Leptocereus grantianus* species in the cliff association of **VMT**, the **Melones** population and its propagation at the **USFWS** greenhouses over the past several years have yielded the following observations and comments:

1. Population habitat size limits seems to be influenced by topography, slope patterns, wind patterns and availability of some cover and protection by larger trees and spiny bush species;
2. The cactus seems to prefer the southern side of the cliff area under or near tree cover that offers more protection from strong winds and possibly wind driven scrub fires;

3. In steep cliff habitat it seems to prefer the hill side above the drainage basin below and the protection of larger trees but will outcrop some stems to sunnier exposure over the cliff;



4. The cactus seems to interact closely with existing trees that afford it some shade and wind cover, including *Bursera simaruba*, and spiny bushes, particularly *Acacia retusa* (Zarza brava – Catch & Keep) and *Celtis iguanaeae* (Uña de Gato – Cockspur), both which protect the cactus from humans, predatory birds and feral cats and goats in the VMT site, and with the large spiny bush *Pithocellobium inguis-cati* (Guama – Uña de Gato – Beefsteak) in the original population site at Punta Melones;
5. Fully exposed plants and segments thrive well and seem to grow faster and stronger;



*Protective Growth with other Spiny Celtis Iguanaeae Species*

6. It exhibits seasonal growth, being more dormant during the dry season with flowering in spring and early summer with new growths manifested during May and the fall rainy seasons.



*Exposed Stand-alone Branch and Protective Growth with other Spiny Species*

7. Older segments on the plant turn gray as well as the older base stems of larger plants. When the segments are damaged or dry out they lose the vegetative softer cover material of the segment's ribs and a core strong stick-like support structure remains. This core is woodier and strong, providing the structural vertical support necessary to keep the plant erect by itself.



After completing this article but before releasing same we were provided and were able to read the Letter Report of Robert Ross<sup>32</sup> who also adds the following additional observation comments that are of interest:

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<sup>32</sup> See Ross, *supra*, note 9



1. The current distribution of the four natural populations (1996) to extreme [*Non-Disturbed*] slopes is probably related to surviving by avoiding human disturbance.
2. Transplant success in **L. grantianus** is more problematic as compared to survival in the original {established} populations.
3. Neither seedlings, nor any stems smaller than .08 cm were found during a survey of all four sites....
4. Without sexual reproduction in the field, new populations can only originate by the rare event of separating a branch which then roots.
5. Additional populations in sunny areas of **Luis Peña or Culebrita**, where fires are extreme rare, will probably be successful if the plants survive the first year after being transplanted.
6. Death of branch sections is apparently the result of damaging winds allowing for infection by bacteria, insect larvae, or other opportunists to invade the stem surface.

### Propagation of Plants:

The **USFWS** has made several attempts to propagate the plant. In their **first propagation efforts during 1996** they collected fragment samples of the four, then known, populations in **Culebra**. The stem fragments were planted and subsequently taken to the field with new fragments to establish new populations. Stem fragments have also been collected in **Culebra** and subsequently transported to **Boquerón USFWL center** on the southwest end of **Puerto Rico**. The field personnel planted the cuttings in their greenhouse in **Boquerón** and these grew and developed well. During the early stages, some of these cuttings were returned to **Culebra** for planting. Unfortunately, these cuttings can no longer be returned to **Culebra** to help establish new populations for fear of contagion of a cactus disease known as the Harrisia cactus mealybug, *Hypogeococcus pungens*, that develops in the dry forests areas of southwestern **Puerto Rico**. The **Boquerón** propagation efforts are shown in the photos (below) taken on April 6, 2009.



### Propagation from the VMT Population Plants :

On April 28, 2009, **VMT** was advised of the commencement of the **second propagation effort** by a letter from the **USFWS** indicating they had “reinitiated a propagation program for the cacti in our Culebra National Wildlife Refuge facilities. The objective is to maintain representation of the known populations of the cactus and propagate the species for recovery activities. As part of our efforts, we need to visit all known populations at the Culebra and out island and collect at least 20 cacti’s fragments (cuttings) per each population. We would like to request permission to visit your property [**VMT**] on May 4 and 5, 2009. There we will collect 60 fragments of these cacti for propagation.”



**VMT** personnel accompanied the USF&WS field biologists on their site visit to collect the samples. The effort lasted about three to four hours and all populations on the site were visited and assessed.



The 60 fragments were collected and transported to the greenhouse at the USF&WS Field Office in **Culebra** located at the Old Navy Camp in San Idelfonso. The stem fragments were planted shortly thereafter and soon established themselves well. The plants developed and on a visit to the greenhouse on May 10, 2010 they were observed to have reached close to 3 feet

in length, one year after collection. One of the cacti had a flower bud fully developed and another had seeded.



On a second visit on May 26, 2012, the plants that had been planted from the **VMT** segments were reportedly removed from the northeastern floor corner of the main greenhouse to be planted in the **Culebra National Wildlife Refuge** behind **Playa Flamenco** or some may have been move next door to the smaller tabled greenhouse. One older cactus plant of unknown origin has been newly placed in the corner of the greenhouse. It appears to be a specimen of the ***Leptocereus quadricostatus*** from the single photograph taken and spines observed, but further information is needed to confirm identification.

The smaller greenhouse has a series of some 60 cacti plants of various species. Some appear to be ***hylocereus trigonus*** with its larger spiny areoles and some could be part of the original ***Leptocereus grantianus*** plants. The greenhouse was locked and photographs and observations were from the outside or through the lattice holes. Further closer inspection and investigation on how they got there is needed. The plants appear well taken care of in the greenhouse.

In the summer of 2011, **Fundación Mi Terruño, Inc. (FMT)**, the scientific, educational and conservation partner of **VMT**, submitted a proposal to the **USFWS** through their Coastal Program to assist in their propagation and recovery efforts. The **FMT** Work Plan proposed construction of a co-funded project for a new greenhouse at the **VMT** site to assist in propagation efforts and to provide more detailed observation and assessment of the species on the **VMT** site in **Culebra**. These joint efforts will assist in the protection and propagation of the species and help to establish populations in other locations of the island. The project proposal was expanded to provide for the reforestation and restoration of 21 cuerdas of the **VMT Ecological Corridor** with endemic tree species to increase the population of hardwoods and other significant tree species that were removed by logging during colonial times from the native Subtropical Dry Forest of Culebra and other Caribbean islands. Conversations have been ongoing during May and June 2012 with a site visit by USFWS field biologists was made on July 2012 to supplement the application process.

## The VMT Subtropical Model Dry Forested Area

To expand the core conservation goals and enhance the dry forest flora of the **VMT Ecological Corridor**, **Fundación Mi Terruño (FMT)** and **Culebra Resorts Associates II (VMT)** have worked together and spent the past decade protecting the significant vegetation in the approximate contiguous 60 cuerdas of the corridor. To continue expanding these efforts, in August, 2012 with the consent of **VMT**, **FMT** entered into collaborative agreement with the **US Fish and Wildlife Service (USFWS)** under the agency's **Partner's Program**. The agreement calls for the construction of a greenhouse, the establishment of two new communities of the endangered ***Leptocereus grantianus* cactus** in the **VMT Ecological Corridor** and the reforestation planting of some 1,260 native dry forest trees.

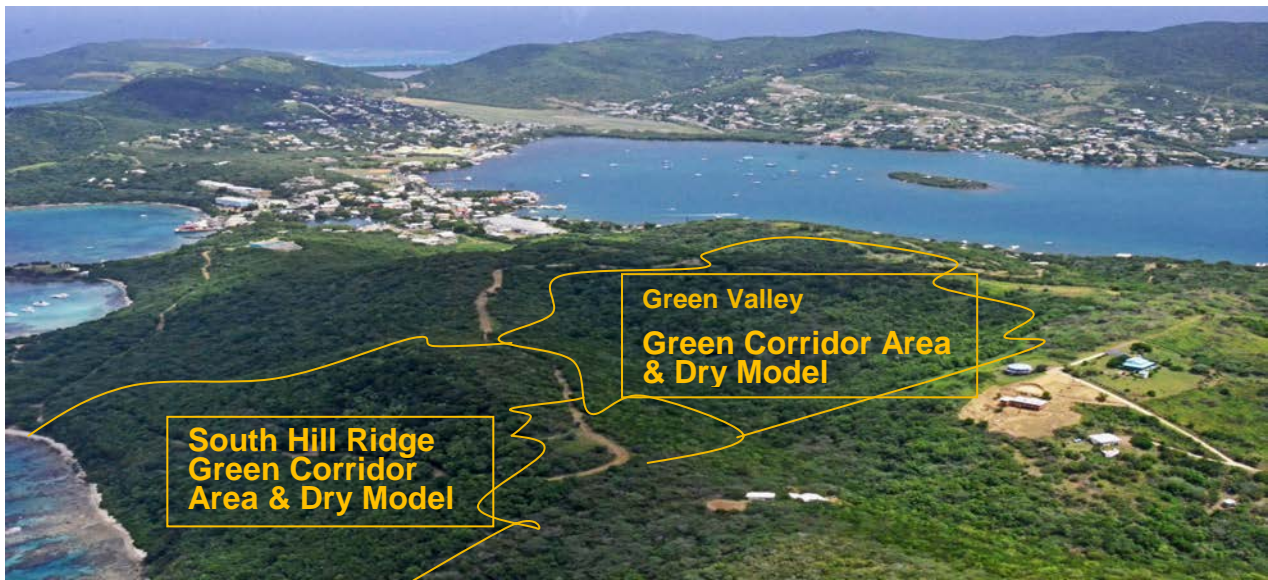


The aggregate conservation set-aside area and the **VMT Ecological Corridor** is one of the nuclear **FMT foundation's** goals and of **VMT's** proposed sustainable and recreational tourism model community. The fulfillment of this goal of creating a relative **large dedicated conservation set-aside area** will establish a new model standard of development that uniquely sets aside some **70%** of the proposed development's master planned area for present and future generations. These proposed conservation parameters are exceptional conservation measures that exceed the standards of **LEED's Platinum** development projects for these types of measures and will provide palpable model guidelines and set standards of sustainable or "green" development for **Culebra** and Puerto Rico.

The **conservation easements** will be imposed on the titled land sites of the 39 future single-family homes as the same may be developed during the next 15 years. These **conservation easements** will be implemented by means of development covenants, easements which shall be incorporated by reference into the individual rights and title transfer deeds in order to reserve and set aside no less than one-half (1/2) *cuerda* of each of the individual one (1) *cuerda* single family home-site lots. The owners of the specific lot, under supervision and in coordination with **FMT** under the easement and community development covenants, can follow the conservation and reforestation guidelines of the covenants and reforest and enhance the half-acre protected areas with native xerophitic vegetation and trees. The conservation

covenants will additionally limit the area for the planting of exotic around the home sites. This allows for a model contiguous protected area and plenty of undisturbed land to pursue the conservation, educational, research and reforestation goals of **FMT**. This natural site will have nature appreciation trails, a greenhouse and plant propagation area, a dry tropical forested area and botanical gardens so it can be enjoyed and appreciated by visiting guests both from **Culebra** and outside the island, students and biologists and other scientists now and in the future.

This joint initiative, that is not frequently similarly seen in development projects, provides for a grant of **\$20,000** from the **USFWS's Partner's Program** and the matching of a similar **\$20,000** amount by **FMT** that is being provided and funded by **VMT**. The agreement allows for the construction of a modern greenhouse on the **VMT** site and the planting and establishing for up to two years in the nursery of sixty plants of the endangered **Leptocereus grantianus** cactus that were gathered by the **USFWS** biologists from the three populations of the cactus that are present and protected in the **VMT** site. Once these plants have established themselves and matured in the nursery, the agreement calls for the planting and establishment of two new populations of the endangered **Leptocereus grantianus** cactus in the core 38 protected cuerdas of the **VMT Ecological Corridor**.



The agreement also calls for maturing 1,260 dry tropical forest trees to be provided by the **USFWS** in the greenhouse nursery. These trees were collected by the **USFWS** in their greenhouse in Boquerón, Puerto Rico and transported to Culebra to be cared and matured in the new **VMT Greenhouse** for planting within the **VMT Ecological Corridor**.



Some of the species to included in the transfer and planting include, among others, *Bucida buceras* L., Ucar - Oxford Bucida, *Bursera simuraba* (L.) Sarg., Almancigo - Turpentine, *Bourreria succulenta* Jacq., Palo de vaca, Roble de guayo - Pigeonberry, *Coccoloba microstachya* Willd. Uberillo - Pockhout, *Eugenia ligustrina* (Sw.) DC. Granadillo, Hoja menuda, Palo de mileta/ de murta – Birch berry, Privet-stopper, *Erythroxylum aerolatum* L., Indio, Cocaina falsa - Coca shrub, *Ficus citrifolia* Miller, Jaguey blanco, macho - Wild Banyan Tree, Boislaglu, *Coccoloba krugii* Lindau, - Wild Grape, Whitewood, and *Guaiacum officinale* L.. Guayacan - Lignun vitea , among others. In addition **VMT** and **FMT** personnel have planted in the Greenhouse other species including, among others, *Ficus benjamina* L., Laurel Benjamin - Weeping Fig, Chinese Bantam, cacti species of Culebra and the *Coccothrinax alta* (O.F.Cook) Becc., Palm Abanico - Teyer Palm that grows on the hills of Culebra. The agreement calls for planting these trees in four annual cycles of 300 trees each during the rainy fall and early winter season of **Culebra's** climate cycle.

The reforestation and planting will assist in further developing the **VMT Subtropical Model Dry Forested Area** of in the **VMT Ecological Corridor** in **Culebra** as authentic dry tropical forest with indigenous vegetation.

In the sharing agreement with **USFWS**, **FMT** with the consent and assistance of **VMT** will provide the personnel and equipment to design and build the greenhouse, prepare the land site for the reforestation, plant and provide occasional maintenance management to the newly planted trees. **FMT** will provide periodical reviews and reports require by the federal agency to document the discharge of the agreement. The **USF&WS** will provide technical and financial co-sharing assistance as well as collecting and providing the 1,260 native dry forest trees. The first work and review visit was carried out during the week of July 7, 2013 to examine the completion of the greenhouse, the condition of the existing populations of *Leptocereus grantianus* being protected in the **VMT Ecological Corridor** and to collect stems and plant material to plant 60 new plants in each of the **USFWS** greenhouse and **VMT** greenhouse. The 1,260 native dry forest trees were picked up- in Boquerón in February 25, 2014 and transported and delivered in the **VMT greenhouse** on February 27, 2014. The dry forest trees will be stabilized at the greenhouse so they can establish themselves and mature in the nursery until

the 2014 rainy season when the first cycles of 300 trees will be planted during the rainy fall and early winter season of **Culebra's** climate cycle. The original target date for completing the project was 2016.



Integrating an initiative to help establish a species in danger of extinction, such as the ***Leptocereus grantianus*** cactus, and the reforestation and planting of some 1,300 species to assist the further development the **VMT Subtropical Model Dry Forested Area** of the **VMT Ecological Corridor** in **Culebra** as authentic dry tropical forest with indigenous vegetation is an effort that requires a solid commitment of all the parties involved. **Fundación Mi Terruño and Culebra Resorts Associates II** have jointly spent the past decade protecting the significant vegetation in the approximate contiguous 60 cuerdas of the **VMT Subtropical Model Dry Forested Area** of the **VMT Ecological Corridor** in **Culebra**. Habitat reforestation and enrichment of species being currently implemented under the Partners Program with the USFWA and DNRA can help prevent degradation and enhance development of the flora communities. It will also allow for an undisturbed forested area where fauna species can also enhance and develop their communities. **VMT** is also committed in developing a **Model Ecologically Sustainable Residential Tourism Project** in the remaining small area of **Playa Sardinias II, Culebra** over a long term period to allow for absorption and proper planning.

### **Repopulation and Recovery Efforts**

This paper next summarizes some of the repopulation and recovery efforts that have been made to help establish new populations of the cactus as recommended in the USFWS Recovery Plan, in addition to informal comments and/or observations.



## **Attempts to Establish New Communities:**

### **1. Flamenco Peninsula Plantings – July 20, 1996:**

The first effort in **Culebra** to establish an additional or second population site of the cactus was carried out in the summer of 1996 by the USFWS in the northern slope of Flamenco Peninsula of **Culebra** in two principal sites. It was reported by R. Ross in his letter report with comments of March 2002.<sup>33</sup> Five new populations were planted at various distances at the base of a rock face on the north face of Flamenco Peninsula 65 feet above the shore and three additional populations were planted at various distances 45 feet up a ravine from 20 individual cuttings from the **Culebra** populations identified by Ross as No. 1 and No.2. No additional data on the current status of this Flamenco Peninsula population is available as of date.

### **2. Luis Peña Plantings – September 6, 1996**

The second effort in **Culebra** to establish an additional or second population site of the cactus was carried out in the fall of 1996 by the USFWS in the western slope of the island of **Luis Peña**. It was reported by R. Ross in his letter report with comments of March 2002.<sup>34</sup> Five new populations were planted at various distances on a light gap in the canopy of a *Bursera* forest on a 50° degree slope on the western face of Luis Peña some 30 feet above the shore from 23 cutting plantlets from the **Culebra** populations identified as No. 3 and No.4 and five additional populations were planted at various distances on the first slope near the crest in partial shade 70 feet above the shore from 23 individual cutting plantlets from the **Culebra** populations identified as No. 3 and No.4..

A sampling of the three year old transplant in **Luis Peña** in October, 2000 yielded evidence that 33 of the original 46 plantlets had survived No additional data on the current status of this population is available as of date. Growth was noted by Ross as slower in the Luis Peña population which he ponders may have been caused by the shadier locations as compared to the sunnier location of **Culebrita**.

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<sup>33</sup> See Ross, *supra*, note 9.

<sup>34</sup> *Ibid*.



### 3. **Culebrita Plantings – End of September, 1996:**

The third effort in **Culebra** to establish an additional or second population site of the cactus was carried out in the fall of 1996 by the USFWS in the western shoreline of the island of Culebrita. It was reported by R. Ross in his letter report with comments of March 2002.<sup>35</sup> Five new populations were planted at various distances on the ashore cliff of **Culebrita** some 10, 15 and 25 feet above the shore from 17 cutting plantlets from the **Culebra** populations identified as No. 1 and No.2 germinated in June 29 ,1996.

A sampling of the three year old transplant in **Culebrita** in October, 2000 yielded evidence that 11 of the original 17 plantlets had survived. Growth was better both in heights and width in **Culebrita** and may be related to the sunnier location. The terrain in **Culebrita** suffered from many landslides. No additional data on the current status of this population is available as of date.

### 4. **Private Landowner 5-cuerda site – 2003:**

The forth effort in **Culebra** to establish an additional or second population of the cactus was carried out in the summer of 2003 between the USFWS and a private landowner of a 5-cuerda parcel of land. It was reported in the Endangered Species Bulletin in an article titled “**Cactus Comeback in the Caribbean**” by Leopoldo Miranda Castro and Silmarie Padrón, USFWS field biologists, in 2005.

Forty (40) fragments were produced from cuttings to propagate the plant from the single known wild population. The one to two-year old segments were planted and raised in the nursery of the USFWS in Cabo Rojo, Puerto Rico, and some of the cuttings were transferred back to **Culebra**. The original intent was to plant them in the **Culebra National Wildlife Refuge** but due to the presence of dangerous unexploded ordnance within the refuge boundary, that option was discarded. **Luis Peña Island** was considered as an alternate site but was dismissed due to the high population of feral goats.

The private landowner was found through The Partners for Fish and Wildlife Program. He agreed to establish the new cactus population on his 5-cuerda estate, which, according to the article, was already subject to a conservation easement. Three (3) individuals had to be relocated due to the wetness of the soil in their planting site. The 2003 class of the **Culebra National Wildlife Conservation Youth Corps** was recognized for their collaboration on the project. They helped clear a half-cuerda site of an invasive grass species using hand tools, and the cacti, already 2 to 4 feet in length (0.05 to 2 m), were planted in the cleared areas, on a rocky hill. In 2005, all the plantings were reported as doing well and sprouting new segments. The landowner and **USFWS** personnel were monitoring the segments, but unfortunately, a wild fire subsequently engulfed the property and the planting site and the two populations were permanently lost.

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<sup>35</sup> Ibid.

## 5. Culebra National Wildlife Refuge below OP in Punta Flamenco – November 2010:

The fifth effort to establish a population site on a hillside of the **Culebra National Wildlife Refuge** below the OP on the cliff side of **Punta Flamenco** was carried out after our May 10, 2010 visit to the USFWS greenhouse in **Culebra**. These **VMT** stems propagated plants or a portion of them were reportedly used to establish the new population. The cacti were planted in a relatively clear exposed area without tree cover to the left of the entrance to the beach facilities. This cliff and hillside of the **Culebra National Wildlife Refuge** below **Punta Flamenco** abuts on its overlooks to the west beautiful **Playa Flamenco**.

The population of this second attempt was also almost completely destroyed by fire the last week of March or first week of April 2011.

During the dry season, fires are known to occur in several areas of **Culebra** for unknown reasons. Fortunately, some plants may have survived the fire and should be growing again. The author has photographed the fire site but has not visited this planting site



### The Road to Recovery of the Species:

The **USFWS Recovery Plan's** objective is to reverse the decline of **Leptocereus grantianus** cactus species and restore the species to a self-sustaining status, thereby permitting its removal from the Federal Endangered Species List.

The discovery of the **Leptocereus grantianus** cactus species in the **VMT** site was indeed extraordinary and significant to the struggle for survival of the species in **Culebra and the planet, since it only grows on the island**. The three separate population habitats of the species over separate areas of the south hill, the size and number of populations and plants found in the habitat areas and its relatively isolated location inside protected private property, offers significantly more guarantees for the survival of the species in **Culebra**.

As noted before, **Leptocereus grantianus** may be considered for down-listing when (1) an agreement between the USFWS, the municipality of **Culebra**, and the Puerto Rico DNER is

reached and implemented for the protection of the species, and (2) new populations capable of self-perpetuation have been established within units of the **Culebra National Wildlife Refuge**.

The area of coverage of the cactus habitat in **VMT**, with its three coastal cliff separate population habitats, is in excess of one *cuerva*. **The almost one *cuerva* area of habitat coverage of the larger habitat area in the highly protected upper central side of the cliff, sustains approximately ten independent separate plant clusters of the populations, some at relative distances from each other. Over two hundred and fifty plants (250) grow in the habitats.** They are protected and many thrive under tree cover. The upper population grows at varying elevations of some thirty three feet (10 meters) down the less graded coastal upper cliff below the Nature Trail. **VMT** has also three cliff side populations in the Playa Cascajo beachfront area.

**The significant discovery of these VMT populations, their conservation and protection for almost ten years, and the successful propagation of some sixty (60) 3 year old plants from the VMT segments in the Culebra populations provide a significant contribution to the recovery efforts and help the long term survival of the species. It meets, independently, most of the original population expansion goals of the USFWS Recovery Plan.**

**To protect the *Leptocereus grantianus cactus* species population habitat areas the VMT Ecological Corridor was extended, the master plan of the proposed VMT model sustainable project substantially modified and the number of proposed density of residential tourism units reduced and relocated following recommendation of the federal and insular environmental protection agencies. The habitat will be protected in perpetuity by deeded grants to FMT and restrictive covenants in the VMT proposed project with FMT, as the dominant tenant.**

The original known population of some 50 plants in **Punta Melones** has a land coverage area of less than one quarter of a *cuerva* in exposed steep rocky coastal cliff. The original population is highly exposed growing on a rocky, unstable shoreline next to a public beach and below what is now a highly developed resort residential area of recent construction with roads and service accesses immediately above the cliff of the first population. The wave action that accompanies a storm surge of a mayor hurricane could eliminate that original only known population due to its proximity to the shoreline.

As of 2012, the original population in the **Punta Melones Area** continues to survive and do well. It is a mature population as can be observed from the color and size of many of its base stems. The original Melones population continues more threatened today than in 1994 when it was declared endangered.

A **recent visit** to the **Punta Melones Area** on May 27, 2014, evidenced a significant deterioration of the original population (Population # One). **Culebra** only received two inches of rain during its 2014 dry cycle from January to April. Contrary to observed conditions during previous visits, significant damage was noted during the last visit. Older segments previously slightly grey or pitted were noted to have suffered substantial damage to the vegetative softer

cover material and had dried out back to their structural inner support core. The population appears to be no longer isolated in its extreme non-disturbed and rock protected habitat. Several stem branches exhibited strait cuts before the end of the stem joint which indicated having been harvested by non-trained personnel, apparently illegally, for propagation. The remaining half of the cut stems are not exhibiting lateral new growth or new stem development as exhibited in greenhouse protected reproduction plantings. Ross<sup>36</sup> had noted in his **Letter Report with Comments to USFWA of March, 2002** that: “Death of branch sections is apparently the result of damaging winds allowing for infection by bacteria, insect larvae, or other opportunists to invade the stem surface.” Some minor gray-damaged younger stem separation falling on the distant rocky ground was noted probably caused by reason of disturbance or damage to plant stems. Unfortunately, the stems were observed to have fallen on fractured rock surface and not on vegetative soil. The area was not reachable and the new inhospitable habitat did not appear to bode well for successful rooting or reestablishment of the separated but damaged younger stems.



### 2014 Deteriorated Condition of the Punta Melones Population

<sup>36</sup> See Ross, *supra*, note 9, item 6 at page 30 above.

The site also exhibits a drainage cut that has cleared the receptive vegetation around the drainage cut. The cut is located to the left of center of the site on the extreme upper slope. In spite of the substantial damage noted, the **Punta Melones Area** [Population # One] continues to thrive with sufficient plants to sustain its survival as a population. Propagation and reestablishment of new plants, within the population, is beginning to look uncertain. The original **Punta Melones Area** population continues more threatened today than in 2012 and from its condition in 1994 when it was originally declared endangered.

### Propagation by Cuttings

Robert Ross concluded that “propagation by cuttings is easily accomplished and transplants in the field can survive without additional care”.<sup>37</sup> Propagation from seeds has been established in control greenhouse environments both at the UPR and by the USFWS. However propagation by cutting has become the preferred method to accelerate establishment of more mature plants in new populations.

The effort of 1996 to plant additional populations in **Punta Flamenco, Luis Peña and Culebrita** were the first effort to establish that replication of new sites is possible. Isolation from human and animal predator interference appears to be essential for long term establishment of populations. No current data has been published on the present condition or existence and condition of these original three efforts to start additional populations in new sites. Additional efforts to visit the planting sites to determine current status are needed. A 2014 reliable informal comment indicates that a few plants may be surviving and establishing themselves in some of the new population areas. No details, however, are available to determine the impact or extent of the establishment of these new populations and their significance in the road to recovery.

After the collection of the 60 segments in **VMT** and their cultivation and development by the USFWS personnel, the **Leptocereus grantianus** cactus species was moving toward recovery. The planting of several new populations on the hillside of the **Culebra National Wildlife Refuge** behind **Playa Flamenco** were some of the awaited last steps. **Had the populations successfully established themselves, the down-listing of the species may have been possible. The destruction of the fourth populations in 2005 and almost complete destruction of the fifth efforts on the Punta Flamenco hillsides in 2011 has made this a frustrating struggle and continued labor of love.**

**FMT is committed to assisting the USFWS in these efforts. We moved forward by establishing the greenhouse on the VMT site and are presently<sup>38</sup> nurturing 60 plants to be able to help in the recovery, propagation and study of the *Leptocereus grantianus* cactus species in collaboration with the DNER, the USFWS and their personnel.**

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<sup>37</sup> See Ross, *supra* p. 2, note 9

<sup>38</sup> As of June 30, 2014

## An Undescribed Cactus of Culebra Island, Puerto Rico

By N. L. BRITTON

### *Leptocereus Grantianus*, sp. nov.

Branched at the base, and above, arching, or suberect, about 1.5 m. high, or lower. Joints 3-5 ribbed, up to 1 m. long, or longer, 3-5 cm. thick. Ribs of young joints thin, 1-1.5 cm. high, low-crenate, the small areoles felted, and bearing 1-3, minute, nearly black spines, only about 1 mm. long, or shorter, which disappear as the joints grow older, and the ribs thicker. Flowers solitary at terminal areoles, 3-6 cm. long, nocturnal; ovary and flower-tube bearing distinct areoles; ovary about 1 cm. in diameter, the nearly obconic tube about 2 cm. in diameter below the spreading limb, the nearly black, circular areoles about 1.5 mm. broad, felted, and bearing a few weak spinules about 1 mm. long, the limb about 4 cm. broad, about one-fifth as long as the tube; outer perianth-segments linear, green, tipped by an areole like those of the tube and ovary; inner segments numerous, cream-colored, oblong-obovate, obtuse, about 8 mm. long; stamens many, with yellow anthers; stigma-lobes several, short; fruit subglobose to ellipsoid; about 4 cm. in diameter.

Culebra Island, Puerto Rico, *Major Chapman Grant*, U. S. A., 1932. The type specimens (*Britton 9725*) are deposited in the herbarium of The New York Botanical Garden.

In habit, this plant resembles *Leptocereus quadricostatus*, differing in the form of flowers, and in their characteristic areoles; it is more nearly unarmed than any other species of the Cereanae known to me.

Plants obtained by Major Grant and brought to San Juan, have flowered repeatedly, and also in the collection of Professor George F. Anton at Mayaguez; I have studied these when in bloom. Mrs. Horne made a water-color painting of the plant at San Juan, and from this painting, from these plants and from specimens sent by Major Grant and Professor Anton, the description has been made.

As observed by Major Grant, Professor Anton, and Mrs. Horne, the flowers open about 10 o'clock in the evening and are closed about 10 the next morning. Mrs. Horne's excellent water-color painting of a flowering branch was made in September, 1932.

Through cross-fertilization by Professor Horne of two flowers which opened at the same time on the type plant, in the spring of 1933, a fruit was obtained, which nearly reached maturity before falling away. Other fruits, were formed naturally on plants in the collection of Professor Anton, in the summer of 1933. Plants have also been added to Mrs. Henry B. Heylman's collection at Casa Maria, San German.

A plant transferred to the New York Botanical Garden, flowered there in November, 1933.



*Leptocereus quadricostatus* from Britton and Rose "The Cactaceae" Vol. II, p. 81. An illustration of the new species will be shown soon in this JOURNAL.

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