Measuring Progress: Methods of Success in Endangered Species Conservation Programs

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Measuring Progress: Methods of Success in Endangered Species Conservation Programs

By

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Abstract: Endangered species conservation is an extensive field, employing several different methods and varying in countless external factors. Vulnerable species are pit against some of the strongest forces of human development and losing some of these species to extinction may unfortunately be inevitable, despite conservationists’ greatest efforts. In their work to increase effectiveness in the field, conservationists should recognize which methods lead to greater success and adopt them when possible. To determine which methods yield greater success among endangered species conservation programs, this study analyzed 378 studies resulting from a Web of Science search, tracking the methods they employed in their conservation plans and the degree of success in their results. Chi-Square tests showed that although some methods were more prevalent than others among the meta-analysis results, no method significantly correlated with success of the programs. Then, the study analyzed a subset of species conservation projects funded by a small, grant-funding organization. Here, a four-criterion framework was established by which to evaluate the success of these projects and the recorded methods employed. Then the patterns of success and methods used were compared to those of the meta-analysis. Assessing whether projects among the case study and the meta-analysis were successful proved difficult because many reports lacked sufficient information regarding their results. This inability to fully evaluate the programs’ outcomes reflects a larger problem in the conservation field which must be alleviated if conservationists are to be constructive.
Preface

I have always held a strong belief that non-human species deserve greater concern than humans currently grant them. Recent human growth and development has left us constantly polluting and destroying habitats, hunting or eradicating species to extinction, and introducing elements and organisms to environments that cannot withstand them. I believe we are obligated to do everything in our power to undo the immense damage done, especially for the sake of species we share this Earth with. For me, this starts with endangered species conservation and habitat conservation work. In the future, I hope to work for a nonprofit focused on one of these types of conservation.

While interning at Global Greengrants Fund I was curious about patterns in their conservation plans since their work is present all around the world and varies greatly from project to project. One of the first things I noticed going into this project was the glaring gap in measurement of each program’s results, leading to an inability to compare success across projects. Improvement of conservation programs is extremely difficult if there is no standard by which to judge them. I saw this as an opportunity to address a need for improvement of the field and developed a framework as a suggested solution.
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Introduction

Endangered species conservation organizations are motivated to improve the survival of endangered or threatened species. Many organizations adopt similar approaches to conservation or even target the same species. Although many organizations share the same methods and conservation goals, they usually lack an effective framework to evaluate their project’s success and the degree to which they effectively protected the species in focus. Also, this field as a whole lacks a universal framework employable by all conservation organizations to evaluate their programs’ success in comparison to other organizations’ similarly focused programs. Lacking a framework to determine whether the methods an organization previously employed and whether other organizations’ methods were successful by the same standards prevents learning from these conservation programs and precludes insight into what methods should be used to better facilitate similar conservation programs in the future. This problem is heightened by the gap in knowledge caused by conservation organizations failing to communicate with one another about the common trends in techniques they have witnessed that lead to the success of their programs. Therefore, a universally understood and applicable framework to evaluate the success of conservation programs should be established to inform organizations of whether their methods worked well and how well they worked in comparison to other organizations. Creating a framework for success available for all conservation organizations to use would likely increase communication between similar organizations regarding effectiveness of methods and facilitate the comparison of research findings. This would improve knowledge across the conservation community, resulting in more effective conservation action.

In this study I seek to answer the question: what methods employed during an endangered or threatened species conservation program improve the success of their efforts? To answer this,
I conducted a meta-analysis to determine the most commonly utilized methods and which of these methods most often correlated with success of species’ conservation projects. Then, I used the results to rank the methods into a hierarchy, which depict the most commonly practiced methods to the least. Next, I provided a case study from the small nonprofit organization Global Greengrants Fund (GGF), where a large collection of endangered/threatened species projects are evaluated to determine whether this organization followed similar patterns of applied methods as were found in the meta-analysis. Further, a framework to evaluate “success” of a conservation programs is created and compared to various established “success” frameworks. Then, a small subset of GGF grant-funded projects are evaluated using this framework and the results are compared to the results of the meta-analysis. The results of this comparison will provide an understanding of patterns found in a large database of well-funded projects versus a group of projects (also varying in organizations) funded by one small-scale organization. This organization, Global Greengrants Fund (GGF), operates by distributing small-scale grants to nonprofit organizations around the world. Therefore, the projects funded by GGF include a range of organizations, types of species in focus, and conservation techniques. The framework for success will be applied to follow-up reports corresponding to GGF’s grant-funded endangered/threatened species programs to determine which grants were “successful” and what methods or variables were common among the “successful” grants, if any. The application of the framework for success I create to GGF’s programs demonstrates how the framework can be similarly applied to evaluate any species conservation work.

Overall, this study provided insight into what methods practiced in endangered/threatened species conservation programs improve the success of the project’s goals. The study established a framework to evaluate success which can be applied to assess any
endangered species conservation plans. A sufficient and universally applicable evaluation technique will be incredibly useful for the conservation realm to determine an organization’s own success and address what could improve their projects, compare techniques and outcomes across conservation organizations of all scales, and share insight regarding useful methods between organizations. Therefore, the proposed new method of evaluation would result in the increased success of endangered/threatened species conservation work all across the world.
Background

Most well-established conservation organizations collect data on the outcomes of each of their conservation programs. The amount of knowledge, research, and scholarly papers regarding conservation has increased over the last two decades and their influence is heightened by the influence of the internet’s increasing ability to quickly spread information between geographically distant parties. However, for the most part, conservation work lacks a sufficient evaluation technique applicable to outcome data, and conservation action is still based on “personal experience and interpretations of traditional land management practices” (Pullin, Knight, Stone, & Charman, 2004). This field needs a solid, universal framework to evaluate the success of these programs so that organizations can exchange insight regarding which methods have improved their efforts, the lack of which has been a consistent problem in the field (Pullin & Knight, 2003). Although conservation organizations exhibit a significant range in techniques they employ to accomplish their goals, in general, they are all working toward similar goals, protecting the endangered or threatened species they choose to focus on. Whether that is done through education and awareness campaigns, habitat protection and the creation of protected areas, or captive breeding and monitoring, conservations organizations track the results of their programs and want to find the best outcomes for these species. In order to achieve the best results of these programs, conservation organizations should establish an accountable framework used to measure the success of their programs that is standardized so that all organizations may rely on it. The universality of this framework is crucial in order to reliably compare results between conservation organizations, especially since there is so much variance in size and methodology of these organizations. If organizations can easily compare each other’s results using a common framework, they will more likely share their discoveries. Overall, this will
result in an increase in effective conservation of threatened species, which is the common goal of these organizations.

My case study will analyze a small non-profit organization, Global Greengrants Fund (GGF). This organization functions by distributing small (under $5,000 USD) grants to various small-scale nonprofits around the world who facilitate projects focused on many different environmental justice motives such as healthy ecosystems and communities (where I focused on endangered species conservation), climate justice, local livelihoods, land, water, and resource rights, and women’s environmental action (Global Greengrants Fund, 2017). They are a successful, established organization that has given over 11,000 grants, in 168 different countries. However, they do not have a structured method of evaluating whether their programs have been successful (Global Greengrants Fund, 2017). This poses a substantial problem for the organization because they do not know if they should change something in their grant-making to increase the success of their funded programs, and if so, they do not know what to change. This is especially pertinent for this organization because many times they give second or third grants to the same organization.

Although GGF lacks a solid framework for evaluation, they do ask the organizations they fund to complete a follow-up report within one year of receiving funding, which helps GGF determine whether to provide another grant to the organization if it is requested. The report outline asks questions about how the receiving organization spent the grant money and what results they saw in comparison to what results they were hoping for when they applied for the grant. However, there is not a requirement from the organization to complete the follow-up reports, and if they do, there is not a word or data minimum to ensure the report is adequately completed. Therefore, after GGF grants are distributed, there is no guarantee that Global
Greengrants Fund will gain substantial information regarding whether the program was successful or not, what it was missing, or what could be gained to improve similar programs in the future. Clearly, these follow-up reports are not a sufficient way to clearly evaluate success of a grant-funded project, which makes it difficult for GGF to determine whether they should alter their methods to improve effectiveness. This is a consistent problem across many nonprofit organizations, especially the ones working toward endangered species conservation.
Literature Review

In a general sense, it is important to know what methods lead to the success of endangered species conservation action because currently there is a lack of an agreed upon metric, which is crucial for the improvement of this work. Success is very difficult to measure in endangered species conservation programs because there is a vast variety of methods in use and organizations working to alleviate threats to these populations. An immense number of organizations all around the globe employ countless different tactics to stabilize or increase threatened and endangered populations of species. This abundance of variables makes it difficult to decide on a sure way to best protect these species. However, if humans want to have any chance of slowing the next mass extinction, we must attempt to understand the most effective conservation methods to save endangered species (Barnosky, 2011). Conservationists must forfeit methods proven to result in the least impact and find ways to spread the facilitation of the successful ones.

A search for a “success” criteria to evaluate conservation programs has been pursued by researchers in the past. For example, Sawhill and Williamson (2001) explain the example of the Nature Conservancy’s search for an efficient and valid method of evaluating how effective their organization’s efforts have been. At first, the conservancy measured its success by the donations they received and the acres of land they preserved. Although these factors are the basis of the organization’s infrastructure, the conservancy did not feel as though these metrics accurately conveyed the mass amount of species continually lost to extinction on a global scale or the habitats of those species that continue to be sacrificed for human development. To establish a new framework to better evaluate whether the organization was truly making a difference, they created an assessment framework that easily collected data, communicated their results, and was
applicable at all levels of this large organization. To accomplish this, they established a family of measures: Impact, which addressed a mission’s success; Activity, which measured whether their goals were achieved; and Capacity, which measured how well the organization used their resources to accomplish their mission. These three broad areas reflect how well the organization executes their goals through individual conservation plans.

Finally, the Conservancy compared how other established nonprofits evaluate themselves in these areas by interviewing leaders at 30 similarly established nonprofits. None of these organizations had formulated an effective way for measuring their success, further proving that lack of evaluation is a major issue for the nonprofit sector. How should nonprofits be expected to accomplish their conservation goals if they cannot measure the impact they have made?

Kanter and Summers (1994) argue that in contrast to non-profits, for-profit organizations that can easily measure their success based on output and monetary profit, thus clearly indicating whether the organization is making a profit and whether it is capable of financially supporting itself. However, nonprofits are based around values and missions that are more difficult to evaluate as to whether they have been accomplished. Instead of goods, they provide services which are inherently difficult to measure. Additionally, nonprofits are based around social values, instead of more easily measured financials ones. Finally, the different parties involved (donors, conservationists, or people affected by or invested in the wilderness/species in focus) in the services provided by a nonprofit may all have different ideas and standards of success. However, a unifying basis of success could alleviate confusion among the groups involved in a specific conservation plan and determine whether nonprofits fulfill their otherwise ambiguous missions and values.
Along with a universal framework for evaluating success, terms commonly used in conservation planning would be helpful to standardize to ensure conservation programs mean the same thing when they use certain terms (Salafsky, et al., 2008). An example of such a term is “success.” A framework for “success” would establish a clear definition of the word resulting in a measured percent that demonstrates the amount of progress made by the program in alleviating at least some stress to the species. This would allow organizations to clearly demonstrate to others their “success” rate and compare this rate to that of other organizations. Further, universally defined terms would also make it easier for conservation organizations to share information on patterns they find that lead to success with other organizations working on similar goals. If communication was clear, organizations could more easily share information learned from specific conservation trials or successes with each other. Hopefully, this would encourage conservation organizations to form partnerships, share these lessons and grow the effectiveness of endangered species conservation.

For partnerships to be effective, they must be unified by the common goal of species recovery. Otherwise, if individual forces are motivated by personal incentives, the overall bond will be weakened and conservation goals are likely to fail (Clark & Brunner, 2002). Organizations working together need to have an established definition for “success” that they agree upon, otherwise they will not know if their plan accomplished anything by its conclusion. These partnerships are very important to facilitate in conservation work because “the expectation is that the goal of recovery is beyond the reach of any one agency or organization; none of them, working alone, has the resources, such as expertise, funds, and authority, necessary or sufficient to get the job done” (Clark & Brunner, 2002). This is why organizations need to have universal terminology and a rating system of “success” in order to share knowledge and resources to
further conservation around the world. Universal language and considerations of success can facilitate partnerships and discussion between organizations regarding what factors they believe impede or improve their programs.

Scholars in the conservation field have reflected on the difficulty of communication around evaluation of conservation actions, realizing that “…it is essential that all people involved in this type of work have a common language with which to describe the systems that they are working with or at least the ability to translate accurately between different sets of terms” (Salafsky, Margoluis, Redford, Robinson, 2002). If any commonly used term in conservation work is not clearly defined to all parties invested in a conservation plan, especially “success,” this misunderstanding could cause parties to have different ideas of the actions they are planning and whether they have accomplished their goals.

Although a universal framework has not been established to determine which methods lead to success of a conservation program, certain traits of specific endangered species themselves have proven to be correlated with higher conservation success. Therefore, these traits’ relation to successful conservation action for the species in focus should be considered. Many studies have evaluated the factors that influence changing status of endangered and threatened species on the United States Endangered Species List. Studies show that the following variables: taxonomy, funding by US Fish and Wildlife Service and National Oceanic and Atmospheric Administration, and agency assessment of risk of extinction and potential to recover were significantly correlated with “endangered” and “threatened” status. Also, amount of time a species spends on the Endangered Species List was found to significantly correlate with status of a species; 12-13 years on the list was associated with the highest percent of stability or improvement, leveling off at 13 years on the list (Male & Bean, 2005). Not surprisingly, the type
of animal also showed a correlation with conservation success. Birds and mammals presented the least species in decline, although greater length of time on the list may have influenced this because birds were shown to mostly be listed before 1970. Further, invertebrates held the highest amount of species decline and most of their species were listed as recently as 12 years ago (Male & Bean, 2005). Other variables are found to affect the improving status of a species, including how long a species was threatened before they were listed; ideally, they should be placed on the list before they become extremely rare (Wilcove, McMillan, & Winston, 1993). These variables should be considered when addressing the “success” of conservation methods because the type of species (and various characteristics of its population) might cause its associated conservation programs to be more or less successful. Also, it is questionable as to why the relationship of these variables’ to conservation effectiveness is known, whereas that of conservation methods remains unknown.

Many factors are still unknown in terms of their effect on conservation. For example, critical habitat of a species has been found in some studies to correlate with increased stability of a species (Taylor, et al., 2005). However, other studies have found there is not a relationship between the two factors (Clark, et al., 2002) & (Male & Bean, 2005). This proves the extent to which variables relating to the external surrounding of a species relative to the species’ endangerment are still debated. Therefore, research is necessary to further understand the influence of these factors, which should be considered when evaluating the success of conservation programs.

Pullin and Knight (2001) present the critique that conservation planning lacks techniques from evidence-based strategies, but instead works off experience-based strategies, which are employed without monitoring or evaluation of their effectiveness. Further, the authors believe
“lack of monitoring and evaluation of conservation action” is one of the two major consistent problems with conservation biology. Pullin, Knight, Stone, and Charman (2004) state that decision-makers involved in conservation actions should use evidence-based plans, such as the ones modeled by the practice of medicine. This provides a more credible prediction of the results of the action. A framework for “success” could be used to track what methods have been used in the past to lead to effective conservation action. This framework could provide the evidence and evaluation that conservation decision-makers use to support the actions they decide to take and the methods they employ.
Chapter 1 – Methods

First, I conducted a meta-analysis of studies summarizing endangered or threatened species conservation programs. Meta-analyses are useful tools to summarize findings of similar studies relevant to your topic and compare across studies to find larger patterns around your topic (Fernandez-Duque, & Valeggia, 1994). To carry-out my meta-analysis, I used the Web of Science database, accessed through the University of Colorado’s Chinook Libraries Website. Web of Science is an online database which is regularly updated with printed literature publications. It offers scholarly articles from 1900 to the present and is considered the standard for finding citations for academic researchers and writers (Falagas, Pitsouni, Malietzis, & Pappas, 2008). In the Web of Science database, I searched the criteria: “endangered species conservation programs” and narrowed the search by adding the topic “success.” I restricted my results to a 10 year range, 2007 through 2017 to ensure only the most recent articles were considered. Then, I sorted through the search results to identify studies that evaluated specific endangered or threatened species conservation programs and the results of the conservation efforts on the species’ population. I only included evaluations of studies that were executed in a real world situation; I did not look at studies using only simulations or recommendations based on general research of a species’ biology. “Field research” is a category of methods that was analyzed, but this means it must be used in a conservation programs, not just used to make recommendations for conservation work. I also did not include conservation programs for the sake of species listed as “vulnerable,” meaning only species with “threatened” or “endangered” status were considered. Therefore, not all studies resulting from the Web of Science search were included in my meta-analysis conclusions.
I presented the studies included in the meta-analysis by organizing each into an individual row of one Excel document. The categories documented included the authors of the article, the year the article was published, the methods used in the project, and whether the program was found to be successful. “Successful” was tracked in two columns; the first indicated whether the program continued through its intended length and the second indicated whether the program increased or stabilized the intended population. In these two columns, a 0 indicated the study was not successful, a 1 meant the study was successful, and N/A indicated the study did not specify whether it was successful. The “N/A” results were present only in the second success column. In terms of the methods which are tallied in columns, each column represented a theme of methods. Also, multiple methods may be tallied in one row, indicating conservationists employed more than one method in their efforts. The use of multiple methods is also analyzed later in my study to determine its implications for success.

I consolidated the resulting large amount of methods from the raw data into another Excel document where methods are categorized into themes. This data is presented in Appendix 2. Then, I created a hierarchical list showing which methods are represented most often within the array of studies I analyzed. These results suggested larger trends of the most commonly employed methods in endangered species conservation programs. Hierarchical lists have commonly been used to rank results of conservation work (Noss, R, 1990 & Schmeller, et al., 2008). Finally, Chi-Square tests were run on the results of the themed methods to determine whether each is significantly related to success.

**Subsection: Data Analysis Methods**

From the raw data organized in the Excel spreadsheet I consolidated methods which presented similar themes to one another. This narrowed the amount of methods I analyzed and
made trends more clearly by the end of the study. The original methods, as well as the methods which were grouped together, were defined and explained in a separate Excel spreadsheet. These definitions can be found in Appendix 1. Then, I input the consolidated data into the JMP program to run statistical tests on the data. First, I hid all the studies resulting in non-applicable (labeled “N/A” in the Excel document) success results, in order to exclusively decipher between successful and not successful. Then, I ran a Chi-Square test to determine whether each method was significantly correlated with a 0 or a 1 in the success column of the Excel spreadsheet to determine whether the method was likely to lead to success of the program. I summed the number of methods used in each study and created a new column in which these values are stated. Then, I input this updated spreadsheet into the JMP program and ran another Chi-Square test to analyze whether using a single method or multiple methods within one project was more likely to lead to success of the program. I presented graphs and data tables to represent my findings, which can be found in Chapter 2.

Subsection: Analysis of Global Greengrants Fund’s Grants

The trends found in the meta-analysis can also be used to predict what factors in the Global Greengrants Fund’s (GGF) grants lead to successful outcomes from stated goals and objectives of their programs. I sorted through a large data set of Global Greengrants Fund’s grants pertaining to endangered/threatened species conservation and evaluated how many of those grants employed similar methods as were found most common in the meta-analysis. This determined whether GGF rewards their grants to organizations that use similar techniques in their conservation work as those of other conservation organizations, which will be useful for Global Greengrants Fund to understand for their future grant giving. It also indicated whether the scale of the organization contributes to what methods they employ, since GGF is a small scale
organization and studies documented in the meta-analysis are likely larger organizations with more expensive conservation projects.

Next, I defined “success” in regards to conservation programs and supported my definition with scholarly references. This provided a standardized definition for the term, which is necessary for clear communication among scholars in this discipline (Salafsky, et al., 2008). I created a framework for “success” with questions about the program whose answers resulted in a percentage indicating how successful the program was. I compared my framework to established frameworks of “success” to explore similarities between factors or methods considered important aspects in conservation programs (Kapos, et al., 2008). I created this framework as an example of a technique that would benefit the conservation field by resolving the need for an evaluation tool by which to judge the outcomes of conservation projects.

To exemplify how this framework could potentially be utilized, I practiced application of the framework on GGF grant-funded projects. In addition to grant reports, GGF asks the grantee organizations to complete follow-up reports regarding the programs funded by GGF. These reports explain how the grantee organization used the money given to them, how well the goals of their projects were executed, and any other information they wish to provide. However, not all grants in the large set of endangered species related grants included a follow-up report. For a small number of grants that provided a follow-up report, I analyzed the follow-up reports (or summaries of the report if reports were not provided) using my established framework. Results of this case study are found in Chapter 3. Finally, I compared the methods and variables found to correlate with “success” (or lack of “success”) among this case study to results of the meta-analysis.
Chapter 2 – Results of Meta-Analysis and Comparison to Global Greengrants Fund’s Grant Methods

I evaluated 38 pages of Web of Science search results, which consisted of 378 individual studies summarizing species conservation projects. However, not all studies resulting from the search were included in my meta-analysis conclusions because many did not summarize conclusions from specific endangered or threatened species recovery projects. For example, many studies that were excluded simply stated predictions of what factors might help a species recover (based on non-experimental research or computer simulations) or warned of the dangers of certain methods, such as genetic outcomes of reintroducing captive-bred populations. These types of studies were excluded from my meta-analysis because they did not directly answer my research question. Also, projects that focused on “vulnerable” species were not included so that the analysis remained narrowed to species holding an “endangered” or “threatened” status. These exclusions kept this study specific and concise to directly answer my research question.

After the raw data was collected, a multitude of methods existed among the 97 studies documented. To make patterns easier to distinguish and results more significant, methods documented in the raw data were consolidated into similar themes (Appendix 1). Studies with inconclusive responses (represented as “N/A” in the raw data table) to the “success” criterion (in terms of species population stabilization/increase) were excluded from conclusive studies. Therefore, 21 studies were removed and 76 conclusive studies remained. These 21 studies were not considered for the statistical tests or the hierarchal ranking of the meta-analysis results. This step was necessary because studies in the raw data table with non-applicable results were impossible to factor into the statistical tests I ran because they did not state a clear yes/no (1/0) answer for the “success” criterion. Results of the conclusive studies and themed methods are
represented in the graphs below (two of which are ranked 7th because they were present in the same number of programs).

<table>
<thead>
<tr>
<th>Hierarchal Rank (based on commonality)</th>
<th>Method (consolidated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Captive Breeding</td>
</tr>
<tr>
<td>2</td>
<td>Habitat Efforts</td>
</tr>
<tr>
<td>3</td>
<td>Reintroduction/Translocation</td>
</tr>
<tr>
<td>4</td>
<td>Aid to Individual Animals</td>
</tr>
<tr>
<td>5</td>
<td>Research and Inventions</td>
</tr>
<tr>
<td>6</td>
<td>3rd Party Involvement</td>
</tr>
<tr>
<td>7</td>
<td>CBP Additional Support</td>
</tr>
<tr>
<td>7</td>
<td>Artificial Insemination</td>
</tr>
<tr>
<td>8</td>
<td>Prevention of Human Actions</td>
</tr>
</tbody>
</table>
Of the studies that fit the above requirements of inclusion in the meta-analysis, captive breeding was by far the most commonly used method. Out of the total 76 conclusive studies, 44 instances of the captive breeding method remained, comprising 41.12% of the total methods used. Even more significant, this method comprises more than twice as many studies as the next most common method.

Also, hand-rearing in captivity, in addition to or independent from captive breeding programs, and soft-release of individuals after captive breeding accounted for a combined total of 4 studies. These two methods were consolidated into “CBP additional support” (captive breeding programs) in the themed methods data table. I kept these methods separate from the main captive breeding method because some of the studies using these methods were testing the hypothesis that these methods were more effective than enacting captive breeding programs.
alone. This meant that the researchers simply captive bred some individuals and compared them to individuals they bred in captivity and hand-reared or practiced soft-release. However, in a way these methods are still a subset of captive breeding because they still employ this method before the additional method, which somewhat contributes to the commonality of captive breeding. “Captive breeding (CBP) Additional Support” is one of the least commonly used methods, consisting of only 3.74% of studies overall. However, when considered as part of the captive breeding method it would make captive breeding 44.86% of total methods, almost half of the total.

The next most commonly used themed method was various habitat efforts. This consolidated method included the previously separate methods of habitat restoration or protection, invasive species removal, and protection from predators. These were grouped together because each factor contributed to the quality of a protected species’ habitat or mitigated various threats of other species within it. Although this was the second most common themed method, “habitat efforts” was only applied in 17 studies, which only accounted for 15.89% of the total studies, meaning it was less than half as abundant as the captive breeding method.

The combined method of “reintroduction and translocation” was found to be the third most commonly used method among the conservation programs. This method means that a population of an endangered or threatened species from a stable population was moved to a new location where a small population of the species may already exist or where a population of this species existed at one time but does not exist there any longer. The “reintroduction and translocation” method was implemented in 14 studies, 13.08% of the total studies. Translocation is unique because it allows diversification of habitats in which one species lives, providing the species with at least two different subpopulations. Providing an at-risk population with an
additional subpopulation may increase the likelihood that the species will continue to survive due to the endurance of one subpopulation even if one of the other subpopulations fails. Based on this presumption, it is surprising that this method is only the third most common among the meta-analysis results and is such a small percent of the total methods utilized. This may be the case because outcomes of these programs are uncertain. Reintroduction and translocation programs may often fail because conservationists are likely to enact the method prior to fully understanding the species’ habitat, biological, biophysical, and demographic constraints of the situation, as well as overlooking whether the original cause of decline in the population has been resolved (Dodd & Seigel, 1991). Therefore, it would be useful to understand whether reintroduction and translocation programs yielded more effective results (in terms of stabilizing a population) if these factors were accounted for prior to engagement of the conservation program.

Also, other variables may inhibit the success of the reintroduction or translocation methods more than others. For example, translocation of some species to areas with higher habitat quality, less competition from rival species, and introduction into habitat core rather than habitat edge increases the likelihood of success of a translocation, regardless of the number of released individuals (Griffith, Scott, Carpenter, & Reed, 1989). This further emphasizes the necessary use of the second most common conservation method, “habitat efforts.” Included in “habitat efforts” were methods of habitat protection and restoration which would account for habitat quality and core versus edge habitat, as well as removal of invasive species and protection from predators which accounts for the competition from rival species aspect of this finding. The finding that combining habitat efforts with translocation increases a species’ ability to assimilate into a habitat and therefore thrive after translocation suggests that studies in the
meta-analysis employing more than one method would be more successful than those employing a single method.

To tests this prediction, I ran a Chi-Square test to determine whether employing more than one method within a single study increases the likelihood that a program would achieve success. However, the p-value for this test was greater than 0.05. Therefore there was not a significant difference between any number of methods used in a single study leading to success. The results of this Chi-Square test are represented below.

Next, I inserted the data into the JMP program to statistically analyze the data. I ran a Chi-Square test to determine if any of the consolidated methods were significantly correlated with success of the program. I found that none of the methods were significantly related to success, since the p-values of each test were greater than 0.05. This proves that none of the
methods used in the studies in the meta-analysis were found to lead to success most of the time. Further, no method exists that can be seen as the most likely application to increase or stabilize the population of an endangered or threatened population. It is understandable that I did not find one single conservation method which could be applied to any species or any project to guarantee the success of a conservation program in terms of ensuring the stabilization or increase of the population. This would be quite remarkable to discover, considering I looked at a wide variety of species and geographic locations. Also, if there was one method that succeeded far more often than all others, it would be likely that most conservationists would already be using this method a majority of the time. Even though the “captive breeding” method was used more than twice as often as the next most common method, it still was practiced less than 50% of the time, and even this method did not yield results significantly correlated to success. In addition, since the Chi-Square test determined the statistical significance of each consolidated method’s correlation to a 0 or a 1 in the “success” column, it can be said that there were no methods that significantly correlated with lack of success either. This finding is also noteworthy because if a single method existed more often than not resulted in failure of the entire project, it would be useful for conservationists to understand this and be wary of employing that method. Results of the Chi-Square test using the JMP program are shown below.
### Results for Chi-Square tests for each conservation method as a predictor of endangered species success

<table>
<thead>
<tr>
<th>Methods</th>
<th>Chi-Square Value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Captive Breeding</td>
<td>0.053</td>
<td>0.818</td>
</tr>
<tr>
<td>Habitat Efforts</td>
<td>0.442</td>
<td>0.506</td>
</tr>
<tr>
<td>Reintroduction/Translocation</td>
<td>0.227</td>
<td>0.634</td>
</tr>
<tr>
<td>Aid to Individual Animals</td>
<td>0.215</td>
<td>0.643</td>
</tr>
<tr>
<td>Research &amp; Inventions</td>
<td>0.177</td>
<td>0.674</td>
</tr>
<tr>
<td>3rd Party Involvement</td>
<td>0.04</td>
<td>0.841</td>
</tr>
<tr>
<td>CBP Additional Support</td>
<td>0.004</td>
<td>0.949</td>
</tr>
<tr>
<td>Artificial Insemination</td>
<td>0.004</td>
<td>0.949</td>
</tr>
<tr>
<td>Prevention of Human Actions</td>
<td>0.161</td>
<td>0.688</td>
</tr>
</tbody>
</table>

The conclusion of these statistical tests is that an all-inclusive method to ensure success does not exist. Therefore conservationists remain obligated to assess the entirety of a species’ survival needs in order to choose a conservation method that best fits the situation. Further research is needed to determine what variables, if any, significantly influence the success of conservation programs, such as population size of endangered or threatened species at the time of conservation action, type of species in focus, or duration/location of the project. Gaining this knowledge would allow conservationists to reduce their waste of resources and give them a better chance of saving species from extinction.

**Subsection: Comparison of Commonly Used Methods Found in Meta-Analysis to Trends of Methods in Global Greengrants Fund’s Grants**

I analyzed whether conservation methods in the Web of Science meta-analysis were also common among methods used in smaller conservation organizations, assuming that studies published on Web of Science were primarily well funded operations by prestigious scientists or
organizations. I examined an Excel document containing the GGF grants given to projects focused on endangered or threatened species, biodiversity, or animals. The document included project descriptions and organization descriptions pertaining to 1,773 grants distributed from 2005 to 2017. These descriptions disclosed the actions taken in each grant-funded project. Similar to the Web of Science search results, not all projects listed in this distribution precisely pertained to my research question; I only documented projects with the specific goal of endangered or threatened species conservation, in order to maintain consistency with the meta-analysis. To identify grants that used the same methods found to be common in the meta-analysis, I used a keyword search throughout the entire Excel document for words that corresponded with the common methods. Project descriptions and organization descriptions allowed me to determine the relevance of the keyword in the grant detected by each search. However, the method’s keyword must be included in the grant’s project description in order to be regarded as relevant for the analysis, otherwise the keyword did not represent a method employed in that specific grant.

First, since captive breeding was found to be the most common method in my meta-analysis, I searched the large Excel document of GGF grants for the keyword “captive.” This search resulted in only two relevant results. To qualify as relevant, “captive” must pertain to captive animals in regards to breeding efforts for conservation of the species. Therefore, this did not include animals used for livestock, which was seen among the results. Of the only two grants containing the keyword “captive,” the first used funds to evaluate the ability for captive reproduction, but did not state whether the organization was taking action to breed the species in captivity. Therefore, it was assumed that the conservationists were not breeding the species in captivity as part of the project supported by the grant. The second result of the “captive”
keyword search was a grant-funded organization that described themselves as promoting amphibians and reptiles through many techniques, captive breeding being one of them. However, the particular program funded by GGF did not include any information about captive breeding in the specific project description, so this project was also not considered in my results to actively practice the method.

Next, I searched the keyword “breed,” which would also include results of the word “breeding,” in the same Excel document. This resulted in 12 relevant studies. One notable study used the funds provided by GGF to buy cages to support the translocation of an endangered bird species from the United States to the wilderness of a Japanese island. This project also reared the birds in nurseries, showing this project used relocation and captive breeding. The remaining 11 projects resulting from this keyword search present methods of researching, cleaning-up, protecting, monitoring, and spreading awareness of breeding grounds. In conclusion, other than the one report, no projects specifically practiced captive breeding as a method to conserve a species. In conclusion, captive breeding was only actively facilitated by one of the 1773 grant-funded projects, this being a significant difference from the 41.12% prevalence of this method in meta-analysis conclusions. However, the 11 other studies resulting from this keyword search prove that organizations receiving these grants acknowledge the importance of breeding for vulnerable species’ survival. While this finding reflects positive on these 11 grants, they only comprise a small 0.620% of the total GGF grants (although not all 1,773 grants related directly to my research question).

Since the second most common method in my meta-analysis was “habitat efforts,” I keyword searched “habitat” for any studies regarding protection of habitat or creation of protected areas. I did not include any studies that only researched a species’ habitat because this
technique would qualify as “field research” in the meta-analysis. This keyword search resulted in 78 studies that were relevant and employed methods to actively protect habitat. There were even more results of the search that were not counted because they were not directly relevant to my research question or “habitat” was only included in the organization description but not the project specific to the grant. Methods that would be categorized as “habitat efforts” in the meta-analysis proved far more commonly used in GGF projects than those of “captive breeding,” which is interesting because “captive breeding” was more than twice as common as “habitat efforts” in the meta-analysis. The comparative abundance of methods pertaining to habitat protection seen in GGF funded projects may again be due to the fact that organizations receiving the grants are usually small and have less funds to support their projects (which is supported by the fact that they are in need of a small grant). Actions to protect a species’ habitat may require less resources and less financial support than captive breeding programs and reintroductions/translocations.

Next, I searched “reintroduc-” to include results of variations of the word “reintroduction.” Two studies were detected, but both were based on collecting injured animals, rehabilitating them, and reintroducing them to the wild. Therefore, these studies do not contribute to the number of projects using the method of reintroducing a species’ population to a new or previously populated area, which was the definition of the “reintroduction/translocation” method in this study.

To assess the commonality of artificial insemination methods, I searched “translocat-” and “insemimat-” but no results were found. Also, “incubat-” was searched to identify projects using artificial incubation. The results showed one study that incubated and released sea turtles (also, employed protection campaigns and a rehabilitation center which encouraged visitation
from the community). Finally, I searched “stock” for stocking a population, but all results were regarding livestock or fish stock, therefore were irrelevant to my research question. In conclusion, only one grant-funded project employed a method qualifying as “artificial insemination.”

With the exception of two grant projects, Global Greengrants Fund’s endangered species projects did not employ the methods of captive breeding, reintroduction, translocation, artificial insemination, artificial incubation, or stocking of a population which were among the most common methods in the meta-analysis results. Further, even when searching the term “breed,” only a few projects reflect a concern for breeding or breeding grounds. This may be due to these small organizations lacking the resources to conduct extensive captive breeding or reintroduction programs which usually require a considerable amount of money, time, and knowledge about the species and its habitat. Finally, the keyword search among the words representative of common meta-analysis methods to yield the most significant results was a search for “habitat,” proving techniques of the GGF grant-funded projects were most similar to the second most common method found in the meta-analysis. The viability of smaller conservation organizations to facilitate actions for the protection or creation of habitat may provide a link to what factors, in this case presumably financial or resource-based factors, influence certain organizations to adopt certain methods over others. Overall, I found that methods commonly practiced by well-funded conservation organizations, like those included in the Web of Science meta-analysis, differ greatly from those facilitated by small scale organizations, such as Global Greengrants Fund.

**Subsection: Implications of the Most Commonly Used Method – Captive Breeding**

Captive breeding was by far the most common method among the Web of Science search results, however, many authors of studies summarizing these projects recommend using this
method with caution. Often authors of these studies introduce the method with the warning that
captive breeding is practiced as a last resort to save a species, because although it may result in
short-term success, it requires abundant funds and resources. Also, this method yields uncertain
long-term effects on the genetic variation among the released population. Many studies express
their concern for the genetic variability of the post-release population, warning that since a
population is being produced from mating just a few individuals, inbreeding is likely to occur.
This may eventually lead to the demise of a captive-bred population some point after release,
even if at first it appears to have successfully increased numbers of individuals (McAliley,
Willis, Ivanyi, & Densmore, 2016; Lawrence, et al., 2017). Still, captive breeding has produced
results of successful genetic variation in captive-bred populations (Hurt, Kuhajda, Harman, Ellis,
Nalan, 2017). Therefore, this method should not be completely overlooked when planning a
conservation project; but conservationists should be wary of its long-term results.

Many studies within the search results attempted to evaluate the long-term effects of
captive breeding on the genetic variability of a post-release population. This proves the widely
recognized need to determine whether captive breeding is ineffective long-term due to
inbreeding and discover what additional methods may be used to improve genetic variation
before releasing a population. It is especially necessary to determine whether resources are being
wasted on populations that are destined to deteriorate due to lack of genetic variation since
captive breeding is so widely present among conservation plans.

Although genetic variability proved to be such a common concern throughout studies in
the meta-analysis, there was not a definitive consensus of whether captive breeding certainly
leads to inbreeding or what factors influence the likelihood of inbreeding. Even if inbreeding
does not occur in a post-release captive-bred population, breeding of the post-release population
may not be as productive as wild populations. Female post-release animals have been found to take more time between births of offspring and start reproducing later in their lifetimes. This implies that although a captive-bred population may be reproducing, the population could be reproducing at a slower rate than a wild population of the same species (Edwards, Walker, Dunham, Pilgrim, Okita-Ouma, & Shultz, 2015). However, techniques to improve the health and therefore likelihood of successful release of captive-bred populations are being explored. This includes enrichment to maintain captive individuals’ health and fitness to give their populations a better chance of surviving threats experienced when released into the wild (Kim-McCormack, Smith, & Behie, 2016). Further, techniques such as creating dens to shelter animals from predators or providing food supplementation to a wild habitat can ease the transition from captivity to the wild. These additional elements have proven to increase survival of some captive-bred animals, leading to stable wild populations (Landa, et al., 2017). These techniques, and similar techniques discovered in the future, may be adopted to increase survival of released individuals, create a larger population, and attempt to decrease the risk of inbreeding in the future.

Although the risk of inbreeding may make some conservationists skeptical of the long-term effectiveness of captive breeding programs, it is possible that captive breeding produces populations showing low genetic variation due to reasons uncontrollable by conservationists. For example, low variation in a post-release population may be due to low genetic variation in the source population. The initial population is likely small and at risk itself therefore unable to donate a genetically stable population to a captive breeding program (Hinkson, Henry, Hensley, & Richter, 2016). Also, success of species’ reintroduction may depend on each individual and its behavioral traits. For example, some individuals may be less fearful of other species because
they have not encountered the other species in captivity, making them more vulnerable to predation (Martin-Wintle, et al., 2017). Other external factors uncontrollable by conservationists may continue to cripple the success of captive breeding programs. For example, diseases that threaten a population to the point of endangerment causing the need for a captive breeding program, may persist and threaten the lives of released individuals (Loc'h, Paul, Camus-Bouclainville, & Bertagnoli, 2016). Finally, some post-release animals are found to be more likely to be struck by cars because they are unaware that vehicles pose a risk and do not know how to avoid them because they were not raised in an environment where cars were a danger (Grueber, et al., 2017). Captive breeding presents many variables that cause post-release populations to deteriorate. However, many of these variables are independent of conservationists’ best efforts. Therefore, rather than apply captive breeding individually, it would be helpful to understand whether this method was more effective in the long-term when combined with other methods, such as disease intervention or protection from predators and human activity.

In addition to understanding whether captive breeding is a viable technique for stabilizing a population long-term, alternative methods should be investigated to determine whether they are more likely to sustain a vulnerable population. Research suggests that translocating endangered species is more likely to result in a stable, increased population size, whereas reintroduction of captive-bred animals result in a diminishing population over time (Moraes, et al. 2017). However, genetic variation is also a concern for translocation programs. In efforts to maintain the diversity among a relocated population, individuals should be brought from as many different natural locations as possible (Dresser, Ogle, & Fitzpatrick, 2017). Although translocation may
not be as commonly implemented in conservation plans as captive breeding, it may result in
more effective conservation long-term.

Although captive breeding is a common last resort for the survival of many endangered
or threatened species, this method should not be considered a guaranteed fix for a diminishing
population. It should still be regarded as an experimental approach that may initially result in
greater reproductive output of a species, but may still cause long-term dangers to a population.
Further research should be conducted for each species in focus of a captive breeding program
before this method is applied.
Chapter 3 – “Success” Meaning and Analysis

To analyze the case study of Global Greengrants Fund’s grants, I created a definition of “success” to evaluate all grants by the same standard. I define success of a conservation program by its adherence to the following four criteria. First, whether the conservation program continued as long as it was intended to or whether it was discontinued because the project ran out of funding or ran into other significant problems. Second, did the program comply with or change existing policy, culture, and societal norms? Clash with these three factors could lead to an unsuccessful program if primary research was not conducted to predict whether the program would coexist with existing infrastructure of the area (Moser & Boykoff, 2013). However, changing a destructive policy for the better may relieve a threat to the given endangered population. Third, did the program stabilize or increase the endangered/threatened species population? A conservation program can be executed well but remain unable to increase the number of individuals, consequently failing to preserve the threatened population. Fourth, was the program completed according to the original plan? Otherwise, if action was taken differently than how it was intended or not completed at all, the results of the program may be compromised. These four criteria were used to establish a score from 0 – 4, then converted to a percentage; if a project received a score of more than 50%, it was considered successful. This creates a useful metric to compare various endangered species programs, even if the programs’ methods and execution differ greatly from one another. It is a simple, straightforward and time efficient analysis of success. This framework is useful because it allows conservationists to evaluate and compare dissimilar programs and identify factors which lead to higher scores among various programs.

Below, I cite and rate follow-up reports from Global Greengrants Fund’s grant-funded endangered species conservation projects. To narrow down the number of projects analyzed, I
only considered grants distributed to organizations in Russia and grants that produced follow-up reports, so that all the grants analyzed were similar in their location as well as their project goals. I chose Russia because a substantial number of grants pertaining to endangered species conservation projects came from the Russian advisory board. The examples below exemplify how my criteria can be employed to judge whether a program was “successful” and if not, what components of the project likely caused it to fail. This tool can be used by researchers and conservationists to evaluate their own conservation programs or learn from other organizations’ work.

This framework is unique and useful because it analyzed the degree of success of GGF’s projects by evaluating their success throughout the entire process of the projects, rather than only examining the results, such as through a simple measure of population size. Also, the methods used by the grantee organization are stated to allow for comparison to the ranking of common successful methods found in the meta-analysis. First, the methods are stated by the category of methods they would fall into if analyzed by my meta-analysis after the methods were consolidated into themes. In order to provide a more detailed explanation of each project, I stated in parentheses each project’s more specific methods as they would have been classified in my raw data collection, before methods were categorized. Methods are stated in this way to allow a clear comparison between the methods of the meta-analysis studies and those of the case study projects. The framework is shown below.
Framework of Criteria for Success:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Did the program continue as long as it was intended? What was the duration of the program?</td>
</tr>
<tr>
<td>2</td>
<td>Did the program coordinate well with pre-existing policy/policymakers and/or coexist with current culture and social standards? Did it change any of these?</td>
</tr>
<tr>
<td>3</td>
<td>Did the program increase or stabilize the population of the endangered/threatened species in focus?</td>
</tr>
<tr>
<td>4</td>
<td>Did the program’s execution follow the conservationists’ plans?</td>
</tr>
</tbody>
</table>

Analysis of GGF’s Grantee’s Reports per the Framework of Criteria for Success:

58-007 Report

1 Yes, about 9 months.

2 Yes. There was support and involvement (which increased by the end of the project) from the community, suggesting positive cultural assimilation. However, there was some trouble with changing foreign monetary exchange, which increased prices of goods and the organization had to re-evaluate some items they planned to buy.

3 N/A (Yes). The report just documented number of moose, but did not measure whether it increased the population. Habitat was successfully created (houses for birds) and food was supplemented. Increased food and habitat may increase the population of these two species.

4 Yes, followed plans.
- Methods: habitat efforts (habitat restoration and protection), third party involvement (community support/involvement/education/awareness, cooperation of authorities/action by stakeholders/officials), research & inventions (field research), aid to individual animals (food/nutrient supplementation)
Concluded Score: N/A. (3/4, 100%)

53-451 Report

1 Yes, 3 months.

2 Yes. Did not seem to go against existing culture.

3 N/A (Yes). The population of salmon was not directly measured, but number of offenses of poaching decreased and amount of bio-resources (caught salmon) seized decreased, even though number of poaching raids slightly increased, meaning that poaching decreased, which implies success and most likely leads to increase in the salmon population.

4 Yes. The program monitored poaching, but did not specify whether the information collected was made available at regional and local levels, as was in the plans. Did not state whether an advocacy campaign was established, which was also in the original plan.
- Methods: prevention of harmful human actions (anti-poaching)
Concluded Score: 4/4, 100%
58-288 Report

1 Yes, 6 months.
2 No, corruption in the area has prevented authorities from taking action when they received reports of violation of nature protection legislation. Continued exploitation of forests and felling prevents successful reproduction and increases death of offspring of birds. Nests destroyed by logging and caused anxiety in individuals. In conclusion, the anthropogenic activities that threaten the livelihoods of birds are unchanging and are stronger than protective legislation.
3 No, stock of free-living individuals decreased and mortality is beginning to outweigh birth rates. "Disappointing results" were found because numbers of birds are declining due to threatening human activities, which violated nature protection legislation, and authorities ignored reports of violation.
4 Yes, plans were followed.
  -Methods: field research, third party involvement (community support/involvement/education/awareness)
Concluded Score: 2/4, 50%

58-305 Report

1 Yes, 6 months.
2 No, did not coordinate well with policymakers. Meetings with rural and district administrations were held as needed. However, the village council’s application for a protected area of municipal significance was refused by the head of the district. Also, the head of district did not recommend any activities to villagers for action to protect the species. Citizens could not publicly discuss the possibility of creating a protected area and were not allowed to create a protected area by collecting signatures of citizens. However, the village population showed support of conservation efforts.
3 N/A (No). It can be assumed that there was not a likely improvement because the proposal for protected area was refused, and it was not possible to hold discussions among the public about creation of protected areas in local communities. Therefore, multiple endangered species’ habitat was not protected, leaving the species to presumably continue to decrease.
4 No, plans to create a protected area were not completed.
  -Methods: third party involvement (community support/involvement/education/awareness, cooperation of authorities/action by stakeholders/officials), habitat efforts (newly protected areas), research & inventions (field research)
Concluded Score: N/A (1/4, 25%)
**55-958 Summary**

1 Yes, unknown duration.

2 Yes, educational program addressed current culture because anthropogenic activities (often illegal) are threatening the population of snow leopards.

3 N/A (No). Population data was not collected, but the results of the program seem positive. Authors of the report consider the program successful because it increased interest and participation among local people, including youths. New partnerships were formed between nature and educational organizations. Although these qualities of the program were positive, they do not indicate a strong likelihood that the population increased.

4 Yes, followed plans.

- Methods: third party involvement (community support/involvement/education/awareness)

Concluded Score: N/A (3/4, 75%)

**57-687 Report**

1 Yes, 5 months.

2 No, the policy that was implemented was not followed. Policy change: authorities forced to monitor the field/habitat more closely and changed their policy on grievance. Report stated the forest ministers were not ready to process trouble during this time due to legal corruption. The project administrators called for a witness protection program because witnesses tend to withdraw their evidence/statements of sightings.

3 N/A (No). It is likely that the population did not improve because although they did not quantify population size before or after program implementation, 13 orangutans were trapped in a deadly situation, which was reported to the forest ministry (authority) and 5 were left behind. Also, multiple accounts of killing of 3 orangutans were reported and no action was taken by the authorities.

4 No. there were plans to create a protected area, which started to be completed but authorities did not abide by their commitment to protect the habitat area from companies continually destroying the land, so these plans were incomplete. Therefore hunting, farming forest, and illegal logging continued.

- Methods: habitat efforts (newly created protected areas), third party involvement (cooperation of authorities/action by stakeholders/officials), efforts for individual animals

Concluded Score: N/A (1/4, 25%)

**59-554 Report**

1 Yes. More than a year.

2 Yes. Successfully persuaded local people to switch from unsustainable to sustainable farming crops that benefitted the species in focus.

3 N/A (Yes). Did not track population but efforts to regrow forest (habitat restoration) were successful.

4 Yes.

- Methods: habitat efforts (habitat restoration), third party involvement (community support/involvement/education/awareness)

- Overall Score: N/A (4/4, 100%)
While this case study accurately demonstrates how to employ this framework, a major difficulty in fulfilling the criteria was present in that the grantees failed to quantify the population of the species in focus before and/or after the completion of the project. This was true for five out of the seven grants analyzed. Failure to determine the effect on population makes it impossible to determine the adherence to criteria 3 of my framework. Therefore, reports lacking this information were difficult to analyze for overall success. However, simply because a program did not measure the number of individuals in a population, does not necessarily mean the population did not increase, stabilize, or improve in some way. It is not surprising that these projects do not quantify the species’ population because the grants are given to small organizations that likely do not have the financial means required to track and record individual animals. This suggests that failure to quantify a population is not a negative reflection on results of the project, but an indication of the limited resources of the grant-receiving organization.

Still, many follow-up reports present information suggesting whether the project was successful or not, or the organization provides a reason why they consider their project as successful. If statements in the follow-up report suggested that the population in focus would likely be better off after the program’s efforts, or the organization writing the report gave reasons why they believed the program was successful, I assumed the score of criteria 3. These assumed scores were displayed in parentheses to differentiate them from grants that provided specific answers to every criterion. For example, reports 58-305 and 57-687 planned to create newly protected areas in attempts to ease the threat imposed on endangered species. However, since these organizations failed to establish these protected areas, and in the case of report 57-687 animals continued to be documented as deceased, it is likely that these populations continued to decline, therefore an assumed 0 was credited for criterion 3. Also, these projects received a 0 for
criteria 2 and 4 due to the friction with policymakers or authorities and the inability to follow the original plans, resulting in an assumed overall score of less than 50%, making them unsuccessful.

Another grant whose results can be assumed is 59-554, whose mission was to regrow forest as habitat for endangered elephants. The regrowth was successful, which provided habitat and reduced human-wildlife conflict. If these two factors were the major causes of elephant decline in this area, which information in the follow-up report leads me to believe, it can be assumed that the population improved as a result of the project. Therefore, the project received an assumed overall score of 100%, meaning it was successful. However, it is not completely certain that the elephant population improved because other factors could inhibit regrowth of the elephant population that were not the original cause of decline.

Another example, report 53-451, did not track the number of salmon expected to exist at the beginning or the end of the conservation efforts, but tracked the number of poaching offences and the number of caught salmon that were discovered. Both of these variables decreased throughout the project, suggesting that the number of live salmon in the lake increased or stabilized, making the project successful. However, without being able to answer criterion 3 with certainty, it is still somewhat unknown whether the decrease in poaching improved the salmon population. Therefore, “success” should be considered with caution.

As seen in these examples, it is not common for small-scale conservation projects to measure the change in a species’ population resulting from their efforts. Therefore, determining success and long term effectiveness of the conservation efforts on the population is very difficult. Further, difficulty or inability to measure their success prevents an organization from knowing
whether to continue employing past methods or what to change among those methods (or other components of the plans) in order to improve their conservation effectiveness.

Another conclusion that can be drawn from the case study is the trend for a conservation project to fail due to problematic cooperation with authorities or policymakers. One grant that was not successful, report 58-305, failed to establish a protected area for a threatened species due to refusal of the proposal by policymakers. This project’s execution failed to fulfill the second criterion and the method of involvement by a third party was unsuccessful in fulfilling the project’s goals. Also, report 58-288 proved to be unsuccessful (receiving a 50% score via the criteria) and did not adhere to the second or third criteria due to corruption of local authorities; the authorities failed to protect the species and their habitat from threats, even though they were obligated to do so according to legislation. So, even though this project did not intend to explicitly use third party involvement in the way of cooperation by authorities and actions by stakeholders, this factor still proved to be the catalyst of the project’s failure.

Third, report 57-687 resulted in a 25% score, their only successful criterion being the completed duration of the program. This grant also experienced significant problems with authority. The organization implemented policy change and established a protected area through consultations with authorities who agreed to the terms of the policy change. However, when the organization alerted authorities of sighted killings of protected individuals, authorities did not act. Also, the authorities allowed illegal logging, hunting, and farming in the forest which was designated as protected. Habitat was continually destroyed and the species’ population continued to experience killings of individuals. Therefore it can be assumed that the population continued to deteriorate. Further, the report states that the organization believed that participation from
authorities was already difficult to achieve due to a corrupt legal system and lack of needed protection for witnesses of animal killings.

In conclusion, the only three programs that failed all failed for the same reason: the inability to cooperate with policymakers and authorities. This means that these projects’ adherence to the second criterion was absent and/or the implementation of the “third party involvement” method failed. Although the themed method of “third party involvement” included the more specific methods (consolidated from my raw data) of “community involvement” and “cooperation of authorities/actions by stakeholders/officials,” only the latter method was seen in all unsuccessful grants. Only one grant used “cooperation of authorities/actions by stakeholders/officials” method alone and it was not successful. Two out of the three grants that used “community involvement” without the authority and stakeholder method were successful. Two grants used both types of “third party involvement” and one was successful and one was not. Therefore, on the basis of this one program the combination of these two does not make the program more or less likely to succeed. Most importantly, the failed implementation of this method contributed to the destruction of the entire project. This finding proves the importance of compliance from stakeholders and authority in the success of the case study grants.

Further, other projects were successful without the implementation of this method at all. This proves that the cooperation of authorities and stakeholders does not necessarily indicate success, but if an attempt to implement this method fails, the project may be more likely to be unsuccessful. However, it is possible that this trend is simply a correlation. Still, it remains a noteworthy correlation which deserves further exploration to determine whether it is a limiting factor on a conservation program’s success. Also, the combination of adherence to the second criterion and the use of the involvement by third parties (cooperation of authorities) may be a
more precise indicator of failure or success of a project, since this combination was present in every unsuccessful grant report. It is important to note that although “cooperation of authority” is grouped in the category of “third party involvement” in the consolidated results of the meta-analysis, the raw data would categorize any type of community support (involvement, education, awareness) separately from cooperation of authorities/actions by stakeholders/officials and legislation/policy change. This is noteworthy because grants 55-958 and 59-554 were successful overall and employed the method of third party involvement, but more specifically, both grants used community support. Therefore, the previous assumptions about third party involvement are only implied if the involvement is by authority or policymakers.

The use of this “success” framework can quickly and simply determine whether an endangered species conservation program accomplished its goals and whether the efforts are likely to stabilize a threatened population. The framework can be used with any type of program, no matter what methods were used because a score is created which is comparable across different studies. Also, it identifies the areas of the program that were not executed well, suggesting the cause of downfall of the entire program. Understanding what factors influenced the failure of the program allows conservationists to repair the problem or change their plans accordingly for the future programs.

Since I analyzed whether more methods used in a particular study led to greater success among studies in the meta-analysis, I examined the same factor for the GGF case study grants. To do this, I counted the themed methods in each follow-up report, not including the raw data methods, to keep this analysis symmetrical to the meta-analysis. In this analysis I found only one project employing a single method, and it was successful. There were two projects employing four methods each, and both were successful. There were two projects employing three methods
each, and both were unsuccessful. There were two projects employing two methods each, and one was successful and one was unsuccessful. Judging by these data, it appears that projects using more than one method are not significantly associated with higher success than those only employing one. It may not be appropriate to claim this assumption is as significant as the same made regarding the meta-analysis because the latter included a wide range of studies and the conclusions of a Chi-Square test. However, this conclusion of the case study builds on the same finding of the meta-analysis.

Subsection: Comparison of this “Success” Framework to Established Success Frameworks

To consider my “success” framework in a fair way, I compare my framework to other established frameworks for analyzing the same principle. First, I compare the Cambridge Conservation Forum framework, evaluation tool, and definition of success. They define successful conservation as “increasing the likelihood of persistence of native ecosystems, habitats, species, and/or populations in the wild (without adverse effects on human well-being)” (Kapos, et al., 2008). The authors categorize the different types of conservation action taken, which is similar to the methods of my meta-analysis. They create a flow chart to show how key concepts of evaluation connect to each other and how they lead to results of the conservation effort. Implementation, outcomes, and effects are the main concepts, with specific methods within them. They then provide a second, more in-depth flow chart with more specific methods within the main concepts of implementation, outcomes, and conservation effect. Although this chart might be useful for this organization to evaluate the conservation methods in their focus, my framework is more concise and easier to use. Also, this tool is fairly specific, therefore may not be applicable to all conservation projects. However, my framework is applicable for all species-focused conservation programs, ranging in size and methods used.
The Cambridge Conservation Forum evaluation tool may be somewhat similar to my framework because part of it is in the form of a few questions with simple answer choices. However, these two broad questions alone cannot determine the level of “success” of an entire project, and employing these questions in addition to either of the flow charts would be very time consuming.

Another study examines Miami-Dade County's Environmentally Endangered Lands (EEL) Covenant Program which defined success of their conservation project using a more anthropocentric lens. This study provides an example of a program to protect environmentally endangered lands by establishing protected areas on privately owned lands through financial incentives for landowners. Success of the EEL program is said to result from partnerships between public and private entities, the government being the public entity and the private being landowners. The authors justify EEL’s believed success by stating that it created public awareness and conservation (Giannini & Heinen, 2014). Although this program was not created for the purpose of protecting endangered species, but endangered lands, it can still be used as a model to compare to my framework of “success.” This study’s version of success is based on the change in human relationships and increased collaboration between authorities and stakeholders. It does not evaluate the conservation impact on the variable the authors attempt to conserve (endangered lands); the fate of the lands themselves by the end of the program should be considered in order to more sufficiently determine “success.” The evaluation of the EEL program proves to be more of an evaluation of whether this program pleased all human parties involved. Whereas my framework evaluates the status of the population of endangered species, as well as whether the program encountered friction with the pre-existing policy in the area (criterion 3).
Therefore, my framework provides a more comprehensive analysis of “success” of a conservation program.

It is noteworthy that the authors evaluating the EEL program concluded that cooperation of stakeholders and authorities proved impactful on the result of the conservation program in that a similar finding was shown to be true in my case study of the GGF grants. The grants proven unsuccessful faltered due to lack of cooperation by stakeholders and authorities. The support from the EEL program evaluation reinforces the notion that this variable influences the results of a conservation program, independent of whether the conservation focus is on endangered species or lands. More specific research is needed to determine exactly how cooperation of stakeholders and authorities influences conservation success and how this factor can be harnessed to increase progress of these programs.

The Washington, Baillie, Waterman, & Milner-Gulland (2015) framework is similar to mine in that it analyzed effectiveness of methods at multiple steps of the conservation process (here, the phases considered are input, output, and outcome). It also determines the factors that affect these stages and which are essential for effective outcomes at each level. The framework was converted into a questionnaire which can be completed in order to analyze multiple conservation acts by the same standards, which is also similar to my evaluation method. However, the questionnaire was sent to hundreds of experts in the field who responded to the questionnaire based on their experience with endangered species conservation. Although the questionnaire called for evidence to support the experts’ responses, the data was not drawn directly from specific conservation programs. Rather, it was based on individual animals and factors that influenced the effectiveness of all the past programs to recover that specific species. Therefore, their results were more of general statements of overall conservation efforts for
endangered species. While general themes may be helpful to grasp, these data conclusions are based only on various individuals’ personal interpretations of all the conservation work they have completed in the past. Consequently, this may skew results depending on whether the individuals misremember or misinterpret said projects. Conversely, my framework directly assesses individual projects themselves, then looks at themes among those results to suggest larger implications within the field of species conservation work. In addition, my framework analyses each project in the exact same way, which reduces bias, as oppose to their framework which relies on various individuals’ account of past conservation work.

Interestingly, the Washington, Baillie, Waterman, & Milner-Gulland (2015) study tracked similar categories of conservation methods as were used in my meta-analysis. For example, “engagement of stakeholders,” “management,” and “education and awareness” were all similar to methods I categorized to analyze the studies in my meta-analysis. Even more significant, engagement of stakeholders (congruent with my method of “third party involvement” in my consolidated methods or “involvement of stakeholders” in my raw data analysis) proved the overwhelmingly highest scoring factor of effectiveness in their analysis, having an almost 5 (4.66) times higher score than all other methods in mammal cases and 6 times higher score in amphibians, other than the one other factor. This finding is significant because it supports the conclusion I found in the Global Greengrants Fund case study that involvement of stakeholders and authority figures is vital in the success of a conservation program.

In conclusion, when compared to established evaluation tools of “success,” my framework proved to be similar, but more concise than others. In addition, two of these frameworks also stress the importance of third party involvement (via stakeholder and authority cooperation) in the effectiveness of conservation programs. Taken as a whole, this factor (when
applied as a method and as a variable of a program’s effective implementation) proved to be a catalyst in my case study as well as within these two frameworks. Therefore, project plans and managers should maintain a positive coexisting relationship with authority and stakeholders throughout conservation work.
Chapter 4 – Discussion

Among the various types of conservation programs analyzed (Web of Science search results and subset of GGF species conservation related grants), most reflect the theme of lacking an evaluation method for conservation results. This was most evident in the Global Greengrants Fund case study where the means were lacking to sufficiently determine whether their grants funded effective projects. Although the organization requests the grant receivers complete a follow-up report, it is often incomplete or very vague. Even when this report is completed, it often lacks essential information, such as the change in a population after a project. Also, through no fault of GGF, the follow-up reports are often in languages other than English which may be translated incorrectly, leading to misinformation. Given these obstacles, GGF grants are difficult to assess, even using my simple framework. However, when all requested information is provided and correctly translated in follow-up reports, GGF still lacks a standard for “success” by which to judge these reports. These major issues force the organization to be uncertain as to whether to continue employing the same methods and funding the same organizations.

A similar lack of information was present in the meta-analysis. Out of 97 studies I documented in the raw data collection, 21 resulted in non-applicable (N/A) responses to whether the study’s efforts increased or stabilized the population being conserved which was the main indicator of success in my analysis. Unfortunately, it was necessary to exclude these 21 non-applicable studies from the data analysis tests. This also meant that the methods employed in these studies were not considered in the hierarchal ranking of commonality in methods of conservation programs. If these studies had disclosed the resulting population change, conclusions of my meta-analysis may have been different with respect to which methods were most common and which methods more often lead to success. As seen in these examples and from external sources in the
literature review, lack of evaluation is a significant, reoccurring problem in the field of endangered/threatened species conservation and must be addressed. This finding urges the establishment of a universal framework to measure conservation “success” or at least a standard definition of the term. Defining a standard and implementing a framework to determine whether a program achieved success would allow conservation planners to critique their projects and communicate their observations to others by the same standard, thus increasing the effectiveness of conservation projects overall and improving the entire field of species conservation.

It is also critical to note in the results of this study, particularly the meta-analysis, that no specific method was found to significantly lead to “success” of the program overall. Conversely, my case study of GGF’s grants found that some factors may more powerfully influence the likelihood of failure rather than the likelihood of success. For example, implementing the method of “3rd party involvement,” (specifically stakeholders and authority) even when employed successfully, does not guarantee a successful project overall. Further, improper application of this method or failure to meet the second criterion, which regards a similar variable, were both seen to lead to failure. The second criterion of the evaluation framework addresses the relationship with authority. When this criterion is not met, the program is more likely to fail because a negative relationship with authorities is likely to impede most conservation plans.

Most importantly, the finding that no one method significantly led to success implies that one specific method cannot be applied to all conservation projects and yield the intended results. In a way, this is positive because it implies that there is no one single successful method that may be expensive or resource/time consuming to implement, which would therefore be out of reach for small, modestly-funded organizations. On the other hand, this finding implies that methods must be chosen based on a case by case understanding of the variables, such as species’
biological and habitat requirements. This will require more time and trial and error experience to fully understand the technique that would be most beneficial in each circumstance.

Considering the finding (in the meta-analysis and case study) that the number of methods at work in one study does not significantly impact “success,” further strengthens the urgency for conservationists to fully grasp the dynamics of how methods work together and which combinations of methods are more effective than others. This finding also stresses the importance of understanding the cause behind a species’ decline so that the appropriate type and number of methods are used to address multiple threats. For example, report 53-451 used only one method and was assumed to be successful; this could be due to this population only experiencing one type of threat, which was poaching. Therefore, anti-poaching methods were successfully implemented and population improvement was assumed. However, if an additional threat also posed a risk to this population, more than one method may be necessary to relieve this population.

Additionally, there may be certain methods capable of mitigating a multitude of threats, such as the creation of a “newly designated protected area,” which could regulate poaching, restore habitat, and remove invasive species. This umbrella method may be easier to implement because it is one unified plan versus attempting to enact the latter three methods independently. In conclusion, research is needed to recognize what methods alone or in combination result in the most effective conservation overall.

Further Study

There were many ways in which my study could be narrowed down or altered in order to obtain more specific results, which may provide more significant implications of success. For
example, the same meta-analysis could be run specific to a certain taxa of animal or geographic location. Perhaps certain taxa are more influenced by certain methods of conservation or are simply more responsive to conservation efforts in general. Also, some methods may work better together than alone (Ferrer, et al., 2014). While my study found that employing multiple methods (rather than just one) did not influence success, I did not look specifically at the success of specific combinations of methods versus others. Also, I did not consider the time variable. It was difficult to narrow down for time since I was analyzing a large number of studies conducted by other researchers. However, certain methods may yield higher success rates in the long-term outside the parameters of evaluation of the original study. With these modifications, another meta-analysis may yield more significant results.

Further study could analyze the cause behind one of the most glaring observations throughout my study, that is, why do conservation organizations lack working frameworks to evaluate the outcomes of their efforts? One perspective that could be taken to understand why so many species conservation organizations fail to establish such criteria is to analyze which conservation organizations adhere to their own or another scholar/organization’s framework. As presented in my third chapter, some scholars have shaped “success” frameworks, but the reports fail to disclose whether any organizations utilize them. There may be variables, such as size and wealth of an organization that may increase the likelihood of their establishing an evaluation framework. For example, as seen in the literature review, the Nature Conservancy, which is well funded and established, is increasing the specificity and relevance of their determinants of success to more fully encompass all aspects of a project (Sawhill & Williamson, 2010). Further, many studies fail to track the number of individuals of the species being protected, which reduced the number of studies I could sufficiently analyze. Therefore, it would be useful to know
what factors contribute to the ability of a program to quantify the number of individuals in a population, before and after conservation measures are taken. Perhaps if this were understood, missing resources could be granted to organizations lacking the ability to quantify populations, thus yielding their programs more conclusive results and providing more data to the entire field concerning successful conservation methods.

**Recommendations**

Global Greengrants Fund’s current system of evaluation (the use of follow-up reports) summarizes the outcomes of their grant projects in voluntary, open-ended, and vague reports from the grantees. While the organization is restricted in the sense that both the monetary amount of the grants and the organizations receiving the grants are both small, I believe asking more specific questions in the follow-up reports could help narrow down the assumptions of the results. This may be difficult for GGF because they use a universal follow-up report outline for all of their grants, not only endangered species conservation projects. Since this is the case, questions in the report form are general and mostly based on anthropocentric determinants. The questions most pertinent to understanding the results for a population after a conservation project ask what general changes were seen after the project and whether there were any improvements to the environment. Therefore, responses substantive enough to determine a score for the program based on my framework were provided voluntarily by grant receiving organizations after prompting by the questions in the report outline. To improve GGF’s method of evaluation, a unique follow-up form could be created consisting of questions specific to endangered species conservation efforts and outcomes. Such a questionnaire might ask: was there was any measure of change in the population in focus, if so, what was the change? What were community and policy attitudes toward the species before and after the project? Did threats to the population...
decrease or increase? Asking these questions could provide more information which could be used to respond to my success criteria or GGF’s own standard of success, should they establish them.
Conclusion

Although the case study and the meta-analysis judge conservation efforts on different scales, the comparison was useful to determine whether the size of the organization and amount of funding for their projects affected the trends in commonality of methods. In general, the projects in the GGF case study employed similar methods as were present in the meta-analysis, even though the overwhelmingly most common method in the meta-analysis, “captive breeding,” was not employed in GGF projects, (with the exception of one grant) even in the large dataset of 1,773 GGF species conservation projects. However, the second most commonly used method, “habitat efforts,” was seen more frequently in these GGF’s projects in the case study of follow-up reports and the large dataset of GGF species grants. Perhaps this is due to the ease of implementation and cost effectiveness of habitat efforts over captive breeding programs making them applicable for large and small scale operations; whereas captive breeding programs require abundant knowledge, time, and resources to complete. While the use of habitat efforts among GGF’s grants was more frequent than captive breeding, the former method still only comprised 4.40% of total GGF grants relating to species conservation work. The infrequent use of these two methods among GGF funded projects, which were the two most common methods found in the meta-analysis, proves the considerable difference in the commonality of methods practiced in small-scale versus large-scale conservation organizations.

While no method among the meta-analysis produced significantly successful outcomes (based on the Chi-Square tests), some methods were considerably more commonly employed than others. These results are formatted into a hierarchy of commonality. However, the method found to be the most common, “captive breeding,” proved highly unreliable in the effectiveness of its implementation and the longevity of its effects on a released population (as reviewed in the
literature, see Chapter 2 Subsection). This finding proves choosing a conservation method is not as simple as employing the most commonly used method. Further, factors specific to each conservation situation such as habitat quality, threats to the population, and animal physiology must be sufficiently understood before deciding on a conservation method in order to gain the best chances of achieving “success.”

Most unsuccessful GGF projects’ downfalls were due to failure of authority or stakeholders to cooperate with conservation efforts or engage in their end of agreed upon conservation plans. Noteworthy among the case study reports was the finding that projects attempting to employ the method of “cooperation by authorities/action of stakeholders or officials” failed to successfully implement agreed upon action from these parties, which led to project downfall. On the other hand, projects employing “community involvement” were mostly (2 out of 3) successful, even though they both fall under the themed method of “third party involvement.” Failed implementation of the authority/stakeholder method and corruption of authority/stakeholders or their failure to respect the established conservation action proved to be a crucial downfall in the case study projects. This emphasizes the importance of positive relationships with these groups for the accomplishment of project goals. Further, it would be interesting to know whether separating these two types of “third party involvement” resulted in more significant correlations with success in the meta-analysis because they were grouped together as one theme during the statistical tests and did not yield significant results.

To exemplify factors I believe are important in determining whether a species conservation program was successful, I created a straight-forward evaluation framework which can be applied to various conservation programs. This framework sets an example for an evaluation tool which must be established in order for all conservation organizations to
understand and accept the principles of a “successful” conservation project. Most importantly, the case study exemplified how the criteria were able to highlight specific areas of the project that led to its downfall. Also, it asks for a statement of the program’s methods, which is another way to compare factors that may be linked to success across projects and organizations. Overall, this standardized evaluation tool allows for an exchange of information within and between organizations which is crucial to understand and correct the faults of plans, ultimately bettering future action.

However, my evaluation framework requires sufficient data regarding the program’s outcomes, otherwise its adherence to the criteria cannot be determined. There may be just enough information provided in most case study reports to suggest results of a program’s actions which allows for the creation of an assumed score. However, this score is not as reliable as a score created with all the necessary information. Relevant data to determine whether the species’ population increased or stabilized in order to respond to the third criterion was the most important information absent in the case study. Although my framework proves simple, precise, and universally applicable when compared to other evaluation tools, it still presents an inability to be answered with certainty when it is practiced on individual conservation actions.

Lack of evaluation is a reoccurring problem highlighted throughout this study. Establishing a clear evaluation method as well as providing the sufficient data to fulfill its criteria merits obvious value which is explained in my study. First, the studies which provided enough information (effect on population stabilization) in my meta-analysis explained the link to success and provided data leading to conclusions regarding the most common methods. Conservation organizations that have the means to track population numbers throughout the course of their projects must do so in order to fully understand whether their efforts have made a
significant impact. The studies lacking this information were not included at all, showing that, although their efforts were for a good cause, their results were not taken into consideration in the overall research. This tells a larger story of the lack of evaluation conclusions causing valuable information to be lost resulting in different implications for my study and others. Lack of evaluation is a prevailing theme that prevents this field from learning from each other’s mistakes and accomplishments. In an area of conservation that needs as much help as it can get, absence of a standard criteria for a term as important as “success” largely decreases the viability for communication between entities of action, leaving teams of conservationists fighting independent, losing battles against the race of the sixth extinction.
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vulnerability of Tasmanian devils to vehicle strike following release to the wild. *Scientific Reports, 7*(1), 2161.


https://www.gviusa.com/blog/10-best-organisations-to-follow-help-endangered-animals/


### Appendix 1 – Raw Data Methods & Themed Data Methods Descriptions

<table>
<thead>
<tr>
<th>Raw Data Methods</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Captive Breeding/Rearing</td>
<td>This includes individuals brought as eggs or juveniles and reared in captivity, as well as individuals born directly into captivity from two parents already living in captivity. This can include a large or small amount of time actually maturing in captivity, what qualifies this method is the birth of an individual in captivity rather than the wild.</td>
</tr>
<tr>
<td>Soft Release after Captive Breeding</td>
<td>This includes releasing individuals into a somewhat protected/monitored area of a natural habitat that allows captive-bred organisms to become acquainted with their habitat before being fully reintroduced to an area, in hopes that this will acclimate them to their surroundings and increase their awareness of potential threats.</td>
</tr>
<tr>
<td>Reintroduction/Translocation</td>
<td>This includes individuals brought from one location that supports a stable population to a new habitat location or a location where the species once existed but is now extinct or severely endangered.</td>
</tr>
<tr>
<td>Habitat Restoration/Protection</td>
<td>This includes any intentional human action to create new habitat for a species or to protect a habitat a species already lives in.</td>
</tr>
<tr>
<td>Artificial Insemination/Genomic Banks/Genetic Management (for Anti-Inbreeding)</td>
<td>This includes artificially inseminating individuals and releasing them into the wild to give birth or taking measures to reduce the genetic inbreeding of a small, endangered population.</td>
</tr>
<tr>
<td>Community Support/Involvement/Education/Awareness</td>
<td>This includes using the community directly in conservation efforts or simply informing the community about reducing threats to a species. &quot;Community&quot; means the local people living in/around a species' habitat.</td>
</tr>
<tr>
<td>Conservation Inventions/Technologies</td>
<td>This includes the creation or use of any technology or device that specifically contributes to the conservation effort. It does not include technology used to monitor a population or measure conservation efforts.</td>
</tr>
<tr>
<td>Predator Control</td>
<td>This includes protection from or removal of a species' natural predators. This does not include any interference with invasive species or human predators.</td>
</tr>
<tr>
<td>Cooperation of Authorities/Actions by Stakeholders or Officials</td>
<td>This includes cooperation or active involvement of anyone who can be categorized as an official, a stakeholder, or a member of authority in conservation plans.</td>
</tr>
<tr>
<td><strong>Removal of/Protection from Invasive Species</strong></td>
<td>This includes removal of or protection from any non-native species that threatens the species or the species' habitat. &quot;Invasive&quot; species includes non-native plants and non-native animals.</td>
</tr>
<tr>
<td><strong>Monitoring/Treatment for the Sick/Light Intervention</strong></td>
<td>This includes efforts by conservationists to monitor a species for sick or injured individuals, bring them into captivity, rehabilitate them, and eventually release them back into the wild. This only constitutes light intervention and is based on action taken for individual animals as these problems present themselves.</td>
</tr>
<tr>
<td><strong>Disease Vaccination</strong></td>
<td>This includes conservationists vaccinating individuals of a wild population for diseases they are vulnerable to.</td>
</tr>
<tr>
<td><strong>Food/Nutrient Supplementation</strong></td>
<td>This includes implementing extra food or nutrients to food for a species to consume in their wild habitat.</td>
</tr>
<tr>
<td><strong>Newly Designated Protected Areas</strong></td>
<td>This includes creating area of habitat for a threatened species that is designated as &quot;protected&quot; by rules, laws, or officials from outside influence/threats. This includes reducing or prohibiting large-scale logging operations and destructive human recreation.</td>
</tr>
<tr>
<td><strong>Financial Incentive</strong></td>
<td>This includes any monetary-based program, such as paying private land owners for participation in conservation plans.</td>
</tr>
<tr>
<td><strong>Field Research</strong></td>
<td>This includes conservationists going into a species' habitat and completing research about a species' reproduction, habitat preferences, biology, etc. Also includes any gathering of information which conservationists feel is needed to improve the species' survival.</td>
</tr>
<tr>
<td><strong>Prevention of Animal Harvesting by Humans</strong></td>
<td>This includes regulation on or complete prevention of individual human actions such as poaching, timber collection, fishing, etc. This differs from designation of a protected area because it puts in place single, specific regulations on human behavior, instead of protecting the entirety of a habitat from most human influence.</td>
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<tr>
<td><strong>Species-Specific Spending/Recovery Planning</strong></td>
<td>This includes species recovery plans which state specifically that funds were only spent on one species and the authors believed this factor contributed to the result of the study.</td>
</tr>
<tr>
<td><strong>Hand-Rearing Animals</strong></td>
<td>This includes the action by conservationists to spend a significant amount of time physically holding captive-</td>
</tr>
</tbody>
</table>
bred juvenile animals throughout their maturity before they are released into the wild as a deliberate means of conservation.

Managing Human-Wildlife Conflict

This includes taking any action in hopes of mitigating threats to a species' population caused by conflicts between humans and the species, such as elephants raiding people's crops and being killed or hurt by humans as a result.

Success - in project completion

"Success" here means the project continued for as long as it was intended to, as opposed to being cut short due to complications or lack of funding.

Success - in species population stabilization/increase

"Success" here means the conservation efforts proved to contribute substantially to the stability of a species' population.

<table>
<thead>
<tr>
<th>Consolidated Method:</th>
<th>Raw Data Methods Included in Consolidated Method:</th>
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<tr>
<td>Captive Breeding</td>
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Appendix 2 – Themed Methods Data Table

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