EEB 2208 TOPIC 17

EX SITU CONSERVATION, RELEASE PROGRAMS

Background for this topic

Primack: Chapter 14

1. Introduction

A) DEFINITIONS

i) **In situ** conservation means that the conservation activities occur where the species naturally occurs in the wild.

ii) **Ex situ** conservation means that actions are taking place that involve removing the species from its natural setting.

B) WHEN IS EX SITU CONSERVATION USED?

i) Ex situ conservation is usually used as a last resort, when a population has become so small or so endangered that extinction is considered inevitable without extreme intervention. E.g., California condor (now reintroduced).

ii) Sometimes ex situ conservation is the only choice, because a species no longer exists in the wild. E.g., some of the plants we will bring to class.

2. Where does ex situ conservation occur?

A) ZOOS, WILDLIFE PARKS, PRIVATE COLLECTIONS, AQUARIUMS, ETC.

i) Over 7,000 vertebrate species are kept in zoos worldwide. A number of endangered invertebrates (e.g., Pacific island snails) are also kept in captivity. For the most part, however, the species represented in zoos are a biased subset of all species, typically emphasizing species that are big and charismatic.

ii) Zoos are relatively good places for maintaining species in captivity and for captive breeding programs, because they already have large facilities geared towards keeping a wide variety of species and a trained staff with husbandry skills geared towards unusual species. Since zoos have an economic function they are also in a good position to take advantage of captive breeding programs and use them to generate some of the money that keeps the program going.

iii) Probably the major conservation function that zoos play is captive breeding. Many techniques are used in captive breeding, often species-specific. In most cases, however, these methods are focused on the simple goal of increasing reproductive output and the survival of offspring. A few examples include:

- **cross-fostering** & **double-clutching** – in many species the reproductive rate can be increased by taking young (or eggs) away from their parents, so that the parents start to breed again more rapidly. One solution for what to do with the removed young is to give them to a closely related species to raise.
- **humans raise young** – another solution is for humans to hand-raise them. This is usually less preferred, because it can be extremely time consuming, but often it is necessary (see whooping crane example, below).
- **artificial insemination** – in some cases, pairs are reluctant to mate; increasingly this problem is being solved by taking sperm from the male and artificially inseminating the female. This technique can also be useful if one wants to determine exactly which individual mates with which, which can be helpful in zoos as a way of limiting the

effects of inbreeding (see notes on studbooks below). A third case when this method might be useful is when several zoos want to pool their animals to increase the size of the overall population: moving vials of sperm around between zoos is easy, whereas moving animals around often is not.

- **embryo transfer to surrogate mothers** – another way of increasing the number of young produced is to create "test-tube" babies and then implant them into surrogate mothers. Sometimes these mothers can be of different – though closely related – species.
- **cryogenics, cloning, etc.** – as technologies develop, sperm, eggs and embryos are being frozen and kept on ice for future use. Cloning has also been promoted as a potential way to help endangered species to reproduce. The science of cloning, however, is still at an early stage and many problems need to be overcome before it becomes a viable solution for more than a few isolated cases.
- **pedigrees, studbooks** – a more traditional, though exceedingly effective, tool is the maintenance of studbooks to keep track of how individuals are related to each other. By constructing a family tree and doing a pedigree analysis it is possible to minimize the relatedness of individuals who mate. By doing this, inbreeding can be kept to a minimum. With the increasing use of artificial insemination, it has become even easier to determine how individuals are paired and to maintain maximally outbred populations. Genetic methods increasingly improve our ability to tell how closely related individuals are, even if detailed family trees are not available.
- **moving animals around** (artificial dispersal) – finally, when sperm transfer is not an option, it is possible to move individuals around to help reduce inbreeding within each small zoo population.

iv) Example: The guar is an endangered wild ox from Asia. Researchers have used the species to develop and experiment with many of the techniques described. In 2001, the first cloned guar was born. This individual was implanted into a surrogate mother of a different species (a cow).

v) Example: The whooping crane is an endangered bird that breeds in Canada and winters in Texas. Only a few 100 are left in the wild, but there is a growing captive population. Double-clutching can be done, but raising the young can be difficult without their parents. Initially a different species (sandhill crane) was used to incubate and raise the young. But the baby whooping cranes imprinted on their surrogate parents and some subsequently chose to mate with sandhill cranes. When humans raise the young, imprinting is also a problem, so people have to dress up like adult whooping cranes whenever they interact with the young birds to prevent them from getting too mixed-up.

B) IMPROVING HUSBANDRY

i) Some species do not survive or breed well in captivity. Consequently, new husbandry techniques constantly need to be developed for these problematic species.

ii) Different facilities vary greatly in their quality. Consequently, there is a lot of variation in how well species do in different settings. Some places have made the breeding of endangered species a major part of their mission and have devoted considerable resources to captive breeding programs. But not all facilities have such a strong commitment or the resources to follow through.

iii) There is also variation in the needs of different species and, although there is a lot of "institutional knowledge" (i.e., the knowledge of individual practitioners), there are relatively few detailed studies that attempt to understand how captivity affects particular species.

iv) One such study showed that species with large home ranges in nature (e.g., polar bears) tend to do worse in captivity (i.e., they had higher infant-mortality, and were more prone to show repetitive behaviors associated with stress, such as constant pacing). Studies like this can help provide ideas for how to improve the zoo environment for susceptible species.

C) BOTANICAL GARDENS, ARBORETUMS, ETC.

i) Many plants can be kept in captivity too. Botanical gardens and arboretums are the main type of location, but lots of plants are grown in gardens, in private collections, etc. We even have some critically endangered species (<100 individuals in the wild) growing right here on campus in the EEB greenhouses.

ii) Worldwide about 80,000 plant species are grown in botanical gardens. This is about 30% of the world's plants. Kew Gardens (just outside London) alone has about 25,000 species, about 10% of which are globally threatened.

iii) Often it is easier to maintain plants away from their natural settings than it is for animals. This is because they do not go anywhere, they do not need much space (usually), and they often require fairly similar growing conditions (dirt). Most plants also lack the complex behaviors that many animals have, making it much easier to keep them alive and breeding.

D) SEED BANKS

i) Just as technology is changing the way zoos operate, with increasing attention to cryogenics, there are parallel changes in plant conservation and breeding. In particular, there is an increasing focus on developing seed banks – places where the seeds (and sometimes also pollen, tissue cultures, etc.) can be stored over the long term.

ii) Seed banks have existed for a long time, but primarily as a repository for storing seeds of commercially important species. Now there is a shift to expand their function, especially for endangered species.

iii) In seed banks, the seeds are kept in cold, dark conditions, which slows down metabolism and prevents the seeds from germinating. In this state, they can be preserved for many years (even decades) as a back-up in case species disappear in the wild.

iv) Currently at least 10,000-20,000 of the world's plants are represented in seed banks. Some seed banks (e.g., the one at Kew Gardens in London) have a goal of obtaining not only a high representation of the world's plants but also good geographic (and therefore genetic) representation for each species.

v) Because seeds are small and do not do much, they take up very little space and require simple maintenance at relatively low cost.

vi) On the other hand, seeds do not last forever and so, periodically, seeds have to be germinated to form plants that can produce new seeds. Seed banks are also vulnerable to breaks in the power supply that keep the refrigerators running. Another disadvantage is that there are some seeds that simply do not survive in storage. Just as with zoos, seed banks will not work as a repository for all species.

3. Captive breeding in practice

A) PROBLEMS

i) <u>Captive breeding programs are expensive</u>. For example, it is estimated that it is fifty times more expensive to protect elephants and rhinos in zoos than in the wild.

ii) They are also inefficient. Conservation work proceeds one species at a time in a captive setting, and it fails to do anything to protect functioning ecosystems. Consequently, it is really only useful as an absolute last resort and can never realistically be applied to more than a tiny proportion of all species on Earth.

iii) Limited capacity. Captive settings (especially zoos, arboretums, and other settings that deal with big organisms) usually cannot maintain very big populations – hence all the problems associated with small populations in the wild exist in captive settings. Genetic problems are especially relevant in captive settings and much of the work that has been done on conservation genetics has been done in conjunction with zoo populations.

iv) Populations are concentrated. Another problem also parallels what happens in nature – individuals become concentrated into a small area. This is akin to having a narrow range and is a problem for the same reasons.

v) Adaptation to artificial conditions. Taking species out of their natural setting can have serious problems because species sometimes adapt (i.e., they evolve) to their captive conditions. This is because there is selection for individuals that do well in captivity, but it has the consequence that certain characteristics of the species are lost. The characteristics that are selected for are often not those that will be most important in the wild (e.g., you might accidentally select for individuals that are not afraid of people – which might create a population that is especially vulnerable to persecution or predation if they are ever released back into the wild).

vi) Behavior. Some individuals also fail to learn key behaviors needed to survive in the wild. Or learn behaviors that are harmful in the wild. Again these can be huge problems if captive breeding is being done with the idea that individuals will be released back into nature. E.g., this has been a concern in the condor release program where several released condors have learned to hang out around people, beg for food, etc. Several of these "nuisance" birds have had to be brought back into captivity; others have died as a result of their interactions with people.

vii) Logistic concerns. Finally, there are logistic problems. Captive breeding programs require a long-term commitment because you cannot simply decide that you want to stop doing them for a few years once they are in progress (e.g., when the economy turns bad). Also, when breeding is successful there can be so much production that facilities cannot cope with the number of animals. If there are no release programs to use the "excess" individuals there are ethical issues about what should be done with them.

B) DOES IT WORK?

i) Ultimately, the biggest question is: Does ex situ conservation work? In some cases, the answer is clearly yes. Although there are other cases when things do not go so well.

ii) The Mauritius kestrel provides an example of how ex situ conservation and captive breeding can save a species from extinction. These small falcons were down to only 4 individuals in 1974 (due to habitat losses and the effects of pesticides such as DDT). A captive breeding program was initiated with birds being bred in Britain and the US. By 1996, the population had increased so that there were about 100 breeding pairs in the wild and a total population of about 400. In 2000, the IUCN decided that the species was doing well enough that it did not need to be classified as Endangered any more (though it is still considered Vulnerable because the population is still small and restricted to a tiny range).

4. Release programs

A) THREE TYPES OF RELEASE

i) Reintroductions. These involve the release of individuals into an area from which the species has been extirpated. The release of gray wolves into Yellowstone is an example of an extremely successful reintroduction.

ii) Augmentation. Sometimes a species persists in the wild, but is precariously close to going extinct. In these situations, captive-bred individuals might be released into the population to increase the population size or to increase genetic diversity in the population. Examples include the whooping crane release program.

iii) Introduction program. In some cases, it is not possible to release individuals into their native range, or it is desirable to move individuals away from their native range to a new site (this is called **translocation**). An example of this is the Devil's hole pupfish. Can you think of reasons why this might be desirable?

B) WHAT MAKES A RELEASE PROGRAM WORK?

i) Removal of the threat. Seems pretty obvious, but often this is hard to do. If you do not remove the threat though, the chances of success are limited.

ii) "Soft" release. Various things can be done to make it easier for released individuals to survive, especially in the period immediately after release. These include: providing supplemental food, providing shelter where animals can rest, putting up pre-release cages for the animals to live in for a period prior to release, timing the release to occur at a time of year when conditions are good, ensuring that some of the released individuals have experience living in the wild, providing behavioral training (e.g., to be afraid of predators) for individuals prior to their release, etc., etc.

iii) Population size. Release programs are more likely to be successful if a large number of individuals (>100) are released, or if additional individuals are periodically added to the population. Releases at multiple sites also increase the long term persistence of the population. How does this relate to the information I gave on invasive species?

iv) Correct genetic stock. Ensuring that released individuals are as genetically similar as possible to the historic population is important. These individuals are generally most likely to have appropriate adaptations for the environment into which the release occurs.

v) Release in core of original range. Studies have shown that release programs are more successful when they release individuals into the core of the species' historic range than when the release occurs near the periphery of the historic range. Why do you think this is?

vi) Post-release monitoring. Monitoring the population after the release is important, not just because it tells you whether the release worked, but also because it can guide you as to whether you need to release more individuals (e.g., to help the population overcome stochastic events such as inbreeding or sex ratio imbalance), or alternatively whether you should not release any more (e.g., if the threat is still present and all released individuals just die).

vii) Public education. Release programs are expensive and consequently need to be well justified through effective public education programs. In some cases, the education is critically important if the program is to exceed. For example, when pink pigeons were first released back into Mauritius many of the released birds were killed for food. No one knew what they were, or that there was a good reason for leaving them alone.