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BIOL 410 Fall 2016
TED Running Bibliography

We wish to research the effectiveness of conservation programs, specifically within zoos, and their attempts to repopulate areas with captive-born individuals of endangered species. There are major biological and economic concerns with these programs we would like to focus on, including potential genetic adaptation to captivity, effects of inbreeding, and if this is a truly worthwhile use of funds to restore a species. Looking at the black-footed ferret, the whooping crane, and other captive-breeding programs, do these reintroduced individuals thrive in their new habitats sufficiently enough to contribute to the restoration of the species, and more broadly, their ecosystems?

## References

**9/6/16**

Hogg CJ. 2013. Preserving australian native fauna: Zoo based breeding programs as part of a more unified strategic approach. Aust J Zool [serial online]. [cited 2016 Sept 6]; (61):101-8. Available from EbscoHost.

This source helps answer our question by showing possible issues that arise with captive breeding programs and provides an overview of how captive breeding programs work. The source argues that in order to be effective, programs must be developed early and be structured with effective communication between all parties involved in the reintroduction. Further research must be done to answer our research question. This prompted further questions of how specifically, do the black footed ferret and the oregon spotted frog do upon reintroduction? What challenges are there to their success? This source may be used for background information but does not pertain to the specific species that we picked to outline our points.

**9/6/16**

Laycock HF, Moran D, Raffaelli DG, White PC. 2013. Biological and operational determinants of the effectiveness and efficiency of biodiversity conservation programs. Wildlife Res [serial online]. [cited 2016 Sept 6]; (40): 142-52. Available from EbscoHost.

This source answers the question of how conservation plans are monitored and evaluated using three different criteria: cost-effective analysis (CEA), cost-utility analysis (CUA), and threat reduction assessment (TRA). Based upon several factors of the species trying to be conserved such as taxon, diet, distribution, and generation time, a specific model would be more applicable and provide the most accurate results. The next question that arises from this is if funding is an issue to provide this type of comprehensive monitoring data, are there any alternatives? And as far as using this research, it is definitely good background on how progress is assessed, but this focuses moreso on the numbers and data as to why a species may not fare well in a reintroduction program, as opposed to our focus on the mechanisms themselves as to why they may fail.

**9/28/16**

Wisely SM, Santymire RM, Livieri TM, Mueting SA, Howard J. 2008. Genotypic and phenotypic consequences of reintroduction history in the black-footed ferret (*Mustela nigripes*). Conserv Genet [Serial Online]. [cited 2016 Sept 28]; (9):389–399. Available from EbscoHost.

This source helps answer the question we are exploring by letting us know more about the genetic diversity of the black footed ferret after reintroduction to the wild. This article stated that years of isolation following reintroduction into the wild caused a decrease in allelic diversity that most likely can be ameliorated through yearly translocation of 30 to 40 ferrets from captivity. Within this article it discusses that an early problem to survival of ferrets after reintroduction was their lack of learned hunting behaviors, and prompted the further question of

"are there any other critical behaviors that went unlearned due to how they were reared, and is this common among released captives?" This issue also relates to our question so should be researched more thoroughly. This source relates much information about issues surrounding black footed ferret reintroduction so will be used in the final presentation.

**9/28/16**

Polasik JS, Murphy MA, Abbott T, Vincent K. 2015. Factors limiting early life stage survival and growth during endangered Wyoming toad reintroductions. Wildlife Mgt [Serial Online]. [Cited 2016, Sept 29]. (80): 540-552. Available from Ebsco Host.

This source helped to answer questions about what a reintroduction process is like if the original threat is not eliminated. As we had discussed in our textbook, the inability to identify and eliminate the threat will hinder the species's survival, as it is with this population of critically endangered Wyoming toads. Reintroduced toads are not surviving, so many different situations are being tried in this study to identify the cause, including food supplement, predator isolation, and grass length. This source will ultimately be used because it is a good example of adaptive management, and also shows that successfully breeding a species is only half of the struggle, as conservation plans most likely never go perfectly smooth. A question that develops from this information is what determines which factors will be tested first? Especially if the number of young allocated to reintroduction is limited, the possible threats must be triaged carefully to minimize unnecessary tadpole loss.

**9/29/16**

McCleery R, Hostetler JA, Oli MK. 2014. Better off in the wild? Evaluating a captive breeding and release program for the recovery of an endangered rodent. Biol Conserv. [Serial Online]. [Cited 2016 Sept 29]. (169): 198-205. Available from Science Direct.

This source correlated with one of our major questions in that is captive rearing and release programs are a truly worthwhile use of funds to restore a species. This study focused on the endangered Key Largo woodrat (*Neotoma floridana smalli),* and compared the success of two populations: one left in the wild with minimal intervention and improved habitat protection, versus a population taken from its habitat to be reared in captivity and released once numbers improved. While those raised in captivity produced greater numbers of individuals than the wild population, once released, the wild population had a lesser chance of extinction. While the major caveat being that this is only one species and captive rearing and reintroduction has been successful in the past, it is important to show the most involved and expensive option does not always yield the best results. A question that arose was if this type of simultaneous study has been done on other species, as this type of research would provide a good foundation to answer our "is it worthwhile" question. This source will definitely be used in the final project for this purpose.

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**9/29/16**

Biggens DE, Vargas A, Godbey JL, Anderson SH.1999. Influence of prerelease experience on reintroduced black-footed ferrets (*Mustela nigripes*). Biol Cons. [Serial Online]. [Cited 2016 Sept 29]. 89:121-129. Available from Science Direct.

This source helps answer how different rearing practices of captive breeding programs can influence survival rates of animals after reintroduction. The experiment showed that ferrets in quasi-natural rearing environments, as opposed to cages, were better adapted to release, as proven by increased roaming and hunting abilities. This source is from 1999, further research should be done to see if there is a newer study showing the more recent findings to answer the question "How did this pre-release training impact them long term?". This article may or may

not be included based on if more recent studies have been done on this topic. Because of the date, this actually prompted the question of, "if and how have captive breeding programs changed from when this was done in 1999 compared to today?".

**10/19/16**

Kleiman DG, 1989. Reintroduction of captive mammals for conservation. Bioscience [serial online]. [cited 2016 Oct 19]; 39(3): 152-161. Available from: JSTOR.

This article defines terms associated with captive-breeding and discussed the aims of reintroduction programs, prerequisites for success, pre- and post- release training, how to choose specimens for reintroduction, the importance of long-term monitoring, habitat protection, education and public relations, and when reintroduction is not appropriate. One very interesting statistic mentioned was that of 1,000 cases of bird reintroductions, only about half succeeded. There are five prerequisites for success mentioned in this article, all of which are difficult to uphold. This makes us wonder, "Do programs that are considered successful adhere to all of these guidelines?" This article supports our preliminary conclusion that captive-breeding programs are not effective. The source is old but we feel that the topics it discuss are still relevant and applicable to captive-breeding today. More evidence must be obtained to confirm this hypothesis so we will search for articles talking about negative aspects of these programs.

**10/19/16**

Snyder NFR, Derrickson SR, Beissinger SR, Wiley JW, Smith TB, Toone WD, Miller B. 1996. Limitations of captive breeding in endangered species recovery. Conserv Biol. [Serial online]. [Cited 2016 Oct 23]. 10:338-48. Available from: ScienceDirect.

http://scholar.google.com/scholar_url?url=https://nature.berkeley.edu/beislab/BeissingerLab/publications/Snyder_etal_ConsBio_1996.pdf&hl=en&sa=X&scisig=AAGBfm21YAdEJDXOlz1Mu961vSTyUGYTdw&nossl=1&oi=scholarr

This article did an extremely comprehensive job outlining seven limitations the authors felt are generally overlooked when carrying out captive breeding programs. These include: establishing a self-sufficient captive population, poor success in reintroduction, high costs, domestication, disease outbreaks, and maintaining administrative continuity, all of which the authors go into detail about and will support our conclusion. There were many nuances associated with breeding programs I did not know before reading this article, such as we must go against natural tendency to catch every last living member of a species to put it in captivity, or the suggested quarantine protocol either upon first entering a new population to a zoo or when a member of the group gets sick. Due to the size of the enclosures required, it is understandable why many of these protocols do not get followed. This article also answered a question I had from Christie et al.'s study concerning if quick domestication was as much of a major problem with mammals as it is for mass-spawning animals like salmon. Apparently, wild foxes are able to become domesticated within just 20 generations. One question that had arisen when I was reading stems from the fact this article is from 1995. While this is a great resource, but I wonder how much captive breeding programs have changed since the publication of this article, maybe even in response to this article.

**10/19/16**

Captive breeding and species reintroductions. [Internet].; [2016 Oct 19]. Available from: http://www-personal.umich.edu/~dallan/nre220/outline23.htm

This webpage defines terms associated with captive breeding, talks about aspects of successful reintroduction programs, and discusses methods that captive breeding programs use to increase genetic variability. One interesting aspect of this article was that it listed the whooping crane as one successful reintroduction to the wild. From reading *Wild Ones,* we would not count the whooping crane as successful due to the fact that only one chick was born to captive-bred parents, as well as the sheer cost and time commitment of the program. This brings up the question, what would qualify as a successful captive breeding program? And do other efforts stretch the definition of what is successful? A next step would be to potentially look into other programs that are considered successful to gauge the reality of this claim.

**10/19/16**

Captive Animal Protection Society. 2001. Captive breeding programs are ineffective. In: Cothran H, editors. Endangered Species. [Internet]. San Diego; Greenhaven Press; [cited 2016 Oct 19]. Available from: http://ic.galegroup.com/ic/ovic/ViewpointsDetailsPage/DocumentToolsPortletWindow?displayGroupName=Viewpoints&action=2&catId=&documentId=GALE%7CEJ3010131215&userGroupName=inde30507&zid=d9a86648425a967b266cf1fa53d78737

This article takes the perspective that all captive breeding programs are ineffective because mortality rates are high, captive bred animals often bring new diseases into wild populations, and these programs are very expensive. The program for the Arabian oryx cost twenty-five million dollars. This article argues that this money could be better spent conserving animals in the wild because it would ameliorate problems that caused population decrease while benefitting other species. This article definitely supports the conclusion that we have come to,

which is captive breeding programs are actually hindrances to conservation. Our next step would be to continue to find sources that bolster our argument.

**10/19/16**

Christie MR, Marine ML, French RA, Blouin MS. 2012. Genetic adaptation to captivity can occur in a single generation. P Natl Acad Sci USA. [Serial online]. [Cited 2016 Oct 23]. 109:236-42. Available from JSTOR.

This article was a study a done on chinook salmon that highlighted how there can be a substantial reduction in fitness after only one generation of captive-born individuals being reintroduced back into the wild. The authors associate this effect with rapid domestication and adaptation to captivity. However, there are other possibilities that can account for this dramatic change, such as inbreeding and relaxed natural selection within the captive environment, all of which would support our argument. I had learned from this article that the negative effects observed with captive breeding can be seen so readily and quickly. My question, though, is if this stark effect is isolated to mass-breeding populations like the salmon, or if this phenomenon is possible in larger mammals who may only produce one or two offspring per year.

**10/19/16**

US Fish and Wildlife Service. Captive-bred Wildlife Registration under the US Endangered Species Act. [Internet]. 2015 Aug. US Fish and Wildlife Service; [2016 Oct 19]. Available from: https://www.fws.gov/international/pdf/factsheet-captive-bred-wildlife-and-endangered-species-act.pdf

This website page for the Fish and Wildlife Service relays the requirements to obtain a captive-bred wildlife registration. It also describes what this permit authorizes those holding it to

do. It allows the take of animals provided that it is to help the species, in addition to allowing the breeding of and interstate travel of endangered animals. This answers one of our questions which was "what is required to begin a captive breeding program?". This site will be used in the background on captive-breeding section of our presentation.

**10/23/16**

Dein FJ, Carpenter JW, Clark GG, Montali RJ, Crabbs CL, Tsai TF, Docherty DE. 1986. Mortality of captive whooping cranes caused by eastern equine encephalitis virus. J Am Vet Med Assoc. [serial online]. [Cited 2016 Oct 24]. 189(9):1006-10. Available from PubMed.

This article explained the outbreak of equine encephalitis within the captive-bred whooping crane population that left 7 of 39 individuals dead, a large blow to the breeding program. Because this species's program is often highlighted and considered a success, and with the coverage of the species in *Wild Ones,* the fact that even "successful" programs encounter fatalities from diseases show how difficult these are to accomplish, which supports our argument. The spread of diseases in captivity is a major issue, and this led to the question whether we are seeing less outbreaks today, given our presumably enhanced knowledge of disease or more frequent outbreaks because of the increased prevalence of captive-breeding programs.