Working group	Co-chair	CS Presenter	Keynote Speaker	Expert	Rapporteur	Attendance

Succulents and Cycads

John Donaldson	☑	☑	☐	☐	☐	YES
Patricia Dávila	☑	☐	☐	☐	☐	YES
Andrew Vovides	☐	☑	☐	☐	☐	YES
Anita Varghese	☐	☑	☐	☐	☐	YES
Colman O'Criodain	☐	☐	☐	☐	☐	YES
Elsabe Swart	☐	☑	☐	☐	☐	YES
Emily Wabuyele	☐	☑	☐	☐	☐	YES
Enriquena Bustamante	☐	☑	☐	☐	☐	YES
Miguel Angel Pérez Ferrera	☐	☑	☐	☐	☐	YES
Margarita Clemente	☐	☐	☐	☐	☐	YES
Nicolas Palleiro	☐	☐	☐	☐	☑	YES
Solomon Kyalo	☐	☑	☐	☐	☐	YES
Uwe Schippmann	☐	☐	☐	☑	☐	YES

Total Participants : 13

Succulents and Cycads

Working Group Summary

The working group compiled and reviewed seven case studies, four on cycad taxa (*Encephalartos* species, *Cycas circinalis*, *Ceratozamia mirandae, Dioon edule*) and three succulent taxa (*Hoodia gordonii, Aloe spp., Carnegiea gigantea*). Two of the case studies dealt with Appendix I taxa and the remainder dealt with species in Appendix II. The case studies dealt with several different products in trade (whole plants, seeds, leaves, bark, roots, and processed material) and different harvest and production systems including artificial propagation, *in situ* nurseries, and offtake of living and dead specimens or parts from wild populations.

Although cycads and succulents have quite different life histories, the case studies focused exclusively on long-lived species of succulents, which resulted in greater convergence between the cycad and succulent case studies. There was a remarkable consistency regarding several risk factors relating to harvest and trade between the cycad and succulent species and this suggests that the grouping of cycads and succulents was not entirely artificial.

Main outcomes

- The risk assessment approach to non-detriment findings was useful to help focus the assessment on specific risk factors. The NDF process requires an assessment of risk at three levels, i.e. impact on the species from the trade event, the impact of harvest on the species in trade, and the impact on the ecosystem.
- It seemed to be possible to identify several factors that could be classified as low, medium, or high risk. This was based on several different elements relating to the biology of the species (identity, life history stage, population size), the source of material (artificial propagation, wild, dead) and the nature of the harvest (volumes, intensity, frequency).
- The level of confidence in the NDF involves an interaction between the availability of information and level of risk. If relatively little information is available, it may still be possible to make an NDF if the trade involves a low risk activity. However, more information is required for an NDF relating to high risk activities. A list of information required for low, medium and high risk activities was compiled.
- There was considerable consistency between cycads and long-lived succulents regarding the vulnerability of the adult stage to lethal harvest. Lethal harvest should only be considered in very abundant species or where demographic studies provide indications of offtake levels.
- Many species of cycads and succulents are threatened and listed on the IUCN Red List and this means that it is very important to apply the precautionary approach when making an NDF.
- Two of the case studies dealt with *in situ* nurseries in which seeds are extracted from the wild but contribute to habitat conservation and restoration and management of wild populations because of benefits to local communities. Such potential benefits need to be considered when making an NDF.
- Illegal trade is a significant problem with many cycads and succulent. As a result, the NDF will be affected by the level of certainty regarding the identity and source of the specimens in trade.
- An assessment of sustainable harvest may require information on both population recovery/ resilience (for lethal harvest) as well as individual recovery (for leaves, fruits, stems)

International Expert Workshop on CITES Non-Detriment Findings

Working Group 3

Succulents and Cycads

FINAL REPORT

1. Information about the target species or related species

List and briefly describe the <u>elements</u> that could be considered when making Non-detriment findings:

1.1. Biological and species status:

General (all species):

- Population size (small populations pose a greater risk)
- Species id (need to be able to determine what species is being traded)
- Threat status
- Population structure (mainly need to determine relative numbers of adults, juveniles, seedlings)
- Recruitment
- Recovery after harvesting,

Specific instances:

- Habitat condition (as an indicator of other impacts on the population)
- Pollinators (cycads and many succulents have specific pollinators)
- Population health (e.g dead-live ratios, infections, predation)
- Growth rates (individual growth rates)
- Mortality (where harvesting of dead material is important)

1.2. Takes/uses (e.g. harvest regime):

- Trade history (what volume has been harvested in the past)
- Frequency of harvest (sporadic, continuous, once off..)
- Harvest method (destructive/ non-destructive)
- Quantities (material harvested)
- Part of the plant being harvested (removal of whole adult plant, seedlings/ juveniles, seed, leaves, bark, male cone, fruits, stems)

1.3. Management, monitoring and conservation:

- Existing management plan (incl. traditional systems)
- Prescribed methodologies exist and are being used for surveys & assessments;
- Adherence to management plan
- Regular monitoring is taking place (e.g. live/dead ratios, recruitment, recovery)
- Artificial propagation (in situ/ ex situ)
- Extent of illegal trade

2. Field methodologies and other sources of information.

List and describe examples of field <u>methodologies</u> and other sources of information for monitoring populations and/or regulating harvests which could be utilized to obtain data on the elements described below.

2.1. Biological and species status data:

- Red data lists
- Population surveys
- Checklists and Floras
- ID manuals/ field keys
- Use of GPS; GIS
- Transect and plot methods; cluster sampling;
- GARP
- Interviews with stakeholders
- DNA methods (in development)
- Demographic models

2.2. Harvesting and trade data:

- Resource assessment
- Interviews with stakeholders
- Permit data
- Import/ export data
- Measurements of harvest
- Data from local markets
- Monitoring of recovery after harvest

3. Data integration for NDF elaboration

List and/or describe data integration that could be helpful in formulating the non-detriment finding.

- o Biological data (to determine production) and market data (to determine demand) integrated to determine whether offtake is likely to impact populations;
- o spatial information on species abundance and harvesting to ensure that NDF accounts for possible clustering of trade in specific areas;
- o Harvesting history and trends;
- o Type, method, and frequency of harvesting and its impact on vulnerable stages
- o management plan (with monitoring programme)
- o information on threats (e.g. invasives, habitat degradation) with information on sites where harvesting occurs
- o threat data, spatial distribution, and harvesting data
- o legal and illegal harvest values (socio-economic information)

4. List and describe the ways data quantity and quality may be assessed

HIGH CONFIDENCE NDFs
1. Distribution range
2. Species Id
3. Population size
4. Population structure
5. Conservation status
6. Vulnerable stages
7. Genetic diversity data (structure)
8. Recruitment data
9. Recovery span of leaf-stems-flower removals
10. Life span
11. Harvest capacity
12. Trade frequency and intensity
13. Management plan
14. Monitoring actions / plots

MEDIUM CONFIDENCE NDFs
1. Distribution range
2. Species Id
3. Population size
4. Conservation status
5. Trade frequency and intensity
6. Vulnerable stages
7. Some data related to the recovery span of leaf-stems-flower removals

LOW CONFIDENCE NDFs
1. Distribution range
2. Species Id
3. Population size
4. Conservation status
5. Trade frequency and intensity
6. Basic life history information on vulnerable stages

5. Summarize the common <u>problems, error, challenges or difficulties</u> found on the elaboration of NDF.

- o Identification of species in trade (species & commodities)
- o Mixed sources of specimens in trade (wild & artificially propagated; in situ and ex situ nurseries)
- o Limits to generalization
- o Lack of finances
- o Lack of information on resilience to harvesting
- o Uncertainty about the extent of illegal trade
- o Incomplete information across the range of the species
- o Inadequate monitoring and feedback
- o Climate change
- o To avoid situations where ex situ production undermines in situ conservation efforts
- o Challenge: good set of information for all the species listed on CITES
- o Capacity in country to generate relevant information

6. Summarize the main <u>recommendations</u> which could be considered when making an NDF for this taxonomic group.

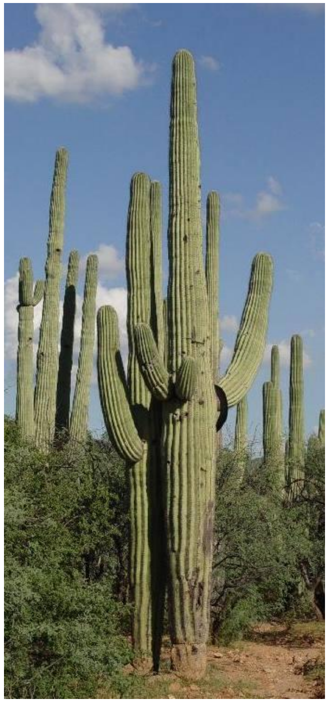
- o Adopt a generally precautionary approach because these groups have a high number of threatened species;
- o If there is certainty about the species and the source, and the trade involves a low risk activity, then its relatively easy to make an NDF from basic sources (e.g. Distribution range, Population size, conservation status, trade frequency and intensity, basic life history information on vulnerable stages)
- o Cycads & succulents are relatively well known groups so scientific authorities should consult experts and utilize the substantial data sources;
- o Compile a database of experts and primary data sources;
- o IUCN Global Cycad Assessment will have very good basic information as a starting point for NDFs
- o

7. Useful references for future NDF formulation.

- o WCMC database
- o National databases on trade
- o IUCN/ SSC Cycad Action Plan / IUCN/SSC 'cactus & succulent' Action Plan
- o IUCN Cycad conservation assessment database
- o IUCN Red list and national red lists
- o Published information (journals & books, including Floras and checklists)
- o CITES identification manuals and checklists
- o PlantNet website for cycads
- o Catalogues of species in trade (including websites)
- o Societies and specialist groups

NDF Workshop

Cycads & Succulents



Application to trade in X number of specimens of a species

↓

Gather information

- IUCN guidelines
- Taxon specific guidelines

↓

Decision

Yes	Yes, but <X	No

Framework for NDF
Cycads & Succulents

RISK BASED NDF ASSESSMENT

Assessment of risk to species from trade event

- Species ID
- Mixing of art prop & wild sources
- Material from different harvesting sources
- Harvesting event

NDF

Framework for NDF

Cycads & Succulents

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Assessment of risk to the species from the harvest event/s

- Resilience
  - Life history
  - population size
- Harvest patterns

NDF

Framework for NDF
Cycads & Succulents

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- Species ID
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- Material from different harvesting sources
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Assessment of risk to the species from the harvest event/s

- Resilience
  - Life history
  - population size
- Harvest patterns

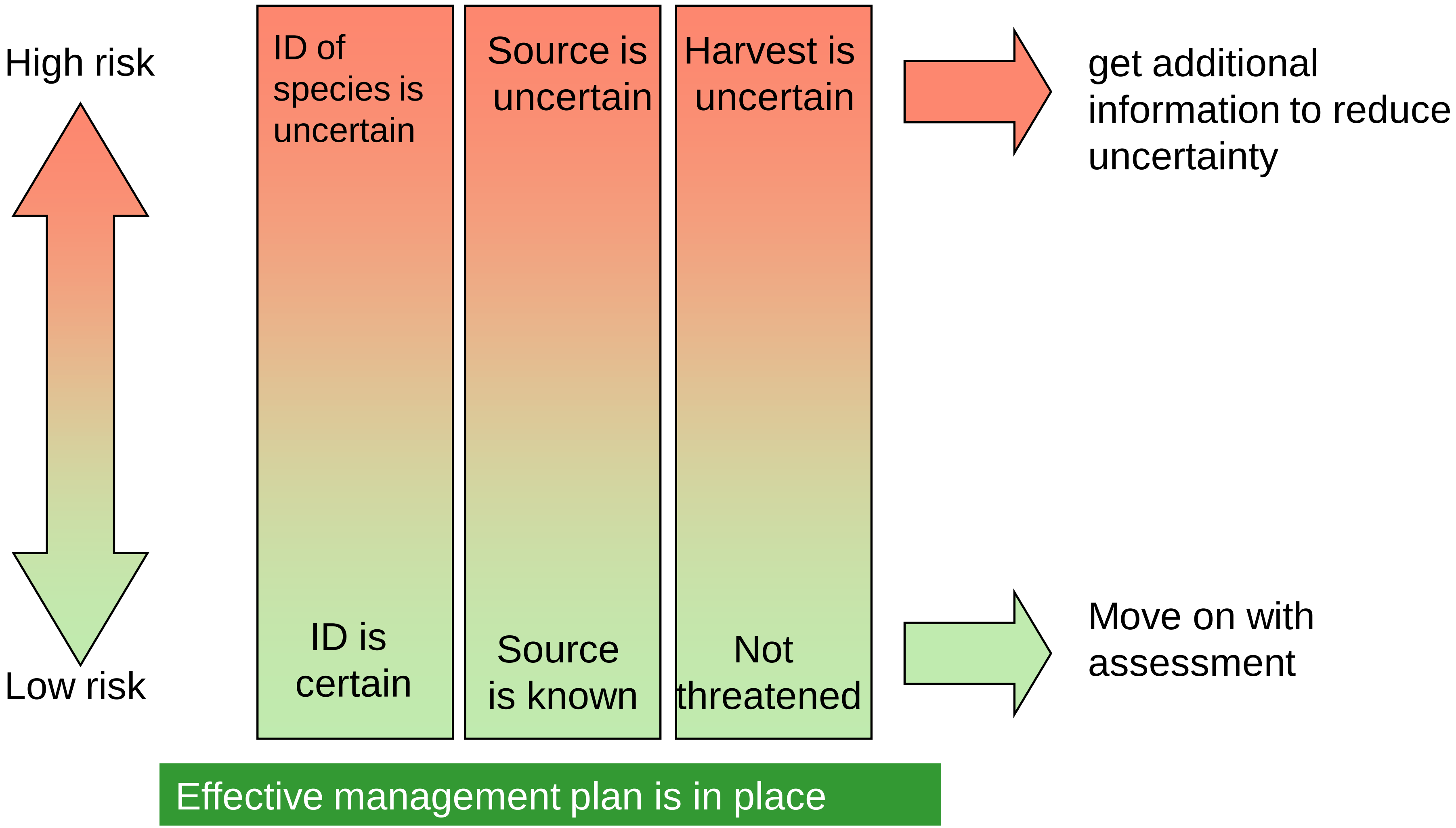
Assessment of risk to the ecosystem from the harvest event/s

- Impact on dependent spp
- Impact on processes
- Impact of harvest method

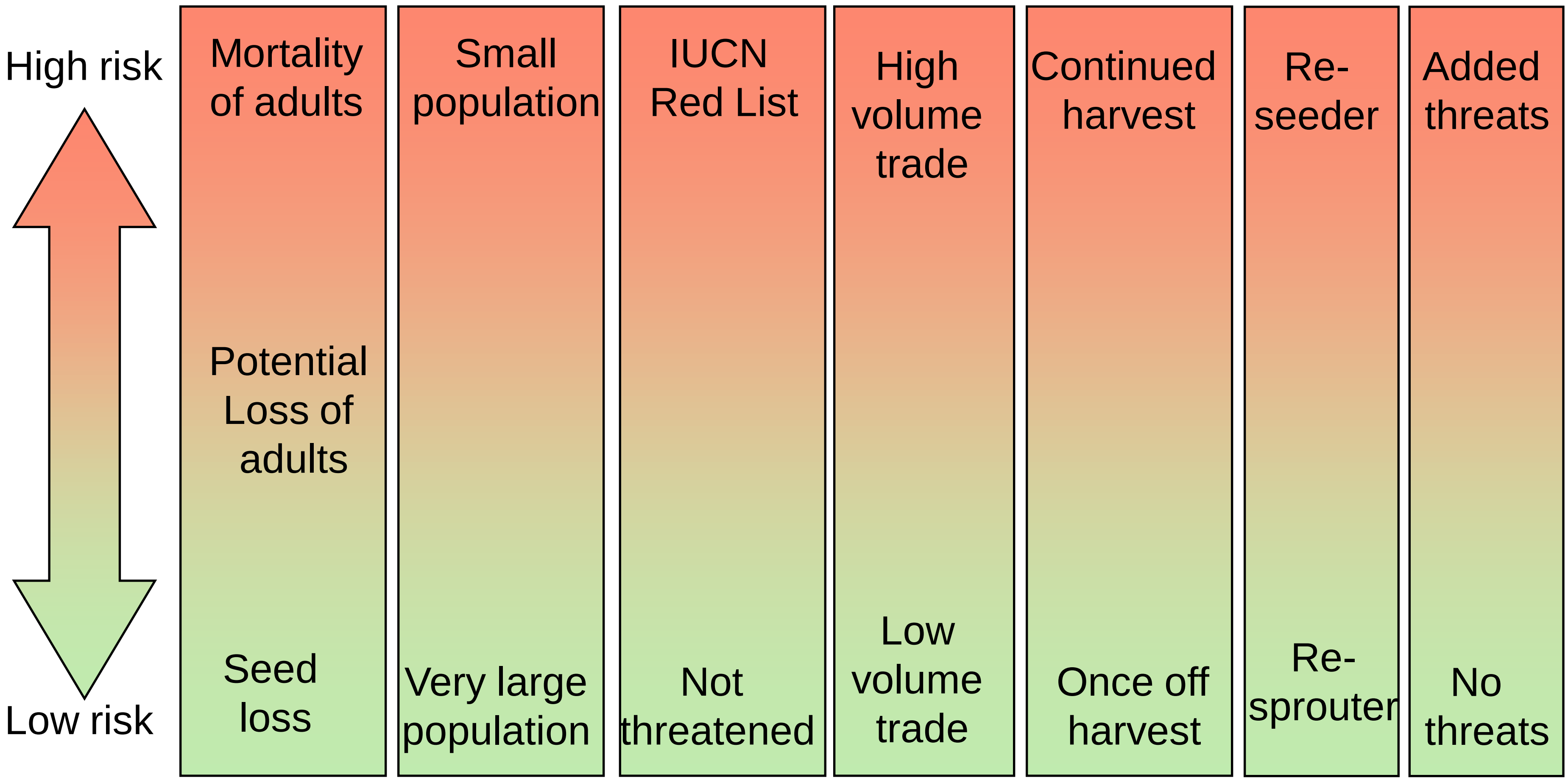
NDF

Risk factors (cycads & succulents)

Trade events

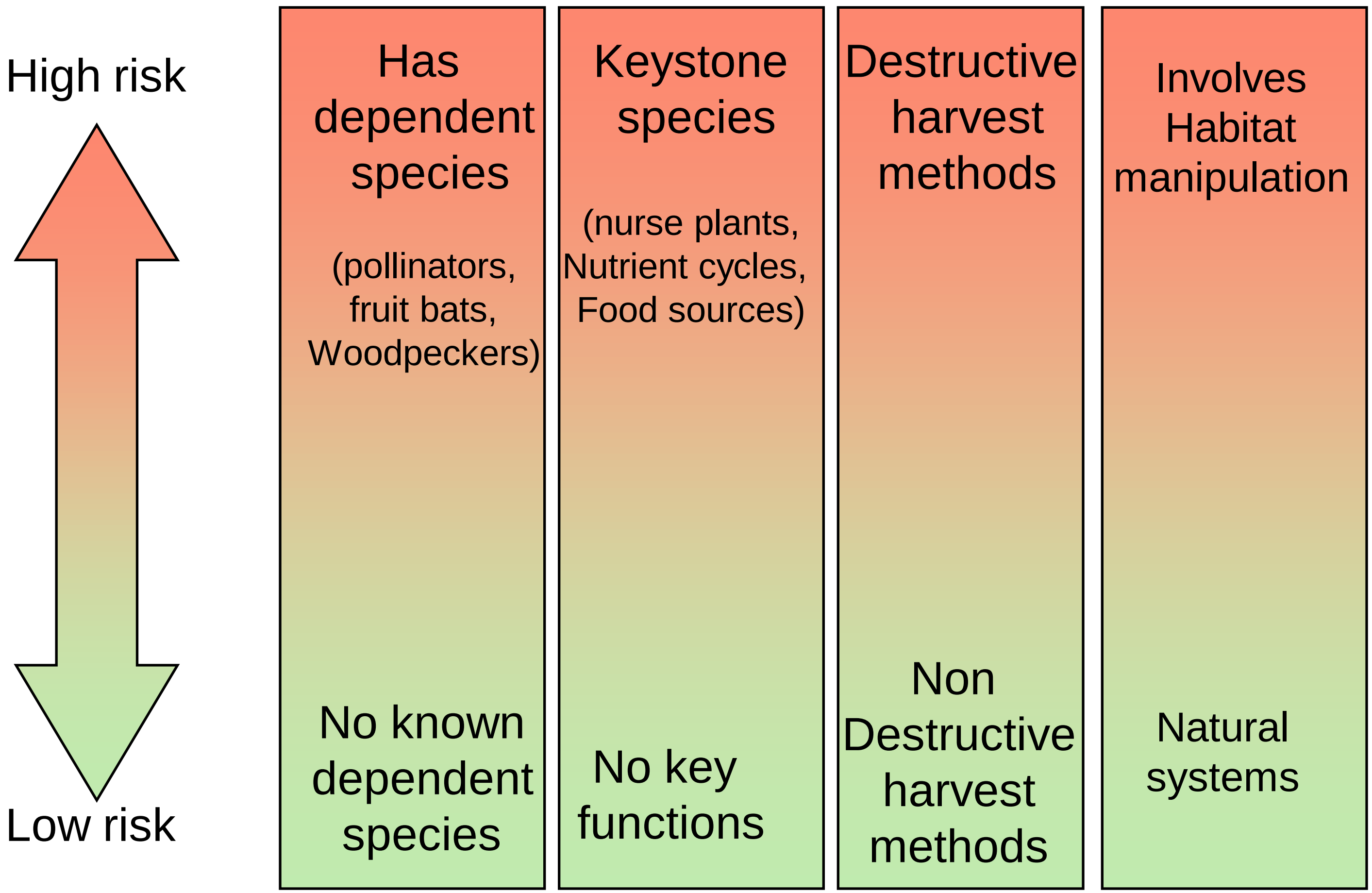


Risk factors (cycads & succulents) impact of harvesting on species



Risk factors (cycads & succulents)

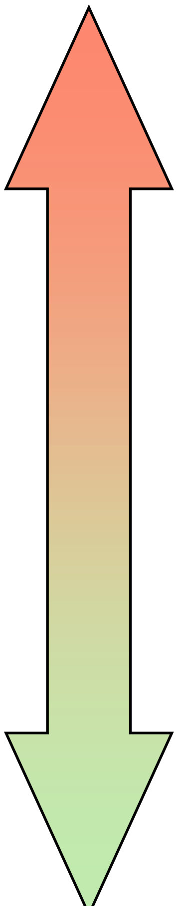
Impact of harvesting on ecosystem



Information requirements relating to risk factors

Information requirements

High risk



Low risk

- Vulnerable stages
- Genetic structure
- Recruitment data
- Life span
- Harvest capacity
- Trade frequency and intensity
- Management plan
- Monitoring actions / plots

- More detail on vulnerable life stages
- Recovery span of leaf-stems-flower removals

- Distribution range
- Species Id
- Population size
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- Trade frequency and intensity
- Basic life history information on vulnerable stages

Confidence in the NDF based on available information

High confidence

- Vulnerable stages
- Genetic structure
- Recruitment data
- Life span
- Harvest capacity
- Trade frequency and intensity
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- More detail on vulnerable life stages
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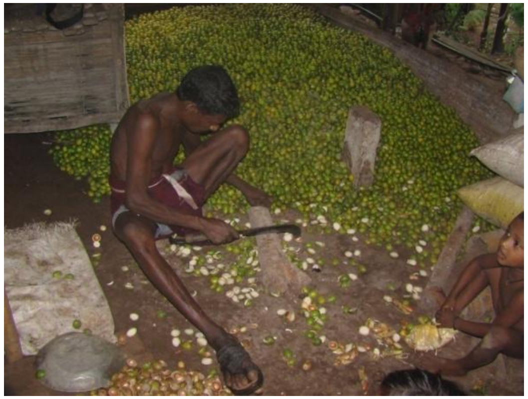
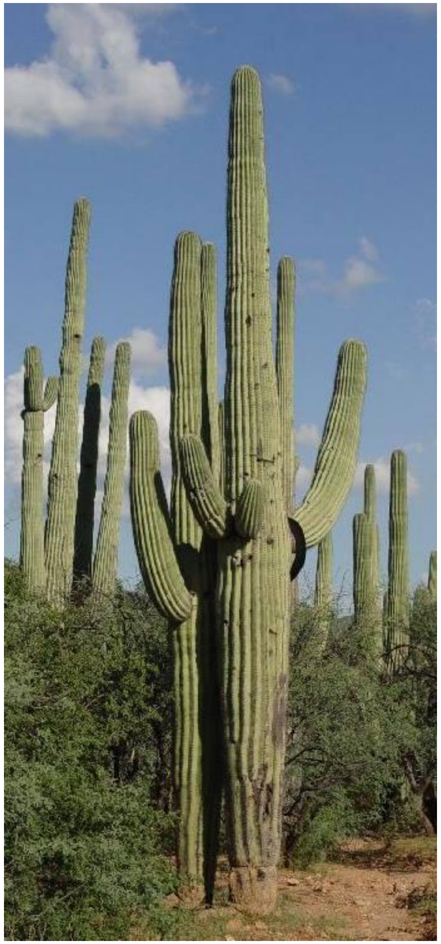
Low

SPECIFIC OUTPUTS
Cycads & Succulents





<u>Elements</u> that could be considered when making Non-detriment findings (specific to cycads & succulents):

- Habitat condition (as an indicator of other impacts on the population)
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1.2. Takes/uses (e.g. harvest regime):

- Trade history (what volume has been harvested in the past)
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Thanks

- Patricia Davila Aranda
- John Donaldson
- Enriquena Bustamante
- Emily Wabuyele
- Elsabe Swart
- Andrew Vovides
- Miguel-Angel Perez Farrera
- Anita Varghese
- Nicolas Palleiro
- Organisers

NDF WORKSHOP CASE STUDIES
WG 3 – Succulents and Cycads
CASE STUDY 1
Aloe spp
Country – **EAST AND SOUTHERN AFRICA**
Original language – English

SUSTAINABLE USE OF EAST AFRICAN *ALOES*: THE CASE OF COMMERCIAL ALOES IN KENYA

AUTHOR:
Emily Wabuyele[1]
Solomon Kyalo[2]
1National Museums of Kenya & 2Kenya Wildlife Service

I. Background information on the taxa

1. BIOLOGICAL DATA

1.1 Scientific names:

Aloe spp. (*Aloe secundiflora Aloe turkanensis, Aloe scabrifolia, Aloe calidophila* and *Aloe rivae*)

Common Names: Aloes (English), Turkos (Pokot), Tangaratwe(Tugen), Suguroi (Maa & Samburu), Kipapa(Taita), Mugwanugu (Kikuyu), Ejichuka (Turkana), Kiluma (Kamba), Kolonje (Duruma) and dahr (Somali).

1.2 Distribution (Specify the currently known range of the species. If possible, provide information to indicate whether or not the distribution of the species is continuous, or to what degree it is fragmented. If possible, include a map).

Sub-Saharan Africa, including the Island of Madagascar accounts for over 90% of the 450 or so taxa (species, subspecies or varieties) of the genus *Aloe* known today, with concentration in Southern Africa (over 260 taxa), in Eastern Africa (over 180 taxa) and on the Island of Madagasar (Ca 77 taxa). A few species have been recorded in the Arabian Peninsular and on small Islands off the Coast of Africa. Kenya is home to about 60 species, five of which have been identified as being commercially exploited for aloe bitter gum trade.

As a genus, aloes are a common feature of the landscape in many dryland areas of Africa. However, aloes are rarely dominant in the ecological sense, except in places devoid of other vegetation. Indeed, many taxa are rare and with narrow range of distribution and high levels of endemicity have been recorded in all the main centres of diversity. Of the five commercial species identified for Kenya, the most common and widely distributed species is *A. secundiflora* with considerable variation across its geographical range. According to Wabuyele *et al*. (2006), the Extent of Occurrence (EOO) for *A. secundifora* in Kenya alone is at least 136 200 km^2. Two varieties are recognised in this species; the first, *A. secundiflora* var. *secundiflora* occurs in Ethiopia, Kenya, northern Tanzania, Uganda, Rwanda and Sudan. The second variety, *A. secundiflora* var. *tweediae* occurs in northern Uganda, northern Kenya and in southern Sudan. In undisturbed pristine habitats, the species occurs in more or less continuous populations, except in marshes and other water-logged soils.

Generally, the geographical distribution of the other four commercial aloes is more restricted in comparison with *A. secundiflora*; *A. turkanensis* occurs in Kenya and Uganda; both *A. calidophila* and *A. rivae* occur in Kenya and Ethiopia, while *A. scabrifolia* is endemic to Kenya. However, all the species are locally common within their distribution ranges. The Kenyan distribution of the five commercially exploited species is shown in figure 1.

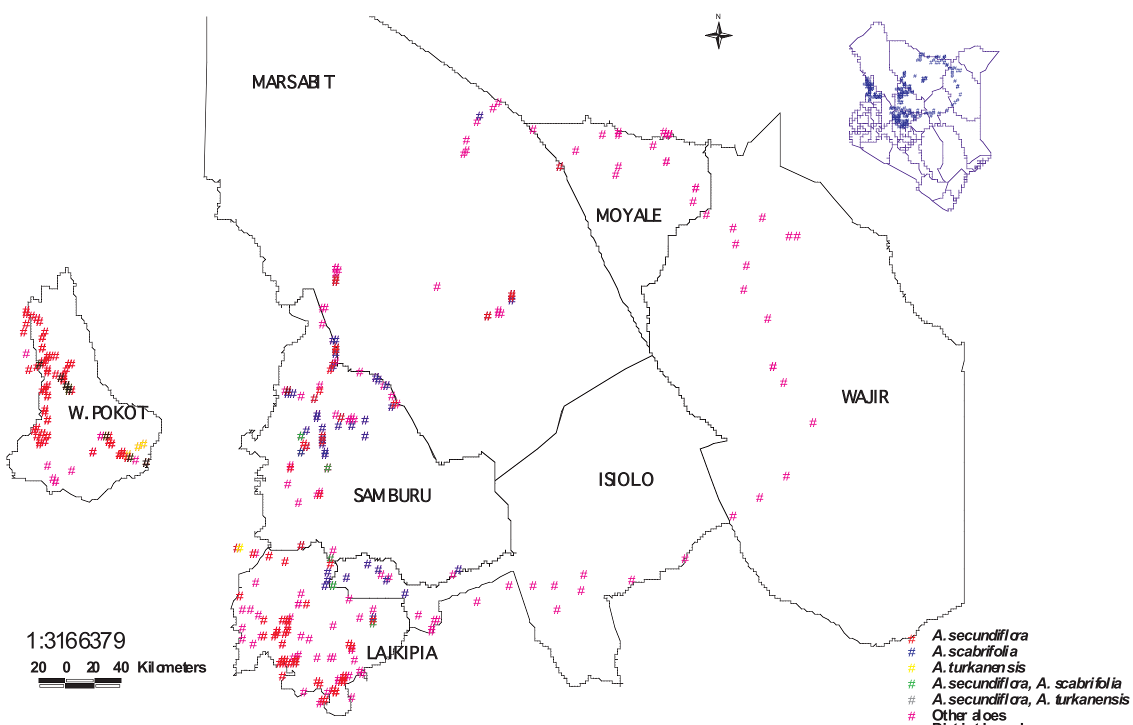

Figure 1

1.3 Biological characteristics

1.3.1 *Provide a summary of general biological and life history characteristics of the species* (e.g. reproduction, recruitment, survival rate, migration, sex ratio, regeneration or reproductive strategies, tolerance toward humans).

Aloes are perennial monoecious plants with a variety of sizes that include the miniature herbs such as the grass aloes, stemless rosette-forming species, stemmed and sprawling shrubs and small trees. The leaves in the stemmed aloes may be borne in terminal rosettes or may be spaced along the stem, which in some cases emerges to about 15 meters in height. The inflorescence in aloes is a raceme, simple or compound; flowers are tubular, brightly coloured red, yellow, orange or rarely white and produce large amounts of sugary nectar with which pollinators are rewarded. Cross pollination in aloes (by sunbirds) is promoted by the protandrous nature of the flowers. Aloes reproduce both vegetatively and by seed and they have been observed to hybridise extensively in nature as well as in cultivation. The fruits of aloes bear numerous seeds that are dispersed by wind. Generally, all aloes have a long lifespan that is estimated at 150 years (Newton & Vaughan, 1996).

Although aloes produce high numbers of seeds and suckers, establishment of recruits is only occasional and dependent on availability of rainfall that is more often than not scanty and erratic in the range areas. This phenomenon combined with the long-lived perennial habit of the plants leads to predominance of older plants in aloe populations. These observations have been corroborated by studies by Wabuyele (2000) on the population structure of maculate aloes in Kenya and Ethiopia that showed a greater proportion of 'juvenile' and 'adult' size classes as opposed to the 'seedling' and 'post-reproductive' plants. Other observations by Mukonyi *et al*. (2005) noted that most populations of the commercial species in Kenya were dominated by mature individuals. It is important to note here that despite the apparent lack of active recruitment of new individuals, the *Aloe* populations studied displayed healthy genetic composition with no signs of inbreeding depression.

In general, aloes have been observed to respond to physical disturbance like injury of plant organs by increasing growth and suckering. Aloes have also been reported as being tolerant of fires especially as occurs in many rangeland vegetation types. Mukonyi *et al*. (2005) observed that, among the five identified commercial species; *Aloe scabrifolia* and *A. calidophila* are least tolerant to fire. A. secundiflora has been demonstrated to be tolerant of trampling by livestock and wildlife as demonstrated on trial plots in Laikipia district of Kenya (Gilfred Powys, Pers.com). However, detailed studies on ecological response to other forms of disturbance are not available.

In East Africa, the optimal flowering season for aloes coincides with the rainy seasons. Most species flower during May to July and from September to November, corresponding to the two peak seasons of high moisture experienced in many localities of the region. Amongst the commercial species, *A. secundiflora* has been observed to seed and recruit more through seeds *A. scabrifolia*, *A. rivae*, *A. turkanensis* and *A. calidophila* recruit mainly by suckers. Efficient seed dispersal and seedling establishment may be one of the factors contributing to the ecological success of *A. secundiflora*.

1.3.2 *Habitat types:* Specify the types of habitats occupied by the species and, when relevant, the degree of habitat specificity

The ecological range of aloes generally excludes rain forest habitats, and except for species previously grouped under the genus *Lomatophyllum*, aloes do not occur in lowland moist forests. Aloe plants growing in shade are generally more robust than those growing on exposed grounds. However, judged by their successful cultivation in different soil mixtures, aloes are apparently tolerant to many soil types. Analysis of habitat preferences for Kenyan aloes showed that 66% of aloes occur in deciduous bushland /woodland, 14% in grasslands while the remaining 20% inhabit edges of thickets, riverine woodlands, scrubland or rock outcrops. The range of altitudes is wide, from 0 m (*Aloe massawana*) to over 2300 m for *Aloe juvenna*. The highest proportion of aloes (32%) occurs between 100-1500 m above sea level. Higher altitudes have been reported from some species in Ethiopia.

With respect to commercial species in Kenya, it has been observed that *A. secundiflora* occurs in a range of grassland and deciduous woodlands in both relatively wet to arid localities. The species does not occur on very steep terrain and is absent in marshy vegetation and other water-logged environments. While *A. secundiflora* is more or less an ecological 'generalist', *A. scabrifolia*, *A rivae*, *A. turkanensis* and *A. calidophila* tend to be 'specialists', with and natural ranges are restricted to harsher and more arid localities in northern Kenya, Southern Ethiopia and eastern Uganda.

1.3.3 *Role of the species in its ecosystem*

Aloes are an important component of the dryland ecosystems where they are associated with species of such as *Acacia*, *Kleinia*, *Cissus* , and *Euphorbia*. It has been suggested that aloes may be primary colonisers of habitats that enable later habitation by other less resilient plants.

Observations made on *A. secundiflora* have shown that vegetation diversity, litter cover, soil retention and soil seed bank are greatly enhanced in the immediate vicinity of the plants. Apparently, the presence of *A. secundiflora* creates microhabitats for associated plants (and animals) probably due to the physical protection, shade and perennial ground cover (King, 2003). In addition, aloes produce large amounts of nectar. In relation to honey-bees, the presence of flowering aloes has been observed to enhance the quantity and quality of honey output over the seasons.

1.4. Population:

1.4.1. *Global Population size*: (Population size may be estimated by reference to population density, having due regard to habitat type and other methodological considerations, or simply inferred from anecdotic data) Detailed census of populations has not been done for many species of *Aloe* and hence difficulties in providing good estimates of population size. However, in a survey by Mukonyi *et al*. (2005) the Kenyan population of commercial aloes was estimated at 129 million plants, 83% of which were *A. secundiflora*. Considering the large ecological range of the species (EOO≥ 136 000 km^2 for Kenya alone), the global population of *A. secundiflora* individuals is likely to be more than double the Kenyan estimate; a meagre 0.1% of commercial species was accounted for by *A. turkanensis*, *A. calidophila* and *A. rivae* combined while the endemic *A. scabrifolia* was estimated at 16.9% (2,180,100 individuals) of the total count.

1.4.2. *Current global population trends:*

Information on *Aloe* species population trends in East Africa is scanty since no specific studies have been undertaken in this area. However, except for species occurring in remote and isolated areas, aloes like all plants of the region, have suffered loss and fragmentation of habitat as a result of human population increase. Coupled with commercial exploitation as noted for the five Kenyan species, the projection is that population sizes are more or less on the decline, albeit at minimal pace. In the case of Kenya, this trend has been kept in check by recent efforts at dialogue with stakeholders and the legalisation in 2007 of sustainable extraction of aloes from the wild.

1.5. Conservation status

1.5.1. *Global conservation status (according to IUCN Red List).*

IUCN Redlisting for aloes of Southern Africa has been extensive and conservation status of many species of the region already established.

For East African aloes, Red list Assessments of twenty-five Aloe species endemic to Kenya were done by Wabuyele *et al*. (2006). Nine of the species were listed as critically endangered, seven are endangered, four are vulnerable, three near-threatened and two are of Least Concern. The endemic and commercially exploited *A. scabrifoia* was assessed as being vulnerable [(B1ab(v)]. Other Redlisting efforts for East African plants have been coordinated under the Critical Ecosystem Partnership funded project of the Eastern Arc Mountains and Coastal forests of Kenya and Tanzania Project. Under this project, twenty-four *Aloe* species occurring in the two East African biodiversity hotspots were targeted for conservation assessment, none of which is exploited on commercial basis.

1.5.2. *National conservation status for the case study country*

Although no objective data was available to make formal conservation assessments, all Kenyan aloes have been regarded as endangered since the 1980s and have been given high priority in conservation efforts. Indeed, reports of indiscriminate harvesting of the commercial species in the wild led to a Presidential Decree in 1986 that banned commercial exploitation of wild-growing aloes. In a recent mapping exercise by Mukonyi *et al*. (2005) of the major aloe growing areas in the country, approximately 129 million individual plants of the five identified commercial aloe species were counted. Although this number is considerably large, the species should be considered 'vulnerable' in the face of habitat loss and alteration and unregulated commercial harvesting, which is the single most potent threat.

1.5.3. *Main threats within the case study country*

As demonstrated by the population census of commercially exploited aloes, Kenya is endowed with a high diversity of species that occur in large numbers. One of the species, *A. secundiflora* is very common and widespread, whereas the other four are more restricted in distribution. Regardless of the distribution trends of the species, sustainable utilisation is possible only for as long as efficient management measures are established. The main threats to aloes in Kenya can be summarised as a) Unregulated commercial exploitation in the case of species harvested for the aloe bitter gum and b) habitat fragmentation and destruction

Unregulated commercial-scale exploitation is a major threat for species that are harvested for aloe bitter gum production. This is most important for species that have a restricted distribution and narrow ecological range. It is hoped that with the new strategy, stakeholders will be more vigilant and avoid indiscriminate harvesting from the wild.

Habitat destruction and fragmentation occurs mainly due to increased human and livestock populations that in turn increase the need for settlement and development activities like road construction and quarrying. Overgrazing in the rangelands leads to decreased ability of aloes and other native plants to compete as invasive alien species take over habitats. In localities with low to medium potential for agricultural production, aloes are cleared to make way for arable land. This problem is exacerbated by the changing land tenure systems in which expansive communally-owned land is subdivided into smaller parcels, a situation that is not helped by the fact that a large number of species occur outside protected areas.

2. SPECIES MANAGEMENT WITHIN THE COUNTRY FOR WHICH CASE STUDY IS BEING PRESENTED

2.1 Management measures

2.1.1 *Management history*

Due to their multi-use nature, aloes have been harvested at household level over many years mainly for use as herbal remedies in combination with other plants. Large scale harvesting of aloes for commercial purposes started in Kenya in the 1950s and, by the mid 1980s, the rate of off take was alarming. Thus, a Presidential Ban was declared in 1968 prohibiting commercial harvesting from the wild. However, for over two decades, enforcement of this Decree remained a challenge since it was never translated into law.

In consideration of the economic potential of aloes, national stakeholders felt the need to streamline their use by developing a framework for regulation. It is against this background that stakeholders consulted widely and came up with Aloe Utilization guidelines that were gazetted by the Kenya government at the end of 2007 as subsidiary legislation; The Wildlife (Conservation and Management) (*Aloe* Species) Regulations, 2007 hence bridging the legal gap in the aloe industry. A National Strategy for Conservation and Management of Commercial *Aloe* species was subsequently formulated and launched in July 2008 to spearhead developments in the aloe commercialisation process and implementation of the Regulations. The Commercial *Aloe* Strategy as a Management Plan for Kenyan commercial species prescribes systems, procedures and institutional arrangements for sustainable management of the species in accordance with the national legislation on wildlife and international obligations regarding international trade in wildlife species and their derivatives.

2.1.2 *Purpose of the management plan in place*

The Strategy for Conservation and Management of Commercial *Aloe* Species in Kenya (Lubia *et al*. 2008) was formulated to guide sustainable utilisation of the resource, with the aim of striking a balance between socio-cultural, economic and ecological needs necessary for sustainable development of the sub-sector. The Strategy provides for sustainable utilization of aloes sourced from both domesticated and wild populations.

2.1.3 *General elements of the management plan*

The aloe commercialisation process proposes both *in-situ* and *ex-situ* strategies to promote the sustainable utilisation of aloes in Kenya. The *in situ* strategy targets sustainable harvesting and production from natural populations in the so-called *Aloe* Management Units (AMUs) that have been identified on the basis of holding large quantities of commercial aloes. Ex-situ production targets areas with low densities or no aloes where establishment of plantations will boost production and alleviate pressure on natural populations. In addition, the Strategy explores ways of promoting sustainable utilisation by proposing incentives for salvaging aloes in cases of land use change; promotes aloe cultivation as a competitive land use option and encourages multiple use of land that combines intercropping of aloes with conventional crops as well as grazing.

2.1.4 *Restoration or alleviation measures*

For conservation purposes, aloes in protected areas will not be exploited for trade. Sustainable utilization of the wild populations will be controlled using areas delineated as *Aloe* Management Units (AMUs) through certification and tracking of the custody chain. *Ex situ* collections will be maintained in botanical gardens and other facilities to augment the natural gene pool. However, no specific measures have been proposed for re-introduction of the species to localities where they may become depleted.

2.2. Monitoring system

2.2.1. *Methods used to monitor harvest*

Prior to the recently gazetted subsidiary legislation and subsequent development of a Management plan for utilization, aloe harvesting and trade in Kenya was illegal and *ad hoc*. The new Strategy proposes establishment of Management Units (AMUs) that will be used for periodic monitoring of the impact of harvesting on natural populations. Within each AMU, standards will be set on harvesting procedures, quantities required and optimum seasons to avoid overexploitation. The amount of off-take and trade statistics will form the basis for allocation of harvesting quotas and eventual evaluation of sustainability.

2.2.2 *Confidence in the use of monitoring*

As already mentioned, implementation of the Strategy for aloe commercialisation in Kenya is at its infancy. However, formulation of this strategy was based on wide consultations amongst stakeholders, making it a people-owned strategy that is founded on best scientific information accruing from a national inventory of the commercial aloe species undertaken in 2005. In addition, the AMUs as proposed here will have internal management structures and production standards agreed upon by the membership and acceptable to the wildlife regulatory authorities. It is therefore anticipated that the system will be cohesive enough to realise the aspirations of aloe farmers and conservation agencies alike.

2.3. Legal framework and law enforcement: Provide details of national and international legislation relating to the conservation of the species.

In Kenya, the Forest Policy (2005) and the Environmental Management and Coordination Act (1999) generally relate to management of biodiversity resources of the country. The Wildlife (Conservation and Management) (Amendment) Act 1989; CAP 376, provides for conservation and management of all wild fauna and flora. However, the recently gazetted subsidiary legislation on aloes: "The Wildlife (Conservation and Management) (*Aloe* Species) Regulations, 2007" based on powers conferred by Section 67 of the Wildlife (Conservation and Management) Act to the Minister responsible for wildlife provide the most relevant/specific basis for Aloe Commercialisation in the country.

At the international level, all aloes except Aloe vera are listed on Appendix I & II of CITES. All East African species are listed on Appendix II, for which trade is regulated through use of permits and certificates and in accordance with Article IV of the CITES Convention, the basis for Non-Detriment Finding Studies if the trade involves specimens collected from the wild. The responsibility for enforcement of both domestic and CITES regulations on wildlife trade is vested upon the Kenya Wildlife Service and the National Museums of Kenya being the national wildlife Management and CITES Scientific Authorities, respectively. Vigilance on movement of plant materials is in addition provided by national Customs and Kenya Plant Health Inspectorate Services

(KEPHIS) to ensure enforcement and compliance with the national legislation and the international protocols relating to trade in the species.

3. UTILIZATION AND TRADE FOR RANGE STATE FOR WHICH CASE STUDY IS BEING PRESENTED

3.1. Type of use (origin) **and destinations** (purposes) (e.g. commercial, medicinal, subsistence hunting, sport hunting, trophies, pet, food). Specify the types and extent of all known uses of the species. Indicate the extent to which utilization is from captive-bred, artificially propagated, or wild specimens

Alongside other medicinal plants extensive use of aloes in treatment of human and livestock diseases in Africa has been documented. Indeed, in some areas of East Africa, herbal treatments are the only option for up to 80% of the population. In an ethnobotanical survey of parts of Kenya Bjøra *et al*., (in prep) documented many uses of aloes that were summarised as: a) human medicine, b) livestock medicine, c) fodder, d) fencing and hedging, e) soil conservation /compaction, f) traditional brewing and g) cosmetic/beauty therapy.

Up to 50% of the species were used as medicine, with malaria being the most common human ailment cured by aloes. Other uses of aloes include their use in traditional rituals and cultural practices in some groups of coastal Kenya. Generally, use of aloes seems to be dictated by availability (distribution) as well as morphology; the widespread *A. secundiflora* was most popular as compared to less well known species; *Aloe lateritia* with its high leaf gel content was popular in beauty therapy and leggy species such as *Aloe kedongenis* were preferred as hedges. Species such as Aloe ruspoliana that are known to be poisonous are used for killing hyenas and wayward dogs in northern Kenya.

Apart from the 'traditional' use of aloes outlined here, commercialisation of Kenyan aloes occurs at two levels; in the last decade or so, the sap of this species has gained popularity as an ingredient of 'homemade' soaps and detergents in many rural villages in Kenya. In this regard, individuals and community groups have taken to 'aloe soap' making as a cottage industry to subsidise income. On the other hand, large-scale commercial extraction of aloes targets markets abroad, mainly in Europe, and the Middle East (Oldfield, 2003) where it is used in the cosmetics and drug manufacturing industries. Farming of aloes is a recent undertaking in Kenya and no known plantations of mature plants exist. All known substantial harvesting of aloes is from wild-growing populations. As noted by Newton (1994) attempts to establish plantations in the past have been flawed since whole plants were dug up from the wild for replanting on farmland.

3.2 Harvest:

3.2.1 *Harvesting regime* (extractive versus non extractive harvesting, demographic segment harvested, harvesting effort, harvesting method, harvest season)

For 'traditional' uses of aloes, only a few leaves were harvested from mature plants and except for use of the roots in fermentation of local brews, plants are not uprooted. The usual practice is to harvest older leaves starting from the base to that the younger leaves towards the growing tip are left intact. However, upsurge in demand for aloe sap in the advent of commercial production has meant that increasingly younger plants are harvested to obtain as much sap as possible. As observed by Bjøra *et al*, the local people have to walk longer distances to harvest aloes (and other plants) for routine use. This has prompted the establishment of herbal gardens closer to homesteads to ensure steady and easy access to these resources.

In a sense, 'illegal' harvesting of aloes has been largely opportunistic with no clear-cut seasons for the activity. This scenario is bound to change within the newly published Strategy in which emphasis is on establishment of AMUs with accepted quotas and standards of production such as safe off-take levels and seasons optimal for harvesting.

3.2.2 *Harvest management / control* (quotas, seasons, permits, etc.)

According to the recently published *Aloe* commercialisation strategy, production from natural populations will revolve around AMUs for which members of each Unit shall be involved in setting internal standards and the levels of performance to which their activities should aspire. The standards will then be assessed and interpreted by the national wildlife authorities and other national partners. Failure to comply with stipulated standards will lead to cancellation of rights to harvest and revocation of trade permits by the Management Authority.

3.3 Legal and illegal trade levels:

3.3 Legal and illegal trade levels: To the extent possible, quantify the level of legal and illegal use nationally and export and describe its nature

Local trade

In all regions where aloes occur, domestic trade has been ongoing for many years mainly as part of the herbal remedies traded/exchanged with neighbours. Market surveys of medicinal plants traded in

Southern- and East Africa reveal substantial volumes of aloes traded. Indeed, many supermarkets in Kenya stock '*Aloe vera*' juices and soaps that are locally manufactured and that have become quite popular in recent years. However, documentation of this trade is scanty and insufficient as a basis for identifying species and quantities exploited.

International trade

International trade in wild collected specimens of aloes was banned in Kenya in 1986 through a Presidential Decree and materials authorized for export under CITES Permits and certificates from Kenya have been small quantities of dried leaf material, sap or seeds that were mainly for scientific analysis abroad.

However, illegal trade in aloe bitter gum has been reported in Baringo, Taita-Taveta, Samburu, Wajir and West Pokot districts. The aloe trade chain in Kenya is very discreet and very little information is available to determine the volumes of this illegal trade. The available information in this regard has been sourced from few local people and some of the trade agents who were unaware of the civil obligations / implications and who have been willing to volunteer the information. In Loruk area of Baringo District, it is reported that between 200-250 plants were required to obtain 5 litres of raw sap that would then be sold for a maximum of USD 0.3/litre.

Despite national and CITES obligations on international trade in aloes and their derivatives, it is apparent that vigilance at the ports of entry/exit has been porous enough to allow passage of substantial amounts of aloes. For instance, according to a report by NAREDA (cited in Oldfield 2003) about 125, 800 kg of dried aloe bitter gum sourced from natural populations was shipped through the port of Mombasa in the years 1995 to 1999. Up to four registered companies, dealing in wood products, resins, essential oil extracts and vegetable products were involved in the business. This suggests that inspection of exports over the period was inefficient and failed to detect aloe products that may have been disguised as vegetables or resins. Ultimately, the laxity of the system is attributable to difficulties in enforcing a Presidential Decree that did not have a legal basis. Thus, the development of subsidiary legislation and formulation of the strategy for conservation and management of commercial aloes that was institutionalized in 2008 is a milestone that provides a framework for mainstreaming the industry in Kenya. This provides a mechanism for monitoring trade and a pathway for undertaking Non-Detriment Finding studies for use and application in adaptive management of commercially exploited species.

Non-detrimental Finding procedure (NDFs)

a) NDF methodology used (Provide detailed information on the procedure used to make the non-detriment finding for the species evaluated.)

The NDF study on commercial aloes in Kenya systematically followed the IUCN checklist for NDFs (Rosser, 2008). Qualitative assessments were augmented by quantitative data generated in the mapping and inventory survey by Mukonyi et al. (2005) and other previous field assessments on aloes in general. Sampling procedures for the inventory were modified from methods used for non-wood forest products, taking into consideration species habits, sizes and distribution.

Optimal harvesting regimes of the species were conceived on the basis of information gathered from the surveys, taking cognizance of the national legal provisions governing the conservation and management of the species. Generally, the IUCN checklist for NDF has been extensively referred to in the process of developing the strategy for conservation and management of commercial aloes in Kenya.

Criteria, parameters and/or indicators used

Final assessment of the impact of commercialisation on species was made in consideration of distributions of species, biological characteristics such as growth habit, potential for regeneration, ecological resilience and tolerance to human disturbance. In order to gauge sustainability of harvesting, information on both legal and illegal trade at domestics and international scales were assessed. Trade statistics were sourced from previous surveys (NAREDA) and from informants in commercial aloe producing centres.

Main sources of data and analysis used (including field evaluation or sampling methodologies)

The following are the sources of data used in making NDF on the commercial *Aloe* species in Kenya. The same methodologies used to generate the data shall continue to be used when undertaking future NDFs on the species.

a) Aloe inventory report: Status and distribution of Commercial aloes in Kenya (Mukonyi *et al.* 2005)

   This is a field assessment that focused on all districts of Kenya where aloes are exploited on commercial basis. During this survey the research team established the national distribution and abundance of species, harvesting and processing techniques, approximate yields per season as well as wild and cultivated sources of aloes.

Based on the information gathered, recommendations were made of appropriate adaptive conservation and utilization approaches for target species.

The aloe inventory exercise was a pioneer study for which methodology is not standardised. Therefore, in consideration of growth forms, patterns, sizes and distribution, methods of sampling for quantification were modified from those used for non-wood forest products. Cluster sampling method was adopted for predominantly suckering species-*A. turkanensis*, *A. scabrifolia*, *A. rivae* and *A. calidophila* while total counts approach was adopted for *A. secundiflora*

Information was collected on entities involved in commercial aloe domestication programs and projections made of current and potential production levels. Interviews were carried out to establish initiatives made towards sustainable utilization of the aloes, the distribution of critical masses of the species as well as the land tenure system in aloe-rich localities. Harvesting methods and the market chain in the commercial aloe industry has been documented as a basis for current and future comprehensive NDF studies.

b) Export permits issued for export of the commercial aloe species and their derivatives. This documentation is kept by the Kenya Wildlife service which is the Management Authority for Kenya.
c) Review of Significant Trade report on East African aloes to the CITES Plants Committee; CITES PC14 Do.9.2.2 Annex 4. This paper draws from a survey by Oldfield (2003) in which trade statistics for the aloes in east Africa were reviewed. On the basis of trade data, it was concluded that significant levels of trade occur on aloes in the region exists. However, the trade is poorly documented and difficult to quantify.
d) Field assessments on the conservation status and economic potential of the genus Aloe in Kenya. This is an unpublished report by Wabuyele (2004) based on field surveys in the main aloe producing areas of Kenya. The survey documented distribution, use and threats to aloes in the country.
e) Studies on Eastern African aloes: Aspects of taxonomy, Conservation and ethno-botany. This is a comprehensive study of regional aloes based on PhD studies from 2003 to 2006.

Evaluation of data quantity and quality for the assessment

Data obtained from the outlined sources was analyzed to determine suitability and approvals for establishing *Aloe* Management Units (AMUs) as entities for controlled and sustainable harvesting of target species from the wild for commercial trade.

The data was used to develop the national strategy for conservation and management of the commercial aloe species in Kenya published in July 2008.

Applications for exports from these AMUs will be compared with the expected levels of production as stipulated in the Management Plans for the species to ensure compliance and enforcement. Regular field assessments shall be undertaken for purposes of monitoring any changes to the species population status and impact of management so as to provide feedback and timely adjustment to the management plan.

Main problems, challenges or difficulties on elaboration of NDF

The major challenge in the elaboration of NDF studies on the commercial aloe species in Kenya is inadequate information on aspects such as auto-ecology, demography and population dynamics especially in areas not covered under the inventory and mapping exercise. The methods adopted in sampling may require further testing and validation. In addition the discrete nature of hitherto illegal trade in specimens of the commercial aloes hampers systematic documentation of trade volumes and market trends thus making it difficult to assess the levels of harvest and the impact of trade on the natural populations.

Recommendations

The IUCN checklist for NDF studies is a practical tool applicable to the case of commercial aloes in Kenya. Efforts shall therefore be made to use the checklist combined with other guidelines and methodologies and procedures to formulate future NDFs for the species. For efficient implementation of the Kenya Strategy for conservation and management of commercial aloes as a management plan and make it as adaptive as possible, it will be crucial to obtain baseline information that will enable future monitoring of the impact of off-take on natural populations. It is recommended that:

- Detailed studies are carried out on the five species to establish pertinent information as relates to spatial and genetic structure and dynamics of populations. Data accruing from such studies will ehance objectivity in application of the IUCN Checklist for NDF on these species.
- In addition, it will be crucial to develop efficient identification and authentication tools for the various commercial species and their products for surveillance at the ports of exit from the country.

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Succulent and Cycads Workgroup case study

Sustainable Use of East African Aloes: the case of commercial aloes in Kenya

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I.Background information on the taxa

Summarize the most relevant information (biology and ecology, conservation status, use and management, trade, legal frame) useful to have a background on the species and its situation. It is not required to include detailed information and could be updated from the species listing proposal.

1. Biological data

1.1 Scientific names: *Aloe* spp. (*Aloe secundiflora Aloe turkanensis*, *Aloe scabrifolia, Aloe calidophila* and *Aloe rivae*)

Common Names: Aloes (English), Tulkos (Pokot), Tangaratwe(Tugen), Suguroi (Maa & Samburu), Kipapa(Taita), Mugwanugu (Kikuyu), Ejichuka (Turkana), Kiluma (Kamba), Kolonje (Duruma) and dahr (Somali).

1.2 Distribution (Specify the currently known range of the species. If possible, provide information to indicate whether or not the distribution of the species is continuous, or to what degree it is fragmented. If possible, include a map).

Sub-Saharan Africa, including the Island of Madagascar accounts for over 90% of the 450 or so taxa (species, subspecies or varieties) of the genus *Aloe* known today, with concentration in Southern Africa (over 260 taxa), in Eastern Africa (over 180 taxa) and on the Island of Madagasar (Ca 77 taxa). A few species have been recorded in the Arabian Peninsular and on small Islands off the Coast of Africa. Kenya is home to about 60 species, five of which have been identified as being commercially exploited for aloe bitter gum trade.

As a genus, aloes are a common feature of the landscape in many dryland areas of Africa. However, aloes are rarely dominant in the ecological sense, except in places devoid of other vegetation. Indeed, many taxa are rare and with narrow range of distribution and high levels of endemicity have been recorded in all the main centres of diversity. Of the five commercial species identified for Kenya, the most common and widely distributed species is *A. secundiflora* with considerable variation across its geographical range. According to Wabuyele *et al.* (2006), the Extent of Occurrence (EOO) for *A. secundifora* in Kenya alone is at least 136200 km^2.Two varieties are recognised in this species; the first, *A. secundiflora* var. *secundiflora* occurs in Ethiopia, Kenya, northern Tanzania, Uganda, Rwanda and Sudan. The second variety, *A. secundiflora* var. *tweediae* occurs in northern Uganda, northern Kenya and in southern Sudan. In undisturbed pristine habitats, the species occurs in more or less continuous populations, except in marshes and other water-logged soils.

Generally, the geographical distribution of the other four commercial aloes is more restricted in comparison with *A. secundiflora; A. turkanensis* occurs in Kenya and Uganda; both *A. calidophila* and *A. rivae* occur in Kenya and Ethiopia, while *A. scabrifolia* is endemic to Kenya. However, all the species are locally common within their distribution ranges. The Kenyan distribution of the five commercially exploited species is shown in figure 1.

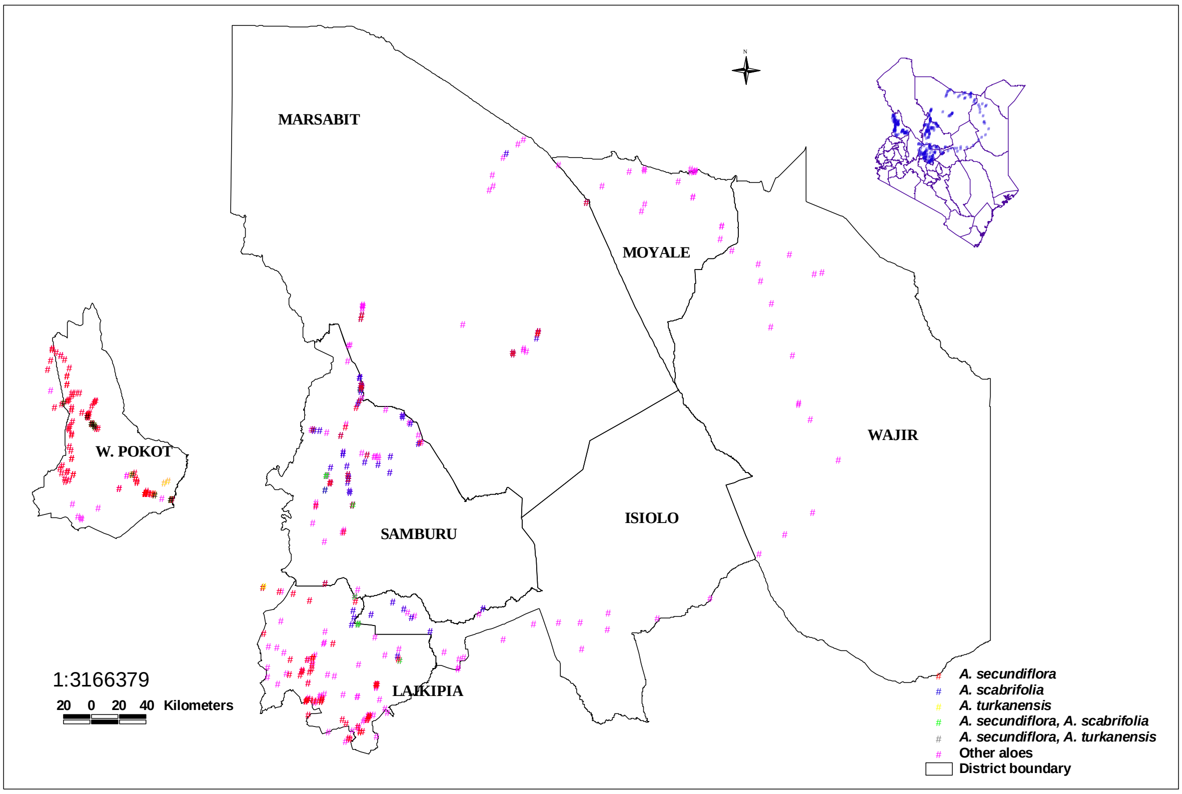

Figure 1

1.3 Biological characteristics

1.3.1 Provide a summary of general biological and life history characteristics of the species (e.g. reproduction, recruitment, survival rate, migration, sex ratio, regeneration or reproductive strategies, tolerance toward humans).

Aloes are perennial monoecious plants with a variety of sizes that include the miniature herbs such as the grass aloes, stemless rosette- forming species, stemmed and sprawling shrubs and small trees. The leaves in the stemmed aloes may be borne in terminal rosettes or may be spaced along the stem, which in some cases emerges to about 15 meters in height. The inflorescence in aloes is a raceme, simple or compound; flowers are tubular, brightly coloured red, yellow, orange or rarely white and produce large amounts of sugary nectar with which visiting fauna is rewarded. Cross pollination in aloes (by sunbirds) is promoted by the protandrous nature of the flowers. Aloes reproduce both vegetatively and by seed and they have been observed to hybridise extensively in nature as well as in cultivation. The fruits of aloes bear numerous seeds that are dispersed by wind. Generally, all aloes have a long lifespan that is estimated at 150 years (Newton & Vaughan, 1996).

Although aloes produce high numbers of seeds and suckers, establishment of recruits is only occasional and dependent on availability of rainfall that is more often than not scanty and erratic in the range areas. This phenomenon combined with the long-lived perennial habit of the plants leads to predominance of older plants in aloe populations. These observations have been corroborated by studies by Wabuyele (2000) on the population structure of maculate aloes in Kenya and Ethiopia that showed a greater proportion of 'juvenile' and 'adult' size classes as opposed to the 'seedling' and 'post-reproductive' plants. Other observations by Mukonyi *et al.* (2005) noted that most populations of the commercial species in Kenya were dominated by mature individuals. It is important to note here that despite the apparent lack of active recruitment of new individuals, the *Aloe* populations studied displayed healthy genetic composition with no signs of inbreeding depression.

In general, aloes have been observed to respond to physical disturbance like injury of plant organs by increasing growth and suckering. Aloes have also been reported as being tolerant of fires especially as occurs in many rangeland vegetation types. Mukonyi *et al.* (2005) observed that, among the five identified commercial species; *Aloe scabrifolia* and *A. calidophila* are least tolerant to fire. *A. secundiflora* has been demonstrated to be tolerant of trampling by livestock and wildlife as demonstrated on trial plots in Laikipia district of Kenya (Gilfred Powys, Pers.com). However, detailed studies on ecological response to other forms of disturbance are not available.

In East Africa, the optimal flowering season for aloes coincides with the rainy seasons. Most species flower during May to July and from September to November, corresponding to the two peak seasons of high moisture experienced in many localities of the region. Amongst the commercial species, *A. secundiflora* has been observed to seed and recruit more through seeds *A. scabrifolia, A. rivae, A. turkanensis and A. calidophila* recruit mainly by suckers. Efficient seed dispersal and seedling establishment may be one of the factors contributing to the ecological success of *A. secundiflora.*

1.3.2 Habitat types: Specify the types of habitats occupied by the species and, when relevant, the degree of habitat specificity

The ecological range of aloes generally excludes rain forest habitats, and except for species previously grouped under the genus *Lomatophyllum*, aloes do not occur in lowland moist forests. *Aloe* plants growing in shade are generally more robust than those growing on exposed grounds. However, judged by their successful cultivation in different soil mixtures, aloes are apparently tolerant to many soil types. Analysis of habitat preferences for Kenyan aloes showed that 66% of aloes occur in deciduous bushland /woodland, 14% in grasslands while the remaining 20% inhabit edges of thickets, riverine woodlands, scrubland or rock outcrops. The range of altitudes is wide, from 0 m (*Aloe massawana*) to over 2300 m for *Aloe juvenna.* The highest proportion of aloes (32%) occurs between 100-1500 m above sea level. Higher altitudes have been reported from some species in Ethiopia.

With respect to commercial species in Kenya, it has been observed that *A. secundiflora* occurs in a range of grassland and deciduous woodlands in both relatively wet to arid localities. The species does not occur on very steep terrain and is absent in marshy vegetation and other water-logged environments. While A. *secundiflora* is more or less an ecological 'generalist', *A. scabrifolia, A rivae*, *A. turkanensis* and *A. calidophila* tend to be 'specialists', and natural ranges are restricted to harsher and more arid localities in northern Kenya, Southern Ethiopia and eastern Uganda.

1.3.3 Role of the species in its ecosystem

Aloes are an important component of the dryland ecosystems where they are associated with species of such as *Acacia, Kleinia, Cissus* , and *Euphorbia.* It has been suggested that aloes may be primary colonisers of habitats that enable later habitation by other less resilient plants. Observations made on *A. secundiflora* have shown that vegetation diversity, litter cover, soil retention and soil seed bank are greatly enhanced in the immediate vicinity of the plants. Apparently, the presence of *A. secundiflora* creates microhabitats for associated plants (and animals) probably due to the physical protection, shade and perennial ground cover (King, 2003). In addition, aloes produce large amounts of nectar. In relation to honey-bees, the presence of flowering aloes has been observed to enhance the quantity and quality of honey output over the seasons.

1.4. Population:

1.4.1. Global Population size: (Population size may be estimated by reference to population density, having due regard to habitat type and other methodological considerations, or simply inferred from anecdotic data)

Detailed census of populations has not been done for many species of *Aloe* and hence difficulties in providing good estimates of population size. However, in a survey by Mukonyi *et al.* (2005) the Kenyan population of commercial aloes was estimated at 129 million plants, 83% of which were *A. secundiflora*. Considering the large ecological range of the species (EOO≥ 136000 km^2 for Kenya alone), the global population of *A. secundiflora* individuals is likely to be more than double the Kenyan estimate; a meagre 0.1% of commercial species was accounted for by *A. turkanensis*, *A. calidophila* and *A. rivae* combined while the endemic *A. scabrifolia* was estimated at 16.9% (2,180,100 individuals) of the total count.

1.4.2. Current global population trends:

Information on *Aloe* species population trends in East Africa is scanty since no specific studies have been undertaken in this area. However, except for species occurring in remote and isolated areas, aloes like all plants of the region, have suffered loss and fragmentation of habitat as a result of human population increase. Coupled with commercial exploitation as noted for the five Kenyan species, the projection is that population sizes are more or less on the decline, albeit at minimal pace. In the case of Kenya, this trend has been kept in check by recent efforts at dialogue with stakeholders and the legalisation in 2007 of sustainable extraction of aloes from the wild.

1.5. Conservation status

1.5.1. Global conservation status (according to IUCN Red List).

IUCN Redlisting for aloes of Southern Africa has been extensive and conservation status of many species of the region already established. For East African aloes, Red list Assessments of twenty-five *Aloe* species endemic to Kenya were done by Wabuyele *et al.* (2006). Nine of the species were listed as critically endangered, seven are endangered, four are vulnerable, three near-threatened and two are of Least Concern. The endemic and commercially exploited *A. scabrifoia* was assessed as being vulnerable [(B1ab(v)]. Other Redlisting efforts for East African plants have been coordinated under the Critical Ecosystem Partnership funded project of the Eastern Arc Mountains and Coastal forests of Kenya and Tanzania Project. Under this project, twenty-four *Aloe* species occurring in the two East African biodiversity hotspots were targeted for conservation assessment, none of which is exploited on commercial basis.

1.5.2. National conservation status for the case study country

Although no objective data was available to make formal conservation assessments, all Kenyan aloes have been regarded as endangered since the 1980s and have been given high priority in conservation efforts. Indeed, reports of indiscriminate harvesting of the commercial species in the wild led to a Presidential Decree in 1986 that banned commercial exploitation of wild-growing aloes. In a recent mapping exercise by Mukonyi *et al.* (2005) of the major aloe growing areas in the country, approximately 129 million individual plants of the five identified commercial aloe species were counted. Although this number is considerably large, the species should be considered 'vulnerable' in the face of habitat loss and alteration and unregulated commercial harvesting, which is the single most potent threat.

1.5.3. Main threats within the case study country

As demonstrated by the population census of commercially exploited aloes, Kenya is endowed with a high diversity of species that occur in large numbers. One of the species, *A. secundiflora* is very common and widespread, whereas the other four are more restricted in distribution. Regardless of the distribution trends of the species, sustainable utilisation is possible only for as long as efficient management measures are established. The main threats to aloes in Kenya can be summarised as a) Unregulated commercial exploitation in the case of species harvested for the aloe bitter gum and b) habitat fragmentation and destruction.

Unregulated commercial-scale exploitation is a major threat for species that are harvested for aloe bitter gum production. This is most important for species that have a restricted distribution and narrow ecological range. It is hoped that with the newly published *Aloe* Commercialisation strategy, stakeholders will be more vigilant and avoid indiscriminate harvesting from the wild.

Habitat destruction and fragmentation occurs mainly due to increased human and livestock populations that in turn increase the need for settlement and development activities like road construction and quarrying. Overgrazing in the rangelands leads to decreased ability of aloes and other native plants to compete as invasive alien species take over habitats. In localities with low to medium potential for agricultural production, aloes are cleared to make way for arable land. This problem is exacerbated by the changing land tenure systems in which expansive communally-owned land is subdivided into smaller parcels, a situation that is not helped by the fact that a large number of species occur outside protected areas.

2. Species management within the country for which case study is being presented.

2.1 Management measures

2.1.1 Management history

Due to their multi-use nature, aloes have been harvested at house-hold level over many years mainly for use as herbal remedies in combination with other plants. Large scale harvesting of aloes for commercial purposes started in Kenya in the 1950s and, by the mid 1980s, the rate of off take was alarming. Thus, a Presidential Ban was declared in 1968 prohibiting commercial harvesting from the wild. However, for over two decades, enforcement of this Decree remained a challenge since it was never translated into law.

In consideration of the economic potential of aloes, national stakeholders felt the need to streamline their use by developing a framework for regulation. It is against this background that stakeholders consulted widely and came up with *Aloe* Utilization guidelines that were gazetted by the Kenya government at the end of 2007 as subsidiary legislation; The Wildlife (Conservation and Management) (*Aloe* Species) Regulations, 2007 hence bridging the legal gap in the aloe industry. A National Strategy for Conservation and Management of Commercial *Aloe* species was subsequently formulated and launched in July 2008 to spearhead developments in the aloe commercialisation process and implementation of the Regulations. The Commercial *Aloe* Strategy as a Management Plan for Kenyan commercial species prescribes systems, procedures and institutional arrangements for sustainable management of the species in accordance with the national legislation on wildlife and international obligations regarding international trade in wildlife species and their derivatives.

2.1.2 Purpose of the management plan in place

The Strategy for Conservation and Management of Commercial *Aloe* Species in Kenya (Lubia *et al.* 2008) was formulated to guide sustainable utilisation of the resource, with the aim of striking a balance between socio-cultural, economic and ecological needs necessary for sustainable development of the sub-sector. The Strategy provides for sustainable utilization of aloes sourced from both domesticated and wild populations.

2.1.3 General elements of the management plan

The aloe commercialisation process proposes both *in-situ* and *ex- situ* strategies to promote the sustainable utilisation of aloes in Kenya. The *in situ* strategy targets sustainable harvesting and production from natural populations in the so-called *Aloe* Management Units (AMUs) that have been identified on the basis of holding large quantities of commercial aloes. *Ex-situ* production targets areas with low densities or no aloes where establishment of plantations will boost production and alleviate pressure on natural populations. In addition, the Strategy explores ways of promoting sustainable utilisation by proposing incentives for salvaging aloes in cases of land use change; promotes aloe cultivation as a competitive land use option and encourages multiple use of land that combines intercropping of aloes with conventional crops as well as grazing.

2.1.4 Restoration or alleviation measures

For conservation purposes, aloes in protected areas will not be exploited for trade. Sustainable utilization of the wild populations will be controlled using areas delineated as *Aloe* Management Units (AMUs) through certification and tracking of the custody chain. *Ex situ* collections will be maintained in botanical gardens and other facilities to augment the natural gene pool. However, no specific measures have been proposed for re-introduction of the species to localities where they may become depleted.

2.2. Monitoring system

2.2.1. Methods used to monitor harvest

Prior to the recently gazetted subsidiary legislation and subsequent development of a Management plan for utilization, aloe harvesting and trade in Kenya was illegal and *ad hoc*. The new Strategy proposes establishment of Management Units (AMUs) that will be used for periodic monitoring of the impact of harvesting on natural populations. Within each AMU, standards will be set on harvesting procedures, quantities required and optimum seasons to avoid overexploitation. The amount of off-take and trade statistics will form the basis for allocation of harvesting quotas and eventual evaluation of sustainability.

2.2.2 Confidence in the use of monitoring

As already mentioned, implementation of the Strategy for aloe commercialisation in Kenya is at its infancy. However, formulation of this strategy was based on wide consultations amongst stakeholders, making it a people-owned strategy that is founded on best scientific information accruing from a national inventory of the commercial aloe species undertaken in 2005. In addition, the AMUs as proposed here will have internal management structures and production standards agreed upon by the membership and acceptable to the wildlife regulatory authorities. It is therefore anticipated that the system will be cohesive enough to realise the aspirations of aloe farmers and conservation agencies alike.

2.3. Legal framework and law enforcement: Provide details of national and international legislation relating to the conservation of the species.

In Kenya, the Forest Policy (2005) and the Environmental Management and Coordination Act (1999) generally relate to management of biodiversity resources of the country. The Wildlife (Conservation and Management) (Amendment) Act 1989; CAP 376, provides for conservation and management of all wild fauna and flora. However, the recently gazetted subsidiary legislation on aloes: "The Wildlife (Conservation and Management) (*Aloe* Species) Regulations, 2007" based on powers conferred by Section 67 of the Wildlife (Conservation and Management) Act to the Minister responsible for wildlife provide the most relevant/specific basis for Aloe Commercialisation in the country.

At the international level, all aloes except *Aloe vera* are listed on Appendix I & II of CITES. All East African species are listed on Appendix II, for which trade is regulated through use of permits and certificates and in accordance with Article IV of the CITES Convention, the basis for Non-Detriment Finding Studies if the trade involves specimens collected from the wild. The responsibility for enforcement of both domestic and CITES regulations on wildlife trade is vested upon the Kenya Wildlife Service and the National Museums of Kenya being the national wildlife Management and CITES Scientific Authorities, respectively. Vigilance on movement of plant materials is in addition provided by national Customs and Kenya Plant Health Inspectorate Services (KEPHIS) to ensure enforcement and compliance with the national legislation and the international protocols relating to trade in the species.

3. Utilization and trade for range State for which case study is being presented.

3.1. Type of use (origin) and destinations (purposes) (e.g. commercial, medicinal, subsistence hunting, sport hunting, trophies, pet, food). Specify the types and extent of all known uses of the species. Indicate the extent to which utilization is from captive-bred, artificially propagated, or wild specimens

Alongside other medicinal plants extensive use of aloes in treatment of human and livestock diseases in Africa has been documented. Indeed, in some areas of East Africa, herbal treatments are the only option for up to 80% of the population. In an ethnobotanical survey of parts of Kenya Bjøra *et al.*, (in prep) documented many uses of aloes that were summarised as: a) human medicine, b) livestock medicine, c) fodder, d) fencing and hedging, e) soil conservation /compaction, f) traditional brewing and g) cosmetic/beauty therapy.

Up to 50% of the species were used as medicine, with malaria being the most common human ailment cured by aloes. Other uses of aloes include their use in traditional rituals and cultural practices in some groups of coastal Kenya. Generally, use of aloes seems to be dictated by availability (distribution) as well as morphology; the widespread *A. secundiflora* was most popular as compared to less well known species; *Aloe lateritia* with its high leaf gel content was popular in beauty therapy and leggy species such as *Aloe kedongenis* were preferred as hedges. Species such as *Aloe ruspo*liana that are known to be poisonous are used for killing hyenas and wayward dogs in northern Kenya.

Apart from the 'traditional' use of aloes outlined here, commercialisation of Kenyan aloes occurs at two levels; in the last decade or so, the sap of this species has gained popularity as an ingredient of 'homemade' soaps and detergents in many rural villages in Kenya. In this regard, individuals and community groups have taken to 'aloe soap' making as a cottage industry to subsidise income. On the other hand, large-scale commercial extraction of aloes targets markets abroad, mainly in Europe, and the Middle East (Oldfield, 2003) where it is used in the cosmetics and drug manufacturing industries. Farming of aloes is a recent undertaking in Kenya and no known plantations of mature plants exist. All known substantial harvesting of aloes is from wild-growing populations. As noted by Newton (1994) attempts to establish plantations in the past have been flawed since whole plants were dug up from the wild for replanting on farmland.

3.2 Harvest:

3.2.1 Harvesting regime (extractive versus non extractive harvesting, demographic segment harvested, harvesting effort, harvesting method, harvest season)

For 'traditional' uses of aloes, only a few leaves were harvested from mature plants and except for use of the roots in fermentation of local brews, plants are not uprooted. The usual practice is to harvest older leaves starting from the base to that the younger leaves towards the growing tip are left intact. However, upsurge in demand for aloe sap in the advent of commercial production has meant that increasingly younger plants are harvested to obtain as much sap as possible. As observed by Bjøra *et al*, the local people have to walk longer distances to harvest aloes (and other plants) for routine use. This has prompted the establishment of herbal gardens closer to homesteads to ensure steady and easy access to these resources.

In a sense, 'illegal' harvesting of aloes has been largely opportunistic with no clear-cut seasons for the activity. This scenario is bound to change within the newly published Strategy in which emphasis is on establishment of AMUs with accepted quotas and standards of production such as safe off-take levels and seasons optimal for harvesting.

3.2.2 Harvest management / control (quotas, seasons, permits, etc.)

According to the recently published *Aloe* commercialisation strategy, production from natural populations will revolve around AMUs for which members of each Unit shall be involved in setting internal standards and the levels of performance to which their activities should aspire. The standards will then be assessed and interpreted by the national wildlife authorities and other national partners. Failure to comply with stipulated standards will lead to cancellation of rights to harvest and revocation of trade permits by the Management Authority.

3.3 Legal and illegal trade levels: To the extent possible, quantify the level of legal and illegal use nationally and export and describe its nature

Local trade

In all regions where aloes occur, domestic trade has been ongoing for many years mainly as part of the herbal remedies traded/exchanged with neighbours. Market surveys of medicinal plants traded in Southern- and East Africa reveal substantial volumes of aloes traded. Indeed, many supermarkets in Kenya stock '*Aloe vera*' juices and soaps that are locally manufactured and that have become popular in recent years. However, documentation of this trade is scanty and insufficient as a basis for identifying species and quantities exploited.

International trade

International trade in wild collected specimens of aloes was banned in Kenya in 1986 through a Presidential Decree and materials authorized for export under CITES Permits and certificates from Kenya have been small quantities of dried leaf material, sap or seeds that were mainly for scientific analysis abroad.

However, illegal trade in aloe bitter gum has been reported in Baringo, Taita-Taveta, Samburu, Wajir and West Pokot districts. The aloe trade chain in Kenya is very discreet and very little information is available to determine the volumes of this illegal trade. The available information in this regard has been sourced from few local people and some of the trade agents who were unaware of the civil obligations / implications and who have been willing to volunteer the information. In Loruk area of Baringo District, it is reported that between 200-250 plants were required to obtain 5 litres of raw sap that would then be sold for a maximum of USD 0.3/litre.

Despite national and CITES obligations on international trade in aloes and their derivatives, it is apparent that vigilance at the ports of entry/exit has been porous enough to allow passage of substantial amounts of aloes. For instance, according to a report by NAREDA (cited in Oldfield 2003) about 125, 800 kg of dried aloe bitter gum sourced from natural populations was shipped through the port of Mombasa in the years 1995 to 1999. Up to four registered companies, dealing in wood products, resins, essential oil extracts and vegetable products were involved in the business. This suggests that inspection of exports over the period was inefficient and failed to detect aloe products that may have been disguised as vegetables or resins. Ultimately, the laxity of the system is attributable to difficulties in enforcing a Presidential Decree that did not have a legal basis. Thus, the development of subsidiary legislation and formulation of the strategy for conservation and management of commercial aloes that was institutionalized in 2008 is a milestone that provides a framework for mainstreaming the industry in Kenya. This provides a mechanism for monitoring trade and a pathway for undertaking Non-Detriment Finding studies for use and application in adaptive management of commercially exploited species.

Non-detrimental Finding procedure (NDFs)
a) NDF methodology used (Provide detailed information on the procedure used to make the non-detriment finding for the species evaluated.)

The NDF study on commercial aloes in Kenya systematically followed the IUCN checklist for NDFs (Rosser, 2008). Qualitative assessments were augmented by quantitative data generated in the mapping and inventory survey by Mukonyi *et al.* (2005) and other previous field assessments on aloes in general. Sampling procedures for the inventory were modified from methods used for non-wood forest products, taking into consideration species habits, sizes and distribution.

Optimal harvesting regimes of the species were conceived on the basis of information gathered from the surveys, taking cognizance of the national legal provisions governing the conservation and management of the species. Generally, the IUCN checklist for NDF has been extensively referred to in the process of developing the strategy for conservation and management of commercial aloes in Kenya**.**

Criteria, parameters and/or indicators used

Final assessment of the impact of commercialisation on species was made in consideration of distributions of species, biological characteristics such as growth habit, potential for regeneration, ecological resilience and tolerance to human disturbance. In order to gauge sustainability of harvesting, information on both legal and illegal trade at domestics and international scales were assessed. Trade statistics were sourced from previous surveys (NAREDA) and from informants in commercial aloe producing centres.

Main sources of data and analysis used (including field evaluation or sampling methodologies)

The following are the sources of data used in making NDF on the commercial *Aloe* species in Kenya. The same methodologies used to generate the data shall continue to be used when undertaking future NDFs on the species.

a) Aloe inventory report: Status and distribution of Commercial aloes in Kenya (Mukonyi *et al.* 2005)

This is a field assessment that focused on all districts of Kenya where aloes are exploited on commercial basis. During this survey the research team established the national distribution and abundance of species, harvesting and processing techniques, approximate yields per season as well as wild and cultivated sources of aloes. Based on the information gathered, recommendations were made of appropriate adaptive conservation and utilization approaches for target species.

The aloe inventory exercise was a pioneer study for which methodology is not standardised. Therefore, in consideration of growth forms, patterns, sizes and distribution, methods of sampling for quantification were modified from those used for non-wood forest products. Cluster sampling method was adopted for predominantly suckering species-*A. turkanensis, A. scabrifolia, A. rivae* and *A. calidophila* while total counts approach was adopted for *A. secundiflora*

Information was collected on entities involved in commercial aloe domestication programs and projections made of current and potential production levels. Interviews were carried out to establish initiatives made towards sustainable utilization of the aloes, the distribution of critical masses of the species as well as the land tenure system in aloe-rich localities. Harvesting methods and the market chain in the commercial aloe industry has been documented as a basis for current and future comprehensive NDF studies.

b) Export permits issued for export of the commercial aloe species and their derivatives. This documentation is kept by the Kenya Wildlife service which is the Management Authority for Kenya.

c) Review of Significant Trade report on East African aloes to the CITES Plants Committee; CITES PC14 Do.9.2.2 Annex 4. This paper draws from a survey by Oldfield (2003) in which trade statistics for the aloes in east Africa were reviewed. On the basis of trade data, it was concluded that significant levels of trade occur on aloes in the region exists. However, the trade is poorly documented and difficult to quantify.

d) Field assessments on the conservation status and economic potential of the genus *Aloe* in Kenya. This is an unpublished report by Wabuyele (2004) based on field surveys in the main aloe producing areas of Kenya. The survey documented distribution, use and threats to aloes in the country.

e) Studies on Eastern African aloes: Aspects of taxonomy, Conservation and ethno-botany. This is a comprehensive study of regional aloes based on PhD studies from 2003 to 2006.

Evaluation of data quantity and quality for the assessment

Data obtained from the outlined sources was analyzed to determine suitability and approvals for establishing *Aloe* Management Units (AMUs) as entities for controlled and sustainable harvesting of target species from the wild for commercial trade.
The data was used to develop the national strategy for conservation and management of the commercial aloe species in Kenya published in July 2008.

Applications for exports from these AMUs will be compared with the expected levels of production as stipulated in the Management Plans for the species to ensure compliance and enforcement. Regular field assessments shall be undertaken for purposes of monitoring any changes to the species population status and impact of management so as to provide feedback and timely adjustment to the management plan.

Main problems, challenges or difficulties on elaboration of NDF

The major challenge in the elaboration of NDF studies on the commercial aloe species in Kenya is inadequate information on aspects such as auto-ecology, demography and population dynamics especially in areas not covered under the inventory and mapping exercise. The methods adopted in sampling may require further testing and validation. In addition the discrete nature of hitherto illegal trade in specimens of the commercial aloes hampers systematic documentation of trade volumes and market trends thus making it difficult to assess the levels of harvest and the impact of trade on the natural populations.

Recommendations

The IUCN checklist for NDF studies is a practical tool applicable to the case of commercial aloes in Kenya. Efforts shall therefore be made to use the checklist combined with other guidelines and methodologies and procedures to formulate future NDFs for the species. For efficient implementation of the Kenya Strategy for conservation and management of commercial aloes as a management plan and make it as adaptive as possible, it will be crucial to obtain baseline information that will enable future monitoring of the impact of off-take on natural populations. It is recommended that:

- Detailed studies are carried out on the five species to establish pertinent information as relates to spatial and genetic structure and dynamics of populations. Data accruing from such studies will ehance objectivity in application of the IUCN Checklist for NDF on these species.
- In addition, it will be crucial to develop efficient identification and authentication tools for the various commercial species and their products for surveillance at the ports of exit from the country.

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SUSTAINABLE USE OF EAST AFRICAN *ALOES*: THE CASE OFCOMMERCIAL ALOES IN KENYA

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Aloes are a common feature of dryand ecosystems in many parts of Africa, with large diversity of species in Southern Africa, Eastern Africa and on the Island of Madagascar. In both traditional and modern times, aloes are popular for use as therapeutic agents in the treatment of livestock and human conditions. A few species like *A. vera* and *A ferox* are traded in large volumes on international markets. Of the sixty taxa found in Kenya, five have recently been identified as being of high potential for commercial harvesting. One of the species, *A. secundiflora* is widespread in Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda; both *A. calidophila* and *A. rivae* occur only in Kenya and Ethiopia, while *A. scabrifolia* is endemic to Kenya. All East African aloes are listed on Appendix II of CITES.

Although commercial harvesting of aloes was banned following a Presidential Decree in the mid 1980s, pertinent data was unavailable for monitoring. In addition, enforcement of the Ban was difficult in the absence of proper policy guidelines. In recognition of the economic potential of aloes, national stakeholders sought to generate baseline information on the *Aloe* resource base in Kenya. A mapping survey was conducted in 2005 in districts where aloe harvesting had been reported. Sampling procedures for the inventory were modified from methods used for non-wood forest products.

On the basis of information generated on this and previous studies, a Non-detriment assessment (NDF) was conducted on the five species found to be in (illegal) trade. The NDF study systematically followed the IUCN checklist for the process (Rosser, 2008) in which qualitative assessments were augmented by quantitative data. Optimal harvesting regimes for the species were conceived on the basis of information gathered from the surveys, taking cognizance of the national legal provisions governing the conservation and management of the species. Final assessment of the impact of commercialisation was based on species distributions, growth habit, potential for regeneration, ecological resilience and tolerance to human disturbance. In order to gauge sustainability of harvesting, information on both legal and illegal trade at domestic and international scales were assessed. Trade statistics were sourced from market reports and from informants in commercial aloe producing centres.

Data obtained from the outlined sources was analyzed to determine protocols for establishing so-called *Aloe* Management Units (AMUs) as entities for controlled and sustainable harvesting of target species from the wild. In addition a National Strategy was formulated and launched in 2008 to guide implementation of aloe utilisation guidelines in sustainable utilisation of aloes. The Strategy as a Management Plan for Kenyan aloes prescribes systems, procedures and institutional arrangements for sustainable management of the species in accordance with the national legislation on wildlife and international obligations regarding international trade in wildlife species and their derivatives.

The major challenge in the elaboration of NDF studies on commercial aloes in Kenya is inadequate information on aspects such as auto-ecology, demography and population dynamics. In addition the discrete nature of hitherto illegal trade in aloes hampered systematic documentation of trade volumes and market trends thus making it difficult to assess the levels of harvest and the impact on the natural populations.

For efficient management of aloe trade in Kenya, it will be crucial to obtain baseline information that will enable periodic monitoring of the impact of off-take on natural populations. It is recommended that detailed studies are carried out on the aloes in trade to establish spatial and genetic structure and dynamics of populations. Data accruing from such studies will enhance objectivity in application of the IUCN Checklist for NDF on these species. In addition it will be crucial to develop efficient identification and authentication tools for the various species and their products for surveillance at the ports of exit from the country.

CYCADALES SPP. IN CHIAPAS, MEXICO (*CERATOZAMIA MIRANDAE*).

AUTHOR:
Miguel Angel Pérez Farrera

I. Background information on the taxa

1. BIOLOGICAL DATA

1.1. Scientific and common names:

Ceratozamia mirandae Vovides, Pérez-Farrera &Iglesias Amenduai

1.2. DISTRIBUTION

Ceratozamia mirandae is endemic to the Sepultura Biosphere Reserve along the west of Sierra Madre of Chiapas (figure 1). It grows in Oak forest and evergreen cloud forest between altitudinal ranges from 900 to 1,200 meters above sea level.

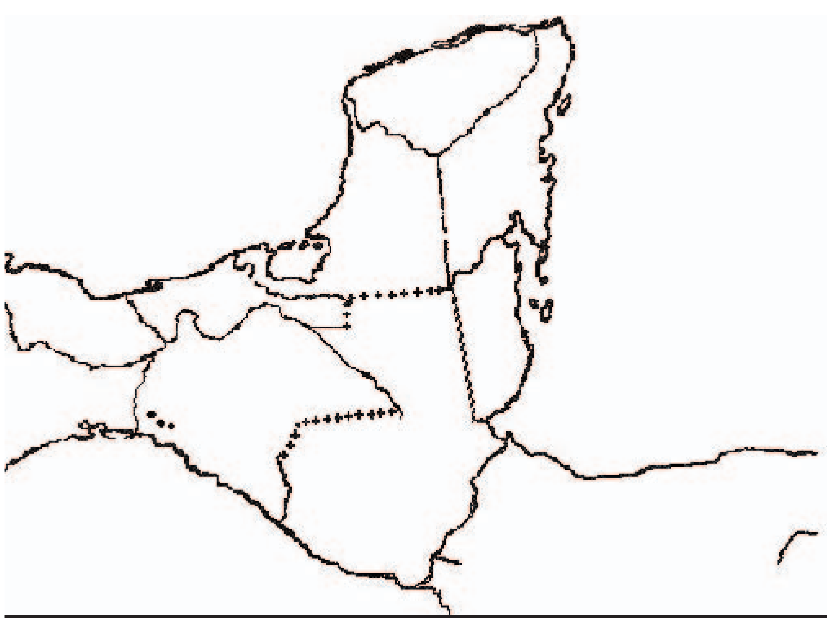

Figure 1. Distribution of *Ceratozamia mirandae*

1.3. Biological characteristics

Perennial dioecious long-lived tree.

1.3.1. *General biological and life history characteristics of the species*

Ceratozamia mirandae is a medium to large sized under-story cycad in pine-oak forests with trunks up to one meter long which are erect or prostrate topped with an ascending to spreading crown of up to 23 pinnate leaves approximately 1.5 m long and 70 cm wide (Vovides et al. 2001) (figure 2). It is dioeceous (consisting of male and female plants). An individual of this species between 80–90 cm tall can to reach up tp 490 years (Pérez-Farrera et al. 2006) (table 1). The species is entomophilous which accords with that reported by De La Cruz (1999) and only langurid beetles have been observed (figure 3). The female cone cycle is approximately one year from initiation, pollination to dehiscence. The size based population structure of this species corresponds to a type I curve according to Bongers et al. (1998) or "J" or Deevey type III curve, where there are more seedlings and juveniles than adults. Seed production and recruitment is relatively high with over 80% germination of seeds and the female cones produce from 74 to 170 seeds. The spatial distribution is non-random and aggregated with a preference to shallow rocky soils. Most seedlings, juveniles and seeds were located at the bases of steep slopes of over 40º, where we assume to be related to dispersal by gravity. In some relatively flat areas inside the study transect, seedlings and seeds were found located around the mother plant and under tree canopy providing shade. This suggests poor dispersion and/or seedling survival associated with tree and mother plant shade, which is a principal factor to the first phases of establishment and development (Pérez-Farrera et al. 2000; Perez-Farrera and Vovides 2004). Mortality is high during the seedling stages of the life history due to the prolonged droughts and fires in its habitats as well as seed predation by the Pecari *Tayassu tajacu* may also play an important role in the first phase of the colonization of other sites of oak forest. The sex ratio is approximately 9:1 male/female respectively but this can be deceiving since male plants cone more frequently than females, hence a greater presence of coning males at any given time.

Figure 2. *Ceratozamia mirandae* in the Sepultura Biosphere Reserve

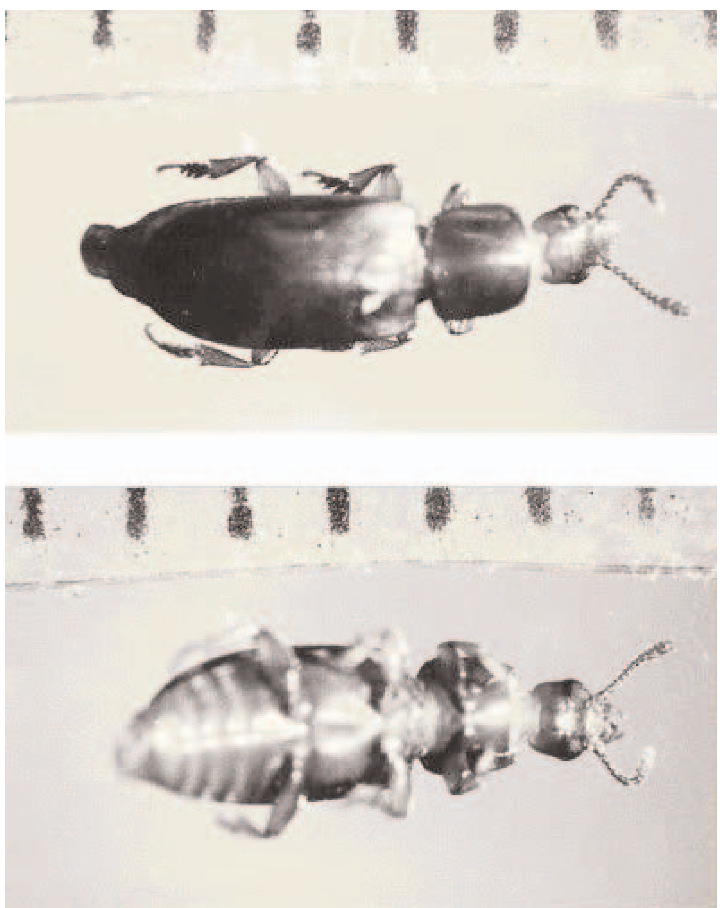

Figure 3. Pollinators of genus *Pharaxonotha* collected on microsporophyll of male cone of *Ceratozamia mirandae*

The finite growth rate Ï (lambda) in *Ceratozamia mirandae* analyzed in a populations in the buffer zone population in the Sepultura Biospere Reserve showed a tendency for decrease whilst in the nucleus zone this estimate remained stable. The highest elasticity values were in the transition of the first three classes of the “La Sombra” population (buffer zone) (figure 4), in “Tres Picos” (nucleus zone) this corresponded to adult plants between 20 and 30 cm tall (figure 5). Given the above, it is proposed that in the nucleus zone, reproductive adults should be of highest conservation priority, whereas in the buffer zone seedling reintroduction should be carried out regularly until the population increases (Pérez-Farrera *et al*. 2006).

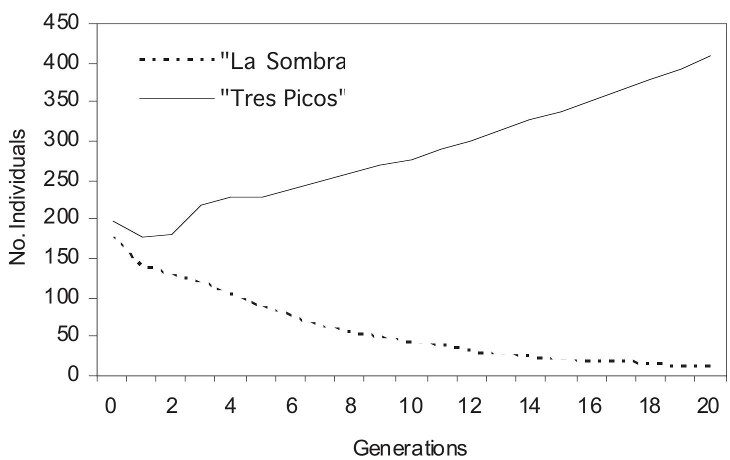

Figure 4. Population projection of two the populations of *Ceratozamia mirandae* in the *Sepultura Biosphere Reserve*

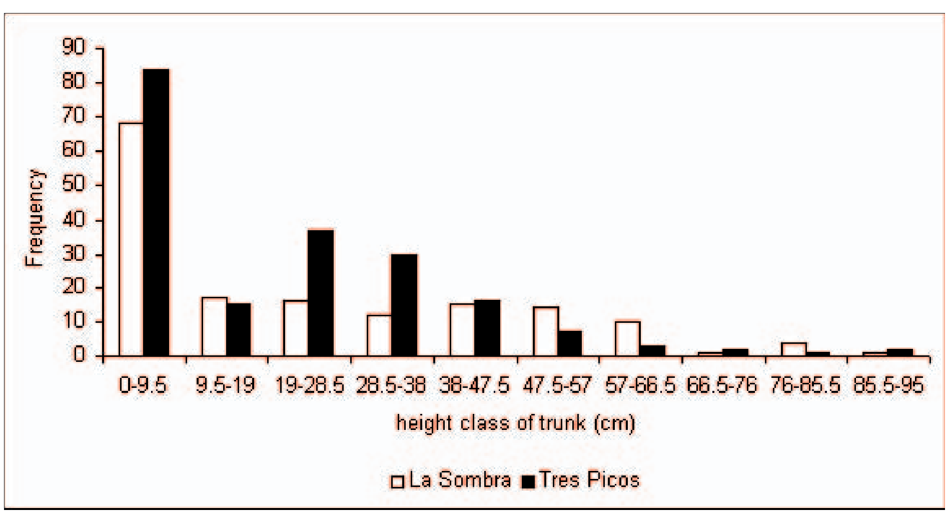

Figure 5. Height class population structure of the two populations of *Ceratozamia mirandae* in the *Sepultura Biosphere Reserve*

The genetic diversity and heterozygosity mean between populations were relatively low (h =0.18; H = 0.29) while the gene flow and percentage of polymorphic loci mean between population pairs was found to be relatively high (*Nm* = 3.68; %P = 67.2). The gene flow between population pairs was significantly correlated with altitude differences (Mantel r = 0.57 p = 0.10, n = 10) (Pérez-Farrera, 2005).

Height Class (cm)	Mean total bases	Increment	Mean leaves /year	Residence	Age (year)
0–10	42.6		1.44	30	30
10–20	123.07	80.5	1	80.5	110.5
20–30	565.68	442.61	2.5	117	227.5
30–40	985.71	420.03	3.67	114	341.5
40–50	1408.2	422.46	7	60.4	401.9
50–60	1721.2	313.05	7.8	40.1	442
60–70	1985	263.77	12	22	464
70–80	1996.1	11.15	16	0.7	464.7
80–90	2523.5	538.48	21.6	24.9	489.6

Table 1. Age estimation of C. mirandae based on mean annual leaf production per size class and the mean total number of leaf bases present on trunks per height class. Leaf production data obtained from 181 individuals in the transect over a period of 3 years at “Ejido La Sombra de la Selva”, Sepultura Biosphere Reserve, Chiapas, Mexico

1.3.2. *Habitat types*

The vegetation type of this cycad’s habitat is mainly oak/pine forest as described by Rzedowski (1978), with an open forest canopy (72–89% cover) on a 40% slope at an elevation of 950 m, dominated by *Quercus elliptica* Neé and *Pinus oocarpa* Schiede, together with less common species such as *Rapanea myricoides* (Schltdl.) Lundell and *Ternstroemia tepezapote* Cham & Schltdl. The shrub layer is dominated by Miconia glaberrima (Schltdl.) Naudin, *Calliandra hirsuta* (GDon) Benth., Canavalia hirsuta Standl. The soil type of this habitat is an acid grey-brown humic cambisol (Cmu) consisting of a loamy-sandy clay texture with abundant surface humus (Vovides *et al*. 2001).

Botanical explorations in other parts of the Sierra Madre de Chiapas have resulted in the discovery of other populations of Ceratozamia mirandae in other vegetation types such as semi-deciduous tropical rain-forest, deciduous tropical forest and cloud-forest as described by Rzedowski (1978). These habitats are all within a range of altitude between 910 to 1,300 meters (Vovides et al. 2001).

1.3.3. *Role of the species in its ecosystem*

It can be considered to occupy the herbaceous to mid strata levels of the oak forests. It sometimes can to be abundant. However every year, forest fires affect the populations; adult plants survive and are benefited by a temporary release of minerals into the ecosystem, but the seedlings do not survive. Also like all cycads, *C. mirandae* fixes atmospheric nitrogen through coralloid roots in association with cyanobacteria. The cycad is also the host for the butterfly (*Eumaeus debora*) during the larval stages when it feeds on leaves and sometimes sporophyll tissue of the female cone. The beetle pollinators, though still not yet identified, are thought to be specific.

1.4. Population:

1.4.1. *Global Population size*

We have observed that this species is distributed on both the Pacific and inland slopes of the Sierra Madre de Chiapas in five municipalities. However, the pine-oak forests that are the cycads principal habitat are rapidly being transformed by slash-and-burn agriculture techniques by subsistence farmers. This activity, though of a lesser extent within the Biosphere reserve, is rendering the cycad an endangered species. During the exceptional drought of 1998, forest fires have affected the cycad populations, including the locality studied within the La Sepultura Biosphere Reserve and biodiversity generally throughout the state of Chiapas. We estimate between 1000 to 2000 plants. We recommend an IUCN Red List category of Vulnerable (VU C, 2a), largely due to difficult-to-control destructive annual forest fires that occur in this Reserve (Vovides *et al*. 2001)

1.4.2. Current global population trends:

___increasing __X_decreasing in one population (by fires)

__X_ stable in two ____unknown in most

1.5. Conservation status

1.5.1. *Global conservation status (according to IUCN Red List):*

___Critically endangered ___Near Threatened

___Endangered ___Least concern

_X_Vulnerable ___Data deficient

1.5.2. *National conservation status for the case study country*.

Amenazada (A) = threatened in the NOM (Norma Oficial Mexicana). We propose En Peligro de Extinción (P) = Endangered.

1.5.3. *Main threats within the case study country*

___No Threats
_X_Habitat Loss/Degradation (human induced)
___Invasive alien species (directly affecting the species)
X__Harvesting [hunting/gathering]
___Accidental mortality (e.g. Bycatch)
___Persecution (e.g. Pest control)
___Pollution (affecting habitat and/or species)
X__Other. Fires and illegal collecting
___Unknown

2. SPECIES MANAGEMENT WITHIN THE COUNTRY FOR WHICH CASE STUDY IS BEING PRESENTED

2.1. Management measures

A program of conservation and propagation began through establishment of three nurseries *in situ* with three communities in the buffer zone in the Sepultura Biosphere Reserve in collaboration with personnel of this reserve, Universidad de Ciencias y Artes de Chiapas (UNICACH) and campesinos.

2.1.1. *Management history*

During period 1995 to 1996 three group of campesinos were invited to collaborate in a pilot project of the Instituto de Historia Natural for the conservation and propagation of *Ceratozamia mirandae* through establishment of nurseries *in situ* with financial support of CONABIO (National Commission for the Knowledge and Use of Biodiversity). Later, the project was taken up by the school of biology at Universidad de Ciencias y Artes de Chiapas 1997 during 1998 to 2000 with financial support from Fondo Mexicano para la Conservación de la Naturaleza, MAB-Tropical Ecosystem Directorate and U.S. Fish and Wildlife Service No. 99 G350, Fauna and Flora International and GTZ-Germany PN93.2208.2-06.201. A nursery was established in Ejido Nueva Independencia, another in Ejido Tres Picos and a further one in ejido La Sombra de la Selva. They received official permits in 1998 from SEMARNAT in order to operate as a non-forest products nursery that became the forerunners to the concept of UMAS for plants (Unidades de Manejo y Aprovechamiento de la vida Silvestre) or wildlife management units (INE-SEMARNAP. 2000). During 1997 to 1998 demographic studies were under development along with taxonomic studies (Vovides et al. 2001; Pérez-Farrera *et al*. 2006). The farmers were being trained on basic horticultural and nursery management with continuous assessment. The original idea is to harvest seed from mother plant, sow and cultivate the plants in order to provide and additional alternative income for the farmers and at the same time the farmers are obliged to protect the habitat from poachers and loggers (Vovides & Iglesias, 1994; Vovides *et al*., 2002). Often, accidental fires or agriculture activities burn the oak forests where *Ceratozamia mirandae* grows. The farmers became concerned about this practice, and after the project began the fires deceased.

2.1.2. *Purpose of the management plan in place*

The main objective of this project is to diminish the pressure for field collecting and illegal traffic through the establishment of *in situ* nurseries. This way, economic incentives are created through the propagation and sale of plants leading to habitat conservation, by this system of harvesting seeds from habitat mother plants. Seedlings are sold and a percentage will be re-introduced back into habitat for conservation of the population. The monitoring process can to continue through the collaboration between the farmers and reserve personnel.

2.1.3. *General elements of the management plan*

The farmers are organized through small group (5 to 8 persons). Each farmer collect seeds in their "Predio" or land but they all collect together. Originally when the project began each farmer established his nursery in his "patio". A condition set by SEMARNAT is that 5 to 10% of the seedlings produced must be re-introduced back into habitat and to establish one ejidal nursery. The SEMARNAT authority requires a management plan where the nursery area is specified, availability of water and other infrastructure. As part special permission they must inventory the approximate number of seeds to be harvested per year, number of plants to be cultivated and an inventory of plants under cultivation, sold, deaths etc. Annual reports are required for permit renewal.

2.1.4. *Restoration or alleviation measures*

In 1999 and 2000 the farmers reintroduced 10% of the total production from 1997 to 1998. The seedlings reintroduced were three years old. These were reintroduced back into the oak-forest habitat. A reintroduction experiment has been established, and the monitoring of plants is in process.

2.2. Monitoring system

2.2.1. *Methods used to monitor harvest*

Normally each female cone is bagged with a mesh bag and tied at the peduncle. When the female cone is dehiscent, the seeds are collected and after storage in a bag with sand and seeds are monitored for embryo maturity (within 9 months) in order to observe if the seeds have matured and are ready for sowing. The monitoring of female cones is made by a farmers group from the same town who keep guard to prevent anyone from collecting seed, seedlings, or adult plants. They also monitor fires in the forest by agriculture activities and they only collect mature seed and never immature cone. The campesinos have received training about identification, collection, and processing of seed, and propagation of seed. When the farmers detect anything unusual, they made a report to SEMARNAT (Secretaría del Medio Ambiente y Recursos Naturales). To collect seed the farmers have organized themselves into groups according to their "Parcelas o Terrenos".

2.2.2. *Confidence in the use of monitoring*

The female and male cone are monitored before pollination. When pollination occurs the females are constantly monitored. Upon cone dehiscence the seeds are collected. The female cone cycle is one year since female cone emerging until that it is dehiscent. The seeds are then stored for a further 9-12 months pending embryo maturity (Pérez-Farrera & Vovides, 1997).

2.3. Legal framework and law enforcement

As a cycad, *Ceratozamia mirandae* is covered by the Norma Oficial Mexicana (national) NOM-059-2001 and CITES (international) legislation. SEMARNAT give special permission to transport, collect, propagate and trade cycads in Mexico by all established UMAS (environment management units). All plants and seedlings propagated from mother plants must have an official label with the nursery and permit number displayed. Breaching of these laws is considered a federal crime with heavy fines and/or imprisonment.

3. UTILIZATION AND TRADE FOR RANGE STATE FOR WHICH CASE STUDY IS BEING PRESENTED

3.1. **Type of use** (origin) **and destinations** (purposes)

In famine time the seeds of *Ceratozamia mirandae* were consumed by farmers in the Frailesca region, but now it is no longer a famine food. The farmer uses the species as an ornamental plant. Sometimes the leaves of *C. mirandae* are cut to adorn some religious event or festivity in some towns in the Frailesca region.

3.2. Harvest:

3.2.1. Harvesting regime

The seeds are collected once a year. However they only have collected seeds during period 1998 to 2000. The collection of seeds is manual. The collecting program was interrupted because permits had expired. However in 2008 SEMARNAT renewed the special permission in order to continue with the collecting program and the same institution awarded financial support for the continuation of the project. They have selected collection areas and conservation areas where seed may be collected. Often the collection is made from August to October and frequently one or two time per month

3.2.2. Harvest management/ control

The UMAS permit covers harvesting of seed, there are no set quotas nor seasons stipulated.

3.3. Legal and illegal trade levels

The nurseries have produced about 15,000 seedlings. They have made a sale to *Cycadmania* in the USA. Also they have made some sales at national events such as national flower exhibitions in Mexico City with sales of about $ 30,000 pesos during 2001. However, sales are not constant. During the period 1998 to 2000 they collected about 5,000 seeds per year. No exports have occurred recently, nor do we have details on illegal trade.

II. Non-detriment finding procedure (NDFs)

1. IS THE METHODOLOGY USED BASED ON THE IUCN CHECKLIST FOR NDFS?

__yes _X_no

2. CRITERIA, PARAMETERS AND/OR INDICATORS USED

Anecdotal and empirical, based on experience at the ejidales nurseries.

3. MAIN SOURCES OF DATA, INCLUDING FIELD EVALUATION OR SAMPLING METHODOLOGIES AND ANALYSIS USED

A demographic study was made during period 1997 to 2000. It included population structure, mortality, recruitment, phenology, spatial distribution of two populations in the Sepultura Biosphere Reserve. This information was used as basis for management. However no information has yet been generated for the reintroduction program. About 1500 seedlings have been reintroduced to their habitat (oak forest). The seedlings were planted 1 to 2 meters distance between seedlings.

4. EVALUATION OF DATA QUANTITY AND QUALITY FOR THE ASSESSMENT

Percentage of germination, number of seedlings obtained, number of seedling established in the first, second and third year, number of seedling sales, organization of the nursery

5. MAIN PROBLEMS, CHALLENGES OR DIFFICULTIES FOUND ON THE ELABORATION OF NDF

If the information provided is what is sought then no difficulty was experienced in the elaboration of the case study.

The main problems have been the organization of the campesinos groups, coordination between them, communication difficulties because the ejidos do not have efficient communication infrastructure such as telephones and roads. Contacting the farmers for meetings has been very complicated. Also, difficulty was experienced in obtaining sufficient long-term funding.

6. RECOMMENDATIONS

It is very important to include a sociologists or anthropologists to solve organizational and communication problems between the farmers. Also long-term funding to this type of lengthy projects is important. Marketing specialist for sales and export are needed as well as a closer collaboration with Reserve personnel and other national authorities such as SEMARNAT and PROFEPA.

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NDF WORKSHOP
WG 3 – Succulents and Cycads
CASE STUDY 2 SUMMARY
Ceratozamia mirandae
Country – **Mexico**
Original language – English

CYCADALES SPP. IN CHIAPAS, MEXICO (*CERATOZAMIA MIRANDAE*).

AUTHOR:
Miguel Angel Pérez Farrera

The management and conservation of the cycad *Ceratozamia mirandae* in the Sepultura Biosphere Reserve was made on base eight years of demographic, genetic and systematic studies and working with farmers or "ejidatarios" in three communities of this reserve. The harvesting of seeds of mother plants was made according to the demographic studies that show a high mortality and seed loss in the natural populations due to dry season and accidental fires. The training of farmers on basic horticultural practices has been important for the establishment of nurseries. 10% of three year old seedlings produced in the nurseries was reintroduced when the nurseries were established for four years.

The nurseries are now in their 13th year and there have been some regional, national and international sales that benefited the farmers but inconsistently. However, the cycad habitat is being conserved and illegal collecting has been discouraged. The following recommendations are crucial to projects of this type:

1. It is very important to include a sociologists or anthropologists to solve organizational and communication problems between the farmers.

2. Solidarity between the farmers and assessors is important.

3. Long-term funding to this type of lengthy projects is important.

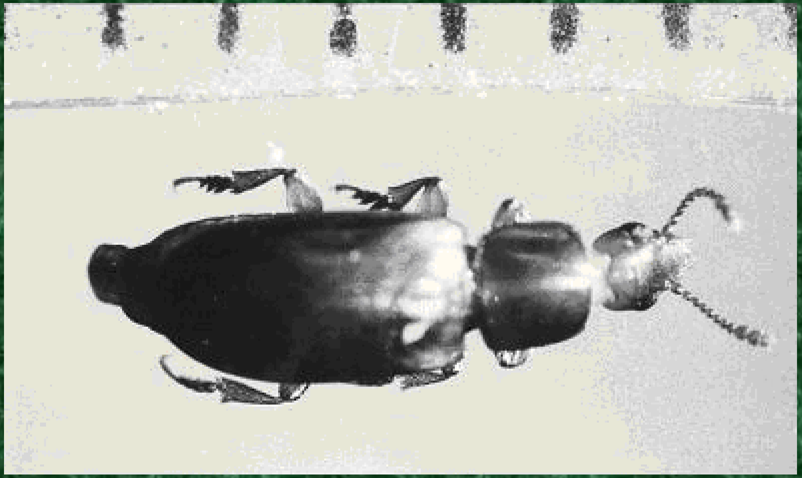
4. Marketing specialist for sales and export are needed

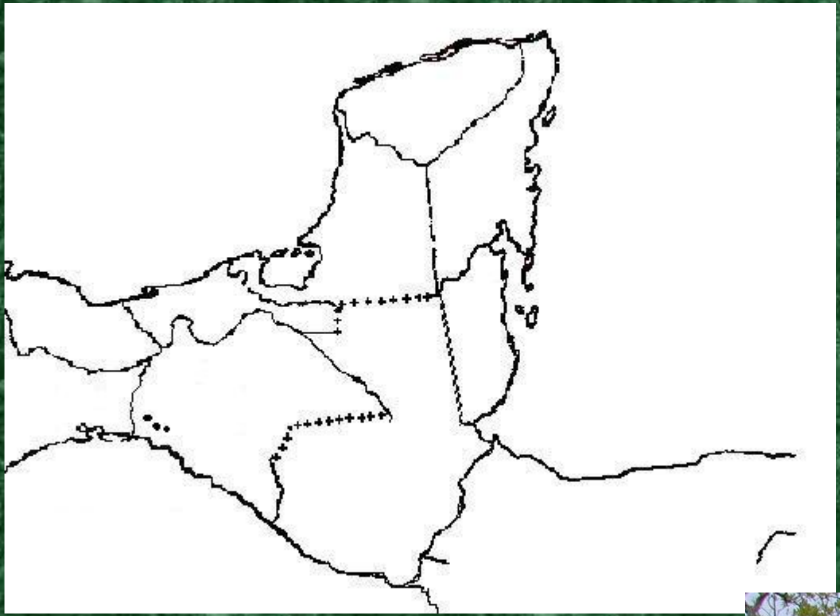
5. Closer collaboration with Reserve personnel and other national authorities such as SEMARNAT and PROFEPA to continue to monitoring the habitat of this cycad

Ceratozamia mirandae

Miguel A. Pérez-Farrera

Ceratozamia mirandae is a medium to large sized with trunks up to one meter long which are erect or prostrate topped with an ascending to spreading crown of up to 23 pinnate leaves approximately. It is is entomophilous which accords with that reported by De La Cruz (1999) and only langurid beetles have been observed





Ceratozamia mirandae is endemic to the Sepultura Biosphere Reserve along the west of Sierra Madre of Chiapas. It grows in Oak forest and evergreen cloud forest between altitudinal ranges from 900 to 1,200 meters above sea level

The pine-oak forests that are the cycads principal habitat are rapidly being transformed by slash-and-burn agriculture techniques by subsistence farmers. This activity, though of a lesser extent within the Biosphere reserve, is rendering the cycad an endangered species.

During the exceptional drought of 1998, forest fires have affected the cycad populations, including the locality studied within the La Sepultura Biosphere Reserve

Systematic studies

Botanical Journal of the Linnean Society (2001), **137**: 81–85. With 2 figures
doi:10.1006/bojl.2001.0459, available online at http://www.idealibrary.com on IDEAL®

Another new species of *Ceratozamia* (Zamiaceae) from Chiapas, Mexico

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Ceratozamia mirandai sp. nov. from the Sepultura Biosphere reserve of Chiapas, Mexico, is described and illustrated. Its closest affinities are with *C. kuesteriana* Regel from Tamaulipas of north-east Mexico, but differs in male and female cone and trunk morphology.

ADDITIONAL KEY WORDS: biosphere reserves – *Ceratozamia kuesteriana* – Chiapas – Cycad – Mesoamerica – Pleistocene refuges.

INTRODUCTION

The genus *Ceratozamia* or 'horned *Zamia*' as the name suggests, is largely restricted to Mexico, with an outlying species (*C. robusta* Miq.) in Guatemala and Belize. Recently a *Ceratozamia* species has been reported from Honduras (Whitelock, pers. comm.). Much of our knowledge of the distribution of *Ceratozamia* in its native Mexico is due to the early exploratory work of Chamberlain (1919). In recent years information on the genus has been greatly expanded by workers from Mexico and Italy (Norstog & Nicholls, 1997; see also Balduzzi, De Luca & Sabato, 1981–82 and Moretti & Sabato, 1988). The genus is found mainly in dense moist tropical woodlands, such as cloud-forests, evergreen tropical rain-forests and also in mid-elevation oak/pine forests. *Ceratozamia* is much like some robust species of *Zamia* and according to Crane (1988) *Ceratozamia*, *Zamia* and the Cuban endemic *Microcycas* are phylogenetically related. Some *Ceratozamia* species are basically arborescent with stems rarely more than about 1 m tall, often leaning or curved and rarely branching. Others are semi-hypogeous and often branching.

During botanical explorations and conservation studies in the recently established Biosphere Reserve of the Sierra Madre (Chiapas) we collected a *Ceratozamia* specimen with a thick, arborescent, branched trunk with large leaves and cones. We first considered that this taxon formed part of the wide species concept of *Ceratozamia norstogii* of Stevenson (1982) and Jones (1993). However, further explorations at the type of locality of *C. norstogii* and other populations of this species in the states of Chiapas and Oaxaca, as well as examination of the type of *C. norstogii* (see preceding paper pp. 77–80) we came to the conclusion that we had collected an unrelated new *Ceratozamia* species.

SPECIES DESCRIPTION

Ceratozamia mirandai Vovides, Pérez-Farrera & Iglesias sp. nov.
(Figs 1, 2)

Truncus primum semiglobosus demum cylindricus, grandis, ramosus, humilis, 32–106 cm altus; cataphylla lanata, triangularia, stipulata; folia pinnata; petiolus 22–59 cm longus; rachis 70–115 cm longa, petiolus et rachis recta; foliola opposita ad subopposita, 49–82-juga, linearia; strobilus masculinus lineari-cylindricus 26.5–57 cm longus, pedunculus tomentosus 3–11.5 cm longus; strobilus femeninus 26–48 cm longus, pedunculus tomentosus, 5.5–14 cm; semina 2.3–2.7 cm longa. Affinis *Ceratozamiae kuesterianae* Regel.

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The cycad *Ceratozamia norstogii* D.W. Stev. (Zamiaceae) from southern Mexico: new information on distribution, habitat and vegetative morphology

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The type locality in Chiapas of the rare and endangered Mexican cycad *Ceratozamia norstogii* D.W. Stev., originally collected by C. A. Purpus in 1925, has been found. This enabled us to emend and illustrate the description of *C. norstogii*, thus clearing up some confusion surrounding the concept of this species. We believe the confusion arose owing to a composite herbarium voucher consisting of unrelated material from apparently different physiographic regions of Chiapas. Two further localities for *C. norstogii* have also been discovered, one in the neighbouring state of Oaxaca. Additional information on its habitat and distribution is presented.

ADDITIONAL KEY WORDS: *Ceratozamia kuesteriana* – *Ceratozamia zaragozae* – Chiapas – Cycadales – Mesoamerica – Oaxaca.

INTRODUCTION

While preparing a revision of the genus *Ceratozamia* in the state of Chiapas, we encountered some difficulty with the species concept of *C. norstogii sensu* Stevenson (1982). Stevenson had reported the distinctive characters of this species as being short stemmed (less than 50 cm), leaflets strongly rolled, parallel to the longitudinal plane and with straight petioles and rachis. He related it to *Ceratozamia zaragozae* Medellin, which has a spirally twisted rachis with flat, straight to falcate leaflets and is restricted to the state of San Luis Potosí in north-eastern Mexico. From this description we find little affinity between the two taxa. However, his description of *C. norstogii* appears to be more applicable to *C. kuesteriana* Regel from Tamaulipas.

Unfortunately, Stevenson (1982) based his description on herbarium specimens and, at best, on cultivated plants. He was hampered by not being able to examine the plants in their natural habitat, especially that of the type cited below:

Holotype cited (Stevenson, 1982): CHIAPAS: leaves and megasporophylls with immature ovules, *C.A. Purpus 6*! iii–iv. 1925 (US) isotypes US, F. The following paratypes were also cited: CHIAPAS; *Purpus 10006*! 24. ix. 1922 (UC); UNITED STATES. CALIFORNIA; (cultivated material) *Chamberlain s/n*! 13. ix. 1937 (F). FLORIDA; (cultivated material) a male cone collected by *Stanley K. Kiem s/n*! 14. vi. 1971 and leaves added at a later date to this voucher by *J. Watson s/n*! 26. vi. 1981 (FTG); A female cone and seed from a cultivated plant at FTG was also cited (access no. 69-421B) that is no longer available.

REVISION OF MATERIAL AND FIELD STUDIES

During this study the above mentioned vouchers were examined and also extensive field studies carried out, especially at the type locality and surrounding areas. We came to the conclusion that the description in Stevenson (1982) was based upon various herbarium vouchers of distinct taxa and populations, thus giving rise to a confusion in the species definition of *C. norstogii*. The leaf voucher of *J. Watson s/n* corresponds

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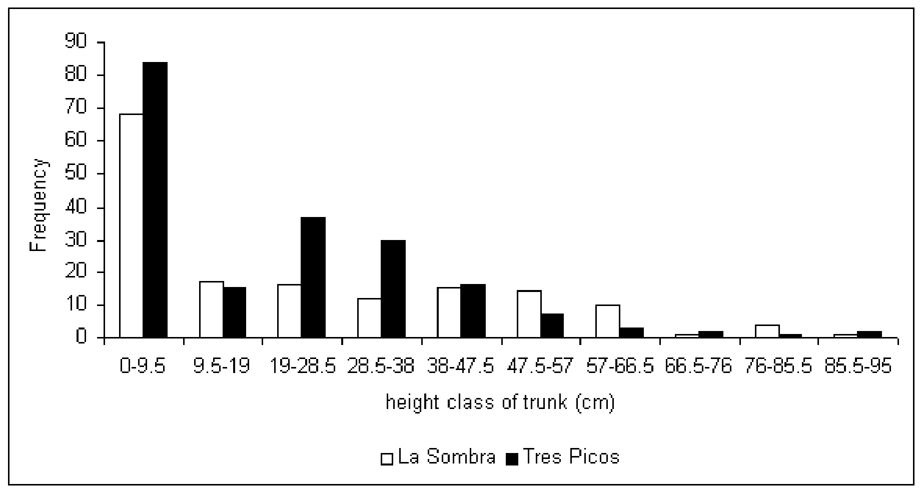
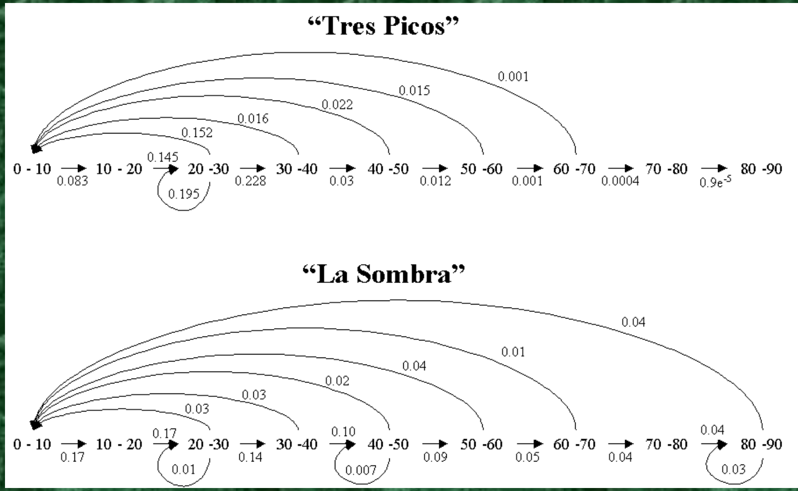
0024–4074/01/090071+06 $35.00/0

Demographic studies





Mortality is high during the seedling stages of the life history due to the prolonged droughts and fires in its habitats

Table 1. Demographic parameters of the two populations of *C. mirandae* in the *Sepultura Biosphere Reserve*. r: intrinsic population growth rate; R_0: net rate of population turnover; λ: finite population growth rate estimated from life table data; V_x: reproductive value (individuals per female); Ex: life expectancy.

Population	r	R_0	λ	V_x	Ex
"La Sombra"	0.57	5.85	1.77	20 - 30 cm = 11.27	10 - 20 cm = 4.95
"Tres Picos"	0.84	8.2	2.33	10 - 20 cm = 13.18	10 - 20 cm = 4.06

Height Class (cm)	Mean total bases	Increment	Mean leaves /year	Residence	Age (year)
0–10	42.6		1.44	30	30
10–20	123.07	80.5	1	80.5	110.5
20–30	565.68	442.61	2.5	117	227.5
30–40	985.71	420.03	3.67	114	341.5
40–50	1408.2	422.46	7	60.4	401.9
50–60	1721.2	313.05	7.8	40.1	442
60–70	1985	263.77	12	22	464
70–80	1996.1	11.15	16	0.7	464.7
80–90	2523.5	538.48	21.6	24.9	489.6

The sex ratio is approximately 9:1 male/female respectively but this can be deceiving since male plants cone more frequently than females

Mortality is high during the seedling stages of the life history due to the prolonged droughts and fires in its habitats

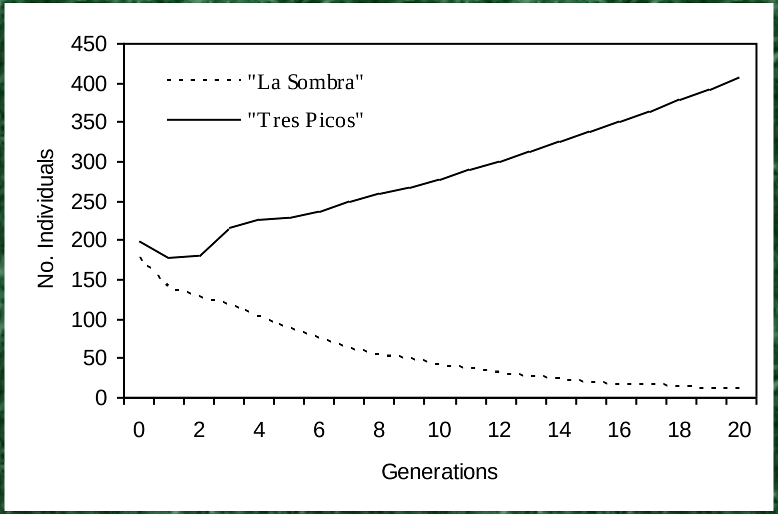


Figure 4. Population projection of two the populations of *Ceratozamia mirandae* in the *Sepultura Biosphere Reserve*

Genetic studies

Cuadro 10. Valores de alelos por locus, diversidad genética, heterocigocidad y porcentaje de loci polimórficos por especie. Los números en negritas corresponden a los valores más altos y bajos.

		na		**A**		**h**		**H**		**P**
Sp/Población	n	M	D.S	M	D.S	M	D.S	M	D.S	%
C. alvarezii	11	1.65	0.48	1.28	0.32	0.18	0.18	0.28	0.25	61.80
C. mirandae **Champerico**	**10**	**1.75**	**0.43**	**1.32**	**0.30**	**0.21**	**0.17**	**0.33**	**0.24**	**75.20**
C. mirandae **Sierra Morena**	**10**	**1.59**	**0.49**	**1.24**	**0.30**	**0.15**	**0.15**	**0.25**	**0.24**	**59.20**
C. norstogii	15	1.75	0.43	1.31	0.32	0.19	0.17	0.31	0.24	75.20
C. **Chimalapas**	**15**	**1.92**	**0.27**	**1.34**	**0.27**	**0.22**	**0.15**	**0.36**	**0.20**	**92.00**
Media	61	1.73	---	1.29	---	0.19	---	0.30	---	72.68

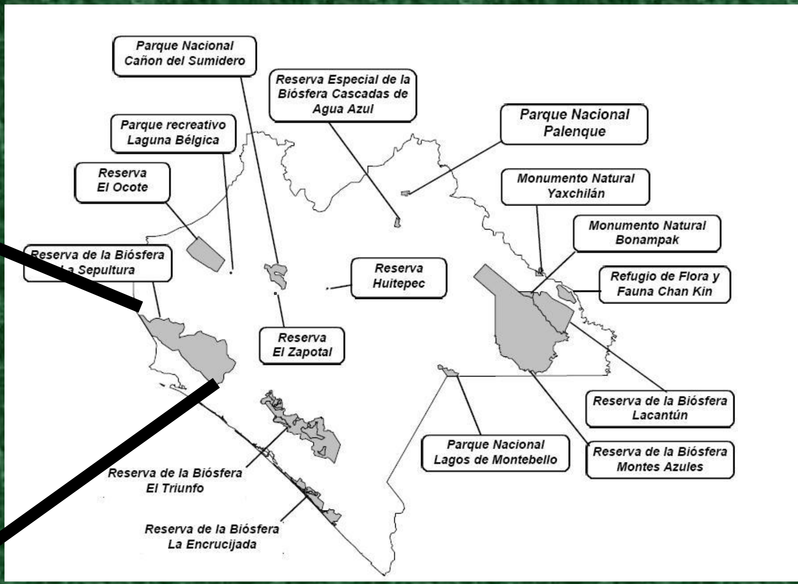
Training with farmers or campesinos or ejidatarios of communities of Sepultura Biosphere reserve

Upon cone dehiscence the seeds are collected. The female cone cycle is one year since female cone emerging until that it is dehiscent. The seeds are then stored for a further 9-12 months pending embryo maturity

Seed production and recruitment is relatively high with over 80% germination of seeds and the female cones produce from 74 to 170 seeds.

The farmers are organized through small group (5 to 8 persons). Each farmer collect seeds in their “Predio” or land but they all collect together. Originally when the project began each farmer established his nursery in his “patio”.

The SEMARNAT authority requires a management plan where nursery area is specified, availability of water and other infrastructure.



We have observed that this species is distributed on both the Pacific and inland slopes of the Sierra Madre de Chiapas in five municipalities. generally throughout the state of Chiapas. We estimate between 1000 to 2000 plants. We recommend an IUCN Red List category of Vulnerable (VU C, 2a), largely due to difficult-to-control destructive annual forest fires that occur in this Reserve

A condition set by SEMARNAT special permission, they must re-introduce 5 to 10% of the seedlings produced back into habitat and to establish one ejidal nursery.

Seedling for sale

Nurseries *in situ*

The original idea is to harvest seed from mother plant, sow and cultivate the plants in order to provide and additional alternative income for the farmers and at the same time the farmers are obliged to protect the habitat from poachers and loggers

Natural populations

Reintroduction

Seedling for reintroduction

The nurseries have produced about 15,000 seedlings. They have made a sale to ***Cycadmania*** in the USA. Also they have made some national events such as national flower exhibitions in Mexico City with sales of about $ 30,000 pesos during sales at 2001. However, sales are not constant. During the period 1998 to 2000 they collected about 5,000 seeds per year. No exports have occurred recently, nor de we have details on illegal trade.

CYCADALES IN MEXICO (*DIOON EDULE*).

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I. Background information on the taxa

1. BIOLOGICAL DATA

1.1. Scientific and common names:

Dioon edule Lindl.
Tiotamal, Quiotamal, Chamal, Palma de Teresita

1.2. Distribution

Dioon edule is endemic to the Gulf of Mexico seaboard along the Sierra Madre Oriental and in one coastal habitat (Fig.1). Most populations are fragmented to highly fragmented and relict due to land-use change. Though the annexed map shows the distributional range of the species to be continuous, the populations are discontinuous throughout the range covering an altitudinal range from 10 to 1,500 meters above sea level. Historically populations may have been continuous (Octavio-Aguilar *et al*., 2008a)

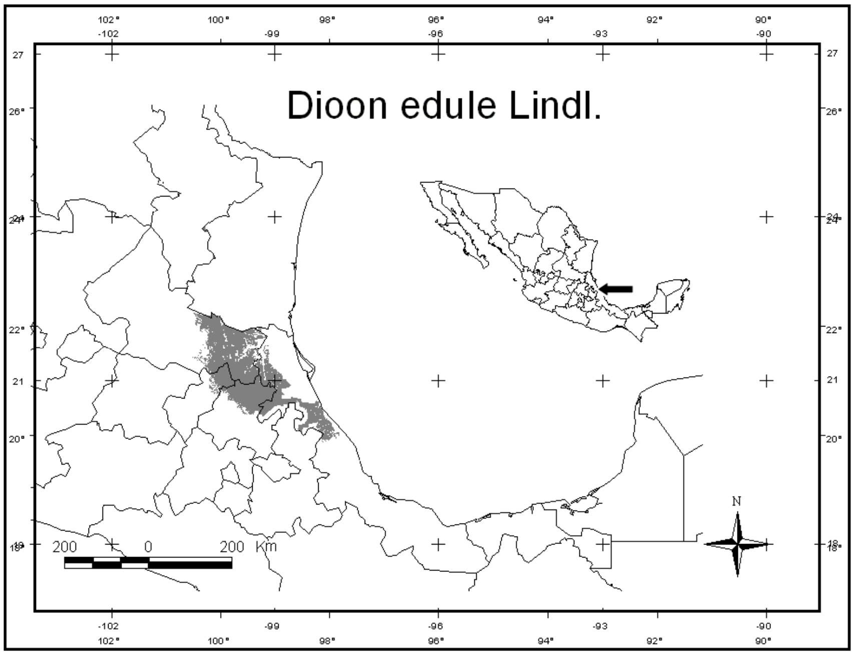

Figura 1. Distribution of *D. edule*

1.3. Biological characteristics

Dioon is an exclusively neotropical (continental) cycad genus with 13 currently known species and 12 are endemic to Mexico with one species known from Honduras and possibly Nicaragua. All species are arborescent with varying trunk lengths and the stems are protected with persistent petiole bases thus protecting the plants from brush fires. *Dioon* spp are entomophilous perennial dioecious long-lived trees (Fig. 2).

Fig. 2. *Dioon edule* in a fire disturbed oak-forest habitat (left). Female cone on plant (right).

1.3.1. *Provide a summary of general biological and life history.*

Like all cycads, *D. edule* is pachycaulous and dioecious (presenting separate male and female plants). It is arborescent and branching with age, generally from the base, stems can reach up 5 m tall becoming decumbent with age. The cycad behaves like a long-lived tree species and attains great age, exceeding 2000 years (Vovides, 1990). Pollination is entomophilous and the weevil pollinators (possibly *Parallocorynus* or *Rhopalotria* spp) are not yet identified for *D. edule* and are thought to be specific, also Langurid beetles have seen to be associated with the male cones (Fig. 3). Sex ratio appears to be strongly male biased due to more frequent coning by male plants.

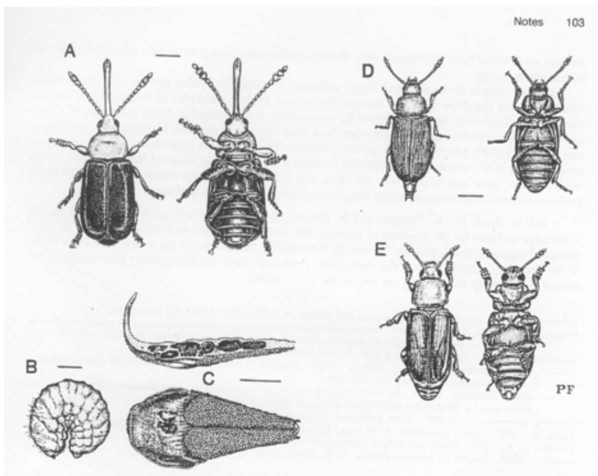

Fig. 3. Weevils and Langurid beetle pollinators (From Vovides, 1991).

The female cone cycle is approximately two years from initiation, pollination to dehiscence. In relatively undisturbed populations of *D. edule* the populations structure is a reverse "J" or Deevey type III curve, where there are more seedlings and juveniles than adults (Fig. 4).

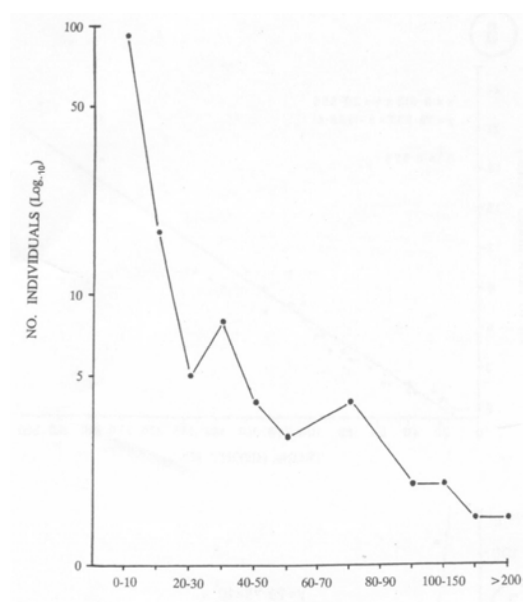

Fig. 4. Population structure of *D. edule* (from Vovides, 1990).

Seed production and recruitment is relatively good and between 78% to over 90% germination of seeds. The spatial distribution is non-random and contagious with a preference to shallow rocky soils. Mortality is high during the seed and seedling stages of the life history due to the prolonged droughts in its tropical dry forest habitats as well as seed predation by the field mouse *Peromyscus mexicanus* that is apparently resistant to the cycad toxins (Vovides 1990). The sex ratio is approximately 3:1 male/female respectively but this can be deceiving since male plants cone more frequently than females, hence a greater presence of coning males at any given time. Matrix projection modelling has shown that Ï (lambda) is most sensitive to abundance of reproductive adult plants in three populations studied (Octavio-Aguilar *et al*., 2008a). In spite of its relatively small populations, genetic variation and percentage of polymorphic loci are high, and there is a negative relationship between genetic diversity and latitude. On average, the gene flow between population pairs was found to be relatively high (Nm = 2.98); furthermore, gene flow between population pairs was significantly correlated with geographical distances (r = - 0.38, P = 0.025) throughout its range. Patterns of genetic diversity in *D. edule* appear to be associated with the post-Pleistocene spread of the species, from its southerly (origin) to its northerly range (derived populations, including its central distribution) (González-Astorga *et al*., 2003). *Dioon edule* is also the first cycad where a CAM-cycling photosynthesis pathway has been reported (Vovides *et al*., 2002a) which is in keeping with its water-stressed environment. Little is known about dispersal and dispersal agents, though gravity plays a great part and the field mouse that often forgets harvested seed in nooks and crannies of its rocky habitat. Dispersal by other small mammals over short distances is likely owing to the sweet sarcotesta of the seed; long-distance dispersal by birds has not been observed and is unlikely owing to the seed size. Natural predators are few with the cycad butterfly larvae (*Eumaeus* spp.) and a chrysomelid beetle that grazes leaves, as well as the field mouse *Peromyscus mexicanus* that predates seeds. The greatest threat is from humans and is mainly habitat destruction, but since the species also occurs in very steep canyons and cliff faces, at least some small and scattered populations have a good chance of long-term survival. Another threat is crown-decapitation that is practised by illegal traffickers to satisfy a domestic demand for ornamental plants, and has a negative impact on reproductive efficiency (Vovides, 1990; Octavio-Aguilar *et al*., 2008a) (Figs 5 and 6).

Fig. 5. Decapitated *D. edule* in habitat.
Fig. 6. Street vendors selling *D. edule* leaf crowns (Photo Glafiro Alanis).

1.3.2. *Habitat types: Specify the types of habitats occupied by the species and, when relevant, the degree of habitat specificity.*

Dioon edule is known from bosque tropical caducifolio (tropical dry forests) or bosque de *Quercus* (oak forests) and bosque de pino y bosque de coniferas y *Quercus* (pine-oak forests) according to the Rzedowski (1978) calssification. An exception to this is a small population on stable sand dunes in tropical costal vegetation. Well-drained rocky soils appear to be a habitat requirement.

1.3.3. *Role of the species in its ecosystem*

It can be considered to occupy the herbaceous to mid strata levels of the forests. Like all cycads, *D. edule* fixes atmospheric nitrogen by means of cyanobacteria in apogeotropic roots forming coralloid masses at soil level. Upon death of the coralloid roots nitrates are released into the soil, but this has not been quantified for this species, see Grove et al. (1980) for N fixation in *Macrozamia*. Like most vascular plants *D. edule* forms symbiosis with arbuscular mycorrhizal fungi (Vovides, 1991). It is host to the cycad butterfly (Eumaeus spp) which is apparently specific to cycad leaves during the larval stages (Castillo-Guevara, 2007). The weevil pollinators, though still not yet identified are thought to be specific.

1.4. Population:

1.4.1. *Global Population size:*

Population trends and genetic variation for *D. edule* is known only for three populations and has been done using standard population dynamic techniques (Octavio-Aguilar *et al*., 2008a,b). Stevenson et al. (2003) estimate over 10,000 plants and consider it near threatened. Disturbance influences the population dynamics of *D. edule* as a function of adult plant persistence. In these long-lived species, the extremely slow capacity for recovery following disturbances renders habitat preservation essential.

1.4.2. *Current global population trends:*

___increasing _X__decreasing ___stable ___unknown

Almost all populations of *D. edule* have declined over the past 30 years. No figure exists for this on a global scale, but demographic data for three populations show that there is a decline in one of these populations where decapitation is practiced (Octavio-Aguilar *et al*., 2008a).

The widespread use of herbicides over the last 20 years or so for land clearing that has replaced traditional slash/burn clearing apparently has had a negative effect on relict populations of the cycad.

1.5. Conservation status

1.5.1. *Global conservation status (according to IUCN Red List):*

___Critically endangered
___Endangered
___Vulnerable
_X_Near Threatened
___Least concern
___Data deficient

According to IUCN Red List, global conservation status of *Dioon edule* is regarded as Near Threatened. This should be revised since our recommendation for the Mexican Norm is P (endangered).

1.5.2. *National conservation status for the case study country*.

We recommend endangered status after a subjective assessment using the Method for Risk Evaluation MER (Spanish acronym) for the Mexican Norm because: i) historically the species was once very abundant but now populations have been reduced drastically to less than 5% of the national territory; ii) many populations are relict with poor or nil regeneration and the species is apparently sensitive to herbicides nowadays in common use; iii) estimated number of adult plants in known populations ca 10,000 (Stevenson *et al*., 2003); iv) decapitation of reproductive adults lessens seed production in the habitats and the species is protected by only one biosphere reserve. Exact figure of the extent of habitat reduction is not available.

1.5.3. *Main threats within the case study country*

___No Threats
X__Habitat Loss/Degradation (human induced)
___Invasive alien species (directly affecting the species)
X__Harvesting [hunting/gathering]
___Accidental mortality (e.g. Bycatch)
X__Persecution (e.g. Pest control) toxic to cattle
X__Pollution (affecting habitat and/or species)
___Other. The use of herbicides in some habitat-clearing for pastureland
___Unknown

The main threats are largely due to human induced habitat loss through deforestation and land use change, illegal collecting especially decapitation of leaf crowns. Purposeful elimination of the plants owing to the cycads toxicity to cattle (no precise data other than anecdotal). The species is on several "Toxic Plants to Cattle" lists. The exact figure of number of plants destroyed by cattlemen is not available since this has been an on-going process over a very long period of time. Also the recent use of herbicides over the last 20 years to induce pastureland is believed to have seriously affected the cycad populations (amount not quantified).

2. SPECIES MANAGEMENT WITHIN THE COUNTRY FOR WHICH CASE STUDY IS BEING PRESENTED.

2.1. Management measures

Conservation through propagation with aims toward sustainable utilization coupled with habitat conservation. This is being done with the collaboration of peasant farmers at Monte Oscuro, Veracruz. Other similar projects with a *D. edule* populations that fall within a Biosphere Reserve (Sierra Gorda, San Luis Potosí and Querétaro) in the municipality of Tamasopo (Community Cuesta Blanca, Ejido la Palma) where the cycad *Ceratozamia microstrobila* among three orchid species are being managed, and in the municipality of Jalpan Querétaro at San Antonio Tancoyol where *D. edule* is also managed in this way by 13 farmers. Some of these farmers were given a three-day workshop at the JBC during 2004. Unfortunately figures on plants cultivated or other data are unavailable.

2.1.1. *Management history*

Based on demographic studies on *D. edule* by Vovides (1990), a group of campesinos (peasant farmers) were invited to collaborate in a pilot project that forms part of the Jardín Botánico Fco J. Clavijero (JBC) botanic garden's outreach to communities' policy for the conservation for endangered and useful native plants. The project began in 1990 to establish a small rustic nursery by the farmers on their ejido lands (allotments for agricultural production) at Monte Oscuro (MO) in central Veracruz near Xalapa. The nursery received its official permit in 1991 in order to operate as a non-forest products nursery that became the forerunner to the concept of UMAS for plants (Unidades de Manejo y Aprovechamiento de la vida Silvestre) or wildlife management units. These are overseen and authorized by the environmental authority of Mexico that monitors and administers permits. MO had a history of exploitation of the cycad by outsiders who decapitate adult plant crowns to be sold by peddlers in the main cities of the country. These crowns rarely root and demographically do affect the seed input into the ecosystem. The farmers, concerned about this practice were willing to take part in our project and received basic horticultural training at the JBC and talks given to them at their nursery with continuous assessment. The process of seed harvest from the wild, sowing and cultivating plants to provide an additional alternative income for the farmers is aimed to create an incentive to reforest and to protect the habitat from poachers and loggers (Vovides & Iglesias, 1994; Vovides *et al*., 2002b).

2.1.2. *Purpose of the management plan in place*

The main objective of this management is to encourage incentive for conservation through propagation and plant sales by a system of harvesting seed, sowing and cultivation and eventual sales. In return they pledge to conserve the habitat and reintroduce back into the wild a small percentage of their production in order to compensate for seed removal. The farmers along with the ejido collective have declared 80 hectares of forest habitat as an ejido reserve.

2.1.3. *General elements of the management plan*

The farmers organized themselves as a small cooperative group. A plot of land (approx. one ha) is borrowed from one of the members and each member donates a number of man/hours per week for its maintenance, though this system has recently been modified. Seed collecting is done on an individual or group basis and there are no set rules. The authorities require a management plan where nursery area is specified, availability of water and other infrastructure, the species to be managed, the approximate number of seeds to be harvested per year, number of plants to be cultivated and a yearly inventory of plants under cultivation, sold, deaths etc. Permits are issued once the management plan is approved and a stipulated percentage of seedling production to be reintroduced, usually 10% but is never done in reality. Annual reports are required for permit renewal.

2.1.4. *Restoration or alleviation measures*

In order to address this point an experiment was set up in the wild during 1997 where 300 seedlings of varying age (2, 4 and 7 years) were reintroduced and monitored on a yearly basis to record growth, deaths or losses due to environmental factors. The objective of this exercise was to verify the minimum age class that can be reintroduced with an acceptable mortality after a period of several years. So far, after ten years we found that all age classes survived with a mortality rate of not exceeding 20% (unpubl. data). Seedling growth rate was practically un-measurable compared to their sisters grown at the nursery that gave five times more leaf production and caudex growth over the 10-year period. Male plants coned after 15 years and females after 17 years of age from seed under rustic nursery conditions. We came to the conclusion that seedlings of 2 years can be safely reintroduced.

2.2. Monitoring system

2.2.1. *Methods used to monitor harvest*

No formal method has been established, other than to examine seed by incision before harvesting the cone to verify embryo presence and maturity. Seeds are excised from a cone then cut lengthwise in order to examine the embryo (Fig.7). This should be developed to over 3/4 of the overall length of the seed. If embryo development is less, seed the cone is left to mature for a further few months (3-4) on the mother plant, if it is approximately 3/4 of the seed length or more the cone may be harvested. Each cone may bear between 100 to 400 seeds with generally over 90% germination.

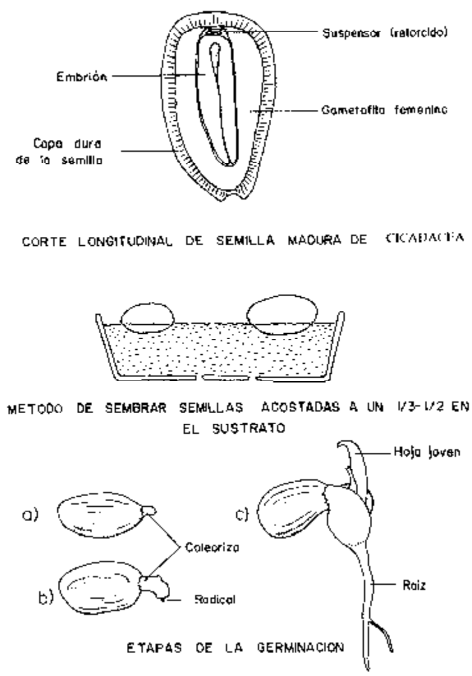

Fig. 7. Illustration of long section of seed showing mature embryo, seed sowing and germination.

2.2.2. *Confidence in the use of monitoring*

Embryo monitoring ensures that pre-fertilization cones are not cut, nor cones that require further maturation in situ on the mother plant. The female cone cycle is two years and cones look apparently ripe in less than one year. Collecting immature seeds leads to poor germination and death through desiccation and or fungal infections. Long term population monitoring other then the demographic studies mentioned have not yet began.

2.3. Legal framework and law enforcement:

All native cycads are covered by the national Norma Oficial Mexicana and international CITES legislation. The national legislation protects all species listed and it is unlawful to collect, transport and trade with listed species within Mexico without an appropriate collecting permit or UMAS permit that allows the collection of seed for cultivation and subsequent sale as is being carried out at MO (Fig. 8). Each plant to be sold must have a label with the nursery and permit number displayed. Breaching of these laws is considered federal crime with heavy fines and/or imprisonment.

Cycads in Mexico are of conservation priority (INE-SEMARNAP, 2000) and national funding agencies for research and conservation of cycads regard them as priority funding. There are also priority areas (biodiverse hot-spots) that are considered by many Mexican and international funding agencies.

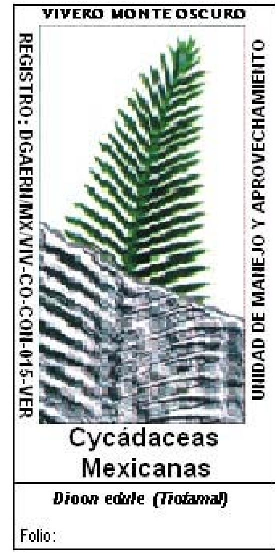

Fig. 8. *D. edule* plants cultivated from seed at the Monte Oscuro Nursery and label.

3. UTILIZATION AND TRADE FOR RANGE STATE FOR WHICH CASE STUDY IS BEING PRESENTED.

3.1. Type of use and destinations:

Historically *D. edule* has been and is still being used as a source of starch by indigenous and mestizo (mixed blood) peoples. Seeds are harvested from wild populations, soaked or boiled to remove toxins and ground to obtain flour for tortillas in times of maize harvest failure. Also in central Veracruz the seeds were used in the past as a source of laundry starch. Cattlemen in the northern limits of the cycad's distribution purposely cut the plants down since the freshly emerging leaves attract cattle and are eaten resulting in hind-leg paralysis syndrome and death. Unfortunately figures on the number of plants destroyed are not available.

The leaves of the cycad are sometimes harvested from wild populations and used for decorating altars during religious festivities and is non-destructive to the plants. However, plants are illegally collected and adult plants decapitated and both the crowns and plants are sold as ornamentals. The implementation of UMAS are slowly giving a positive solution to this, but has happened to a limited extent but nevertheless encouraging. The municipality of Xalapa has on two occasions bought from the MO nursery several hundred *D. edule* plants for municipal landscaping (Fig. 9), also private sales at the JBC garden shop and town fairs as well as garden centres has also been encouraging to the producers.

3.2. Harvest:

3.2.1. *Harvesting regime:*

Legally, seed harvesting by UMAS is extractive and usually on a 'what is available' policy, there are no pre set quotas other than they should be reported in the annual reports by the UMAS. Crown decapitation is illegal but it still occurs but we have no detailed data on this, nor the quantity of plants illegally trafficked.

3.2.2. *Harvest management/:*

The UMAS permit covers harvesting of seed, there are no set quotas nor seasons stipulated. Management will probably be refined in the future taking into account information generated by the population studies of Octavio-Aguilar *et al.* (2008a,b) such as taking 20% of seeds per ripe cone and sampling as many cones as possible in order to represent genetic variation in the nursery and subsequent reintroduction.

3.3. Legal and illegal trade levels:

The nursery at MO has the capacity to produce around 2,000 plants per year, this considering the input of seeds from the habitat which may vary between about 500 seeds during bad years and up to 10,000 seeds or more during good (flush) years. However, the farmers do not always harvest seeds every year owing to seedling saturation in the nursery. They will harvest seed following a period of good sales that free up space in the nursery.

Legal trade – In terms of income the MO nursery between the years 1991 to 1995 earned approximately $1,500 US total. For the years 1996 to 1998 a total of $2,700 US; and for the years 1999 to 2006 a total of $4,600 US and from 2007 to date approx. $10,000 US. All this is through domestic sales (Fig. 9).

Export experience of cultivated plants has been bad. During 1998, 500 plants were exported to Germany through a GTZ-Germany/ProTrade/Mexico funded project in order to explore international markets. An exhibition stand was presented at the international horticultural trade exhibition at Essen, Germany on two occasions but no significant sales occurred. This owing to fierce competition from professional nursery produced *Cycas revoluta* plants, and we feel a non-specialist ornamental plants market was being explored.

No exports have occurred recently, nor de we have details on illegal trade.

Fig. 9. Municipal Landscaping with *D. edule* and sales at the Monte Oscuro nursery

II. Non-detrimental Finding procedure (NDFs)

1. IS THE METHODOLOGY USED BASED ON THE IUCN CHECKLIST FOR NDFS?

The methodology based on the IUCN checklist for NDFs was not used. The findings were based on a previous demographic study on the population being managed (Vovides, 1990) based largely on the natural mortality in the seed and seedling stage. Further population dynamic studies that include elasticity matrixes (Octavio-Aguilar *et al*., 2008a) may enable the fine-tuning of seed harvesting and plant reintroductions.

2. CRITERIA, PARAMETERS AND/OR INDICATORS USED FOR THE MONTE OSCURO (MO) NURSERY:

The population harvested is in ca 80 ha of relatively well-preserved tropical dry forest. We estimate at least 3,000 reproductive adult plants and only seeds are harvested. There is no set criterion or any specific indicators used. However, since the female cone cycle for *D. edule* is two years from emergence to dehiscence and there is no visible external difference to distinguish immature and ripe cones the producers have been trained to monitor embryo development of the seed without removing the cone. This is easily done by excising a sporophyll (seed scale) from the cone, removing a seed and cutting it longitudinally with a sharp pen-knife, the embryo is easily seen and the criterion for cone removal is that the embryo should be at least 3/4 of the seed length and if less, the cone is left to ripen for a further 3 to 4 months. A practical manual has been published that covers these instructions for the cycad species managed in Mexico (Pérez-Farrera & Vovides, 1997).

3. MAIN SOURCES OF DATA, INCLUDING FIELD EVALUATION OR SAMPLING METHODOLOGIES AND ANALYSIS USED:

Demographic information from the literature and especially the population study by Vovides (1990) was used based on a 30 x 10 m transect through the cycad population and observations over a four year period as well as empirical data from the MO nursery and personal data. No set sampling or seed harvesting methodology was used save the reintroduction experiment of planting 300 seedlings between 50 and 100 cm distance and annual monitoring and measuring of growth done by a vernier calliper gage and counting leaves produced.

4. EVALUATION OF DATA QUANTITY AND QUALITY FOR THE ASSESSMENT:

No particular prescribed method was used. High germination percentage with small losses through deaths was observed but not quantified. Seed harvest is not done on a yearly basis and can very between 500 and 10,000 seeds collected. Comparison between growth in the nursery and growth of reintroduced plants has found to be about five times faster in the nursery under rustic conditions.

The reintroduction experiment indicated that seedlings from 2 years old and more can be reintroduced without any heavy losses during establishment. Though the demographic and population genetic study by Octavio-Aguilar *et al*. (2008a,b) indicated finite population growth to be sensitive to changes in adult plant density and the population is less diverse genetically when compared with two other populations, that is likely due to habitat fragmentation and adult plant crown decapitation. Population elasticity is greater than 80% due to permanence of the adult class, but the seed and seedling classes were found to be a reservoir for genetic diversity of the species (Octavio-Aguilar *et al*., 2008b). This is an important factor to consider for management of the species and we sustain that it is best to conserve reproductive adult plants and stop crown decapitation, which will in turn result in greater seed production giving rise to positive repercussions in genetic composition, such as avoiding bottlenecking effects and decrease in effective population size. With this in mind we are reconsidering the reintroduction techniques. Nursery grown plants take 17 years for female and 15 years for male plants to enter reproductive age (Fig. 10). We are contemplating in reintroducing a much lower number of nursery produced adult reproductive plants, perhaps one for every 10,000 seeds collected rather than hundreds of seedlings which will take very much longer to mature under natural condition. The collection of small proportions of seed over a wide range of ripe cones available, rather than the total seed of just a few cones will conserve genetic diversity.

Fig. 10. 17 year old female coning D. edule (left); 15 year old male coning *D. edule* plant (right).

The success of the nursery has been through outcome from plant sales and the long-term organization of the nursery. There are currently three sales points for the nursery; i) a local garden centre ii) botanic garden shop and iii) attendance to town fairs and local horticultural events.

Plant sales at botanic garden shop (left); and local garden centre (right).

5. MAIN PROBLEMS, CHALLENGES OR DIFFICULTIES FOUND ON THE ELABORATION OF NDF:

The initial stages were found to be the most difficult since not all members of the farming community were convinced in growing 'a weed' for profit and there were many dropouts among the convinced members (25 members at onset in 1990 reducing to three at present).

Other important challenges to the project were; i) absence of consistent funding during the early stages of the project; ii) a need to constantly provide continuous assessment to the growers and to consider their idiosyncrasies that debilitates work force and budget.

Marketing was specifically a problem for lack of expertise and looking into this factor at a late stage of the project had caused frustration among the growers by having a nursery full of plants but few sales. Important aspects of marketing are just beginning to be addressed. Marketing assessment is a must before or during the early stages of such a project (Vovides *et al.*, 2002).

6. RECOMMENDATIONS:

i) Marketing assessment is crucial during the early stages of innovative sustainable management projects.

ii) More long-term funding is required to get projects such as this one working.

iii) A multidisciplinary team is required for these projects especially in the fields of conservation biology, horticulture, anthropology and sociology as well as marketing expertise.

iv) Projects involving sustainable management of threatened species should be encouraged nationally and internationally, especially within buffer zones of biosphere reserves.

v) It is highly recommended to start first with small medium-term pilot project and grow on from this rather than to inject mega-scale funding on a short-term basis.

vi) The species to be managed should be on the farmers' collective (ejido) or individual private property and the habitat must be an integral part of the management system in which the habitat is managed for seed thus creating incentive to conserve. Establishing mother seed plants at the nursery is contrary to this since independence from the habitat is not recommended.

vii) There should be a mechanism for assisting the growers during their permit renewal applications and other paperwork, since on a local basis in Mexico the farming communities are in remote communities on Reserves. This is being addressed in Chiapas since 2006 where the authorities were willing to assist the growers on these matters. In the absence of this aid, then projects should contemplate an administrative section, possibly a part to the marketing officer's duties.

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CYCADALES IN MEXICO(*DIOON EDULE*).

AUTHOR:
Andrew Vovides

The results of demographic and population genetic studies on *Dioon edule* has enabled us to elaborate a conservation strategy through sustainable utilization. We now know that within natural populations of *D. edule* there is a high seedling mortality and seed loss, largely through the prolonged dry season of the habitat. The species maintains an unexpectedly high genetic variation and that especially the seeds are a genetic reservoir. Seed harvest for propagation in the Monte Oscuro (MO) nursery is not considered detrimental owing to the natural mortality rate of seedlings in the field. However, habitat disturbance influences the population dynamics of *D. edule* as a function of adult plant persistence and elasticity matrix projection has shown that the conservation of reproductive adult plants is critical for the species survival. We recommend the reintroduction of a low number nursery grown reproductive plants rather than large amounts of seedlings. Reintroduction of nursery grown seedlings of 2, 4 and 7 year old seedlings since 1997 has shown so far a low mortality rate (ca 20%) but extremely slow growth that is consistent with findings from the demographic study. However seedlings of the same cohorts maintained in the nursery have shown a growth and leaf production rate of about five times that of the field seedlings, and reproduction events initiated after 15 years for males plants and 17 years for females. This has given us further impetus for cultivation improvement in the Botanic Garden involving root pruning and use of mycorrhiza (experiments in process). Findings will be passed on to the producers.

The project at MO is now in its 18th year and there have been some domestic sales that benefited the producers though inconsistent. Export has been so far unsuccessful. However the habitat is being conserved and illegal collecting has been discouraged. Efforts have been made to improve marketing by promoting the nursery through two sales points and a web page. We regard the following recommendations to be crucial to a project of this kind:

i) Marketing assessment is crucial during the early stages of innovative sustainable management projects.

ii) More long-term funding is required to get projects such as this one working.

iii) A multidisciplinary team is required for these projects especially in the fields of conservation biology, horticulture, anthropology and sociology as well as marketing expertise.

iv) Projects involving sustainable management of threatened species should be encouraged nationally and internationally, especially within buffer zones of biosphere reserves.

v) It is highly recommended to start first with small medium-term pilot project and grow on from this rather than to inject mega-scale funding on a short-term basis.

vi) The species to be managed should be on the farmers' collective (ejido) or individual private property and the habitat must be an integral part of the management system in which the habitat is managed for seed, thus creating incentive to conserve. Establishing mother seed plants at the nursery is contrary to this since independence from the habitat is not recommended.

vii) There should be a mechanism for assisting the growers during their permit renewal applications and other paperwork, since on a local basis in Mexico the farming communities are in remote communities on Reserves.

Jardín Botánico Fco. J. Clavijero

NDF CASE STUDY:

DIOON EDULE

Compiled by: Andrew P. Vovides

Curator: Jardín Botánico Fco. J. Clavijero

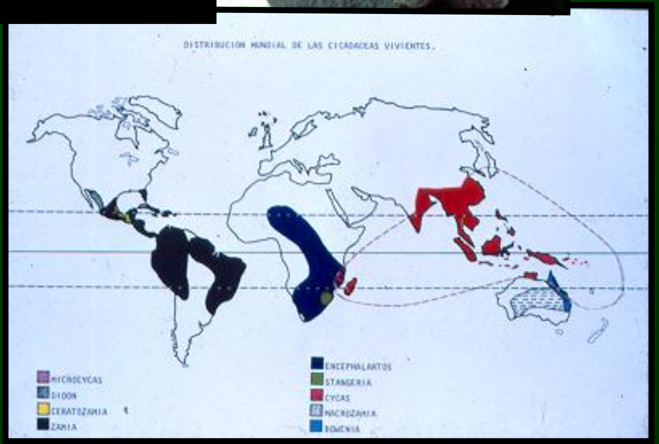
CONABIO

CITES Convention on International Trade in Endangered Species of Wild Fauna and Flora

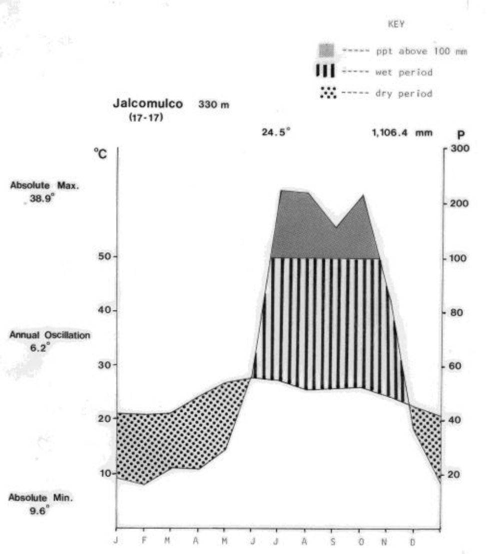
INSTITUTO DE ECOLOGIA, A.C.

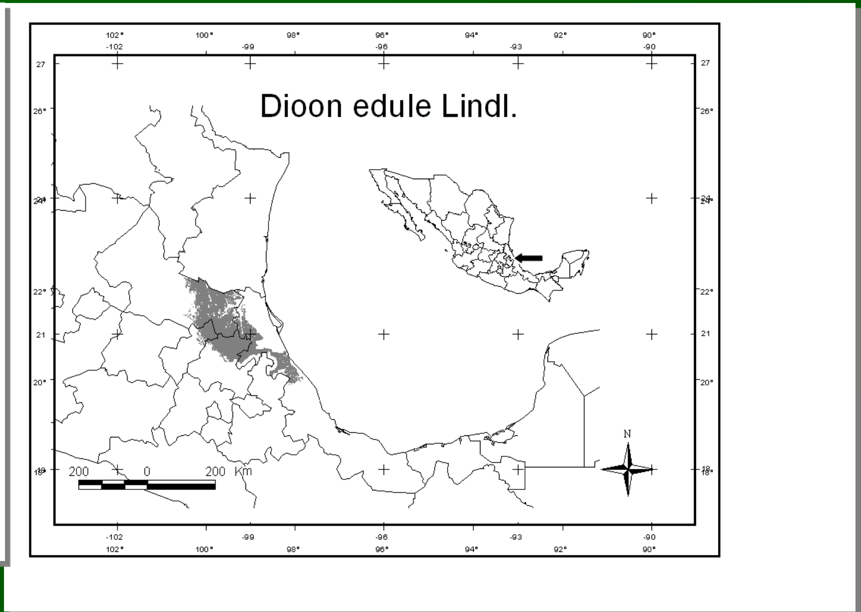
What are cycads?

- Primitive living seed plants classified with the gymnosperms with fossil history going back to the Permian
- About 300 species known worldwide with 50 in Mexico giving it 2nd place worldwide for cycad diversity
- *Dioon edule* is endemic to Mexico and there are estimated over 10,000 plants in the wild
- Major threats are habitat loss and illegal harvesting of leaf crowns (decapitation) for the domestic market
- They are much appreciated as ornamentals



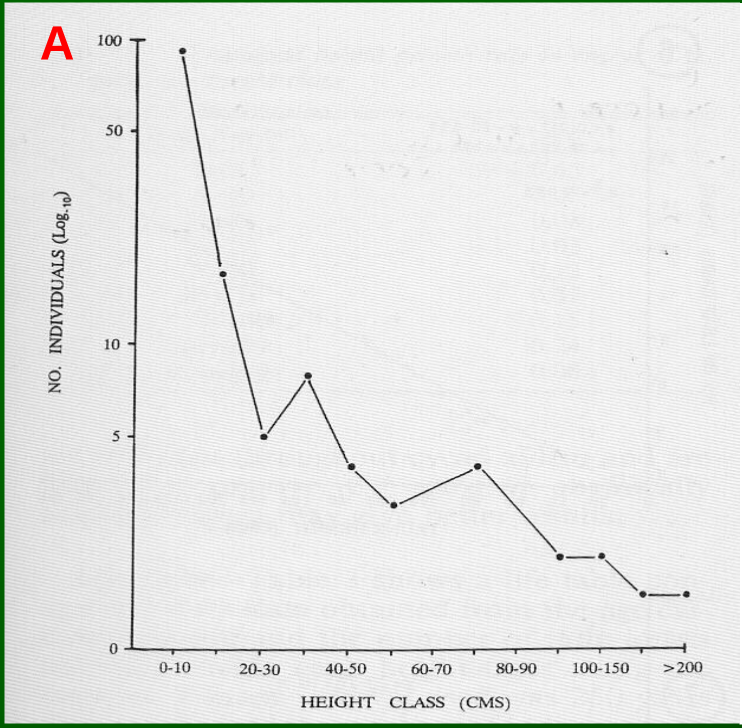
Distribution of *Dioon edule*

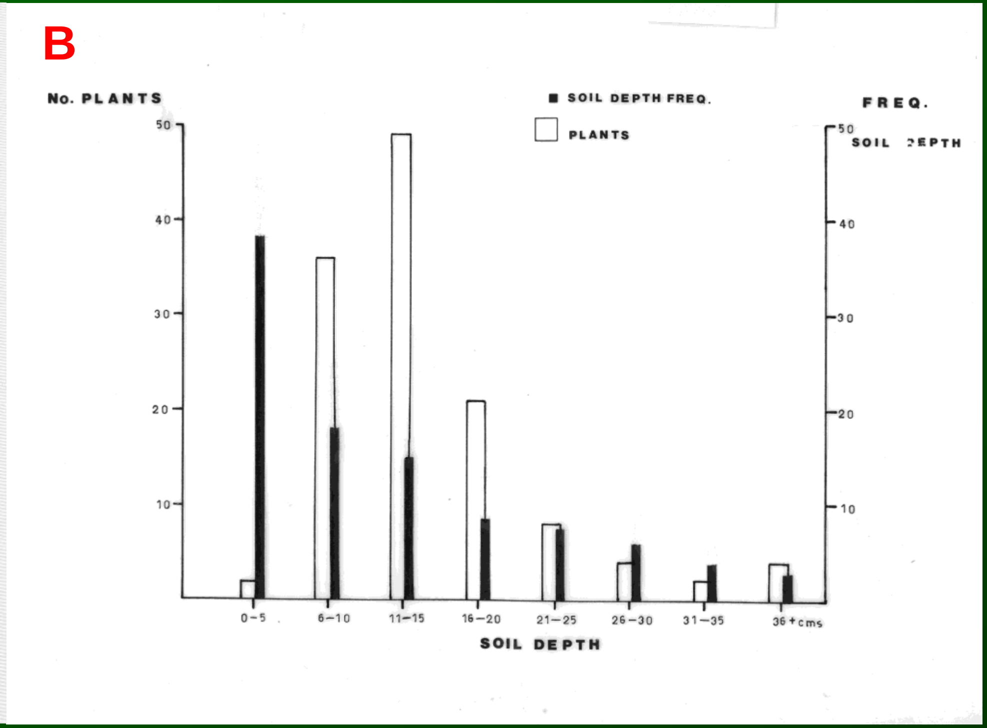




- Along the Gulf of Mexico seaboard
- In tropical dry forests on rocky soils
- Also in steep canyons
- Climate with prolonged dry season with summer rains

POPULATION STRUCTURE OF *DIOON EDULE*





A) Graph shows a reverse "j" structure with high seedling mortality

B) Spatial distribution with preference on shallow soils

Vovides (1990) *Amer. J. Bot.* 77: 1532-1543

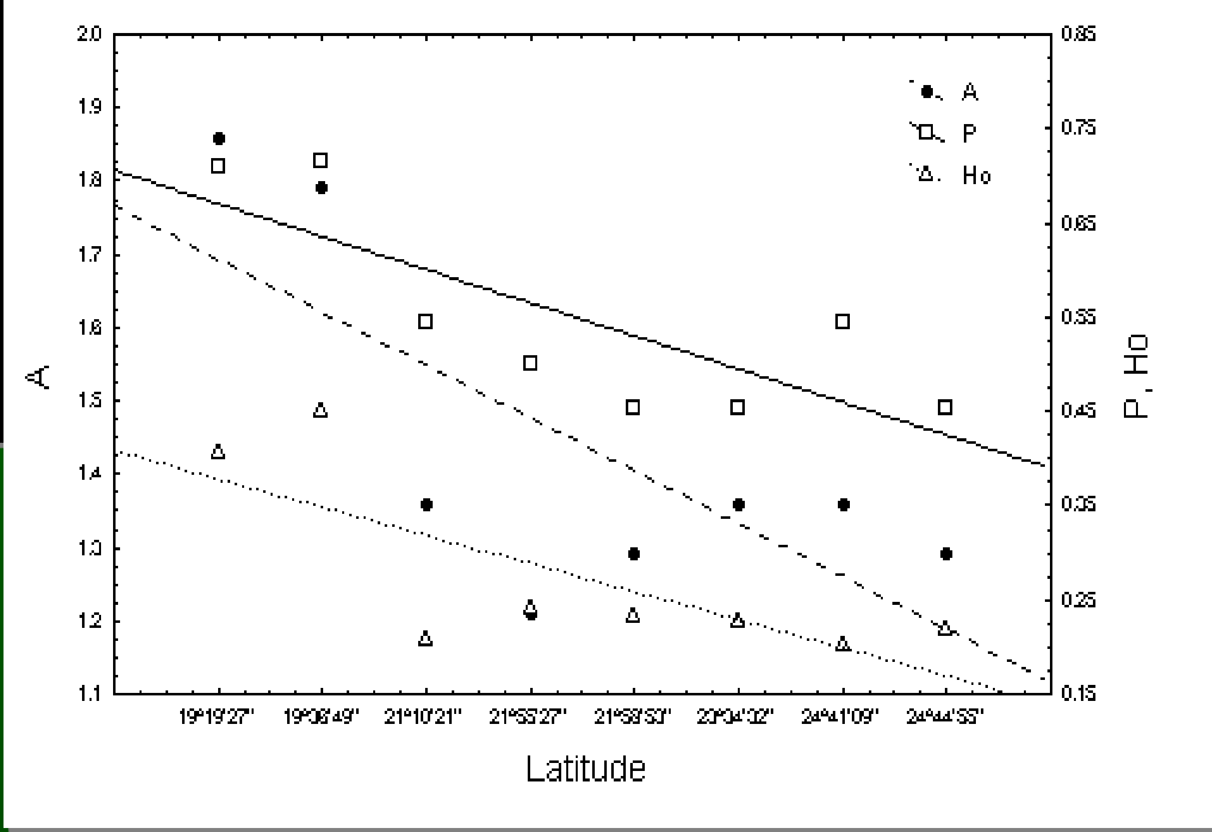
Dioon edule is genetically diverse

- **Genetic diversity de *Dioon edule* is high throughout its range and is correlated with latitude**

- **Highest diversity is found in the south**

- **Seeds are a reservoir of genetic diversity**

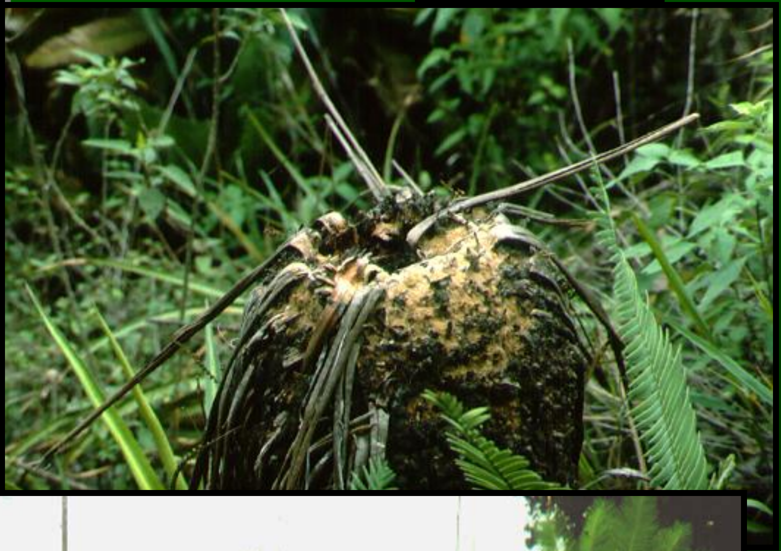
González-Astorga *et al*. (2003) *Biol. J. Linn. Soc.* 80: 457-467.
Octavio-Aguilar et al. (In press) *Plant Biol*.



Major threats

- Global habitat destruction:

- Land use change for agricultural expansion
- Deforestation
- Use of herbicides for land clearing
- Illegal national commercial collecting
- Decapitation of *D. edule*

THE JARDIN BOTANICO FCO. J. CLAVIJERO
& The National Cycad Collection

• For education, outreach and extension
• For research and *ex situ* conservation
• For propagation and assessment to sustainable management nurseries (UMAS)

PROPAGATION & CULTIVATION

Cultivation and germination trials on cycads enabled us to produce an adequate technology easily transferable

D. edule presents over 90% germination

Monte Oscuro Nursery, Veracruz

(*Dioon edule*)

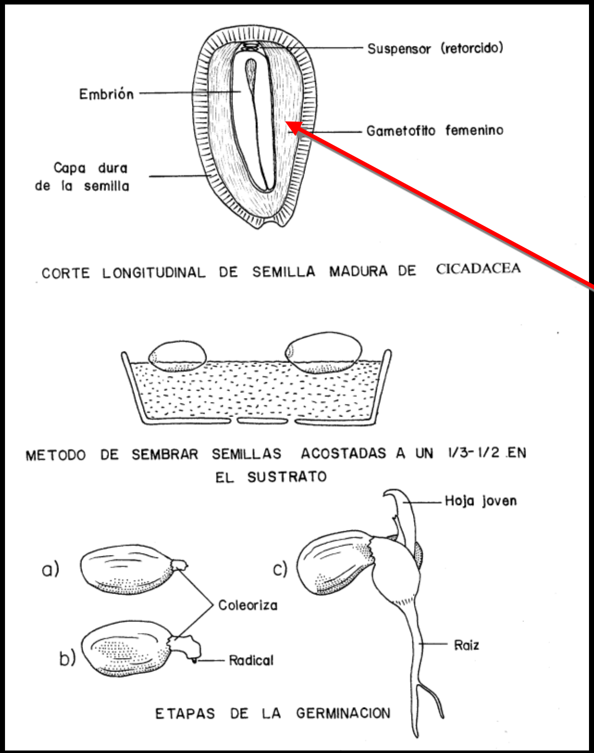
Based on ecological studies and germination trials:

- Farmers who own cycad habitat were given talks and invited to take part in a sustainable management project
- Hands-on basic horticultural training was given
- First sustainable managment nursery established in 1990
- Many drop-outs during early years

(Vovides 1990 *Amer. J. Bot*. **77:** 1532-1543)
(Vovides & Iglesias, 1994, *Biodiversity and Conservation* **3:** 137-141)

AT MONTE OSCURO

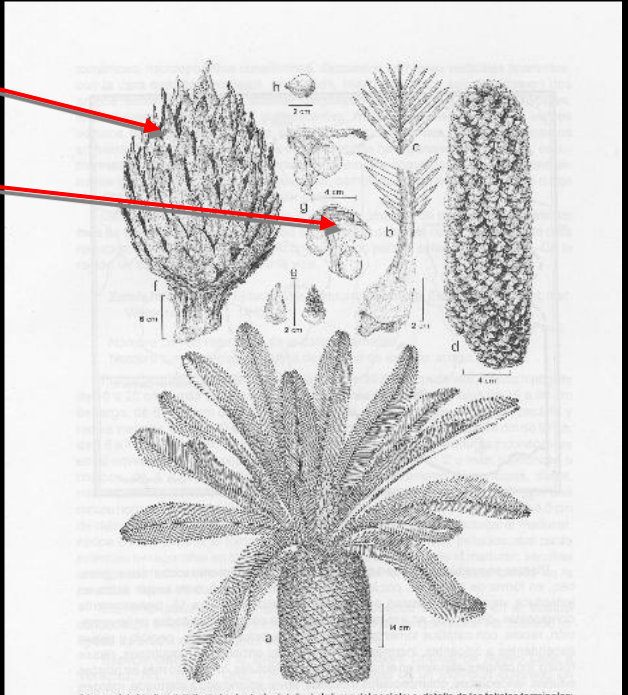
- Ca 80 ha of relatively well-preserved tropical dry forest is harvested
- Seeds (500 - 10,000) are harvested from a population of ca 3,000 plants
- Harvesting done in autumn but not every year
- Female cone monitoring is done to ensure ripe seed since the female cone cycle for *D. edule* is two years
- A seed scale is removed and the seed cut lengthwise to examine embryo
- Cone harvested if embryo length is ¾ of the seed length or more
- If less cone is left for a further period to ripen



Female cone

Seed scale with seeds

Seed cut lengthwise exposing embryo

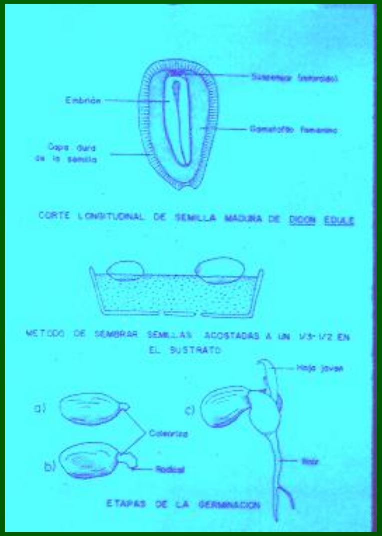


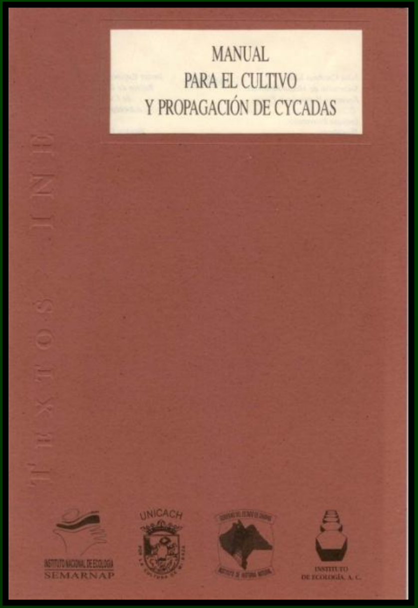
Dioon edule Lindl. a. hábito de la planta; b. detalle de la base del pecíolo; c. detalle de los folíolos terminales; d. microstróbilo; e. microsporofilo mostrando los microsporangios; f. megastróbilo; g. megasporofilo con dos óvulos; h. semilla. Ilustrado por Edmundo Saavedra.

The teaching process

- Basic nursery practice by using available materials
- Combining farmers' traditional knowledge
- Improving and adapting technical practices
- to their needs
- The publication of a practical manual

(Pérez-Farrera, M. A., & A.P. Vovides 1997. *Manual para el cultivo y propagación de cycadas.* México, D.F., INE-SEMARNAP)

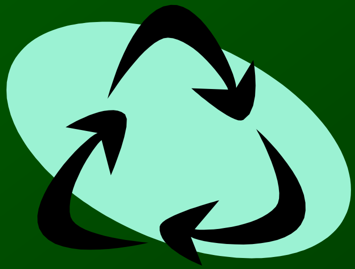




Plant reintroduction into habitat

Farmers participate in reintroduction projects

- In Sept. 1997 300 2, 4, and 7 yrs old seedlings of *D. edule* were introduced into habitat
- Yearly monitoring took place to register growth and deaths
- Mortality has not been greater than 20% for all classes
- Two year old plants can safely be reintroduced



Growth in nursery 5x that in habitat

1. Reintroduced *D. edule* plants in 1997 - No significant change in stem dia, (approx 4 cm) max no. leaves 3, no appreciable stem growth detected in 2005 (ca 4 cm)

2. Plants in nursery - aprox. 12 cm stem dia, max leaf no. 15 (2005)

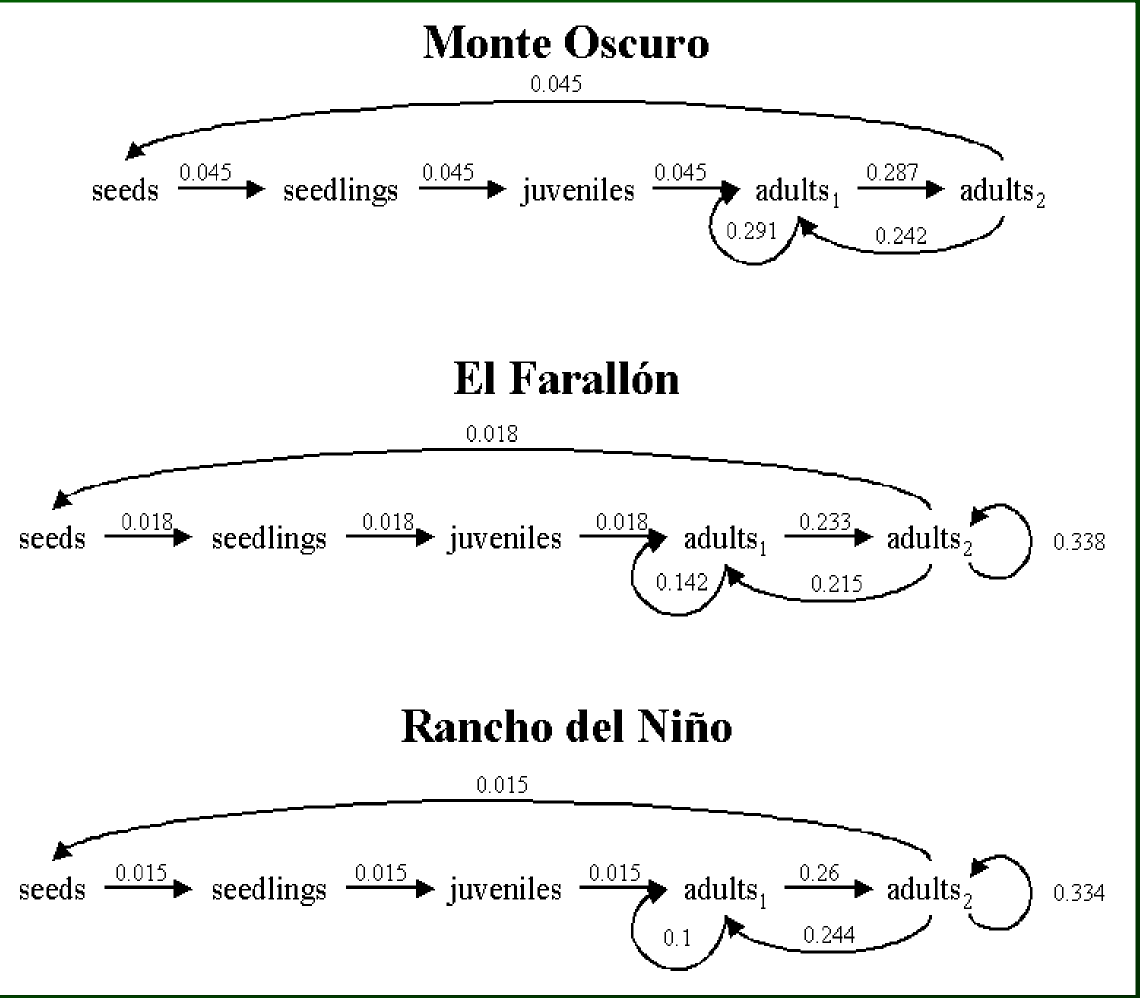
3. Male plants began to cone at 15 years after germination in nursery

4. Female plants cone after 17 years (2007)

(Unpubl. Data)

BUT IS IT WORTHWHILE REINTRODUCING SEEDLINGS OF *D. EDULE*?

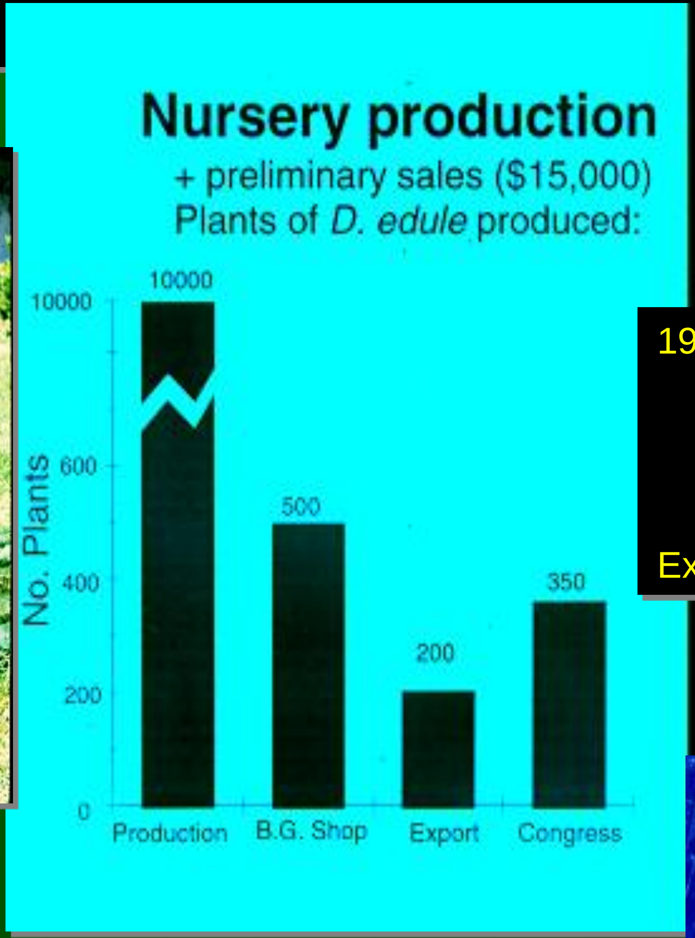
Life cycle and elasticity values in 3 populations



- Demographic studies and elasticity matrix modelling (Lefkovich) indicate that the most important life-cycle stage for maintaining the population is the adult stage
- Habitat conservation and especially adult plants (avoid decapitation) is more efficient for population growth and conservation than introducing seedlings
- It is better to reintroduce few nursery produced reproductive plants than many seedlings

Octavio-Aguilar et al. (2008) *Bot. J. Linn. Soc.* **157:** 381-391

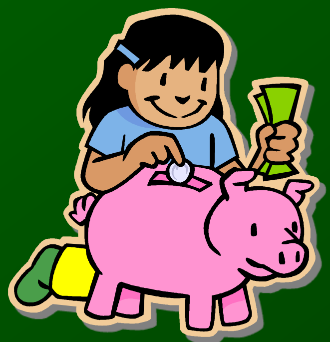
EARLY MARKETING



1994-95: 25,000 Pesos (Garden shop & congress)

+ 200 USD (export to USA)

Export of 500 plants to Europe (1998-99) not successful



Education for marketing

Marketing workshop, Tuxtla Gtz, May 2006

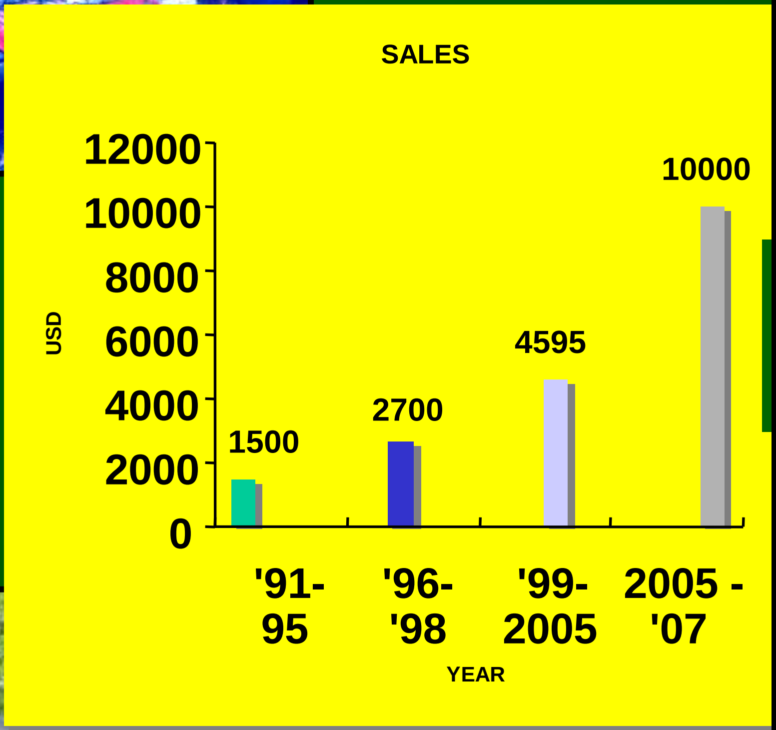
- Creation of CYCAMEX 1998
- Web page 2006
- Sales point: Botanic Garden shop 1994
- Official plant lables 2000
- Meeting with producers in Chiapas to connect with CYACMEX 2006
- Invitation of local authorities

Cycadáceas MEXICANAS

CYCAMEX SHOP INAUGURATION: PARQUE DOÑA FALLA, XALAPA 30 JUNE 2006

It is hoped to link nurseries to national and international markets

Market and sales



- **Successes:**
- **Conservation through propagation accepted by farmers**
- **Other communities are following example**

- **Failures:**
- **Cycads relatively unknown in Mexico**
- **Sporadic and inconsistent sales**
- **Competition by poachers**
- **Lack of marketing experience**
- **Lack of coordination between producers and authorities**

- **Challenges:**
- **Improve cultivation**
- **Market exploration**

VIVERO
La Curva
ARQUITECTURA DE PAISAJE

OUTCOME

Landscaping with *Z. furfuracea*

Landscaping with *D. edule*

Growing interest in cycads among landscape architects

It is becoming fashionable to use native plants

- Residential estates
- Hotels
- Municipal landscaping

CHALLENGES: Cultivation improvement

Experiments at the Botanic Garden

ENDOMYCORRHIZA

- *Dioon edule* has mycorrhizal symbiosis with *Glomus* sp.
- Better growth of *D. edule* seedlings after inoculation with *Glomus*
- Mycorrhizal and root pruning experiments in process at the Botanic Garden with *D. edule*

Vovides (1991) *Brenesia* 35: 97-103

VISIBLE DIFFERENCES IN GROWTH

ANOVA of FW differences between treatments and controls after one year (n = 15)
P = 0.019 (significant)

ANOVA

Origen de las variaciones	*Suma de cuadrados*	*Grados de libertad*	*Promedio de los cuadrados*	*F*	*Probabilidad*	*Valor crítico para F*
Entre grupos	153.536	1	153.536	6.243	0.019**	4.196
Dentro de los grupos	688.599	28	24.593			
Total	842.134	29				

The importance of solidarity

("If you sink, we sink with you")

- Training must be kept simple, and by example
- Much repetition is necessary
- Continuous assessment essential
- Local idiosyncrasies must be considered
- Assessor identification and solidarity with the farmers is also essential

(Vovides et al. 2002. Peasant nurseries: A concept for an integrated conservation strategy for cycads in Mexico. In: Maunder, M. et al. (eds) *Plant Conservation in the Tropics: perspectives and practice.* Pp. 421-444. RBG Kew)

RECOMMENDATIONS

- Marketing assessment is crucial during the early stages
- More long-term funding is required
- A multidisciplinary team required in; conservation biology, horticulture, anthropology, sociology and marketing expertise
- Start off with small medium-term pilot project rather than to inject mega-scale funding on a short-term basis.
- The species/habitat to be managed should be on the farmers' collective or individual private property and must be an integral part of the management system
- Close coordination between producers and authorities should be encouraged, possibly a marketing officer's duties.
- Projects involving sustainable management of threatened species should be encouraged nationally and internationally, especially within buffer zones of biosphere reserves.

ACKNOWLEDGEMENTS

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Jorge González-Astorga (genetics); Pablo Ocatvio-Aguilar (demography); Miguel Angel Pérez-Farrera (research collaborator, UNICACH, Chiapas)

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THANKS, GRACIAS!

SOUTH AFRICAN *ENCEPHALARTOS* SPECIES

AUTHOR:
John Donaldson

The main focus of the NDF workshop is on species in Appendix II that are currently found in international trade. The section dealing with succulents and cycads includes two cycad species in Appendix II that provide adequate coverage of the requirements for Appendix II taxa. However, in terms of Article 3 of the Convention, Parties must also determine whether trade in specimens of Appendix I taxa is detrimental to the survival of the species and this is an important dimension for trade in cycads. As a result, this case study focuses on species of *Encephalartos* from South Africa.

I. Background information on the taxa

1. BIOLOGICAL DATA

1.1. Scientific and common names:

Encephalartos spp. cycads, broodbome, uMpanga

1.2. Distribution:

The genus *Encephalartos* currently comprises 68 species and is endemic to Africa. Species occur predominantly in south and east Africa but are also distributed across central Africa to Angola, Benin and Ghana in the west (Fig.1). The majority of species occur in southern Africa and South Africa is a regional centre of diversity with 37 species. Within South Africa, species occur in an almost continuous range from Willowmore in the south to the Umtamvuna river on the border between the KwaZulu Natal and Eastern Cape provinces. In this region, cycads occur in most major river systems, at least in the gorges near to the coast. North of the Umtamvuna River, species tend to become more isolated with disjunct distributions. Several species occur on single isolated inselbergs or outcrops.

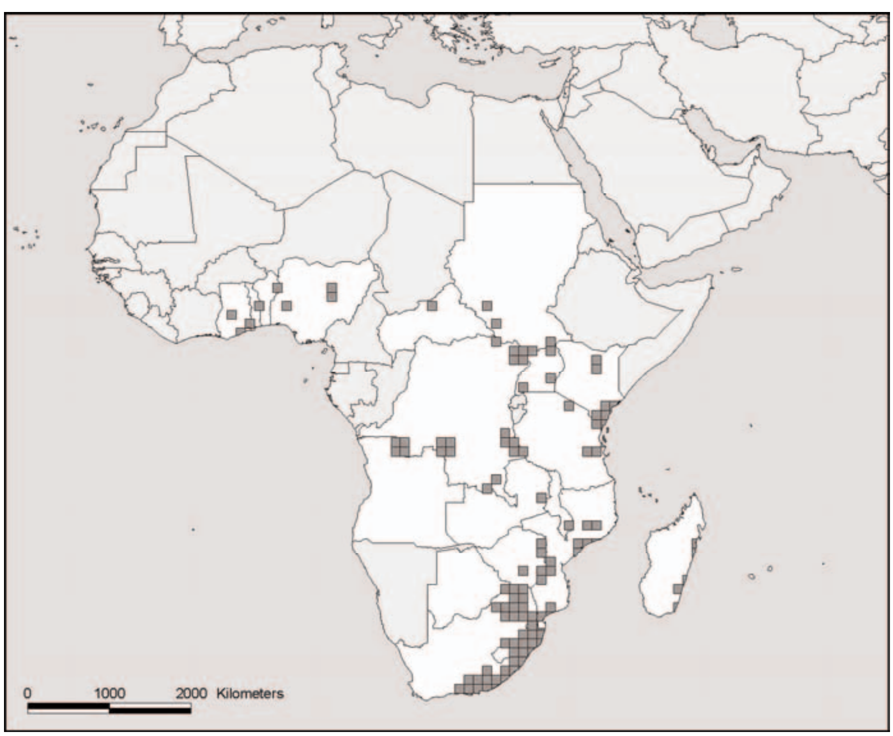


Fig. 1. Distribution of the African cycad genus *Encephalartos*

1.3. Biological characteristics

1.3.1. *Life History*

Encephalartos spp. are perennial dioecious plants. Of the 37 species in South Africa, three have subterranean stems, three are dwarf species, and the remainder are classified as trees. *Encephalartos* spp. are all classified as long-lived but the average adult life span for different species varies from ca. 150 years for species with single subterranean stems (e.g. *E. villosus*) to > 1000 years for multistemmed species (e.g. *E. cycadifolius*) (Raimondo & Donaldson 2003). Insect pollination by weevils and/ or languriid and cucujid beetles is known to occur in two species (Donaldson et al 1995; Donaldson 1997) and is thought to be the general condition in *Encephalartos* spp. Reproduction in all species is infrequent and irregular. Synchronous reproduction (mast seeding) occurs to some degree in most species (Donaldson 1994), meaning that there may be distinctive 'coning years' in which most adult individuals in a population will produce cones. At one stage it was thought that coning was induced by fire but experiments have only shown this to be true in one species (*E. cycadifolius*) whereas other species in fire prone habitats have shown no response.

The production of viable seed depends on population size. In very small populations of < 50 individuals, seed set is very low or non-existent, but in populations >250 individuals seed set is generally between 70 and 100%. Seed predation is common in *Encephalartos* spp. where weevils in the genus *Antliarhinus* can destroy up to 90% of the seed (Donaldson 1993). In most populations, seeds experience additional mortality due to desiccation so that only a small proportion germinates successfully. Species that have been studied in detail have either a reverse J-type curve with a high number of seeds and seedlings and a small number of mature plants (typically in mesic forest habitats), or a sigmoid curve with very few seedlings and a preponderance of adult plants (xeric and exposed habitats). These population profiles reflect a qualitative difference in habitats with seedlings tending to dominate in mesic forest environments and adult plants dominating in xeric environments and grasslands.

Comprehensive studies of large populations indicate that the sex ratio of *Encephalartos* spp is typically 1:1 (Grobbelaar 1999) although coning populations may show a male bias due to more frequent coning by male plants. Small populations also appear to have a strong male biased sex ratio (4:1) either due to selective harvesting of female plants or higher natural mortality in females.

Seed dispersal is one of the most poorly understood aspects of *Encephalartos* biology. Dispersal of the large seeds by birds (e.g. hornbills), rodents (e.g. vlei rats and squirrels), and baboons has been observed and seems to result in dispersal close to the parent plant. In some species (e.g. *E. cycadifolius*) caching by rodents is essential for seed survival.

Matrix projection models have been developed for two species of *Encephalartos* with different life histories and the models were used to explore the impacts of different harvesting practices (seed harvest, mature plants) (Raimondo & Donaldson 2003). Despite differences in longevity, seed production, and population structure, the results showed that survival was most sensitive to the number of reproductive adult plants in populations of both species. The implication is that for all groups of *Encephalartos* removal of adult plants would result in population decline whereas seed harvest did not seem to impact on population survival.

1.3.2. *Habitat types:*

Species of *Encephalartos* occur in three different habitat types – forest, grassland, and savanna. Species in forest and grassland tend to be specific to those habitats. The greatest diversity of species occurs in savanna and these species appear to tolerate a range of conditions from open habitats with little tree cover to closed canopy systems resembling forest.

1.3.3. *Role of the species in its ecosystem*

The role of cycads in ecosystems is not well understood. All cycads produce coralloid roots with symbiotic cyanobacteria that fix atmospheric nitrogen. However, the impact of this form of nitrogen fixation on nutrient dynamics is unknown. *Encephalartos* in South Africa host a greater diversity of insects than any other cycads studied so far with up to 12 cycad specific insects occurring on a single species. Several of these insects are rare in their own right and depend on their cycad hosts for survival.

Encephalartos spp. produce nutrient rich seeds and birds, monkeys, baboons, and rodents feed on either the carbohydrate rich sarcotesta or, occasionally, on the starch and protein rich gametophyte. When cycads populations are in cone, they can produce significant resources for local wildlife but it is not known to what extent animals are dependent on these resources.

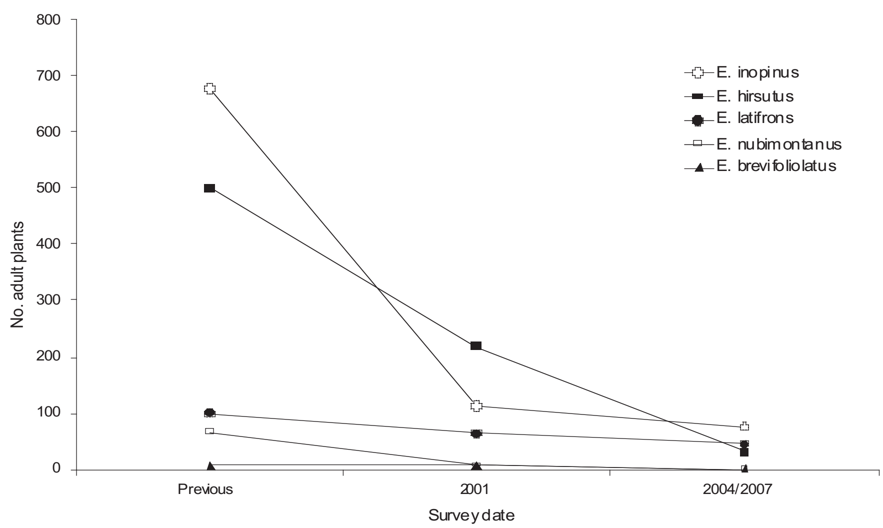
1.4. Population:

1.4.1. *For the 12 Critically Endangered species from South Africa, population sizes range from <100 for* E. latifrons, E. inopinus, E. cerinus, *and* E. msinganus*, to at most a few hundred individuals for other species.*

1.4.2. *Current global population trends:*

___increasing __X__decreasing ____ stable ____unknown

Almost all populations of threatened *Encephalartos* species have declined over the past 20 years. Monitoring data for individual species (Fig. 2) show that some of these declines have been dramatic and, in two cases, have resulted in extinction in the wild.



s of
opu-
lation status between 1985 and 1995)

1.5. Conservation status

1.5.1. *Global conservation status (according to IUCN Red List):*

__x_Critically endangered __x__Near Threatened
__x_Endangered __x_Least concern
__x_Vulnerable ___Data deficient

The global cycad conservation assessment was recently completed by the IUCN/SSC Cycad Specialist Group. The assessment paints a bleak picture for South African species of *Encephalartos*. In total, 73% of the South African species are classified as threatened with extinction, comprising 3 species that are Extinct in the Wild (8%), 12 that are CR (32%), 4 that are EN, and 8 that are VU. Only 10 species are regarded as Near Threatened or Least Concern.

1.5.2. *National conservation status for the case study country*

Almost all the cycads occurring in South Africa are endemic to the country (only five species have a cross border distribution), so the IUCN status (under 16.1) represents the national and global status.

1.5.3. *Main threats within the case study country*

____No Threats
__X_Habitat Loss/Degradation (human induced)
__X_Invasive alien species (directly affecting the species)
__X_Harvesting [hunting/gathering]
____Accidental mortality (e.g. Bycatch)
____Persecution (e.g. Pest control)
____Pollution (affecting habitat and/or species)
____Other_______________
____Unknown

The threats have been studied in some detail. A repeat photograph study concluded in 1999 that most of the decline was associated with removal of adult plants, with a much smaller threat associated with habitat loss or degradation. Invasive species do occur in some habitats but only have a direct impact on ca. 10% of cycad habitats.

2. SPECIES MANAGEMENT WITHIN THE COUNTRY FOR WHICH CASE STUDY IS BEING PRESENTED

2.1. Management measures

2.1.1. *Management history*

South Africa has only recently introduced an obligation for management plans as part of the regulations promulgated in terms of the National Environmental Management Biodiversity Act of 2004 (NEMBA). The responsibility for managing cycad populations is devolved to the six provincial governments where cycads occur naturally and, prior to NEMBA, most provinces had developed their own cycad management plans and strategies. The now defunct Transvaal Provincial Administration had a comprehensive management plan for the ca. 16 species that occurred within the province, which included on site management, surveys, an ex situ nursery, and restoration programmes. Aspects of this programme have been continued and modified by the provinces established after 1994. The KwaZulu-Natal province has also established a comprehensive cycad conservation strategy.

2.1.2. *Purpose of the management plan in place*

The management plans are intended to provide a framework for co-ordinated action to conserve cycads. In some cases this may include aspects intended to support sustainable use.

2.1.3. *General elements of the management plan*

The elements of management plans developed in terms of NEMBA are still being finalised but the draft template includes the following elements.

- Conservation status of the species
- Species details (taxonomy, distribution, ex situ populations, threats, socio-economic issues)
- Planning methodology
- Threats
- Action Plan to address threats
- Habitat conservation
- Harvesting
- Ex situ conservation
- Restoration
- Responsibilities (lead agents)
- Monitoring programme

2.1.4. *Restoration or alleviation measures: see 2.1.3*

2.2. Monitoring system

The monitoring systems currently in place are in the form of general surveillance monitoring and are not necessarily linked to a management plan. Two forms of monitoring are in place: 1) some provinces have continued with helicopter surveys that were first initiated in ca. 1985. These surveys provide excellent baseline information for plants that can be spotted from the air and that may be difficult to survey on the ground. 2) Some conservation agencies and research units (SANBI) have set up site based monitoring programmes. These monitoring programmes provide more detailed information on population status and demography.

Additional monitoring may be required for management plans developed in terms of section 2.1 (above) because the monitoring will need to inform the management plan by providing specific feedback (e.g. are restored plants surviving or has the management plan reduced illegal harvesting).

2.2.1. *Methods used to monitor harvest*

Harvest of wild plants is prohibited for both local and international trade. Only seeds are allowed to be harvested from some populations. Monitoring occurs on an ad hoc basis where seed harvesting is allowed. Typically monitoring involves either direct observation during harvesting or checking the number of seeds collected after harvesting.

2.2.2. *Confidence in the use of monitoring*

There is too little information available on monitoring to test confidence in the methods being applied.

2.3. Legal framework and law enforcement: Provide details of national and international legislation relating to the conservation of the species.

All species of *Encephalartos* are listed in CITES Appendix I and this means that international trade is restricted to artificially propagated specimens. In South Africa, the most threatened cycads are protected by the Threatened or Protected Species (TOPS) regulations, published in terms of the National Environmental Management-Biodiversity Act of 2004 (NEMBA). These regulations make special provision for listed threatened or protected *Encephalartos* species, and prohibit specific activities unless they form part of a species management plan. Such activities include collecting, damaging or destroying wild specimens of any listed *Encephalartos* species, or trading in specimens above a certain size. A key provision of the regulations is that certain activities can be allowed as part of an approved management plan for the species.

The NEMBA regulations provide a minimum set of national regulations. Provincial governments are obliged to enforce these minimum regulations but may then promulgate more stringent regulations. Each province has its own provincial ordinances with provisions for threatened or protected species.

3. UTILIZATION AND TRADE FOR RANGE STATE FOR WHICH CASE STUDY IS BEING PRESENTED

3.1. Types of trade

Historically, species of *Encephalartos* have been used as a source of starch by indigenous people, usually in times of famine. This practice was first documented in South Africa in 1772 (Masson 1779) and explains the derivation of the Afrikaans common name (broodboom = bread tree). This practice seems to have disappeared in South Africa and has only been recorded in Mozambique in recent times, where local people may harvest entire stems to obtain an edible starch.

Although there is almost no documented information on this form of use, it seems to be very rare, highly localised, and only occurs in subsistence economies.

Fig. 3. *Encephalartos* bark (circled) for sale in a muthi market

A more common local practice is the harvesting of sections of the outer bark for medicinal use. The precise medicinal purpose is not known, but an increase in this form of harvesting has been noted in numerous wild localities across South Africa. The harvesting is not species specific and almost all arborescent species of *Encephalartos* are utilised. Sections of bark (ca. 15 cm^2) are stripped from the plant and then sold at 'muthi' markets as part of the substantial local trade in medicinal plants. At this stage, most (and perhaps all) of the trade is from wild plants and the trade is either within South Africa or may involve cross border trade with Swaziland, Mocambique and Lesotho.

Although the intentional removal of cycads from grazing land (to prevent neurological effects in cattle) is well known in other cycad hotspots (e.g. Australia and Mexico), this has not been recorded in South Africa.

By far the largest trade in *Encephalartos* is for horticultural purposes. Cycads are popular collector plants and have achieved iconic status in suburban gardens. Most retail nurseries only deal in one or two relatively common species (e.g. *E. altensteinii*) but specialist cycad nurseries trade in a wider variety of species, including Critically Endangered species and even species that have recently become Extinct in the Wild (e.g. *E. nubimontanus*). The internal trade in South Africa has not been quantified but is generally considered to be substantial and often includes relatively large plants. There is also a substantial informal trade between collectors.

3.2. Harvest:

3.2.1. *Harvesting regime*

Some provinces allow the harvest of seeds from wild populations. The level of harvest varies between species. In some cases, e.g. *E. latifrons*, all the seeds are harvested because seed mortality is exceptionally high and better conservation results are obtained from re-introducing propagated seedlings. In all cases, seed harvest occurs as soon as the female cone has disintegrated. The seeds typically dry out within a month after dehiscence except for a small proportion that are dispersed to moist sites.

3.2.2. *Harvest management/ control (quotas, seasons, permits, etc.)*

Where seed harvesting occurs, it is usually managed on a quota system based on total population size.

3.3. Legal and illegal trade levels:

There is currently no mechanism for monitoring legal trade within South Africa. Some provinces have required permits for possession of cycads in the past and the new NEMBA regulations require possession permits. However, these data were not available for analysis.

International trade has been analysed using the CITES data compiled by UNEP World Conservation Monitoring Centre. The data show that there is a relatively small legal export trade in seeds (Fig. 4) and live plants (Fig. 5) of *Encephalartos* species. Legal export of live plants from South Africa comprised <20,000 specimens over 20 years for the most heavily traded species. This is a very small number compared to the several million specimens traded internationally for commercially popular cycad species such as *Cycas revoluta*. The majority of these plants were traded as artificially propagated specimens although this is difficult to prove (see under NDF section) and there is a high probability wild collected plants are included in shipments of apparently artificially propagated specimens.

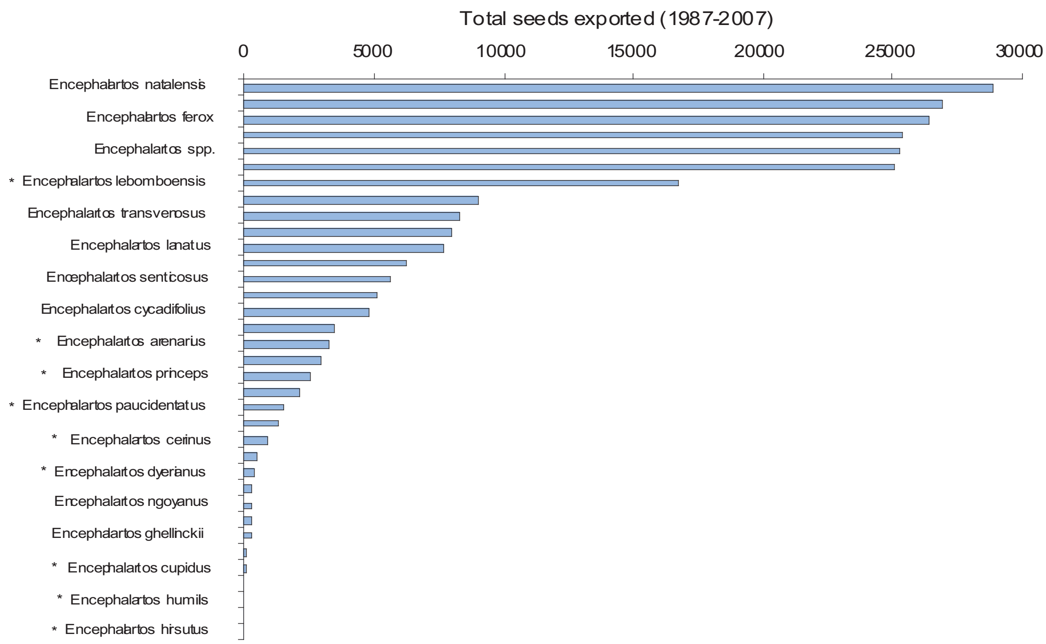
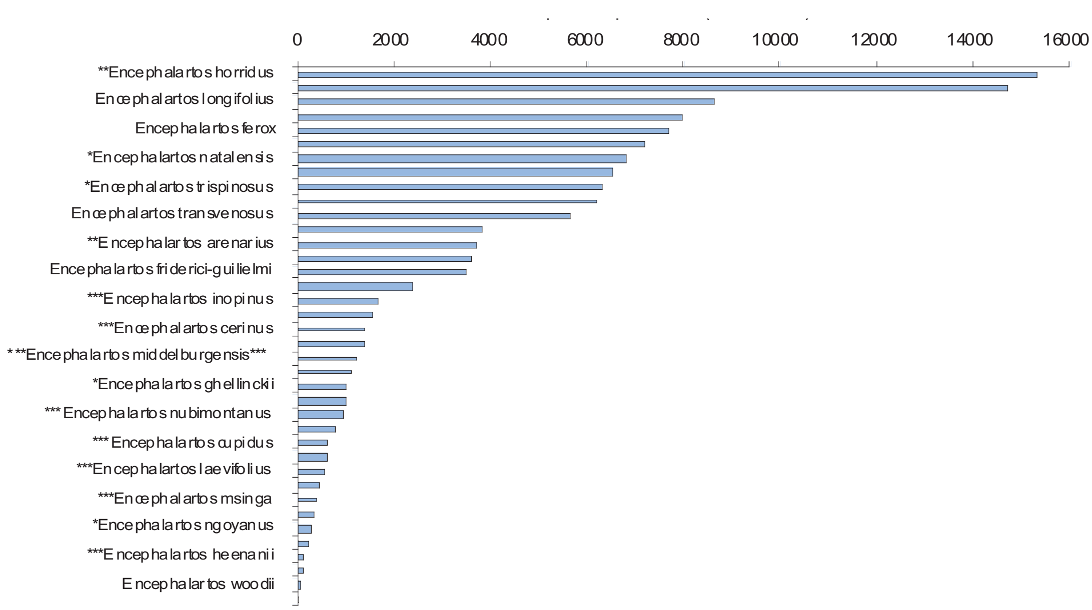


Fig. 4. T
and 2007. CITES data compiled by UNEP WCMC.



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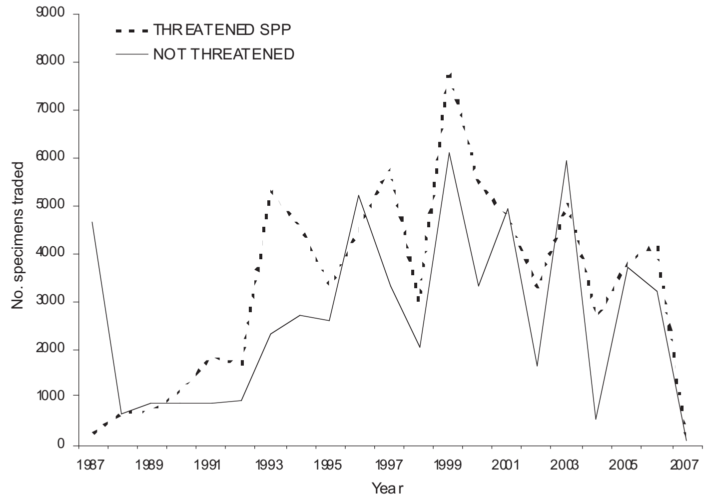
cies between 1987 and 2007. CITES data compiled by WCMC.

In 2007, several provinces imposed a moratorium on cycad exports until new regulations could be introduced. This is reflected in the trade figures for that year from the CITES database.



South Africa

3.3.2. *Illegal trade in specimens collected from wild localities is the greatest threat to cycads in South Africa.*

A study of repeat photographs completed in 1997 showed that 67% of the 130 populations included in the study had declined due to loss of adult plants, probably as a result of plant collecting. It is difficult to quantify the extent of the trade based on enforcement statistics but monitoring of specific populations has shown that dramatic declines have occurred due to illegal collecting. Good examples of this decline include the extinction (in the wild) of *E. brevifoliolatus* where the last remaining plants were taken out by collectors, the local extinction of *E. laevifolius* at Mariepskop in 2006, and the removal of > 100 plants of *E. dyerianus* from a secure locality in January 2008. Very often, the number of specimens removed seems small but the potential impact on species that have been reduced to <100 individuals can be catastrophic. In a highly publicised sting operation in the USA, 19 specimens of *E. hirsutus* were confiscated. At the time this constituted 10% of the entire wild population.

Trade in wild collected specimens is probably initially restricted to South Africa but there are strong indications that these plants eventually end up in international markets. The strength of trade within South Africa is regarded as one of the main drivers of decline and extinction. It is interesting to note that South Africa has a disproportionately high number of species classified as Critically Endangered and Extinct in the Wild compared to all other cycad hotspots (Mexico, Australia, S.E. Asia) and this is most likely due to the pressure from wild collecting that is linked to both local and international markets.

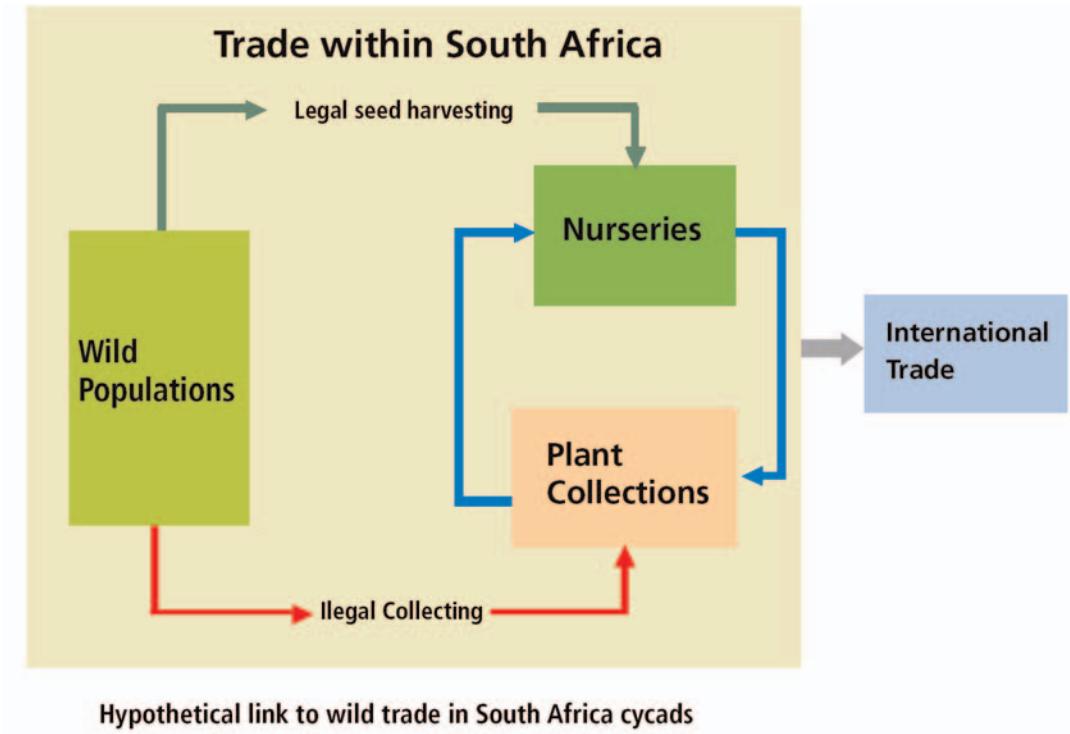


Fig. 7. Diagramatic representation of the possible link between wild trade and 'legal' international trade in *Encephalartos* species

II. NON-DETRIMENT FINDING PROCEDURE (NDFS)

A non-detriment finding relating to Appendix I cycad taxa needs to be informed by an assessment of how trade, even from supposedly artificially propagated sources, will impact on wild populations of the species. In the case of *Encephalartos* spp. from South Africa, the main concern is that illegal trade in wild collected specimens can be passed off as trade in artificially propagated specimens. The NDF assessment therefore needs to assess first whether trade is definitely from artificially propagated sources and, if there is any uncertainty in this respect, to assess the risk that the intended trade might have on wild populations.

1. IS THE METHODOLOGY USED BASED ON THE IUCN CHECKLIST FOR NDFS?

__Not Exactly. A decision tree for NDF assessments is provided in Fig. XX.

2. CRITERIA, PARAMETERS AND/OR INDICATORS USED

The NDF assessment for Encephalartos taxa needs to be based on the following five criteria.

a. *Proof of artificial propagation*

Artificial propagation is the crux for trade in Appendix I taxa and it is therefore included as the first criterion for the NDF assessment. There are various indicators that can or could be used to assess artificial propagation, i.e. plants that are traded as seedlings (plants with a trunk diameter <50mm); plants that are traded as a cohort of similar-aged seedlings (e.g. 10 or more plants of the same size); DNA fingerprinting of mother plant and "artificially propagated" plant indicates that specimen is the offspring of a cultivated mother plant (see section 4 below); and the registration of nurseries with verifiable parent stock as allowed under CITES. The propagation of plants from basal suckers taken off cultivated plants would also qualify as artificial propagation. These plants are more difficult to associate with parent plants without either regular inspection or genetic fingerprints. Suckers also represent a higher risk for wild populations because it is relatively easy to collect suckers in the wild and then pass them off as artificially propagated plants, and because suckering is an important strategy for survival in wild plants. For this reason, the assessment needs to be strictly applied to plants derived from suckers. The size thresholds that has been used to restrict trade in artificially propagated plants has in the past excluded plants that would most likely be derived from suckers.

b. *Identity of the specimens in trade*

One of the main concerns for cycad trade is that traders will purposefully misidentify plants so that trade in Critically Endangered or Endangered species, possibly of wild origin, can take place under the guise of more common species that are unlikely to raise suspicions among law enforcement agencies. The identity of any large specimens in trade is therefore a critical criterion for any NDF assessment. It is less of an issue for seedlings because the assumption is that seedlings are artificially propagated.

c. *Threatened status of the species in trade*

The species of greatest concern for NDF assessments are those classified as CR, EN and VU. Most of the other species are listed in CITES Appendix I for 'look a like' reasons. As a result, if specimens can be identified to species level, then the NDF assessment needs to focus on the CR, EN, and VU species. The assessment needs to be strictly followed for these species. For those species that are not threatened, a less rigorous assessment process can be followed.

One of the issues that must be considered in the NDF process is what to do about species that are Extinct in the Wild. Three species from South Africa fall into this category: *E. woodii*, which was only known from one plant that was removed from the wild 100 years ago before trade became an issue; *E. nubimontanus* and *E. brevifoliolatus* that became Extinct in the Wild as a result of recent trade in wild specimens. Trade in *E. woodii* has no negative impact on cycad conservation and is generally regarded as a positive action to ensure that the species survives in cultivation. However, trade in E. nubimontanus and E. brevifoliolatus needs to be regulated so that illegal collectors do not benefit from the EW status and to provide a framework for restoration efforts. As a result, these species that have recently been classified as EW (last 20 years) should be treated in the same way as CR species.

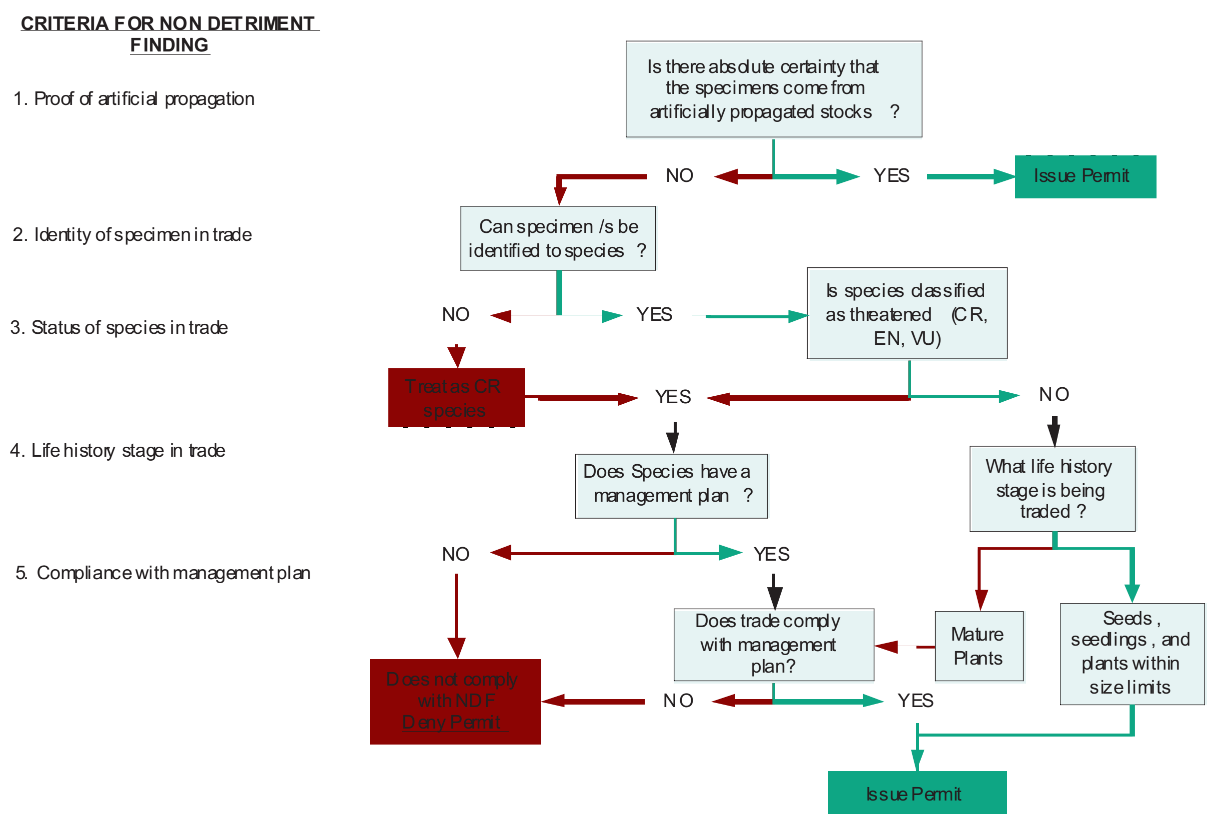
d. *Life history stage being traded*
Population studies and matrix models (see section 1.4.1) have shown that populations of *Encephalartos* are particularly sensitive to the removal of adult plants. As a result, trade in adult plants must be treated as a high risk activity if there is any uncertainty regarding the origins of the plants in trade (i.e. where proof of artificial propagation is missing). The NDF assessment should therefore only allow trade in mature plants if there is absolute certainty that they are from artificially propagated sources or if trade in mature plants forms part of a species management plan (e.g. removal of adult plants from development zones). However, at this time it is extremely difficult to manage trade in large plants. The use of microchips has been tried (so that specific plants can be identified) but with relatively little success.

In contrast, matrix models indicate that populations of *Encephalartos* species are quite resilient to the removal of seeds. Trade in seeds is therefore regarded as a low risk activity in terms of its likely impact on wild populations.

e. *Compliance with a management plan*
The NEMBA legislation makes provision for species management plans and the Threatened or Protected Species (TOPS) regulations developed under NEMBA stipulate that certain activities can only take place if they form part of a management plan. These management plans have specific actions, indicators, and mechanisms for monitoring. As a result, trade that occurs as part of a management plan represents a low risk activity and may even be essential for the survival of species in the wild. It is not possible to be too specific about these provisions

in the criteria or the decision tree because they will vary from species to species. For example, *E. latifrons* has been reduced to <60 mature plants where no natural seed set takes place. A draft management plan for the species advocates artificial pollination of wild plants and the use of these 'wild' seeds for propagation purposes. Sale of seedlings derived from these seeds is proposed as a mechanism to ensure sustainability of the project. In other species, artificial pollination is not necessary and other factors will be prioritised in management plans.

DECISION TREE FOR NON-DETRIMENT-FINDING REGARDING TRADE IN *ENCEPHALARTOS* SPECIES



African *Encephalartos* species (CITES Appendix I)

3. MAIN SOURCES OF DATA, INCLUDING FIELD EVALUATION OR SAMPLING METHODOLOGIES AND ANALYSIS USED

Proof of artificial propagation: the main sources of data for proof are those supplied by the grower/ trader (e.g. permits) and any verification provided by the provincial conservation authorities who act as the management authority for CITES.

Species identification: Cycads are difficult to identify in the seedling stage but seedlings are a low risk stage for assessment. Juvenile and adult stages are more important and the key factor here is that plants must have leaves present to facilitate identification. Recent tools that have been developed include a leaf key for species of Encephalartos.

Threatened status of species in trade: the threatened status of Encephalartos species has been determined by the South African National Biodiversity Institute (SANBI) and the IUCN/ SSC Cycad Specialist Group.

Life History stage: information on life history stage is supplied by the trader/ grower.

Compliance with management plans: this is a new requirement. Information on compliance will have to be supplied by the agency tasked with monitoring the implementation of a species management plan.

4. EVALUATION OF DATA QUANTITY AND QUALITY FOR THE ASSESSMENT

Proof of artificial propagation: Artificial propagation is difficult to prove and/ or monitor for cycad taxa because there is no definitive way to link propagated plants to specific parent plants. Permits are a very poor mechanism to prove artificial propagation because they can be obtained fraudulently. Pilot studies on the development of DNA fingerprints (initially using AFLP techniques) have shown potential but the technology has not yet been developed to a stage where it can be implemented. The main sources of data for proof are therefore those supplied by the grower/ trader and any verification provided by the provincial conservation authorities who act as the management authority for CITES. These sources of proof are often regarded with suspicion due to lack of enforcement capacity in the provinces and the only basis for assessment is the reputation of the grower and the availability of cultivated parent stock for propagation.

Species identification: although the taxonomy of South African *Encephalartos* spp is well known, plants are difficult to identify unless they are in cone. However, most plants in trade are immature and therefore do not have cones. The identification of seedlings is also particularly difficult because seedling leaves are different to those of mature plants. Identification keys based on leaf characters have been developed and, if properly applied, do provide accurate identification of plants (except seedlings).

Threatened status of species in trade: the data used to assess the threatened status of *Encephalartos* species is of a high quality and does not seem to be a constraint for NDF assessments.

Life History stage: Life history stage is relatively easy to determine and the quality of information is likely to be sufficient for an informed NDF assessment. The only problem is likely to be associated with plants that are propagated from suckers. Suckers are usually taken off the plant when the sucker is 10-15cm in diameter and the problem is that suckers taken off wild plants, or juvenile wild plants, could be illegally traded as artificially propagated suckers. Until genetic tests or alternative tests for linking suckers to specific parent plants are available, there will always be some uncertainty regarding propagation.

Compliance with management plans: this is a new requirement and it is not yet possible to assess the quality of information that will be supplied.

5. MAIN PROBLEMS, CHALLENGES OR DIFFICULTIES FOUND ON THE ELABORATION OF NDF

The main problem with NDFs for South African *Encephalartos* species relates to two specific issues: a) problems with identification of species in trade and b) verification of artificial propagation. Until these issues are resolved, there will always be some uncertainty regarding the possible impact of trade on wild populations and, particularly, on the survival of Critically Endangered species.

6. RECOMMENDATIONS

Proper application of NDFs for *Encephalartos* species requires the development of tools to assist with identification of specimens in trade and to verify the source of artificially propagated material. At present, genetic markers seem to offer the best solution to both these problems. AFLP markers have been tried with limited success and additional projects are being investigated using microsatellite techniques. These tools have the potential to assist with maternity testing (i.e. linking plants in trade to specific parents from cultivated stocks) and identifying species.

However, genetic tools are not the only option. The development of management plans in terms of NEMBA offers a potentially powerful tool for assessing trade within the context of an overall management plan for the species. The management plan for a Critically Endangered species is likely to include assessments of plants in the wild and in *ex situ* facilities as well as the capacity for nurseries to produce artificially propagated material. These plans should therefore provide access to specific data that can be more easily monitored and assessed. DNA tools may still be needed to assist with monitoring components of the management plan but other tools can be applied until molecular techniques are better developed.

By way of example, the draft management plan for *E. latifrons* includes the following components that can all be monitored and verified:

- Number of mature plants in the wild by locality (monitored to detect any decline)
- Artificial pollination of wild plants using wild pollen supplemented by pollen from known and genetically diverse sources (number of cones pollinated and number of seeds produced)
- Propagation of plants from wild sources (number of plants)
- Propagation of plants from ex situ sources of known provenance
- Plants introduced into wild localities (number of plants by locality)
- Plants in collections that can be registered as sources of seeds for artificial propagation

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NDF WORKSHOP
WG 3 – Succulents and Cycads
CASE STUDY 4 SUMMARY
Encephalartos
Country – **South Africa**
Original language – English

SOUTH AFRICAN *ENCEPHALARTOS* SPECIES

AUTHOR:
John Donaldson

The African cycad genus *Encephalartos* is globally one of the most threatened groups of plants and trade in wild plants is one of the main causes of decline. The centre of diversity for African cycads is in South Africa, where 73% of the 37 species are listed as threatened and 12 species are categorised as Critically Endangered. The single greatest cause of decline is wild collecting for both domestic and international markets. The genus is listed in CITES Appendix I and Article 3 of the Convention compels Parties to determine whether trade in specimens of Appendix I taxa is detrimental to the survival of the species and this is an important dimension for trade in *Encephalartos* from South Africa.

Non-detriment findings have been done on an *ad-hoc* basis but several provincial scientific authorities and the South African National Biodiversity Institute have been working towards a framework for non-detriment findings that is supported by recent legislation. The main components of the NDF assessment focus on the risk factors for wild populations, i.e. proof of artificial propagation, the identification of species in trade, the threat status, life history stage, and compliance with management plans. A decision tree is presented that enables authorities to determine the likelihood that trade will have an impact on wild populations.

Two critical factors for NDF assessments were identified: a) problems with identification of species in trade and b) verification of artificial propagation. Until these issues are resolved, there will always be some uncertainty regarding the possible impact of trade on wild populations and, particularly, on the survival of Critically Endangered species. As a result, the main recommendations arising from this case study emphasize that proper application of NDFs for *Encephalartos* species requires the development of tools to assist with identification of specimens in trade and to verify the source of artificially propagated material. At present, genetic markers seem to offer the best solution to both these problems, but they require further development and refinement.

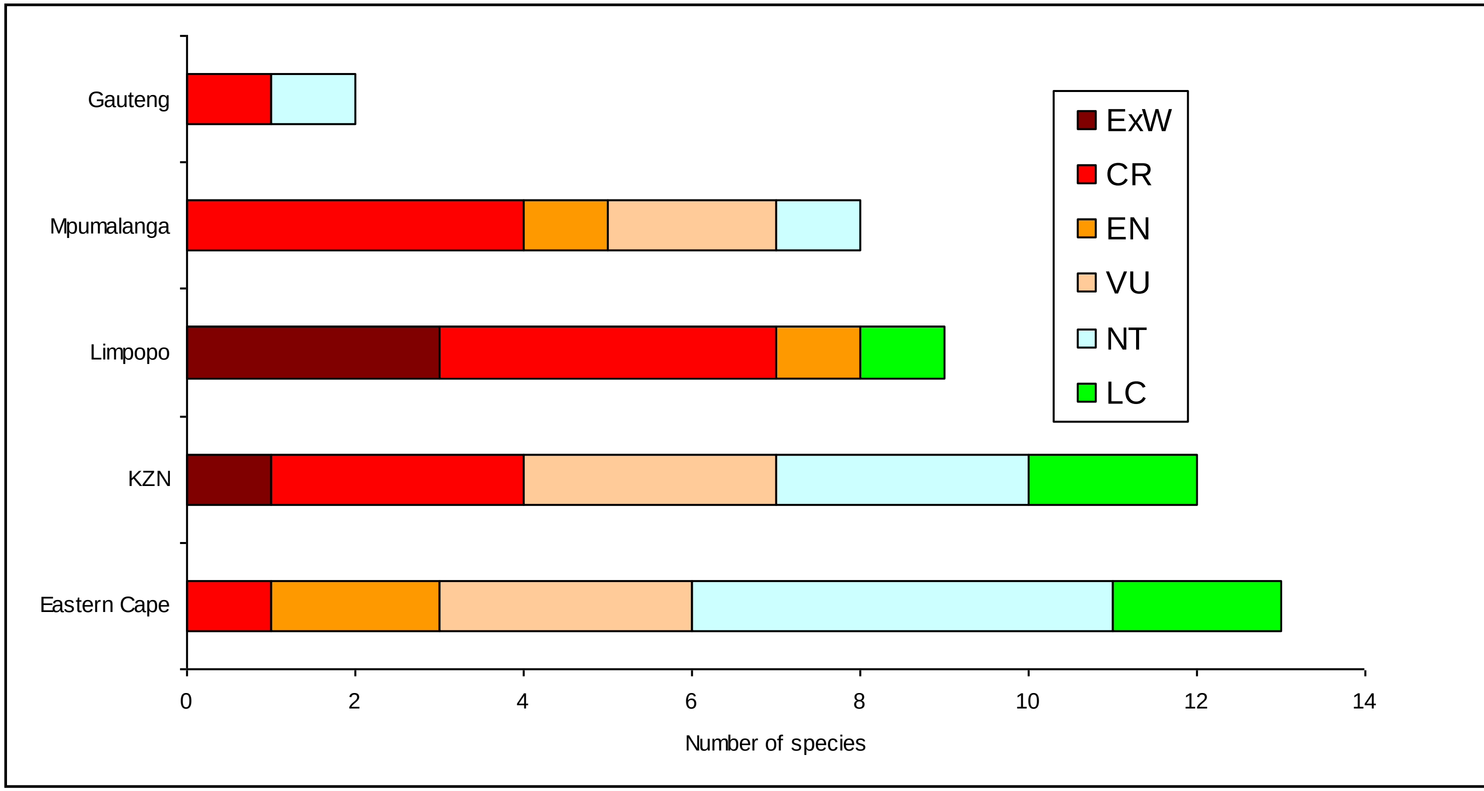
CITES-NDF Workshop

Case Study: South African *Encephalartos* spp.

SOUTH AFRICAN
national
biodiversity
institute
S A N B I

Encephalartos
37 spp in South Africa

Threatened status in South Africa



Declines in South African cycads

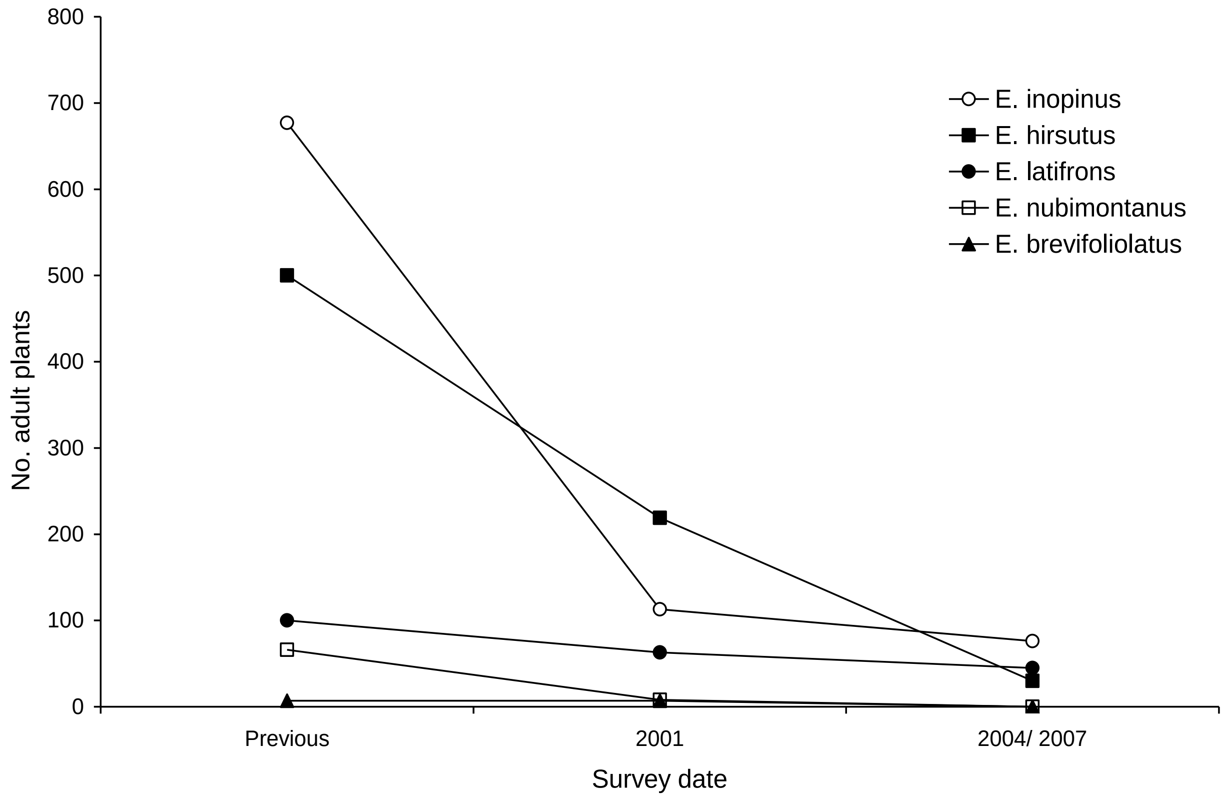
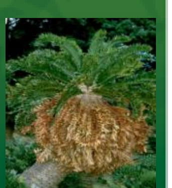


Fig. 2. Population trends for 5 Critically Endangered (one now EW) species of *Encephalartos* from South Africa. The first data point (previous) represents the population status between 1985 and 1995)

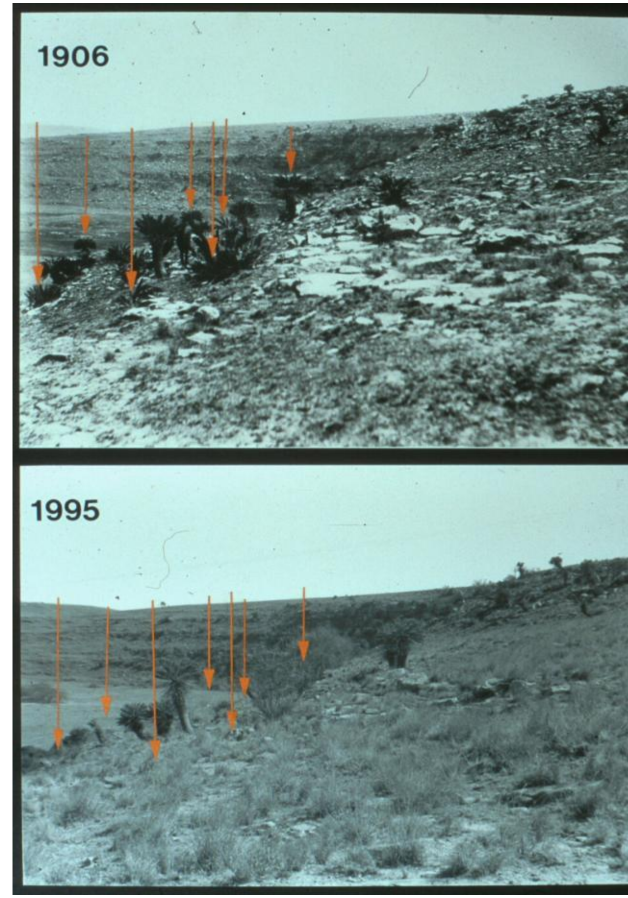


Trade & decline

Fig. 3. *Encephalartos* bark (circled) for sale in a muthi market

10%

67%



Trade in SA *Encephalartos*

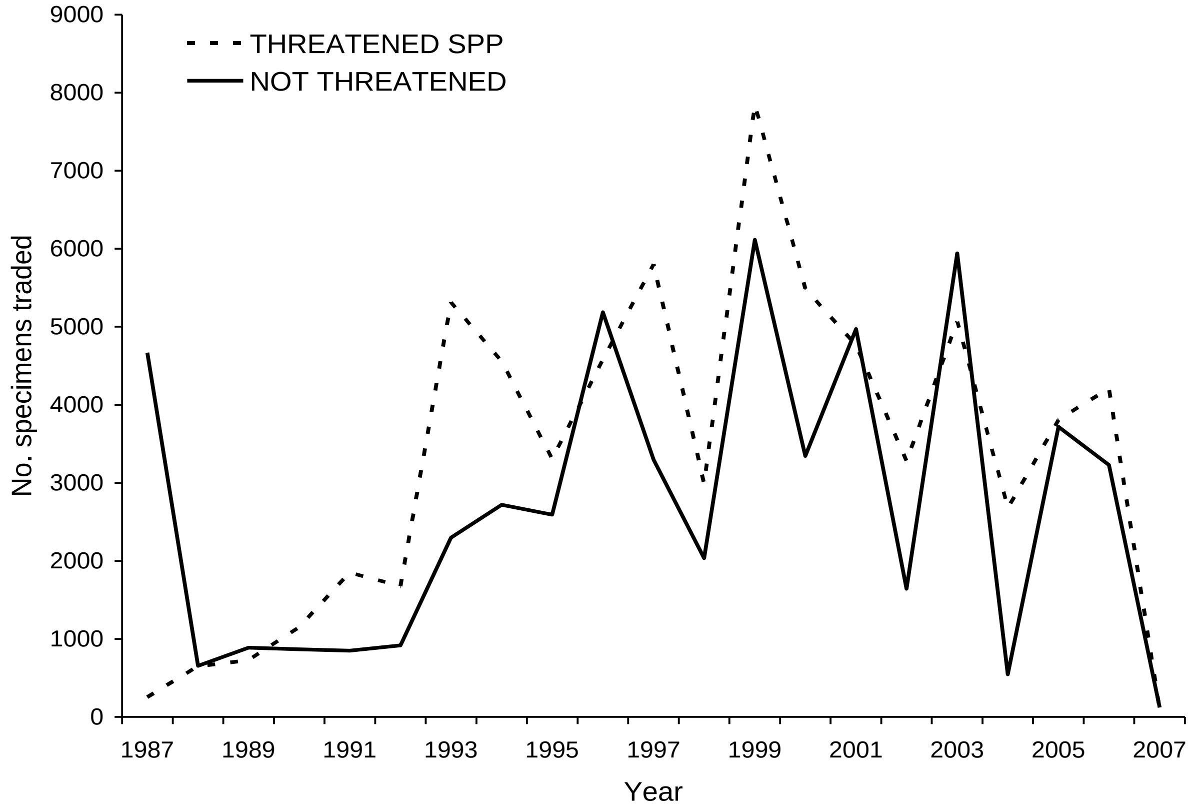
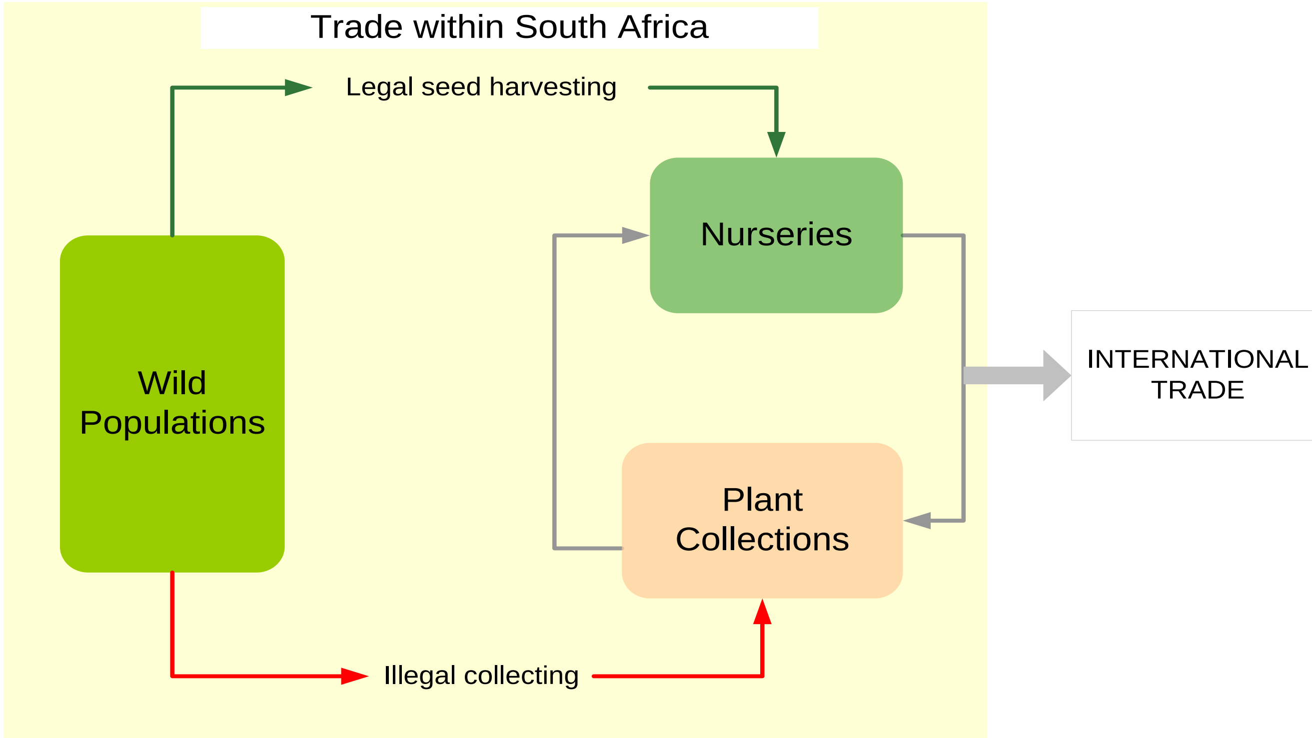


Fig. 6. Exports of indigenous *Encephalartos* species (live plants) from South Africa during the period 1987-2007



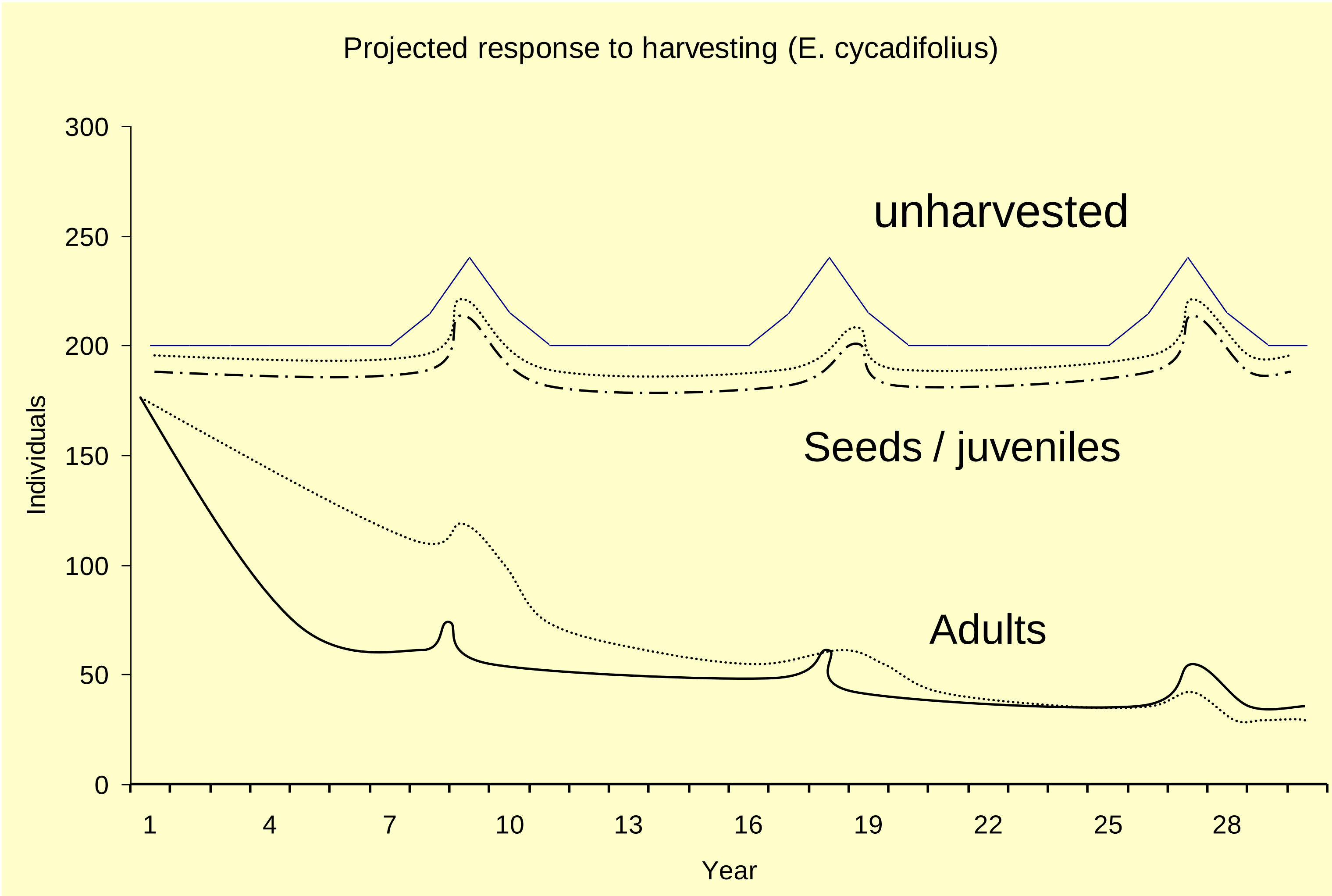
Hypothetical link to wild trade in South African cycads

Fig. 7. Diagramatic representation of the possible link between wild trade and 'legal' international trade in *Encephalartos* species

Population data

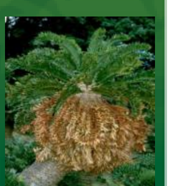
- General biology
- Population size
- Conservation status
- Demography (50%)
- Long term trends (30%)
- Site monitoring
    - 10 yrs (2 spp)
    - ad hoc (8 spp)

Modeling populations

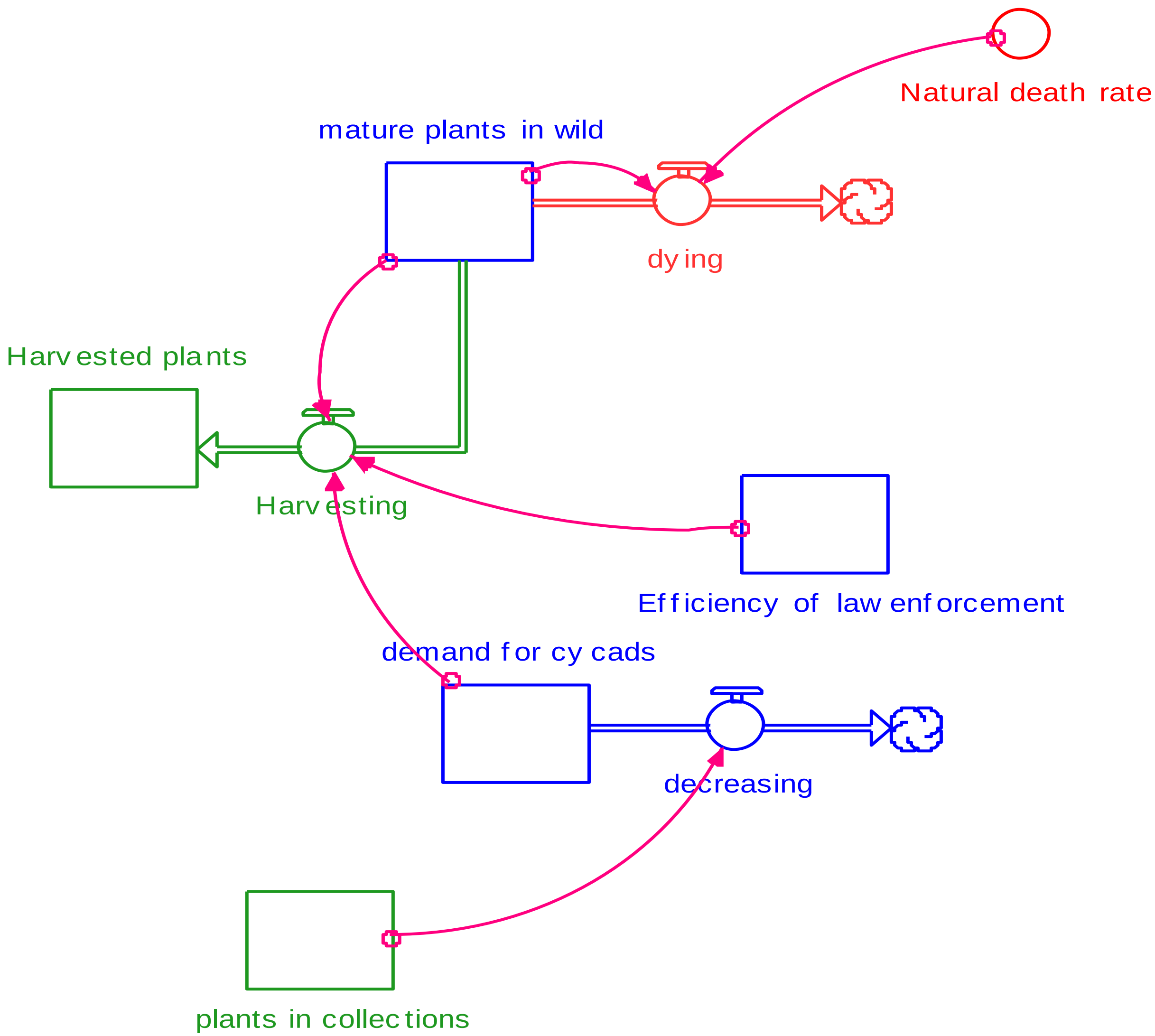


Lessons from population models

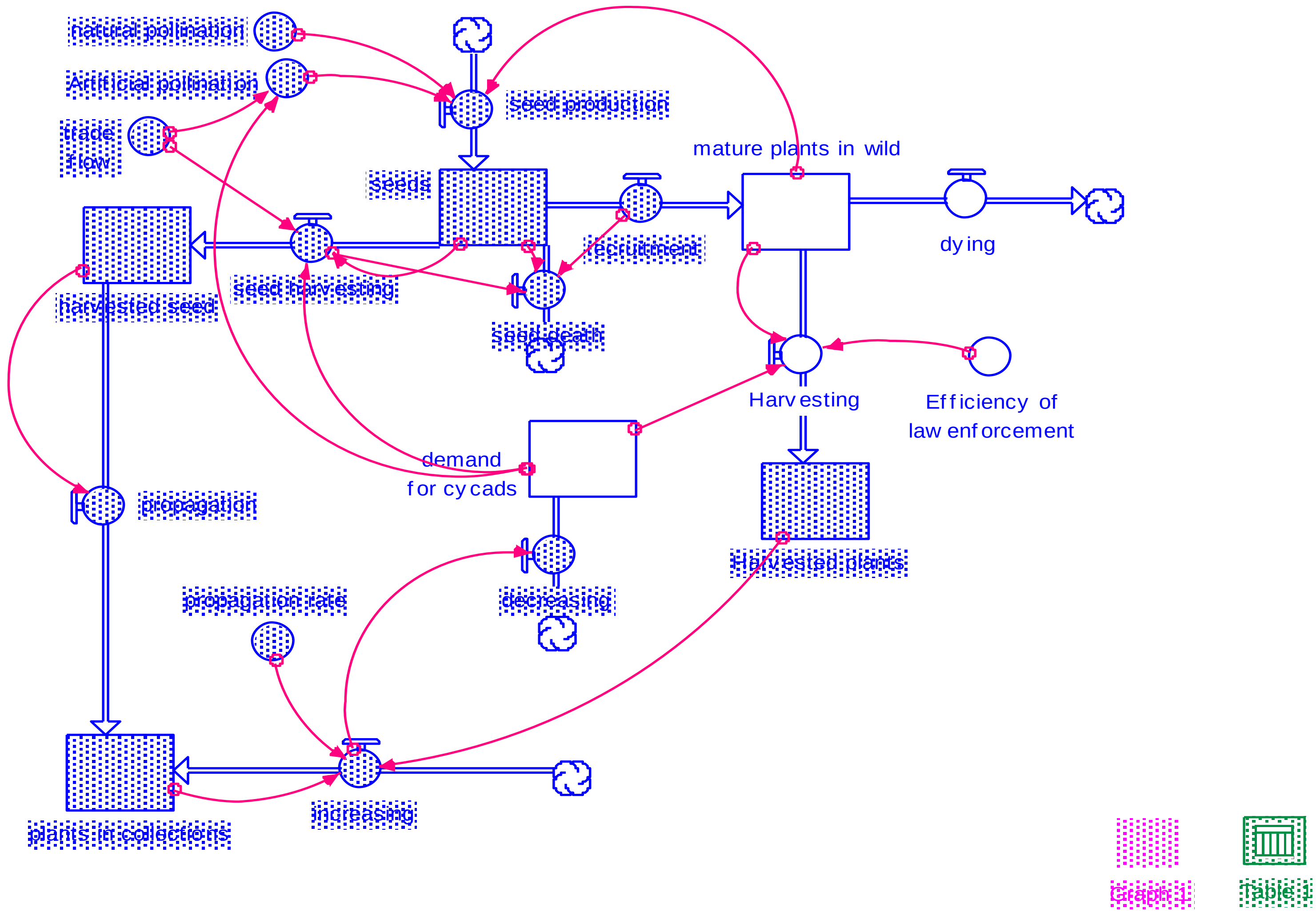
- Similar risk factors irrespective of life history
- Seeds were least vulnerable stage (harvest had almost zero impact)
- Adult plants were most vulnerable, irrespective of population size



Modeling cycad population / trade

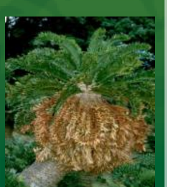


Stock Flow models



Lessons from stock-flow models

- Need to concentrate on factors that decrease loss of mature plants
- Enforcement is critical
- Incentives are critical (especially if artificial pollination or site management is necessary)
- Therefore, NDF needs to consider trade as a risk and a benefit



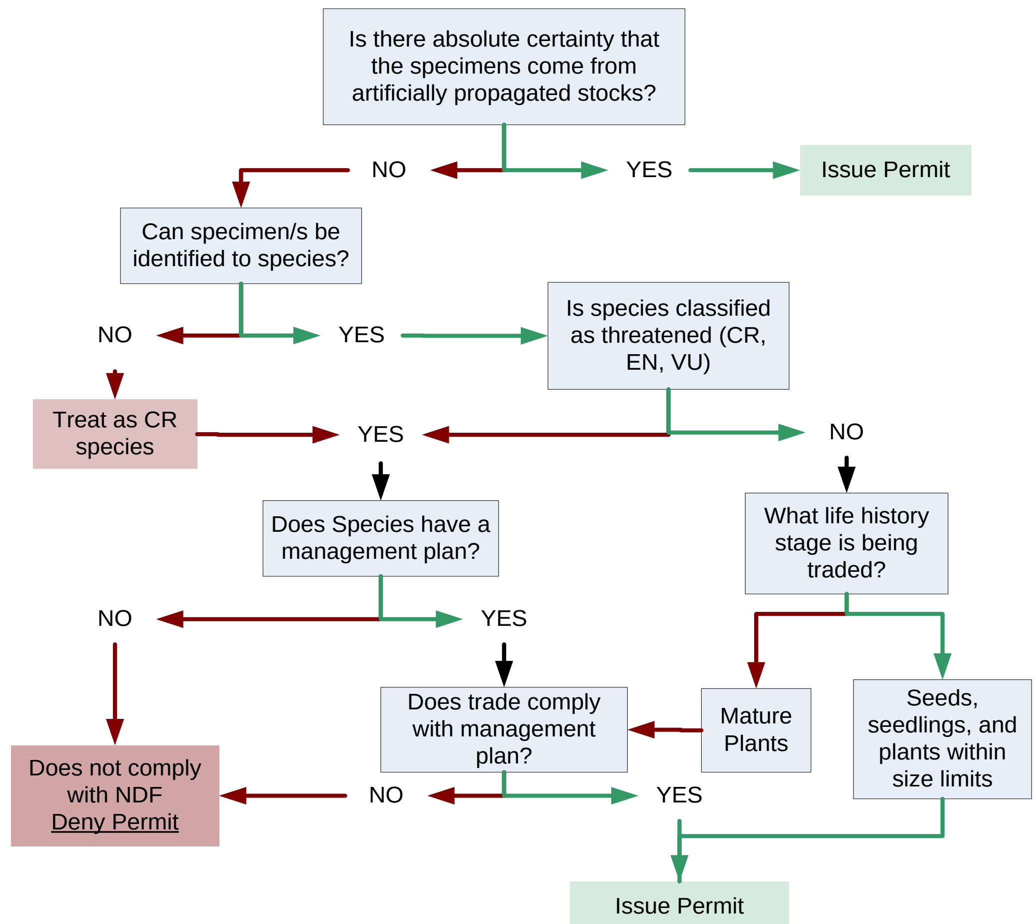
Key factors for NDF assessment

- Proof of artificial propagation:
- Species identification:
- Threatened status (population size)
- Life History stage:
- Compliance with management plans:

DECISION TREE FOR NON-DETRIMENT-FINDING REGARDING TRADE IN *ENCEPHALARTOS* SPECIES

CRITERIA FOR NON DETRIMENT FINDING

1. Proof of artificial propagation
2. Identity of specimen in trade
3. Status of species in trade
4. Life history stage in trade
5. Compliance with management plan



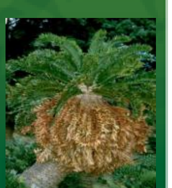


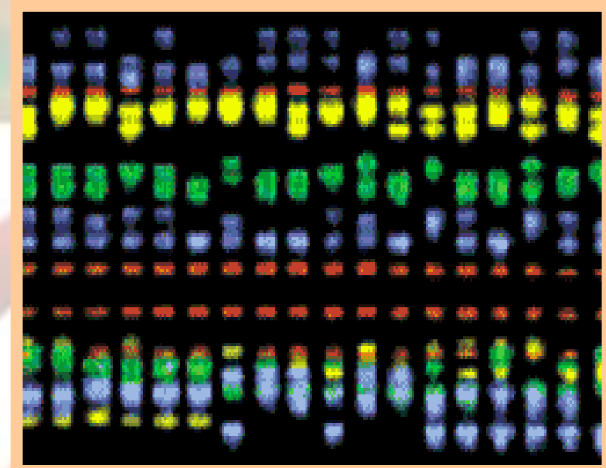
Fig. 8. Decision tree to support Non Detriment Findings relating to trade in South African *Encephalartos* species (CITES Appendix I)

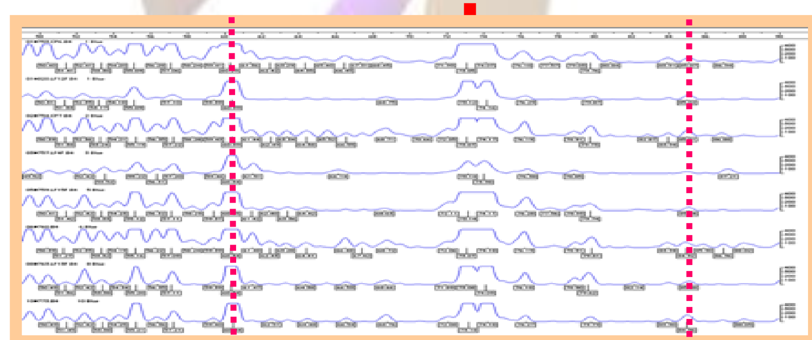
Main problems/ uncertainties

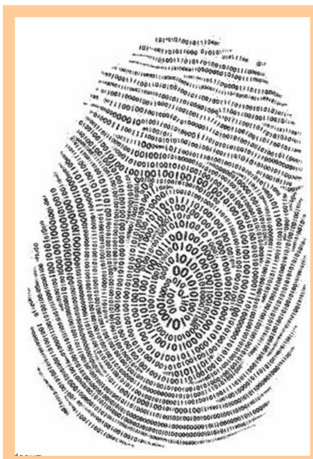
- ALL LINKED TO ILLEGAL TRADE
- Mixing wild and artificially propagated stock
- Trading rare species under false names:

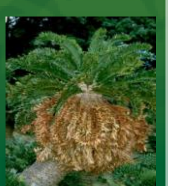
- NDF needs to deal with species identification and proof of artificial propagation:
- Compliance with management plans can achieve this:

DNA fingerprinting









CYCAS CIRCINALIS L. IN INDIA

AUTHORS:
Anita Varghese and Tamara Ticktin
Keystone Foundation (www.keystone-foundation) in collaboration with People and Plants International (www.peopleandplants.org) and University of Hawaii (www.botany.hawaii.edu/faculty/ticktin).

I. Background information on the taxa

1. BIOLOGICAL DATA

1.1. Scientific and common names:

Cycas circinalis L. Vernacular names: Hindi-Jangli madan must ka phul; Kannada-Mund isalu, Goddu eechalu; Malayalam-Eentha panna; Marathi-Malabari supari; Sanskrit-Hintalah; Tamil-Madana kama raja, Salaparai, Eentha panai; Telugu-Rana guvva, Per ita, Madana Kamakshi.

1.2. Distribution

C. circinalis is an endemic restricted to the Western Ghats (Fig.1) and hilly regions of the southern peninsula, in the states of Kerala, Karnataka, Tamil Nadu, and the south of Maharashtra (Hill 1995). *C. circinalis* is usually found in fairly dense, seasonally dry scrubby woodlands in hilly areas.

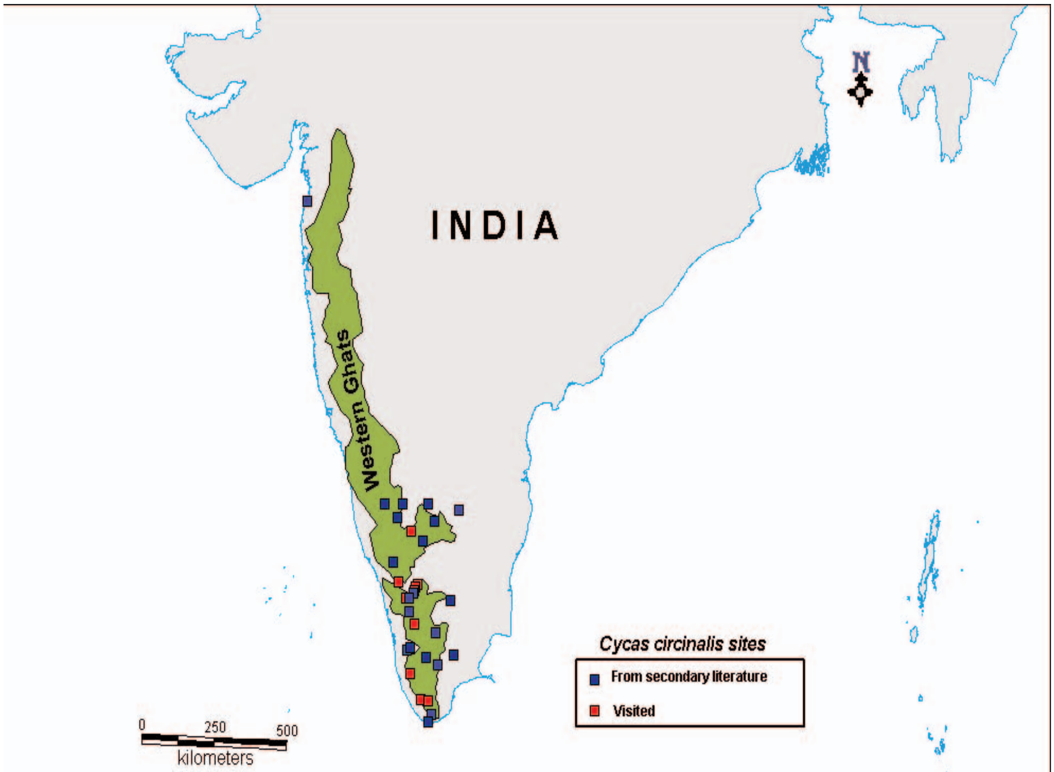


Fig.1 – Locations of *C.circinalis* populations along the Western Ghats, India.

1.3. Biological characteristics

1.3.1. *General biological and life history characteristics of the species*

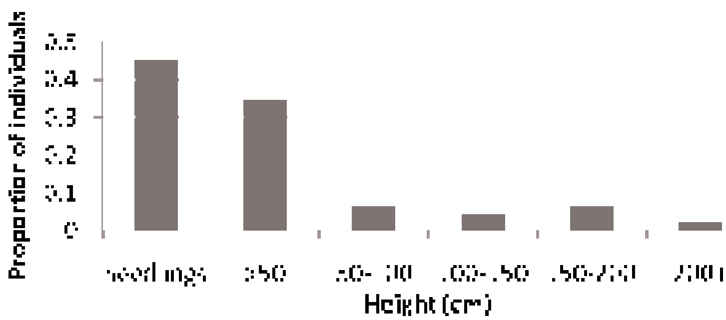
Very little is known to date about *C. circinalis* rates of reproduction, recruitment, survival,or sex ratios although this information is currently being gathered. There is some information available on population structure, impacts of harvest, and rates of leaf production. In a study of the population structure of *C.circinalis* in the Nilgiri Biosphere Reserve (Varghese & Ticktin 2006), it was found that populations that were harvested only for seeds showed a reverse J curve, with many individuals in the smaller size classes. This suggests good levels of regeneration despite seed harvest.

Populations subject to seed and leaf harvest showed a much lower proportion of seedlings and saplings. This may indicate lower rates of regeneration as compared to those populations that are not harvested for their leaves. In addition there were no individuals in the 150-200 cm height size class. The very high rates of leaf harvest (92% of all individuals > 20 cm high were harvested for their leaves, and 91.3 ± 15 % of all leaves per tree were harvested) reported above suggest that the lack of individuals in this size-class could be a result of repeated overharvest of leaves.

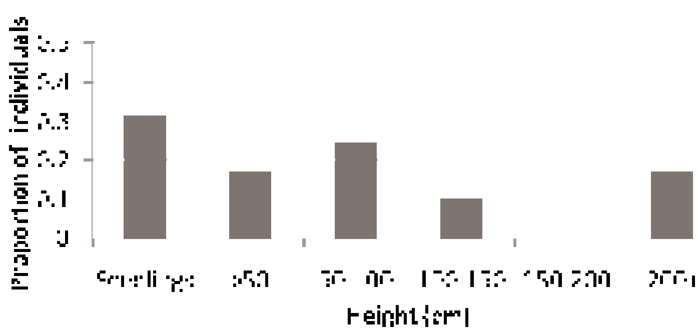
The structure of the populations subject to seed, leaf, stem and male cone harvest consisted almost entirely of individuals in the smallest size classes. There were no individuals larger than 100 cm in height. The one exception was one very large individual (> 200 cm height), but this was found among rocks and highly inaccessible. The lack of adult individuals points to high levels of stem harvest and depletion of the adult population.

Fig 2. Population structure of *C. circinalis* is dependent on harvest type ($X^2 = 25.02$ $p < 0.001$)

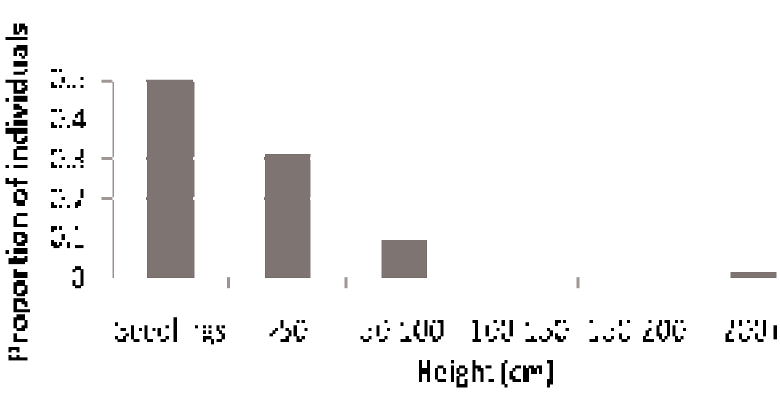
a. Seed harvest only, N= 63



b. Seed and leaf harvest, N=33



c. Seed, leaf and stem harvest, N=69.



Rates of leaf production are greatly variable, with larger individuals producing more leaves per year and individuals in areas of higher precipitation producing a greater number of leaves per year. Individuals in mid elevation dry deciduous forests appear to produce a flush of leaves only once per year, even when harvested, whereas as harvested individuals in low elevation wetter forests produce leaves throughout the year.

Branching appears to be a response to heavy leaf harvest. None of the *C. circinalis* individuals in populations that were not harvested for their leaves showed any branching. However, 21.3 % of the individuals in leaf harvested populations were branched, with the main apical meristem not producing leaves anymore.

1.3.2. *Habitat types:*

Found from the coast up to 1200m in the hills. Mostly in the mid elevation deciduous tracts of the hills, low elevation moist deciduous forests and along the low elevation riverine vegetation. Also found in the low elevation teak plantations of Kerala. Appears to grow profusedly in fire prone areas. The regeneration levels were observed to be very high. One of the populations along the hills in the Nilgiris were observed on steep slopes that were prone to land slips.

1.3.3. *Role of the species in its ecosystem*

BUTTERFLY – Plains cupid butterfly was observed laying eggs on the immature leaves. The larvae rested at the base of leaf and in a period of 7-9 days emerged.

SPIDER – One species of Signature Spider was observed weaving its web on the leaves.

BATS – The juices of the seed coat are ingested by bats and the seed is dispersed. Rates of regeneration from partially eaten seeds are being recorded at the nursery.

Indian Sambar Deer-The Sambar deer found throughout Asia feeds on the acrid tasting fibrous seed with little flesh.

BEES – Dammer bees were observed collecting resinous sap from the tender leaves of the plant.

Ants – Two species of ants were also observed on *Cycas circinalis* trees, collecting the resinous sap from the young unfurling leaves of the cycad and collecting secretions from the bodies of plains cupid butterfly larva.

An article with regard to these observations was published in the newsletter of the Cycad society and can be accessed at http://www.cycadsg.org/publications/TCS-December2007-Varghese.pdf

1.4. Population:

1.4.1. *Global Population size:*

Table 1 – Populations of *Cycas circinalis* observed in various locations along the Western Ghats, India.

Locations	Altitude (msl)	Habitat	Estimated # of adults
Site 1 Tamil Nadu	1000	Dry deciduous and Savanna woodland type	>300
Site 2 Tamil Nadu	300-500	Riparian forests	>300
Site 3 Tamil Nadu	500-800	Dry deciduous, Savanna woodland, Riparian	<200
Site 1 Kerala	300-500	Semi evergreen, Moist deciduous, Teak plantations	>500
Site 2 Kerala	300-800	Riparian, Teak plantations, Moist deciduous	>200
Site 3 Kerala	Not visited	Not visited	Not visited
Site 4 Kerala	300-500	Semi evergreen, Moist deciduous, Teak plantations	>300
Site 5 Kerala	300-500	Semi evergreen, Moist deciduous, Areca plantations	>100
Site 4 Tamil Nadu	300-500	Moist deciduous, Teak plantations	>200
Site 5 Tamil Nadu		Savanna woodland, Teak plantations, Semi evergreen	>200
Site 1 Karnataka		Scrub woodland	800
Site 2 Karnataka		Scrub woodland	100

1.4.2. *Current global population trends:*

___increasing __X_decreasing ___stable ___unknown

1.5. Conservation status:

1.5.1. *Global conservation status (according to IUCN Red List):*

___Critically endangered ___Near Threatened
_X_Endangered ___Least concern
_X_Vulnerable ___Data deficient

1.5.2. *National conservation status for the case study country*

Cycas circinalis is included in the negative list of exports notified by the GOI Notification 2 (RE-98) dt. 13-04-1998, 1997-2002 (Ravikumar and Ved 2000). The plant is also listed as an RET species.

1.5.3. *Main threats within the case study country*

___No Threats
_x_Habitat Loss/Degradation (human induced)
___Invasive alien species (directly affecting the species)
_x_Harvesting [hunting/gathering]
___Accidental mortality (e.g. Bycatch)
___Persecution (e.g. Pest control)
___Pollution (affecting habitat and/or species)
___Other_______________
___Unknown

2. SPECIES MANAGEMENT WITHIN THE COUNTRY FOR WHICH CASE STUDY IS BEING PRESENTED

2.1. Management measures

There have been no specific management plans so far put forth for the management of this species in India.

2.2. Monitoring system

2.2.1. *Methods used to monitor harvest*

There is no formal monitoring program in place to monitor *C. circinalis* harvest throughout its range. However, Keystone Foundation has established a monitoring program throughout the NBR (including populations in Tamil Nadu and Kerala states) to monitor harvest. This involved establishing permanent plots with tagged individuals, and monthly monitoring of the number of leaves, seeds, cones or stems harvested. This monitoring was carried out over a period of one year.

2.2.2. *Confidence in the use of monitoring*

The indigenous communities living closest to the *Cycas* populations are being involved in a community monitoring program. For now the program has started with an interpretation center and a nursery in the village. The cycas areas are being mapped with people's participation. The threats to the populations will be identified and a permanent plot will be set up in consultation with the harvesters that will be monitored seasonally. This involves measures of growth, survival, reproduction, regeneration and a calculation of sex ratios.

2.3. Legal framework and law enforcement:

Listed in Appendix II of the CITES, the species is included in the negative list of exports notified by the Government of India (Notification 2 (RE-98) dt 13.04. 1998, 1997-2002) (Ravikumar and Ved 2000).

3. UTILIZATION AND TRADE FOR RANGE STATE FOR WHICH CASE STUDY IS BEING PRESENTED.

3.1. **Type of use** (origin) **and destinations** (purposes)

In Kerala and Tamil Nadu indigenous communities harvest mainly the seed and the young leaves of *C. circinalis*. These are considered delicacies and are highly valued. In Tamil Nadu, some villagers relish the young leaves and steamed seed. Although in Tamil Nadu *C. circinalis* seed is harvested for home consumption, in Kerala there is also local demand for the dried seed. The harvest is heavy here as the harvesters harvest the seed and sell it after some processing and drying to the market. The ripe seed is picked (about 25 kg per day) and smoked on a bamboo mat and then dehusked and dried. Harvesters report that 25 kg of seed would yield only up to two kg of dried seed. In a harvest village 20 tonnes of fresh seed were collected in 2008.

Harvesters in Tamil Nadu and Kerala harvest the mature leaves of *C. circinalis* yearly for making the shelters for special rituals.The mature leaves are also heavily harvested for the floriculture industry and the pith from Tamil Nadu is sold in medicinal markets. The price per kg of dried pith is 20 rupees per kg, if it is milky white. A traditional trader at Virudhanagar market in Tamil Nadu estimated that from Tamil Nadu itself about 200-300 tons of the pith is being traded annually. He reported that the bulk of it was coming from Kerala. The pith is sent to traders in North India to supply to the herbal medicine industry. An extract of the pith is used to increase milk production in lactating mothers. He also reported that the male cone is very important for the production of a male aphrodisiac and much in demand but difficult to get.

The vendor emphasized that *C. circinalis* trees were very abundant about 10 years ago and even found in gardens, but now they are gone so that pith is now brought from homesteads in Kerala, where the whole tree is purchased for Rs. 50 -60. When gatherers harvest in the monsoons it is difficult to dry the produce properly making it brown in color. When the color is brown the price also drops and the traders are not able to sell the produce then.

In Kerala, there is a demand for *C. circinalis* male cones by local farmers. Most paddy farmers place the cone in the middle of their paddy fields to drive away a particular insect which attacks the young paddy. The insect is drawn to the cone because of the smell and leaves the paddy alone.

Table 2. Use, harvest patterns and demand for *C. circinalis* products in Tamils Nadu and Kerala portions of the NBR.

Part harvested	Harvest Status		Use	Harvest patterns		Demand	
	Tamil Nadu	Kerala		Tamil Nadu	Kerala	Tamil Nadu	Kerala
Young leaves	Yes	Yes	Food	Men and women involved, but mostly older people. Harvest once per year Oct/Nov or mid April. Hill communities	Men and women involved, young and old people. Harvest once per year.	Indigenous villages	Indigenous villages
Mature leaves	Yes	Yes	Floriculture, Thatching	For cultural events and small traders who pay up to 2 rupees per leaf. Mostly men involved. Heavy harvest for market.	For religious and cultural events. Men go for collection. Not sold.	Indigenous villages and local markets within the district	Indigenous villages
Seed	Yes	Yes	Food and medicine	Men and women involved, collection rates of about 80% per individual	Men and women involved, collection rates of about 80% per individual. Observed in August.	Indigenous villages be used in medicinal preparations.	Indigenous villages and markets within the district due to local demand for the dried kernel to
Pith	Yes	Yes	Medicine	Traders bring their own set of harvesters. Clandestine operations with no local people involved. High harvest rates. Exhaustion of populations in Tamil Nadu resulted in move to harvest from homesteads in Kerala.	Traders from Tamil Nadu come to collect the whole plant form the homesteads where it grows abundantly	South Tamil Nadu	South Tamil Nadu
Male cone	No	Yes	Medicine,	Insect repellent	Local farmers	None come in to harvest this for use in their paddy fields	Local farmers within the district

3.2. Harvest:

3.2.1. *Harvesting regime*

Harvest of young leaves:

The young leaves are collected around October to November and in mid April. All new leaves from an individual are harvested. This harvest is only for home consumption and not frequent.

Harvest of seed:

Harvesters report that the seeds are not available for harvest every year. The seed is collected during the months of July and August in the Nilambur area and between February and March in the Nilgiris area.

Harvest of mature leaf and pith:

Harvest of mature leaf and pith continues today in the Nilgiri Biosphere Reserve area. Since the harvest of pith is not permitted by the Forest Department the harvests happen secretly and are usually from distant areas. Occasionally the indigenous peoples are paid a per-leaf rate and harvest the mature leaves for the floriculture industry.

There are many small time contractors operating from the base of the forested slopes of the Nilgiris. One forest contractor reported that he used to contract harvesters to extract *C. circinalis* leaves and pith. One rupee is paid per mature leaf. Leaf is in most demand around January-February and October to November. He confirmed that pith harvesters look for the younger trees around 5 ft. tall and it is the pith found at the lower end of the trunk that is used. Bigger trees have more fibrous piths and are not favorable.

3.2.2. *Harvest management/ control*

No permits are issued for collection of Cycas parts.

3.3. Legal and illegal trade levels

Since there is no clarity on the legislation regarding this species, levels of trade are difficult to assess. The only trade is the illegal trade. 200-300 tonnes of the dried pith was one of the estimates given by a trader who was located near the coast in Tamil Nadu. In Kerala a trader came asking for the male cones and one village harvested 350 kgs of the cone for him.

A recent study on methods to identify authenticity of raw material cites the use of dried pith of Cycas sp. as an adulterant for tuber of Peuraria tuberosa (Devaiah & Venkatasubramanian, 2008).

II. Non-detriment finding procedure (NDFs)

1. IS THE METHODOLOGY USED BASED ON THE IUCN CHECKLIST FOR NDFS?

__yes _X__no

2. CRITERIA, PARAMETERS AND/OR INDICATORS USED

1) Part of plant that is harvested. Harvest of pith and male cones appears to be unsustainable. Harvest of seeds and leaves may be sustainable at some levels depending on at least some of the following:
2) Quantity that is harvested as determined by amount of leaves or seeds harvested/individual and proportion of individuals in a population that remain unharvested. Preliminary research (Varghese & Ticktin 2006) suggests that repeated heavy leaf harvest of *C. circinalis* may decrease growth and reproductive output, leading to lowered regeneration. Very heavy seed harvest could also lead to lowered regeneration.
3) Time for recovery after harvest and timing of harvest, as determined by frequency and seasonal timing of harvest of leaves. For example, the harvest of leaves once a year, soon before they are (naturally) shed, may have little impact on the individual.
4) Local management for regeneration: Harvest of seeds and/or leaves can be sustainable in communities that are actively growing *Cycas* in nurseries, maintaining their homestead populations and planting them out to increase populations.
5) Size of population: It would probably not be sustainable to harvest from very small populations especially if it is an isolated population.
6) Region harvested: *C. circinalis* populations have been observed in many different habitats with very different environmental conditions and these appear to significantly affect vital rates. For example, individuals in wetter regions have significantly greater rates of growth and reproduction than those in drier regions. It is possible that some populations may withstand higher levels of harvest because of the more favourable growing conditions.

3. MAIN SOURCES OF DATA, INCLUDING FIELD EVALUATION OR SAMPLING METHODOLOGIES AND ANALYSIS USED

1. Part of plant harvested: easily identified.
2. Quantity that is harvested: This would have to be provided by the seller, along with location of harvest. It could also be verified

through field evaluation because both leaf harvest rates (through evidence of harvested leaves) and the proportion of individuals harvested can be quantified. Since seeds and leaves are not sold through organised markets or government mechanisms actual data on volume could only be gathered through a community based monitoring where possible. Visits to local markets can also provide some of this information.

3. Frequency and timing of leaf harvest: This would also have to be provided by the seller and/or through community-based monitoring where possible. In the case of protected areas like National Parks and Sanctuaries collections are technically not permitted.
4. Local management for regeneration: Evidence in community nurseries, out planted populations in home gardens and/or forests.
5. Population size: Documented through field evaluation.

4. EVALUATION OF DATA QUANTITY AND QUALITY FOR THE ASSESSMENT

1. Plant of part harvested: easily determined accurately.
2. Quantity that is harvested. This can be determined fairly accurately through field surveys. The limitation is that it is not practical to do regularly, especially given that many populations are in remote locations. Community-based monitoring programs can obtain the information accurately, documenting harvest that could include both local people and outsiders. The limitation is number of communities where programs can be established, right now these programs are just in initiation in a very small number of communities.
3. Frequency and timing of harvest. This can only be determined accurately by fairly regular monitoring and so may only be a possibility in communities with community- monitoring programs. This is because *C. circinalis* appear to flush at different times of the year depending on their location, so it is difficult to identify a time of year when harvest is optimal across all regions. For the same reason, annual monitoring cannot accurately determine when/how frequent harvest was.
4. Local management for regeneration: easily generated by assessment of nurseries and out plantings
5. Population size: can be determined fairly accurately in the field. Limitation is localizing the existing populations.

5. MAIN PROBLEMS, CHALLENGES OR DIFFICULTIES FOUND ON THE ELABORATION OF NDF

Right now there is not enough data to develop specific guidelines on harvest practices that are sustainable (especially with respect to quantity and frequency). We have ongoing studies specifically aimed at addressing this and expect to have this information within the next few years.

There is also no clarity on the species in each location, this needs to be determined and we need to develop a good field guide to the Cycads of India. When the species itself is not clearly defined then framing management practises for it become even more tricky.

Another problem is the lack of transparency on the uses of the cycad parts that find themselves in the trade, especially of pith and male cones. There is still very little information available on trade (quantities traded, demand for different plant parts, trade routes etc) of *C. circinalis* (and other Cycas species).

There also needs to be a complete ban on destructive harvests that involve stems and piths.

6. RECOMMENDATIONS

Identify sustainable management practices/plans (quantity, frequency, timing of harvest) that can be promoted at the community level and maintained through community-monitoring programs. This will entail further research on the ecology of this species, its uses/harvest by communities across its range and their impacts.

Strengthen and further promote the community-based Cycas monitoring programs that have been initiated.

Improve identification of the cycad species in India, with an easy to read Field Guide that would help to identify species in the wild and potentially from parts in markets. This would help to clarify which populations are actually *C. circinalis* or other species.

Carry out a survey of the market for Cycas (including both South and North India). This has not yet been done and could throw more light on quantity of trade and demand (including timing of demand) for different parts of the plant.

Develop a Cycas database which could be held with the Biodiversity Board to disseminate and enhance information on species/populations in the wild.

Dialogue with the Medicinal Plant Board to identify the threats to the species and work with them to come up with criteria for procurement of raw material.

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CYCAS CIRCINALIS L. IN INDIA

AUTHORS:
Anita Varghese and Tamara Ticktin

Cycas circinalis L. is a multiuse cycad endemic to the Western Ghats, India. An Appendix II species, *C.circinalis* is listed in the IUCN Red List database of threatened species as data deficient (Hill, 2003). Keystone Foundation (www.keystone-foundation) in collaboration with People and Plants International (www.peopleandplants.org) and University of Hawaii (www.botany.hawaii.edu/faculty/ticktin) have been involved in a monitoring of *Cycas circinalis* to assess its conservation status. Keystone Foundation works with indigenous communities in the Nilgiri Biosphere Reserve, India to monitor ecology, use and trade of *C.circinalis*.

The assessments undertaken so far have been done in the states of Tamil Nadu and Kerala covering more than 50% of the sites where the species is present within each state. Criteria and parameters that were studied so far have been nature of harvest, impact on population of different part harvest, quantity of harvests, time of recovery after harvest, local management for regeneration, size of populations and distribution across habitats.

Populations subject to seed and leaf harvest show lower rates of regeneration as compared to those populations that are not harvested for their leaves. The structure of the populations subject to seed, leaf, stem and male cone harvest consisted almost entirely of individuals in the smallest size classes. There were no individuals larger than 100 cm in height. The lack of adult individuals points to high levels of stem harvest and depletion of the adult population.

Cycas circinalis is included in the negative list of exports notified by the GOI Notification 2 (RE-98) dt. 13-04-1998, 1997-2002 (Ravikumar and Ved 2000). The plant is also listed as an RET species. Total number of adult individuals is estimated to be below 4000. The species is restricted to isolated patches in the Western Ghats, India. The main threat to the species is from habitat loss and indiscriminate harvesting.

Lack of clarity on the species, geographical source of cycas products and their authenticity make the assessment difficult. The conservation status of the species is at a crucial stage and can be improved through collective action. Much work is needed to build a database on the different species, its population, harvest practises and demand in trade. A concerted effort that involves the State and National Biodiversity Boards and the Medicinal Plant Board can lead to improved practises that promote the conservation of the species. The species has been in use for food and medicinal purposes traditionally. An understanding of this will contribute to a sustainable use management plan that can be implemented successfully and reduce the pressure on this limited distribution species.

Case Study *Cycas circinalis* L.

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University of Hawaii& People and Plants International

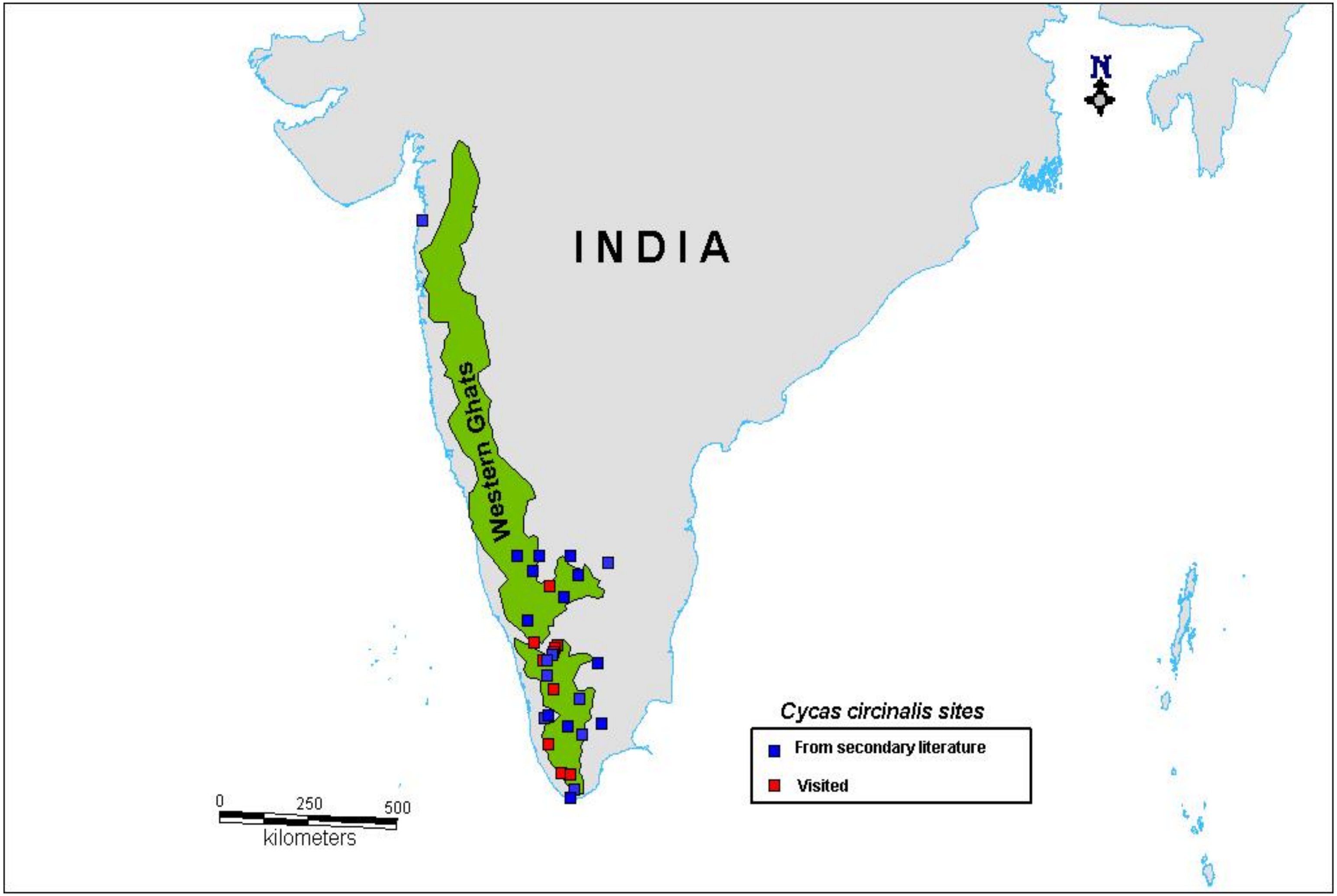
INTERNATIONAL EXPERT WORKSHOP ON CITES
NON-DETRIMENT FINDINGS
CANCUN, MEXICO
NOVEMBER 17-22, 2008

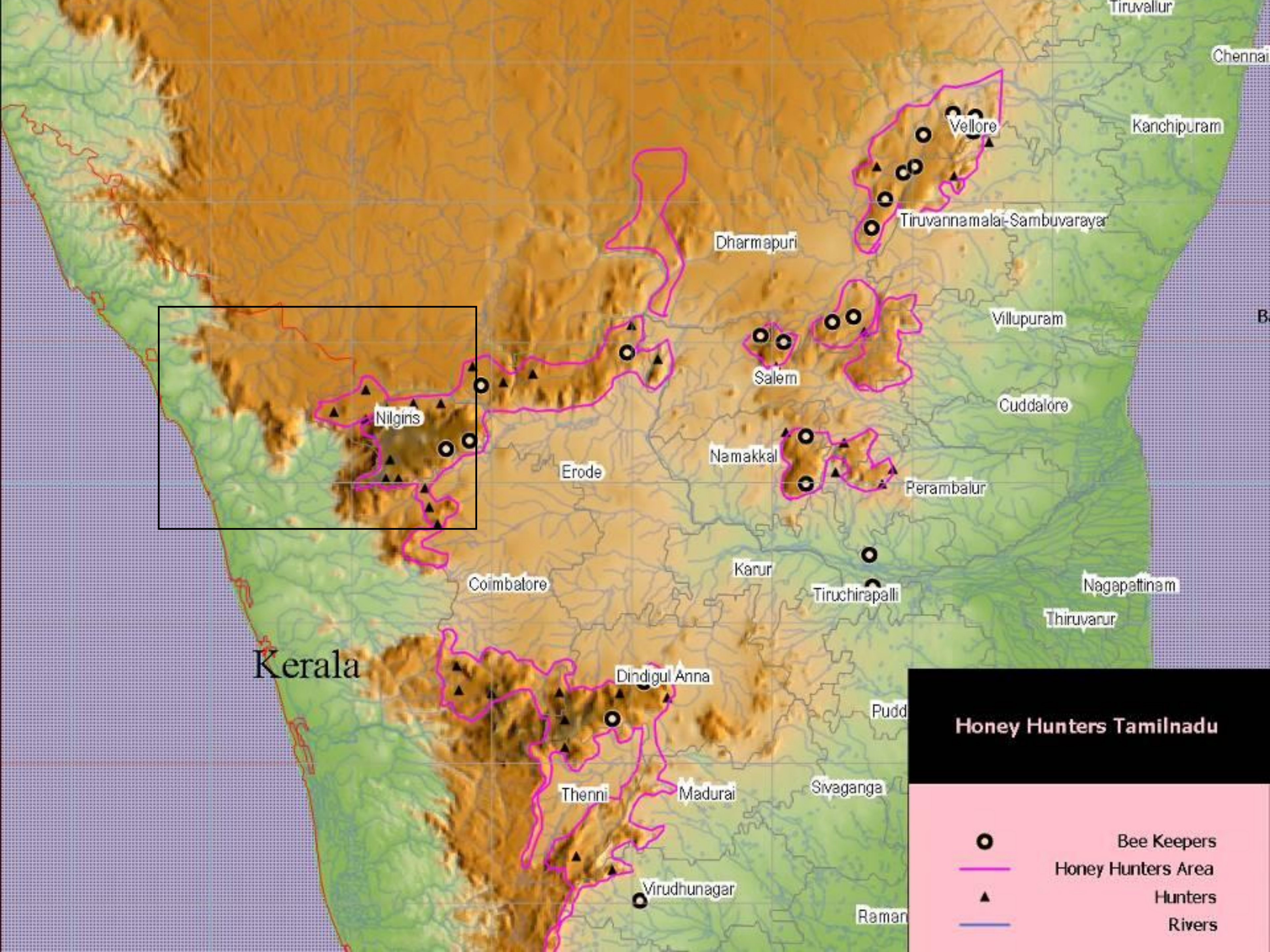
Cycas circinalis **L.** **CYCADACEAE**

Appendix II

Endemic -Western Ghats, India

Distribution-*Cycas circinalis*




Tiruvallur
Chennai
Kanchipuram
Vellore
Tiruvannamalai-Sambuvarayar
Dharmapuri
Villupuram
Salem
Cuddalore
Nilgiris
Namakkal
Erode
Perambalur
Karur
Coimbatore
Tiruchirapalli
Nagapettinam
Thiruvarur
Kerala
Dindigul Anna
Pudd
Thenni
Madurai
Sivaganga
Virudhunagar
Raman
Honey Hunters Tamilnadu
Bee Keepers
Honey Hunters Area
Hunters
Rivers

Cycas circinalis - A multi use cycad

- **Subsistence use** characterized by low volume and high traditional value
- **Commercial use** characterized by high volume and low ecological concerns
- **Users** traditional and non traditional communities
- Food, Decorative purpose, Medicine and Construction

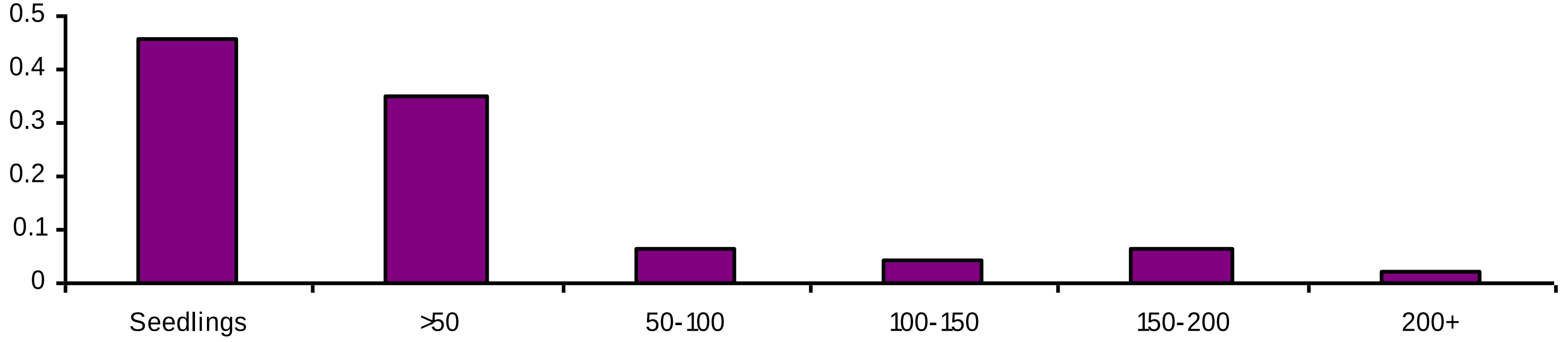
Patterns of Use - Subsistence

Patterns of Use-Commercial

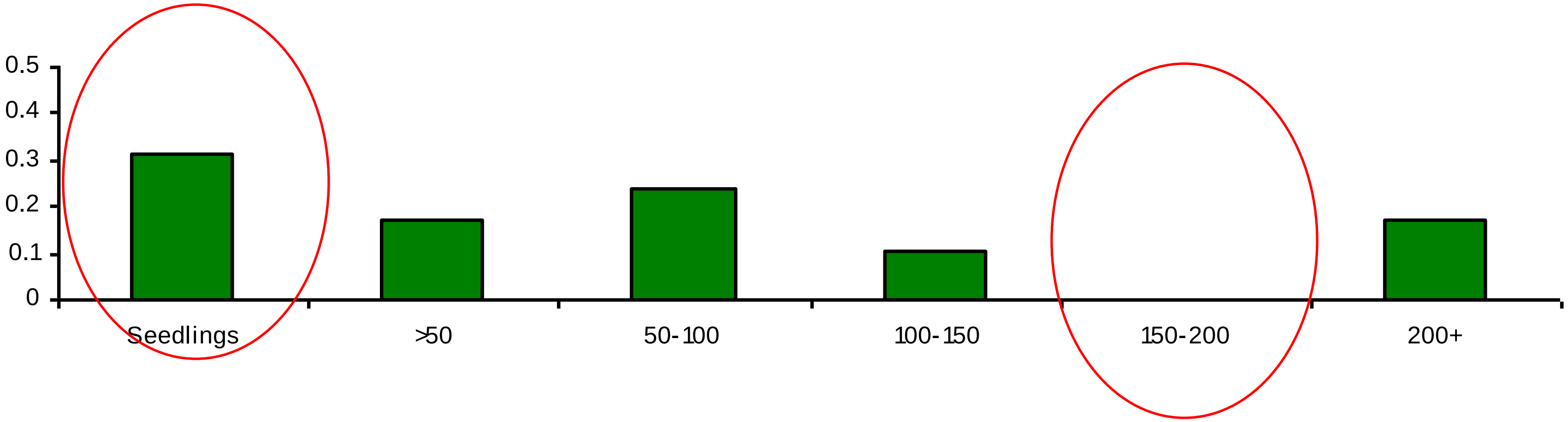
Important biological features of the species

- Flowering not regular, identifying male and female plants takes time
- Variations in responses of population to different part harvests
- Differential growth rates from low elevation wet forests to mid elevation dry forests
- Direct responses to fire

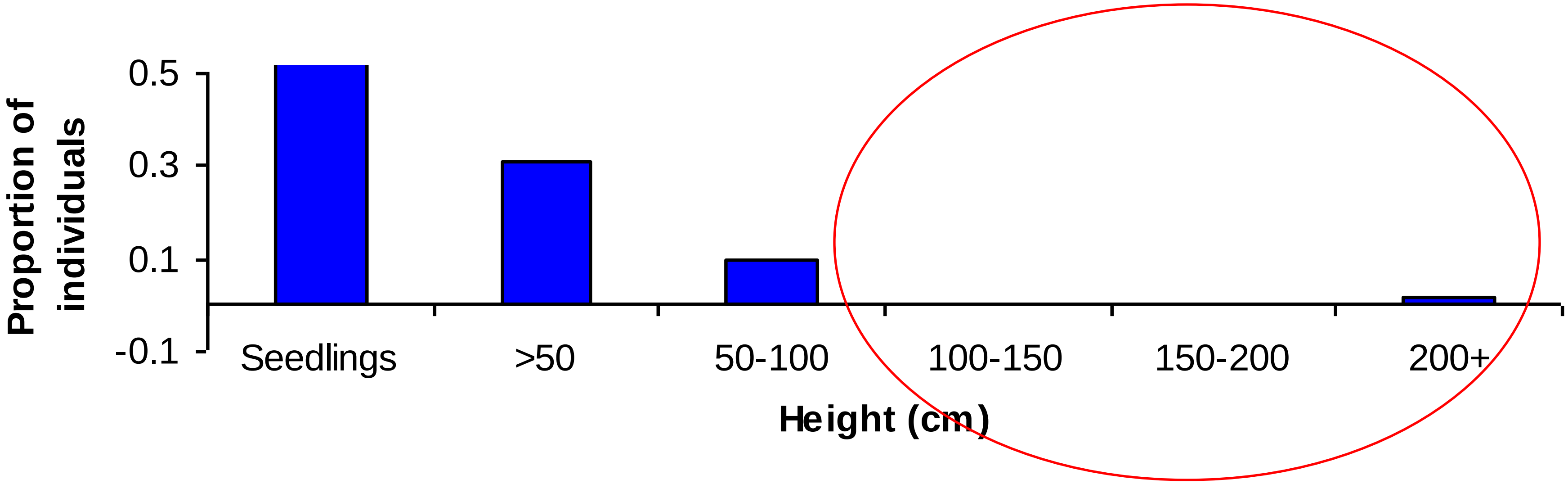
Seed Harvest only: Good levels of regeneration



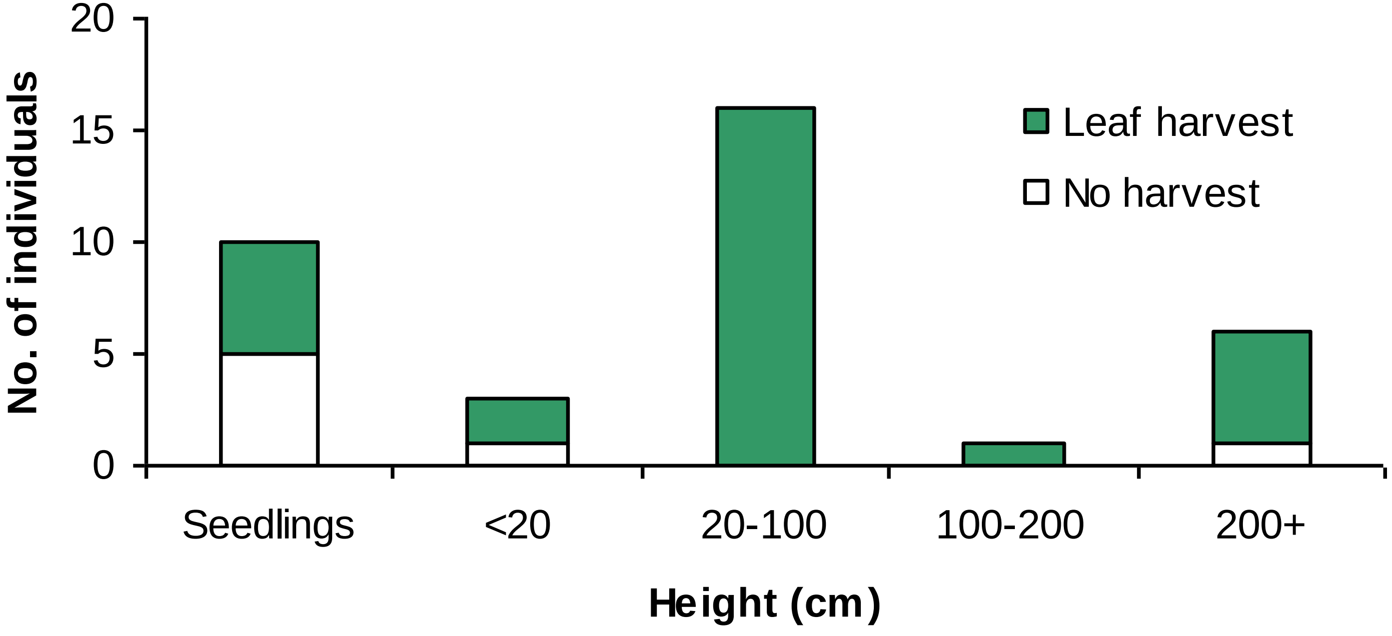
Seed & leaf harvest:
Poor recruitment and some adult mortality



Seed, leaf, stem harvest: Adults are depleted



Levels of leaf harvest are extremely high: only the smallest and largest are spared



Average of 91.3 % of leaves on EACH individual removed

Responses to Fire

Current methods for (NDF) assessments

- Part of Plant that is harvested
- Quantity of harvest
- Time for recovery
- Local management for regeneration
- Size of population
- Region harvested

Review of criteria, parameters, and data sources for NDF assessments

- Part of plant harvested – Relatively simple to identify except in case of pith harvests which are the most detrimental
- Quantity that is harvested – with involvement of community this can be collected with a greater degree of confidence
- Local management practices need to be documented
- Periodic monitoring of populations through assessments

Key lessons for developing NDF assessments for this type of taxon

- Integrating different kinds of knowledge, indigenous, scientific, managerial etc
- Following the trade routes closely and monitoring them – winning over traders
- Long term monitoring programs for the biology of the species
- Taking different stakeholders along from the inception of the monitoring program
- NDF procedures need to be communicated by the management authority to harvesters and licenses issued at site should be guided by a NDF

Need for regular monitoring

Questions..??

Questions that face us today is the relevance of this assessment to the harvester, trader and manager who are constantly involved in the trade

- How does one come up with a strategy for assessment that looks at habitat, climate and role of the species in the ecosystem?

- How does one increase the stakeholder's participation in the assessment process?

- How does one factor in all the knowledge available as part of the process of assessment?

- Assessment seems like a one time effort. These changes need to be assessed over a period of time and move to a regular monitoring – NDF monitoring

- Who will bear the costs and reap the benefits of this process?


Thank you

NDF Workshop Case Studies
WG 3 – Succulents and Cycads
Case Study 6
Hoodia gordonii
Country – **South Africa**
Original Language - English

HOODIA GORDONII IN SOUTHERN AFRICA

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Mexico, November 17-22, 2008

I. Background information on the taxa

1. BIOLOGICAL DATA

1.1. Scientific and common names

Species: *Hoodia gordonii*
Genus: *Hoodia* (14 *Hoodia* species within the genus)
Family: Apocynaceae family (formerly under Asclepidaceae)
Common names: Ghaap, Bitter ghaap, Xhoba, Hoodia, lgoa.-l, lkhoba.b, lkhowa.b, lgoai-l, lhoba, lkhoba.bls, lkhobab, lgoab, otjinove, !nawa#kharab

Figure 1. *H. gordonii* in flower (and seed set) in the Northern Cape province, South Africa.

1.2. Distribution

H. gordonii has a fairly wide distribution (between 290 and 330 S), occurring predominantly in South Africa and Namibia, and to a lesser extent in Botswana and Angola. The species has a patchy spatial distribution pattern, meaning that its density varies a lot throughout its distribution range. Although its distribution is not continuous, nor uniform, it is uncertain whether it is fragmented as it has not been investigated.

The species is primarily associated with summer rainfall regions (South Africa and Namibia), but does occur in winter rainfall areas (Namibia) as well.

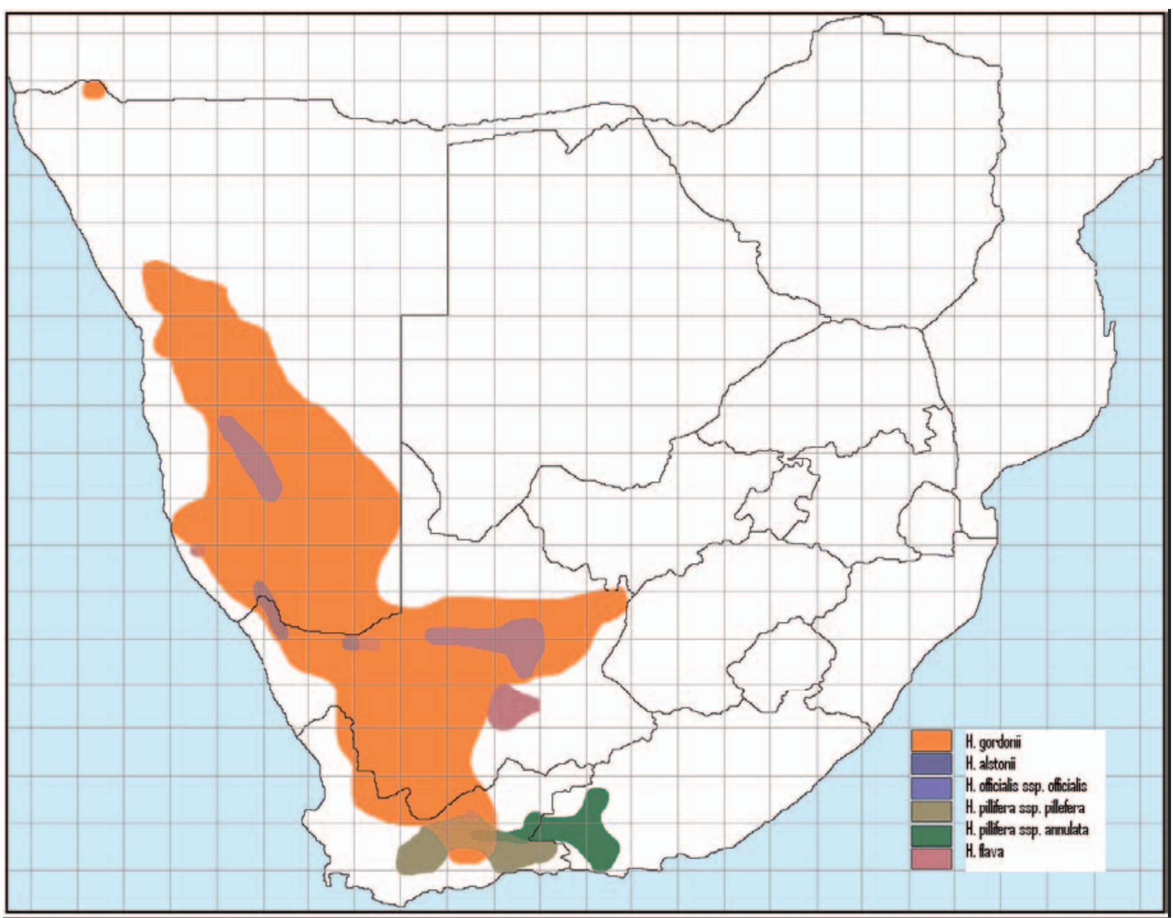


Figure 2. Schematic illustration of the known distribution ranges of six *Hoodia* species in southern Africa (PRECIS data 2005, SANBI).

Namibia is regarded as the country with the greatest richness in *Hoodia* species (11 taxa), followed by South Africa (9 taxa). However, there is disagreement amongst some taxonomists as to the species' names and classifications.

1.3. Biological characteristics

1.3.1. *Provide a summary of general biological and life history characteristics of the species.*

H. gordonii is a slow growing perennial, leafless succulent. This stem succulent forms fleshy fingerlike stems that branch near ground level. The stems are pale-green, round and covered with spiny tubercles found in rows along the length of the stems. The estimated height of an adult plant is around 60cm, while the diameter of the finger-like stems reaches more than 40cm.

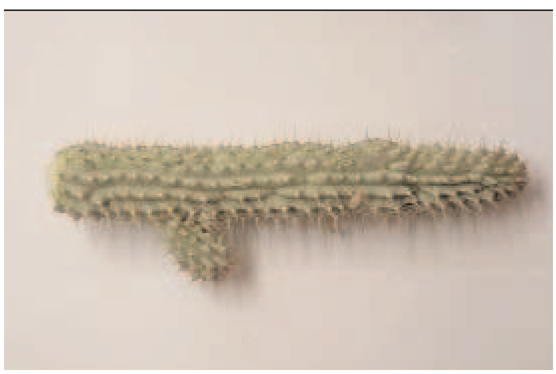


Figure 3. H. gordonii stem illustrating the spiny tubercles running along the length of stems (photo by CSIR).

The life-span and age at maturity of *H. gordonii* is unknown, but anecdotal data indicated it to be 15-20 years, with the first flowering event only occurring after three to six years. Coincidently, this is also the time (three years) it takes cultivated material to produce sufficient active ingredients to be accepted for trade.
Flowering is protracted (based on herbarium records, PRECIS records) and unsynchronised, reacting to rainfall events irrespective of the season. During good rainfall events, the plants are covered by flowers, producing masses of seed follicles after one month. Seeds ripen about two to three months after flowering.

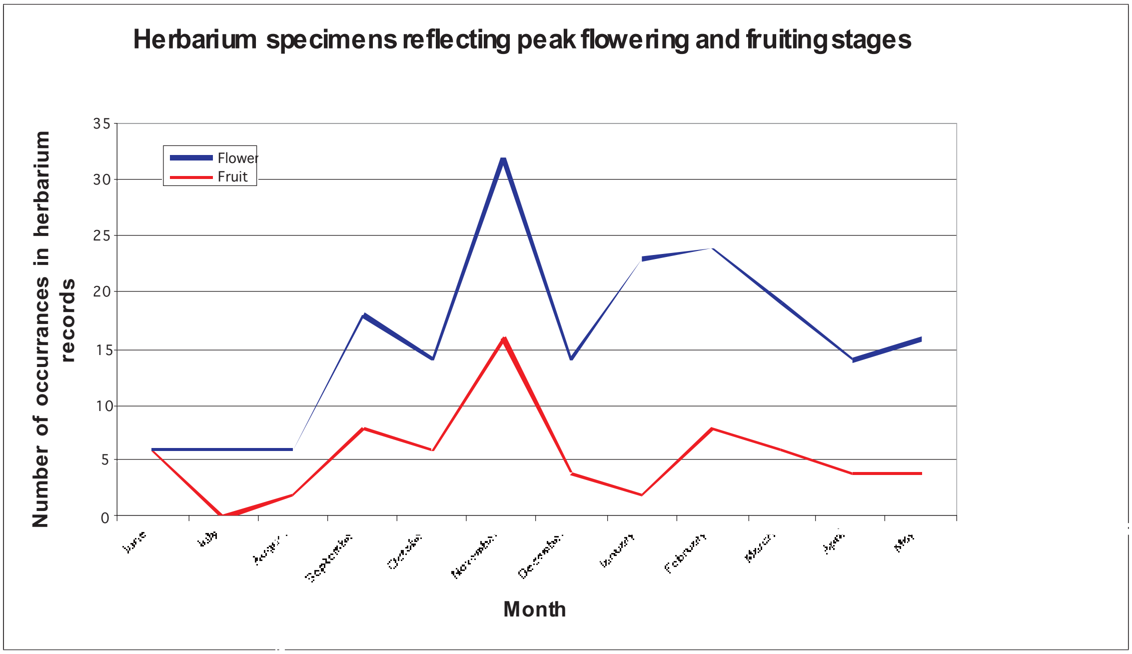


Figure 4. Illustration of the flowering cycles of *H. gordonii* (PRECIS herbarium data, 2005).

Flowers are generally dish-shaped (50-110mm in diameter), with a fleshy colour (colour does vary from red to purple to brown to mottled dark yellow). Flowers are also referred to as carrion-flowers or stapeliads and smell like decaying meat to attract pollinators, namely flies and blow-flies. Pollination occurs when the flies lay their eggs inside the flower.

Figure 5. One of the pollinators (a fly) of *H. gordonii*.

Follicles can get up to 250mm long, containing several seeds that are wind dispersed. The follicles split open along the sides, releasing the seeds which are then blown under nurse plants or other protective sites where they germinate and establish themselves. However, the potential seed production (average number of seeds per follicle) and its longevity in the veldt are unknown. According to one expert (P. Bruyns pers. Com), *H. gordonii* exhibits a weedy character and seeds germinate readily.

Figure 6. *H. gordonii* follicle releasing seed into the wind for dispersal.

Long term population trends are unknown, but drastic population declines have been observed in nature, mostly due to die-back of established plants. The reasons for these drastic die-back events are unknown, but they appear to coincide with prolonged high rainfall events when *Fusarium* (a fungus) and other pests attack the species. No studies have been undertaken to assess the survival rate and recruitment of seedlings.

Population size and density is uncertain. *H. gordonii* clusters vary a lot in density and demography. Cluster densities range between only a few plants per hectare to over 130 plants per hectare (exceptional cases reflected a few hundred plants per hectare).

Figure 7. Die-back event observed in the Northern Cape, South Africa, in the Bushmanland region. Forty percent of the population at one of the sites in the Bushmanland died within two years (2000-2002), while the above photo illustrates that it can result in more than a ninety percent decline (2005).

More information is needed on habitat requirements regarding what conditions favour germination and seedling establishment.

Natural and anthropogenic threats also need to be quantified. Some of the preliminary natural threats that have been identified include fungus infections (Figure 8, *Fausaria* sp. infestation), snout beetles (*Paramecops stapeliae*), mite infestations and fruit flies (Figure 9, *Dacus bistrigulatus*). The milkweed bug (Figure 10, *Spilostethus pandurus*) and the African Monarch butterfly caterpillar (Figure 11, *Nymphalidae*, *Danaus chrysippus*) impacts negatively on seed production. Natural die-back could result in more than ninety percent decline in clusters (refer to Figure 7). If these die-back events are followed by recruitment events (replacement), there is no immediate concern. However, should these die-back not be followed by recruitment events, then there is for urgent investigation. Another threat that still needs to be evaluated is climate change. Some of the preliminary anthropogenic threats include commercial wild crafted harvesting (illegal harvesting) and habitat destruction (over grazing, trampling, cultivations, road construction, off road driving, urban development, mining).

Figure 8. A *H. gordonii* plant that died due to *Fausaria* sp. infestation.

Figure 9. The fruit fly, *Dacus bistrigulatus*, which lays its eggs in *H. gordonii* stems. Here the caterpillars feed on the inner parts of the stems, causing them to fall over and die.

Figure 10. The Milkweed bug, *Spilostethus pandurus*, lays its eggs in *H. gordonii* follicles.

Figure 11. The African Monarch caterpillar, *Danaus chrysippus*, feeds on *H. gordonii* flowers.

Figure 12. Unidentified ‘fly’ that lays its eggs in *H. gordonii* follicles.

1.3.2. *Habitat types.*

H. gordonii occurs in a wide variety of arid habitats characterised by sparse vegetation, ranging from coastal to mountainous habitats. Generally the species do, however, prefer arid gravel or shale plains, slopes and ridges, ranging in altitudes from 250m to 1200m. However, the specific habitat requirements (niche habitat) remain unknown. In the Northern Cape Province, South Africa, the species does occur more readily (more densely populated) in some regions.

Figure 13. Examples of some of the habitats of *H. gordonii* in the Northern Cape Province, South Africa.

Habitat availability is not regarded a limiting factor to the species' distribution range and it is not expected to have a negative impact on the population status at this stage.

1.3.3. *Role of the species in its ecosystem*

H. gordonii is a minor source of food and moisture to wildlife in arid ecosystems. However, the multiple above ground stems provide shelter and breeding sites for small animals and insects, like spiders. The overall ecological function of the species is unknown.

1.4. Population:

1.4.1. *Global population size*

The global population size, or available resource, is unknown. Resource information is also not available on Provincial level in South Africa. Accordingly a Resource Assessment Report system was developed to obtain at least local basic information on population health (demography) and density (ref. permit applications for wild harvesting). From these surveys, the recorded densities ranged from less than seven plants per hectare to a few hundred plants per hectare. However, as mentioned previously, *H. gordonii* is not evenly dis-

tributed; therefore no direct population size can be calculated in reference to the total distribution range of the species.
Surveys for the Resource Assessment Report should cover at least one percent of the total distribution range of the species on the farm to make sure it is at least to some degree representative.

1.4.2. *Current global population trends:*
The global population trend is unknown, but local decline has been observed at sites where exploitation and die-back have occurred. Recruitment events have also been observed, but these were not necessarily at the sites where decline has occurred (possibly random recruitment).

1.5. Conservation status

1.5.1. *Global conservation status (according to IUCN Red List):*
Until 2002 *H. gordonii* was regarded Near Threatened. However, towards 2005 it was suggested to change it to Least Concern (unpublished). We await the most recent evaluation which is due for publication this year.
H. gordonii is listed as a CITES Appendix II species.

1.5.2. *National conservation status for the case study country*
Hoodia is protected in five on the nine Provinces in South Africa, namely the Western Cape, Free State, North West, Northern Cape and Kwazulu Natal Provinces. Legislation include, e.g., the Nature and Environment Conservation Ordinance No. 19 of 1974 in the Northern Cape Province, the TOPs Regulations, i.e. the Biodiversity Act No. 10 of 2004 (the implementation of TOPs only occurred 2006/07, as it was not finalised or delegated to provinces).
The species is protected in Namibia (Nature Conservation Ordinance No. 4 of 1975 and No. 247 of 1977), but Botswana, has no legislation specifically addressing the protection of Hoodia. The Agricultural Resources Conservation Act [CAP35:06] of Botswana addresses "harvesting from the veldt", which is used to manage *Hoodia*.
The current list of Protected Areas and Conservancies said to contain H. gordonii need to be reviewed as some of those listed do not have H. gordonii but some of the other *Hoodia* species.

1.5.3. *Main threats within the case study country*
Habitat loss/degradation (human induced), invasive alien species (directly affecting the species), harvesting (illegal gathering), accidental mortality (e.g. bycatch), natural die-back and climatic events appear to be important threats.

Of all the threats listed, illegal gathering is regarded the most important, followed by agricultural activities. It is uncertain whether the establishment of *Hoodia* cultivation sites itself are having negative impacts on its natural distribution, but needs to be investigated as these are established within its habitat.

Legal wild harvesting appears not to be a local threat at this stage as harvested sites have not died-back, and harvested plants are sprouting again.

The possibility of future commercial collection and the accidental (mistake in identity) collection of other *Hoodia* sp. is of concern. *Hoodia pillifera* was the species being investigated by the CSIR for appetite suppressant activity in 1983, and is regarded the preferred food source. The common names are indicative of the reasons for mistaken identity with H. *pilifera* being called ghaap and *H. gordonii* being called "muishondghaap" or "jakkelsghaap". It therefore makes more sense to manage the genus rather than the individual species.

Internet trade is not quantified, but is of great concern.

2. SPECIES MANAGEMENT WITHIN THE COUNTRY FOR WHICH THE CASE STUDY IS BEING PRESENTED.

2.1. Management measures

2.1.1. *Management history*

The Northern Cape Province, South Africa, issued research permits until early 2000, where after permits for commercial harvesting from the wild was put on hold to enable the department to put systems in place to handle such applications (except Patent Rights Owners of P57). Commercial applications only started after the CSIR announced their 'discovery' in the media.

However, none of the other provinces in South Africa have put *H. gordonii* permits on hold like with the Northern Cape Province did, meaning that harvesting continued in the Western Cape Province and the other Provinces transported and exported without strict cross referencing to make sure that it was legal material. Illegal material were accordingly 'legalised' due to this unsynchronised management by Provinces.

No permits for wild crafted *H. gordonii* was issued until the legal aspects of the Patent Rights contravention were resolved. A Review Report has been compiled and a Resource Assessment and Management Report (RAMR) system has been developed to manage the resource should permits be issued.

In the review process the information available on the species and the Access and Benefit Sharing aspect (the San has been acknowledged as the Indigenous Knowledge Keepers) was taken into consideration.
The RAMR include the applicant's details, resource details, harvesting management details, and trade details (trade information is not mandatory due to the free market system). Only landowners are allowed to harvest on their own properties due to illegal activities that were reported in the Western Cape Province. Harvesting methods were prescribed.
RAMR is similar to TRAFFIC's sustainable harvesting of medicinal plants document, with limitations regarding the social aspects.
No proper national and international management system is in place yet (including Range States). One of the major concerns is the cultivations occurring outside the natural distribution range of the species, thus economic benefits are not being shared with the countries of origin and Knowledge Keepers.

2.1.2. *Purpose of the management plan in place*

The purpose of the developed system is to enable economic benefits to accrue to the province, to obtain minimum baseline information to ensure that landowners harvest on their own property, to enable quota formulation for sustainable resource use (permitting), to obtain baseline information to build a database for the province on its resources and the impacts harvesting has on *H. gordonii* populations, and to acknowledge and respect the ABS/IKS.
The methodology developed was kept as simple as possible to enable non-scientists to implement the system as the department is unable to conduct all surveys (not all farmers can afford consultants). It also included prescribed guidelines as to how and when you may harvest to be able to evaluate harvesting impacts (uniform methods enable comparisons).

2.1.3. *General elements of the management plan*

Landowner confirmation (Deeds)
Available resource and general health of the resource
Harvest reporting (harvested, wet:dry ratios)
Trade information (optional)
Monitoring (harvested sites, permits)
Gap: Management efforts concentrate on *H. gordonii* though related species might also be impacted on.

2.1.4. *Restoration or alleviation measures*

No restoration is needed if prescripts are followed, only monitoring to evaluate whether adaptive management (harvesting) is needed. The only aspect of high impact is the development of cultivation sites.

2.2. Monitoring system

2.2.1. *Methods used to monitor harvesting*

Sites harvested are re-visited and visual inspections are done (no quantification). This is followed-up at a later stage (at least one year after harvest) during which time a survey is done within the harvested area, using similar methods as for the original resource assessment (an alternative is fixed point photography and making notes for interpretation).

The Permit Section has put a database system in place which can be used to monitor permits issued. However, this is a new system and not all data have been captured on it. Previously limited information could be retrieved from the database, and manual scrutiny of the ODB (investigation diaries) had to be done.

Permit monitoring is difficult as detailed recording of permits have not been done before 2006, i.e. differentiate between wild and cultivated, and wet and dry mass e.g. This has only recently been rectified.

2.2.2. *Confidence in the use of monitoring*

The confidence level is moderate – those figures indicated would always be linked to confidence levels or gaps, meaning that you would have an idea of accuracy and confidence.

Monitoring is not structured properly regarding the permits, but might be now after the new database has been implemented.

Species monitoring is not formally structured, and initially the responsibility was placed with the landowner, but it was found that it was not implemented. Accordingly the department is re-visiting the sites, with the first quantifying survey being done about one year after the harvesting took place. Due to personnel constraints the responsibility was initially placed with the client.

2.3. Legal framework and law enforcement

Refer to section 1.5.2.

The species is nationally listed as protected under NEM:BA (National Environmental Management: Biodiversity Act No. 10 of 2004, TOPs Regulations of 2007). The species is listed provincially as protected in five of the nine Provinces in South Africa. The species is also listed in CITES Appendices II.

3. UTILISATION AND TRADE FOR RANGE STATE FOR WHICH THE CASE STUDY IS BEING PRESENTED

3.1. Type of use (origin) and destinations (purposes)

Traditionally it was used by the San while hunting to suppress appetite, thirst and to maintain their energy levels. They ate portions of the fresh stems of about 180-250g per day. The commercial uses are similar, with dieting and energy boosting (cyclists) being the major consumer markets (300-400mg per day, three times per day). Interestingly, the Patent actually includes anti-diabetic and prevention of aspirin induced gastric damage characteristics.

Limited cultural and traditional use still continuous today. It has been reported by communities that the resource have become scarcer (anecdotal information). Other traditional uses (treatments) include abdominal cramps, haemorrhoids, tuberculosis, indigestion, hypertension, diabetes, peptic ulcerations and allergic reactions in eyes.

Horticulture is limited.

At this stage *H. gordonii* is commercialised as a food-source and/or -supplement, not a pharmaceutical product. The CSIR patented P57, and then licensed it out to Phytopharm (UK), who sub-licensed it to Unilever to commercialise it as a food product/supplement. Benefit sharing agreements are in place with the San (6%).

Most exports from the Northern Cape were to the UK (Phytopharm) and the Western Cape Province of South Africa. Others include the USA, US Texas and North America.

Material is exported as dry material (discs or milled), or as extracts.

Up to now, wild crafted trade was more than cultivated material. However, the number of cultivations has increased and it is anticipated that wild harvesting would not form such a large part of the trade in the future.

The collection of dead wild *H. gordonii* material was combined as wild crafted data and should be kept in mind. Nearly half of the wild harvested material (kg) was dead material that was collected.

It takes at least three years before cultivated material can be harvested, therefore it is anticipated that the pressure from wild crafted material would decrease.

Cloned / tissue culture methods have been successful but regarded unfeasible, thus no material produced via cloning / tissue culture have been exported.

(Permit figures are being double checked to eliminate double counts due to system changes, i.e. new database).

3.2. Harvest:

3.2.1. *Harvesting regime*

No harvesting prescripts are given to cultivated material collection as they mostly harvest the entire plant anyway. A register must be kept through recording all activities and weights.

General guidance (booklets) was given to applicants specifying that older plants also contain the active ingredients. Thus, plants larger than 40cm in diameter could be harvested.

Only ten of the stems may be harvested or 25% of a plant that is larger than 40 cm in diameter, only on the southern side (down wind), near ground level. Only trained harvesters may harvest *Hoodia* material, i.e. trained in the prescribed methods provided by the department. Harvesting will only be considered on sites where an excess of 2 500 plants are available that are in good health and of optimal size.

Harvesting of wet plant material may only occur if it is not in flower or seed, which is normally between April and August. Seed collection must be specified and will be evaluated in a similar manner as in wet plant material collection, except for time of year to be collected. Only every second to forth large plant (larger than 40cm in diameter) should be harvested in the wild.

Stems must be cut off at least three fingers' width (5cm) above ground level with a sharp stainless steel blade. The blade must be disinfected (3% chlorine solution, like Jik) between each plant being cut. The cut stems that remain on the plant must be dusted with lime sulphur powder. The collected stem-parts are washed and cut into disc shaped pieces. These pieces must be dried in an appropriate manner to ensure quality and prevent rotting. Plant material mass must be determined and signed off by Conservation Authorities before and after drying. Drying must occur as close as possible to the harvesting site.

The sealed dried discs are sent to accredited and endorsed Processing and Quality Assurance entities. Quality products are sealed with tamper proof Quality Labels and Logos. These products are ready for trade after quality assurance approval and labelling.

Monitoring programmes must be put in place at sites where wild crafted collections occurred / are planned.

Clients were given the opportunity to deviate from the proposed methods, IF they can provide scientifically proven data that their proposal is more effective than the prescribed method and must be reported as such in their RAMR.

Figure 14. A schematic illustration of how you should cut stems on the southern side of a plant in the veldt, using a sharp stainless steel blade.

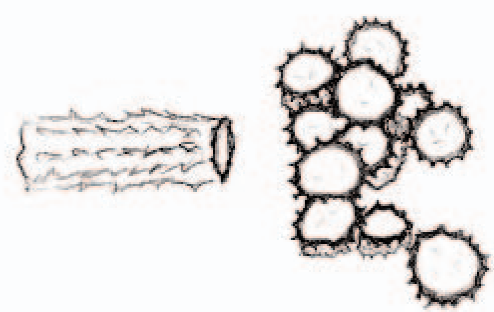


Figure 15. A representation of the cut slices of *Hoodia* stems harvested.

Mature seed pods/follicle should be collected just prior to opening of the pod, or with seed collection bags. If not done at this time, it will compromise the success rate of germination. It is recommended that seeds should be collected over two flowering seasons to minimise its impact on natural populations.

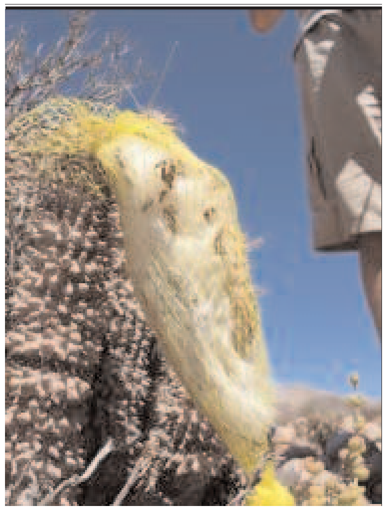


Figure 16. Example of a *H. gordonii* seed collection bag.

3.2.2. *Harvest management/ control (quotas, seasons, permits, etc.)*
Refer to section 3.2.1.

3.3. Legal and illegal trade levels

From 2005 until March 2008 a total of 15.7 tonnes of dry illegal material have been confiscated. Anecdotal data indicate that it could be more (more than 41 tonnes dry weight), but it is unconfirmed. It is suggested that only 10-15% of illegal trade is reported and/or caught.
Legal harvesting peaked in 2007 at 45-50 tonnes of dry material being collected (2005 until March 2008 adds to 70-75 tonnes dry weight).
(Exports and CITES records are being double checked).

II. NON-DETRIMENTAL FINDING PROCEDURE (NDFs)

1. IS THE METHODOLOGY USED BASED ON THE IUCN CHECKLIST FOR NDFs?

No, although there are various similarities. Several of the aspects to be addressed according to the IUCN checklist have been addressed through our methods being used.

2. CRITERIA, PARAMETERS AND/OR INDICATORS USED

The general health of the population is taken into consideration, the size of the population (adult plants), the total area surveyed should have covered at least 1% of distribution area to make inferences from

RAMR data, the total number of plants per site must be more than 2 500 harvestable plants, and no more than 15% of a population may be harvested (prescribed harvest methods of 25% of plant's stems, every second to fourth plant).

A precautionary principle was used, meaning that for any uncertainty in the data, the quota was reduced accordingly.

The same sites may not be harvested for the next three years, i.e. every forth year the same site might be harvested (depend on re-evaluation and site visit).

Quality control measures to secure the market and establish sustainable trade might have to be implemented. *Hoodia* differ from other Cactaceae species morphologically (e.g. grouped spines / thorns), anatomically (e.g. presence of druse crystals and hairs) and their chromatographic fingerprints (TLC, HPLC and NIR).

3. MAIN SOURCES OF DATA, INCLUDING FIELD EVALUATION OR SAMPLING METHODOLOGIES AND ANALYSIS USED

Literature, anecdotal information, Industry (who are willing to share some of their information), and the RAMR (demographic and density data, as well as habitat description) is used.

Demographic information was obtained through the following method:

The first live 100 individuals encountered in the densest part of each population must be surveyed. A plot of 1 ha (ideally 100 m x 100 m) should be documented. If a plot of 100 m x 100 m cannot be established, plot sizes should be adjusted to enable the documentation of at least 100 live individuals and a surface area of 1 ha. A template for measurements to be taken was provided.

In case of infection, or infestation / physical damage, the rating is between 0 and 3, with 0 being none and 3 being severe (rating 0 for no, 1 for presence of, 2 for moderate (60% affected), and 3 for severe infection, infestation / scarring (covered with infection or infestation / expect death).

Rating: 0 (healthy plant) Rating: 2 (infested plant) Rating: 3 (dying plant)

Rating: 0 (healthy plant)	Rating: 2 (infested plant)	Rating: 3 (dying plant)
		

Figure 17. Examples of plants to illustrate ratings of health as per RAMR.

Dead individuals that are encountered within the same plot where the 100 live individuals are being surveyed should be documented. Also take a view photo of each plot you survey, noting the GPS coordinates and the direction in which you take the photo (north, south, east, etc.) of the photographic point. If possible, also take a photo of each individual plant respectively next to a measure rod – this will be used for future monitoring purposes to detect, e.g., growth rate.
GPS mark and note each individual Hoodia surveyed, dead and/or alive on a spreadsheet.
Site characteristics like aspect, habitat, grazing intensity (dung frequency and type), mountainous, plains, and soil type should be noted.

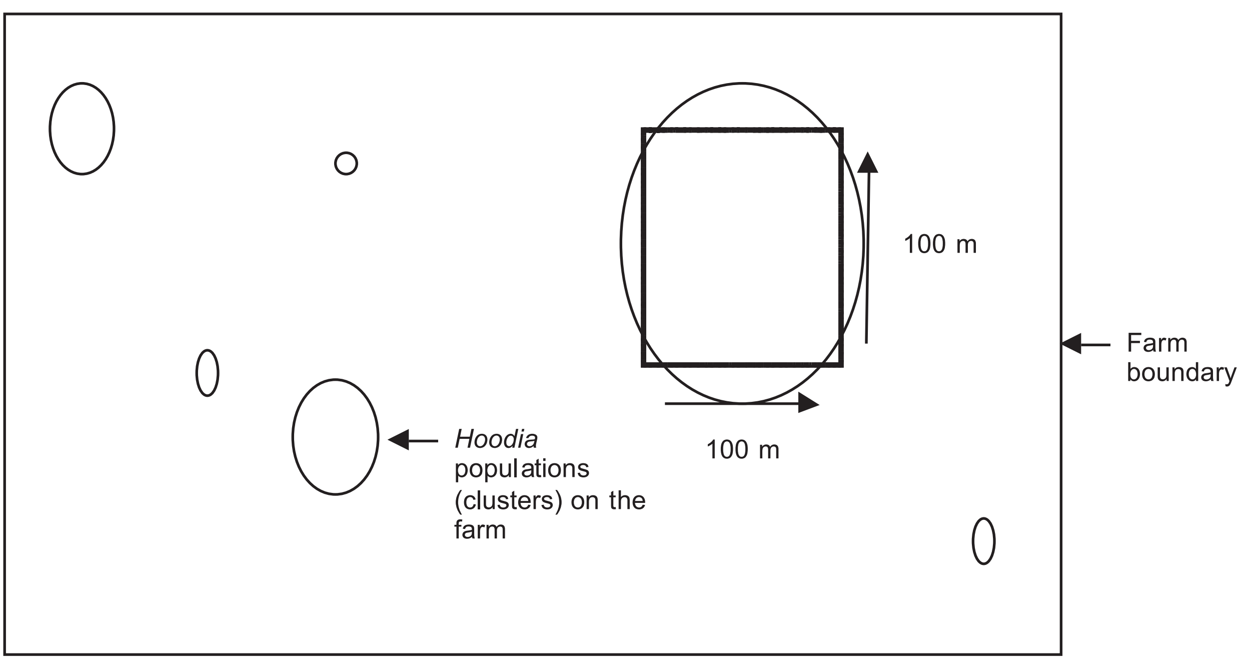


Figure 18. A schematic illustration: How to identify the site for the survey and how to place your quadrant in which you then survey individual plants.

Additional population information (density):
Population density and mortality information will be used to extrapolate your potential resource availability on the farm / site. Count live and dead individuals encountered within 4 parallel, 250m line transects that bisects the densest part of the population (and the demographic survey plot) and span its topographic gradients. Count all individuals occurring within the range of 2m on each side of the line transect (thus, total area covered is 4 000m2).
Note whether the dead individuals are standing or lying and its possible cause of death.

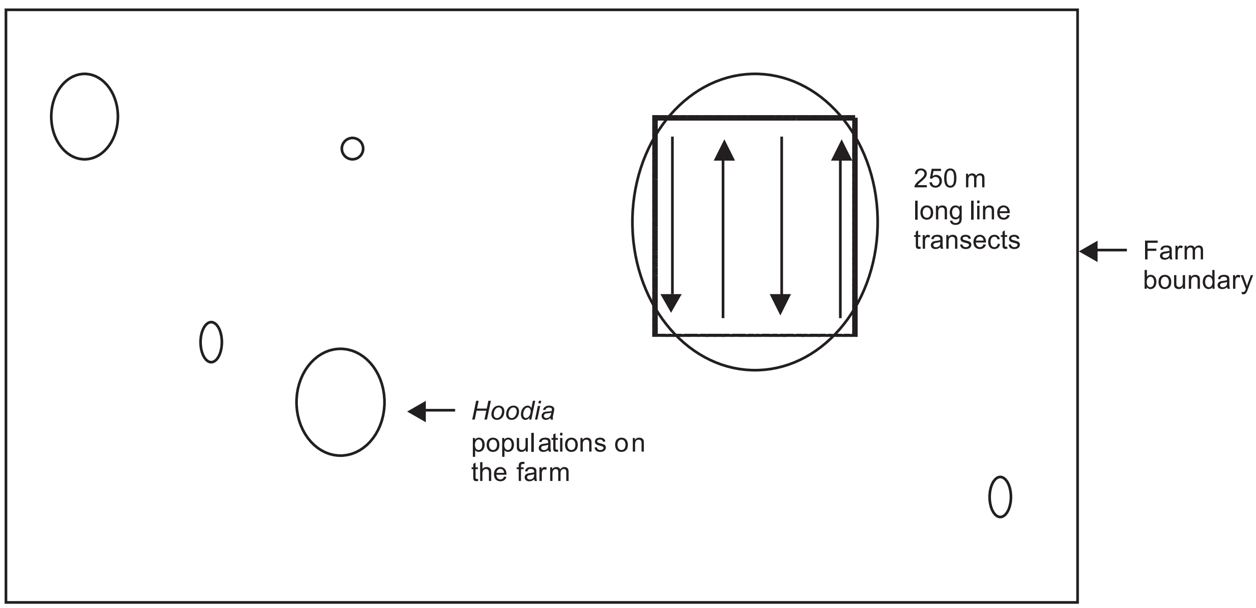


Figure 18. A schematic illustration of your line transects' layout.

This information relates to the optimum resource. An indication of part of the farm having clusters and the number of clusters on the farm is also recorded. A 1km line transect should also be walked to get a more general indication of density.

4. EVALUATION OF DATA QUANTITY AND QUALITY FOR THE ASSESSMENT

Generally most of the data could be used; however there were differences in how and what various people interpreted. This means that not all data can be lumped directly.
Data collected by departmental personnel is generally of good quality, but it was difficult to train farmers and consultants to do the surveys correctly while noting relevant information.

The line transect method is a questionable method if the department's scientist have not visited the site. Overestimation is a concern with the four parallel transects, though it provides better guidance with regard to the cluster's resource.

Preliminary information used for evaluation calculations:

Dry:wet ratios:	1:10 to 1:12 for wild material, 1:20 to 1:30 for cultivated material
Products:	each 33g serving contain 300-400mg active ingredients, that must be taken three times per day
Market:	Estimated weight needed to launch one international product is about 7 tonnes dry material (70 tonnes wet material) per month.
Resource need:	7 tonnes dry material relates to 23 333 wild plants (if 3kg wet material can be collected per plant harvested). If 30kg wet material can be collected per plant, it relates to 2 333 plants needed per month (i.e. 28 000 plants per year). When implementing harvest of every second plant, 56 000 plants are needed in the wild (if everyforth plant is harvested, 112 000 plants are needed).
Preliminary seed production:	200-250 seeds per follicle, 3mg per seed.
Cultivations:	25 000 – 50 000 plants/ha (cannot exceed 60 000 plants/ha) Ca. 4 tonnes dry material/ha (variable)

5. MAIN PROBLEMS, CHALLENGES OR DIFFICULTIES FOUND ON THE ELABORATION OF NDF

Lack of biological information is problematic (regeneration cycles, population trends, longevity of seed, seedling survival, etc.).

Lack of cooperation between provinces prevents proper management and monitoring of material/permits, enabling illegal trade via 'less-strict' provinces.

Development of the management of systems occurred within a time-frame where national legal structures (ref. Biodiversity Act) was not in place, causing uncertainties, lack of guidance and difficulties in Range State collaboration on government level.

Departmental staff shortages prevent them from being present at all harvesting activities for monitoring and recording. Although it was requested that harvesting dates should be arranged with the department beforehand to enable scheduling and their presence, it was difficult to execute.

Although it was thought to be a simple method, easy understandable guideline to be used for RAMR, most were unable to execute it properly.

6. RECOMMENDATIONS

Southern Africa should implement the same rules and methods in addressing wild crafted trade. Liaison with regard to transport and export permits is needed.

Capacity on provincial level is limited, varies in expertise and personnel turnover is of concern. It is uncertain as to how one can address these aspects, but a checklist (ticking off yes or no blocks) might be an option for evaluation (with reference to permit evaluations). However, for this more information is needed on the biology and regeneration of the species. Field experience and personal knowledge play a role in the permit evaluation processes currently, meaning that it is dependant on the person doing the evaluation (subjective to an extent).

A consultant or student should be sponsored / given a bursary to obtain the relevant biological information needed to enable the development of improved quota systems that inexperienced scientists can use to evaluate applications.

Provincial departments should be capacitated (more scientists), or provided with financial support to appoint consultants for surveys, or national departments should assist provincial departments where capacity constraints are being experienced.

Preferably the departments should do the resource assessments because it was found that the clients struggle too much with it. The time it takes to train them and assist them in getting it right, means that it is not really less time consuming as anticipated. Then you also need to either computerise their data, because they do not have computers, or you must try to unravel what applicants tried to say in their documents.

Importing countries should monitor *Hoodia* that is being imported, which should then be cross referenced with the countries of export. Any discrepancies in the data should be investigated.

International Expert Workshop on CITES Non-Detrimental Findings: Case study: *Hoodia gordonii*

Compiled by: Department of Tourism, Environment and Conservation,
South Africa, Northern Cape Province

Mexico, November 17-22, 2008

I. Background information on the taxa

1. Biological data

1.1. Scientific and common names

Species: *Hoodia gordonii* (Masson) Sweet ex. Decne

Genus: *Hoodia* (14 *Hoodia* species within the genus) (Germishuizen & Meyer 2003; CITES proposal 2004)

Family: Apocynaceae family (formerly under Asclepidaceae) (Van Wyk & Gericke 2000)

Common names: Ghaap, Bitter ghaap, Xhoba, Hoodia, |goa.-l, |khoba.b, |khowa.b, |goai-l, |hoba, |khoba.b|s, |khobab, |goab, otjinove, !nawa#kharab

Figure 1. *H. gordonii* in flower (and seed set) in the Northern Cape province, South Africa.

1.2. Distribution

H. gordonii has a fairly wide distribution (between 29^0 and 33^0 S), occurring predominantly in South Africa and Namibia, and to a lesser extent in Botswana and Angola. The species has a patchy spatial distribution pattern, meaning that its density varies a lot throughout its distribution range. Although its distribution is not continuous, nor uniform, it is uncertain whether it is fragmented as it has not been investigated.

The species is primarily associated with summer rainfall regions (South Africa and Namibia), but does occur in winter rainfall areas (Namibia) as well.

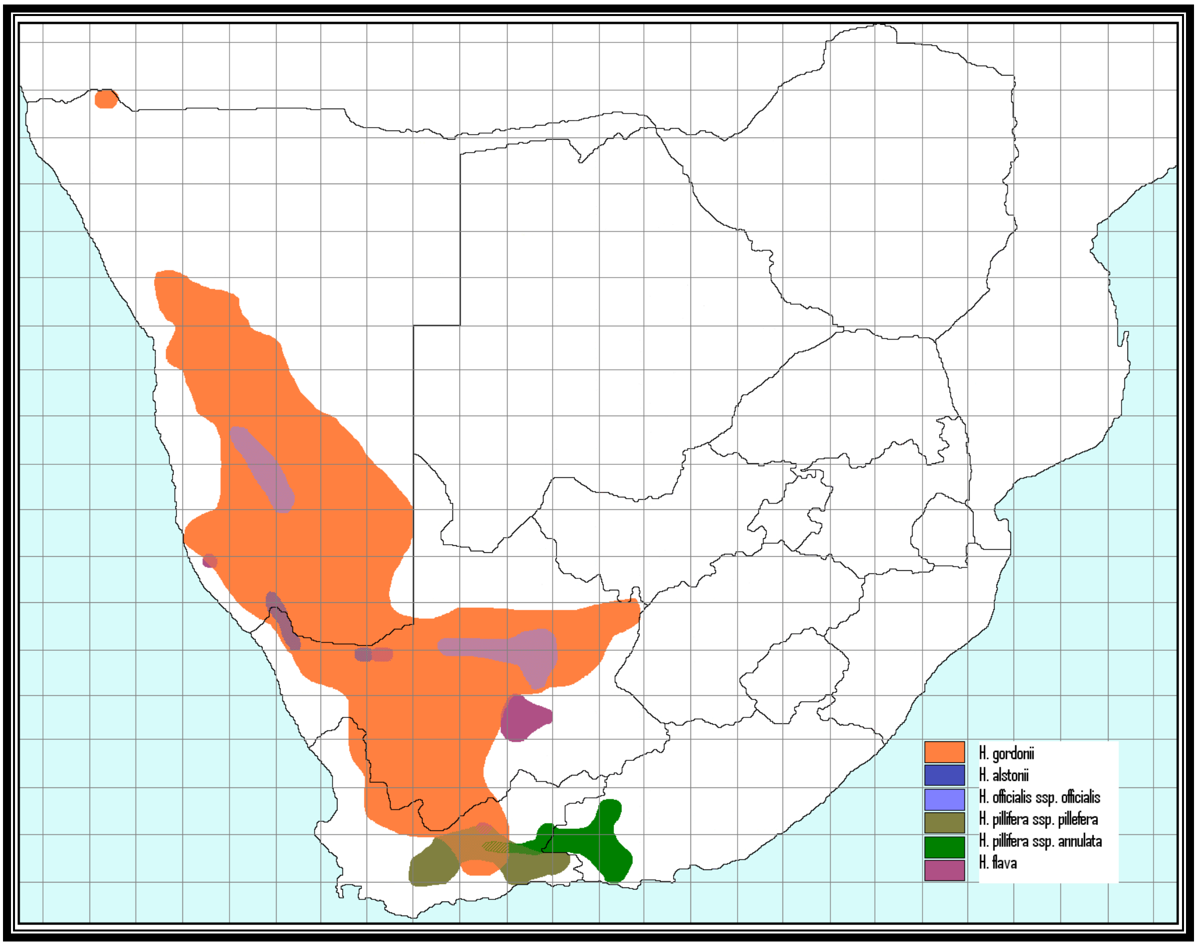


Figure 2. Schematic illustration of the known distribution ranges of six *Hoodia* species in southern Africa (based on PRECIS data 2005, SANBI).

Namibia is regarded as the country with the greatest richness in *Hoodia* species (11 taxa), followed by South Africa (9 taxa). However, there is disagreement amongst some taxonomists as to the species' names and classifications.

1.3. Biological characteristics

1.3.1. Summary of general biological and life history characteristics of the species.

H. gordonii is a slow growing perennial, leafless succulent. This stem succulent forms fleshy fingerlike stems that branch near ground level. The stems are pale-green, round and covered with spiny tubercles found in rows along the length of the stems. The estimated height of an adult plant is around 60cm, while the diameter of the canopy of the finger-like stems reaches more than 40cm.

Figure 3. *H. gordonii* stem illustrating the spiny tubercles running along the length of stems (photo by CSIR).

The life-span and age at maturity of *H. gordonii* is unknown, but anecdotal data indicate it to be 15-20 years, with the first flowering event only occurring after three to six years.

Flowering is protracted (based on herbarium records, PRECIS records) and unsynchronised, reacting to rainfall events irrespective of the season. The herbarium records supported the statement of Gutterman (1993) who stated that *Hoodia* is day-neutral for flowering. During good rainfall events, the plants are covered by flowers, producing masses of seed follicles after one month. Seeds ripen after about two to three months after flowering.

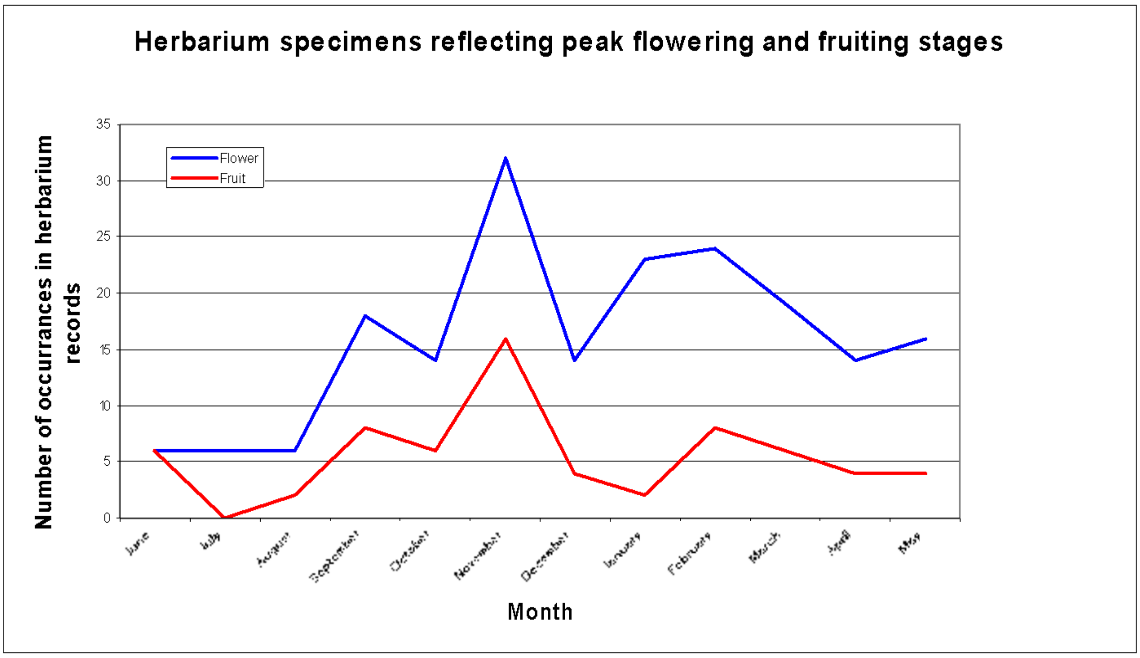


Figure 4. Illustration of the flowering cycles of *H. gordonii* (PRECIS herbarium data, 2005).

Flowers are generally dish-shaped (50-110mm in diameter), with a fleshy colour (colour varies from red to purple to brown to mottled dark yellow). Flowers are also referred to as carrion-flowers or stapeliads, and smell like decaying meat to attract pollinators, namely flies and blowflies. Pollination occurs when the flies lay their eggs inside the flower.

Figure 5. One of the pollinators (a fly) of *H. gordonii.*

Follicles can get up to 250mm long, containing several seeds that are wind dispersed. The follicles split open along the sides, releasing the seeds which are then blown under nurse plants or other protective sites where they germinate and establish themselves. However, the potential seed production (average number of seeds per follicle) and its longevity in the veldt are unknown. According to one expert (P. Bruyns, pers. com.) *H. gordonii* exhibits a weedy character and seeds germinate readily.

Figure 6. *H. gordonii* follicle releasing seed into the wind for dispersal.

Long term population trends are unknown, but drastic population declines have been observed in nature, mostly due to die-back of established plants. The reasons for these drastic die-back events are unknown, but they appear to coincide with prolonged high rainfall events when *Fusarium* sp. (a fungus) and other pests attack the species. No studies have been undertaken to assess the survival rate and recruitment of seedlings.

Population size and density is uncertain. *H. gordonii* clusters vary a lot in density and demography. Cluster densities range between only a few plants per hectare to over 130 plants per hectare (exceptional cases reflected a few hundred plants per hectare).

Figure 7. Die-back event observed in the Northern Cape, South Africa, in the Bushmanland region. Forty percent of a population at one of the sites in the Bushmanland died within two years (2000-2002), while the above photo illustrates that it can result in more than a ninety percent decline (2005).

More information is needed on habitat requirements regarding what conditions favour germination and seedling establishment.

Natural and anthropogenic threats also need to be quantified. Some of the preliminary natural threats that have been identified include fungus infections (Figure 8, *Fusarium* sp. infestation), snout beetles (*Paramecops stapeliae*), mite infestations and fruit flies (Figure 9, *Dacus bistrigulatus*). The milkweed bug (Figure 10, *Spilostethus pandurus*) and the African Monarch butterfly caterpillar (Figure 11, Nymphalidae, *Danaus chrysippus*) impacts negatively on seed production. Natural die-back could result in more than ninety percent decline in clusters (refer to Figure 7). If these die-back events are followed by recruitment events (replacement), there is no immediate concern. However, should these diebacks not be followed by recruitment events, then there is need for urgent investigation. Another threat that still needs to be evaluated is climate change. Some of the preliminary anthropogenic threats include commercial wild crafted harvesting (illegal harvesting) and habitat destruction (over grazing, trampling, cultivations, road construction, off road driving, urban development, mining).

Figure 8. A *H. gordonii* plant that died due to *Fusarium* sp. infestation.

Figure 9. The fruit fly, *Dacus bistrigulatus*, which lays its eggs in *H. gordonii* stems. Here the caterpillars feed on the inner parts of the stems, causing them to fall over and die.

Figure 10. The Milkweed bug, *Spilostethus pandurus*, lays its eggs in *H. gordonii* follicles.

Figure 11. The African Monarch caterpillar, *Danaus chrysippus*, feeds on *H. gordonii* flowers.

Figure 12. Unidentified ‘fly’ that lays its eggs in *H. gordonii* follicles.

1.3.2. Habitat types.

H. gordonii occurs in a wide variety of arid habitats characterised by sparse vegetation, ranging from coastal to mountainous habitats. Generally the species do, however, prefer arid gravel or shale plains, well-drained and sandy, slopes and ridges, ranging in altitudes from 250m to 1200m. However, the specific habitat requirements (niche habitat) remain unknown. In the Northern Cape Province, South Africa, the species does occur more readily (more densely populated) in some regions.

Figure 13. Examples of some of the habitats of *H. gordonii* in the Northern Cape Province, South Africa.

Habitat availability is not regarded a limiting factor to the species’ distribution range and it is not expected to have a negative impact on the population status at this stage.

1.3.3. Role of the species in its ecosystem

H. gordonii is a minor source of food and moisture to wildlife in arid ecosystems. However, the multiple above ground stems provide shelter and breeding sites for small animals and insects, like spiders or birds. The overall ecological function of the species is unknown.

1.4. Population:

1.4.1. Global population size

The global population size, or available resource, is unknown. Resource information is also not available on Provincial level in South Africa. Accordingly a Resource Assessment Report system was developed to obtain at least local basic information on population health and density. From these surveys, the recorded densities ranged from less than seven plants per hectare to a few hundred plants per hectare. However, as mentioned previously, *H. gordonii* is not evenly distributed; therefore no direct population size can be calculated in reference to the total distribution range of the species.

Surveys for the Resource Assessment Report should cover at least one percent of the total distribution range of the species on the farm to make sure it is at least to some degree representative.

1.4.2. Current global population trends:

The global population trend is unknown, but local decline has been observed at sites where exploitation and die-back have occurred. Recruitment events have also been observed, but these were not necessarily at the sites where decline has occurred (possibly random recruitment).

Climatic influences are undoubtedly an important factor that influences the survival rate of the species. The species is neither pure K-selected (perennial survivalist) nor pure r-selected (ephemeral avoider). Like normal K-selected species it is of larger size, does not mature quickly and has extended reproductive intervals (iteroparity), but unlike K-selected species it does have a lower reproductive allocation with few seeds produced with a big investment in offspring survival. It has been suggested that *Hoodia* acts as a weed at times by responding to favourable environmental conditions with abundant seed production and germination, but this is also true for many perennial species in the arid regions. The relationship with environmental fluxes needs improved understanding.

1.5. Conservation status

1.5.1. Global conservation status (according to IUCN Red List):

Until 2002 *H. gordonii* was regarded Near Threatened. However, towards 2005 it was suggested to change it to Least Concern (unpublished). We await the most recent evaluation which is due for publication this year.

H. gordonii is listed as a CITES Appendix II species.

1.5.2. National conservation status for the case study country

Hoodia is protected in five of the nine Provinces in South Africa, namely the Western Cape, Free State, North West, Northern Cape and Kwazulu Natal Provinces. Legislation include, e.g., the Nature and Environment Conservation Ordinance No. 19 of 1974 in the Northern Cape Province, the Threatened or Protected Species (TOPS) Regulations, i.e. the Biodiversity Act No. 10 of 2004 (the implementation of TOPS only occurred 2006/07, as it was not finalised or delegated to provinces).

The species is protected in Namibia (Nature Conservation Ordinance No. 4 of 1975 and No. 247 of 1977), but Botswana has no legislation specifically addressing the protection of *Hoodia.* The Agricultural Resources Conservation

Act [CAP35:06] of Botswana addresses “harvesting from the veldt”, which is used to manage *Hoodia*.

The current list of Protected Areas and Conservancies said to contain *H. gordonii* need to be reviewed as some of those listed do not have *H. gordonii* but some of the other *Hoodia* species.

1.5.3. Main threats within the case study country

Habitat loss/degradation (human induced), invasive alien species (directly affecting the species), harvesting (illegal gathering), accidental mortality (e.g. bycatch), natural die-back and climatic events appear to be important threats.

Of all the threats listed, illegal gathering is regarded the most important, followed by agricultural activities. It is uncertain whether the establishment of *Hoodia* cultivation sites itself are having negative impacts on its natural distribution, but needs to be investigated as these are established within its habitat.

Legal wild harvesting appears not to be a local threat at this stage as harvested sites have not died-back, and harvested plants are sprouting again.

The possibility of future commercial collection and the accidental (mistake in identity) collection of other *Hoodia* sp. is of concern. *Hoodia pillifera* was the species being investigated by the CSIR for appetite suppressant activity in 1983, and is regarded the preferred food source. The common names are indicative of the reasons for mistaken identity with *H. pilifera* being called ghaap and *H. gordonii* being called “muishondghaap” or “jakkelsghaap”. It therefore makes more sense to manage the genus rather than the individual species.

Internet trade is not quantified, but is of great concern.

2. Species management within the country for which the case study is being presented.

2.1. Management measures

2.1.1. Management history

The Northern Cape Province, South Africa, issued research permits until early 2000, where after permits for commercial harvesting from the wild was put on hold to enable the Department to put systems in place to handle such applications (except Patent Rights Owners of P57). Commercial applications only started after the CSIR announced their 'discovery' in the media.

However, none of the other provinces in South Africa have put *H. gordonii* permits on hold, meaning that harvesting continued in the Western Cape Province and the other Provinces transported and exported without strict cross referencing to make sure that it was legal material. Illegal material were accordingly 'legalised' due to this unsynchronised management by Provinces.

No permits for wild crafted *H. gordonii* was issued until the legal aspects of the Patent Rights contravention were resolved. A Review Report has been compiled and a Resource Assessment and Management Report (RAMR) system has been developed to manage the resource should permits be issued.

In the review process the information available on the species and the Access and Benefit Sharing aspect (the San has been acknowledged as the Indigenous Knowledge Keepers) was taken into consideration.

The RAMR include the applicant's details, resource details, harvesting management details, and trade details (trade information is not mandatory due to the free market system). Only landowners are allowed to harvest on their own properties due to illegal activities that were reported in the Western Cape Province. Harvesting methods were prescribed.

RAMR is similar to TRAFFIC's sustainable harvesting of medicinal plants document, with limitations regarding the social aspects.

No proper national and international management system is in place yet (including Range States). One of the major concerns is the cultivations occurring outside the natural distribution range of the species, thus economic benefits are not being shared with the countries of origin and Knowledge Keepers.

2.1.2. Purpose of the management plan in place

The purpose of the developed system is to enable economic benefits to accrue to the province, to obtain minimum baseline information to ensure that landowners harvest on their own property, to enable quota formulation for sustainable resource use (permitting), to obtain baseline information to build a database for the province on its resources and the impacts harvesting has on *H. gordonii* populations, and to acknowledge and respect the ABS/IKS.

The methodology developed was kept as simple as possible to enable non-scientists to implement the system as the Department is unable to conduct all surveys (not all farmers can afford consultants). It also included prescribed guidelines as to how and when you may harvest to be able to evaluate harvesting impacts (uniform methods enable comparisons).

2.1.3. General elements of the management plan

Landowner confirmation (Deeds)

Available resource and general health of the resource

Harvest reporting (harvested, wet:dry ratios)

Trade information (optional)

Monitoring (harvested sites, permits)

Gap: Management efforts concentrate on *H. gordonii* though related species might also be impacted on.

2.1.4. Restoration or alleviation measures

No restoration is needed if prescripts are followed, only monitoring to evaluate whether adaptive management (harvesting) is needed. The only aspect of high impact is the development of cultivation sites.

2.2. Monitoring system

2.2.1. Methods used to monitor harvesting

Sites harvested are re-visited and visual inspections are done (no quantification). This is followed-up at a later stage (at least one year after harvest) during which time a survey is done within the harvested area, using similar methods as for the original resource assessment (an alternative is fixed point photography and making notes for interpretation).

The Permit Section has put a database system in place which can be used to monitor permits issued.

2.2.2. Confidence in the use of monitoring

The confidence level is moderate – those figures indicated would always be linked to confidence levels or gaps, meaning that you would have an idea of accuracy and confidence.

Species monitoring is not formally structured, and initially the responsibility was placed with the landowner, but it was found that it was not implemented. Accordingly the Department is re-visiting the sites, with the first quantifying survey being done about one year after the harvesting took place. Due to personnel constraints the responsibility was initially placed with the client.

2.3. Legal framework and law enforcement

Refer to section 1.5.2.

The species is nationally listed as protected under NEM:BA (National Environmental Management: Biodiversity Act No. 10 of 2004, TOPs Regulations of 2007). The species is listed provincially as protected in five of the nine Provinces in South Africa. The species is also listed in CITES Appendices II.

3. Utilisation and trade for range State for which the case study is being presented.

3.1. Type of use (origin) and destinations (purposes)

Traditionally it was used by the San while hunting to suppress appetite, thirst and to maintain their energy levels. They ate portions of the fresh stems. The commercial uses are similar, with dieting and energy boosting (cyclists) being the major consumer markets. Interestingly, the Patent actually includes anti-diabetic and prevention of aspirin induced gastric damage characteristics.

Limited cultural and traditional use still continues today. It has been reported by communities that the resource has become scarcer (anecdotal information). Other traditional uses (treatments) include abdominal cramps, haemorrhoids, tuberculosis, indigestion, hypertension, diabetes, peptic ulcers and allergic reactions in eyes.

Horticulture is limited.

At this stage *H. gordonii* is commercialised as a food-source and/or -supplement, not a pharmaceutical product. The CSIR patented P57, and then licensed it out to Phytopharm (UK), who sub-licensed it to Unilever to commercialise it as a food product/supplement. Benefit sharing agreements are in place with the San (6%).

Most exports (wild crafted) from the Northern Cape were to the Western Cape Province of South Africa.

Material is exported as dry material (discs or milled), or as extracts.

Until recently, wild crafted trade was more than cultivated material. However, the number of cultivations has increased and it is anticipated that wild harvesting would not form such a large part of the trade in the future.

The collection of dead wild *H. gordonii* material was combined with wild crafted data and should be kept in mind. Nearly half of the wild harvested material (kg) was dead material that was collected.

3.2. Harvest:

3.2.1. Harvesting regime

No harvesting prescripts are given to cultivated material collection. A register must be kept throughout recording all activities and weights.

General guidance (booklets) was given to wild collection applicants specifying that older plants also contain the active ingredients. Thus, plants larger than 40cm in canopy diameter could be harvested.

For material collected from the wild, the guidelines stipulate that only ten of the stems may be harvested or 25% of a plant that is larger than 40cm in diameter, only on the southern side (down wind), near ground level. Only trained harvesters may harvest *Hoodia* material, i.e. trained in the prescribed methods provided by the Department. Harvesting will only be considered on sites where an excess of 2500 plants are available that are in good health and of optimal size.

Harvesting of wet plant material may only occur if it is not in flower or seed, which is normally between April and August. Seed collection must be specified and will be evaluated in a similar manner as in wet plant material collection, except for time of year to be collected. Only every second to fourth large plant (larger than 40cm in diameter) should be harvested in the wild.

Stems must be cut off at least three fingers' width (5cm) above ground level with a sharp stainless steel blade (recently evidence indicate that cuts at thin basal stem sections could be less damaging). This is to enable resprouting, if the species has the ability to do so. The blade must be disinfected (3% chlorine solution, like Jik) between each plant being cut. The cut stems that remain on the plant must be dusted with lime sulphur powder. The collected stem-parts are washed and cut into disc shaped pieces. These pieces must be dried in an appropriate manner to ensure quality and prevent rotting. The mass of the harvested plant material must be determined and signed off by Conservation Authorities before and after drying. Drying must occur as close as possible to the harvesting site. The sealed dried discs are sent to accredited and endorsed Processing and Quality Assurance entities. Quality products are sealed with tamper proof Quality Labels and Logos. These products are ready for trade after quality assurance approval and labelling.

Monitoring programmes must be put in place (by the permit applicant) at sites where wild crafted collections occurred / are planned.

Clients were given the opportunity to deviate from the proposed methods, if they can provide scientifically proven data that their proposal is more effective than the prescribed method and must be reported as such in their RAMR.

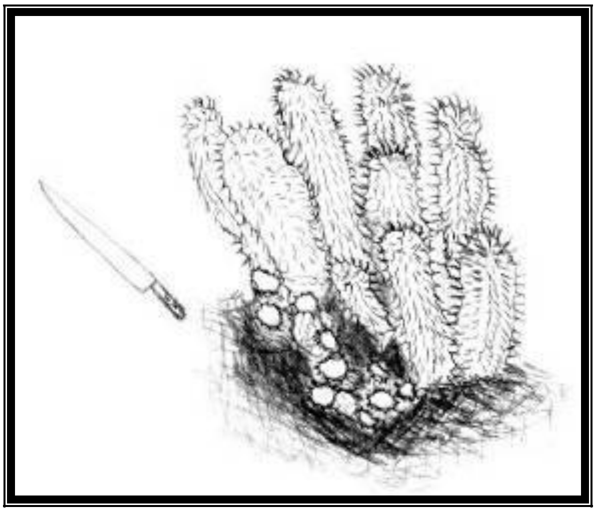


Figure 14. A schematic illustration of how you should cut stems on the southern side of a plant in the veldt, using a sharp stainless steel blade.

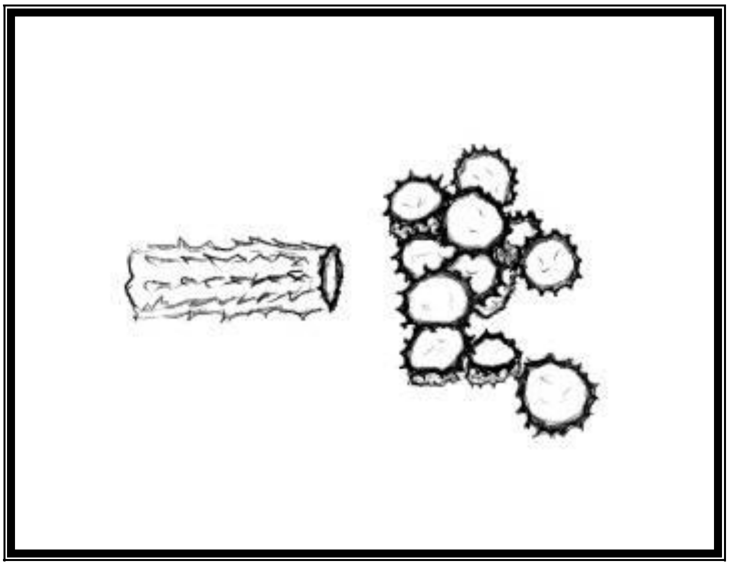


Figure 15. A representation of the cut slices of *Hoodia* stems harvested.

Mature seed pods/follicle should be collected just prior to opening of the pod, or with seed collection bags. If not done at this time, it will compromise the success rate of germination. It is recommended that seeds (not more than 20% of population's follicles) should be collected over two flowering seasons to minimise its impact on natural populations.

Figure 16. Example of a *H. gordonii s*eed collection bag.

3.2.2. Harvest management/ control (quotas, seasons, permits, etc.)

Refer to section 3.2.1.

3.3. Legal and illegal trade levels

From 2005 until March 2008 a total of 15.7 tonnes of dry illegal material have been confiscated. Anecdotal data indicate that it could be more (more than 41 tonnes dry weight), but this is unconfirmed. It is suggested that only 10-15% of illegal trade is reported and/or detected.

Legal harvesting peaked in 2008 of which most were obtained from cultivated material.

Wild harvesting peaked in 2007 and it included the collection of dead plants. Dead plant material contributed 52.4% of the total wild harvested weight.

The collective wild harvested weight obtained from live plants since 2002 (until March 2008) potentially relates to ca. 0.25 million plants that were ‘harvested’/available resource.

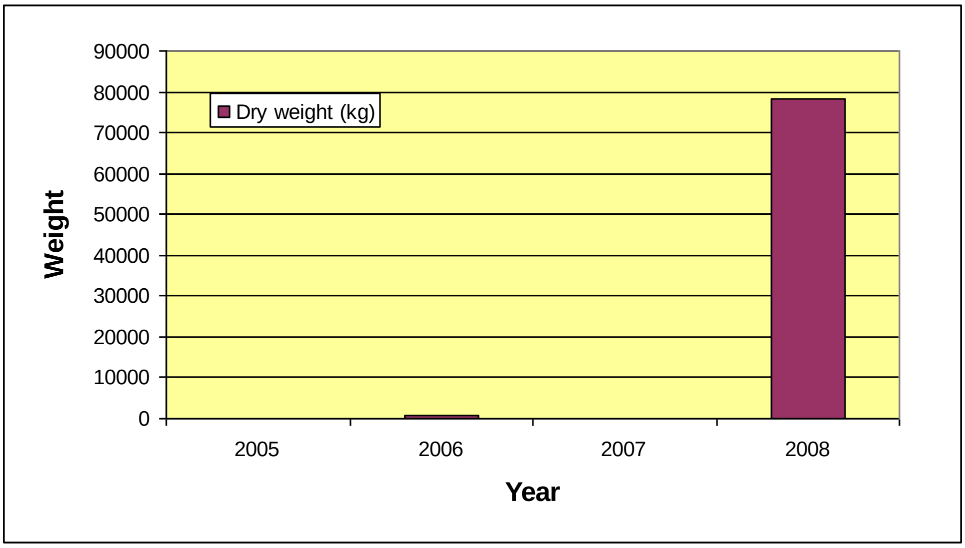


Figure 17. The collective (wild crafted and cultivated) dry weight exported through CITES permits from 2005 until August 2008.

II. Non-detrimental Finding procedure (NDFs)

1. Is the methodology used based on the IUCN checklist for NDFs?

No, although there are various similarities. Several of the aspects to be addressed according to the IUCN checklist have been addressed through our methods being used.

2. Criteria, parameters and/or indicators used

Due to the lack of a provincial resource assessment, site assessments were done according to our developed prescripts (i.e. per farm application) to enable site evaluation and quota estimation.

Each permit application is evaluated individually, i.e. each permit quota is calculated according to each individual resource assessment / inspection. The aspects taken into consideration while evaluating each resource assessment include the following:

a) The surface area surveyed in relation to farm size and *Hoodia* cluster distribution

According to the RAMR guidelines the total size of a farm should be provided, together with the extent of *Hoodia* cluster occurrence on the property.

Improved survey site identification is expected with increased area inspected before placing survey sites.

The greater the percentage surface area surveyed on the farm, the more representative the data (quantification) would be. Accordingly, the more extensive the surveys the more reliant the data presented and resource assessment.

b) The general health of the population surveyed

Aspects taken into consideration while evaluating general health include live:dead ratios, visual observation of infestations and infections, adult:juvenile ratios and associated environmental threats, like alien invasive species, erosion, etc.

It is uncertain whether *Hoodia* can be regarded as a fugitive species, but a population would be regarded 'healthy' if: more live than dead plants are present on the property, if there are no or low visible infections and infestations on the plants, if there are at least no other immediate threats to the species present (e.g. erosion and alien invasive like *Prosopis* sp.). The presence of various size classes is regarded as a representation of continuous re-establishment (no size class variation is regarded sporadic random recruitment, ref. *Opuntia*).

c) The estimated population size / cluster density (extrapolated)

Line transect (1000m and/or 4 x 250m) and sample plot (100 live individuals) data is compared and used for calculations (extrapolations). It is suggested that if the survey sites have been chosen representatively, then the data should be comparative.

Quota calculations are based on the number of adult live plants. Qualitative sustainable resource use studies are extremely limited, but according to Pfab &

Scholes (2004) *Aloe peglerae* (60 year life span) cannot be harvested sustainable (entire plant removal) as less than one percent of the population needs to be harvested to allow for sustainability, which is regarded unfeasible for trade. In the case of *Hoodia* only a part of the plant would be harvested (not destructive) and it has been reported that not all harvested plants in the Western Cape died after harvesting. Accordingly the observed best practices from Western Cape 'trials' were collated into harvesting prescripts for the Northern Cape. Monitoring would reveal whether re-sprouting of harvested plants is possible and if harvesting is not detrimental.

d) The harvesting history on the same farm

The general rule applied is that no harvesting may occur at the same site to allow recovery of harvested plants, while also enabling the monitoring of resilience to harvesting. No information was available to determine rotation periods yet and therefore renewal applications are linked to a re-evaluation and inspection. This means that should it be found that no follow-up harvesting should be allowed, the harvesting permit would be rejected.

If harvesting is requested for the same farm, but different camp or site it must be inspected and/or assessed again before considering the permit application.

No harvesting (extension) would be allowed on a farm where indications of stress are visible in harvested sites.

e) Harvesting method to be used

Harvesting methods are prescribed based on observations recorded in the Western Cape Province (Ceres Karoo) and by Industry members. As the method was not optimised through experimentation, it is allowed to alter it provided that documentary proof can be provided to support the method to be more environmentally friendly and sustainable. (Twisting off branches at ground level is currently being looked at as an alternative)

Only 25% of every second (to fourth) individual plant may be harvested from. Harvesting may only be on the down-wind side as observations in the Western Cape indicated that plants are more susceptible for infections if it is harvested on other sides of the plant.

f) Precautionary principle

If there is any uncertainty in the data, the quota was reduced accordingly. In cases where data is insufficient the re-assessment of the resource is requested.

If the site to be harvested contain less than 2500-3000 harvestable plants, it is regarded unfeasible for trade (the harvested mass does not justify the harvesting expenses, and is too little for trade according to the industry) and the impact regarded unnecessary. Harvesting for research is handled differently as smaller quantities are used in this case.

Quality control measures are useful for the industry, but might also have benefits to Conservation. In situations where illegal material is found, morphological and chemical controls can be used to identify and quantify illegal *Hoodia* (morphologically e.g. grouped spines / thorns, anatomically e.g. presence of druse crystals and hairs and their chromatographic fingerprints using TLC, HPLC and NIR). It remains to be seen whether region of origin can be identified based on chemical analysis (chemotypes). Through an improved knowledge of illegal harvests, an improved conservation assessment can be made regarding harvest impact.

3. Main sources of data, including field evaluation or sampling methodologies and analysis used

Background information: Literature, anecdotal information, Industry (who are willing to share some of their information), and the RAMR (demographic and density data, as well as habitat description) is used.

Field information for assessing habitat condition, population size and impacts of harvesting:
Demographic information was obtained through the following method:
The first live 100 individuals encountered in the densest part (cluster) of each population must be surveyed. A plot of 1 ha (ideally 100 m x 100 m) should be documented. If a plot of 100 m x 100 m cannot be established, plot sizes should be adjusted to enable the documentation of at least 100 live individuals and a surface area of 1 ha. A template for measurements to be taken was provided.
These surveys, thus far, have only been done on the farms where harvesting permit applications were received from. It is anticipated to expand it towards a provincial assessment.

As part of the assessment of general habitat condition, the level of plant damage through infection, or infestation, or physical damage, was rated as 0 (no damage), 1 (presence), 2 (moderate, up to 60%) and 3 (severe).

Rating: 0 (healthy plant)	Rating: 2 (infested plant)	Rating: 3 (dying plant)
		

Figure 18. Examples of plants to illustrate ratings of health as per RAMR.

Photographic records (with GPS co-ordinates) are also collected for each plot, and include a photograph of the site as well as, where possible, photos of each individual plant next for use in monitoring of growth rate and survival.

GPS mark and note each individual *Hoodia* surveyed, dead and/or alive on a spreadsheet.

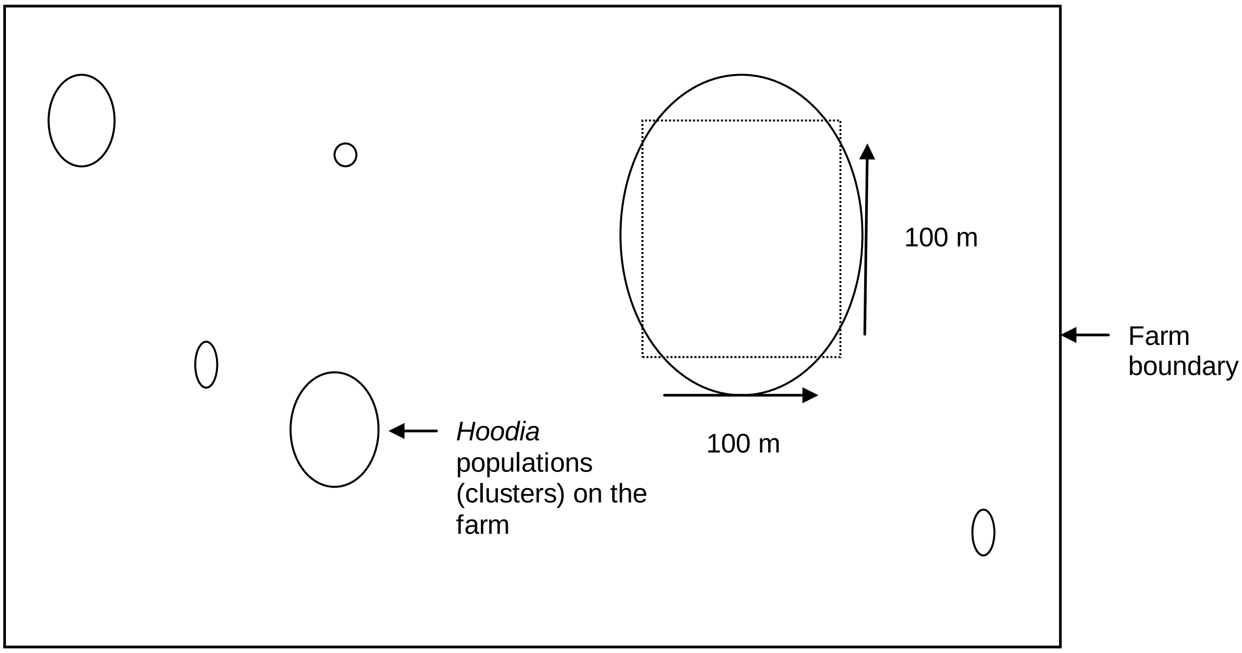
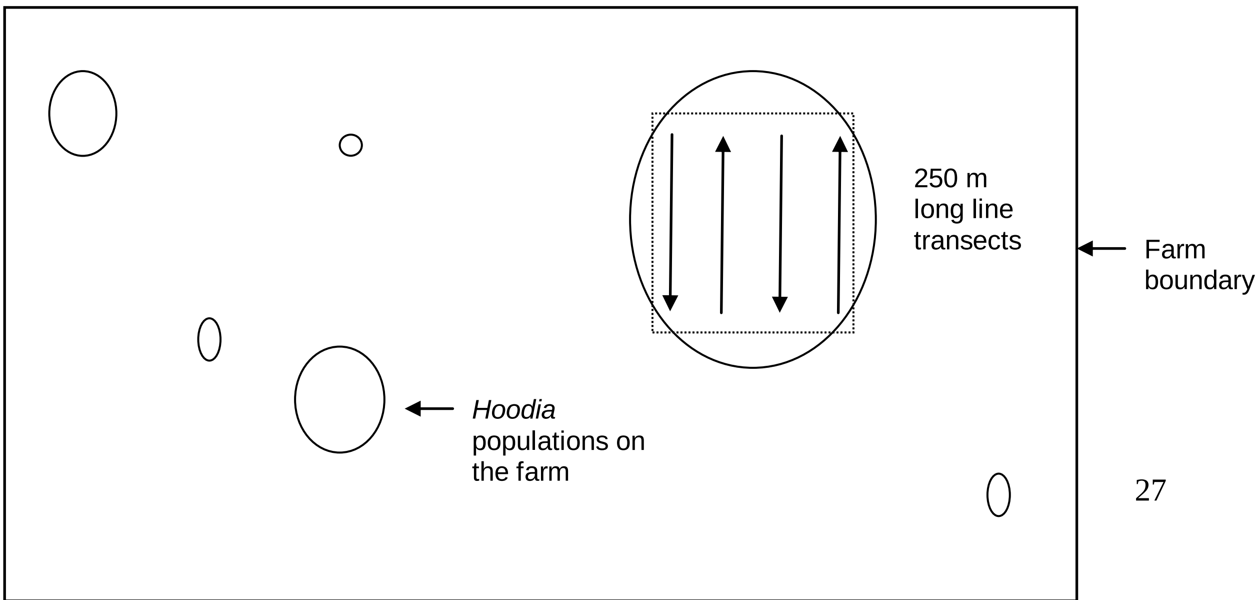


Figure 18. A schematic illustration: How to identify the site for the survey and how to place your quadrant in which you then survey individual plants.

Density information was obtained through the following method:
Applicants are expected to provide information on population density and mortality derived from 4 parallel, 250m long line transects that bisects the densest part of the population (and the demographic survey plot) and spans its topographic gradients. Applicants are expected to count all individuals occurring within the range of 2m on each side of the line transect (thus, total area covered is 4000m^2). Note whether the dead individuals are standing or lying and its possible cause of death.

Further population and habitat information is obtained from permit application's RAMRs. Site characteristics like aspect, habitat, grazing intensity (dung frequency



and type), mountainous, plains, and soil type should be noted.

Figure 18. A schematic illustration of your line transects' layout.

This information (4 x 250m transects) relates to the optimum potential resource. An indication should be given to the extent of the clusters and the number of clusters on the farm to enable extrapolation.

It is recommended that a 1000m line transect is also walked to get a more general indication of density, but has not been done at all sites.

4. Evaluation of data quantity and quality for the assessment

Wild harvesting has only been granted for farms ca. 55983ha in total surface in the Northern Cape (ca. 8 332 700.2ha). It is expected that *H. gordonii* occurs throughout about 50% of the Northern Cape, i.e. harvesting occurred within ca. 1.34% of the distribution area of the species (based on farm sizes, not cluster sizes). However, it should be noted that it is not an accurate spatial representation of the actual *Hoodia* distribution vs harvesting surface area.

The spatial statistics should still be confirmed using GIS analysis, which can only be done after the provincial assessment.

The harvesting method was developed based on observations made in the Western Cape where wild harvesting occurred. No die-back has been reported to date using the prescribed harvesting methods, and the continual collection of monitoring data is hoped to confirm these preliminary data. At this stage permits are used to gather valuable harvesting information to enable more informed decision making in the future.

Wild harvesting is regarded non-detrimental on a provincial scale based on preliminary observations and data. It is also not regarded destructive at this stage as only a part of the fingers are removed. However, no qualitative data is available to support our inferences at this stage. Resprouting has been recorded at harvested sites though (in the process of being quantified). In a worst case scenario where all harvested sites might have died, it would be localised.

There is concern with respect to a more localised scale (site level) as the harvesting applications are concentrated towards its southern distribution ranges in the Northern Cape and there is a possibility that it (in a worst case scenario) might result in the southern distribution patterns to be altered in the future if harvesting pressure increases (collective impact of plant material and seed harvesting).

Resource assessments were the responsibility of the permit applicants. Resource assessment guideline booklets were compiled to assist applicants (or consultants) to do these assessments in a uniform manner. Generally most of the data received was of acceptable quality; however there were differences in how and what various people interpreted, even after training by Conservation. This means that not all data can be collated directly. It is hoped that with an increased number of surveys we would be able to have improved data for a better understanding of the species.

Data collected by departmental personnel is generally of good quality.

The line transect method (4 x 250m) is a questionable method. Overestimation is a concern with the four parallel transects, though it provides better guidance with regard to the cluster's resource specifically. Some of the methods consulted during the development of the *Hoodia* methods included, amongst others, the method used by Hachfeld B (2003) for *Harpagophytum procumbens*, as the spatial distribution pattern is also regarded patchy. The method used by DTEC for *Aloe dichotoma* surveys (based on the method used by Foden W, 2002) was also consulted, especially for health rating.

The methods used for the RAMR surveys are regarded sufficient in gathering basic information to enable some quota formulation. The shortcomings at this stage include: Possible overestimation of the resource through placing line transects through the densest clusters, especially if no comparative 1000m line transect was done. The provincial resource is not known, meaning that no comparison can be made on a provincial scale. Regeneration and survival information is critical in determining the impact on the population, which lack currently. It is inferred that the protracted production of seed will ensure resettlement. The tolerance of the species to harvesting is not known, but it is anticipated to have some level as it is known to be browsed by goat and sheep at times.

Most of the information used for calculations is based on anecdotal information from the industry and preliminary data, and is not yet quantified to have potential deviation (statistics).

Preliminary resource assessments reflected that the average density on farms varied between 15-105 plants per hectare, with exceptions where several hundred plants per hectare have been recorded (based on 1000m transect data). The cluster sizes varied, but the 1000m line transect was regarded representative of the general density on the various properties as it always have crossed at least one cluster.

The potential resource that provided for harvesting from 2002 until March 2008, relates to ca. 0.25 million plants. The potential available resource according to preliminary resource assessments (using averages, not exact data) relates to ca. 0.033 to 0.23 million plants. Large variability exists with data and only after the collation of more extensive survey data can an improved comparison be made (having average and, minimum and maximum estimated). Spatial impact evaluation might proof valuable.

On site level harvesting is regarded sustainable due to the fact that no die-back has been recorded to date.

It is suggested that wild harvesting alone will not sustain the market needs as more than one product is expected to be launched.

With regard to cultivations, similar calculations can reflect whether plantations are sufficient in meeting the market demand (weight per year needed by the market vs production per ha). However, an independent market analysis is needed in this regard as the industry views this as confidential information as it relates to their financials of trade.

5. Main problems, challenges or difficulties found on the elaboration of NDF

The lack of biological information is problematic (regeneration cycles, population trends, longevity of seed, seedling survival, etc.). Biological information, especially on survival rate, can enable stochastic analysis. This means that an estimated sustainable quota guideline can be developed. Similarly, if habitat requirements are known (environmental conditions favouring recruitment) recruitment cycles can be modelled. In the absence of such data, monitoring is important and an adaptive management approach needs to be implemented (the shorter the life-span of a species and the less specialised the lower the risk).

Hoodia harvesting is limited to succulent stems of adult plants and seed. This is regarded non-destructive and therefore harvesting is not regarded detrimental if managed and monitored. However, monitoring is essential in ensuring sustainable utilisation.

Departmental staff shortages prevent them from being present at all harvesting activities for monitoring and recording. Although it was requested that harvesting dates should be arranged with the department beforehand to enable scheduling and their presence, it was difficult to execute. If harvesting is not done according to prescripts, e.g. harvesting of entire plants, the risk of exploitation increases. To date all farmers have adhered to harvesting procedures though. The integrity of permit applicants and the working relationship between the applicant and Conservation therefore plays a major role.

Also, if monitoring is done after harvesting occurred it is reactive and not pro-active as nothing can be done to change the harvesting impact, it can only be recorded. Through spatially (distribution) evaluating potential harvesting impact, some guidance is given with regard to 'worse case scenario' evaluations.

Although it was thought to be a simple method, easy understandable guideline to be used for RAMR, most were unable to execute it properly. This can be attributed to the fact that most applicants do not have biological backgrounds. The fact that applicants were willing to participate helped a lot as they were patient with criticism from Conservation regarding their data. The option of explanatory videos should be considered if manpower at Conservation is limited for training.

Alternatively, a consultant should be appointed by Conservation to do assessments. Where trust and personal relationships play a role, it is always a risk as not everyone would participate.

Lack of cooperation between provinces prevents proper management and monitoring of material/permits, enabling illegal trade via 'less-strict' provinces. Permit monitoring is one of the ways through which illegal trade can be detected: If all provinces share their information and ensure that the material being applied for is of legal origin before issuing the next permit, illegal quantification can be improved. There are permit holders who use one permit for several transactions, meaning that they use a legal permit for illegal material as well. Other permit holders export to less strict provinces where they apply for another permit, legalising illegal material.

Provincial and National collaboration should improve to address 'legalisation of illegal material'. It would also be helpful in conservation assessments.

Development of the management of systems occurred within a timeframe where national legal structures (ref. Biodiversity Act) was not in place, causing uncertainties, lack of guidance and difficulties in Range State collaboration on government level. Through collaboration, southern Africa can evaluate their natural resource and assess harvesting impact on an international level. If similar methods are used for data collection, it can be collated for conservation and sustainable use assessments, representing the entire distribution area of the species.

6. Recommendations

Capacity on provincial level is limited, varies in expertise and personnel turnover is of concern. It is uncertain as to how one can address these aspects, but a checklist (ticking off yes or no blocks) might be an option for evaluation (with reference to permit evaluations). However, for this more information is needed on the biology and regeneration of the species. Field experience and personal knowledge play a role in the permit evaluation processes currently, meaning that it is dependant on the person doing the evaluation (subjective to an extent).

At times allowing / permitting utilisation in a controlled manner is the best way of obtaining information to improve future evaluations, especially if capacity is limited. However, this will only work if monitoring is done and adaptive management implemented strictly. Generally, in arid regions, one might need to regard a species more susceptible for harvesting the longer the life-span (ref. *Aloe dichotoma, Aloe pillansii, Welwitchia* sp. e.g.).

A consultant or student should be sponsored / given a bursary to obtain the relevant biological information needed to enable the development of improved quota systems that inexperienced scientists can use to evaluate applications.
In most cases, biological information lack to make a confident scientifically based quota recommendation. However, with supplementary information from Research Institutes, Conservation can improve on their confidence levels.

If a spatial analysis could guide your impact on a spatial distribution level while gathering information. Harvesting is expected not to be detrimental with regard to non-destructive harvesting methods. The identification of core conservation areas (where no harvesting is allowed) might also be valuable in ensuring that a 'seedbank' is maintained. However, it might not be possible to know where to place such a protected area, nor what minimum size it should be to supply sufficient seed.

Preferably Conservation should do the resource assessments because it was found that the clients struggle too much with it, while simultaneously capacitating the scientist to make improved evaluations. The time it takes to train and assist them in getting it right, means that it is not really less time consuming as anticipated. Then you also need to either computerise their data, because they do not have computers, or you must try to unravel what applicants tried to say in their documents.

A review report is recommended (to be compiled by the person who would attend to the NDF) before trying to develop quotas. Through this process the scientist is forced to obtain and learn about the species to be utilised. In addition, literature on sustainable utilisation of other species can sensitise the scientist with regard to aspects to consider when 'guessing' guidelines for quota formulation.

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MEXICO 2008

NDF Workshop
WG 3 – Succulents and Cycads
CASE STUDY 6 SUMMARY
Hoodia gordonii
Country – **South Africa**
Original Language - English

HOODIA GORDONII IN SOUTHERN AFRICA

AUTHOR:
Elsabe Swart

Hoodia gordonii (family: Apocynaceae) has a fairly large distribution range occurring predominantly in South Africa and Namibia. The spatial distribution pattern is patchy and is mainly associated with summer rainfall areas, in a range of habitats. Biological information, population trends and resource availability information lack on the species, but there are indications that this perennial succulent has an estimated life-span of 15 to 20 years and only flowers after three to six years. Flowering is protracted and seeds are wind dispersed. It has also been suggested that the species has a weedy character and that germination occurs readily.

Natural die-back events have been recorded and natural threats are present. Global trends are unknown, but local declines have been recorded. In an attempt to manage the resource sustainable a Resource Assessment Management Report (RAMR) system was implemented. Through this system basic demographic and population density information is collected (site specific), together with related management and environmental information. The demographic information was used to determine population health while the line transect data was mainly used for quota calculations. Quality of data was checked by referring to the area surveyed vs the area of occurrence and comparing line transect data with that of the quadrant data (ref. health and density). Harvesting methods were prescribed using information obtained from previously harvested sites (not scientifically verified). A spatial impact analysis was done to sensitise ourselves on potential harvesting impact within its distribution range.

A preliminary market demand calculation was done as reference to evaluate the potential demand we could expect – and whether we would regard it sustainable or not if all trading material was obtained from wild harvesting. All applicants were urged to resort to cultivations in the long-term as initial indications are that wild harvesting will not be sustainable.

Harvesting permits could facilitate information obtainment, though it depends on collaboration between clients and authorities. However, research Institutes should assist in the obtainment of biological information to enable improved quota formulation. Systems and guidelines that could ensure non-detriment finding (NDF) evaluations within a dynamic environment (personnel turnover and environmental) would be helpful, but should not replace scientific expertise as it should still be evaluated for compatibility to the species at hand. Therefore the first step should always remain a review of the species before conducting any non-detriment finding.

CASE STUDY: *HOODIA GORDONII*

By

E Swart & C Geldenhuys

Department of Tourism, Environment and Conservation, Northern Cape, South Africa

Cancun,
Mexico
15-22 November 2008

INTRODUCTION

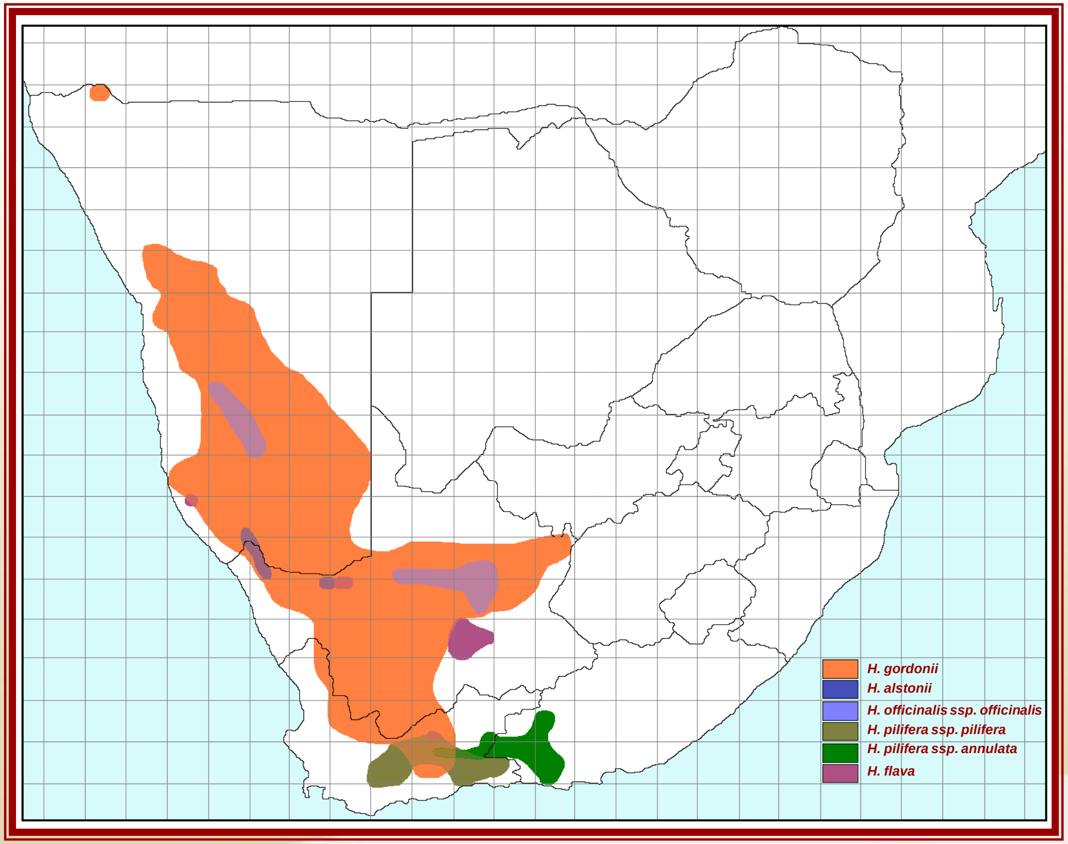
- *Hoodia gordonii* (Apocynaceae, 14 species)
- Perennial succulent
- Finger-like stems branching at ground level
- Biological information, population trends and resource availability estimates lack

HOODIA GORDONII

- 15-20 year life span
- 3-6 years before flower
- Protracted flowering
- 250 seeds / follicle
- Weedy character
- Natural die-back events

HOODIA GORDONII

- Southern African distribution range
- Diverse habitats
- Patchy spatial distribution
- Role in ecosystem is unknown
- Appetite suppressant (P57)

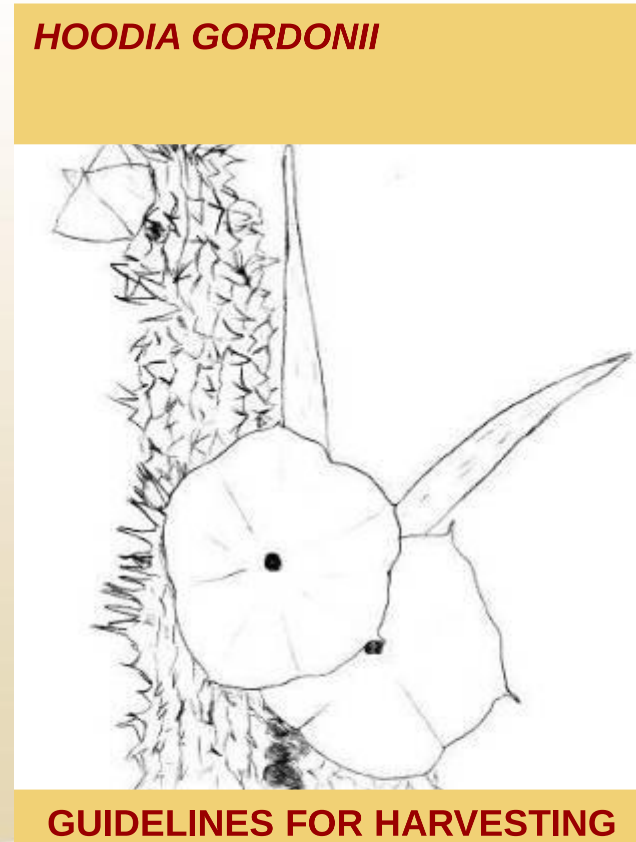


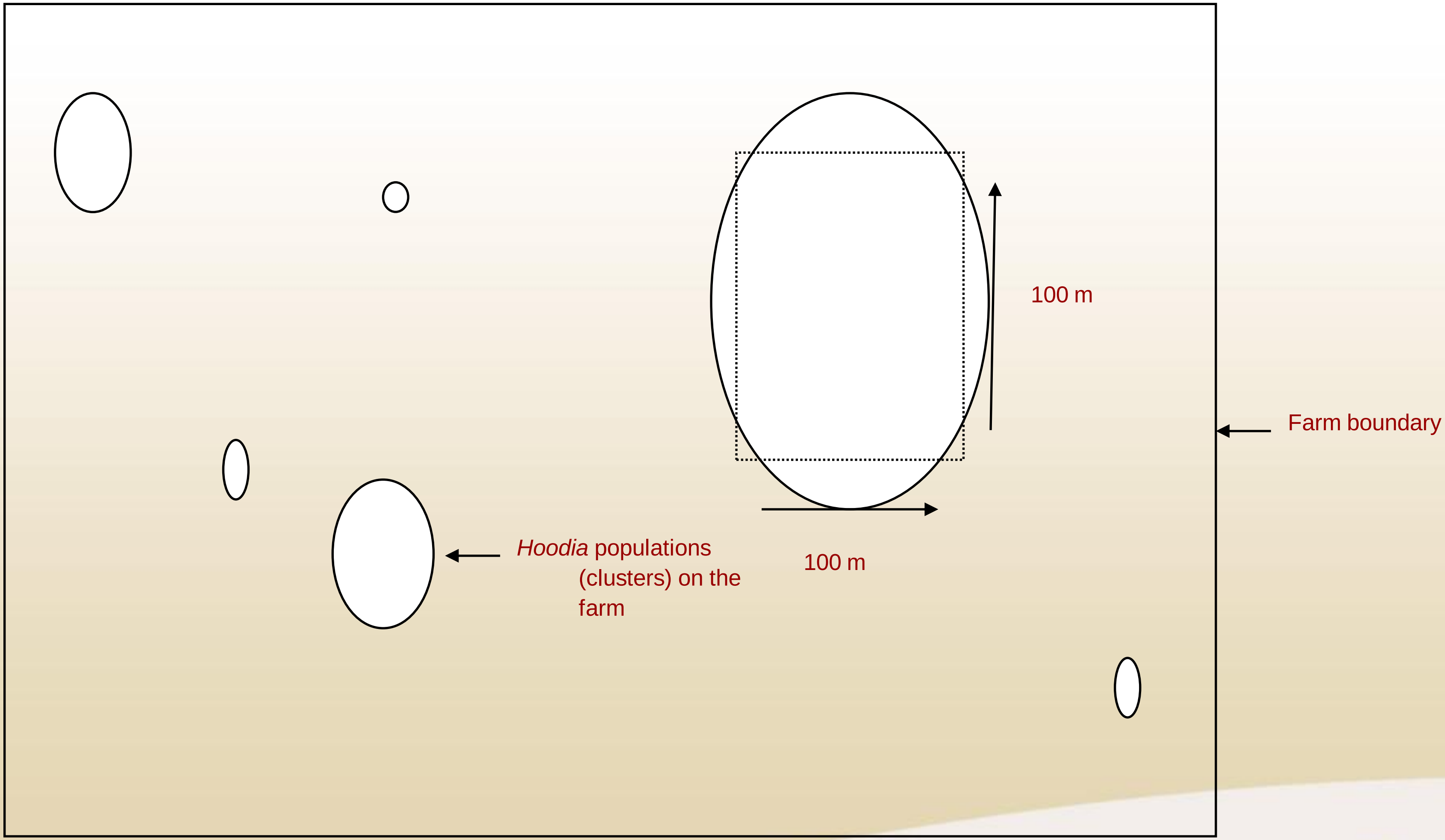
TRADE

- Export dry material / extracts / seeds / seedlings (no live exports outside natural range)
- Cultivated & wild crafted material traded
- Wild crafted include dead material collected (52.4% dead)
- Export primarily within South Africa (UK, Spain)
- Illegal harvesting (15.7t)
- Decline in wild demand

NDF ASSESSMENTS

- Literature, anecdotal information (experts, industry, etc.), RAMR information
- RAMR
  - – Demographic information via quadrant method
    - Health
  - – Density information via line transect method
    - Quota

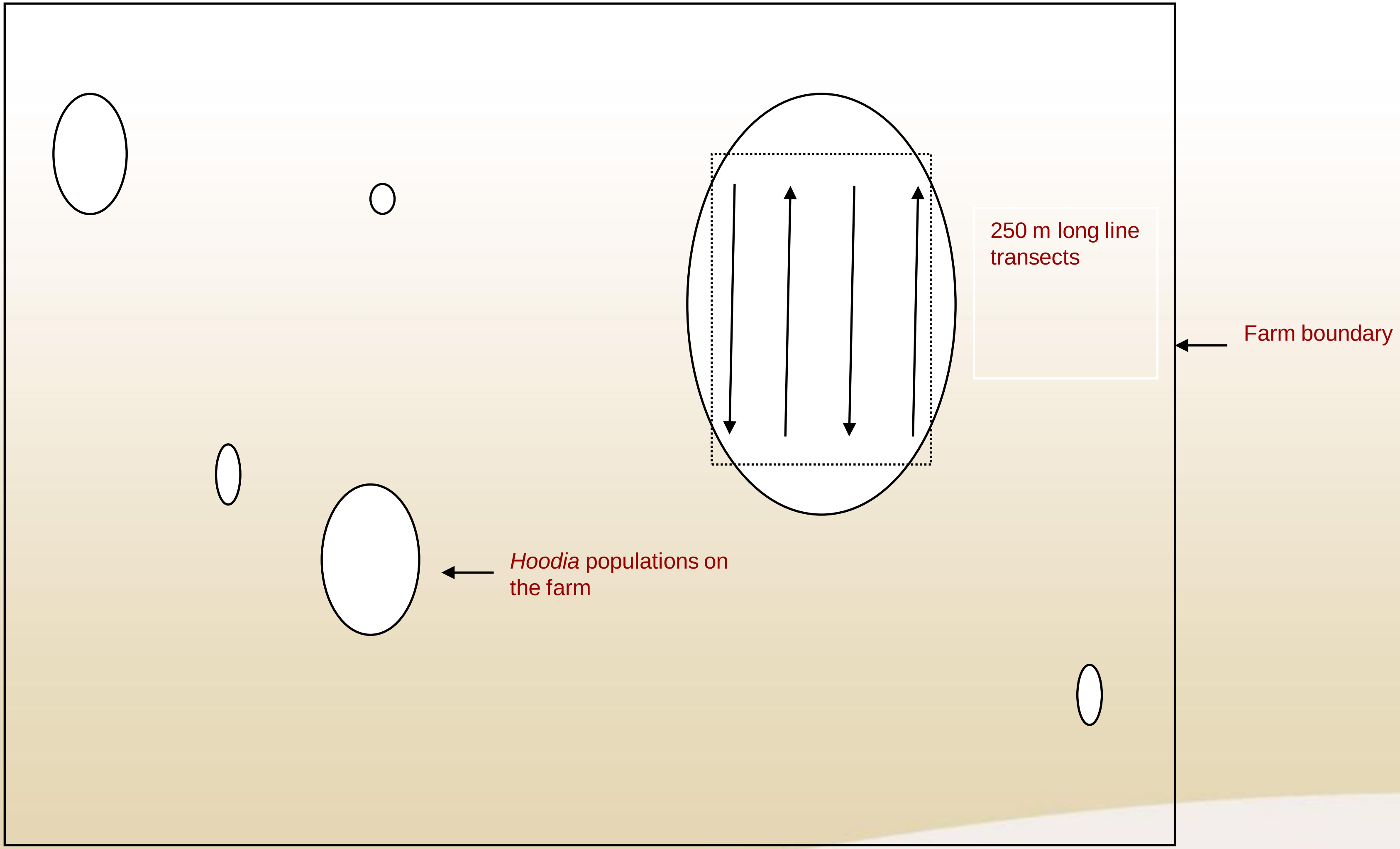




Demographic information

Rating: 0 (healthy plant)	Rating: 2 (infested plant)	Rating: 3 (dying plant)
		

- Visual health rating
- L : D ratio
- Adult : Juvenile/seedling



Density information

NDF guidelines

- Landowner harvest own property
- Property having excess of 2500 plants of optimum size, good health
- Size >40cm diameter
- Harvest every 2nd to 4th plant (5cm above ground level)
- 25% of canopy (fingers) / 20% of seed harvest
- Southern side (down wind)

NDF guidelines

- Disinfect cutting blade after each plant (3% chlorine, Jik)
- Lime sulphur powder on scars
- Harvest when not in flower (April – August, summer rainfall areas)
- Record wet mass vs dry mass

NDF CRITERIA / PARAMETERS

- Applications evaluated individually
- Surface area surveyed in relation to farm size / clusters occurrence on property (1%)
- Population health
  - D:L, infections, seedling: adult, associated environmental threats, health ratings (guide)

NDF CRITERIA / PARAMETERS

- Extrapolate population size (plants/ha for quota)
  - 4 x 250m / 1km line transect (optimum potential resource)
  - Line transect vs plot data (should be comparative)
- Harvesting history
  - No harvesting same site / rested / re-evaluation
- Harvesting method prescribed
- Precautionary principle
  - Quality of data

DATA QUANTITY / QUALITY

- Data = site specific, extrapolated
- Granted for 1.34% of potential distribution area in NC (SA), **not** cluster distribution
- Non-destructive harvesting
- Concern: harvesting concentrated in S ranges (alter distribution pattern)

DATA QUANTITY / QUALITY

- Guideline booklets – constant methods, but surveyors implemented differently
- Concern: parallel line transect method overestimation
- RAMR enable basic resource assessment
- Provincial resource lack, thus no comparison can be made
- Regeneration and survival info lack, limiting predictive impacts of harvests – infer protracted seed production would ensure resettlement

DATA QUANTITY / QUALITY

- Tolerance to harvesting unknown - inferred as it is browsed
- Conversion estimates (wet:dry ratio etc.) not quantified and scientifically verified
- 2002 - March 2008 harvested wild material relates to ca. 0.25 mil. plants
  – conversions lack statistical analysis (variation)

KEY LESSONS

- A review on species by person who attend to NDF
- RAMR & harvesting facilitated obtainment of information
- RAMR information should be augmented by research and provincial (global) resource assessments
- Client cooperation is vital
- Spatial analysis of area being harvested vs distribution might be useful

KEY LESSONS

- Training videos if clients need to do surveys / consultant
- Initially thought wild harvesting to be an interim arrangement (thereafter Moratorium) – impact on community applications?
- Authority cooperation in permit monitoring
- Checklists / guidelines to calculate quotas could address personnel turnover
- No management on internet trade

THANK YOU

SAHUARO (*CARNEGIEA GIGANTEA*) IN MEXICO

AUTHOR:
Alberto Búrquez

I. BACKGROUND INFORMATION ON THE TAXA

1. BIOLOGICAL DATA

1.1 Scientific and common names

Carnegiea gigantea (Engelmann) Britton & Rose Sahuaro, saguaro, sawaro

1.2 Distribution

The sahuaro (also known as saguaro) is a member of the large cacti group known as columnar cacti. It is distributed in North America over the continental extent of the Sonoran Desert. It is found in sites below 1000 m in the state of Sonora, Mexico, across southern Arizona, and in a very small area near the Colorado River in southern California. At the core of distribution, along the border between Sonora and Arizona, it forms extensive populations that cover thousands of ha. However, in most other areas, it is patchily distributed (Shreve, 1951; Turner *et al*., 1995; Felger *et al*., 2001).

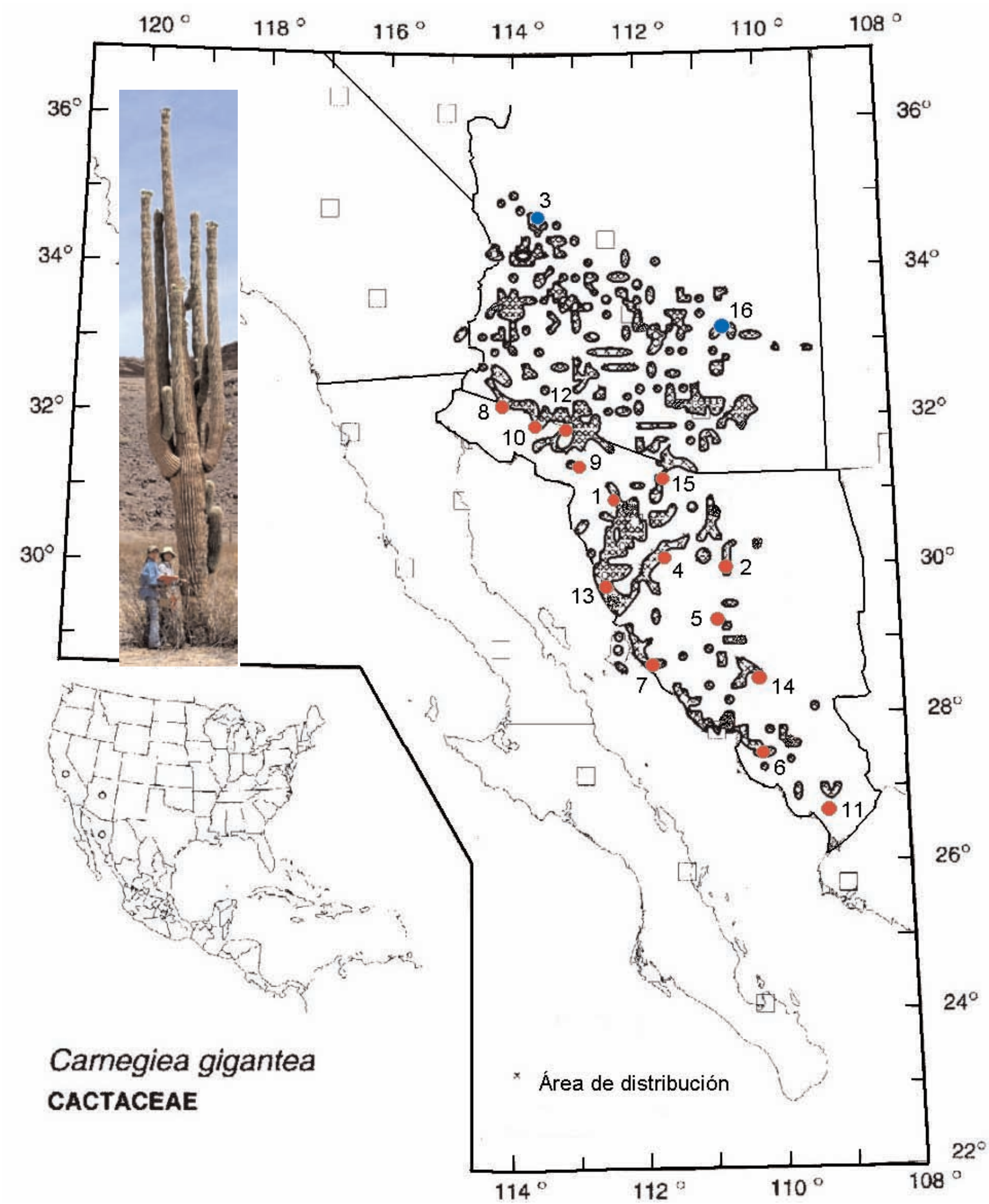
1.3 Biological characteristics

1.3.1 *General biological and life history characteristics of the species.*

Long-lived perennial, hermaphroditic, leafless crassicaulescent tree The sahuaro, and emblematic species of northwestern Mexico and the

American southwest, can reach up to 17 m in height and live up to 200 yr. Its main stem can be over 70 cm in diameter. Old individuals can have many lateral shoots. However, sahuaros do not branch until they are taller than 2-3 m, and sometimes they remain monopodial and unbranched all their life. The main stem has between 12-25 furrows or ribs that run longitudinally. Along these, the areolae are distributed. Areolas have 15-30 black, brown or grayish spines, about 2-6 cm long. Large, hermaphrodite, funnelform, green flowers develop at the apex of the stems. They open at dusk exposing a white-creamy corolla and secreting copious nectar. These are pollinated by bats, but some birds and honeybees are known to be able pollinators. The greenish fruits have a red to purplish pulp with several hundreds of small (0.75 mm diameter) black seeds (Shreve, 1951; Turner *et al.*, 1995; Felger *et al.*, 2001). Sahuaro recruitment has been associated to with the presence of some desert perennials, and Steenbergh and Lowe (1969, 1983) proposed the "Nurse Plant Theory" to explain its preferential dispersal and recruitment under the shade of *Parkinsonia microphylla* trees. Recruitment is highly dependent on particular environmental conditions, mainly precipitation, temperature and perhaps some biotic variables. As these occur haphazardly and very infrequently, most populations show skewed size/age distributions (Steenbergh and Lowe, 1969, 1977, 1983; Pierson and Turner, 1998). Large levels of phenotypic variation for many morphological characters are present across its range. It is likely that genetic differentiation plays a role in processes of local adaptation.

Uses: Some individuals are extracted from the wild for ornamental purposes, the extent of this activity is apparently highly localized and of low impact. In Mexico there are no nursery grown sahuaro seedlings for commercial trade. Harvesting of sahuaro "ribs", the woody skeleton of dead sahuaros has been carried out by native peoples for centuries. Desert people, relied on these materials for construction, crafts, and firewood. Today, there is great demand, mainly in the USA markets for sahuaro ribs to make furniture and constructions in the "southwest style". As the species is protected in the USA, most stocks of sahuaro ribs have been imported legal and illegally from Mexico. Cattle ranching, particularly the transformation of desert into pastures of exotic buffel grass (*Pennisetum ciliare*), has extirpated, or severely reduced many local populations contributing to fragmentation (Búrquez y Martínez-Yrizar, 2006; Búrquez *et al.* 1999, 2002).



1.3.2 *Habitat types*

The sahuaro grows in most habitats in the Sonoran Desert. It is bounded in the north and east by freezing temperatures (Turner et al. 1995) Limiting factors in the south are likely to be biological, mainly the shade cast by thornscrub and tropical deciduous forest species that impede its growth. It is known to grow on rocky habitats in the periphery of its distribution and almost all soil types in the centre. The most common habitats across its range are south-facing slopes. Some areas that seem prime habitat for sahuaro have no populations, while marginal habitats, in some cases have stragglers.

1.3.3 *Role of the species in its ecosystem*

Sahuaro is a prominent species of the desert. In some communities it can attain large population sizes. However, it shows a highly patchy distribution throughout its range. It provides edible fruits designed for bat dispersal that are also consumed by most vertebrates, including humans (Yetman 2007). In high-density populations, the fruits provide a late-spring bounty of resources for many species. Gila woodpeckers carve nesting holes in the sahuaro (McAuliffe and Hendricks, 1988). These nests, last for decades. Later, some of these are used by other species like the elf owl. Little is known about the role of dead sahuaro skeletons. These can stay in the desert for decades while slowly decomposing. A fascinating succession process starts when sahuaros die. It includes microbial communities, fungi, many arthropod species and vertebrates. However, no formal study on the role of dead sahuaros on ecosystem processes has ever been attempted.

1.4 Population

1.4.1 *Global Population size*

Population size is large. It amounts millions of individuals. Some populations are healthy and thriving while others are marginal and declining. It is worrying that some of the populations in the southernmost (more tropical), westernmost (close to the Gulf of California), and along the northwestern edge of distribution (along the fringes of the Gran Desierto) are highly fragmented and show small populations sizes. Development pressures related to tourism, agriculture and cattle ranching in the south and west are likely to hit sahuaro populations hard.

1.4.2 Current global population trends

__increasing   __X__   decreasing   __stable   __unknown

1.5 Conservation status

1.5.1 *Global conservation status (according to IUCN Red List)*

1.5.2 *National conservation status for the case study country*

None

1.5.3 *Main threats within the case study country*

__No Threats
_X__Habitat Loss/Degradation (human induced)
_X__Invasive alien species (directly affecting the species)
_X__Harvesting [hunting/gathering]
_X__Accidental mortality (e.g. Bycatch)
___Persecution (e.g. Pest control)
___Pollution (affecting habitat and/or species)
_X__Other___Trampling by cattle______
___Unknown

2. SPECIES MANAGEMENT WITHIN THE COUNTRY FOR WHICH CASE STUDY IS BEING PRESENTED

2.1 Management measures

2.1.1 *Management history: None*

2.1.2 *Purpose of the management plan in place: No Management Plans*

2.1.3 *General elements of the management plan*

2.1.4 *Restoration or alleviation measures*

None

2.2 Monitoring system

2.2.1 *Methods used to monitor harvest*

None known to the author. Usually harvest occurs without any managing body intervention. Most harvest is illegal. Little, if any, government monitoring of trade has ever been done.

2.2.2 *Confidence in the use of monitoring: None*

2.3 Legal framework and law enforcement

There is no legal protection at the national level. It is included as Appendix II CITES species. The USA has recently amended the law. Now it is enforcing the compulsory check of quantity imported with CITES permits. Previously, the permit was presented, but no inspection on amounts was performed.

3. UTILIZATION AND TRADE FOR RANGE STATE FOR WHICH CASE STUDY IS BEING PRESENTED

3.1 Type of use (origin) and destinations (purposes)

Wild sahuaros are heavily used throughout their range. Native cultures, particularly in northwestern Sonora and southern Arizona, use their edible fruits. The wooden ribs are also used locally for many construction purposes, from light fencing to furniture. Trade in live wild specimens is carried in a small scale, mainly for ornamental purposes. These are usually limited to plants 1-3 m tall. Harvest of dead ribs for commercial purposes has increased since the 1990s. A big market for these is present in the southwest states of the USA, and by USA citizens living in México. The demand of ribs has provoked the disappearance of dead individuals in most populations, and it even has led harvesters to illegally cut sahuaros within biological reserves. The price that high quality ribs fetch has led to the deliberate killing of sahuaros for later harvesting. We have gathered strong evidence of extraction of live individuals from several populations.

Although in some populations small harvesting quotas for sahuaro ribs could be granted, in the absence of intensive monitoring and surveillance, we found that it is tempting for harvesters or dealers to deliberately kill sahuaros for later collection. This phenomenon has happened in the past.

3.2 Harvest

3.2.1 *Harvesting regime*

Harvesting of sahuaro ribs is all extractive. Dead sahuaros seem to play a major role in ecosystem dynamics, but no formal study on the extent of the role of dead carcasses has ever been done. Extraction of live sahuaros for their ribs, or for ornamental purposes also occurs and is evidently extractive. Most sahuaros taken alive should be over 6 m tall to yield adequate ribs. The same applies to dead sahuaros. Smaller size-classes produce sub-standard non-market quality ribs.

Harvesting is a non-intensive activity carried out throughout the year, but usually concentrated during the fresh winter and spring months. Many people are involved, but their involvement is brief because the stocks are very limited and sparsely distributed. The harvesting technique is simple: cutting the dead sahuaros with a hack or a chain-saw and carrying them by horse, mule, or car to the nearby ranch where they are sorted and cleaned. Ribs are later collected by a dealer that that has the knowledge, and in some cases the political and administrative “clout” to get CITES and forestry permits.

3.2.2 *Harvest management/ control* (quotas, seasons, permits, etc.)
There is no quota system, but Mexican government authorities have established a moratorium on issuing permits until the sustainable use of ribs is clarified. In previous years, large quotas were authorized. The allotments differed in the units used: ribs, cubic meters, weight, etc. Harvesting a hectare of never harvested sahuaro can yield between $50-$150 US dlls. at present trade value. However, these sites are becoming scarce, and most populations, especially in northern and northwestern Sonora (and many populations outside protected areas within the USA) have been heavily harvested. Being a long-lived plant, its cultivation for harvesting purposes is not feasible. The minimum return time for harvested plants is about 60-80 years.

3.3 Legal and illegal trade levels

Historically there are large discrepancies between the issued permits and the exported quantities reported. In one year more than 500,000 ribs were not accounted for by a permit. Nationally, the use is almost restricted to traditional practices. However, there is a trend towards the use of ribs to decorate USA citizen homes in Mexico using sahuaro rib furniture and construction.

II. NON-DETRIMENT FINDING PROCEDURE (NDFS)

1. IS THE METHODOLOGY USED BASED ON THE IUCN CHECKLIST FOR NDFS? __YES __X_NO

2. CRITERIA, PARAMETERS AND/OR INDICATORS USED
Evaluation and modelling through population structure of yield and return times for harvesting dead individuals.

3. MAIN SOURCES OF DATA, INCLUDING FIELD EVALUATION OR SAMPLING METHODOLOGIES AND ANALYSIS USED
Field research specifically designed to find if non-detrimental harvest was possible. Modelling and statistical analysis of population survival schedules coupled with allometric constants of growth and population interviews were used. No evaluation of non-detrimental effects were assessed for the removal of dead sahuaro wood, although is recognized as a major element in the ecosystem dynamics of the desert.

4. EVALUATION OF DATA QUANTITY AND QUALITY FOR THE ASSESSMENT

Scientific research that will eventually find its way into peer review publications.

5. MAIN PROBLEMS, CHALLENGES OR DIFFICULTIES FOUND ON THE ELABORATION OF NDF

Extensive distribution, population differentiation, difficulty of access to some sites, secrecy about trading, especially about illegal trading. Recognition that granting the recollection of dead

6. RECOMMENDATIONS

a) Given the sparse distribution of populations, the discontinuous recruitment, the slow growth rate, the minimum size of harvestable individuals, and the important, but not yet scientifically studied, role of dead sahuaro skeletons, it is recommended not to grant export permits of dead sahuaro ribs. Other forms of export that are non-detrimental and can be granted include the export of glasshouse grown individuals from wild produced seeds, or the export of wild fruits and their derivatives. In both cases, the effect of such wild recollection has no apparent detrimental effect on populations, particularly when considering that: i) Only an exceedingly small proportion of the large production of seeds ever enters the population, and ii) Historically the harvest of fruits was probably much higher (probably for hundreds of years) and geographically extensive. In summary, it is not possible to make a positive NDF for ribs, but it is possible to do so for trade based on the harvest of wild seeds and fruits, including their derivatives.

b) More studies to elucidate growth rates on populations throughout the distribution range are needed, mainly to calibrate the relationships between size and age of the individuals.

c) More research to determine the extent of genetic differentiation between populations is needed. That will allow grading the effect of harvesting across the whole distribution range, or if populations can be assigned to certain biotypes, to assess the most imperilled populations.

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NDF Workshop
WG 3 – Succulents and Cycads
CASE STUDY 7 SUMMARY
Carnegiea gigantea
Country – **Mexico**
Original Language – English

SAHUARO (*CARNEGIEA GIGANTEA*) IN MEXICO

AUTHOR:
Alberto Búrquez

This project is the first phase of a monographic study of sahuaro, an emblematic species of the Sonoran Desert included in CITES Appendix II. We studied 16 populations throughout the distribution range of the species and assessed the basic demographic parameters, as well as the geographic variation in morphological traits. We found large levels of variation and conclusive evidence of episodic recruitment probably related to El Niño years. Study of the structure of dead individuals allowed the calculation of potential harvestable volumes, minimum harvestable size and other use-related parameters. When linked to a social and economic database from a field survey, we discovered that sahuaro usage is concentrated along the border with the USA and along the coast of Sonora. We also found that demand quickly depletes of their dead wood any population. The removal has unknown effects on the ecosystem dynamics. Through simulation, we modeled the time to replenish the population after harvesting, finding that the return time is usually very long; between 10-50 years.

Wild sahuaros are heavily used throughout their range. Native cultures, particularly in northwestern Sonora and southern Arizona, used to harvest their edible fruits. The wooden ribs are also used locally for many construction purposes, from light fencing to furniture. Trade in live wild specimens is carried in a small scale, mainly for ornamental purposes. These are usually limited to plants 1-3 m tall. Harvest of dead ribs for commercial purposes has increased since the 1990s. A big market for these is present in the southwest states of the USA, and by USA citizens living in México. The demand of ribs has provoked the disappearance of dead individuals in most populations, and it even has led harvesters to illegally cut sahuaros within biological reserves. The price that high quality ribs fetch has led to the deliberate killing of sahuaros for later harvesting. We have gathered strong evidence of extraction of live individuals from several populations.

Given the sparse distribution of populations, the discontinuous recruitment, the slow growth rate, the minimum size of harvestable individuals, and the important, but not yet scientifically studied, role of dead sahuaro skeletons, it is recommended not to grant export permits of dead sahuaro ribs. Other forms of export that are non-detrimental and can be granted include the export of glasshouse grown individuals from wild produced seeds, or the export of wild fruits and their derivatives. In both cases, the effect of such wild recollection has no apparent detrimental effect on populations, particularly when considering that: i) Only an exceedingly small proportion of the large production of seeds ever enters the population, and ii) Historically the harvest of fruits was probably much higher (probably for hundreds of years) and geographically extensive. In summary, it is not possible to make a positive NDF for ribs, but it is possible to do so for trade based on the harvest of wild seeds and fruits, including their derivatives. Given the slow recovery, the little yield, and the landscape value for the species, it is recommended to keep it within CITES Appendix II, and to include it within the Norma Oficial Mexicana NOM-059-ECOL-2001 under the special protection category.

The ecology of sahuaro: Linking population ecology to conservation and management

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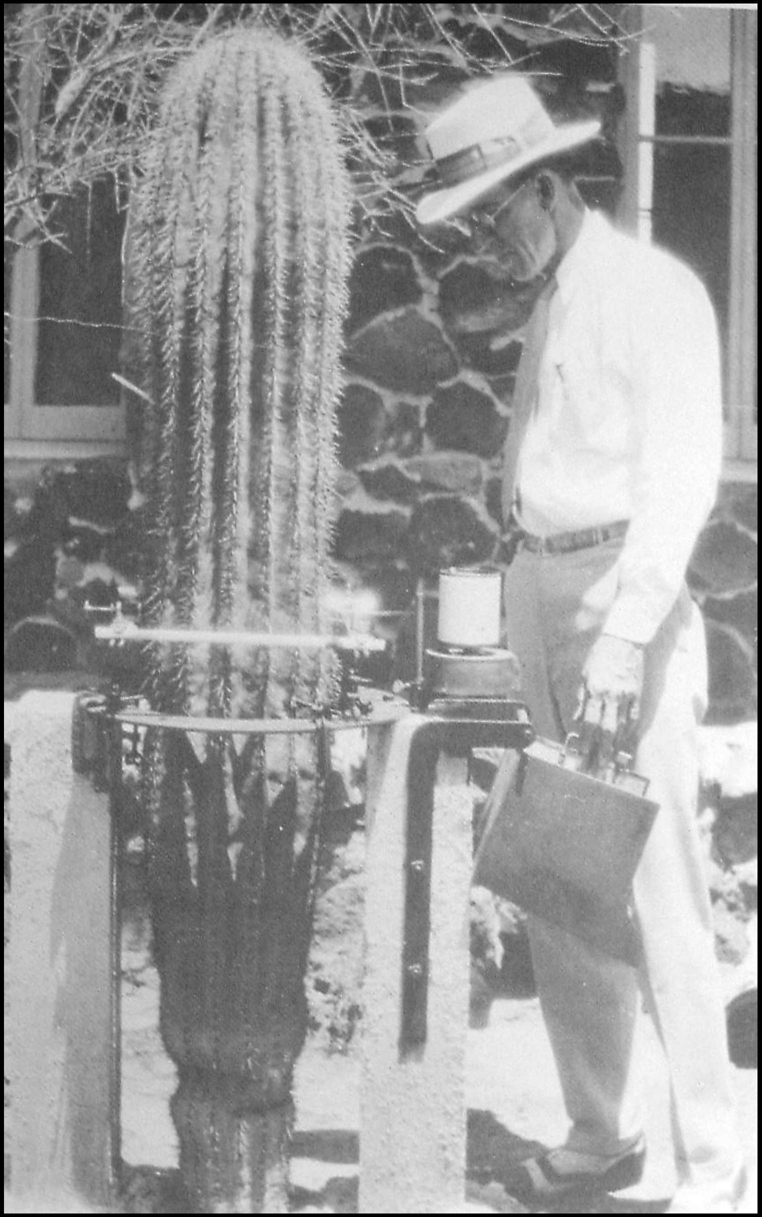


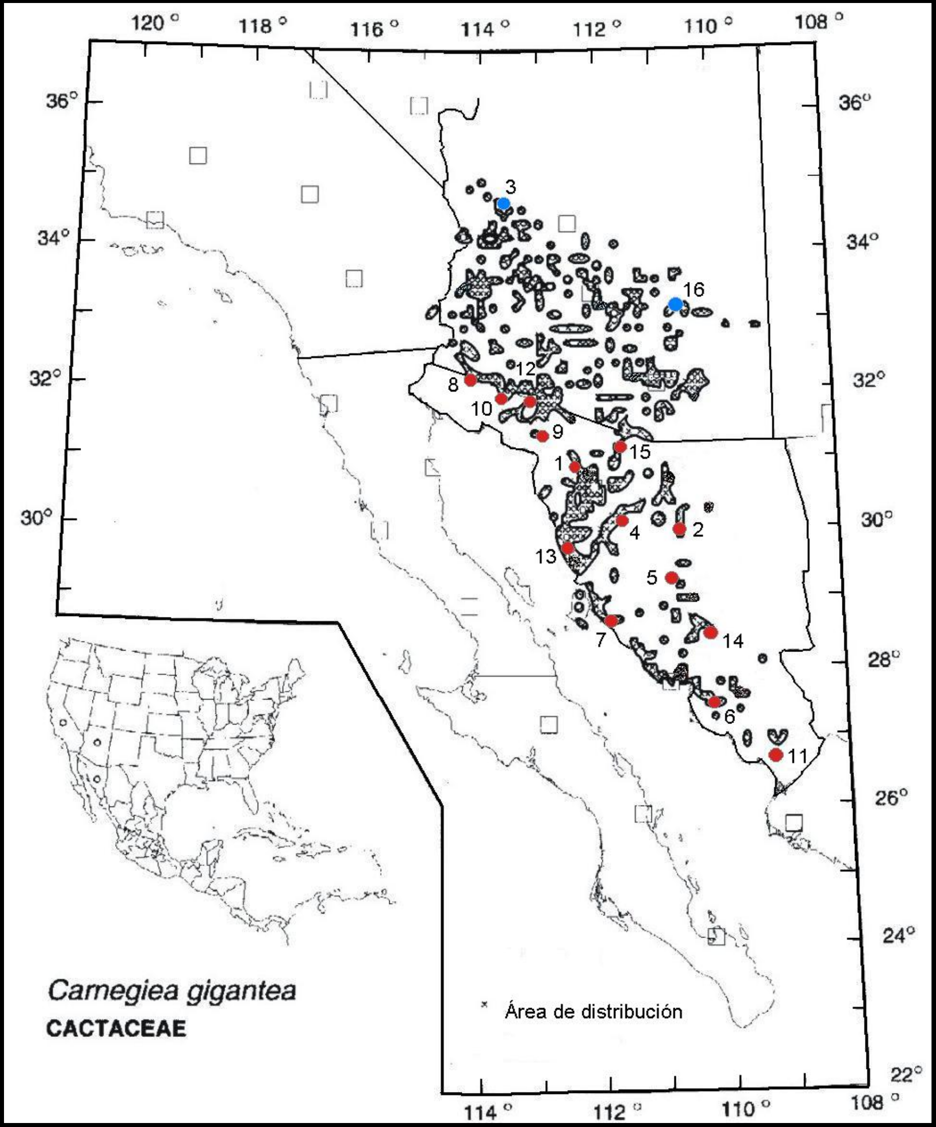
The sahuaro is an emblematic species of the Sonoran Desert. Its study goes back to the origin of the Desert Laboratory in Tucson, AZ in the early 1900. Since then, It has been subject of numerous studies ranging from physiological responses to environmental cues, to disentangling its population ecology, including the famous “Nurse Plant theory”.

The sahuaro is one of the largest columnar cacti

- Can attain up to 17 m
- Maximum diameter up to 1 m
- Usually none, or few arms
- 12-26 “ribs” with areoles armed with spines
- It has a woody skeleton –secondary growth
- Infrequent recruitment

There is much variation on these traits in natural populations

The Sahuaro (also saguaro: *Carnegiea gigantea* (Engelmann) Britton & Rose 1908) is a widespread species that delimits most of the Sonoran Desert Continental extent



Its usage in southwest style construction and furniture has led to a wider usage of its wooden “ribs”

The sahuaro has been the source of food (fruits and seeds), and construction materials for native Americans

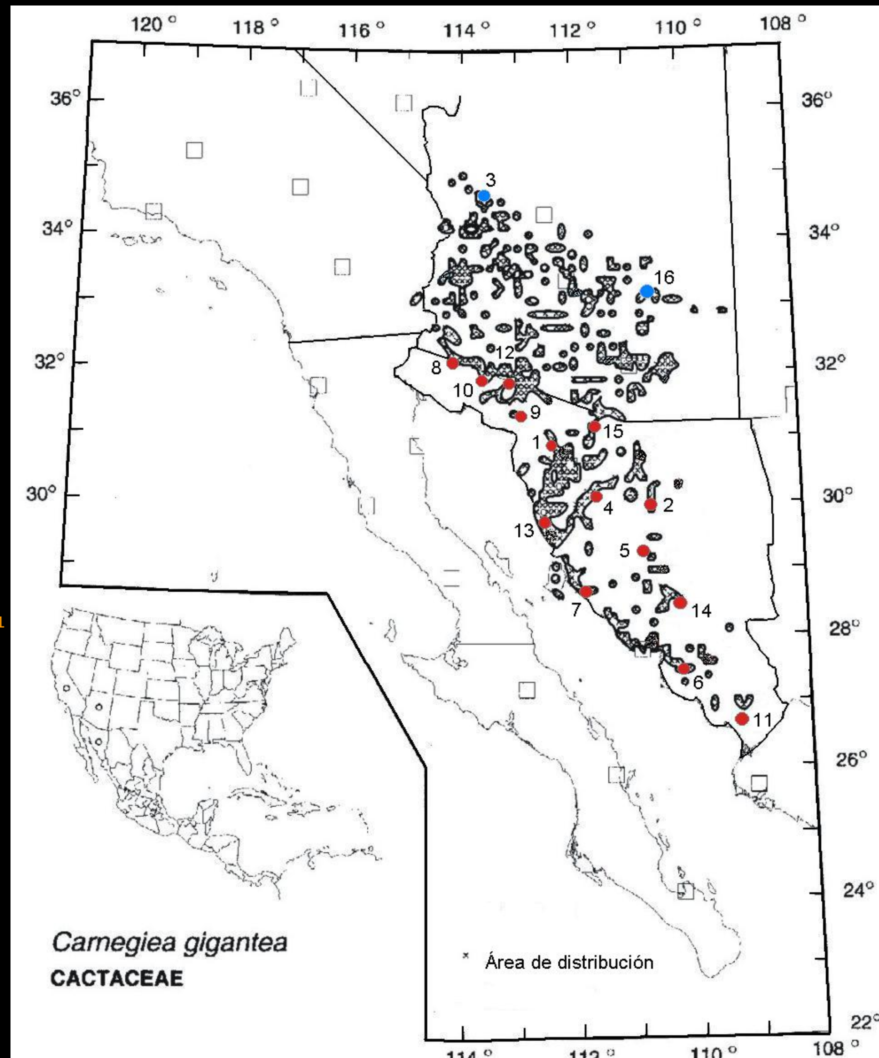
This study was primarily designed to assess the status of the sahuaro within the Appendix II of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora). Funds from CONABIO-SEMARNAT-CITES

It was a unique opportunity to propose a research scheme to gather basic information, to explore new research avenues, and to apply the results to conservation and management.

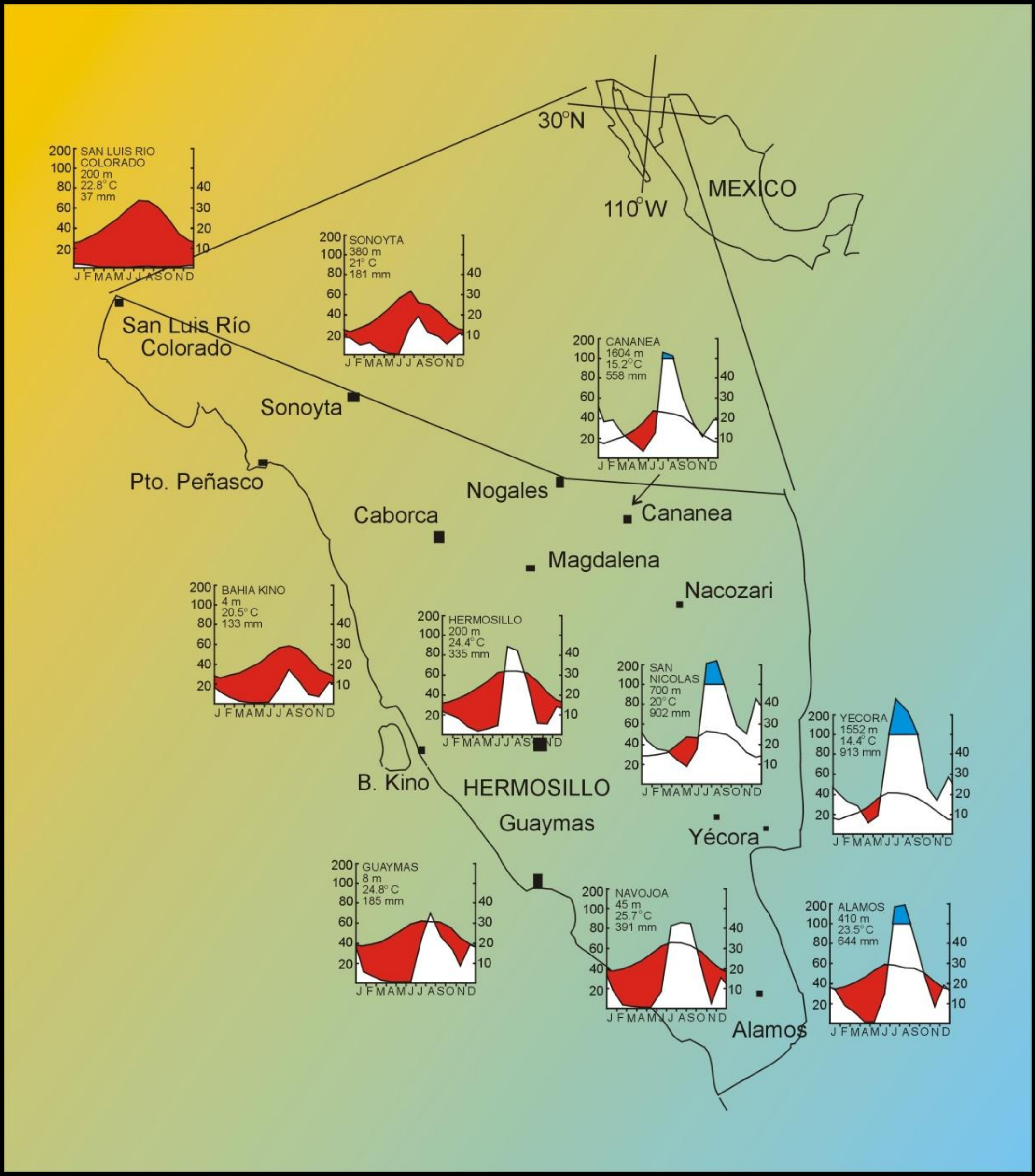
1. Model the niche extent in terms of the physical environment using GARP.
2. Describe and model the phenotypic variation in terms of allometry and adult traits, and correlate that variation with the physical and biological environment.
3. Assess and model the spatial variation among populations in ecological structure, recruitment and growth.
4. Assess the standing dead individuals and their structure.
5. Explore the regional knowledge and use of sahuaro products, particularly the use and trade of sahuaro ribs.
6. Model the expected standing crop of dead individuals suitable for trade in the near and far future, and the trade value, all framed in the sustainability-ecosystem services paradigm.

The Sahuaro (also saguaro: *Carnegiea gigantea* (Engelmann) Britton & Rose 1908) is a widespread species that delimits most of the Sonoran Desert Continental extent

(Shreve, 1951) Subdivisions	Site
Plains of Sonora	El Dipo
	El Orégano
Arizona Upland	Caborca
	Cucurpe
	La Primavera
	Sáric[3]
	Winkelman
	Date Creek Ranch[1]
Lower Colorado River Valley	La Joyita[2]
	Los Vidrios[2]
	MacDougal[2]
Central Gulf Coast	Bahía Kino
	Rancho Lobos[3]
Foothills of Sonora*	Las Guásimas
	San Marcial
Coastal Thornscrub*	Masiaca[4]



It ranges from extremely xeric and warm conditions to relatively mesic environments, and it is difficult to ascribe its present distribution to single climatic factors

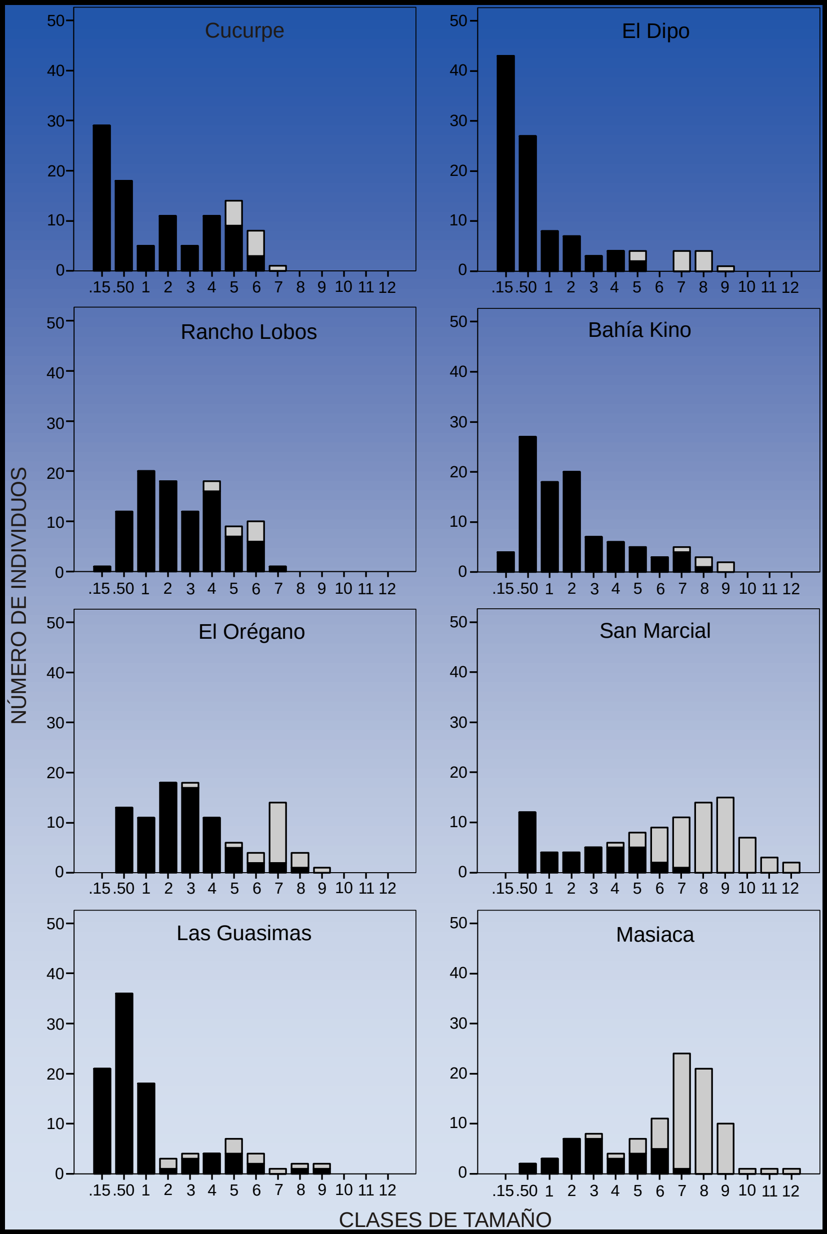


Despite the conscious effort to select the densest populations at the core of local distribution on each locality…there is great variation. Low vs High density in highest density sites

					HEIGHT CATEGORIES								
		Total			0-50 cm			50-250 cm			>250 cm		
POPULATION	N	MEAN	SEM	CD	MEAN	SEM	CD	MEAN	SEM	CD	MEAN	SEM	CD
El Dipo	**12**	**218.8**	**50.4**	**5.6**	**145.8**	**42.9**	**6.0**	**33.3**	**18.3**	**4.8**	**39.6**	**10.4**	**1.3**
El Orégano	**534**	**4.7**	**0.9**	**3.5**	**0.6**	**0.2**	**1.6**	**1.9**	**0.4**	**2.0**	**2.1**	**0.5**	**2.5**

The variation between populations is also evident in morphological terms

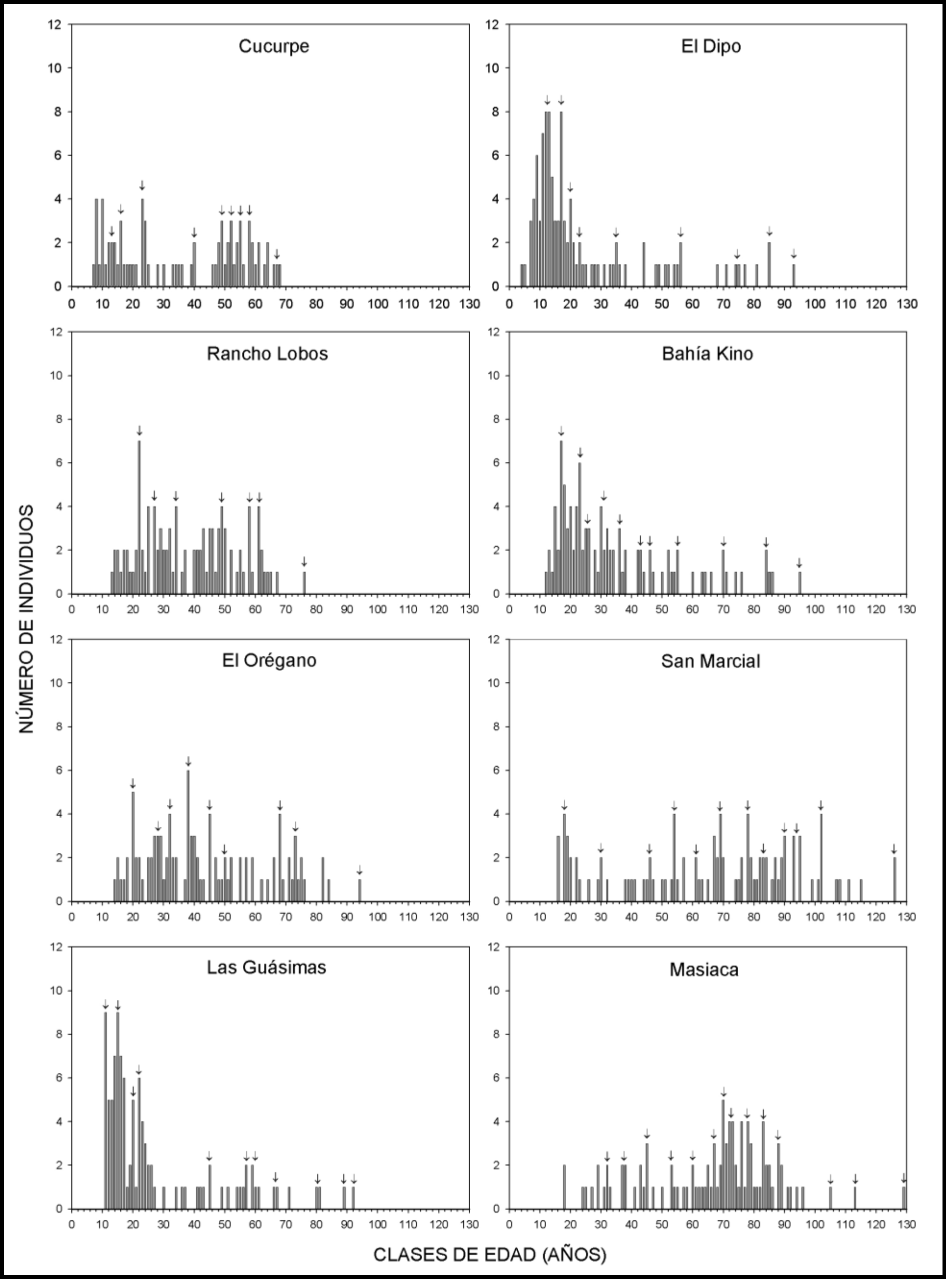
	N	% non-branched individuals	% branched individuals	mean number of arms
Date Creek Ranch	**76**	**54**	**46**	**5.2**
Bahía Kino	**100**	**95**	**5**	**2.0**



Size distributions do not fit into a stable size distribution.

The multimodal distributions in size clearly point out to “Episodic Recruitment” events

In the absence of growth data, we used the relationship between height and age proposed by Steenbergh and Lowe in the 70s to translate size into age



The general shape of the age distributions is the same. It offers more resolution on the small-size age-classes

Recording the classes that where numerically higher than the neighboring younger age-classes, we were able to estimate the intervals between recruitment events.

	N	MEAN	SEM	LAST EVENT
Caborca	10	11.33	2.28	18
Cucurpe	9	6.87	1.77	12
Date Creek Ranch	10	9.00	1.85	21
El Dipo	9	10.00	2.47	9
El Orégano	9	9.25	2.27	20
Las Guásimas	11	8.10	2.07	11
Bahía Kino	11	7.80	1.34	17
La Joyita	10	8.66	1.45	17
La Primavera	12	9.45	3.90	13
Cráter MacDougal	11	10.50	2.26	19
Masiaca	13	6.83	1.04	**31**
Los Vidrios	12	9.63	3.59	19
Rancho Lobos	7	9.33	2.27	22
San Marcial	12	9.81	1.70	18
Sáric	7	12.00	4.70	15
Winkelman	10	9.88	2.77	16

The 6.9-12 yr periodicities are consistent with modulation by strong to very strong El Niño events (Between 1525-1988 the recurrence of strong El Niño events has periods of 6.75 and 14.0 years)

But the last events of recruitment show a longer periodicity, up to 31 years in some populations. Enticing…The actual El Niño return intervals vary between 4 and almost 40 years. For each site there are, of course, site-specific modifiers

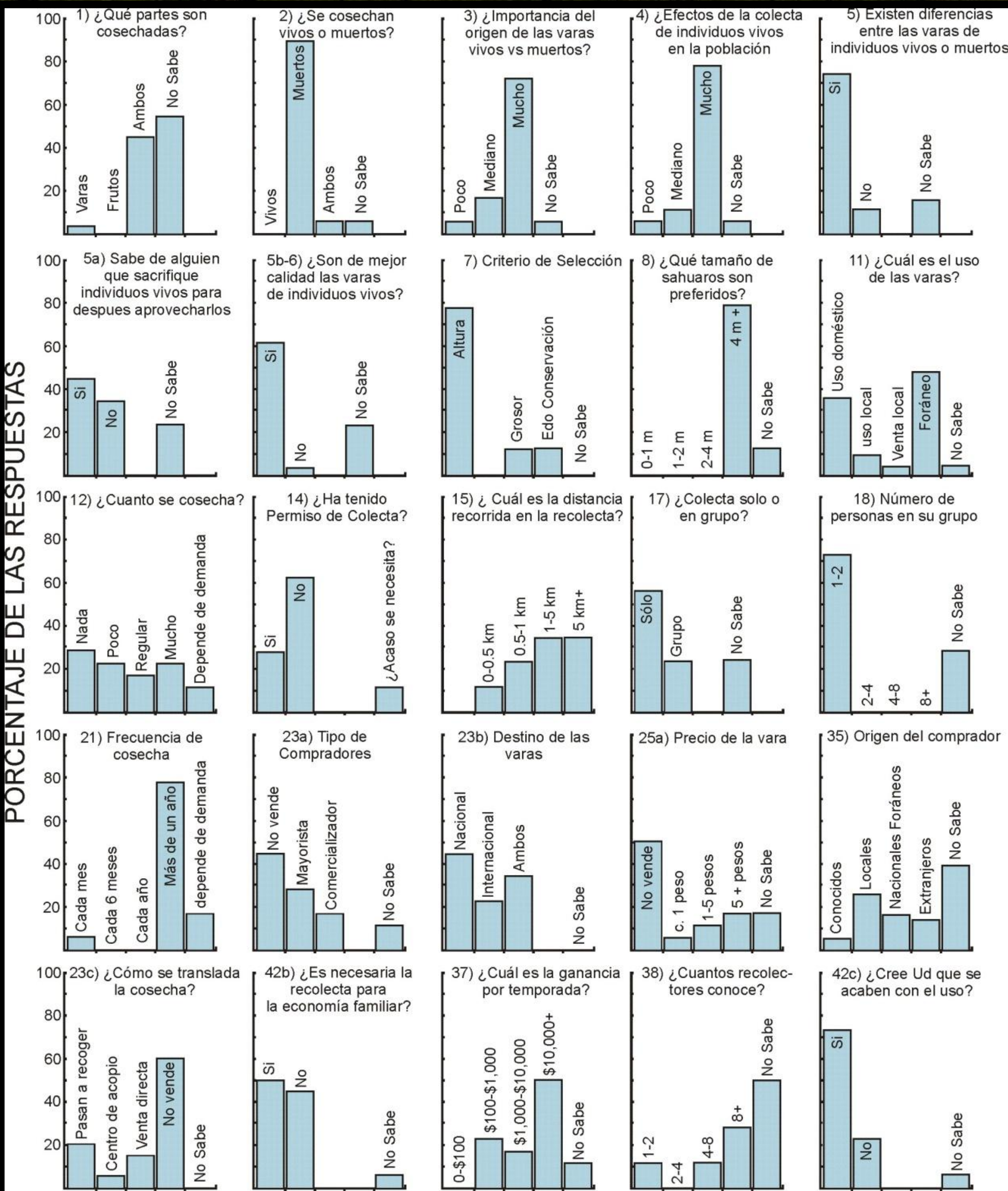
That´s enough of basic ecology. How this data drives conservation and management policies?

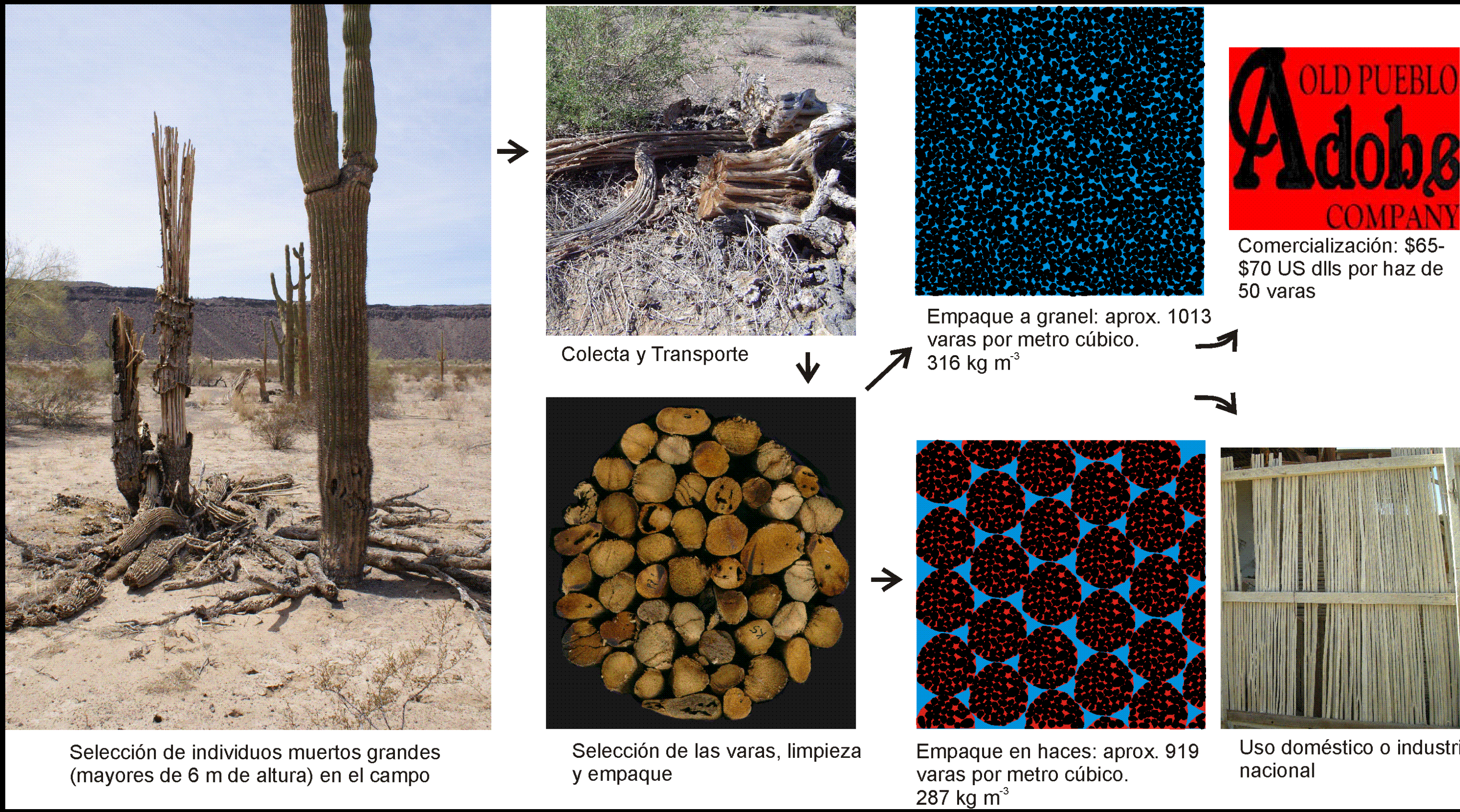
First, let’s see how people use the resource

people use it a lot!

While the traditional harvest of sahuaro fruits is fast disappearing…

the commercial harvest of its ribs, fueled by a hungry international market, show a steady growth, and at $0.50 a rib at the local ranch, it seems good business. Not only Free Enterprise, but Free Ecosystem Services!





Modus Operandi: harvesting, processing and trading

But first…more science.

How many ribs a given sahuaro can produce?

Considering that there was a general agreement than useful ribs should have at least 1’’ (2.54 cm) in diameter.

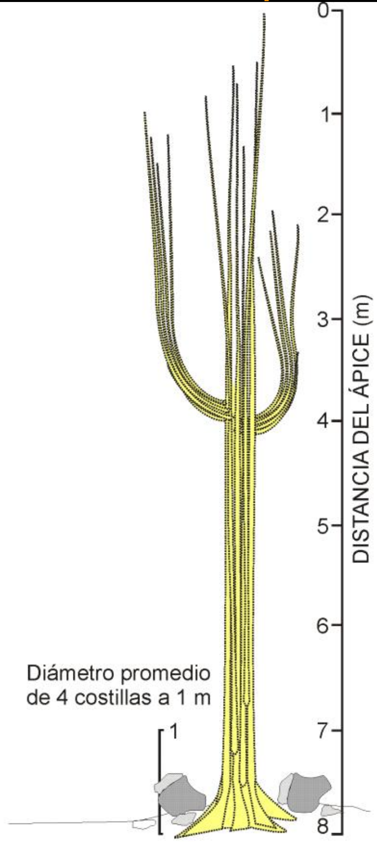
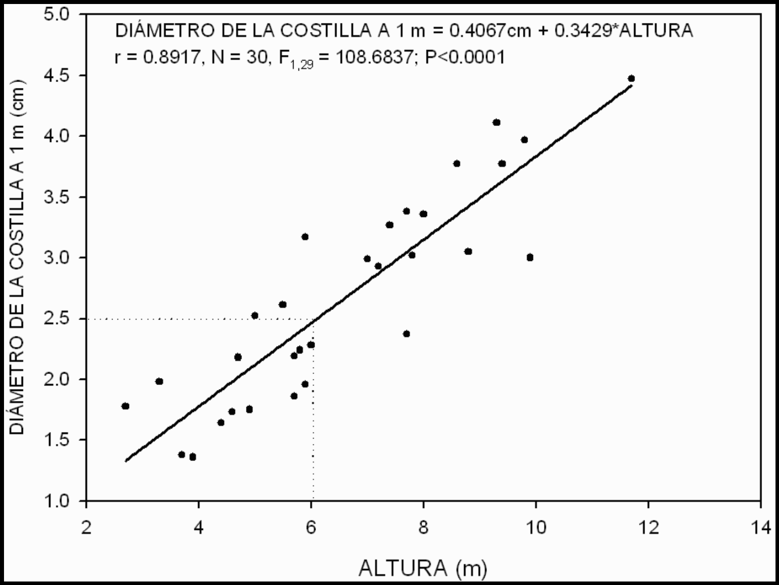
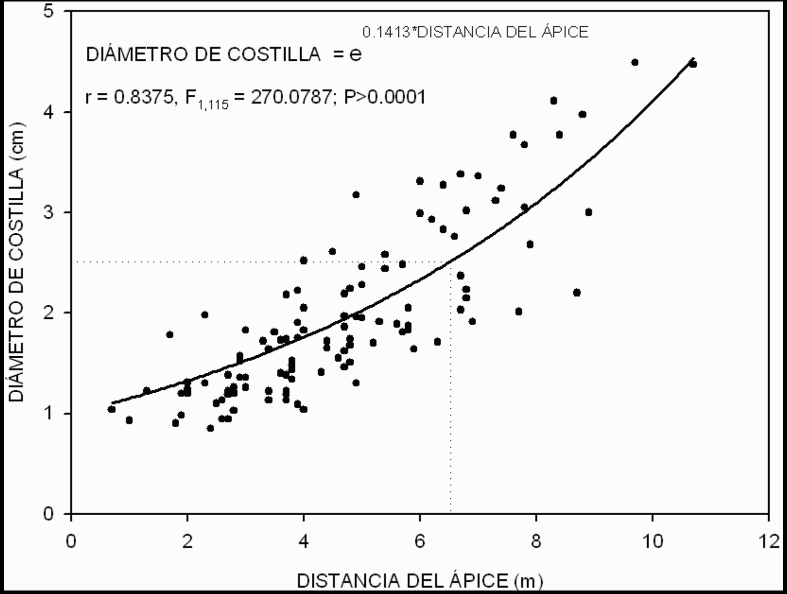
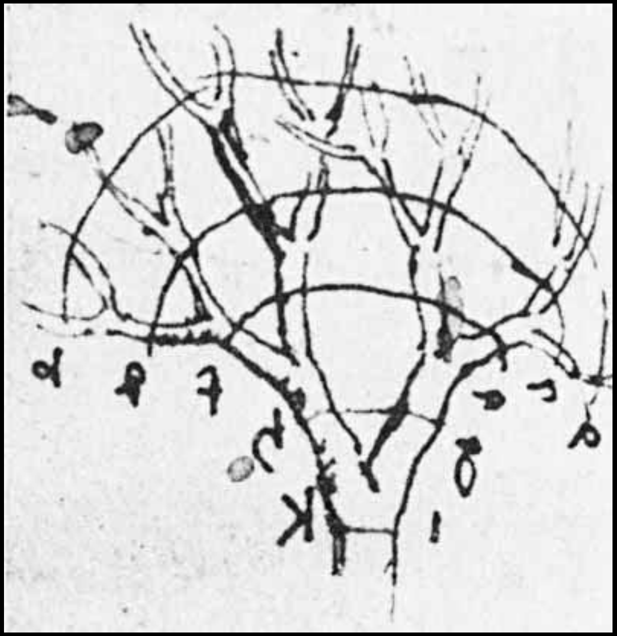


Figura 7.2. Diagrama esquemático de la medición del diámetro promedio de cuatro costillas cada metro desde el ápice y a un metro de altura en sahuaros muertos en la Reserva de la Biosfera Organ Pipe Cactus National Monument, Arizona.



We measured dead sahuaros using two methods, and discovered that their wooden skeletons were not useful (from a trade standpoint) until they reached about 6 m in height .
Something that was obvious when we did the allometric relationships.





The number of dead saguaros (and ultimately ribs for trade) depend on three variables:

1) The actual number of dead individuals
2) The population structure and demographic parameters
3) The permanence of dead saguaros on site (decay)

As dead sahuaros can stay for decades on site, either standing, of lying in the ground, the ratio between dead and alive individuals should be high in non-harvested populations.

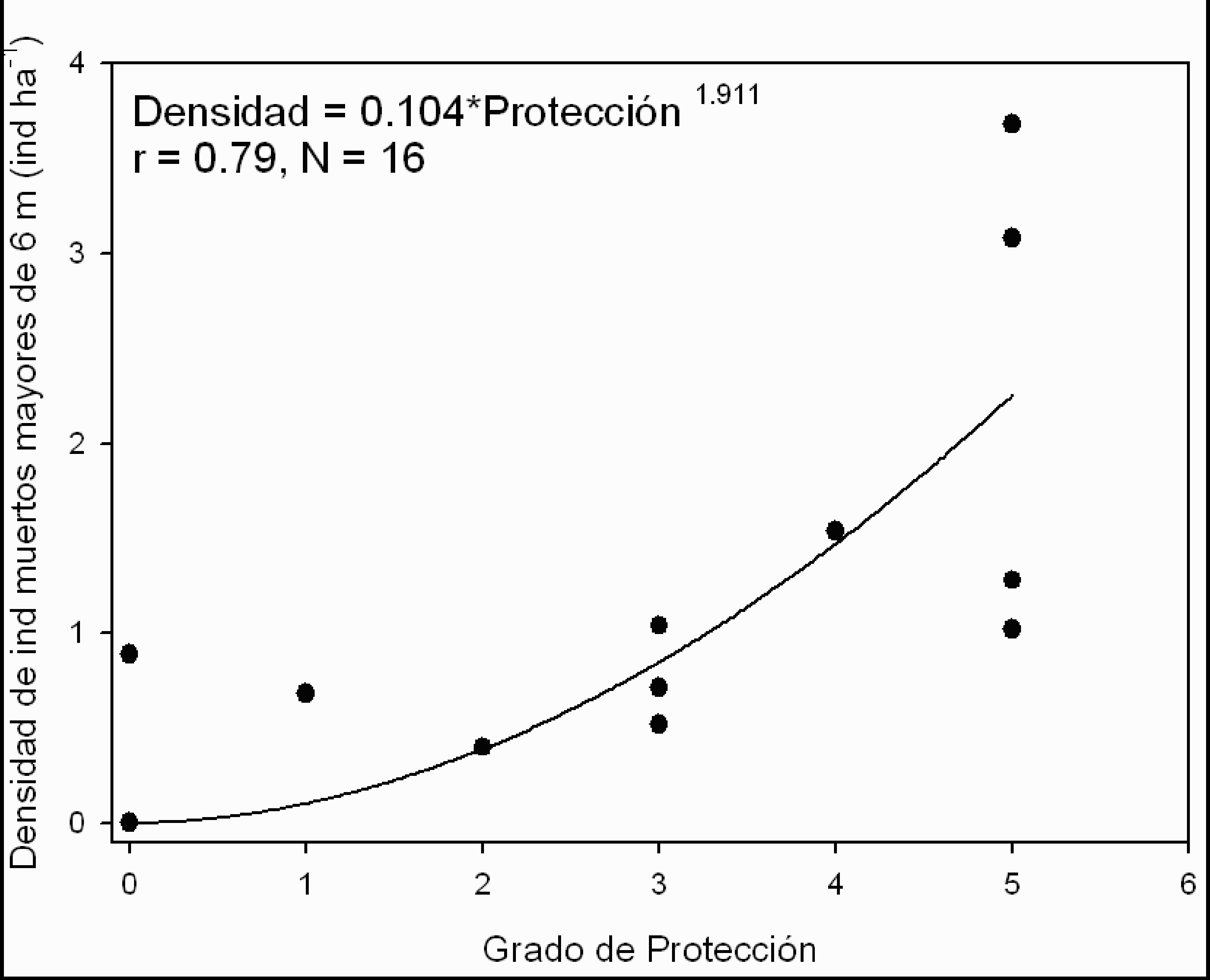
It is evident that most populations have been harvested, some of the relentlessly

		Live Individuals ha-1			Dead Individuals ha-1			Dead/Alive
Population	N	Mean	SEM	CD	Mean	SEM	CD	Ratio
Caborca	91	28.02	3.58	1.66	1.65	0.65	0.94	0.06
Cucurpe	14	182.14	49.13	7.42	5.36	2.85	0.85	0.03
Date Creek Ranch	49	38.78	5.93	1.77	2.04	0.99	0.94	0.05
El Dipo	12	218.75	50.39	5.57	2.08	2.08	1.00	0.01
El Orégano	534	4.68	0.88	3.54	0.28	0.13	1.32	0.06
Las Guásimas	28	91.07	15.23	2.85	11.61	4.36	1.83	0.13
Bahía Kino	37	67.57	10.06	2.22	5.41	1.97	1.06	0.08
La Joyita	114	22.15	3.05	1.91	6.36	1.28	1.17	**0.29**
La Primavera	24	104.17	18.35	3.10	5.21	2.12	0.83	0.05
Cráter MacDougal	68	34.19	5.16	2.12	11.76	2.54	1.49	**0.34**
Masiaca	105	24.05	3.33	1.94	1.90	0.73	1.19	0.08
Los Vidrios	73	34.59	4.07	1.40	9.25	2.04	1.31	**0.27**
Rancho Lobos	48	52.60	6.28	1.44	4.69	1.77	1.28	0.09
San Marcial	309	8.09	1.18	2.14	1.38	0.38	1.30	**0.17**
Sáric	15	170.00	36.20	4.63	3.33	2.27	0.93	0.02
Winkelman	39	64.74	9.03	1.97	5.13	2.09	1.33	0.08

Little is known about the precise role of dead sahuaros on wildlife, but many animals find shelter and reproduce on dead sahuaros.

When considering only 6+m individuals, some populations simply vanish…

Further support for the idea of heavy usage comes by correlating the density of dead sahuaros and the degree of protection of the sites



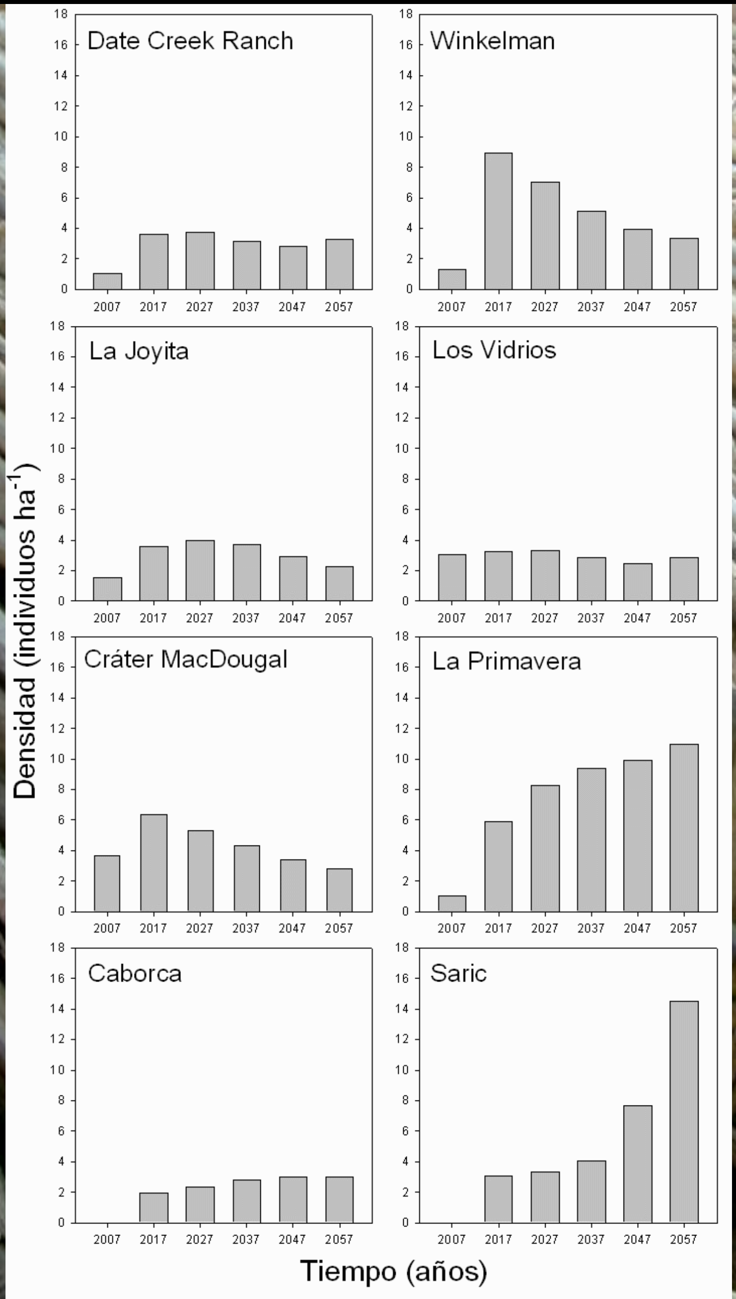
Once known the population densities, the demography, the mortality schedule, the permanence of dead individuals in the field and their numbers, and the prices and trade on sahuaro ribs, we were able to estimate the present yield on each population… and the profit

	Ribs ha^{-1}	Bulk ha m^{-3}	Bunch ha m^{-3}	kg ha^{-1}	ha Mg^{-1}	Dollars ha^{-1} @\$0.09	@\$0.46	@\$1.29
Caborca	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cucurpe	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Date Creek	32.00	31.79	28.84	9.94	100.60	2.90	14.52	41.24
El Dipo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
El Orégano	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Las Guásimas	15.50	65.41	59.34	4.83	206.98	1.41	7.06	20.05
Bahía Kino	12.50	80.24	72.80	3.94	253.90	1.15	5.75	16.34
La Joyita	58.00	17.45	15.83	18.11	55.21	5.29	26.46	75.15
La Primavera	17.00	59.39	53.88	5.32	187.93	1.56	7.77	22.08
MacDougal	105.50	9.61	8.72	32.89	30.40	9.61	48.05	136.47
Los Vidrios	78.00	12.96	11.76	24.39	41.00	7.13	35.63	101.19
Masiaca	18.50	54.34	49.30	5.82	171.93	1.70	8.50	24.13
Rancho Lobos	9.50	106.66	96.76	2.96	337.48	0.87	4.33	12.29
San Marcial	9.00	112.48	102.04	2.81	355.91	0.82	4.10	11.66
Sáric	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Winckelman	34.00	29.75	26.99	10.62	94.13	3.10	15.52	44.08

In some populations, a big profit can be made with a cheap, small chain saw…

It is good to know how much we can presently harvest, but the real question is if the harvesting is sustainable

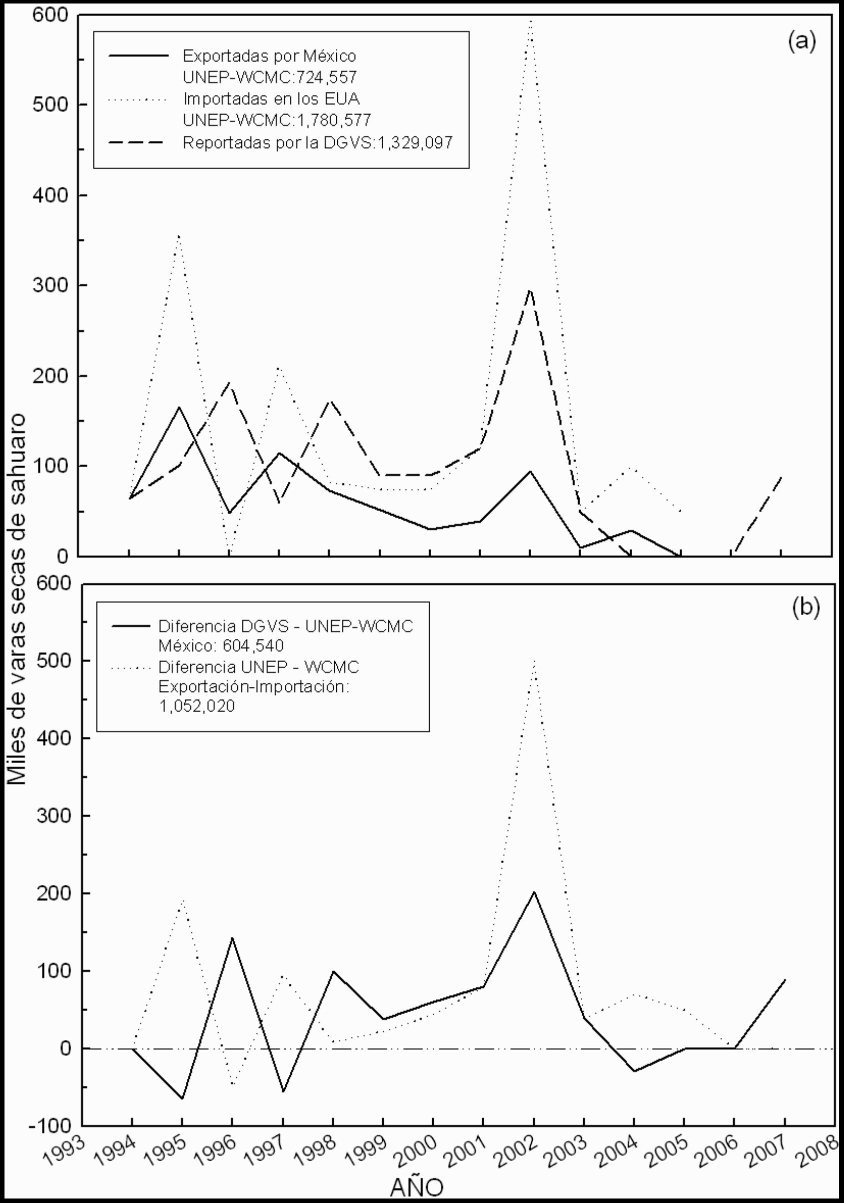
So, using the mortality schedules and the population structure, we were able to model the dead 6+m individuals expected in10, 20…50 years



In populations with little change through time we can be sure that no live individuals have been taken, but in populations where the increase is steady there is suspicion of deliberate extraction of live specimens

Not only populations have been impacted, but large illegal quotas have been collected .

Most of these have managed to go into the US market



Conclusions:

1. From the GARP analysis we conclude that the sahuaro is strongly affected by the thermal environment. Irradiance seems the best modulator of distribution. At the northern edge freezing temps limit its distribution. In the south, vegetation density impedes recruitment. High irradiance restores “aridity” in the tropical south and adds “warmness” in the cool north.

2. Phenotypic differences among populations are large. Some characters are likely to have a strong genetic component.

3. The variation among populations in ecological structure, recruitment and growth is difficult to interpret. 1) All populations show multimodal age distributions. 2) The recurrence time of recruitment seems linked to El Niño events, but last recruitment events have occurred many years ago. 3) We labelled individuals to measure growth. Hints of differential growth (and age) among populations.

4. In terms of resource use, not all dead sahuaros are the same: only those bigger than 6 m tall are valued. In some populations large dead sahuaros have all been harvested. From the analysis of population structure and mortality schedule the return times vary from 10-50 years.

5. Trade is highly profitable. It has been much higher than the quotas allowed by the permits. Live specimens have been killed for later harvesting. It is difficult to have a sustainable use sahuaro ribs whit little control and long return times. Little is known about the role of dead sahuaros on wildlife.

6. The sahuaro should remain within Appendix II of CITES. If trade is allowed a much tighter control on its trade should be enforced: from the assessment for harvesting, to the verification of origin, and traded amounts.