Action Plan

for the Conservation of Cuban Cacti

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# Table of contents

Summary.................................................................................................................................................. i

I. Introduction........................................................................................................................................1

II. Background and justification .............................................................................................................2
   II.1. General geographic characteristics of Cuba ................................................................. 2
   II.2. Cactus diversity in Cuba ................................................................................................. 3
   II.3. The main habitats of cacti in Cuba .............................................................................. 5
   II.4. Importance of Cuban cacti ............................................................................................. 8
   II.5. Conservation strategies/tools ......................................................................................... 9
      II.5.1. Legal framework ........................................................................................................ 9
      II.5.2. *In situ* conservation in the National System of Protected Areas ................ 9
      II.5.3. *Ex situ* conservation ............................................................................................. 11
         Botanical gardens ............................................................................................................. 12
         Seed banks ......................................................................................................................... 13
      II.5.4. Public awareness and environmental education ............................................ 14

III. The conservation survey .............................................................................................................. 15
   III.1. Criteria to delimitate ‘unit of conservation’ ............................................................... 15
   III.2. Units and their conservation status ............................................................................... 16
   III.3. Setting of conservation priorities .................................................................................. 32

IV. The action plan .............................................................................................................................. 34
   Task 1. Lobbing for final approval of the already proposed protected areas ............ 34
   Task 2. Propose new protected areas ............................................................................... 35
   Task 3. Making plant available for people ........................................................................... 36
   Task 4. Living collection for conservation in botanic gardens ...................................... 37
   Task 5. Seed bank .................................................................................................................... 38
   Task 6. Monitoring invasive species ...................................................................................... 38
   Task 7. Environmental education and public awareness ............................................ 38

V. Concluding remarks........................................................................................................................ 39

References
Summary

Cuba supports the highest diversity of cacti in the Caribbean hotspot. At the present, 27 species are reported for the country, 14 of them endemic. This cacti flora is also characterized by ancient (*Pereskia zinniflora*), intriguing (*Leptocereus* spp.) or isolated (*Escobaria cubensis*) lineages. The cacti of Cuba occur mainly in coastal thicket, dry evergreen forest, thorny serpentine thicket and mogote vegetation complex. The narrow distributions of the majority of Cuban cacti and human activities on their habitats have led to a dramatic decline in the populations of several species. In fact, according to the Red List of Cuban Vascular Plants there are 10 Critically Endangered species, 4 Endangered and 3 Vulnerable. The objective of this project is to design an action plant for the conservation of Cuban cacti considering different strategies or techniques available for plant conservation.

This work is based on ‘units of conservation’ –delimited here– to avoid the instability or lack of agreement on taxonomic entities that make it difficult to address conservation work. In this case most of the units are the whole distribution of a taxon or a particular distinct population. Any species with uncertain origins are excluded from this work.

We identify 27 unit of conservation and set priorities for the conservation of them considering actual or potential threats, endemism and conservation category. The population size and species distribution is also taking into account but higher priority for conservation is giving to those species that are already facing any threat in all their population or in the majority of them. The most highly threatened species are *Leptocereus wrightii*, *L. arboreus*, *L. carinatus*, *Melocactus actinacanthus*, *Escobaria cubensis*, *Cylindropuntia hystrix*, *Pereskia zinniflora*, *Dendrocereus nudiflorus* and *Leptocereus sylvestris*. We propose lobbying for the final approval of the already proposed protected areas that contains 13 cacti and the worldwide threatened dry evergreen forest (tropical dry forest). We also identify 5 new areas to be included in the National System of Protected Areas. These new areas will provide protection to 7 of the most threatened species. We also suggest propagating cacti to make them available for people and so decrease the pressure
on the wild populations, this measure is particular important for the dwarf cacti (*Escobaria cubensis*, *Melocactus* spp., *Mammillaria prolifera*). Some species have lost their habitat almost completely so keeping them in living collection it is the only real alternative now, meanwhile it could be done research on seed conservation for these and all other Cuba species. We also outline the necessity to monitor the alien invasive species *Leucaena leucocephala* and *Dychrostachis cinerea* widespread in some cacti habitats and which are changing the community structure. Finally, we propose to work on public environmental education and raising effective awareness on local people.
I. Introduction

The Cactaceae contains 124 genera and about 1816 species (Hunt et al. 2006). This family is endemic to the New World with the exception of *Rhipalis* which also occurs in Tropical Africa (Taylor & Zappi 2004). It is a particularly conspicuous component of arid regions and represents one of the world’s most spectacular desert radiations (Edwards et al. 2005).

Cuba supports the highest diversity of cacti in the Caribbean hotspot (Mittermeier et al. 1999). At the present, 27 species are reported for the country, 14 of them endemic (Hunt et al. 2006). This cacti flora is characterized for a mixture of taxa coming from the north and other from the south and very ancient (*Pereskia zinniflora*) and intriguing lineages (*Leptocereus* spp.).

The cacti of Cuba are mostly distributed in coastal ecosystems but some interesting species grow in limestone and serpentine outcrops localized inland from west to east of the country. Although some species occur over very large areas, most have very narrow distributions. Narrow distribution and human activities, like urbanization including the development of infrastructure for tourism, agriculture, grazing, fires, and mining and quarrying have led to a dramatic decline in the populations of several species (González-Torres et al. 2005). In fact, according to the Red List of Cuban Vascular Plants there are 10 Critically Endangered species, 4 Endangered and 3 Vulnerable (Berazaín et al. 2005).

The objective of this project is to design an action plan for the conservation of Cuban cacti considering different strategies or techniques available for plant conservation.
II. Background and justification

II.1. General geographic characteristics of Cuba

The Republic of Cuba is an archipelago composed by more than 1600 islands, islets and cays. The largest island is Cuba. The archipelago is between 23°17’ – 19°50’ lat. N and 74°08’ – 84°58’ long. W (CNNG 2000) in the entrance of the Gulf of Mexico Gulf (fig. 1).

![Fig. 1. Geographic position of Cuba (modified from Google Earth http://earth.google.com/).](image)

The geology is complicated and it is characterized by a high diversity of rocks including limestone, serpentine, dolomite, basalt, granite, diorite, gabbro, sandstone and slate (Borhidi 1991). The oldest rocks are those of the mountain ranges and date from the
Jurassic or Cretaceous. The rocks of the lowlands date from Palaeogene to Quaternary (CNNG 2000).

The 70 percentage of the country are lowlands and the main mountain ranges are Guaniguanico, Guamuhaya, Nipe-Sagua-Baracoa and Sierra Maestra. The last one contains the highest hill is Pico Turquino with 1972 m (CNNG 2000).

The Cuba climate is tropical. Due to its narrow configuration, east to west oriented the country receives the refreshing action of trade winds and marine breezes. During the short winter are influences of cold air masses coming from the North. The average temperature throughout the year oscillates between the 20 and 35ºC, lowering sometimes to 10ºC. There is two main season the rainy from May to October and the dry one from November to April. The mean rainfall reach 3000 mm in some mountain ranges and 600 mm in the south cost of Guantánamo (CNNG 2000).

II.2. Cactus diversity in Cuba

Although the number of cacti in Cuba is not large, if we compare it with that of some countries in Central and South America, there are still some taxonomic problems in most genera. The last national checklist of Cactaceae reported 50 native taxa to Cuba (Rodríguez 2005) and a recent review of the family worldwide reports 26 native species for the country (Hunt et al. 2006).

The incongruence of taxonomic overviews is mostly a consequence of the high variability of morphological characters between populations of the same species that reaches its highest score in the genus Melocactus. On the other hand some studies are biased by the quantity and quality of the herbarium specimens of Cuban plants (inter alia Taylor 1991), but others because their research is somewhat restricted to mainly Cuban specimens (inter alia Mézsáros 1976, 1977).
List of the native cacti of Cuba (compiled from Hunt et al. (2006)).


*Consolea macracantha* (Griseb.) A. Berger, Entwickl. Kakteen, 94. 1926.

*Consolea moniliformis* (L.) A. Berger, Entwicklungslin. Kakt, 94. 1926.


II.3. The main habitats of cacti in Cuba

The cacti of Cuba are mostly distributed in coastal ecosystems but some species grow in limestone and serpentine inland hills. The majority of Cuban cacti are restricted to coastal thicket, dry evergreen forest, thorny serpentine thicket and mogote vegetation complex. However, climbing or epiphytic cacti like *Selenicereus grandiflorus*, *Hylocereus* sp., *Epiphyllum phyllanthus* and *Rhipsalis baccifera* may also occur in other vegetation types. The last 3 species do not occur in coastal vegetations but usually inland wet ones.

**Coastal thicket**

The shrub layer is dense and composed of small leaves shrubs of 1-5 m height. There may be also scattered small trees. Succulents could be abundant mostly in the south coast of eastern provinces (Capote & Berazaín 1984). These plant communities are widespread in the limestone or coral limestone seashores of the country. The soil is usually shallow, rocky and humic-carbonated (Borhidi 1991).

**Dry evergreen forest**

These forests have two layers of trees—the tallest reaches 12-15 m and the other between 5-10 m (fig. 3). Epiphytes, climbers and spiny shrubs are common as well as columnar or tree-like cacti (*Dendrocereus nudiflorus*, *Leptocereus sylvestris*, *Stenocereus fimbriatus*) and other succulents (*Agave* spp.) (Capote & Berazaín 1984). This forest occurs on the limestone or coral limestone shallow and rocky soil of Cuban seashores (Borhidi 1991).
Semideciduous forest

These forests have two layers of trees—the tallest reaches 12-15 m and the other between 8-10 m (fig. 4), some of them are spiny and usually have small leaves (Capote & Berazaín 1984). They occur on slightly deep limestone or coral limestone derived soils in the seashores usually behind the dry forests (Borhidi 1991).

Thorny serpentine thicket

These thickets are distributed on the chain of serpentine outcrops west-east spread along the island. The communities are mostly composed by 1 to 4 m high, evergreen shrubs with scattered emergent low trees (fig. 5). These are one of the richest plant communities of the Caribbean and the endemism on some of these areas reach 80-85% (Borhidi 1991). The succulents can be locally abundant mostly Agaves spp. and
*Furcraea hexapetala* but cacti (*Melocactus, Escobaria* and *Pilosocereus*) be likely to form small and clustered populations (Capote & Berazaín 1984).

**Mogote vegetation complex**¹

This unique vegetation occurs in deeply inclined, tower-like kastic hills with narrow and deep gorges. These mountains are composed of old, very hard upper Jurassic rocks (blue limestone), emerged in the Cretaceous. The soil of these mountains is usually bare rock. These hills usually support a very ancient and specialized flora. This vegetation is composed by three units (Borhidi 1991). The one on the top are high xerophytic scrubs rich in bromeliads and some cacti may occur (*Leptocereus* spp., *Pereskia zinniiflora*). The vegetation of the rocky cliffs is scattered scrubs of *Agave* with *Mammillaria* but the one in the base of the mountains support semideciduous or evergreen forests (Capote & Berazaín 1984).

¹ Mogote vegetation complex in its strict sense only occurs in Sierra de los Órganos, Pinar del Río. But in this text we use this term in the broad sense to refer the vegetation of all the mogote-like hills occurring along the island.
II.4. Importance of Cuban cacti

Scientific relevance

The cactus flora of Cuba is the richest of the Caribbean hotspot with 26 species, 13 endemic. The most important group is the genus *Leptocereus* – a very primitive and particular lineage within Cactoideae that is endemic to the Caribbean. This genus has 7 species in the country, all of them endemic. *Pereskia zinniiflora* is another species restricted to the island and quite important considering that it represents the oldest lineages of the whole family (Edwards et al. 2005). There are other particularly important species since they are unique within genera like *Escobaria cubensis* or quite isolated from their relatives like *Melocactus matanzanus*, *Cylindropuntia hystrix* and *Dendrocereus nudiflorus*.

Economic, aesthetic and religious relevance

The native cacti are not used much by people in Cuba. These plants are not important either for national or for regional economies but for local communities. Fuentes (2005) states that some species are used locally as living fences (e.g. *Stenocereus fimbriatus*, *Harrisia eriophora*, *Opuntia stricta*), as human food (e.g. fruits of *Harrisia eriophora*, *Opuntia stricta*, *Selenicereus grandiflorus*) and even some are used in the traditional medicine (e.g. *Harrisia eriophora*, *Opuntia stricta*, *Selenicereus grandiflorus*, *Pereskia zinniiflora*, *Rhipsalis baccifera*).

Some species, such as *Opuntia stricta*, *Selenicereus grandiflorus* and *Rhipsalis baccifera* are frequently planted in gardens, but some small species, especially *Melocactus matanzanus*, are valued as pot plants. The cultivation of cacti like *Opuntia* and *Consolea* is in some cases related with the popular superstition that these plants protect the house and the family against the ‘evil eye’.
II.5. Conservation strategies/tools

II.5.1. Legal framework

Cuba has signed and ratified the Convention of Biological Diversity (CDB) in 1994 and 2003 (CBD 2006). After this international agreement several institutions of the country worked on the ‘National Study of the Biological Diversity of the Republic of Cuba’ (Vales et al. 1996) and in 1997 the National Strategy and Action Plan for Biological Diversity Conservation of Cuba (Vilamajó et al. 1997) was approved.

The National Environmental Strategy of Cuba is being adapted to a new strategic cycle from 2005 to 2010, which incorporates most of the 2010 biodiversity targets (CBD 2007) to achieve a significant reduction of the current rate of biodiversity loss by this date. The protection of areas of particular importance to biodiversity is being incorporated into different plans and programmes, in particular through the National System of Protected Areas.

One output of the Convention for Biological Diversity is the Global Strategy for Plant Conservation (GSPC). This was adopted unanimously at the sixth meeting of the Conference of the Parties to the Convention held in The Hague in April, 2002. The GSPC is aimed at all organisations that can contribute to plant conservation, and lays down specific and measurable targets for 2010 (GSPC 2002).

II.5.2. In situ conservation in the National System of Protected Areas

The best strategy for long-term conservation of biological diversity is the preservation of natural communities and population in the wild, known as in situ conservation (Primack 2002, Frankel et al. 1995). This is the only way to preserve ecological process, complex biological structures (e.g. communities), as well as to allow the continuity of evolutionary process. This strategy is implemented by the establishment of protected areas.
In Cuba, there is a National System of Protected Areas that will be composed by 263 areas distributed in the whole country (fig. 7) when it is completely approved by the Cuban Government. At present, there are 35 approved and 20 in the evaluation procedure (González & Castañeira 2004). Some of them have special importance for the conservation of Cuban cacti (Table 1).

Fig. 7. National System of Protected Area of Cuba (CNAP 2005). Reserva Natural = Natural Reserve (Category I IUCN), Parque Nacional = National Park (Category II IUCN), Reserva Ecológica = Ecological Reserve (Category II IUCN), Elemento Natural Destacado = Natural Monument (Category III IUCN), Refugio de Fauna = Fauna Refuge (Category IV), Reserva Florística Manejada = Flora Managed Reserve (Category IV IUCN), Paisaje Nacional Protegido = Protected Landscape (Category V), Área Protegida de Recursos Manejados = Managed Resource Protected Area (Category VI IUCN).

The system is composed by 79 Protected Areas of National Relevance – the ones with International, National or Regional importance, 196 Protected Areas of Local Relevance (196) – the ones with important natural values but small sizes and poor conservation status, and 4 Special Regions for Sustainable Development – this are very large regions (the
four mountain massif) with fragile ecosystem and economical and social importance that deserve special management.

Table 1. Protected areas important for cacti conservation in Cuba.

<table>
<thead>
<tr>
<th>Name</th>
<th>Management category*</th>
<th>Province</th>
<th>Legal status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baitiquiri</td>
<td>RN</td>
<td>Guantánamo</td>
<td>Proposed</td>
</tr>
<tr>
<td>Boquerón</td>
<td>RE</td>
<td>Guatánamo</td>
<td>Proposed</td>
</tr>
<tr>
<td>Caleta</td>
<td>END</td>
<td>Guantánamo</td>
<td>Proposed</td>
</tr>
<tr>
<td>Cerro Galano</td>
<td>RN</td>
<td>Holguín</td>
<td>Proposed</td>
</tr>
<tr>
<td>Desembargo del Granma</td>
<td>PN</td>
<td>Granma</td>
<td>Approved</td>
</tr>
<tr>
<td>Guanahacabibes</td>
<td>PN</td>
<td>Pinar del Río</td>
<td>Approved</td>
</tr>
<tr>
<td>Hatibonico</td>
<td>RE</td>
<td>Guantánamo</td>
<td>Approved</td>
</tr>
<tr>
<td>Imías</td>
<td>RN</td>
<td>Guantánamo</td>
<td>Proposed</td>
</tr>
<tr>
<td>La Coca</td>
<td>RE</td>
<td>C. Habana</td>
<td>In evaluation!</td>
</tr>
<tr>
<td>Maisí</td>
<td>RE</td>
<td>Guantánamo</td>
<td>Proposed</td>
</tr>
<tr>
<td>Sabanas de Santa Clara</td>
<td>RFM</td>
<td>Villa Clara</td>
<td>Approved</td>
</tr>
<tr>
<td>Tres Ceibas de Clavellinas</td>
<td>RFM</td>
<td>Matanzas</td>
<td>Approved</td>
</tr>
<tr>
<td>Viñales</td>
<td>PN</td>
<td>Pinar del Río</td>
<td>Approved</td>
</tr>
</tbody>
</table>

* END = Natural Monument, PN = National Park, RE= Ecological Reserve, RFM = Flora Managed Reserve, RN = Natural Reserve.
! The proposal is being analyzed by government authorities.

II.5.3. *Ex situ conservation*

*In situ* strategies are the most advantageous ones for the conservation of the biological diversity but they are not always viable. In some cases, when the species is naturally rare or its populations have declined dramatically, it is necessary to maintain individuals temporally under artificial conditions due to the populations usually are unable to maintain by itself in the increasing changing environment or even in protected areas (Primack 2002). These strategies are known as *ex situ* but they are unsuitable for conserving process,
complex ecological structures and they do not allow for the natural evolution of the populations. In fact, this strategy is called ‘static conservation’ by Frankel et al. (1995) due to gene and allele erosion is minimized and recombination with alien material is avoided however the frequencies of genotypes or alleles change. Therefore ex situ conservation should be conceived as a temporally tool and complementary to an in situ strategy. Ex situ facilities for plant preservation include botanical gardens and seed banks.

**Botanical gardens**

These are scientific institutions traditionally addressed in displaying the beauty of the plants and their diversity but they are increasingly focusing their efforts on cultivating rare and endangered species for conservation purpose (Primack 2002). These institutions are in a unique position to contribute to conservation efforts because the living collections and the herbaria represent the best sources of information available on plant distribution and habitat requirements (Primack 2002). Botanic gardens can keep as living collections a great diversity of taxa but usually very few collections can keep within population genetic diversity due to maintenance is expensive and the space requirements.

In Cuba, there are 12 botanic gardens distributed along the whole country (fig. 8). All these institutions are members of the Cuban Network of Botanic Gardens (CNBG). The Network works according to the International Agenda for Botanic Gardens in Conservation to contribute to achieve the Global Strategy for Plant Conservation targets (Leiva 2006).

The CNBG is working on the new flora of Cuba –covering 25 families in the last two years (target 1 GSPC). As regarding the target 2 GSPC, Botanic garden staffs and the Cuban Plant Specialist Group have developed a continue work assessing the conservation status of 1414 species compiled in the Red List of the Cuban Vascular Flora (Berazaín et al. 2005) and in the last year undertaking rapid assessment of more than 500 species.
Fig. 8. Cuban Network of Botanic Gardens (Leiva 2000).

The Botanic Gardens Network has also collaborated in the identifying the flora of five protected areas (target 7 GSPC) and they are cultivating 83 endemic and threatened species \textit{ex situ} (target 8 GSPC) (Leiva 2006).

**Seed banks**

These are institutions or departments focused on the establishment and conservation of seed collections. The first seed banks were focused on the approximate 100 plant species that make over 90% of human food consumption, but they are devoting more and more attention to a wider range of species that may be threatened with extinction or loss of genetic variability (Primack 2002).

Approximately 10% of the world’s plant species have recalcitrant seeds that either lack dormancy or do not tolerate low-temperature storage conditions and consequently cannot be stored in seed banks (Primack 2002). But fortunately seeds of most plants species are orthodox and can be stored in cold (e.g. -20°C) and dry conditions (e.g. 15% RH) for long
periods of time and then later germinated to produce new plants. Recalcitrant seeds are more common in wet environments.

These collections allow preserving a greater diversity of species than the traditional living collection and a greater range of within population genetic variation as well, with lower space and funds requirements for maintenance.

Cacti seem to be suitable for being conserved in seed banks. There are no records of any recalcitrant species but several (18) of orthodox ones (Flynn et al. 2006). Ocampo-López et al. (2003) report 97.3% of germination on seed of *Mammilaria spuertexta* stored in seed bank conditions during 6 years.

**II.5.4. Public awareness and environmental education**

Despite the fact of the massive diffusion of information regarding the global crisis of the environment, most of the people do not yet grasp the arguments or they are not convinced by them (Given 1994). The general goals of the broad field of environmental education are to foster clear awareness of, and concern about, economic, social, political and ecological interdependence; to provide every person the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment; and to create new patterns of behaviour of individuals, groups, and society as a whole toward the environment.
III. The conservation survey

III.1. Criteria to delimitate ‘unit of conservation’

The instability or lack of agreement on taxonomic entities makes it difficult to address conservation work and sometimes can delay or even stops it. Given this, the delimitation of ‘units of conservation’ – that identify taxonomic entities – could facilitate the setting of priorities for resource allocation as well as planning and management conservation projects. According to Lindermayer & Burgman (2005) a unit of conservation is the smallest set of organisms considered in conservation planning. It could be a genotype, a group of individuals in a single place (a deme or population), a set of populations, a taxonomic group or a group of species that makes a community. In the context of Cuban cactus conservation most of the units could be the whole distribution of a taxon or a particular distinct population.

The units of conservation were defined considering the taxonomic review of Hunt et al. (2006), other taxonomic papers and field experience. It is necessary to check these units after studying the herbarium specimens and discuss their definition with regional experts. They are referred to by the name of the microspecies if this is appropriate for the conservation purpose and does not promote ambiguous interpretations.

Species with uncertain origin are excluded from this work. Those ones have been collected on few occasions and most of the collections are from places close to human settlements or within them raising doubts as to their native status. The excluded species are *Acanthocereus tetragonus*, *Epiphyllum phyllanthus* and *Hylocereus* sp.
III.2. Units and their conservation status

Consolea macracantha

Here, this includes *C. nashii* (Britton) A. Berger and *C. millspaughii* (Britton) A. Berger, according to Hunt et al. (2006).

**Distribution and habitat:** This species is widely distributed in the Caribbean region (Cuba, Hispaniola, Bahamas, Puerto Rico, Cayman Islands, British Virgin Islands, US Virgin Islands and Florida-United States) (Hunt et al. 2006).

In Cuba this species occurs on the eastern cays of the archipelago Sabana-Camagüey, north of Las Tunas, northwestern of Holguín and in the south of the eastern provinces from Pilón in Granma to Jauco in, Guantánamo. This plant grows in coastal thickets (fig. 9), dry forests and semideciduous forests (Areces 1996).

**Conservation issues and threats:** *C. macracantha* is Vulnerable according to Berazain et al. (2005). The Cuban populations of this species are out of protected areas. There is not data regarding the conservation status of this species out of Cuba. The populations occurring on the cays at the north of Camagüey and the north coast of Las Tunas and northwest coast of Holguín are affected by habitat fragmentation or even completely habitat destruction as consequences of tourism infrastructure construction, forestry, agriculture and charcoal production (Rifá et al. 2005, Leyva et al. 2005a). Leyva et al. (2005a) state that
the populations of Holguín are mostly composed by adult plants with very few young ones. 

The populations of the south coast of Granma, Santiago de Cuba and Guantánamo are less threatened excluding those near to the city of Santiago de Cuba where the natural vegetation has been completely altered. The stem segments develop easily new plants when fell down to the soil.

**Consolea moniliformis**

The populations of this species that grow in Cuba are considered by some author (e.g. Areces 1996, Rodríguez 2005) a different subspecies (*C. moniliformis* subsp. *guantanamana* Areces) of those occurring in Hispaniola and Mona Island. Here these taxa are considering a single one following the review of Hunt *et al.* (2006).

**Distribution and habitat:** This species occurs in Cuba, Hispaniola and Mona Island. In Cuba this species grows on coastal thickets or dry forests from Imías to Jauco, Guantánamo.

**Conservation issues and threats:** This species is categorized as Lower Concern in Cuba (Berazaín *et al.* 2005). There is no data regarding its conservation status in the other islands. The populations of this species are not included in any protected area but its habitat is not highly disturbed. Its area of distribution in Cuba supports small settlements of fishermen and farmers so the human pressure on the species habitat is low. The stem segments develop easily new plants when fell down to the soil.
**Consolea sp.**

This species was found recently (Hernández *et al.* 2005) and there is not information regarding its taxonomical status. It is probably *Consolea macracantha* the most widespread species of the genus in Cuba but there is not yet any study regarding its identity.

**Distribution and habitat:** Hernández *et al.* (2005) referred this new population of *Consolea* to Fomento, Sancti Spíritus. This is the western population of this genus ever recorded in Cuba but also the unique one that grows in the inland. This population grows in a semiciduous forest on rocky limestone soil.

**Conservation issues and threats:** This population had two adult plants and several young plants in 2005. There were also several plants dead by the attack of a leaf miner that destroyed the succulent flat stems (Hernández *et al.* 2005).

**Cylindropuntia hystrix**

**Distribution and habitat:** This species is endemic to the south coast of Guantánamo. According to Rodríguez (2005) this species is restricted to the surround of the US Base at Guantánamo Bay but it could be also found from this locality to Imías. It occurs on the coastal tickets on shallow limestone derived soil.

**Conservation issues and threats:** *C. hystrix* a Critically Endangered species [B2a+b(i,ii,iii,iv)] according to Berazaín *et al.* (2005). This species is rare although it could form groups where it appears. It is not included in any protected area. According to local people of the region this plant uses to grow in large areas from the surrounding of Imías to Baitiquirí but most of these areas are now covered by crops plantations. Local farmers burn the plants when they find them due to their spines are harmful for livestock. These plants do not produced seeds at all but their stem segments develop easily new plants when fell down to the soil.
Fig. 11. Disturbed thicket with *Cylindropuntia hystrix*, and detail of a flowering branch (bottom left). Photo: L.R. Gonzalez-Torres.

*Dendrocereus nudiflorus*

Anderson (2000) considers this species and *D. undulosus* (DC) Britton & Rose from Hispanola a single taxon. Hunt *et al.* (2006) maintain both species but they stated that the differences between both species may not be significant.

**Distribution and habitat:** In Cuba, this species is distributed in the north coast of Matanzas (Varadero) (Enriquez *et al.* 2005), south coast of Sancti Spíritus (Trinidad) (Herández *et al.* 2005), coast of Holguín (Rafael Freyre) (Leyva *et al.* 2005a) and in the south coast of Granma from Pilón to Cayo Cruz. This species occurs in dry forests or semideciduous forests on shallow limestone derived soil.
Conservation issues and threats: D. nudiflorus is an Endangered [C2a(i)] species according to Berazain et al (2005). The population of Granma is within the National Park ‘Desembarco del Granma’. The other populations are not within any protected area. The population of Varadero was completely damaged by tourism infrastructure construction and most of the plants are now in the hotels gardens (Enríquez et al. 2005). The habitat of this species in Sancti Spiritus and Holguín is degraded by agriculture, forestry, infrastructure construction and charcoal production (Leyva et al. 2005a). This species is infrequent even in well preserved habitats and all the populations are almost completely composed by adult plants. These plants produce a lot of large fleshy fruits that get well ripe in the soil at the bottom of the mother plants. There is not any evidence of seed dispersion, seed germination or seedling development. However the germination of these seeds by traditional methods is quite successful.
**Escobaria cubensis**

**Distribution and habitat:** This species is endemic to the northwestern serpentine outcrops of Holguín. Currently this species occurs in the thorny serpentine thickets of Matamoros, Loma del Fraile, Cerro de Galano, La Cejita y Cima del Cerro Colorado. In the past, *E. cubensis* also occurred in the area where the city of Holguín stands today (Leyva *et al.* 2005b).

**Conservation issues and threats:** This cactus is a Critically Endangered species [B1ab(ii,iii,iv,v)c(ii,iii,iv,v)] according to Berazaín *et al.* (2005). Any population is within a protected area. This species is highly threatened by harvesting, forestry, fires, charcoal production, roads building and waste disposal. This species is infrequent within its habitat. It grows only in very small places within the whole serpentine outcrop (Leyva *et al.* 2005b).

**Harrisia eriophora**

In the latest national checklist of the Cactaceae family 4 other species of *Harrisia* (*H. earlei* Britton & Rose, *Harrisia fernowii* Britton, *Harrisia taetra* Areces and *Harrisia taylorii* Britton) were reported for the country (Rodríguez 2005) but Hunt *et al.* (2006) consider all these species local races or varieties of *Harrisia eriophora* (Pfeiff) Britton, a species widespread in Cuba.
**Distribution and habitat:** This species is endemic to Cuba. It occurs in coastal thickets, dry forests or semideciduous forests on limestone shallow rocky soils.

**Conservation issues and threats:** It is a Lower Concern species according to Berazaín *et al.* (2005). Although it endures in secondary vegetation, some populations are highly damaged by the development of tourism infrastructure, forestry, oil mining, agriculture (Enríquez *et al.* 2005). Some populations are in protected areas (e.g. Península de Guanacahabibes, Ciénaga de Zapata, and Parque Nacional Desembarco del Granma).

**Leptocereus arboreus**

**Distribution and habitat:** This species is endemic to the south of Cienfuegos and Sancti Spíritus. It occurs in coastal thickets or dry forest on limestone shallow rocky soils.

**Conservation issues and threats:** This species is Vulnerable according to Berazaín *et al.* (2005). It is infrequently in its habitat and the populations are mostly composed by adult plants. Its habitat is degraded or in some areas destroyed by agriculture, forestry, fires and urbanization. It is not within any protected area.

**Leptocereus assurgens**

According to Hunt *et al.* (2006) this species includes *L. ekmanii* (Werderm.) F.M. Knuth and *L. prostratus* Britton & Rose.

**Distribution and habitat:** This species is endemic to the limestone hills of Viñales, Sierra de la Güira and Mogotes de Sumidero in Pinar del Río province (western Cuba). This plant grows mostly in the top of these limestone hills.

**Conservation issues and threats:** This species is Critically Endangered [B1ab(ii)+2ab(ii)] according to Berazain *et al.* (2005). The main threat for this species is its very narrow
distribution. In general the habitat of this species is well preserved due to the very deep slopes of these hills make them inaccessible. The population of Viñales is within the National Park ‘Viñales’

**Leptocereus carinatus**

**Distribution and habitat:** This species is endemic to Sierra del Chorrillo in Najasa, Camagüey. This is a small and low limestone hill that supports a semideciduous forest on shallow soil (Areces 1993a).

**Conservation issues and threats:** This species is Critically Endangered [B1ab(ii)+2ab(ii)] according to Berazaín et al. (2005). The main threats for this cactus are its very narrow distribution, the small size of its population (less than 250 mature plants) and habitat degradation by fires, agriculture and livestock (Rífa et al. 2005).

**Leptocereus leonii**

**Distribution and habitat:** This cactus is restricted to Sierra de Anafe and Sierra del Esperón in Havana. These low limestone hills support a semideciduous forest on shallow soil (Areces 1993b).

**Conservation issues and threats:** This species is Endangered according to Berazaín et al. (2005). There is not any threat for this species but its very narrow distribution. The area is not protected by the National System of Protected Areas but the access to its habitat is controlled.

**Leptocereus scopulophilus**

**Distribution and habitat:** This cactus is restricted to Pan de Matanzas a limestone hill in the western of Matanzas. This species lows in the understory of a semideciduous forest
limestone rocky soil (González-Torres et al. 2006). This species is also reported to Somorrostro hills (Areces 1993b) but this locality is completely destroyed now (González-Torres et al. 2006).

**Conservation issues and threats:** This species is Critically Endangered according to Berazain et al (2005). There is not any threat for this species but its very narrow distribution. The area is not protected by the National System of Protected Areas but the access to it is controlled.

**Leptocereus sylvestris**

Here, includes *L. maxonii* Britton & Rose and *L. santamarinae* Areces according to Hunt et al. (2006)

**Distribution and habitat:** This *Leptocereus* occurs in the cays and the north coast of Camagüey, Las Tunas and Holguín provinces but also in the south coast of Granma and Santiago de Cuba provinces. It grows in the semideciuos forests of the north coast and in the dry forest of the south one. The soil is usually on limestone shallow rocky soil.

**Conservation issues and threats:** This species is Critically Endangered [B1ab(i,ii,iii,iv) +2ab(i,ii,iii,iv)] according to Berazain et al (2005). There is a population within the National Park ‘Desembarco del Granma’. The other populations are out of protected areas. The habitat of this species is threatened by fires, agriculture, forestry, urbanization and infrastructure construction.
Leptocereus wrightii

**Distribution and habitat:** This species occurs in the north coast of Havana. It grows in the coastal thicket on shallow limestone soil (González-Torres *et al.* 2007).

**Conservation issues and threats:** This species is Critically Endangered [B2ab(i,ii,iii,iv)+C2a(i)] according to Berazaín *et al.* (2005). This population is not protected. The unique known population has 10 mature plants and their habitat is almost completely destroyed by fires and livestock (González-Torres *et al.* 2007).

Mammillaria prolifera

**Distribution and habitat:** This species occurs in Cuba, Hispaniola, Mexico and United States. In Cuba, this species grows in the sunny slopes of Mogotes-like hills in Pinar del Río (Borhidi 1991), Sancti Spíritus (Hernández *et al.* 2005) and Camagüey (Rifá 2005), and also in the dry forest of the south coast of Guantánamo.

**Conservation issues and threats:** This species is Vulnerable (Berazín *et al.* 2005). The major threat for this species is over harvesting but it usually grows in inaccessible places. The populations of Viñales are within the National Park ‘Viñales’.

![Mammillaria prolifera in the wild.](image)
Melocactus curvispinus

Here includes Melocactus holguinensis Areces and Melocactus quitartii León according to Hunt et al. (2006).

Distribution and habitat: This species has a broad distribution in the Caribbean and in Central and northern South America (Taylor 1991). In Cuba, it grows in lowland serpentine thickets of Matamoros, La Cejita, Presa Gibara and Cerro Galano in Holguín province (Leyva et al. 2005a) and on diorite outcrops at Dagamal, Piedra Gorda, La Rana, Tramojos and Manaquitas in the province of Sancti Spíritus (Hernández et al. 2005).

Conservation issues and threats: The populations of this species in Holguín have been severely affected by forestry, agriculture, infrastructure construction and livestock (Leyva et al. 2005a). The populations of Sancti Spíritus are largest (more than 3000 individuals in total). The one from Dagamal is within a protected area.

Melocactus harlowii

According to Taylor (1991) and Hunt et al. (2006) this species includes several microspecies (M. acunae León, M. borhidii Meszaros, M. evae Meszaros, M. nagyi Meszaros, M. perezassoi Areces and M. radoczii Meszaros).

In general it is difficult to identify the concepts of M. borhidii, M. evae, M. nagyi, and M. radoczii due to the high morphological variability of most of the populations. This morphological variation is particularly evident in the population of Boca del Rio Tacre. However the population of M. perezassoi and M. acunae are quite different from the previous mentioned taxa. Therefore we will consider for conservation purpose M. acunae, M. harlowii (incl. M. borhidii, M. evae, M. nagyi, and M. radoczii) and M. perezassoi Areces.
Melocactus harlowii (incl. M. borhidii, M. evae, M. nagyi, and M. radoczii)

**Distribution and habitat:** *M. harlowii* occurs in the coastal thickets and dry forests in the south coast of eastern Cuba from La Mota in Granma to Boca del río Tacre in Guantánamo but also on inland outcrops of serpentine or gravel conglomeration (Borhidi 1991).

**Conservation issues and threats:** *M. harlowii* is Endangered (Berazain et al. 2005) but it has very large populations and it is very common in most of its distribution. Some populations could be completely depleted by agriculture, urbanization and fires.

![Fig. 17. Melocactus harlowii in the Wild. Photo: L.R. González-Torres.](image)

Melocactus acunae

**Distribution and habitat:** This is the most eastern form of *M. harlowii*. It occurs in the coastal thickets and dry forests from Cajobabo to Maisí.

**Conservation issues and threats:** Berazain *et al.* (2005) report *M. acunae* as Lower Concern. The majority of its populations are within an area with controlled access and small and few human settlements.
Melocactus perezassoi

**Distribution and habitat:** This is the most isolated population of this complex. It occurs in a deep slope limestone hill at Jibacoa in the Guamuhaya Massif, Villa Clara (Areces 1993c).

**Conservation issues and threats:** *M. perezassoi* is Critically Endangered (Berazaín et al. 2005). The main threatens for this species is its narrow distribution as well as harvesting and fires.

Melocactus matanzanus

According to Taylor (1991) and Hunt et al. (2006) the concept of *M. matanzanus* includes *M. actinacanthus* Areces. Both forms *M. matanzanus* and *M. actinacanthus* have morphological features that differentiate clearly each population without overlapping and will be considered here as different units of conservation.

Melocactus matanzanus

**Distribution and habitat:** *M. matanzanus* is restricted to the serpentine thickets of Tres Ceibas de Clavellinas in Havana.

**Conservation issues and threats:** This species is Critically Endangered [B1ac+2abc,C] according to Berazaín et al. (2005). Its population is within the protected area ‘Tres Ceibas de Clavellinas’. The major threat for this species is habitat degradation by forestry activities carried out in the 1980s. Robledo et al. (2005) state that the number of plants in the population is being increasing since 1999.
Melocactus actinacanthus

**Distribution and habitat:** Endemism of the serpentine thickets of Sierra Alta de Agabama, Santa Clara (Areces 1976) and of serpentine areas in Havana.

![Melocactus actinacanthus](image)

Fig. 18. One of the two mature plants of *Melocactus actinacanthus* in Sierra Alta de Agabama, Villa Clara. Photo: L.R. González-Torres.

**Conservation issues and threats:** This species is Critically Endangered [A3ce, B1+B2ac, C2a] (Berazaín et al. 2005). Both populations of this species are in protected areas. The populations of this species have no more than 35 individuals each. The one from Santa Clara has only 2 adult plants. This species is very successful to harvest and to any other disturb due to the very small size of its populations.
**Opuntia stricta**

**Distribution and habitat:** This species is distributed in the Caribbean, Central America, South America (Ecuador) and south of United States. In Cuba, it grows in coastal vegetation of the whole country.

**Conservation issues and threats:** This species is not threatened at national level but some populations are threatened by tourism development, oil extraction, fires, forestry and agriculture (Enríquez *et al.* 2005).

**Opuntia triacantha**

**Distribution and habitat:** This species occurs in Cuba, Puerto Rico and US (Florida). In Cuba, it grows in the thickets and dry forests that surround Guantánamo Bay.

**Conservation issues and threats:** Berazaín *et al.* (2005) report this species as Lower Concern. It is not in a protected area but in region with limited access and use.

**Pereskia zinniiflora**

**Distribution and habitat:** This species is endemic to Cuba. It grows in mogote-like hills in Pan de Matanzas, south coast of Sancti Spíritus and Camagüey.

**Conservation issues and threats:** This species is Endangered (Berazaín *et al.* 2005). The habitat of this species in Pan de Matanzas is well conserved.

Fig. 19. Female flower of *Pereskia zinniiflora*. Photo: L.R. González-Torres
In Sancti Spíritus and Camagüey the habitats of this species is degraded by invasive species (*Dychrostachys cinera* (L.) Wight & Arn.), agriculture, livestock and infrastructure construction (Rifá *et al.* 2005).

**Pilosocereus polygonus**


**Distribution and habitat:** This species is distributed in the Caribbean and Florida (United States). In Cuba it grows in coastal vegetation of the whole country or on inland outcrops of limestone or serpentine.

**Conservation issues and threats:** This species is not threatened at national level but some populations are threatened by tourism, oil extraction, fires, forestry and agriculture (Enríquez *et al.* 2005, Leyva *et al.* 2005a).

**Rhipsalis baccifera**

**Distribution and habitat:** This is the most widespread of all cacti (Hunt *et al.* 2006). It is widespread in lowland or mountain semideciduous forests.

**Conservation issues and threats:** This species is not threatened at national level but its population can be severed damaged by deforestation.

**Selenicereus grandiflorus**

This is here circumscribed to *S. boeckmannii* (Salm-Dyck) Britton & Rose, *S. brevispinus* Britton & Rose, *Selenicereus donkelaartii* (Salm-Dyck) Britton & Rose, and *S. urbanianus* (Guerke & Weingart) Britton & Rose.
**Distribution and habitat:** This species is distributed in the Caribbean. In Cuba it grows in coastal vegetation of the whole country or in limestone or serpentine outcrops inland.

**Conservation issues and threats:** This species is not threatened at national level but some populations are threatened by tourism, oil extraction, fires, forestry and agriculture (Enriquez et al. 2005).

*Stenocereus fimbriatus*

**Distribution and habitat:** This species is distributed in the Greater Antilles. In Cuba it grows in the coastal thickets and dry forest of south coast of Guantánamo on limestone or coral limestone derived soil.

**Conservation issues and threats:** This species is not threatened at national level but some particular populations are threatened by fires, forestry and agriculture. The populations of this species are not included in any protected area but its habitat is not highly disturbed.

**III.3. Setting conservation priorities**

The priorities for conservation are established considering threats, endemism and conservation status according to Berazaín et al. (2005). The population size and species distribution is also taking into account but higher priority for conservation is giving to those species that are already facing any threat in all their population or in the majority of them (Table 2). Therefore, in some case the priority set for a particular species do not match with the category reported by (Berazaín et al. 2005) due to some species in this work are considering highly threatened only because of they have very small populations or very narrow distribution even when they occur in very well preserved places.
Table 2. Proposal of prioritizes for conservation of Cuban cacti.

<table>
<thead>
<tr>
<th>Unit of conservation</th>
<th>Threats</th>
<th>Actual</th>
<th>Potential</th>
<th>Endemic</th>
<th>Category*</th>
<th>Priority</th>
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<td>VU</td>
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<td>X</td>
<td>CR</td>
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<td>Escobaria cubensis</td>
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<td>X</td>
<td>CR</td>
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<td></td>
<td></td>
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<td></td>
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<td></td>
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<td>LC!</td>
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<td></td>
<td>LC</td>
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<td></td>
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</table>

* According to Berazaín et al. (2005)
!
Considering the populations of M. guitartii and M. holguinensis all together.
IV. The action plan

An action plan is a simple list of all of the tasks that it needs to carry out to achieve an objective (Mind Tools Ltd, 1995-2007)—in this case the conservation of Cuban cacti.

Here, we do not limited the plan to a single list by providing details on the benefits of each proposed task and on the justification of each one as well. These tasks were set up considering the information gathered in the previous epigraphs.

Task 1. Lobbing for final approval of the already proposed protected areas

Considering that \textit{in situ} conservation is the best approach for the conservation of biological diversity it is necessary to lobby for the approval of the protected areas already proposed. These areas will provide protection for 13 species (Table 3) and their habitat as well that are currently unprotected.

The first five new reserves (from left to right) will protect the larger extension of dry evergreen forests (tropical dry forest) and coastal thickets of the Caribbean hotspot. Both habitats the dry evergreen forest and the coastal thicket are center of endemism of arid plants from several plant families in Cuba and in the Caribbean region too (Borhidi 1991).

Table 3. Cacti growing within the proposed new protected areas.

<table>
<thead>
<tr>
<th>Unit of Conservation</th>
<th>Priority*</th>
<th>Baitiquiri</th>
<th>Boquerón</th>
<th>Caleta</th>
<th>Imías</th>
<th>Maisí</th>
<th>Cerro Galano</th>
<th>La Coca</th>
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</table>
### Task 2. Propose new protected areas

There are some small localities still well preserved which are feasible for protection. They will provide protection to another 7 cacti (Table 4) all of them threatened (Berazaín et al. 2005) and prioritized (Table 2). These areas have also other threatened endemic plants and animals as well as unique habitats. All these facts will provide support for the proposal.

<table>
<thead>
<tr>
<th>Unit of Conservation</th>
<th>Priority*</th>
<th>Baitiquiri</th>
<th>Boquerón</th>
<th>Caleta</th>
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* see III.2.
Table 4. Proposed areas for protection under the National System of Protected Areas and their cacti associated.

<table>
<thead>
<tr>
<th>Area/Locality</th>
<th>Unit of conservation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pan de Matanzas</td>
<td><em>Leptocereus scopulophilus,</em></td>
</tr>
<tr>
<td></td>
<td><em>Pereskia zinniflora</em></td>
</tr>
<tr>
<td>Cejita de La Palma</td>
<td><em>Escobaria cubensis,</em></td>
</tr>
<tr>
<td></td>
<td><em>Melocactus curvispinus</em></td>
</tr>
<tr>
<td>Sierra de Anafe</td>
<td><em>Leptocereus leonii</em></td>
</tr>
<tr>
<td>Sierra del Chorillo, Najasa</td>
<td><em>Leptocereus carinatus</em></td>
</tr>
<tr>
<td>Habananilla</td>
<td><em>Melocactus perezassoi</em></td>
</tr>
</tbody>
</table>

In the particular case of the locality Pan de Matanzas, it could be added to the adjacent protected area ‘Lomas de Galindo’ already approved. Both areas are continues a probably they contain the unique well conserve transitional habitat (ecotone) between serpentine community and kartic (limestone) one.

**Task 3. Making plant available for people**

Harvesting is sometimes the most important threat for some species (e.g. *Escobaria cubensis*, *Melocactus* spp. and *Mammillaria prolifera*), specially for those with small populations. Botanic gardens and other institution can work propagating these species and then sell them to the people. In this way the pressure on wild populations should decrease.

It is important to involve local communities in this task and make the plant available for them too. To have plants available in local communities it is also necessary because collectors usually go straight to the field looking for the plants. Fortunately, cultivate Cuban cacti do not require so much investment then it is likely to establish small local nurseries. At this time, the National Botanic Garden and the Enterprise for the Protection
of Flora and Fauna are trying to establish a small nursery in Revacadero –the local community close to *M. actinacanthus* population.

**Task 4. Living collection for conservation in botanic gardens**

Sometimes the habitat of one species is severely altered (*Leptocereus arboreus*) or its area is important for the economic development (*Dendrocereus nudiflorus* –the population of Varadero). In these cases, the likelihood of establish a protected area is very low and the maintenance of living collection in botanic gardens could be one of the unique alternative for species survival or for population preservation. Unfortunately, there are no protected areas with similar habitat in the surrounding areas of the population of both species. It is possible to establish population replicas as both species can be successfully propagated by cuttings.

This strategy is the unique alternative for *ex situ* conservation of *Cylindropuntia hystrix* as it does not produce seeds. This species should be kept in living collection in the Cactus Botanic Garden at Santiago de Cuba locate in a habitat similar to that where this species grows and in the Cuban National Botanical Garden where they have been cultivated this taxa for more than 30 years.

The populations of *Leptocereus wrightii* and *Melocactus actinacanthus* are almost completely depleted. In this case, it is necessary to develop *ex situ* collection and propagation to reintroduce or reinforce the wild population. Therefore it is also necessary to increase the genetic diversity of the existing material by asking plant material to collectors who keeps these species in their collections. However, we are only accepting materials from very well documented collections. In the case of our work with *Melocactus actinacanthus* we have already received seeds for our *ex situ* collection from Cuban collectors and Kew Gardens as well (Taylor 2007). As regarding *Leptocereus wrightii*, there is one accession in the Kew collections (Taylor 2003), one in the Desert Botanical Garden (Arizona) (Desert Botanical Garden 1999) and two in the New York Botanical
Garden (The New York Botanical Garden 2003). We are thinking of designing a project between the National Botanical Garden and Kew Gardens to raise an *ex situ* collection of this species gathering also material from outside Cuba.

**Task 5. Seed bank**

At the present, there is no research on the capacity of Cuban cactus seeds to resist dehydration and cold storage. However, preliminary researches can be done with low requirements (see Ocampo-López *et al.* 2003). Ideally, the higher the number of taxa conserved in seed banks the better it is but priorities could be set up considering epigraph III.3.

**Task 6. Monitoring invasive species**

*Leucaena leucocephala* is a plant of the legume family introduced in Cuba for cattle consumption that now is colonizing important areas of the south coast of Santiago de Cuba and Guantánamo. *Dychrostachis cinerea* another plant of the legume family was introduced in Cuba probably as a pot plant but now it is widespread all over the country (Bässler 1998). Both species provide shadow to shade-intolerant plants like most of the cacti but they also compete for the space and nutrients. There have not been any studies in Cuba about the effect of these species on native communities or species but it must be considered.

**Task 7. Environmental education and public awareness**

Increasing the awareness of local people and authorities can contribute greatly to the conservation of Cuban cacti. Even those already protected by legislation are suffering from human activities which are avoidable. Protected areas are usually very large and they do not have enough staff to cover the whole area, therefore the support of local communities to protected local resources is essential for effective protection. But also, sometimes it is the local people who intentionally or by the ignorance severely damage the habitats when they are managing them.
V. Concluding remarks

The conservation of cacti in Cuba is a long-term goal but some species obviously cannot wait so much longer for the ideal conditions so it needs some action immediately. This action plan suggests a way forward and a range of specific tasks which can result in effective conservation of Cuban cacti.

Further than outline some actions for future works, the most important idea probably delineated by this action plan is the necessity of work together the government, the protected areas, the botanic gardens, other researches institutions, and essentially the people for the conservation of Cuban cacti.

This document needs the feedback of as many experts as possible therefore it should be discussed and revised for final the approval. A national workshop might be a good alternative way of analyzing this document but also to establish partnerships between the different institutions related to cactus conservation and the groups that were already working toward this goal.
References


