cycad conservation in south africa

issues, priorities and actions

John S. Donaldson, Editor

CYCAD CONSERVATION IN SOUTH AFRICA
ISSUES, PRIORITIES AND ACTIONS

John S. Donaldson (Editor)

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PREFACE:
TOWARDS A COORDINATED STRATEGY FOR CYCAD CONSERVATION IN SOUTH AFRICA

South Africa is fortunate to have a number of organisations and individuals contributing to the conservation of the whole or part of the country's rich cycad flora. Together, these groups represent a wealth of skills, ingenuity and resources that should enable them to overcome many of the problems that threaten the survival of cycads in the wild. However, to realise this common goal, it is essential to develop and maintain effective communication between the various contributors at both management and functional levels and to have some form of coordination at a national level. Without this cooperation, a situation could easily develop where different organisations duplicate each others activities while other vital tasks remain undone. The need for an open dialogue between all the participants in cycad conservation is particularly necessary during the development of a fully democratic society in South Africa which will result in changes to political boundaries and administrative structures, the reformation of legislation at both national and local levels, and greater participation by local communities in the decision making process. Cycad conservation plans cannot remain static at this time - there will be fresh opportunities to overcome problems that have frustrated cycad conservationsists in the past, e.g. that of effective legislation, as well as new openings for involving local communities in cycad conservation projects, but there are also potential threats to cycad conservation efforts as new administrations respond to different interest groups and revise their priorities accordingly. The cycad conservation community therefore needs to work together to use their resources to maximum effect.

To address this need, the National Botanical Institute organized a one day symposium held in Pretoria on 16th June 1994. Representatives from government departments, statutory bodies, provincial conservation departments, universities and Non Government Organisations were invited to participate. The primary aim of the meeting was to deal with the practical issues involved in stopping the destruction of cycad populations in the wild and managing those that remain. A few participants were asked to prepare formal presentations to provide an overview of cycad conservation in South Africa and to direct discussions towards important issues relating to cycad biology, legislation, *ex situ* propagation, monitoring and evaluation, the fate of confiscated plants, and opportunities for cooperation. In response to a request by all the participants in the symposium, most of these presentations have been brought together in this publication. Unfortunately, some of the speakers preferred for their contributions to remain unpublished, and it has also not been possible to include the extensive and constructive discussion that followed each of the presentations. Nevertheless, several of the papers have been revised to include the comments and views of the broader audience. It should be clear from the objectives of the symposium that the content and scope of these papers is not meant to provide a comprehensive account of cycad conservation in South Africa. Instead, this publication should be seen as basis for further discussions leading to the development of a coordinated strategy for cycad conservation in South Africa.

The changes underway in South Africa presented one minor difficulty for the authors and editor, namely how to deal with the changes in Provincial boundaries. Wherever possible, current terminology has been used, but in many instances this has not been possible either because some administrations are still organised according to former provincial boundaries or because the original data on which some of the papers are based is organised in this way. Former provinces, particularly the Transvaal, are therefore referred to as such in the text.

ACKNOWLEDGEMENTS

The editor wishes to thank all those who contributed to this document, notably the authors of the various papers, as well the participants at the mini-symposium who greatly enriched the written contributions. I would also like to thank the National Botanical Institute and the Cycad Society of South Africa for encouraging and supporting the publication of this document.

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AN OVERVIEW OF CYCAD CONSERVATION IN SOUTH AFRICA

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INTRODUCTION

Amongst the large and diverse spectrum of indigenous plants in South Africa, the cycad flora stands with a special image and identity (Dyer, 1965; Giddy, 1984; Goode 1989). The layman perceives these plants to be rare, valuable, slow-growing, very old and rather odd plants with a distinct element of "snob appeal". The botanist views them from a perspective of their critical position in plant evolution, their unusual reproductive systems, their odd cyanobacterial symbioses, their unique toxins and a host of less obvious characters which make them different to "ordinary" plants. Laymen, botanists and conservationists alike, however, are aware that the continued existence of these plants in the wild is under threat now more than at any time in the past. Problems of this sort are not confined to South Africa, at present Mexico is in much the same situation (Gilbert, 1984; Tang, in print) and it now appears that Chinese cycads are similarly at risk (Chen *et al*., in print).

In this text, I report on the present conservation status of the cycads in South Africa; the main threats facing these plants, what conservation measures are presently in operation, the rôles of the various organisations involved, what has been achieved so far, and some possible routes for the future.

CONSERVATION STATUS OF CYCADS IN SOUTH AFRICA

Present conservation status of South African cycads

To report on the present conservation status of the South African cycads is not as simple a task as first appears. The situation is complicated by five factors, all of which require attention, viz:

1. The taxonomy of *Encephalartos* is incomplete. Names presently in common usage which need proper assignment are *E.* sp. "Msinga" (*affinis E. natalensis*), *E.* sp. "Piet Retiefii" (*affinis E. lebomboensis*) and *E.* sp. "venitus" (possibly several taxa) (*affinis E. cupidus*).
2. Definitions for the various categories of threat are presently under review (Mace *et al*., 1992).
3. Categories of threat are based on species numbers without regard to population size and dynamics.
4. Quantitative data on all species except those in the former Transvaal province are unreliable.
5. The conservation status of species straddling provincial boundaries are determined separately by each provincial authority.

Notwithstanding these limitations, it is useful to peruse the situation in overview. During the course of 1991–1992, a World Cycad Census was carried out (Osborne, in print), in which the number of mature cycad specimens, for each species, in the wild, in public institutions, and in private gardens, was estimated as closely as possible. On the basis of the data obtained, the original "Red Data Book" categories (Lucas & Synge, 1978) were re-assigned and proposals are made for revision to categories of threat following the Mace *et al*. (1992) model. The results, insofar as they concern the South African cycads, are summarised in Table 1, while Table 2 explains the numerical basis for the assignments.

What emerges from this work is that, of the 38 cycad taxa represented in South Africa, one is extinct in the wild (*Encephalartos woodii*), three are critically rare (*E. cerinus*, *E. latifrons* and *E.* sp. "Msinga"), 13 are endangered, 15 are vulnerable and only 6 are considered to be safe or at low risk.

Threats facing the wild cycad flora

The main threats facing wild cycad populations are listed below, but no attempt is made to assess these in terms of relative impact. Perhaps too often the illegal removal of specimens by traders and collectors is considered as the only threat; it is important to realize that there are several contributory factors:

1. Agricultural development and afforestation
2. Urban and rural land demands
3. Road and dam construction
4. Removal of plants by traders/collectors

TABLE 1. Present and proposed conservation status of the South African cycads

Species	Locality	Estimated wild numbers	IUCN status (1978)	Proposed status - Model 1	Proposed status - Model 2
Encephalartos aemulans Vorster	N. Natal	500	—	E	EN
E. altensteinii Lehmann	E. Cape, Ciskei, Transkei	4 500	R	V	VU
E. arenarius R.A. Dyer	E. Cape	800	V	E	EN
E. caffer (Thunberg) Lehmann	E. Cape	2 800	V	V	VU
E. cerinus Lavranos & Goode	KwaZulu	30	—	E	CR
E. concinnus R.A. Dyer & Verdoorn	S.W. Zimbabwe, Transvaal(?)	300	V	E	EN
E. cupidus R.A. Dyer	E. Transvaal	950	E	E	EN
E. cycadifolius (Jacquin) Lehmann	E. Cape	4 800	V	V	VU
E. dolomiticus Lavranos & Goode	E. Transvaal	250	—	E	EN
E. dyerianus Lavranos & Goode	E. Transvaal	550	—	E	EN
E. eugene-maraisii Verdoorn	W. Transvaal	4 500	V	V	VU
E. ferox Bertolini fil.	N. Natal, KwaZulu, Mozambique	7 750	U	R	VU
E. friderici-guilielmi Lehmann	E. Cape, Transkei	7 750	R	R	VU
E. ghellinckii Lemaire	Natal, Transkei	>10 000	V	NT	S/LR
E. heenanii R.A. Dyer	E. Transvaal, Swaziland	400	V	E	EN
E. horridus (Jacquin) Lehmann	E. Cape	4 800	V	V	VU
E. humilis Verdoorn	E. Transvaal	4 600	V	V	VU
E. inopinus R.A. Dyer	E. Transvaal	550	E	E	EN
E. laevifolius Stapf & Burtt Davy	E. Transvaal, Swaziland	820	V	E	EN
E. lanatus Stapf & Burtt Davy	Central Transvaal	>10 000	V	NT	S/LR
E. latifrons Lehmann	E. Cape	70	E	E	CR
E. lebomboensis Verdoorn	N. Natal, E. & S.E. Transvaal, Swaziland, Mozambique	10 000	V	R	S/LR
E. lehmannii Lehmann	E. Cape	5 800	R	R	VU
E. longifolius (Jacquin) Lehmann	E. Cape	4 500	V	V	VU
E. middelburgensis Vorster, Robbertse & v.d. Westhuizen	Central Transvaal	420	—	E	EN
E. natalensis R.A. Dyer & Verdoorn	Natal, KwaZulu, Transvaal(?)	8 300	R	R	VU
E. ngoyanus Verdoorn	N. Natal, KwaZulu, S.E. Transvaal, Swaziland	4 300	V	V	VU
E. paucidentatus Stapf & Burtt Davy	E. Transvaal, Swaziland	2 400	V	V	EN
E. princeps R.A. Dyer	E. Cape, Ciskei, Transkei	4 500	V	V	VU
E. transvenosus Stapf & Burtt Davy	N. & E. Transvaal	>10 000	R	NT	S/LR
E. trispinosus (Hooker) R.A. Dyer	E. Cape, Ciskei	4 850	V	V	VU
E. umbeluziensis R.A. Dyer	Swaziland, Mozambique	3 450	V	V	VU
E. villosus Lemaire	E. Cape, Transkei, Natal, KwaZulu, S.E. Transvaal, Swaziland	>10 000	U	NT	S/LR
E. woodii Sander	(KwaZulu)	0	X	X	EW
Stangeria eriopus (Kunze) Baillon	E. Cape, Natal, KwaZulu & Transkei	10 000	U	R	S/LR
E. sp. "Msinga"	KwaZulu	50	—	E	CR
E. sp. "Piet Retiefii"	N. Natal, E. Transvaal	1 800	—	V	EN
E. sp. "venitus"	E. Transvaal	325	—	E	EN

TABLE 2: Proposed revisions of IUCN status of cycad taxa based on estimated numbers of wild plants

MODEL 1

Number of plants	Proposed IUCN status
0	Extinct (X)
1-999	Endangered (E)
1 000-4 999	Vulnerable (V)
5 000-10 000	Rare (R)
Indeterminate	Indeterminate (I)
Unknown	Unknown (U)
>10 000	Not threatened (NT)

MODEL 2

Number of plants	Proposed IUCN status
0	Extinct in the wild (EW)
1-249	Critical (CR)
250-2 499	Endangered (EN)
2 500-9 999	Vulnerable (VU)
10 000	Safe/low risk (S/LR)
Unknown	Insufficiently known (IK)

5. Removal of plants (Figure 1) or parts thereof (Figure 2) for the *umuthi* trade. A recent report has revealed that 3 410 plants of *Stangeria eriopus* were sold in one month alone, from the two main *umuthi* outlets in the greater Durban area (Osborne *et al.*, 1994).
6. Ecological disturbances (e.g. fire regime, insect associations).

Conservation measures presently in operation

Legislation applicable to cycad conservation operates at the provincial, national and international level, as indicated below.

1. Nature Conservation Ordinances:

— Natal No. 15 of 1974 and amendments thereto.

— Cape No. 19 of 1974 and amendments thereto.

Figure 1. Sections of roots of *Stangeria eriopus* offered for sale at the Umlazi 'muthi' market.

Figure 2. Sections of cycad trunk (probably *Encephalartos lebomboensis*) for sale at the Umlazi 'muthi' market.

— Transvaal No. 12 of 1983 and amendments thereto.

— Relevant sections from the National States legislation which apply to Ciskei, Transkei, KwaZulu, Venda, Lebowa & KaNgwane.

2. Forest Act of South Africa, Act No. 122 of 1984.
3. Environmental Conservation Act of South Africa, Act No. 73 of 1989.
4. CITES (Convention on International Trade in Wild Species of Flora and Fauna) regulations, 1975. [All southern African cycads are listed in Appendix 1].

The common objectives of these laws are to prevent removal of plants from the wild and to prevent trade in wild-collected specimens. Despite the simplicity of the objectives, the laws are perceived as being difficult to understand and interpret in detail. For cycad researchers in South Africa, the permit system is "a bureaucratic procedure" both in terms of the numbers of permits required and the requirements for each permit (Donaldson, 1993a). Provincial laws suffer from the disadvantage of not being consistent from one province to another. Furthermore, the genuine (and fully conservation-minded) hobbyists, nurserymen and researchers find the laws so restrictive as to inhibit what might otherwise be quite reasonable efforts to propagate and exchange plants. As an example, the amendments to the Natal Nature Provincial Ordinance, announced in October 1993, in Schedule 12A can be cited. The family Cycadaceae is referred to as the "true cycads", possibly implying that members of the other families such as Zamiaceae, which includes the genus *Encephalartos*, are not true cycads. Furthermore the Zamiaceae is then referred to as the "Tumboa family". The name Tumboa is a long obsolete name for *Welwitschia mirabilis*, which, although certainly a gymnosperm, has no botanical association with the order Cycadales.

Rôles of various organisations

In the schedule below, I have listed some of the governmental, non-governmental and international agencies which are either directly involved, or potentially involved, with aspects of cycad conservation. Their involvement is self-explanatory from the names.

Governmental agencies

- SA Department of Environment Affairs
- Provincial Nature Conservation Departments
- Endangered Species Unit of the South African Police
- National Botanical Institute
- Foundation for Research Development
- Natural Heritage Programme for Sites of Conservation Significance

Non-governmental agencies

- Cycad Society of South Africa
- South African Association of Botanists
- Botanical Society of South Africa
- Endangered Wildlife Trust of South Africa
- Wildlife Society of Southern Africa
- Institute of Natural Resources (UNP)
- Traditional Healers Association
- The South African Nurserymen's Association

International agencies

- CITES Plants Committee
- Cycad Specialist Group of the IUCN's SSC
- IUCN's Botanic Gardens Conservation International
- The Committee for International Conferences on Cycad Biology
- TRAFFIC
- World Wildlife Fund

What has been achieved so far?

It is gratifying to report that progress, in some form or another, and usually in the form of additive small increments, has been made on a number of fronts.

1. Large numbers of selected cycad species are being grown from seed by institutional and private nurserymen and by cycad enthusiasts. As an example, some 54 000 seedlings of *Encephalartos transvenosus* were raised at the Lebowa Nature Conservation Department's nursery from seed gathered in the Modjadji Nature Reserve (Osborne, 1989). Another large-scale propagation effort is that by the KaNgwane Parks Corporation for the supply of *E. lebomboensis*, *E. paucidentatus*, *E. natalensis* and possibly *E. heenanii* (Stalmans, in print).
2. The concept of controlled "seed-orchards" is well-established and fully operational at least at one site (Hurter, in print).
3. 24 Cycad species are preserved within one or more nature reserves (Table 3).
4. Accurate population data have been obtained for at least the Transvaal cycad taxa (Fourie & Boyd, in print).
5. Penalties for transgressors of conservation ordinances have been increased to realistic levels.
6. The Cycad Society of South Africa has made a significant contribution in developing conservation awareness amongst the cycad hobbyists, largely through the journal *Encephalartos* (Osborne, 1989; Grobbelaar, 1992; Giddy 1993a).
7. Recognition of the third-world sociological aspects of conservation strategies and the need for community participation (Giddy, 1993b; Giddy, in print).

TABLE 3. Cycad -oriented nature reserves in South Africa

Cycad species	Name of reserve	Controlling authority
E. altensteinii	Bathurst State Forest	Cape Dir. Nat. & Env. Conservation
	East London State Forest	Cape Dir. Nat. & Env. Conservation
	Amatola State Forest	Ciskei Dept. of Forestry
	Kiwane Coastal Resort	Ciskei Dept. of Forestry
	Kologha State Forest	Ciskei Dept. of Forestry
	Tamara State Forest	Ciskei Dept. of Forestry
	Dwesa Nature Reserve	Transkei Dept. Nature Conservation
	Hluleka Nature Reserve	Transkei Dept. Nature Conservation
E. arenarius	Alexandria State Forest	Cape Dir. Nat. & Env. Conservation
	Woody Cape Nature Reserve	Cape Dir. Nat. & Env. Conservation
E. caffer	Grahamstown Cycad Reserve	Cape Dir. Nat. & Env. Conservation
	Longmore/Otterford State Forest	Cape Dir. Nat. & Env. Conservation
	Suurberg National Park	RSA National Parks Board
E. cupidus	Blyderivierspoort Nature Reserve	Transvaal Dir. Nat. & Env. Conservation
E. dyerianus	Lillie Nature Reserve	Transvaal Dir. Nat. & Env. Conservation
E. ferox	Kosi Bay Nature Reserve	KwaZulu Dept. of Nature Conservation
	Lake Sibaya Reserve	KwaZulu Dept. of Nature Conservation
E. friderici-guilielmi	Lawrence de Lange Nature Reserve	Queenstown Municipality
E. ghellinckii	Cathedral Peak Nature Reserve	Natal Parks Board
	Giant's Castle Game Reserve	Natal Parks Board
	Royal Natal National Park	Natal Parks Board
E. heenanii	Malolotja Nature Reserve	Swaziland National Trust Commission
	Songimvelo Game Reserve	KaNgwane Parks Corporation (incorporating Ida Doyer Nature Reserve)
E. horridus	Uitenhage Nature Reserve	Uitenhage Municipality
E. laevifolius	Blyderivierspoort Nature Reserve	Transvaal Dir. Nat. & Env. Conservation
	Malolotja Nature Reserve	Swaziland National Trust Commission
	Starvation Creek Nature Reserve	RSA Dept. Environment Affairs (Forestry Branch)
E. lanatus	Botshabelo Reserve	Middelburg Municipality
E. latifrons	Bathurst State Forest	Cape Dir. Nat. & Env. Conservation
	Waters Meeting Nature Reserve	Cape Dir. Nat. & Env. Conservation
E. lebomboensis	Itala Nature Reserve	Natal Parks Board
	Pongola Nature Reserve	Natal Parks Board
	Pongola Nature Reserve	Transvaal Dir. Nat. & Env. Conservation
	Mkuzi Game Reserve	Natal Parks Board
E. lehmannii	Suurberg National Park	RSA National Parks Board
E. longifolius	Baviaanskloof State Forest	Cape Dir. Nat. & Env. Conservation
	Groendal Wilderness Area	Cape Dir. Nat. & Env. Conservation
	Loerie Dam Nature Reserve	Dias Divisional Council
	Longmore/Otterford State Forest	Cape Dir. Nat. & Env. Conservation
	Suurberg National Park	RSA National Parks Board
	Van Staden's Wildflower Reserve	Dias Divisional Council
E. natalensis	Karkloof Falls Nature Reserve	Privately owned
	Krantzkloof Nature Reserve	Natal Parks Board
	Oribi Gorge Nature Reserve	Natal Parks Board
	Soada Nature Reserve	Natal Parks Board
	Umgeni Valley Nature Reserve	Wildlife Society of Southern Africa
	Umtamvuna Nature Reserve	Natal Parks Board
E. ngoyanus	Ngoye Forest Reserve	KwaZulu Dept. Nature Conservation
	Pongola Nature Reserve	Natal Parks Board
	Pongola Nature Reserve	Transvaal Dir. Nat. & Env. Conservation

TABLE 3 continued

Cycad species	Name of reserve	Controlling authority
E. paucidentatus	Malolotja Nature Reserve Songimvelo Game Reserve	Swaziland National Trust Commission KaNgwane Parks Corporation
E. transvenosus	Happy Rest Nature Reserve Lekgalameetse Nature Reserve Mphaphuli Cycad Reserve Modjadji Nature Reserve	Transvaal Dir. Nat. & Env. Conservation Venda Dept. Nature Conservation Venda Dept. Nature Conservation Lebowa Dept. Nature Conservation
E. trispinosus	Bathurst State Forest Andries Vosloo Kudu Reserve Double Drift Nature Reserve	Cape Dir. Nat. & Env. Conservation Cape Dir. Nat. & Env. Conservation Ciskei Dept. of Forestry
E. umbeluziensis	Mlawula Nature Reserve	Swaziland National Trust Commission
E. villosus	Entumeni Nature Reserve Krantzkloof Nature Reserve Oribi Gorge Nature Reserve Shongweni Dam Reserve Umtamvuna Nature Reserve East London State Forest Pongola Nature Reserve	Natal Parks Board Natal Parks Board Natal Parks Board Natal Parks Board Natal Parks Board Cape Dir. Nat. & Env. Conservation Transvaal Dir. Nat. & Env. Conservation
Stangeria eriopus	Dlinza Forest Nature Reserve Entumeni Nature Reserve Krantzkloof Nature Reserve Ngoye Forest Reserve Vernon Crookes Nature Reserve	Natal Parks Board Natal Parks Board Natal Parks Board KwaZulu Dept. Nature Conservation Natal Parks Board

8. Recognition of the role of insects in cycad population dynamics (Donaldson, 1993b).
9. Prominence of conservation in the agenda of the International Conferences on Cycad Biology.
10. A Conservation Biology Research Unit has been formed by the National Botanical Institute with a project on cycads.
11. Plans for the CITES-registration of nurseries for trade in Appendix 1 plants (Giddy, 1993a).
12. Progress has been made in nursery propagation. (Giddy, 1990; Dehgan & Almira, 1993; Grobbelaar, in print) and in micropropagation techniques (Osborne, 1990a).
13. The matter of germplasm storage is being addressed (Osborne *et al.*, 1992).

Possible routes for the future

The author proposed (Osborne, 1990b) a "seven-point cycad conservation action plan" which met with substantial support, the central points being as follows.

1. Rationalisation and revision of existing legislation.
2. Proclamation of additional reserves for threatened populations.
3. Establishment of viable *ex situ* cycad gene pools
4. Catering for the horticultural demand.
5. Creation of a register of mature cycad plants in public and private gardens.
6. Encouraging education at all levels.
7. Stimulating and encouraging cycad orientated research.

These proposals were followed by a suggestion from Grobbelaar (1992) that conservation authorities should remove selected highly-threatened specimens from the wild and re-establish them in managed reserves, so that their reproductive potential could be fully exploited. This has been carried out on a small scale in the Transvaal (Boyd, in print).

It is my belief that, although progress has been made on a number of fronts, all seven points in the above "action plan" still need more of the "action" component. I would suggest that the following points are added:

1. Encouraging local community participation in cycad conservation projects.
2. Relocating breeding stock from highly endangered, non-viable populations to managed "seed orchards".

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UNDERSTANDING CYCAD LIFE HISTORIES: AN ESSENTIAL BASIS FOR SUCCESSFUL CONSERVATION

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INTRODUCTION

There is a danger that, in an attempt to find general solutions for conserving cycads in South Africa, and in the absence of detailed information on how different cycads respond to changing conditions, conservation practitioners will base their actions on generalizations and assumptions (see Table 1) and thereby ignore important differences in cycad life histories. The main aim of this paper is to examine some cycad life histories to determine whether the generalizations listed in Table 1 are valid and to identify problems that may arise when conservation actions are based on invalid assumptions. At the same time, the opposite approach, in which the idiosyncracies of each population are emphasized to the extent that generalizations are seen as meaningless, can also be a problem when resources are limited and it is simply not possible to undertake detailed studies of each population. The second aim of this paper is, therefore, to determine whether it is possible to identify natural groupings of cycads with similar life histories that may respond to their environment in similar ways. For the purpose of this paper, I will concentrate on the South African species of *Encephalartos,* and especially on *E. cycadifolius* and *E. villosus.*

CYCAD LIFE HISTORIES

The study of life histories introduces a gamut of questions relating to reproduction. For example, at

TABLE 1. Prevailing generalizations and assumptions that may influence cycad conservation actions in South Africa.

Generalization/ Assumption	Conservation action
Individual cycads are long-lived so that populations are likely to persist in one locality for a long time.	The establishment of permanent reserves sometimes including only one small cycad population.
Large numbers of surplus seed are produced in the wild where they simply go to waste and die.	Recommendations that seed should be harvested from wild populations and used to propagate cycads for *ex situ* conservation programmes and for sale to the public.
Cycads growing in fire prone environments will cone after fire.	Burning is seen as a potential management practice to induce coning and thereby boost reproduction.
The absence of seedlings or juveniles in a cycad population is a sign that the population is not behaving normally.	Remedial measures are implemented to improve seed set and recruitment, e.g. artificial pollination and altered burn regimes.
Pollination by species specific insect pollinators is essential for reproduction and the continued survival of cycad populations.	Studies of insect pollination have become a high priority research topic and there is increasing pressure on conservation agencies to ensure that pollinators are conserved.
Cycad populations will respond in similar ways to a reduction in numbers.	The use of uniform criteria to determine the threatened status of cycad taxa, e.g. < 250 = Critical whereas > 10 000 = Low risk.

what age and size does a cycad first reproduce? How much energy does it allocate to sexual reproduction as opposed to linear growth or suckering? How many times does sexual reproduction take place in its lifetime and how many seeds are produced during each reproductive event? The answers to these questions have important consequences for the size and structure of cycad populations that can probably best be illustrated by examining the life histories of *E. cycadifolius* and *E. villosus*. The narrative describing their life histories is based on population studies carried out over the past few years (Donaldson, 1993a & b; Donaldson in print a & b; unpublished data).

Encephalartos cycadifolius

The mature cones on a female plant begin to break up exposing the ripe seeds. Hundreds of other female plants in the surrounding grassland have also produced cones and a troop of baboons foraging in the area is attracted by the bright colours and fruity smell of the seeds. The baboons tear open the cones and feast on the hundreds of thousands of seeds. They nibble at the fleshy sarcotesta and discard the seed on the rocky ground or between tussocks of grass. During the nights that follow, rodents feed on those seeds where part of the sarcotesta is uneaten and they drag some of the seeds under nearby shrubs or cycads where they store them in piles of up to 100 seeds. The available storage space is soon saturated and the thousands of seeds that remain on the open ground desiccate under the hot sun and die. In the piles of seeds cached by rodents, the development of the embyro in each seed proceeds slowly and, after 18 months, the seeds germinate. Only a handful survive to produce their first set of leaves and, finally a single seedling survives, growing under a large shrub. When the plant is fifteen years old, a fire sweeps through the grassland and in spring two years later the plant produces its first cone at the same time that all the other plants in the burnt area are coning. The plant is female and the nearest male plant is a few meters away. Beetles carry pollen to the female cone and 98% of the 200 seeds are fertilized. The cone matures, but none of the seeds survive. In the years after coning, the plant increases in size and produces a sucker so that after the next fire there are two stems which each produce a single cone. In its 150th year, it has ten stems each capable of producing a cone but an older stem is destroyed by porcupines. A ten year long drought nearly kills the plant but a few stems survive. By the time the cycad is 500 years old, it has 15 stems, none of them part of the original plant. After 1000 years, a storm washes away the soil from the usually subterranean stems and the plant dies. During its lifetime it has reproduced sexually every eight to 15 years, a total of 86 reproductive events, it hasproduced 893 cones and 178 600 viable seeds. Two of these seeds survived and developed into mature plants.

Figure 1. A multi-stemmed *Encephalartos cycadifolius* female growing in fire climax grasslands. Note that each stem bears a single cone.

Encephalartos villosus

In the shadowy understorey of a coastal forest, a lone cycad slowly accumulates resources and, eight years after the previous coning event, a single female cone is produced. There are no other coning plants nearby and the nearest male cone is 800 m away. A small number of beetles bearing pollen arrive from the male cone and deposit pollen on the micropyles of half the receptive ovules. At the same time, weevils arrive and lay eggs in 86% of the ovules. When the cone disintegrates and releases its seed, only 14 of the 200 seeds are viable. The fleshy seeds attract loeries and Samango monkeys which completely consume the sarcotesta before discarding the cleaned seed on the forest floor a few meters from each other and from the parent plant. Further scrummaging in the understorey by the birds and monkeys soon covers the seeds in a thin layer of damp soil and debris. Six months later, seven of the seeds have germinated and they produce a single leaf before the end of their first year. Three of the seedlings are trampled by a bushbuck and two more die within the next few years. The two remaining plants store up nutrients and five years later when they are 12 years old one plant produces its first cone. It turns out to be a male. Beetles visit the male cone and lay eggs, their larvae develop in the cone and the adults emerge when the cone is releasing pollen. Doused in pollen the beetles fly off into the forest. One beetle makes it to a female plant coning 1.5km away and deposits pollen on the ovules but the cone is attacked by leopard moths and none of the seeds develop. The other plant turns out to be female when it reproduces a few years later. The original parent plant survives one more coning season but dies soon afterwards at the age of 75. In its lifetime it has produced seven cones and a total of 1500 seeds, it has left two established offspring which have each given rise to several seedlings and it has produced no basal suckers.

Figure 2. A single-stemmed *Encephalartos villosus* growing in the forest understorey.

The description of these two life histories could just have easily been presented as a series of tables and graphs showing that the average *E. cycadifolius* plant in the populations I have studied has nine stems whereas *E. villosus* almost invariably has a single stem under natural conditions. Populations of *E. cycadifolius* are dominated by multistemmed, and presumably very old, adult plants and sexual reproduction is characterised by spectacular masting events in which fire stimulates all the plants to produce cones in the same year (Dyer 1965; Donaldson, in print b). By contrast, studies of age structure in *E. villosus* populations show that young plants predominate and there are relatively few large mature adults. Adult *E. villosus* reproduce asynchronously so that each year there are a few isolated cones in the population. In populations of *E. cycadifolius*, vast numbers of seed are produced in a mast year and mortality is initially dependent on the density of seed – once the rodent stores are saturated, the remaining seeds die. Even the seeds dispersed by rodents have a very small chance of survival. In the forest understorey, viable seeds of *E. villosus* have a better chance of surviving but the half life of the population appears to be between 50 and 100 years so that adult plants have a relatively short life expectancy. The implications of these differences in cycad life histories for conservation actions need to be explored further.

Will cycads persist in one locality for a long time?

In the two examples used so far, *E. cycadifolius* populations are characterized by extremely persistent adults with a slow rate of population turnover. The establishment of small permanent reserves will therefore probably succeed for cycads with this type of life history. The same may not be true for *E. villosus* where adults have much shorter lifespans and there is a higher rate of population turnover. Studies of *E. villosus* show that populations may 'move' in the forest because the conditions are not uniform throughout the forest so that plants in some patches reproduce or die at higher rates than in others.

Can cycad seeds be harvested without affecting the population?

The high mortality rate of seeds is often interpreted as an indication that there is surplus seed in cycad populations (e.g. Grobbelaar *et al.*, 1992). This interpretation is only valid when the removal of 'excess' seed has no effect on the number of seeds that germinate and become established in the population. In the case of *E. cycadifolius*, seeds that cannot be dispersed by rodents, because the available cache sites are saturated, represent surplus seed and can probably be harvested without affecting population growth. Mortality among *E. cycadifolius* seeds that are dispersed to suitable germination sites is mostly not influenced by the number of seeds at each site so that there is probably no surplus seed at this stage. In *E. villosus* populations there appears to be no stage at which seeds or seedlings experience density dependent mortality (Donaldson, in preparation). This means that each seed has an equal chance of survival so that harvesting of even a few seeds could influence population growth. It is therefore imperative that seed harvesting is not adopted as a general policy for managing cycad populations.

Will cycads produce cones in response to fire?

Coning in response to fire is well documented in some cycads, e.g. *E. cycadifolius* (Dyer, 1965; Donaldson, in print a,b) but it appears that other cycads, e.g. *E. caffer*, are not stimulated to cone by fire (J. Briers personal communication; personal observations). The phenomenon of fire stimulated coning is poorly understood but could be linked to the overall life history of the plant. For instance, *E. cycadifolius* produces additional basal suckers between reproductive events (i.e. between fires) which means that the plant can survive long intervals between fires and at the same time produces more crowns on which to produce cones. By contrast, a plant such as *E. caffer* has no basal suckers so that it may not survive a long interval between fires and would also not increase its reproductive capacity by increasing the number of stems. This subject needs further investigation but, purely on theoretical grounds, it seems likely that fire stimulated coning will be more prevalent amongst cycads with certain life histories, e.g. those with persistent adults and a tendency to produce suckers

Does the absence of juveniles mean the population is in decline?

A once off population study may reveal that a cycad population has a preponderance of well established sexually mature plants with relatively few juveniles or seedlings. There is a tendency for this sort of data to set alarm bells ringing, raising questions about the absence of pollinators and wrong management practices, and to result in various types of remedial action (Table 1). Such concern may be unnecessary where cycad life histories are characterized by long individual life spans and a propensity for clonal reproduction (suckering), and where a slow rate of replacement (i.e. few juveniles) might be expected, e.g. in *E. cycadifolius* populations. However, for cycad species with life histories similar to *E. villosus*, in which individuals have relatively short lives and the population is maintained by a continuous process of recruitment, the absence of juveniles would rightly be a matter for concern.

Are pollinators important in all populations?

A shortage or absence of pollinators is likely to have its greatest impact on cycad populations that are maintained by ongoing seedling recruitment and where seeds are a limiting factor in population growth, e.g. *E. villosus* populations. By contrast, pollinator limitation will have less severe implications for populations where individuals also reproduce (persist) by means of basal suckering (i.e. they are not seed dependent) and where seeds usually experience density dependent mortality, e.g. *E. cycadifolius* populations. Bond (1994) has proposed a vulnerability index in which plant populations that are seed dependent, seed limited and rely on species specific pollinators are regarded as the most vulnerable to pollinator limitation. At the same time, Bond (1994) has argued that this combination of traits should be rare as a result of the evolution of compensation mechanisms, i.e. plants with specialist pollinators should not be seed dependent and those that are should have generalist pollinators. Compensation mechanisms have not been examined in cycad taxa but there are indications that species such as *E. villosus* would fit into the most vulnerable category. By contrast, *E. cycadifolius* would be placed in the least vulnerable category because, in addition to its other life history traits, it is pollinated by insects that visit a number of species of *Encephalartos*.

Do population numbers mean the same thing for different species?

Comparative numbers of plants in the wild provide the most simple and easily obtained information for determining the threatened status of a species (Mace *et al.*, 1992; Osborne, in print). So, for example, a cycad with 500 individuals left would be regarded as more threatened than another species with 1000 individuals. However, a population of *E. cycadifolius* with 500 persistent adult plants may be far less threatened than an *E. villosus* population with 1000 relatively short-lived individuals. The revised categories of threat (Mace *et al.*, 1992) take these sorts of differences into account and provide several methods for assessing the threatened status of a species depending on the detail and type of information available. The use of life history data can provide a further scale of resolution for detemining the threatened status of cycad populations and needs to be used to greater effect in these assessments.

A CLASSIFICATION OF CYCAD LIFE HISTORIES

A detailed comparison of life history traits among species of *Encephalartos* will almost certainly show that there are species specific differences in the propensity for basal suckering, the frequency of sexual reproduction, the number of cones produced on each occasion, the number of seeds per cone and the maturity of the seed at the time of dispersal.

While recognizing these differences, the aim of this section is to determine whether, at a broader scale of resolution, it is possible to classify species of *Encephalartos* into groups with similar combinations of life history traits. Based on studies to date I have identified four types of life history within the genus *Encephalartos* (Table 2) and I have included several examples of each type. Type 1 (persister) and Type 4 (reproducer) are most easily recognized but between these two extremes there are at least two further

TABLE 2. A classification system for cycad life histories comprising four types each with a distinctive growth form and cone number. The four types represent a gradation from a life history where clonal reproduction and persistence are dominant traits (Type 1) to a life history where sexual reproduction takes precedence (Type 4).

TYPE 1 **Persister** • A large number of basal suckers with relatively short individual stems. • Long-lived (persistent) individuals • A single cone per stem (at least for females) • Infrequent sexual reproduction Environmental correlates: • Associated with arid environments or grasslands. • A tendency to mast seed in response to cues such as fire or rainfall. E.g.: *E. cycadifolius, E. humilis, E. trispinosus*	**TYPE 2** **Persister/ reproducer** • Aerial stems reaching several meters in height with several basal suckers. • A single (often large) cone per plant (females only). Environmental correlates: • Associated with arid environments or fire climax vegetation. • A high incidence of mast seeding in fire climax vegetation E.g. *E. longifolius, E. lehmannii*
TYPE 3 **Reproducer/ persister** • Aerial stems reaching several meters in height with few basal suckers. • Several cones per plant. Environmental correlates: • Found in woodlands, forests and grasslands. • A high incidence of mast seeding in grasslands but not in forests and woodlands. E.g. *E. altensteinii, E. natalensis, E. transvenosus*	**TYPE 4** **Reproducer** • Single (often subterannean) stems with no basal suckers under natural conditions • Relatively short-lived individuals • A single cone per plant (at least for females) • High reliance on sexual reproduction Environmental correlates: • Found in grasslands, forest margins and in the forest understorey. • A low incidence of mast seeding E.g.: *E. villosus, E. umbeluziensis, E. caffer*

groups in which there is a more complex combination of persistent and reproductive traits but where one (Type 2) or the other (Type 3) is more evident.

Although it still needs further investigation, species with the same type of life history do appear to occur in similar environments and to respond to their environment in similar ways. For example only species with Type 1 or Type 2 life histories occur in arid areas and these types are not found in forests where species with Type 3 or Type 4 life histories occur. Similarly, Type 1 species occurring in grasslands tend to mast seed after fire whereas Type 4 species occurring in grasslands do not.

The classification of cycad life histories still needs a lot more refining and may need to include facultative changes in life history parameters, e.g. there is some evidence that the resources allocated to cone production and suckering vary along environmental gradients. Nevertheless, a simple classification of cycads according to important life history characteristics offers a system that can be of great help to cycad conservationists. The intention is to develop conservation strategies that are appropriate for cycads with different life histories.

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LEGISLATION: NEEDS AND IMPLEMENTATION WITH SPECIAL REFERENCE TO CITES

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Cycads in South Africa are protected by both domestic legislation and international conventions. The needs and problems at these levels are dealt with separately.

DOMESTIC LEGISLATION

Cycads are protected by law in all provinces or regions under regional conservation ordinances. These ordinances have jurisdiction only in that region. On a national basis cycads are protected under the Forest Act of 1984 and the Environment Conservation Act of 1989. However, loopholes exist and are exploited. Plants can therefore be laundered between provinces e.g. Cape and KwaZulu/Natal cycads can be sold in the other provinces with no proof of legal acquisition being required of the seller.

To overcome this problem, a committee should be appointed to look at provincial legislation in depth and a working document should be drafted and presented to the Minister of the Environment urging national legislation or uniform regional legislation.

Further, fines prescribed by the various ordinances, are often so low in relation to the monetary value of the cycads concerned that the fines imposed by the courts do not serve as a deterrent. Magistrates do not appreciate either the monetary value or the botanical rarity of cycads unless an expert witness testifies to this effect. The Cape Conservation authorities have remedied this by not only increasing the fines and bringing them in line with the penalties imposed for trade in ivory and Rhino Horn but using expert witnesses in court.

In part, low fines could be remedied by a public awareness campaign through the media to get public opinion to demand that the courts implement conservation legislation more effectively.

INTERNATIONAL LEGISLATION

CITES

Internationally the trade in cycads is monitored by the Convention in International Trade in Endangered Species of Flora and Fauna (CITES). South Africa has been a signatory to CITES since 1978 and the Department of Environment Affairs is the management authority. They in turn have delegated the implementation of CITES to the four provinces.

Both *Encephalartos* and *Stangeria* are on Appendix 1 of the CITES schedules. This means that no trade is permitted in wild collected plants or seeds. Trade is restricted to artificially propagated (i.e. nursery grown) specimens. Although CITES permits trade in garden produced Appendix 1 seeds, the S.A. Management Authority has instructed the provinces not to issue CITES export permits for *Encephalartos* and *Stangeria* seeds on the grounds that it is difficult to distinguish between seed of wild and garden origin.

Contraventions of CITES for both wild collected plants and seeds occur. For example.

1. Large quantities of *Encephalartos* and *Stangeria* seeds are still exported. They are either mislabelled with Appendix II names or they are not declared as seeds on the package.
2. Wild collected plants are described as "artifically propagated seedlings" on the documenation due to the fact that plants are not physically inspected prior to the issuing of CITES export permits. These permits are issued on telephonic or written application.

At every Plants Committee meeting the Cycad Specialist Group has been shown photographs of confiscated plants of wild origin and incorrect CITES documentation from South Africa.

To overcome these problems, the S.A. Management Authority should run seminars and issue guidelines to the provincial authorities to ensure that the CITES regulations are correctly implemented.

THE ROLE OF THE CITES SECRETARIAT AND THE PLANTS COMMITTEE

The Secretariat

The CITES Convention is implemented through a permanent Secretariat which is sited in Geneva. A full-time Plants Officer, Dr Ger van Vliet, is in charge of all matters relating to endangered plants. All violations, queries etc. are directed to the Plants Officer for investigation. In addition, he visits the six regions and arranges seminars on the implementation of the Convention as well as inspects nurseries and CITES sponsored projects in various countries.

The CITES Plants Committee

This committee which was established five years ago meets annually in the six regions: Europe; North America; South, Central America and the Caribbean; Africa; Asia; and Oceania.

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In addition to the six nominated regional representatives, Plants Committee meetings are also attended by representatives of the Management Authorities and Scientific Authorities of member countries as well as large numbers of NGOs e.g. TRAFFIC, the various IUCN Specialist Groups and other conservation linked organisations. More than 80 delegates attended the recent Plants Committee in Mexico.

The Function of the CITES Plants Committee

The Plants Committee serves in an advisory capacity to the Convention of the Parties. Draft legislation is discussed and modified before being presented to the Convention of the Parties.

At present, with reference to Cycads, the following draft resolutions have been considered:

Draft Resolution on Nursery Registration

At the 1985 Convention of the Parties in Buenos Aires it was resolved that nurseries who propagate Appendix I plants be registered with CITES in order to facilitate the issuing of CITES documentation. Several draft resolutions ré the proposed nursery registration have been extensively examined by the Plants Committee with input from the Specialist Groups, TRAFFIC, the nursery industry and other interested groups. The final draft was put to the Convention of the Parties in November 1994.

CITES recognises that nursery registration and the inspection associated with it, forms an important tool in the conservation of rare species for the following reasons.

1. Facilitating the documentation procedures to reliable nurseries is the only way to prevent their giving up the propagation of rare species or to stop them exporting them under false names. Once artificially propagated specimens are available in large quantities there will no longer be a need to collect them from the wild.

   The easy recognition of shipments from CITES registered nurseries would also mean that customs inspectors of importing countries could focus on other shipments that require inspection.

2. It is also hoped that the system of nursery registration will help to equalise the competition between nurseries in countries of origin and those in importing countries which, until now, have dominated the market in artificially propagated plants of Appendix I species. The requirement to prove the legal origin of parental stock could be an important element in bringing about such equality.

It must be stressed that the suggested registration procedure will only be implemented successfully, and to the benefit of wild populations of the species concerned, if the Parties are willing to implement the simplified procedures for the issuance of export permits.

Briefly, it means that a nursery which propagates and wishes to export Appendix I species (*Encephalartos* and *Stangeria*) will register with their Management Authority who, in turn, will forward the application to the Secretariat. The application will include the following.

1. A list of the species concerned.
2. A description of the facilities and propagation techniques of the nursery.
3. A description of the inspection procedures used by the Management Authority to confirm the identity and legal origin of the parental stock.

The Management Authority will ensure that the number of specimens of wild origin designated as parental stock is not depleted by the disposal of specimens other than through natural causes or, with the consent of the Management Authority, through the transfer of such stock to another registered exporting nursery.

The Management Authority will ensure that registered nurseries are inspected annually by a specialist from the Scientific Authority or other qualified entity to certify the size of the parental stock and the number of plants produced from it and that the nursery holds no other specimens of wild collected Appendix I species. The Management Authority will also design a simple procedure for the issuance of export permits for such registered nurseries.

Further clauses deal with the procedures for obtaining and replenishing parental stock, the resolving of disputes and the delisting or removal of nurseries from the register of the Secretariat.

In brief, CITES registration, by facilitating the issuance of export documentation, will encourage more export nurseries to propagate rare species. The burden of ensuring that nurseries comply with the CITES regulations now rests on the Management Authority of the country of origin who will control and monitor these nurseries. Note that this is a voluntary registration and nurseries who object to such monitoring procedures have the option of continuing to export under the existing system of lengthy delays in the issuance of export documentation.

Return of confiscated stock

CITES makes provision for the return of confiscated stock to the country of origin. In practise this provision raises a problem about who will pay for the freight costs incurred in returning them. In cases where no documentation is provided (smuggled plants) false addresses are often given on the packages. The present practice is to place such plants in designated Rescue Centres in the importing country. CITES is at present addressing these issues as many of the Rescue Centres are unwilling or unable to assume the financial burden of indefinitely housing and maintaining such plants. Botanic Gardens, too, are unwilling to accept undocumented specimens. Commercial nurseries may well be a suitable repository for such confiscated plants rather than the more research oriented institutions. This problem is receiving attention from CITES.

As the spokesperson for the Cycad Specialist Group on the Plants Committee I would welcome any questions or suggestions on matters pertaining to CITES legislation as they affect cycads. These can be presented at the next meeting or forwarded to the persons concerned in the mean time.

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POPULATION CENSUS DATA AND LONG-TERM MONITORING OF CYCAD POPULATIONS

Steve P. Fourie

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INTRODUCTION

The Chief Directorate of Nature and Environmental Conservation of the Transvaal Provincial Administration (TNC) has been involved with the monitoring of threatened plant populations since 1984.

This involvement was created by the need to determine possible changes or long-term trends in the population base, structure and dynamics of threatened plant species, in order to yield a sound scientific foundation on which management can base decisions. Cycad monitoring programmes were initiated through approved conservation strategies as documented in so called, Species Conservation Plans. These programmes made provision for the long-term censusing of populations of specific cycad species and more short-term actions geared to generate information on possible changes in population structure and dynamics. Some monitoring actions were also initiated to try and determine the response of certain populations to the implementation of specific management measures.

The aim of this short paper is to give a critical appraisal of the TNC's cycad monitoring programme.

MONITORING METHODS

Prior to 1988 the TNC based all its monitoring actions on a monitoring method designed at a workshop on Threatened Plant Research Methodology held during 1985 at Stellenbosch. During 1988 the TNC adopted a more dynamic approach which necessitated the implementation of objectives-driven monitoring methods.

Depending on the specific goal, one or a combination of the following methods may be chosen:

- Inventory study;
- Survey study; and
- Demographic study.

The Inventory Study

This is a thorough count of all the individuals in a population (or populations) of a species. This count may be performed annually or at any desired frequency. Although applied over a broad spectrum of cases it is especially applied as part of the TNC's long-term cycad population census programme where specific populations are routinely counted with the aid of a helicopter and a trained team of spotters. Table 1 reflects the species that have been monitored using this particular method.

The Survey Study

This method implies the application of repeatable sampling techniques, such as line transects, stratification, and random sampling to make estimates about community or population parameters. It is also suitable for sub-sampling a very large population if additional field data is required.

The Demographic Study

The Demographic Study involves the application of permanent study plots where specific detailed data are collected on a regular basis. This technique makes provision for two types of applications, viz.

1. Long-term demographic studies aimed at documenting population trends such as stability growth or decline using survivorship and seed production (and/or vegetative segmentation) as primary elements.
2. More short-term eco physiological studies to generate information on the physiological status and reproductive performance of established individuals using *in situ*, non destructive measurements to determine if favourable conditions for growth and reproduction exist at a specific time.

Both these types of applications can be incorporated at various stages and may be interchanged to take full advantage of the important relationship between short-term physiological processes and more long-term demographic trends within populations.

Table 1 reflects the techniques selected to monitor cycad populations.

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This method implies the application of repeatable sampling techniques, such as line transects, stratification, and random sampling to make estimates about community or population parameters. It is also suitable for sub-sampling a very large population if additional field data is required.

The Demographic Study

The Demographic Study involves the application of permanent study plots where specific detailed data are collected on a regular basis. This technique makes provision for two types of applications, viz.

1. Long-term demographic studies aimed at documenting population trends such as stability growth or decline using survivorship and seed production (and/or vegetative segmentation) as primary elements.
2. More short-term eco physiological studies to generate information on the physiological status and reproductive performance of established individuals using *in situ*, non destructive measurements to determine if favourable conditions for growth and reproduction exist at a specific time.

Both these types of applications can be incorporated at various stages and may be interchanged to take full advantage of the important relationship between short-term physiological processes and more long-term demographic trends within populations.

Table 1 reflects the techniques selected to monitor cycad populations.

TABLE 1. Recommended monitoring methods for cycads in the former Transvaal province.

TAXON	MONITORING METHOD			
	A	B	C	D
E. cupidus	X	X		
E. dolomiticus	X			
E. cf. *venitus*	X			
E. dyerianus	X		X	X
E. eugene-maraisii	X			
E. cf. *concinnus*	X			
E. heenanii	X	X		
E. humilis	X		X	X
E. inopinus	X			
E. laevifolius	X		X	X
E. lanatus	X			
E. lebomboensis	X	X		
E. middelburgensis	X		X	X
E. natalensis	X			
E. ngoyanus	X			
E. paucidentatus	X	X		
E. transvenosus	X	X		
E. villosus	X			
E. spec. nov. 1	X			
E. spec. nov. 2	X			

A = Inventory Method : aerial census technique
B = Survey Method
C = Demographic Method: Type I
D = Demographic Method: Type II

RESULTS

The TNC's long-term population census programme has proved to be a very cost-effective and efficient programme. Through the application of this programme the TNC managed to accurately map all populations of the total range of *Encephalartos* species in the Transvaal, excluding those species which occurred inside the boundaries of independent states such as Venda. Table 2 reflects the sum total of the number of individuals found in all the populations of the various species.

Although aerial counts proved to be a success, the application of this technique (as part of the inventory monitoring programme) failed. Due to new plants being found with every repetitive count during follow-up surveys, the baseline data became meaningless. Recordings of plant losses became obscured by increases in total plant numbers and possible negative trends were regrettably overlooked.

Results obtained through the application of the Survey Method were never regarded as very reliable data. Data generated through this method were usually based on estimations and could seldom be used to satisfy management needs. It did however provide population size estimates for certain species which could not be arrived at through other means.

The Demographic monitoring method which was designed to provide reliable data on population trends and was sensitive enough to show change at adequate confidence levels, proved to be very successful in its application. Definite population growth trends were established for several of the populations using this technique. However, due to inconsistent data collection, causal factors could not be determined.

TABLE 2. Population Census Data for Cycads in the former Transvaal Province.

TAXON	ESTIMATED NUMBER
E. cupidus	500
E. dolomiticus	500
E. cf. *venitus*	100
E. dyerianus	1 000
E. eugene-maraisii	1 000
E. cf. *concinnus*	500
E. heenanii	500
E. humilis	10 000
E. inopinus	1 000
E. laevifolius	1 000
E. lanatus	50 000
E. lebomboensis	100 000
E. middelburgensis	500
E. natalensis	50
E. ngoyanus	100
E. paucidentatus	10 000
E. transvenosus	70 000
E. villosus	100
E. spec. nov.1	50
E. spec. nov.2	50

CONCLUSION

In conclusion, it must be stated that the TNC's cycad monitoring programmes, as presently being executed, have only been partly successful. The main problems were as follows.

1. Monitoring became a goal in itself. In other words, the original objectives were forgotten and teams started to monitor for the sake of monitoring.
2. Inconsistent data collection made it impossible to determine trends or possible causal factors.
3. Inadequate scientific supervision and guidance resulted in ineffective evaluation and feedback.
4. Continuity was lost through frequent staff changes.

RECOMMENDATIONS

The continued monitoring of cycads will depend largely on the validity of the original goals. If these goals are still of relevance, given present population data and conservation status ratings, then such programmes will continue. In order to prevent the mistakes of the past, every monitoring objective will have to be carefully evaluated and very clearly spelled out. The correct monitoring method should be determined and applied consistently. Project leaders will have to supervise and continually interact with monitoring teams to prevent inconsistent documentation of data. Every monitoring action must be followed by a joint evaluation session between the scientist in charge and his team members.

If all monitoring actions are executed within the framework of the Chief Directorate's Research and Monitoring Strategy, I believe that we can look forward to more useful evaluations in future.

MATCHED PHOTOGRAPHS AS A MEANS OF ASSESSING LONG-TERM CHANGES IN CYCAD DISTRIBUTION AND ABUNDANCE

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INTRODUCTION

There are no long-term population data for cycad populations in South Africa. Probably the most comprehensive monitoring dates back to 1984 (Fourie, 1995). This means that it is only possible to guess the extent to which cycad numbers have declined over the past 50 – 100 years when the impact of human activities has probably been greatest. It also makes it difficult to determine the success of various conservation measures or to identify the major factors that may affect cycad persistence in the medium to long term (50 – 200 years). There are, however, photographs taken of cycads in the wild that date from at least 1905 to the present and which represent a potential source of data on long-term changes in cycad populations. The technique of 'matched photographs', in which a locality is rephotographed from exactly the same position as an existing picture, provides an opportunity to determine the extent and nature of change in the interval between the two photographs. Matched photographs have been used successfully to monitor changes in plant populations (e.g. Turner, 1990) as well as changes in overall vegetation cover (Dunham, 1989; Turner, 1990; Hoffman, unpublished data) and, in the case of cycads, could yield the following information.

Change in population size and structure

Where a picture comprises a number of cycads in a landscape, it should be possible to determine changes in the number of cycads present as well as the relative size (age) of individuals (e.g. Figure 1).

Change to individual plants

Many photographs focus on an individual plant. Where there is sufficient background detail to recognise and rephotograph the same locality, it will be possible to establish whether the plant is still present and to observe other changes such as the production or loss of suckers/ stems.

Causes of change

Returning to sites to rephotograph them can help to identify the causes of any change in population size or structure. Obvious examples are where cycads have been replaced by agricultural or urban development. New threats, such as damage caused by 'muthi' collectors can also be identified.

Change in associated vegetation

Because cycads are generally long-lived, changes in their habitat may occur that could affect cycad population structure and even their survival. For example, the recruitment of new individuals to populations of *Encephalartos cycadifolius* appears to depend on the presence of shrubs which provide shelter for the developing seedling (Donaldson, unpublished data). An understanding of overall vegetation change may therefore help to interpret changes to cycad populations (see Figure 2).

The effectiveness of conservation measures

An evaluation of the effectiveness of measures implemented to conserve cycads requires, in the case of legislation, a comparison of cycad populations before and after new laws or penalties have been applied or, in the case of reserves, a comparison of populations inside reserves with those outside. If a sufficiently large number of photographs, taken at different times and representing a number of localities, can be located, then it should be possible to carry out at least a crude assessment of existing conservation measures. This analysis could supplement other sources of information such as that from prosecutions which give an indication of how many plants are still being removed from the wild.

RESULTS

Photographs representing ca. 130 sites have been obtained mainly from herbaria, botanical archives and publications. A press release requesting photographs from the public, and published in over 50 local and regional newspapers yielded a few additional pictures as well as other data on cycad populations. The earliest useable photographs located so far were taken by Prof. H.W.H. Pearson in 1905, but the bulk of the photographs were taken by Dr R.A. Dyer between 1935 and 1965. To date, matched photographs have been taken at 10 sites that were first photographed between

Figure 1. Matched photographs of an *Encephalartos longifolius* locality first photographed by R.A. Dyer in 1935 (above) and rephotographed in 1994 (below). Note that one cycad (arrowed) present in 1935 is now absent.

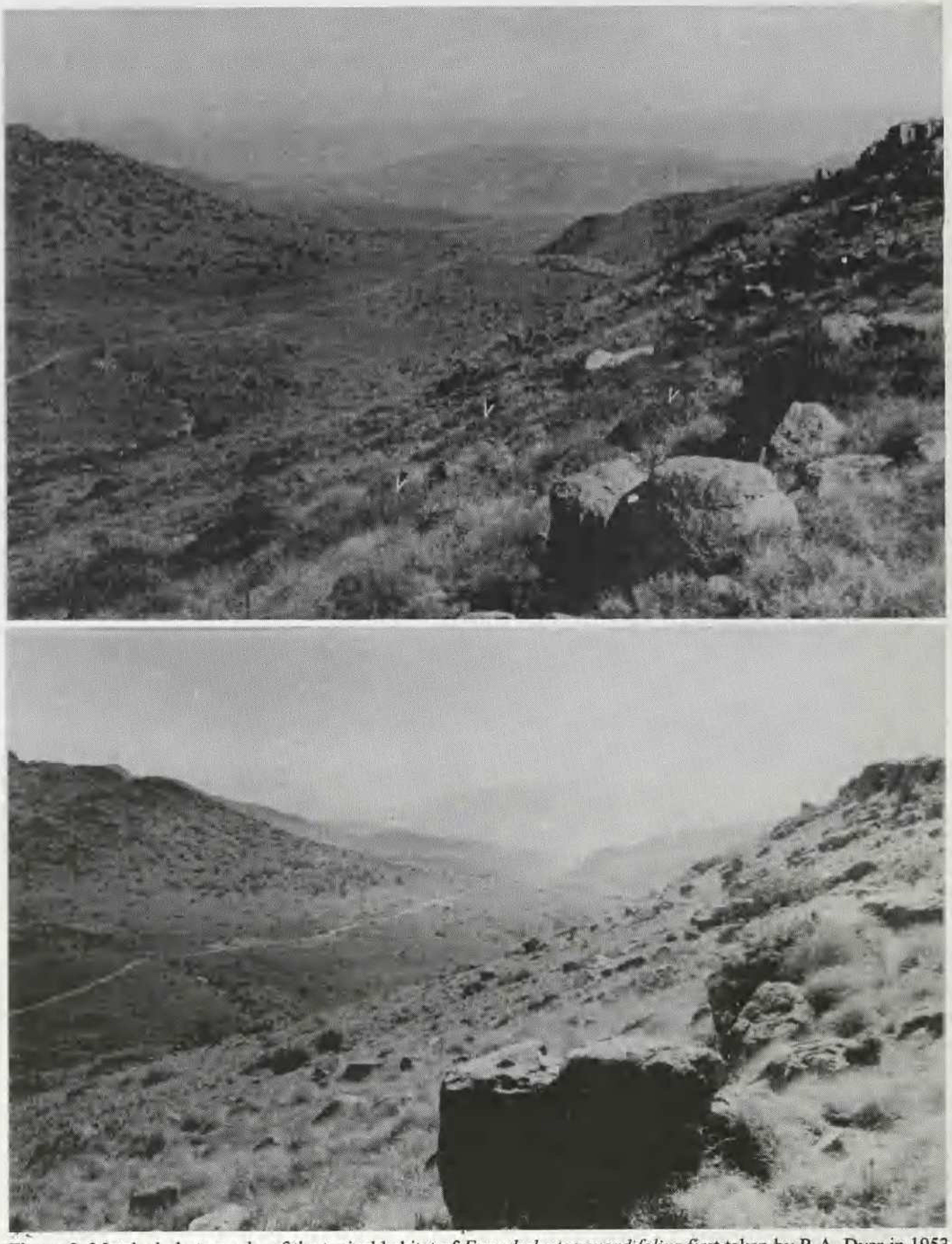

Figure 2. Matched photographs of the typical habitat of *Encephalartos cycadifolius* first taken by R.A. Dyer in 1953 and retaken in 1994. On closer inspection, it is clear that Dyer's photograph does not include any cycads, but it is still valuable because it shows other important changes in the vegetation such as a reduction in the number of shrubs (see arrows in top photograph).

1935 and 1953. An indication of the type of data that can be generated by this technique is given by the results obtained so far. For example, at five (50%) of the sites all the cycads present in the first photograph are now absent whereas at two (20%) further sites at least one quarter of the plants represented in the initial photographs had disappeared. There were only three (30%) sites where all the plants were still present although, in each case, individual plants had undergone some change mainly through the death of older stems. In the case of the seven sites where cycads had disappeared, one site had been cleared for agriculture and another had been converted into a marina. At the remaining sites, the indigenous bush was still intact and 'missing' plants must have died or been removed. Matched photographs of cycads in reserves showed no mortality over the same period so there is a strong likelihood that missing plants had been removed.

The results from the first ten sites show that the technique of analysing matched photographs will provide valuable data for cycad conservation. If the trends observed in these sites are repeated in the whole data set, there will be clear evidence that a substantial proportion (50-70%) of cycads have disappeared from the wild mostly as a result of the removal of individual plants. In addition to providing empirical data to support calls for more effective conservation measures, matched photographs will also provide a telling visual message about the decline in cycad populations. On the positive side, the initial data set indicate that reserves are an effective means of protecting cycads. At this stage, however, the sample size is too small to draw any firmconclusions about changes in cycad populations and the priority must now be to visit sites and increase the number of matched photographs. It may also be necessary to acquire additional historical photographs if new sources can be identified. The project is being sponsored by the Southern African Nature Foundation and Mazda Wildlife Fund and should be completed by June 1996.

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DIE VOORDELE VAN KUNSMATIGE BESTUIWING VIR BEIDE *IN SITU* EN *EX SITU* BEWARING

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Voordat ons oor die voordele van kunsmatige bestuiwing kan gesels, moet ons egter eers oor die doel en nodigheid daarvan besin.

BESTUIWING VIR *IN SITU* BEWARING

Waarom *in situ* bestuiwing? Hoekom kan ons nie die natuur sy gang laat gaan veral in bewaringsgebiede nie? Die antwoord is heel eenvoudig — a.g.v. verskillende faktore waarvan menslike inmenging, hetsy deur roof of ontwikkeling, sekerlik die grootste bydrae gelewer het, vind daar by sommige *Encephalartos*-spesies min of geen natuurlike aanwas plaas nie. Ek gaan konsentreer op *Encephalartos middelburgensis* waarop ek sedert 1992 werk en waarvan ongeveer 500 plante nog in die natuur voorkom.

By drie lokaliteite wat ek besoek het, kon geen saailinge of jong plante gevind word nie. By twee van die lokaliteite het manlike en vroulike plante so ver van mekaar voorgekom dat dit natuurlike bestuiwing onmoontlik gemaak het. By die derde lokaliteit wat uit 'n redelike populasie bestaan en waar daar 'n goeie balans tussen manlike en vroulike plante was, kon ek ook geen saailinge of jong plante buiten suiers vind nie. Hierdie onrusbarende verskynsel verg baie intensiewe navorsing om die rede vas te stel waarom hierdie op die oog af gesonde populasie oënskynlik dormant is.

Alhoewel die plante slegs in 1992 keëls gemaak het, en die waarnemings dus slegs oor een keëlseisoen gestrek het, is die volgende waarnemings van belang.

1. Dit was baie moeilik om 'n persentasie sukses te bepaal wat behaal is met keëls wat in 1992 by een lokaliteit bestuif is, omdat die bobbejane die keëls verwyder het en die saad oor die hele area verspreid was. Van die saad wat verwyder is, het 60% wel ontkiem.

   By die ander twee lokaliteite waar die keëls toegemaak kon word en bobbejane hulle dus nie kon verwyder nie, blyk die persentasie sukses tussen 80% en 90% te wees. Keëls wat by die eerste lokaliteit nie kunsmatig bestuif was nie, is ook deur bobbejane afgehaal, maar nie uitmekaar gehaal nie. By toetsing het hulle óf 'n baie lae persentasie óf geen bevrugte saad bevat nie — dit ten spyte van die feit dat voldoende stuifmeel teenwoordig was sodat natuurlike bestuiwing wel kon plaasvind.

2. Bobbejane benut die vlesige gedeelte van die saad en in die proses word heelwat van die sade stukkend gebyt of beskadig. Terselftertyd word die saad oor die hele terrein versprei. 'n Interessante waarneming was dat hulle die keëls wat nie kunsmatig bestuif was nie slegs afgebreek het, maar nie die vlesige gedeelte afgeëet het nie. Hierdie sade en die ander sade wat nog vleis aangehad het, het geblyk onvrugbaar te wees.

3. Die saad word ook deur knaagdiere benut. Saad wat ek in Maart 1993 by die drie lokaliteite rondom geplant het, was teen Februarie 1994 by twee van die lokaliteite almal uitgegrawe en uitgevreet, terwyl daar ook van die saad by die derde lokaliteit uitgegrawe was. Agtien persent van die saad het egter wel ontkiem.

4. Alhoewel nie al die saad in 1992 uit lokaliteite verwyder is nie, kon ek in Februarie 1994 geen saailinge ander as die waarvan ek die sade fisies geplant het, vind nie.

Met bogenoemde in ag geneem, is dit duidelik dat ons sal moet ingryp en die populasies sal moet vergroot in die hoop dat sommige van die saad sal oorleef en natuurlike aanwas dan sal plaasvind.

As gevolg van die saad wat in 1992 deur middel van *in situ* kunsmatige bestuiwing bekom is, is daar nou geneties suiwer saailinge beskikbaar wat teen 1997 gereed sal wees om in die drie gebiede te hervestig. Behalwe die plante wat hervestig gaan word, word 20% van die saailinge teruggehou om ons *ex situ* versamelings in botaniese tuine aan te vul en gaan van die plante teen 'n billike prys aan die publiek beskikbaar gestel word. Sodoende sal die druk op natuurlike populasies hopelik verminder word.

Lokaliteite waar *E. eugene maraisii* voorkom, is ook sedert 1993 besoek, maar tot dusver kon geen vroulike keëls gevind word nie. Baie min saailinge is in die gebiede gevind en geen jong plante nie. Ongelukkig kom baie min van die plante in bewaringsgebiede voor en moet mens baie sterk staatmaak op die integriteit van privaat grondeienaars om toe te sien dat die plante nie uitgeroei word nie. Dit is verblydend om te kan sê dat al die grondeienaars wat ek ontmoet het, die plante jaloers beskerm en almal baie opgewonde is oor die moontlikheid van hervestiging en die uitbouing van populasies op hulle grond.

In die voormalige Transvaal het ons die heelhartige samewerking van die Traansvaalse Natuurbewaring gekry asook die Nasionale Parkeraad, Suid-Afrikaanse Weermag en grondeienaars en werk ons hand in hand om ons doel te bereik. Vir *E. middelburgensis* en *E. eugene maraisii* is dit dalk nog nie te laat nie — vir ander spesies dalk wel.

EX SITU BESTUIWING

Ex situ bestuiwing word in al die Nasionale Botaniese Instituut tuine, waar *Encephalartos*-spesies voorkom gedoen, asook in publieke en privaattuine waartoe ons toegang verkry. Groot sorg word gedra om kruisbestuiwing te voorkom deur alle manlike keëls vroegtydig te verwyder en stuifmeel apart in stuifmeelbanke te stoor.

Deur *ex situ* bestuiwing toe te pas word waardevolle ondervinding opgedoen en word ons in staat gestel om te eksperimenteer om die beste metode van bestuiwing op verskillende spesies vas te stel - hierdie ondervinding kom dan weer handig te pas by *in situ* bestuiwing. Dit stel ons ook in staat om navorsing te doen oor verskillende fasette, soos saadvorming. Belangrike data word versamel i.v.m. keëltyd, bestuiwingstyd, speentyd, ontkiemingstyd en die groeitempo van verskillende spesies. Hierdie data word weer gebruik met *in situ* bestuiwing en hervestiging.

Saad wat deur *ex situ* bestuiwing verkry word, word ontkiem en die plante teen 'n redelike prys aan die publiek beskikbaar gestel. Hierdeur word nie net 'n inkomste gegenereer nie, maar word die druk op natuurlike populasies weereens verminder.

Dit is ironies dat die mens wat hoofsaaklik verantwoordelik gehou moet word vir die uitroeiing van *Encephalartos*-spesies in die natuur, nou verantwoordelik moet wees vir hulle voortbestaan, want vir spesies soos *E. inopinus, E. dolomiticus, E. cupidus, E. arenarius, E. latifrons* en *E. cerinus* mag die enigste bron van saad vir hervestiging dalk "tuinplante" wees.

Dit is dan veral in hierdie gevalle waar *ex situ* bestuiwing 'n baie belangrike rol gaan speel in die bewaring van sommige *Encephalartos*-spesies. Dit is werklik jammer dat daar nog van ons skaarser plante in tuine staan en saad onbenut toegelaat word om te vergaan. Pogings moet aangewend word om versamelaars en broodboomeienaars aan te moedig om hulle plante doelmatig te benut. Om hierdie doel te bereik sal die NBI in samewerking met alle natuurbewaringsorganisasies 'n al hoe groter rol in die toekoms moet speel en sal ons almal skouer aan die wiel moet sit en daadwerklike pogings moet aanwend, nie net in die *ex situ* bewaring van ons *Encephalartos*-spesies nie, maar ook in die vermeerdering daarvan in beskermde lokaliteite.

Om op te som is die voordele soos volg.

1. Deur *in situ* bestuiwing toe te pas word geneties suiwer saad bekom wat gebruik kan word om plante te kweek hetsy vir hervestiging, die daarstelling van genetiese poele, of om plante te kweek vir verskaffing aan die publiek en sodoende die druk op habitat plante te verlig.
2. Deur *ex situ* bestuiwing onder beheerde toestande toe te pas, word saad verkry waarvan redelike suiwer plante gekweek kan word en aan die publiek beskikbaar gestel kan word. Sodoende word die druk op natuurlike populasies verminder.
3. By sommige broodbome is *ex situ* bestuiwing die enigste manier om die voortbestaan van die spesies te beveilig en plante moontlik weer in die natuur te hervestig.
4. Deur *ex situ* bestuiwing word belangrike data opgebou wat weer baie nuttig in *in situ* bestuiwing gebruik kan word.

CONFISCATED PLANTS: WHERE CAN THEY BEST BE USED IN THE INTERESTS OF CONSERVATION?

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INTRODUCTION

The matter of finding a satisfactory home for confiscated, wild-collected, cycad plants (e.g. Figure 1) is an important issue which has not hitherto received much direct attention. Until the present time, it appears that decisions in this regard have been made on an *ad hoc* basis and that stocks of confiscated cycads, despite their conservation and financial value, often represent an uncomfortable dilemma for legal officers and conservation authorities. Rumours in the cycad community have it that confiscated plants sometimes end up in the gardens of private persons who have "connections" with the local magistrate or conservation officer. Clearly, there is a need for a nationally-consistent, workable policy that is based primarily on conservation interests.

Figure 1. Wild collected *Encephalartos ghellinckii* confiscated by Natal Parks Board officials. Photo: C. Giddy

A second problem is that of the time interval between the confiscation of the material and the conclusion of the legal proceedings. This often involves months, sometimes years, during which the plants are court exhibits with consequent restrictions on their maintenance. This issue too, needs to be addressed.

WHERE TO RELOCATE PLANTS - WHAT ARE THE OPTIONS?

Factors to be taken in account

In attempting to reach a decision about where best to relocate confiscated plants, the following key factors need to be considered. They are ranked in order of decreasing importance.

i. Survival prospects of the specimens.
ii. Security for the specimens.
iii. Possible genetic contamination of wild populations.
iv. Potential germplasm value (seed and pollen resource).
v. Value for education, research and display purposes.

Identification of sites for relocation

Given the factors to be considered in relocating confiscated plants, one can consider the following options, each with certain advantages and disadvantages. Again, they are ranked in order of decreasing conservational importance.

1. Return plants to the original site in the wild.
2. Relocate plants to a proclaimed reserve as near the original site as possible.
3. Place plants in appropriate national, provincial or municipal reserves.
4. Place plants in appropriate national, municipal or university botanic gardens.
5. Donate plants to appropriate overseas botanic gardens.

Although these might be ranked appropriately in terms of conservation ethos, the survival and security aspects for plants returned to the wild are, in most cases, fairly gloomy. The necessarily more pragmatic view is that, considering the management requirements for the relocated specimens during the critical first few years after re-establishment, the botanic gardens, in my opinion, offer the best general option. Apart from better survival prospects, wild-collected plants in botanic gardens serve the multifold purposes of providing seed and pollen resources, being available for research projects and contributing to the garden's education and display objectives.

Appropriate botanic gardens for confiscated cycads

At this stage, it is not wise to draw up a prescriptive list of which botanic gardens represent the "best" homes for confiscated cycads. Rather, the course of action which seems sensible is to invite motivations from all interested institutions, and subsequently to evaluate their appropriateness. It is clear also that the chosen gardens cannot be "flooded" with numerous specimens of species already sufficiently well-represented in their holdings. An administrative mechanism will be required to co-ordinate these distributions.

Amongst the list, I would envisage the following as possible sites.

- Pretoria National Botanical Garden, Pretoria
- Kirstenbosch Botanical Garden, Cape Town
- The Lowveld National Botanical Garden, Nelspruit
- The Karoo National Botanical Garden, Worcester
- Natal Parks Board's Queen Elizabeth Park, Pietermaritzburg
- Natal Botanical Garden, Pietermaritzburg
- Durban Botanic Gardens
- The University of Pretoria
- The University of Natal, Durban and Pietermaritzburg
- Fairchild Tropical Garden, Miami, Florida, USA

THE TIME DELAY FACTOR

Plants removed from the wild by plant traders are usually mishandled; roots and leaves are cut off and trunks are bruised in the haste of clandestine operations in awkward terrain. When these plants are kept as court exhibits for protracted periods of time, the specimens rapidly deteriorate. Recently, permission has been given for conservation authorities to act as caretakers of such exhibits, in which case the specimens can be potted up and given an improved chance of survival. It is desirable that this procedure becomes a matter of routine.

SUMMARY AND CONCLUSION

There is no doubt that the matter of finding appropriate "homes" for confiscated cycad plants needs attention at a national level. The survival and security prospects of the plants are key factors in deciding on venues. Considering the various options, certain botanic gardens should become "approved" sites for the plants, where the plants will serve as a resource for germplasm, research, education, and display projects. Specimens need to be adequately maintained for the duration of legal proceedings.