CITES AND CYCAD CONSERVATION: A WAY FORWARD

John Donaldson, National Botanical Institute, P/Bag X7, Claremont 7735, South Africa

The Convention on International Trade in Endangered Species of Wild Fauna and Flora, known simply as CITES, is an international agreement for regulating trade in endangered species of animals and plants. Within the cycad community, CITES is perceived, at best, as an irritating tool that bureaucrats use to frustrate the good intentions of cycad growers. At worst, cycad enthusiasts argue that CITES does nothing to conserve cycads and contributes to the decline of cycads in the wild by blocking trade in cultivated plants. The purpose of this article is to provide some background to CITES, to look at its achievements and shortcomings in cycad conservation, and to ask what the cycad community can do about it. The last question is particularly relevant because the Cycad Society has co-sponsored a project to examine what can be done to make it easier to trade in cycad seeds and to exchange cycad pollen and herbarium material.

WHAT EXACTLY IS CITES?

CITES developed after a meeting of the World Conservation Union (IUCN) in 1963, where it became clear that trade in live plants and animals, skins, horns, tusks, and medicinals was pushing many species towards extinction. The IUCN meeting was followed by several years of negotiation, and the wording of the CITES Convention was finalised at a meeting of 80 countries in Washington DC (USA) in 1973. CITES entered into force on 1 July 1975.

CITES was specifically set up to provide a framework for co-operation between countries involved in international trade in plant and animal specimens. Governments (States) that voluntarily agree to be bound by the Convention (Parties) have to develop their own laws to make sure that CITES is implemented. There are now 163 Parties to CITES and more than 30,000 species of animals and plants are protected by CITES regulations. Species that are protected by the CITES agreement, are listed in one of three appendices, each with different regulations regarding international trade.

1) **Appendix 1** is for species with a high risk of extinction where any trade in wild collected specimens could contribute to extinction (note that trade does not have to be the main cause of decline). If a species is listed in Appendix 1, *no international trade is allowed in wild-collected specimens (or parts), except for scientific and conservation purposes. Trade is allowed in artificially propagated specimens*. Trade in Appendix 1 species requires an export permit from the Management Authority (see Table 2) in the exporting country and an import permit from the Management Authority in the receiving country.

2) **Appendix 2** is for species with a lower level of threat than Appendix 1, but where over utilization may increase the risk of extinction. *Trade in wild-collected specimens of Appendix 2 species is allowed* as long as the Scientific Authority (see Table 2) in the range State can show that wild harvesting will not cause the populations to collapse (in CITES language this is called a 'non-detriment' finding). International trade can occur once a permit is obtained from the Management Authority in the *exporting* country.

3) **Appendix 3** is for species that are in trade but where the impact of trade on wild populations is unknown. Range States can place a species on Appendix 3 to enable them to monitor levels of trade. Trade requires an *export* permit from the Management Authority in the exporting country.

CITES DECISIONS

CITES is essentially a monstrously large committee made up of all the member countries, and operating in three languages (English, French, and Spanish). Almost all decisions are taken during a massive and infrequent gathering of all the member States, called the Conference of the Parties (CoP). Delegations from member States meet at the CoP, held every two to three years, to debate, argue, lobby and eventually vote on any proposal to alter CITES. Proposals that win support become CITES decisions, binding on the member States and needing a counter decision from the CoP to be undone. Proposals that fail, end up back where they began, with those people who feel the issue is important enough to pursue and have the energy to put forward a new proposal for the next CoP.

Anyone wishing to change some aspect of CITES has to be aware of three key elements of the process. First, decisions to list or de-list species, or to change the regulations, only take place at the CoP (except for Appendix 3 lists where the range State can ask for a listing at any time). This means it can be painfully slow, relying on a process of decision-making that takes three years to complete. Second, proposals have to be submitted by a member State. Other organisations and institutions (such as the IUCN Cycad Specialist Group) can observe, prod, lobby, cajole and even bully member States, but it is the members who submit proposals and only the members who vote. Third, members are unlikely to submit proposals unless they feel they will get support for their point of view. Otherwise a negative vote will mean a wasted effort and probably some embarrassment for the country concerned. In other words, the way to get something in CITES accepted or changed is to get a member State to put forward a well motivated proposal that is likely to get good support from other countries.

CYCADS AND CITES

What does all this have to do with cycads? When CITES came into force in 1975, cycads were already popular collector plants and cycad populations in countries like South Africa were being decimated by collectors. Consequently, cycads were some of the first plants to be included in the CITES appendices (Table 1). All species of *Encephalartos,* as well as *Microcycas,* and *Stangeria* were listed in CITES Appendix 1 in July 1975, followed by a listing of all remaining species in the families Cycadaceae and Zamiaceae in Appendix 2 in February 1977. The genus *Bowenia* was originally listed in Appendix 2 as part of the Zamiaceae but when the genus was included in the Stangeriaceae in 1990, *Bowenia* was listed separately in Appendix 2. The potentially devastating trade in wild cycads from Mexico (mainly to the USA) during the 1970's and early 1980's resulted in the genus *Ceratozamia* being upgraded to Appendix 1 in August 1985. The genus *Chigua* was listed in Appendix 1 in January 1990 as a precautionary measure and *Cycas beddomei* was listed separately in Appendix 1 in 1985.

CITES has been heavily criticised by cycad enthusiasts, but supporters are quick to point out that CITES has achieved its primary goal - not a single species of plant or animal protected by CITES has become extinct as a result of trade since the Convention entered into force. Today, most of us would hesitate to buy a tiger skin or an ivory bracelet or, hopefully, a large wild-collected cycad, because we know that doing so might contribute to the extinction of these species in the wild. But this was not the case 30 years ago when extinction seemed inevitable unless the international community worked together to slow the rapid decline in species threatened by trade.

There is a good chance that several cycad species would have become extinct if trade regulations had not been implemented. During the 1970's, species of *Encephalartos* were being removed from the wild at a rate that decimated wild populations. Species of *Ceratozamia* and *Zamia* suffered a similar fate in the 1970's and 80's. As soon as these species were listed on CITES, trade declined and the overall impression is that cycads benefited from early trade restrictions.

Ironically, despite the early success of CITES, cycads could be among the first species to become extinct through trade while protected by CITES. Species such as *Encephalartos cerinus* and *E. latifrons* have become so scarce that they are close to Extinct in the Wild. This is also becoming true of species such as *E. inopinus*, *E. munchii* and *E. pterogonus* (although there are conflicting and unconfirmed reports of more plants in the wild than previously thought), which have continued to decline due to wild collecting. As with many African cycads, these species are not threatened by habitat destruction and it is mainly collecting and the subsequent effects of small population size that are driving them to extinction.

There is no shortage of explanations for why cycads have continued to decline, despite CITES or how to save them. Cycad enthusiasts often point out, with some justification, that CITES places unnecessary restrictions on legitimate trade so that there is little incentive to trade in artificially propagated plants versus wild collected ones. The aspects of CITES that particularly irritate cycad enthusiasts and scientists are restrictions on trade in cultivated material, seeds, and pollen, and the difficulties associated with collecting herbarium material. The IUCN Cycad Specialist Group has also concluded that some of these issues have a negative effect on cycad conservation. The Cycad Society has co-sponsored a project with the Cycad Specialist Group to look into these issues and to see what can be done about them.

CITES, SEEDS, POLLEN, & HERBARIUM MATERIAL

In general, once a plant species is listed on a CITES appendix, the agreement refers to all plant parts (specimens, leaves, roots, pollen, seeds) and even to herbarium specimens. This may seem strange, but the CITES agreement applies to a wide range of plants, some of which are traded in a form that can be disguised as an herbarium specimen.

To accommodate the exchange of scientific material, CITES has asked each country to identify scientific institutions that can be registered with the CITES Secretariat. University and government herbaria, scientific organisations, and gardens may be registered as scientific institutions. Once registered, these institutions can exchange cycad specimens with a similar registered institution without applying for a permit. For example, the Montgomery Botanical Centre in the USA can exchange herbarium material with the Kirstenbosch Research Centre for scientific purposes.

But this is not where the problem lies. Cycads occur in 58 countries and many regions are poorly known, so exploration and collecting of herbarium material is an essential activity to expand our knowledge of cycads. Reputable and registered institutions such as the Montgomery Botanical Centre, New York Botanical Garden, the National Botanical Institute (in South Africa), and Royal Botanic Gardens Sydney (Australia) are all involved in cycad surveys and exploration work. The problem arises when a scientist undertakes an expedition and wants to take herbarium specimens back to their home institution. Unless they work together with a registered institution in the country of origin (which is usually the case when there is one), they have to apply for CITES permits and this can take many months. If the country of origin is not a Party to CITES, then it becomes virtually impossible to obtain material legally. Exchange of pollen should be simple for Appendix 2 cycads. All cycads on Appendix 2 have an annotation stating that "seeds, spores and pollen" are not covered by trade regulations. Trade in species listed on Appendix 1 covers all parts and derivatives (including pollen). This is a problem for artificial propagation of cycads and needs to be investigated.

The situation with seeds is more complicated. It is easiest to deal first with trade in seeds of Appendix-2 species. Technically, *seeds of Appendix-2 cycad species are exempt from CITES controls* (CITES Secretariat 2002). The only Appendix-2 seeds of any plants that are subject to the provisions of the Convention are seeds of Mexican cacti species, originating in Mexico (CITES Secretariat 2002). This means that trade in seeds of Appendix 2 cycads should be easy, but this is not necessarily true (see discussion later on).

In contrast, seeds of *Appendix-I species are subject to the provisions of the CITES Convention*. This has two important implications for trade in Appendix-I seeds.

1) Seeds of cycad species listed on Appendix-I can only be traded internationally if they are artificially propagated (see definition below).

2) Propagation of Appendix-I species for commercial purposes *from wild-collected seeds* is possible only in the range State concerned (CITES Secretariat 2002). Outside the range State, artificial propagation must take place from artificially propagated seeds. This may seem strange, but it is linked to the definition of 'artificial propagation' (see paragraph (a) below). Under this definition, seedlings grown under controlled conditions in the country of origin (and therefore complying with the definition of artificial propagation) can be traded as artificially propagated irrespective of the origin of the seeds (wild or artificially propagated).

   In terms of CITES resolution 11.11, seeds are regarded as artificially propagated "if they are taken from specimens acquired in accordance with the provisions of paragraph b)" (see below) "and grown under controlled conditions, or from parental stock artificially propagated in accordance with paragraph a) (see below) (CITES Handbook 2001).

   a) the term 'artificially propagated' shall be interpreted to refer only to live plants grown from seeds, cuttings, divisions, callus tissues or other plant tissues, spores or other propagules under controlled conditions; and that 'under controlled conditions' means in a non-natural environment that is intensively manipulated by human intervention for the purpose of producing selected species or hybrids. General characteristics of controlled conditions may include but are not limited to tillage, fertilization, weed control, irrigation, or nursery operations such as potting, bedding or protection from weather;

   b) the cultivated parental stock used for artificial propagation must be, to the satisfaction of the competent government authorities of the exporting country:

      i) established in accordance with the provisions of CITES and relevant national laws and in a manner not detrimental to the survival of the species in the wild; and
      ii) managed in such a way that long-term maintenance of this cultivated stock is guaranteed;

The best way to understand what this means is to look at a couple of examples.

1) A person living in Japan wants to export *Cycas revoluta* seeds to the USA. *Cycas revoluta* is listed on Appendix-2, which means that seeds are exempt from CITES controls and the person can export the seeds without a CITES permit (but see below for some caveats).

2) A person living in the USA wants to export *Ceratozamia hildae* seeds obtained from garden plants. *C. hildae* is listed on Appendix-I, which means that seeds are subject to the provisions of CITES, and international trade therefore requires an import permit and export permit. The seeds fit the definition of artificially propagated and the permit should be issued without a problem.

3) A South African wants to export wild collected seed of *Encephalartos latifrons*. All *Encephalartos* species are listed in Appendix-I, so that the seeds are subject to CITES regulations. The seeds are not artificially propagated and the intended trade therefore contravenes CITES regulations. The permit should not be issued. If the seeds had come from a cultivated plant, they would be classified as artificially propagated. In this case, the permit should be issued (but see below).

4) The same South African decides to germinate the *E. latifrons* seeds and grow the plants in a greenhouse. A year later, he applies to export the seedlings. In this case, the seedlings would be classified as artificially propagated and the trade is therefore legal in terms of current CITES regulations and requires an import permit and export permit.

Although trade in Appendix 2 seeds (no CITES permits) and cultivated seeds of Appendix 1 species (permit for artificially propagated) should be easy, reality is a bit different. Trade in seeds has become more complicated because Parties to the CITES convention can implement stricter domestic control measures than required by CITES. For example, South Africa has applied stricter control measures on trade in seeds of Appendix-I cycads. They have made it almost impossible to trade in seeds of Appendix-I species. Some of these issues are dealt with in the accompanying article. The main question is what can be done to promote legal trade and to make it easier to exchange seeds, as well as pollen and herbarium specimens.

MOVING FORWARD

There are two approaches to dealing with problems in trade in cycads.

1) Set about changing the CITES regulations. CITES is a convenient target because it has a specific identity and there are established procedures and committees that can be used. However, some decisions are beyond the control of CITES structures, whereas others may be difficult to change. For trade in cycad seeds, CITES has already agreed that trade in Appendix 2 seeds should not be controlled – it is a handful of countries that implement their own legislation to regulate trade in seeds. Similarly, trade in cultivated seeds of Appendix 1 species should be straight forward, but it is the implementation by certain countries (such as South Africa) that causes problems. The right approach here seems to be to alert the CITES community to the problems and to work with individual governments modify aspects of implementation.
   For herbarium specimens, the issue goes well beyond cycads and affects all plants listed on CITES. In this case, cycad specialists need to work together with other botanists to show that collecting herbarium specimens of CITES listed species is a global problem. The alternative is to propose that CITES treats cycad specimens differently. To achieve success, cycad scientists would need to prove to the CITES community that the benefits of collecting herbarium specimens without permits outweighs the risk of unscrupulous collectors using this concession to smuggle plants.

2) Get range States and the main trading Parties to implement regulations that facilitate legitimate trade.
   This is the more cumbersome option because it involves dealing with numerous range States and trading countries, rather than with CITES structures. However difficult, it seems that this will be unavoidable since many problems associated with cycad trade cannot be dealt with by going directly to CITES.

The CSG is following various leads to improve cycad conservation, including actions to facilitate legal trade in cultivated plants. Experience over the past few years has shown that we need to follow a structured approach which entails building an understanding of the conservation status and threats to cycads, working with CITES and trade organisations to identify and quantify threats posed by trade, and to develop constructive workable solutions. The main activities so far are listed below.

1) The Cycad Action Plan was published in 2003 (Donaldson 2003). The Action Plan gives decision makers a complete view of the status of the world's cycads, the threats to their survival and the actions required to save them. One of the actions (Action 10.3.2) is to "Facilitate sustainable trade in cycad seeds".

2) The status of cycads has been updated on the IUCN Red List. The Red List is the global benchmark for comparing the threatened status of different species. Having the cycad status up to date provides greater credibility to any arguments put forward to promote cycad conservation.

Table 1. The CITES status of different cycad species, genera, and families. All the species of Cycadaceae and Zamiaceae are listed in Appendix 2 unless specifically listed in CITES Appendix 1. All species of *Ceratozamia, Chigua,* and *Encephalartos* are listed in CITES Appendix 1.

CITES APPENDIX 1		
Ceratozamia	1985	Upgraded from CITES Appendix 2
Chigua	1990	Listed separately after the genus was described
Encephalartos	1975	
Microcycas	1975	
Stangeria	1975	
Cycas beddomei	1987	The only species of *Cycas* listed in Appendix 1
CITES APPENDIX 2		
Bowenia	1990	Listed separately when the genus was placed in Stangeriaceae
Cycadaceae (*Cycas*)	1977	
Zamiaceae (*Dioon, Lepidozamia, Macrozamia, Zamia)*	1977	

3) The Cycad Specialist Group (CSG) worked with TRAFFIC to undertake a Significant Trade Review of cycads for the CITES Plants Committee (completed December 2003). The Significant Trade process is used to evaluate the implementation of CITES and to highlight problems. Usually the Significant Trade process only deals with species on Appendix 2, but the report on cycads included issues relating to species on Appendix 1 (the report can be viewed at http://www.cites.org/eng/cttee/plants/14/E-PC14-09-02-02-A1.pdf)

4) Working with range States. The CSG has been obtaining information from major range States and trading partners to determine how they interpret and implement CITES regulations, including Australia, Mexico, South Africa, USA, China, Colombia, Thailand, and Vietnam. South Africa is in the process of revising its cycad trade policies and the CSG has been actively involved in this process.

5) Finally, the CSG has been encouraging conservation agencies to think outside the box when it comes to cycad conservation. There is a growing realisation that policies to protect cycads have failed in many parts of the world. Systems models have been used to work out the costs and benefits of different approaches, including freeing up trade in seeds. The results of this work are being summarised in a brochure that can be circulated to conservation agencies. Some of these ideas are dealt with in the accompanying article.

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Seeds of Hope: Can Trade in Cycad Seeds Help Save Cycads from Extinction?

John Donaldson
National Botanical Institute, P/ Bag X7, Claremont 7735, South Africa

Wild cycad populations are threatened by habitat destruction and the removal of plants by collectors. These threats are well known and their impact on wild populations is well documented (Osborne 1990; Giddy 1993; Osborne et al 1994; Whitelock 2002; Donaldson 2003). What is less certain is what to do about it. Several decades ago, when people first became concerned about cycad conservation(e.g. Dyer 1965; Giddy 1974; Gilbert 1984), the solution seemed simple - put fences around cycad populations and ban trade in wild collected cycads. Many cycad species got conserved in reserves and all cycads ended up in the CITES appendices, which places restrictions on international trade (see accompanying article). If we measure success in terms of numbers of reserves with cycads, or number of regulations that restrict trade in cycads, or the effort spent on law enforcement, then cycads would be high on the list of success stories for plant conservation.

There is no doubt that cycads have benefited from conservation efforts. However, the only real measure of cycad conservation is whether wild cycads are more abundant now than they were 30 – 40 years ago. Although the proportion of threatened species appears to have dropped from 82% in 1997 (IUCN Red List, Walter and Gillet 1998) to 53% in 2003 (IUCN Cycad Action Plan, Donaldson 2003), these changes are mostly due to the description of new species with large populations in Australia and South East Asia, and the use of new IUCN criteria (Donaldson 2004). At a population level, many cycad species are worse off now than they were 30 years ago. In Southern Africa, populations of *Encephalartos altensteinii, E. aplanatus, E. cerinus, E. horridus, E. inopinus, E. laevifolius, E. latifrons,* and *E. natalensis* (Goode 1989; Donaldson and Bosenberg 1999; Golding and Hurter 2002; Donaldson 2003) have declined during this time, some by more than 50%. Reports from Australia, China, Mexico, and Viet Nam indicate that continuing decline in cycad populations is happening in many parts of the world (Hill 2003; Hill et al 2003). The obvious question to ask is why this is happening when so much effort has gone into conserving cycads. Part of the problem seems to be that conservation actions have not considered the often complex dynamics that affect cycad populations. The focus on setting up reserves and enforcing trade restrictions may lead to less attention being paid to biological problems such as pollination failure and disease. At the same time, enforcing trade restrictions within the 58 countries of origin, as well as internationally, is difficult and is seldom 100% effective. There is a poor understanding of the demand side of cycad trade, especially what happens when law enforcement (of laws that restrict collecting and trade) is relaxed, or whether the demand for plants by cycad collectors can have positive consequences for wild cycad populations. Finally, the interaction between habitat destruction and trade is not considered even though there seems to be a feedback loop in which land owners may be inclined to destroy cycad habitat if they cannot derive an income from cycads (Tang et al 2003). Clearly a more holistic approach to conservation is required to save cycads from extinction.

Systems models provide a tool for analysing complex dynamics. These models don't necessarily try to capture all the details of a system, but they provide a realistic understanding of the relationships between different parts of a system. In this way, models allow us to see how the system responds to particular actions and to identify the most effective solutions. More importantly, models can be used to test novel or contentious ideas, and to show policy makers the possible outcomes of their decisions. I used such a model (Appendix 1) to see why current cycad conservation actions seem to be ineffective and what could be done differently. The results are rather interesting and are being used to inform decision makers in organisations such as the IUCN and CITES as well as policy makers in countries with indigenous cycads. The work forms part of a project cofunded by The Cycad Society and the outcomes are particularly relevant to trade in seeds. The outcomes are different for small and large populations so they are presented separately.

SMALL POPULATIONS (< 200 PLANTS)

Conservation actions have focused on limiting access to wild populations and restricting trade in wild collected plants. The first interesting outcome of the model (Fig. 1) is that, even when law enforcement is 100% effective (i.e. no wild harvesting), small populations (<200 plants) continue to decline. This makes sense because the model takes into consideration several aspects of cycad biology that have been observed in wild populations, namely male biased sex ratios in small populations (so that there are fewer reproductive females), low reproduction (possibly due to the absence of pollinators), and ongoing mortality. The simple fact that some plants are dying naturally while reproduction is failing means that populations will decline despite the best efforts of law enforcement agencies.

If law enforcement is relaxed (50% effectiveness) (Fig. 1), then small populations decline rapidly. This is because the model includes demand for rare cycads and the assumption is that demand for rare cycads will exceed supply in small populations (at least in the first few years). As soon as law enforcement relaxes, wild harvesting takes place. This seems to be a realistic assumption, at least for a country like South Africa where illegal collecting is an ongoing problem.

The most interesting outcome of the model comes from trying to find interventions that increase the size of small wild populations. Reproduction and recruitment are the two factors that can influence population growth (if natural death remains constant) but reproduction can usually only be increased through artificial pollination. If we add in artificial pollination, population size only increases when law enforcement remains high. Why? Because when law enforcement is low (50%) reproduction cannot keep up with illegal harvesting. Interestingly, when law enforcement is high and there is artificial pollination, then the population increases even if 50% of the seeds are harvested. This may not always be true (e.g. if the conditions for seed germination are not favourable) but the principle remains that artificial pollination produces more fertile seeds than would happen naturally.

What does this mean for policy makers?

1. Trade restrictions and law enforcement alone are not effective for long term conservation. Small populations will decline when reproduction is less than natural mortality. Artificial pollination is required to boost reproduction and other interventions may be required to improve seedling survival.

2. Law enforcement is still essential - the best results were obtained when law enforcement and artificial pollination were used together.

3. Seed harvesting could be allowed when it is combined with artificial pollination and actions that stop illegal harvesting of plants. In this example I used a seed harvest of 50% but the actual harvest will depend on the species.

These results provide several options for policy makers. They could decide that nature conservation staff must protect cycad populations and artificially pollinate female cones, assuming that they have the staff and resources to do this. Alternatively, they can allow land owners to harvest seeds on condition that they artificially pollinate cones (which they would have to do to get seeds) and that they either leave a proportion of the seeds in the wild or plant out seedlings to increase the chances of population growth. Either way, harvesting provides an incentive for land owners.

LARGE POPULATIONS (>1000 PLANTS)

The results for large populations are equally interesting. This time, when law enforcement is 100%, the population remains stable or increases slightly, due to successful seed production and survival of seedlings. Under 50% law enforcement, populations decline dramatically. This is consistent with the outcomes of more rigorous population simulation models (Raimondo and Donaldson 2003), which show that cycad populations take a long time to replace adult plants removed by collectors. What is most interesting is the effect of propagation by enthusiasts (from cultivated plants) and the effect of seed harvesting. If enthusiasts are able to propagate between 10 and 30% of all the seeds produced in cultivation, then the demand for plants can be met from sources of cultivated plants and population decline slows down after a couple of years. When seed harvesting (50%) is included in the model, the decline stops even earlier because there is a greater supply of seeds for propagation.

The lessons for policy makers are as follows.

1. Law enforcement that is 100% effective still provides the best results for wild populations.

2. But, assuming that law enforcement is not 100% effective (and there is ample evidence to support this assumption), then populations will continue to decline unless regulations are implemented that facilitate propagation. A propagation rate of 10-30% of all seeds produced in cultivation is relatively high and won't be achieved unless there is active support for propagation.

3. Allowing seed harvesting from wild populations could slow the rate of decline in wild populations and provide better medium- to long-term results for conservation than prohibiting seed harvesting. This result is supported by population studies that show that up to 95% of seeds can be harvested without a negative impact on population growth (Raimondo and Donaldson 2003).

CHANGING THE APPROACH TO TRADE IN CYCAD SEEDS

Cycad enthusiasts have claimed that restricting trade in seeds (and pollen) through CITES and national legislation has negative implications for cycad conservation. At the same time, horticulturists have emphasised the potential benefits of conservation through cultivation (Dehgan 1983; Dehgan and Almera 1993). The model supports this view (although it reinforces the need for laws to protect mature plants in small populations). Based on their collective knowledge of cycad populations, members of the Cycad Specialist Group are also advocating a review of the laws regarding trade in seeds. On the other hand, supporters of restrictions on trade in seeds base their decision on the following arguments.

1. That trade in all seeds of species on CITES Appendix 1 should be restricted because it is impossible to distinguish wild collected seed from cultivated seed and trade in wild-collected seed of Appendix 1 species is illegal.

2. That trade in wild collected seeds should be restricted because seed harvesting will have a negative impact on wild populations (at least for rare species)

Technically, the first point is correct. CITES regulations prohibit international trade in wild-collected seed of Appendix 1 species and there is no easy way to tell a wild-harvested seed from a cultivated one. DNA techniques may make it possible to determine whether a seed originated from a particular parent plant, but this tool is expensive and time consuming and will probably not be used on a regular basis. It also seems totally unnecessary. The approach to wild-harvested seed should depend on the second point, i.e. will seed harvesting have a negative impact on wild populations.

Cycad populations may produce viable seed, but there are often relatively few seedlings and even fewer plants that make it through to the adult stage. Conservation agencies and collectors interpret this observation quite differently. Collectors tend to conclude that seeds are wasted if they do not germinate and give rise to seedlings. In their view, seeds should be collected. After all, the same seeds have a high chance of germination in controlled nursery conditions, providing plants that can satisfy the demand for cycads. In contrast, conservation agencies conclude that the ecological processes involved in seed dispersal, germination, and seedling establishment are under stress and that the populations are too fragile to allow any form of harvesting. So far, population studies and models indicate that cycad populations can sustain a high level of seed harvesting. In the end, the problem with seed harvesting could be quite simple. In large populations (> 1000 individuals) seeds are relatively abundant and seed harvesting has a low negative impact on population growth and could even contribute to conservation objectives. In small populations, reproduction has already failed and seed set depends on artificial pollination. Under these circumstances, it should be relatively easy to monitor seed harvesting and even to use seed harvesting as an incentive for land owners to pollinate rare species.

At present, the situation for many cycad species seems hopeless. It is estimated that 37 species have numbers so low that reproductive failure is a reality (i.e. populations of less than 200 plants or plants widely spread in the landscape) (Donaldson 2003). Reducing restrictions on trade in seeds is a risk, but current conservation actions are not working and the risk associated with sticking to systems that have failed may be greater than the risk of trying to facilitate sustainable use of seeds from wild populations. For this reason, the Cycad Specialist Group has been reviewing the policies of different countries to trade in seeds and highlighting some of the problems associated with the implementation of CITES regulations. The CSG is also putting together a brochure on problems associated with trade in cycad seeds for the 13th Conference of the Parties, which takes place in October 2004 in Thailand.

APPENDIX 1: OUTLINE OF THE MODEL

The model was developed using STELLA ver 7.0.3 (High Performance Systems) and has three main components, i.e. the wild cycad population, the cycad habitat, and plants in cultivation (Figure 3). This makes it possible to model the cycad population in the context of its habitat and in relation to factors influencing collecting (demand, abundance in gardens, ease of propagation).

Population biology

Aspects of population biology (seed set, recruitment, death) and responses to harvesting were based on actual data from cycad populations as well as simulation models of cycad populations (Raimondo and Donaldson 2003).

Harvesting

Harvesting is included in the model as both legal and illegal harvesting. Legal harvesting is restricted to seed harvesting and is based on a quota that represents a proportion of the seed produced. Values from 0 (no quota) to 100% can be used. In the model, illegal harvesting only affects plants (not seeds). I have based the model on several simple assumptions. 1. If law enforcement is 100% effective, there will be no illegal harvesting. 2. If there is no law enforcement, the amount of illegal harvesting will depend on the demand for that species (see below). In other words, if a species is common in cultivation or is just not popular, illegal harvesting can remain low in the absence of law enforcement. The model allows different amounts of illegal harvesting based on the efficiency of law enforcement (0-100%) and the demand for plants.

Demand

This is an estimate of market forces. It is difficult and misleading to generalise about the demand for cycads since the actual trade in particular cycad species varies from < 10 to > 1 million plants per year (UNEP WCMC database). In the model, demand can be changed from 0 – 50 000 plants per year. For this model run, I used an initial demand of 10 000 plants.

Plants in cultivation

The model requires an initial number of plants in cultivation, which can be varied from 0 –20 000. I used a starting value of 1000 plants, because almost cycads are represented in cultivation so that there is usually some stock for artificial propagation.

Propagation

The propagation rate can be adjusted from 0 – 50%. This refers to the proportion of seeds that can be successfully propagated and takes pollination, germination, and growth into consideration. In other words, if a cone of 30 seedlings were obtained from a cone with 100 ovules, the propagation rate would be 30%.

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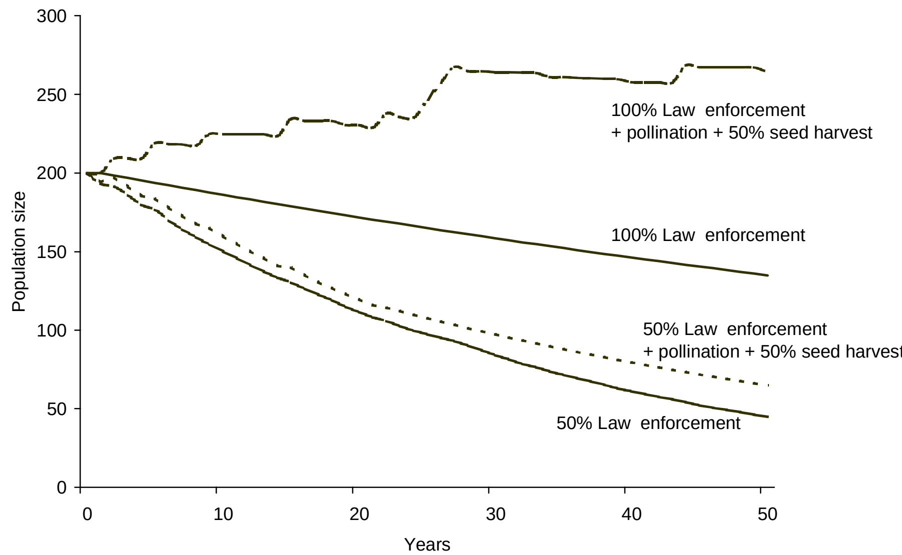

Fig. 1. Model outcomes for a small cycad population (200 plants) over a period of 50 years, with 100% law enforcement (no harvesting), 50% law enforcement (i.e. illegal harvesting takes place), and the same levels of law enforcement with artificial pollination and seed harvesting as additional management options.

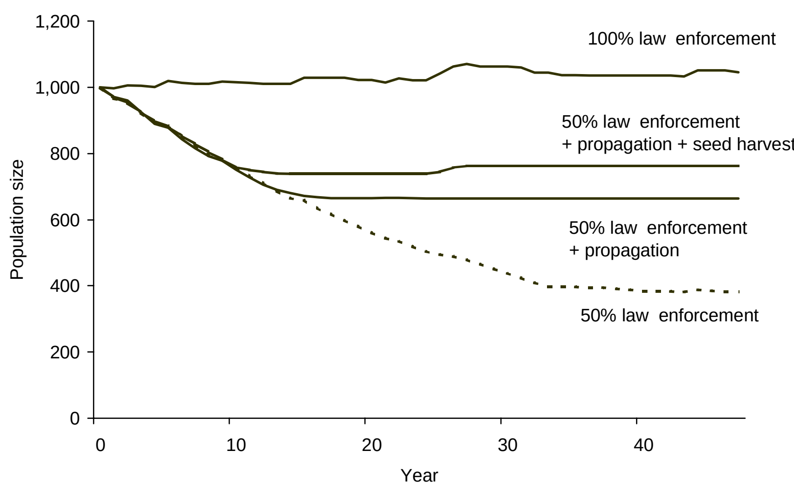

Fig. 2. Model outcomes for a large cycad population (1000 plants) over a period of 50 years, with 100% law enforcement (no harvesting), 50% law enforcement, and 50% law enforcement together with 30% propagation and 50% seed harvesting.

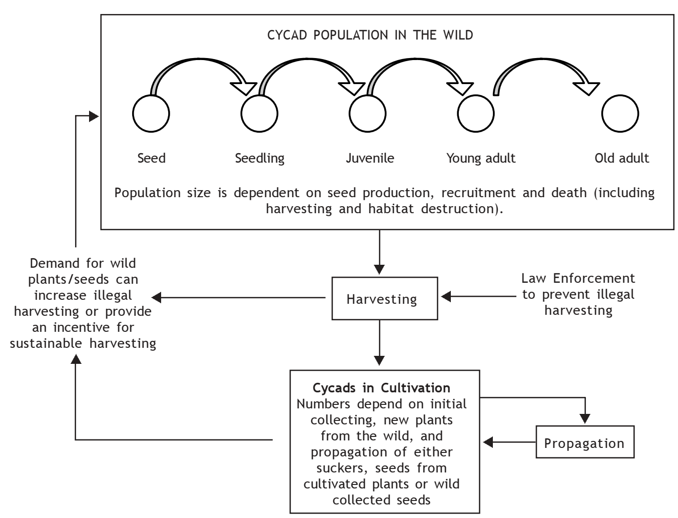

Fig. 3. Components of a model of cycad populations in relation to plants in gardens/ collections.