Ex Situ Conservation

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Introduction To Ex-situ Conservation

- Involves taking an animal or plant out of its habitat and placing it in human care
- This term covers old methods such as zoos, as well as new methods such as seed banks and gene banks
- Ex-situ conservation may not be the ideal method but often the only answer

The Three Sides To Ex-situ Conservation

- Zoos, parks and botanical gardens
- Seed banks
- Gene banks

The World Zoo Conservation Strategy

- This paper suggests that genetic degeneration and domestication can be minimised by co-operatively managing zoo populations
- Guidelines are set out to try to maintain as much genetic variability as possible and when this is carried out properly these populations can serve as genetic reservoirs for species survival in the wild

The World Zoo Conservation Strategy

- There are a few ways of maintaining genetic diversity. Many zoos keep stud books or use population management software and animal record databases e.g. ARKS or ISIS
- A population of 250 to 500 individuals is required to maintain genetic variability for at least 100 years
- Ex-situ conservation will not work for all species so subjects must be carefully chosen. Zoos must be able to maintain and breed the species and species must raise public awareness

Botanical Gardens

- There are estimated to be around 1600 botanical gardens throughout the world and these receive over 150 million visitors a year
- The Botanic Gardens Conservation Institute (BGCI) was set up in 1987 and its role is to collect and make available information on plant conservation
- These botanical gardens are important as it is estimated that 60,000 plant species could be lost in the next 50 years

Botanical Gardens

- Botanical gardens tend to look after plants in one of the five categories below [2]
  - Rare and endangered
  - Economically important
  - Species that are needed for the restoration of an ecosystem
  - Keystone species
  - Taxonomically isolated species

Botanical Gardens

- Selecting these species is hard and a number of factors must be taken into consideration [2]
  - Extinction risk
  - Suitability of plant for ex-situ conservation
  - Value of plant
  - Ease of collection
  - Funds available
  - Chances of success

Botanical Gardens – Plant Re-introductions

- In some ways plant re-introductions are easier than animal e.g. easy to monitor as plants don't move
- In others, it is harder because if the wrong site is selected then the plant cant get up and move
- When re-introducing it must be decided on whether seeds, seedlings or adults are going to be replaced, each has their pros and cons

Botanical Gardens

- Another type of botanical gardens are like plantations
- They provide a safe place for plants that do not take well to seed banks
- Problems include;
  - The risk of disease like any mono-culture
  - Take up space
  - Less genetic diversity than normal seed banks
  - Vulnerable to environmental disaster

Botanical Gardens Successes – Malheur Wire Lettuce

- In the 1970s there were about 750 individuals of the Malheur wire lettuce (*Stephanomeria malheurensis*) in the wild
- Thankfully, Dr L Gottlieb collected seeds from all portions of the population in the 1970s
- After a fire in 1972 an exotic called cheat grass (*Bromus tectorum*) took over
- By 1985 the wire lettuce was extinct in the wild

Botanical Gardens Successes – Malheur Wire Lettuce

- The collected stock was maintained
- Re-introductions took place
- In some plots where the lettuce was re-introduced the cheat grass was removed
- In the first year 40,000 seeds were produced
- Plots with cheat grass remaining yielded smaller and less quick to flower plants
- Now numbers fluctuate due to cheat grass, mammals, rainfall etc

Botanical Gardens Successes – Torrey Pine

- In 1988 there were only 400 to 500 individuals of the Torrey pine (*Pinus torreyana*) in the wild

The Torrey pine

Botanical Gardens Successes – Torrey Pine

- In 1989 there was an outbreak of Ips beetles (*Ips paraconfusus*)
- By 1991, 840 trees had died due to the Ips beetle
- 30,000 seeds from 149 trees were collected
- Before the trees could be re-introduced the Ips beetles had to be exterminated

Ips paraconfusus

Botanical Gardens Successes – Torrey Pine

- In the first 6 months of 1991, 280,000 Ips beetles were caught in funnel traps and the Ips were eliminated by 1992
- In 1992 trees were returned
- Returning progeny to correct area genetically
- Seeds only had a 2% germination rate
- Container grown seedlings did well
- Now there are 6000 individuals in the wild

Botanical Gardens Failures – *Sophoro Toromiro*

- The last wild individual died in 1960
- There have been 13 unsuccessful re-introductions between 1965 and 1994
- Trees are kept in botanical gardens in New Zealand, Australia, Chile and Europe but they are probably all from the same parent

Seed Banks

- Seed banks allow the storage of genetic diversity of whole plant populations
- Preserving the seeds for use later is a long process, it involves;
  - Cleaning
  - X-ray analysis
  - Drying, packaging and storage
  - Germination monitoring

Seed Banks – Cleaning

- Occasionally clean seed is collected in the field.
- More often seed is collected still in its fruit
- Seed must be taken from the fruit undamaged
- This reduced bulk and disease risk
- Seeds are often liberated by hand

Seed Banks – X-ray Analysis

- A few seeds are taken and X-rayed
- This is done to see how many of the sample are empty seeds and find any insect larvae hiding in the seeds
- The X-rayed seeds are often thrown away afterwards as they may be genetically damaged

Seed Banks – Drying, Packaging and Storage

- Drying and freezing the seed increases the time that the seed will last
- Seeds are dried in cool conditions (15-18°C) with the relative humidity at 11-15%
- This takes about a month
- The seed is then put into an airtight container and kept at -20 °C

Seed Banks – Germination Monitoring

- A few seeds are tested for viability once they have been frozen
- If they do not germinate they are either dead or dormant, to distinguish between the two states the vital stain Tetrazolium is used
- A few seeds are tested every ten years to check germination

Seed Banks – The Millennium Seed Bank Project

- Global conservation program
- Linked to Kew gardens
- Aims of the project are;
  - Conserve 10% (24,000 spp) of the worlds seed baring flora
  - Conserve all the seed baring flora in the UK by 2000
  - Research into seed conservation
  - Allow seeds to be used in research elsewhere
  - Make seeds available for re-introduction
  - Assist in plant conservation globally
  - Public education

Seed Banks – The Millennium Seed Bank Project

- So far the project has managed to secure most of the UKs native flowering plants
- Collaborations have been formed with 16 other countries
- As well as conserving seeds these collaborations are helping to prioritise species to conserve, research into local plants and train local people
- Each of these collaborations are different depending on the country e.g. Kenyan seed for life, USA seeds for success

Seed Banks – The Millennium Seed Bank Project In South Africa

- Collaboration with National Botanical Institute started 2000
- Aim to conserve SAs flora by creating seed collections that are well documented concentrating on threatened and endemic spp
- exciting discoveries;
  - *Brachystegia spiciformis* has been found in a Miombo woodland in Soutpansberg, 20m tree that has been undetected until now
  - Rediscovery of *Dioscorea elephantipes* (Elephants foot yam)
  - Rediscovery of the last remaining population of *Cylindrophyllum hallii*
- 2 MSC projects investigating germplasm storage of the medicinal plants of the family Amaryllidaceae

Gene Banks

- Gene banks are rather like seed banks
- Eggs, sperm and embryos are cryogenically frozen to protect the genetic variation of a species
- The zoological society of San Diego has developed a frozen zoo

The Problems With Ex-situ Conservation

- Captive and wild populations diverge genetically
- Interbreeding
- Hybridisation
- In the case of gene banks, living populations are necessary to pass on non-genetic learned behaviours
- Ex-situ tends to only save particular species whereas in situ saves whole ecosystems
- Impossible to conserve whales!

The Benefits Of Ex-situ Conservation

- With only 3% of land in nature reserves world wide often the only answer [8]
- "No large wild terrestrial animal will persist long into the future unless cared for in some way by man. There will be insufficient habitat for most large species and protected habitats will be in pieces too small or too unstable to sustain viable populations of the plants and animals they seek to protect. For these and other reasons conservation biologists will be forced to depend more and more on ex-situ care and biotechnology to help protect diversity at both species and genetic levels"

The Benefits Of Ex-situ Conservation

- Botanical gardens can help in ethno biology strengthening collections that have traditional and cultural implications [2]
- Re-introductions have occurred for at least 120 animal species and 15 of these are definitely established in the wild and are now self sufficient populations [4]