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SOUTH AFRICAN *ENCEPHALARTOS* SPECIES

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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.

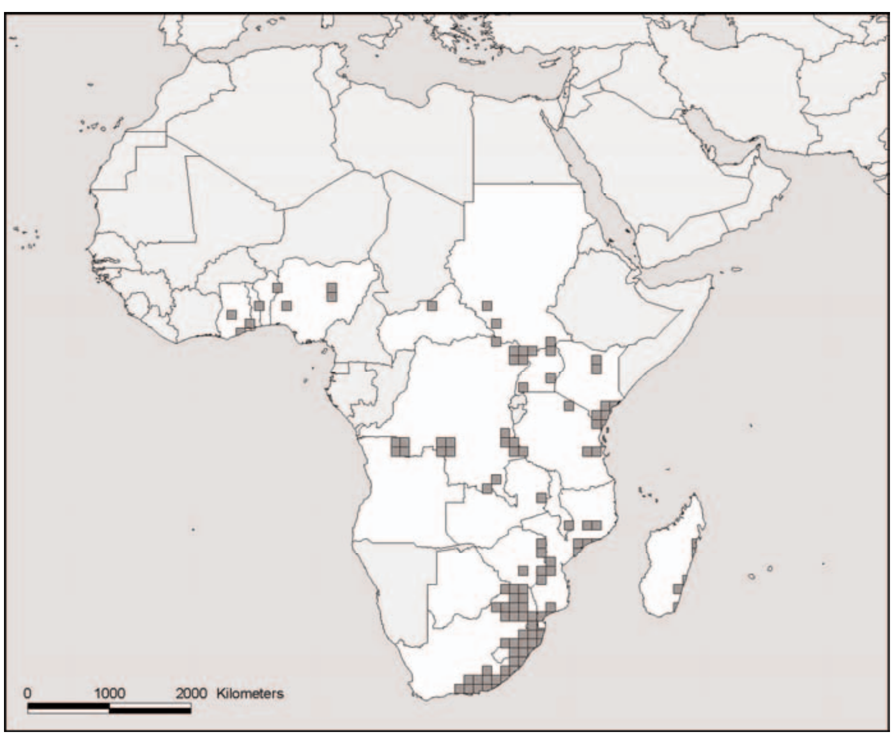


Fig. 1. Distribution of the African cycad genus *Encephalartos*

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.

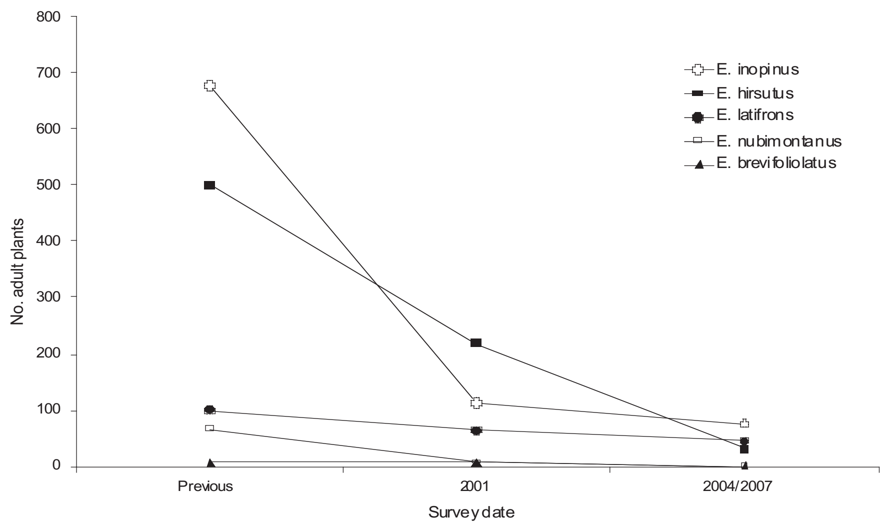
1.4. Population:

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.



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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.

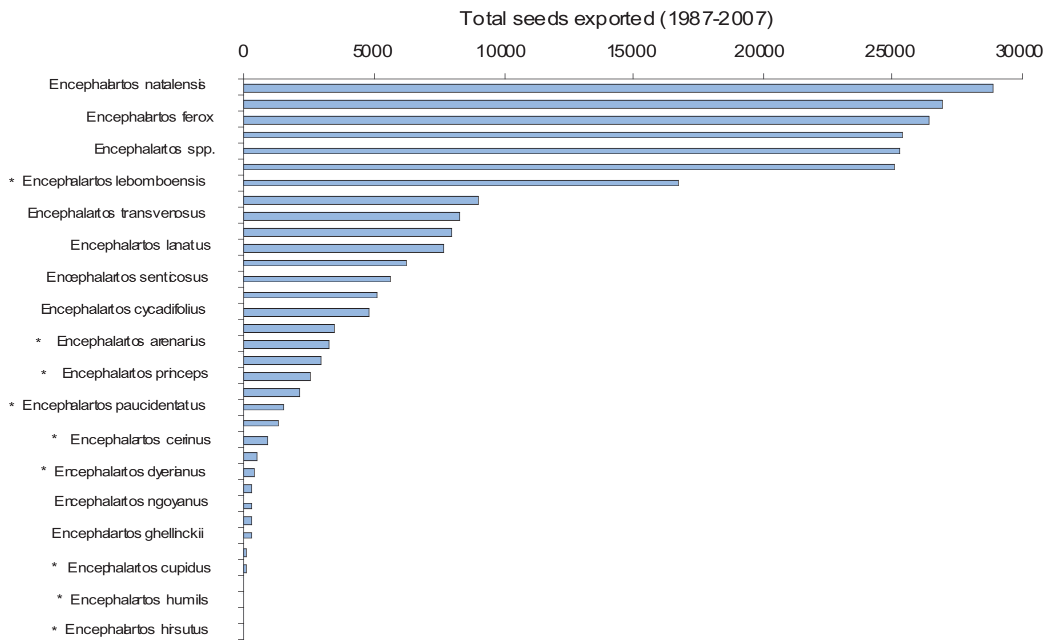
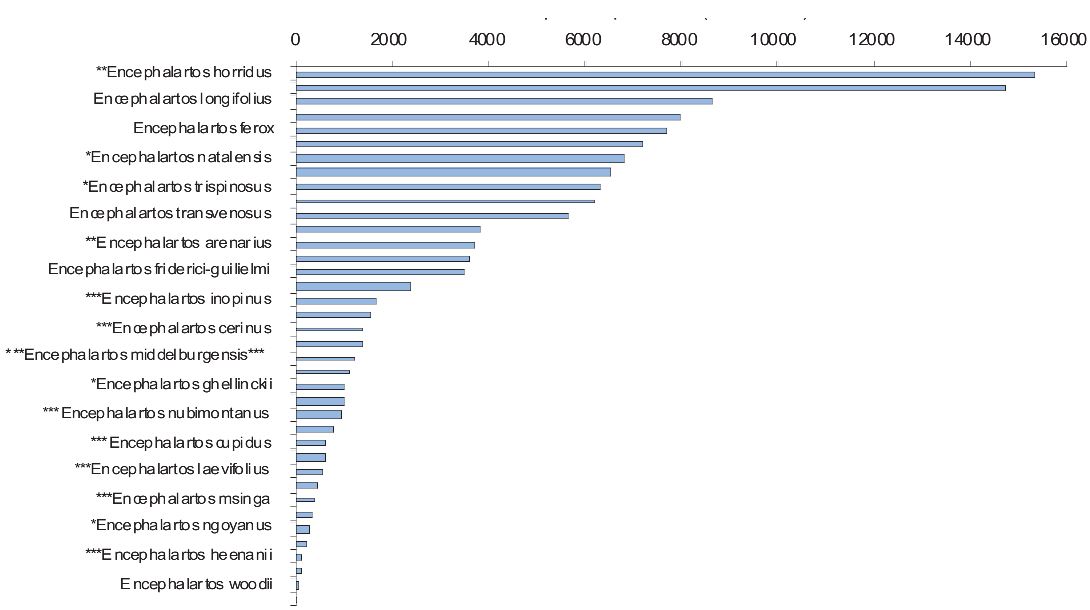


Fig. 4. T
and 2007. CITES data compiled by UNEP-WCMC.



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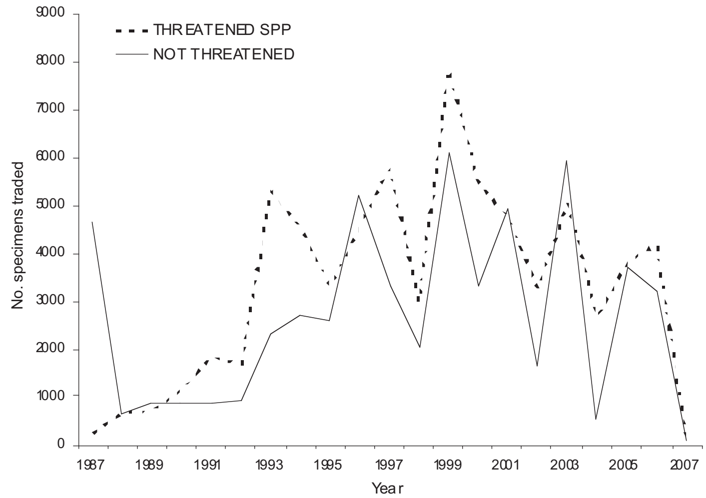
cies between 1987 and 2007. CITES data compiled by WCMC.

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.

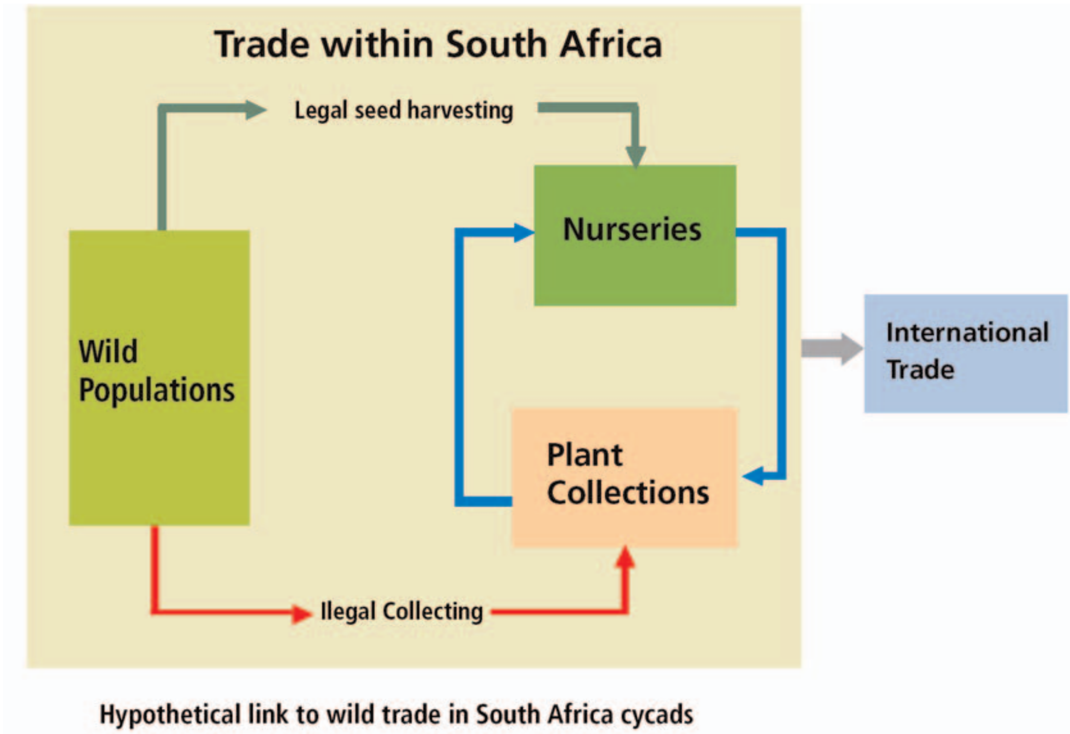


Fig. 7. Diagramatic representation of the possible link between wild trade and 'legal' international trade in *Encephalartos* species

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.

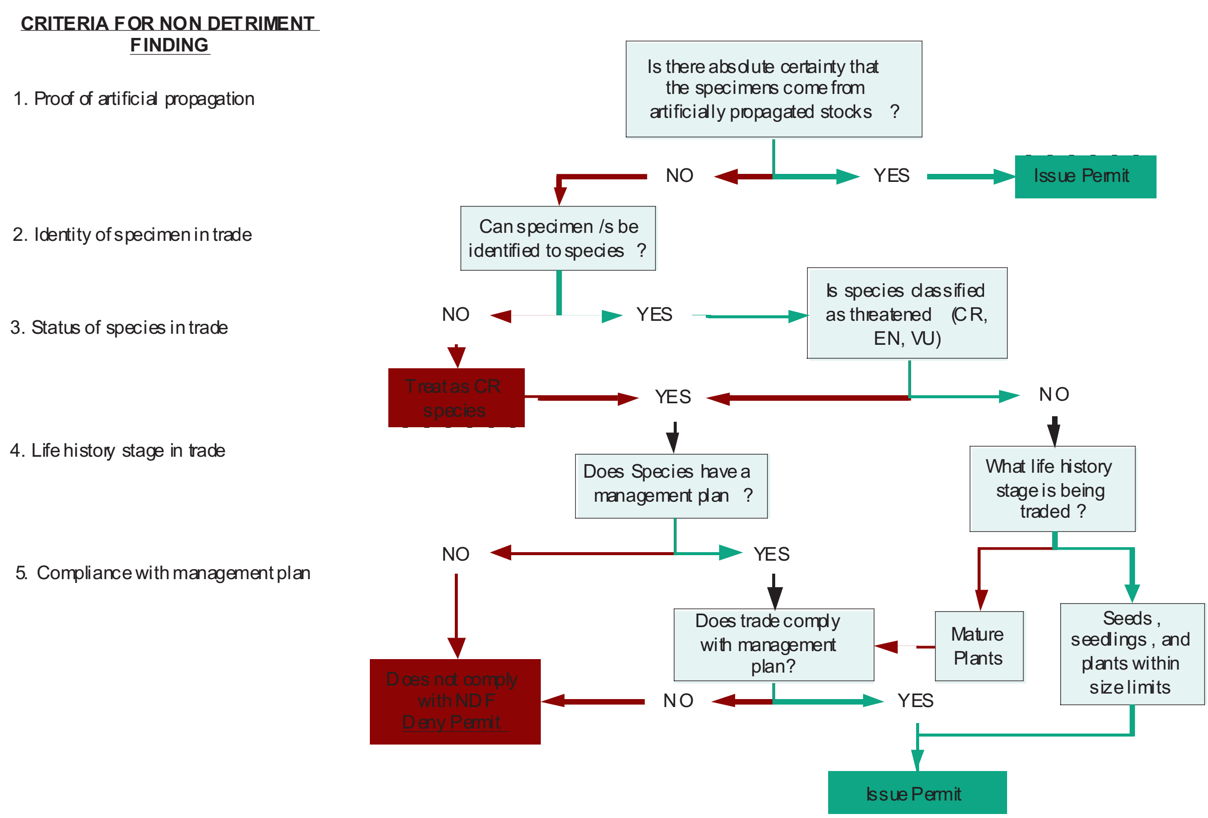
d. *Life history stage being traded*
Population studies and matrix models (see section 1.4.1) have shown that populations of *Encephalartos* are particularly sensitive to the removal of adult plants. As a result, trade in adult plants must be treated as a high risk activity if there is any uncertainty 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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