RECOVERING AMERICA'S WILDLIFE ACT OF 2022

WORKSHOP IN APPLIED EARTH SYSTEMS MANAGEMENT, SUMMER 2022

American bison, *Bison americanus*

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Ferret, *Mustela putorius furo*

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EXECUTIVE SUMMARY

Biodiversity is increasingly in crisis as populations of wildlife decline and species are being driven to extinction. Currently, there are more than 142,500 species on the IUCN Red List of Threatened Species with more than 40,000 species at high risk of extinction (IUCN, 2022). In North America, one-third of all known species are at risk of extinction (Almond et al., 2020). With this in mind, every species has some risk of extinction, but the classification of species as threatened or endangered is based on elevated risk. Some, but not all, risks include small population size, small or decreasing spatial extent, rapidly declining species numbers, or the degradation of livable habitats. Populations of North American birds have declined by 29% from a combination of factors including habitat loss and chemical pollution and 30% of the plant pollination network has disappeared (Rosenberg et al., 2019; Almond et al., 2020). These population declines are the result of habitat loss and direct exploitation, driven by anthropogenic activity from urban development to climate change.

The existing wildlife conservation laws, principally the Endangered Species Act (ESA) and Pittman-Robertson Act, lack sufficient funding. Though the ESA has been successful at preventing extinction by identifying causes of decline, providing legal protections for both the populations and their habitats, and requiring a recovery plan for listed species, only 46 species – or about 3.5% of listed species – have ever been removed from the list as recovered populations (WWF, n.d.). According to the Center for Biological Diversity, an estimated $2.3 billion will be required annually to effectively implement existing recovery plans for endangered species in the United States and its territories (Greenwald et. al, 2016). The Pittman-Robertson Act, which currently provides funding for conservation, provided $700 million in 2021, only about 30% of the need. The Recovering America's Wildlife Act of 2022 would address this gap in funding by offering additional fiscal support of over $1 billion per year, drawn principally from environmental damage funds, to support wildlife conservation.

This report examines the biodiversity crisis, conservation obstacles, and solutions proposed by the Recovering America's Wildlife Act of 2022. This Act was introduced by Congresswoman Debbie Dingell (D-MI) in the U.S. House of Representatives and has already passed with bipartisan support. It was introduced in the U.S. Senate by Senator Martin Heinrich (D-NM), and as of August 2022, the bill has been debated in committee but has not yet been taken up for a vote.

The Importance of Biodiversity

Bumble bee, *Bombus*

Biodiversity is the essential living infrastructure that supports the planet, including human life. Biodiversity provides the foundation for nature-based solutions to many of the most critical environmental, economic, and social challenges that we face as human society, including the effects of climate change, sustainable development, health, and water and food security. Preserving biodiversity is an investment in ecosystem services that will pay off, both today and in the future.

Public Health

For as long as the human species has practiced medicine, the products of nature have been the foundation for curing illness. This remains true today; globally, 35% of new drugs and 70% of cancer treatments are derived from natural products (Brauman et al., 2020). Modern medicine is intertwined with biodiversity – roughly 70,000 medicinal plant species provided pharmaceutical companies and other medical traditions the chemical foundation for staple drugs and natural remedies (Brauman et al., 2020).

In addition to medicine, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Global Assessment Report links biodiversity to air quality, water quality, the intensity of natural disasters, and even the spread of pathogens (Brauman et al., 2020). In forests and wetlands, water quality depends on microorganisms, fungi, plants, and animals, biological communities whose functions may be compromised by biodiversity loss (MacDonald, 2020). When native plant and microorganism populations decline, drinking water quality will also be affected (MacDonald, 2020). For example, biodiversity plays a key role in the maintenance and function of tidal marshes, which clean water by trapping sediments, cycling nutrients, and retaining chemicals and metals (Peterson et al., 2008).

Biologically diverse ecosystems may prevent the spread of forest fires by regulating fuel, modifying hydrology, and dissipating energy (Brauman et al., 2020). Evidence from California, an increasingly fire-prone region, shows that when a forest is rich in diversity of understory plant and animal species, fires are significantly more likely to burn at more moderate intensities compared to forests with low plant and animal diversity (Richter et al., 2019). Note, however, that biodiversity is only one element of forest fires risk.

Culture

Nature forms the basis for a range of religious, spiritual, and social experiences: providing a sense of place, purpose, belonging, and connectedness associated with different entities of the living world (Diaz et al, 2018). This is especially true for indigenous peoples, many of whom consider their societies to be integrated elements of nature, and nature as an integrated element of culture (Descola et al., 2013). Pronghorns and wild turkeys are both culturally significant to the Pueblo tribe in Santa Ana, New Mexico (Connected corridors, n.d.). Both of these species went locally extinct, but the tribal leaders worked to create wildlife corridors and reintroduce them, which they did successfully in 2005 (Connected corridors n.d.).

Biodiversity and the natural world play a strong role in shaping the identities of people. Small-scale fishing is not only about food and income, but also about fishermen's way of life. In many situations, cultural services are among the most important values people associate with nature. An example of this is fisherwomen in Brazil who account for about half of all fisheries in the country and whose identities are created from a young age because children take part in fishery activities (Santos 2015). Fishing is both crucial to identifying and maintaining household livelihoods (Santos 2015).

Agriculture

Certain animals, such as pollinators, are vital to agriculture. Without pollinators, more than 35% of global food production, an estimated US$235-$577 billion, would be lost annually (based on 2009 market prices, inflated to 2015 US$; Potts et al., 2016). The agricultural benefits of pollinators are variably distributed around the world (Figure 1). Currently, habitat loss, pollution, and other anthropogenic factors threaten 40% of invertebrate pollinator species and 16.5% of vertebrate pollinators with global extinction (FAO, n.d.). These declines in animal pollinators could have significant negative consequences on the level and stability of pollination of crops, and, therefore, on the quality of human life (Potts et al., 2016).

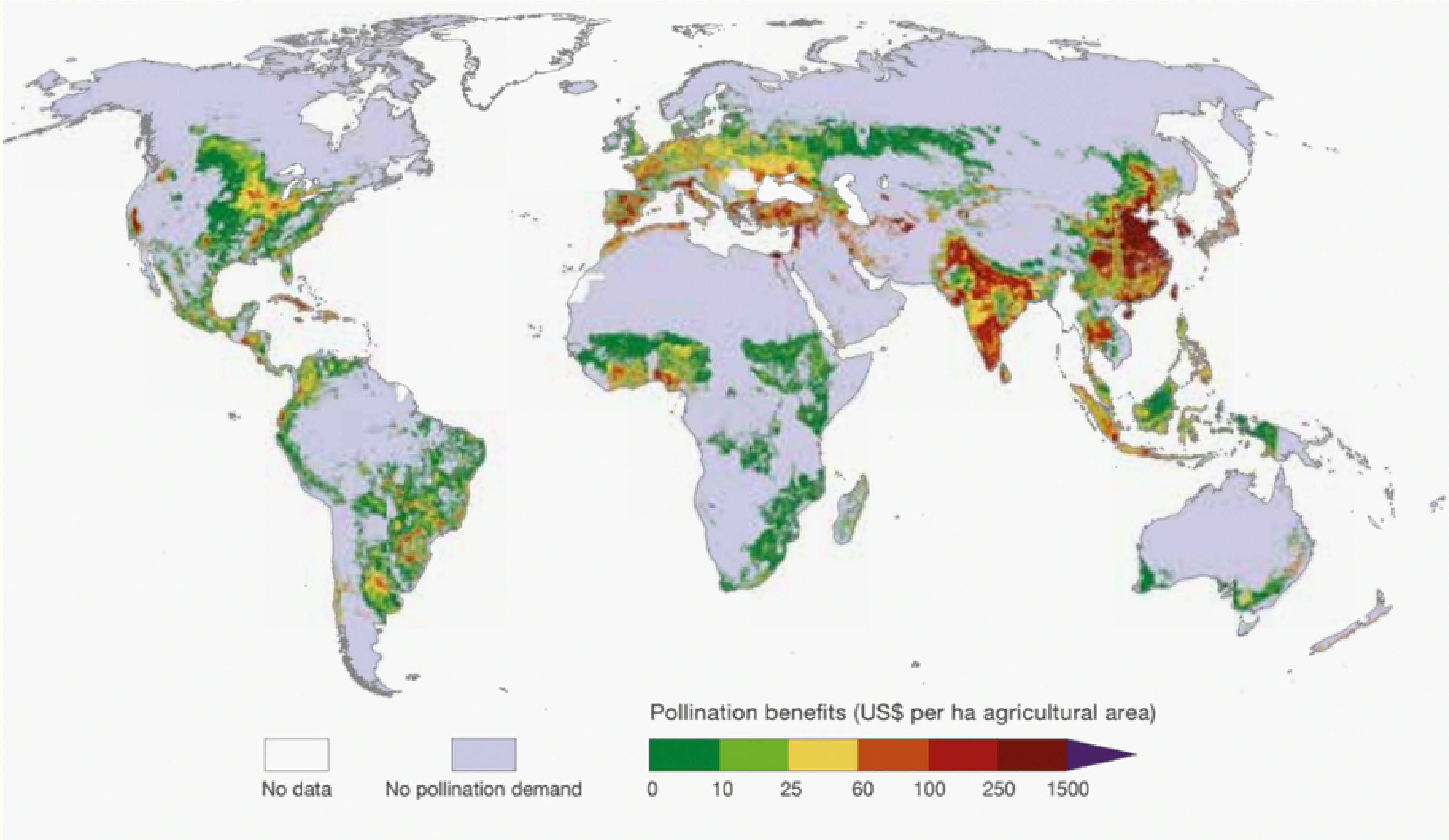


Figure 1. Global pollination service to direct crop market output in US$ per ha agricultural area. Source: IPBES, 2016

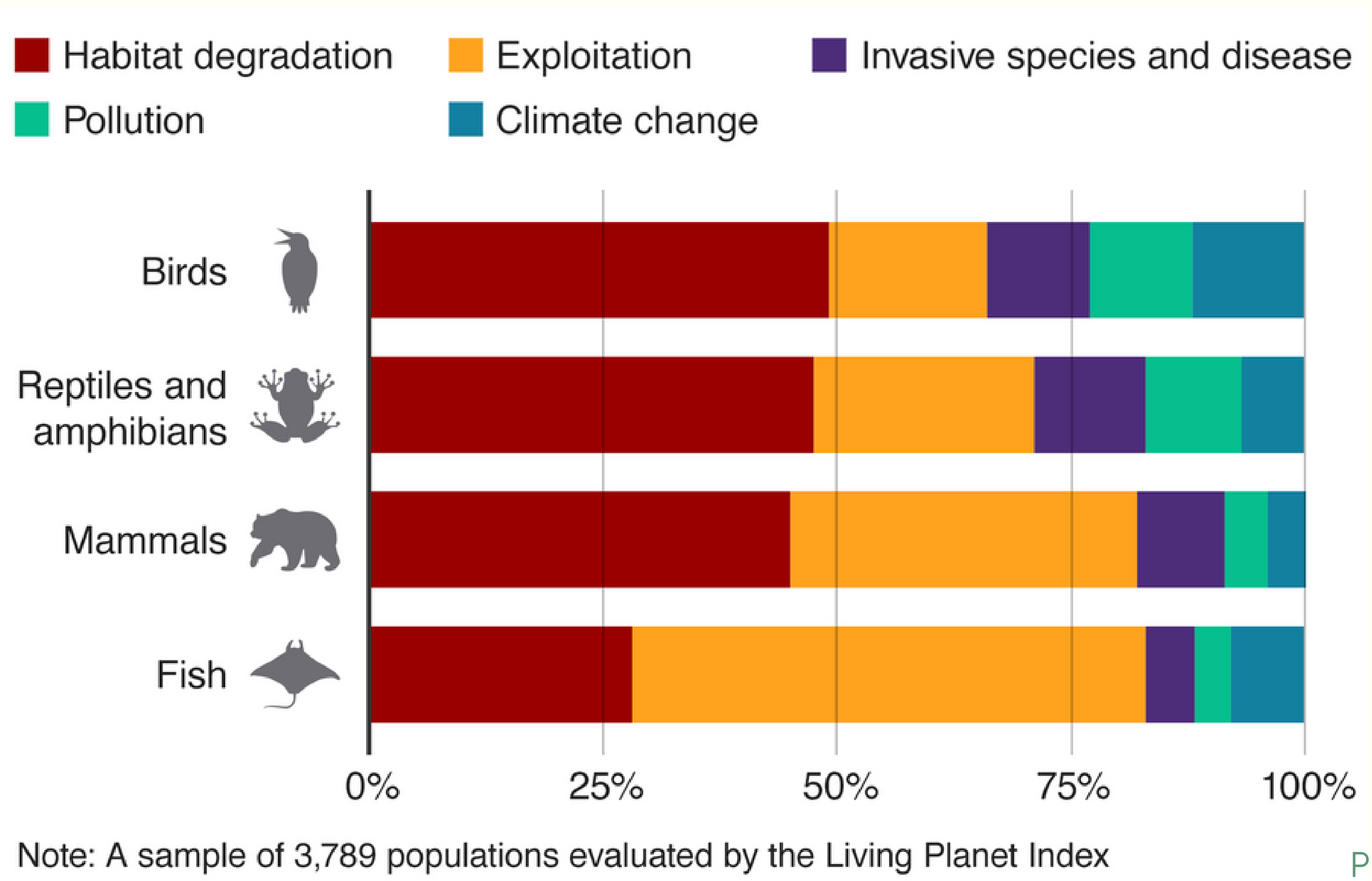
Pest Control

Lastly, biologically diverse agricultural landscapes are more capable of sustaining pest control functions (Bianchi et al., 2006). Predatory insects and spiders control crop pests by eating pests (Barbercheck 2020). As the population of pests increases, populations of predators also increase, which decreases the amount of damage to plants (Barbercheck 2020). If those predator populations are reduced or eliminated by human pressures, pest populations will increase unchecked and agriculture and forestry will suffer increased damage. There is also a concern that many undesirable weeds, which are usually self-fertile and can produce seeds without pollinators, would become more prevalent due to the reduced competition from pollinator-dependent species (Rodger, 2021).

The Biodiversity Crisis

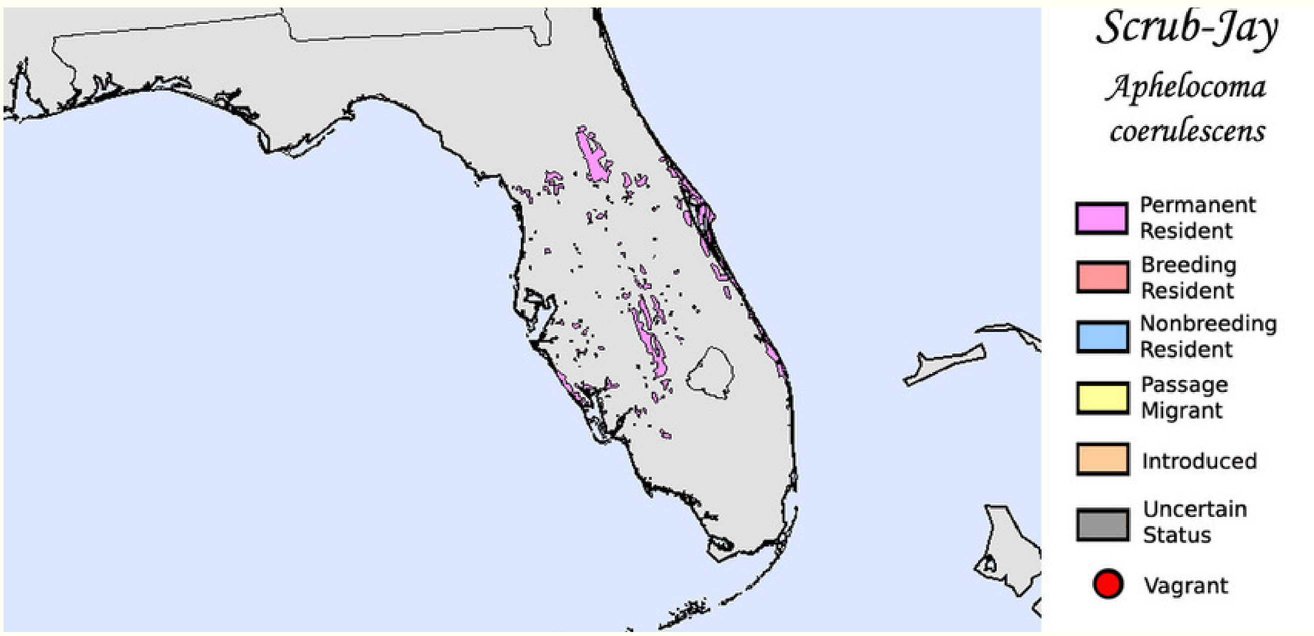
Globally-monitored population sizes of mammals, fish, birds, reptiles, and amphibians saw an average decline of 68% on the Living Planet Index (LPI) between 1970 and 2016 (WWF Living Planet Index, 2020). The LPI measures the average change in the number of individuals across animal populations. North America has seen an average decline in population size by 33% of monitored animal species during this period (Buckland et al., 2011). There are five main threats to biodiversity: habitat loss, invasive species, climate change, pollution, and overexploitation (Bowman et al., 2017; Figure 2).

Figure 2Figure 2. Living Planet Report, 2018. Source: BBC.



Habitat Loss

Habitat loss is the primary driver of biodiversity declines both within the U.S. and around the world. Habitat degradation and destruction are the most pervasive threats to biodiversity, contributing to the endangerment of 85% of species analyzed (Wilcove et al., 1998). For example, less than 10% of the Florida scrub-jay population remains due to the land development of dense scrub oak and saw palmettos packed into the dry, sandy hills of the Florida scrub, which is the only habitat in which they thrive (Figure 3, United States Department of Agriculture, 2022). If a species' habitat is significantly altered or destroyed, that species is less likely to survive in that habitat.



Florida scrub-jay, *Aphelocoma coerulescens*

Figures 3a and 3b of a Florida Scrub-Jay and Florida Scrub-Jay distribution. Sources: NatureServe and Volusia County web.

The main causes of habitat loss in the United States are land conversion for agriculture or development, water development, pollution, and climate change (The National Wildlife Federation, 2022). Humans have dramatically altered land in the United States by creating farms, roads, and cities, and for resource extraction activities, such as logging and mining.

Invasive Species

Since the 1400s, there has been a drastic breaching of the biogeographic barriers that had isolated the continental biotas for millions of years (Mooney & Cleland, 2001). Humans have relocated many species from their native habitat into new ranges. Some of these species become invasive, having major negative impacts on the ecosystems into which they have been introduced. One way these invasive species can impact the ecosystems is by competing with native species. As a result, the invasive species can displace native species, reducing the native species populations.

Case Study of the Lionfish

Populations of the Lionfishes Pterois volitans and Pterois miles – originally from the Indian and Pacific oceans – have been expanding in the Northwest Atlantic Ocean and have had detrimental impacts such as competing with local fish – i.e., snappers or groupers – to eat herbivores. As the herbivore population declines due to increased predation, algae grow unchecked, which ultimately degrades coral reefs by depriving them of oxygen, often by smothering or shading (Grieve et al., 2016). Studies suggest that just one lionfish on a coral reef can reduce native reef fish populations by 79% (NOAA, 2022). Their successful invasion is likely due to lionfish having high fecundity, a generalist diet, and venomous spines that protect them from native predators; this has resulted in a decrease in the diversity of native fish species (Grieve et al., 2016). Lionfish populations expanded rapidly from 1985-2020 (Figure 4).

Figure 4. These maps show that lionfish populations have grown exponentially since they were first discovered. Biologists suspect that lionfish populations have not yet peaked in the Gulf of Mexico, which means that their demand for native prey will continue to increase. Source: U.S. Geological Survey

Lionfish, *Pterois*

Climate Change

Rising temperatures are affecting biodiversity, changing rainfall patterns, and increasing extreme weather events, all of which put additional pressure on already endangered species. Climate change currently affects over 10,000 species on the IUCN Red List of Threatened Species, increasing the likelihood of their extinction (Maxwell et al., 2019). Rising temperatures have led to ecological changes including the migration of Chinook salmon to Arctic rivers, while behavioral changes in species include earlier breeding times for North American tree swallows (IUCN Issues Brief, 2019).

Climate change is also causing significant physiological effects on wildlife. Warmer temperatures during egg incubation affect the sex ratios among endangered green sea turtles, with females accounting for 99% of newly hatched turtles on some nesting beaches (IUCN Issues Brief, 2019). Genetic changes attributed to climate change include hybridization resulting from increased contact with other populations and interbreeding as ranges shift in response to climate change (IUCN Issues Brief, 2019).

Furthermore, climate change is a complex threat to address because it is a global issue and requires multilateral collaboration. The complexity of combating climate change to save a species is controversial because reversing climate change effects will likely be a slow process; the most climate-endangered species will have likely already gone extinct before the climate threats can be mitigated.

Pollution

Ecosystems are impacted by air pollution, chemical runoff, oil spills, and plastic. Chemical runoff in wastewater can affect the health of freshwater streams. Some types of chemical and thermal pollution can reduce dissolved oxygen in freshwater environments. Reductions in dissolved oxygen compromise many aquatic organisms' ability to survive temperature extremes and affect reproductive ability (Bassem, 2020).

Oil spills are a major source of pollution in the ocean. The Deepwater Horizon Oil Spill was the largest offshore oil spill in U.S. history and affected nesting – including nesting females, eggs, and hatchlings – juveniles, and adult sea turtles throughout the Gulf of Mexico (NOAA, 2021).

Plastic and marine debris are other major sources of pollution. At least 8 million metric tons of plastic end up in the ocean every year, and plastic makes up the majority of anthropogenic marine debris (NOAA, n.d). Ingestion of marine debris is another threat to all species of sea turtles. Sea turtles may ingest fishing lines, balloons, plastic bags, floating tar or oil, and other materials discarded by humans that they can mistake for food. When marine organisms ingest this plastic, contaminants enter their digestive system, and over time, accumulate in the food web (Center for Biological Diversity, n.d).

Evolutionary Consequences of Biodiversity Loss

Small populations experience a high frequency of inbreeding resulting from a lack of unrelated mates (Loeschcke et al., 1994). Inbreeding results in greater homozygosity and a higher chance of passing on unfavorable genetic variation (Bowman et al., 2017). As unfavorable genetic variants accumulate through each generation, the number of offspring can decrease, resulting in inbreeding depression and a higher potential for extinction (Charlesworth & Willis, 2009).

Case study on the Black-footed Ferret

Indian Tribes have worked in partnership with U.S. and state governments to conserve the black-footed ferret (Figure 5). Listed as endangered in 1967 (Smithsonian, 2021), black-footed ferrets were faced with a high risk of extinction in the 1960s and 1970s after years of the widespread extermination of prairie dogs, which make up 90% of the black-footed ferrets' diet (The Nature Conservancy, 2021). Black-footed ferrets are also highly susceptible to the sylvatic plague, which also played a significant role in their decline (The Nature Conservancy, 2021). In the mid-1970s, it was presumed that there were no wild black-footed ferrets left, and in 1979, after the last captive ferret died, they were declared extinct (Defenders of Wildlife, 2013). However, in 1981, a dog in Wyoming brought home a dead ferret, the first sign that the species was not, in fact, extinct (Defenders of Wildlife, 2013). Conservationists captured what were thought to be the last remaining black-footed ferrets from the wild, 24 ferrets, and started a captive breeding program with seven of them in 1987 (The Nature Conservancy, 2021).

Ferret, *Mustela putorius furo*

Beginning in 1991, captive-bred ferrets were reintroduced into the wild (The Nature Conservancy, 2021). Six of the release sites were located on tribal lands, including in North Dakota (the Lower Brule Sioux, Cheyenne River Sioux, Rosebud Sioux), Montana (Northern Cheyenne and Fort Belknap), and Navajo land in Arizona (McNeel, 2018). The Fort Belknap reservation utilized buffalo pasture to release about 200 captive-bred ferrets, but the plague, which infects both ferrets and prairie dogs, prevented the population from succeeding (McNeel 2018). The Tribal Wildlife Department worked in partnership with conservation organizations to treat the plague in prairie dogs on the reservation because healthy numbers of prairie dogs are required to support the ferret population (Defenders of Wildlife, 2013). Prairie dog populations on this reservation have since rebounded, and in 2013, the population was deemed robust enough to attempt another release of black-footed ferrets. Ferrets continued to be released on reservations throughout the 1990s to the present day. However, the plague has prevented the ferret population from increasing at a faster rate (Chrobak, 2021). For a 1,500-acre reintroduction area, costs to control plague alone are estimated at $40,000 per year (Chrobak, 2021). Currently, there are an estimated 300 black-footed ferrets in the wild (The Nature Conservancy, 2021).

The story of the black-footed ferrets shows how federal, state, and tribal governments have worked and continue to work together to conserve an endangered species. However, tribes have incurred direct costs as a result of these conservation efforts and lost income from being unable to lease the land upon which the ferrets are released (McNeel, 2018). From 2010 to 2040, the projected cost of recovering the black-footed ferrets is $151.1 million (U.S. Fish and Wildlife Service & Interior, 2013). The federal spending on black-footed ferret conservation from 1989-2018 amounted to only $67.8 million (U.S. Fish and Wildlife Service, 1989-2018). From 2010-2018, the years in which data for estimated spending and actual spending overlap, federal spending equaled only $28.4 million, whereas the funding recommended for 2010 to 2020 outlined in the recovery plan was $55.1 million (U.S. Fish and Wildlife Service & Interior, 2013). The significant gap between allocated funds and recommended spending shows that present efforts are inadequate and more funding overall is necessary to support meaningful work to recover black-footed ferrets. That includes additional funding for Indian Tribes who incur many of the costs of working to conserve these species.

As human activity continues to threaten biodiversity, we can expect there to be a continued decline in plant and animal populations. Classifying species as endangered can help species recover, but there are also several cases where populations go extinct even with legal protections. It takes time to research individual species, and by the time they're listed as endangered, the populations may have declined past the point where effective conservation is possible. Improving the management of declining populations before they're classified as endangered will lead to better outcomes in preserving biodiversity. This situation requires new policy tools to support conservation – leading to the Recovering America's Wildlife Act of 2022.

California condor, *Gymnogyps californianus*

The Recovering America's Wildlife Act of 2022

The Recovering America's Wildlife Act of 2022 (hereafter, "the Act") is proposed legislation that will support conservation efforts in the U.S. by building a more comprehensively-funded system of conservation. Specifically, Title I of the Act will distribute between $850 million to $1.3 billion to conservation efforts with an annual increase from 2022 to 2025. These funds will come from fines on environmental damages, supplementing the existing Pittman-Robertson Act that is funded through taxes on the import and sales of firearms and hunting equipment. Pittman-Robertson's apportionments provide varying amounts of funding per year (Figure 6). Funding from Recovering America's Wildlife Act will supplement Pittman-Robertson funds (Figure 8).

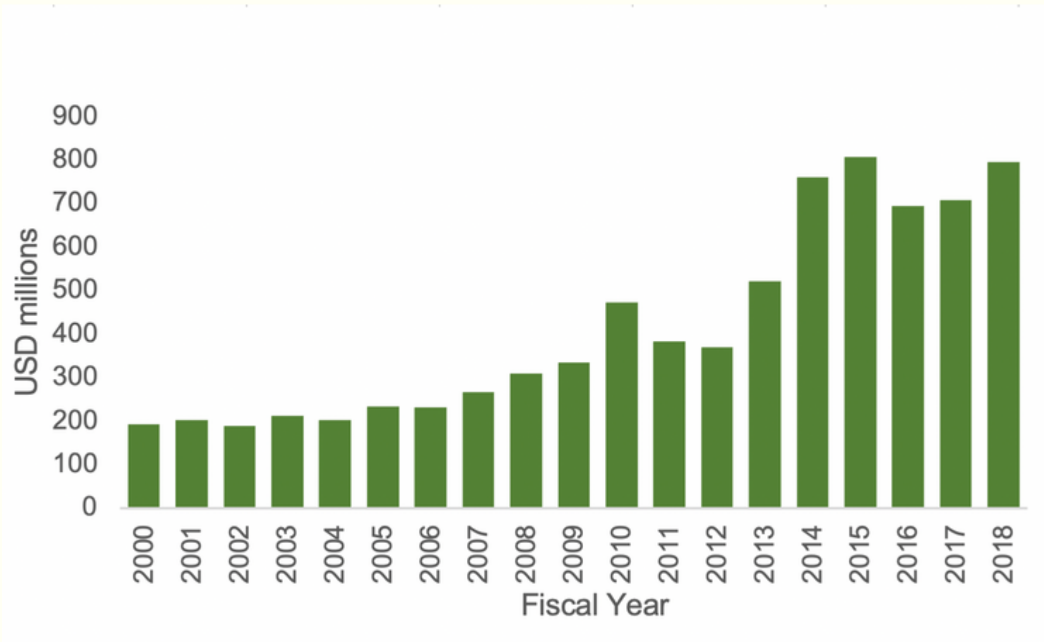


Figure 6. Pittman-Robertson Apportionment (Millions of Dollars) by Fiscal Year (2000-2018)
Source: US Fish & Wildlife Service

Title II establishes a "Tribal Wildlife Conservation and Restoration Account," which is similar to the Title I Subaccount in that both secure funding for conservation. However, the account in Title II is dedicated to conservation efforts conducted in Indian Tribes. Indian Tribes are historically significant partners in conservation to the Federal government. Many species – American bison, for example – have been released on Tribal lands in coordination with Tribes (The National Wildlife Federation, 2012). The total amount of funding is $97.5 million every fiscal year and has included a series of comprehensive sources mentioned in Title I. Title II aims to protect the interests of Indian Tribes through the conservation and restoration of wildlife species identified by Tribes as culturally significant and requiring conservation.

Title III establishes the “Endangered Species Recovery and Habitat Conservation Legacy Fund,” which provides an annual amount of $187.5 million from 2022 to 2025. These funds are to be used for recovering the species listed in the Endangered Species Act and available for the conservation of species that are not listed as threatened or endangered as an early intervention to prevent them from becoming endangered. It is essential that the Fund should be supplemental rather than supplanting any other federal funds concerning this section. The annual breakdown of titles and funding for the Act can be seen in Figure 7.

Implementing species recovery plans, which are mandated by the ESA, is one of the most effective ways to promote species recovery. However, 57% of listed endangered species lack a recovery plan (USFWS, n.d.). The Center for Biological Diversity estimates that $2.3 billion a year is required to implement existing recovery plans for threatened and endangered species. This number does not account for wildlife restoration initiatives for those who are not listed in Endangered Species Act. This $2.3 billion is more than three times the amount currently raised by the Pittman-Robertson Act – $700 million each fiscal year. The total funding from the Act and the Pittman-Robertson Act will increase annually from $700 million to $2.3 billion over time, which will adequately fund existing conservation projects (Figure 8). The Act would remedy the insufficient funding by expanding funding streams outlined in the Pittman-Robertson Act, increasing funding for Indian Tribes’ conservation work, and providing additional funding beyond what the ESA currently provides.

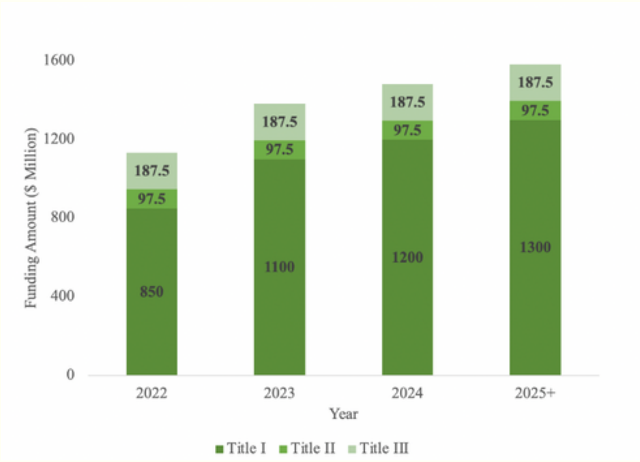


Figure 7. Funding Amount of Title I, II & III from 2022 to 2025 and after

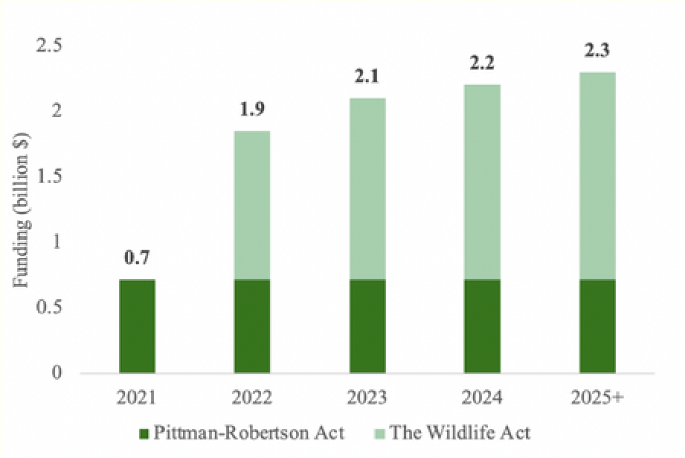
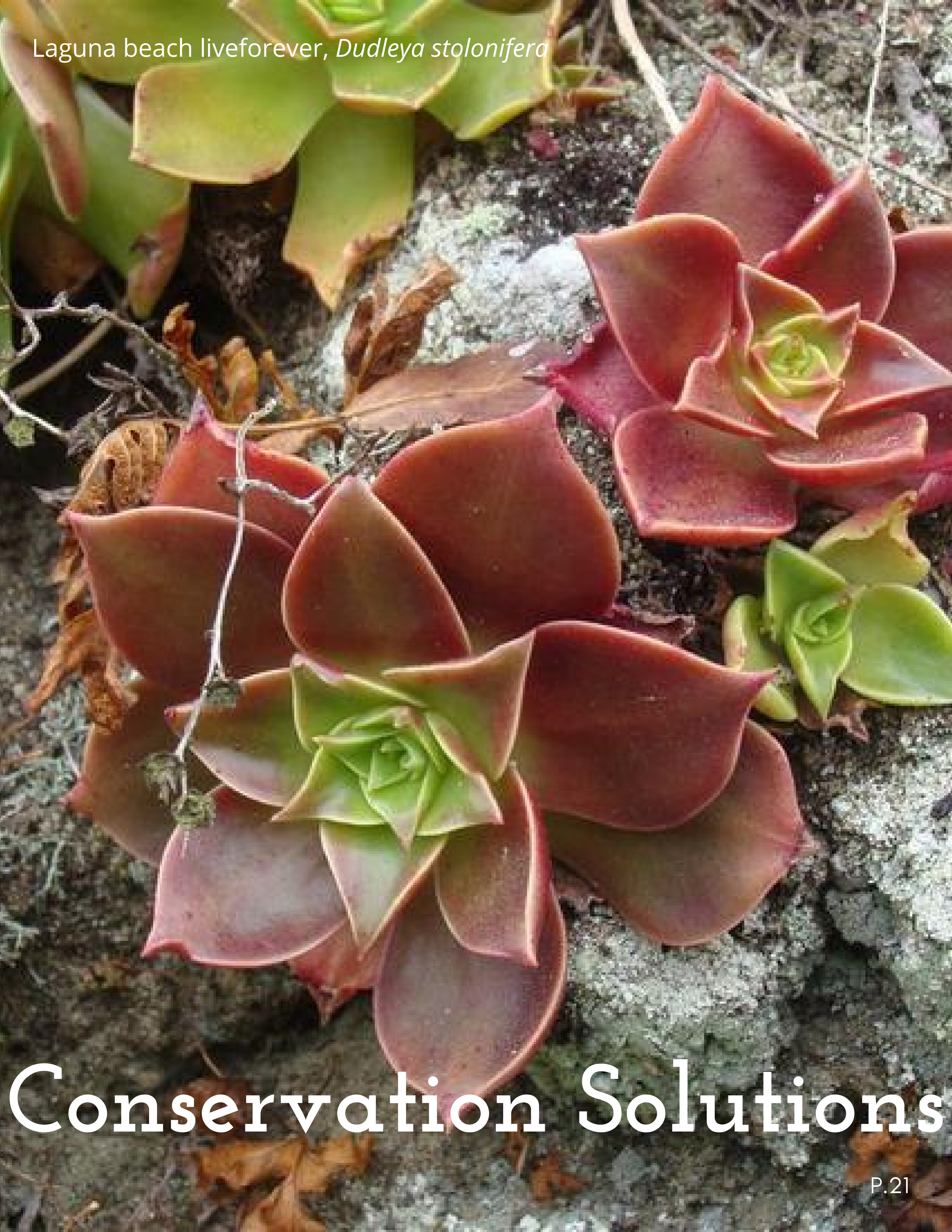


Figure 8. Illustration of the amount of funding Recovering America’s Wildlife Act of 2022 will raise compared to the existing funding of the Pittman-Robertson Act (assuming no change in funding received from the Pittman-Robertson Act over the period 2021-2025)



Laguna beach liveforever, *Dudleya stolonifera*

Conservation Solutions

Conservation solutions consist of both *in-situ* and *ex-situ* conservation. The Latin "*in-situ*" translates to "on-site." *In-situ* conservation involves recovering and preserving species without removing them from their natural habitats. If the population of a species within a region is able to recover on its own once stressors are removed or reduced through conservation techniques, *in-situ* conservation is employed. Common recovery methods that fall into this category are habitat restoration and land management. Habitat management through land management and habitat restoration are some of the most effective methods of preserving wildlife. The effectiveness of these techniques is reflected in the recovery of American elk populations. In the early 1900s, the American elk population was reduced to less than 100,000 individuals (United States Department of Agriculture, 1999). In recent years, populations of elk have increased. For instance, populations of the Rocky Mountain elk (C. elaphus nelsoni), one of the four species of elk found in America, are now estimated to be between 800,000 to 900,000 individuals (United States Department of Agriculture, 1999).

"*Ex-situ*" is Latin for "off-site." Sometimes, species populations decline to such low levels that recovery in the wild is unlikely. When a small population is experiencing such conditions, it must be taken out of its natural habitat to protect those last individuals and methodically recovered, usually through a process known as captive breeding or captive propagation.

Land Management

Maintaining adequate grazing land for both wildlife and livestock is an important aspect of land management. Properly managed grazing of cattle can improve elk habitat and provide winter forage, though overgrazing by cattle can also damage habitat and cause land degradation (Vavra 1996). Sustainable hunting of elk can help control populations in the absence of predators and serve as a source of revenue for other conservation practices (Elk and Vegetation Land Management Plan, 2022).

Prescribed Burning

One land management strategy that improves the quality of elk habitat is prescribed burning. Prescribed burning returns nutrients to the soil and continues to maintain grasslands and woodlands as open habitats while promoting the growth of grasses, forbs, and shrubs preferred by the elk (United States Department of Agriculture, 1999) (Figure 10). Prescribed burning also can reduce the spread of invasive and pest species which improves grasslands (Department of Natural Resources, n.d.).

Figure 10. Shows the changes in a grassland before and after prescribed burning. Before prescribed burning the landscape was mostly invasive species. After prescribed burning there was an increase in native plant populations. Source: Austintexas.gov

Selective Timber Harvest

Managing timber harvests is another aspect of land management that reduces stress on some wildlife populations. For instance, selectively harvesting trees can open forest canopies and increase the growth of understory forb and grass species, which are an important winter forage source for the elk (United States Department of Agriculture, 1999).

Habitat Restoration

Habitat restoration is a subset of restoration ecology focused on restoring the ecosystem functions that sustain a target species. Habitat restoration often targets a single species but can benefit additional species as well. When a habitat is restored, outcomes are improved for all the species within that ecosystem (Aradottir, 2013). Habitat restoration is generally undertaken when scientists and land managers believe that the ecosystem will not recover adequately without intervention, or that natural recovery will not create sufficient suitable habitat (Araddotir, 2013)

Habitat restoration uses a number of techniques to achieve its goals, including;

- Improving vegetation cover
- Restoring soil nutrients
- Building topsoil
- Anchoring loose sediment
- Restoring watershed patterns
- Reintroducing important species
- Removal of invasive species
- Remediating pollutants

Source: Aradottir, 2013

Case Study of the Bald Eagle

Having received abundant funding from various sources such as the tax on firearms mentioned in the Pittman-Robertson Act, the bald eagle is one of the most well-known conservation success stories. Bald eagles were listed as an endangered species in 1978 due to their rapid population decline. The population continued to decline because of trapping, hunting, and the negative effects of pesticides such as DDT (ABC's Bird Library, 2022). Bald eagles ate fish that were exposed to DDT which resulted in the poisoning of the eagles and interfered with their ability to produce strong eggshells. As a result, their eggshells were so thin that they often broke during incubation or the eggs otherwise failed to hatch. Fortunately, with significant investment and consistent efforts put into the conservation of this species, populations recovered enough that the species was delisted in 2007. Though the bald eagle is no longer considered endangered, the species continues to receive protection under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. Both laws prohibit killing, selling, or otherwise harming eagles, their nests, or eggs (U.S Fish & Wildlife Service, 2022).

Within the consistent efforts put into the conservation of the bald eagles, there are four main supporting programs including habitat protection, banning of DDT, interagency cooperation, and recovery programs. After receiving legal protection under the ESA, their habitats have been protected and their population has also benefited from the banning of DDT by the federal government in 1972. Beyond that, the interagency cooperation between states, federal agencies, Indian Tribes, NGOs, and even private landowners also helped the United States national symbol to flourish. Listing the species as endangered provided the springboard for the stakeholders to accelerate the pace of recovery through captive breeding programs, reintroduction efforts, law enforcement, and nest site protection during the breeding season (U.S. Fish & Wildlife Service, 2022).

There were only 417 nesting pairs in 1963, which increased to 71,400 in 2021 (U.S. Department of the Interior, 2021). According to the data available, the total expenditures from the federal and state governments is $156 million from 1989 to 2007 (USFWS, 1989-2007).

Bald eagle, *Haliaeetus leucocephalus*

Controversies Relating to Solutions

Deciding Whether to Save a Declining Species

With an increasing number of species becoming endangered or threatened due to habitat loss and degradation, it may not be possible to intervene and save every threatened species before they go extinct. With limited money available for conservation, conservationists and land managers are forced to make difficult choices. Should funds focus on protecting the most endangered species, which require significant funds and may not survive long term anyway? Or should conservationists bolster the populations of less endangered species so that they have a robust long-term survival chance? The optimal scenario would be utilizing minimal resources while fully recovering a species. The inapt scenario would be utilizing a great deal of resources and failing to recover a species. This follows the idea of conservation triage, which is the process of prioritizing the allocation of limited resources to maximize conservation gains (Gerber, 2016).

Comparative Conservation Case Study

The Maui parrotbill, also known as Kiwikui, is a Hawaiian honeycreeper endemic to the island of Maui. The estimated population size was less than 312 individuals in 2017, and the population is declining (USFWS, n.d.). There are a variety of factors that are contributing to the population decline including disease, habitat loss and degradation, predation, and low reproduction (HLNR, 2015). Captive breeding for the Maui parrotbill at the Maui Bird Conservation Center and the Keauhou Bird Conservation Center have been unsuccessful for the past 20 years due to low reproduction success and survivorship (USFWS, n.d.). Due to all the factors impacting the Maui parrotbill and the lack of breeding success to date, it may be futile to continue using conservation resources to try and save this species. Therefore, it may be more effective to reallocate those resources to a different bird species that have a better chance of recovery.

Another very different scenario of a species that can also benefit from conservation efforts is the endangered red-cockaded woodpecker. Currently, this bird can be found in 11 states across the southeast region of the United States (Center for Biological Diversity, n.d.). In 2017, there were an estimated 3,150 active clusters of red-cockaded woodpeckers with approximately 1 to 5 birds in each cluster (Roth, 2017), reduced from an estimated historical population of over 1.5 million birds (The Nature Conservancy, n.d). The main threat to these birds is the destruction of their critical habitat - mature pine forests (The Nature Conservancy, n.d).

Woodpeckers are keystone species for their role in creating cavities in trees which other woodland organisms use for shelter (Audubon, n.d.). Conservation efforts to increase red-cockaded woodpecker populations have been successful. Although the population has shown improvements, intervention is still needed to fully restore the population. In a hypothetical scenario, conservation resources would likely be more effectively used on the red-cockaded woodpecker than the Maui parrotbill due to the woodpecker having a better chance of recovering.

Red-cockaded woodpecker
(*Leuconotopicus borealis*)

Maui parrotbill
(*Pseudonestor xanthophrys)*

Captive Breeding

One tool that is commonly used for conservation is captive breeding. Captive breeding is a process in which a small number of individuals of an endangered species are removed from the wild to an artificial environment in order to propagate the species. It is a conservation tool that requires a lot of human labor, specialized equipment, and techniques such as artificial insemination.

There is essentially no limit to how much a captive breeding program can cost but estimates range from $2 to $10 million per species (Greenwald et al., 2017). Cost is often based on the amount of staff needed to run a captive breeding program and is amplified by the fact that breeding and husbandry practices are not well understood for most endangered species, which requires trial and error (Fritts, 2022). During captive breeding, the animals are in frequent contact with humans, which can change the way the animals respond to humans and their behavior (Figure 11). This could even lead to a species undergoing some form of domestication. For these reasons, the survival rate of released animals tends to be quite low. In the case of large predators, 66% of individuals that are released into the wild die before reproducing (Owen, 2008).

Cloning

The purpose of cloning for conservation is either to add genetic diversity to the gene pool of a species in jeopardy of inbreeding depression or to revive an extinct species. However, cloning as an instrument for animal conservation is highly controversial (Sandler et al., 2021). Some argue that because of the risks, an extensive ethical analysis should be conducted prior to every cloning effort for conservation. They lay out multiple criteria with which can be assessed whether cloning is the most suitable conservation tool and whether the project is desirable overall (Sandler et al., 2021). The largest points of contention are the opportunity costs of the project, animal welfare, and the impact on broader conservation issues.

In the case of the black-footed ferret, cloning was used to add genetic diversity to a very small gene pool. At the San Diego frozen zoo, they had frozen tissue that had 10 times more unique alleles (Figure 12). They then successfully created a clone using a domestic ferret as a surrogate.

Figure 11. This Bald Eagle hatchling is being fed by a conservationist with an eagle puppet.
Image credit: Scientific American.

Even if cloning were to be successful at adding genetic diversity to an imperiled species, it has been argued that intra-species cloning remains an imperfect process (Pei et al., 2007). There are also ethical considerations regarding the impact on broader conservation issues. Cloning runs the risk of providing decision-makers and the general public with the false assurance that bioengineering alone can solve the biodiversity problem (Sandler et al., 2021). Though there are many proponents of cloning – cloning can be an incredibly valuable tool as there are almost no other ways of recovering lost genetic diversity – its detractors argue that the state of animal conservation would be better off if cloning were forgone completely due to the high costs diverted to this one solution (Fritts, 2022; Sandler et al., 2021).

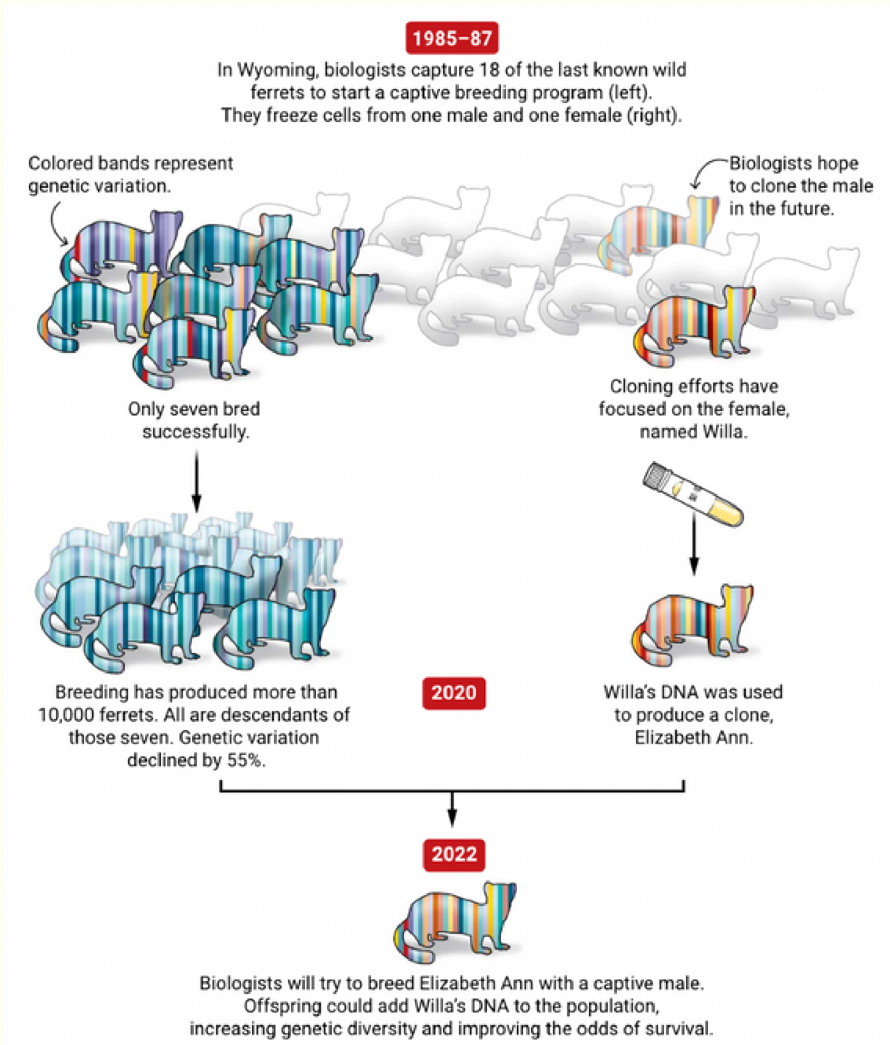


Figure 12. Depicting potentially genetically diverse black-footed ferrets from captive breeding and frozen cells. Source: Fritts, 2022

Northern leopard frog, *Lithobates pipiens*

Measuring the Program's Success

The main goal of the Act is to recover species to a point where they are no longer in imminent danger of extinction. To measure its success, we recommend assessing performance at two levels: direct population management and key habitat management.

Under direct population management, the IUCN measures five key population indicators: population decline rate, geographic distribution, population size, and probability of extinction (IUCN, n.d.).

The criteria of indicators of success for an endangered species by the IUCN standard are:

Population growth rate

The population growth rate is defined by the change in the number of mature individuals in the species over a unit of time (IUCN, n.d.). A negative population growth rate is a sign of population decline. The indicator of success with respect to population decline would be to halt and reverse the population decline over a similar time period.

Spatial extent and occupancy

Endangered species occupy less than 500 square kilometers and exist within a range of less than 5,000 square kilometers (IUCN, n.d.). An indicator of success would be to increase a species range to above 5,000 square kilometers, and for the species to occupy an area within that range of over 500 square kilometers.

Population size

Endangered species have fewer than 2,500 mature individuals. An indicator of success for the Program would be to increase the number of mature individuals to over 2,500.

Probability of extinction

An endangered species has a probability of extinction in the wild of at least 20% within 20 years or five generations, whichever is longer (IUCN n.d.). An indicator of success for the Program would be the likelihood of extinction drops below this threshold, as close to 0% as possible, within that same time period.

Under key habitat management, there are three important aspects: quantity of habitat, quality of habitat, and resilience of habitat. Both quantity and quality of habitats can be measured by underlying indicators that indirectly influence the population of a species while resilience can be tested using different scenarios.

The habitat indicators that determine success are:

Quantity of habitat

The quantity of habitat has been proven to be an important factor in determining a species' resilience to stressors. For example, Manes et al. (2014) found that endemic species with a narrow geographic range are exposed to three to 10 times more risks compared to more widespread native and introduced species when facing the stressor created by climate change. In other words, the quantity of habitats matters to the survival of a species. The quantity of habitat can be measured simply by measuring the extent of the critical habitat or habitats within a given region.

Quality of habitat

The quality of habitats also matters. The quality of habitats can be measured by a set of indicators such as access to food, the concentration of toxins, and the presence of invasive species. The quality of habitat matters because these factors indirectly create stressors that influence the population of a species.

Food is one of the most important resources that sustain an animal population. Without sufficient food resources, the population will decline due to increased death rates and decreasing birth rates associated with poor nutrition. For example, in the case of bald eagles, there is a strong correlation between the population of eagles and salmon, which is an important food source for eagles (Walter et al. 2021). Therefore, identifying the source of food and tracking the abundance of food is a helpful metric in evaluating the prospects for the success of a conservation program. The abundance of food can be measured by the population size of relevant prey species.

Besides factors that support a population, it is also important to monitor habitat factors that create physiological stress for a population, such as the concentration of environmental toxins. In the case of bald eagles, they were exposed to lead and DDE through bioaccumulation through the food web (National Park Service n.d.). The concentration of lead and DDE can be directly measured on the feathers of nesting eagles. The decrease in the toxins such as lead and DDE was reflected in the increase in the population of bald eagles in recent years (National Park Service n.d.).

In the aggregate, the goal is to increase the number and the percentage of listed species recovered, which is calculated using the number of species recovered divided by the total number of listed species. This provides an objective measure of the proportion of listed species that recovered. The current rate of success of species recovery is at 2.9%, or 46 species recovered since the Endangered Species Act was enacted. For the Recovering America's Wildlife Act to be deemed successful in achieving its main goals, the rate of species recovered should ideally exceed the rate of species added as endangered or threatened such that there is an overall decline in the absolute number of listed species (Figure 13).

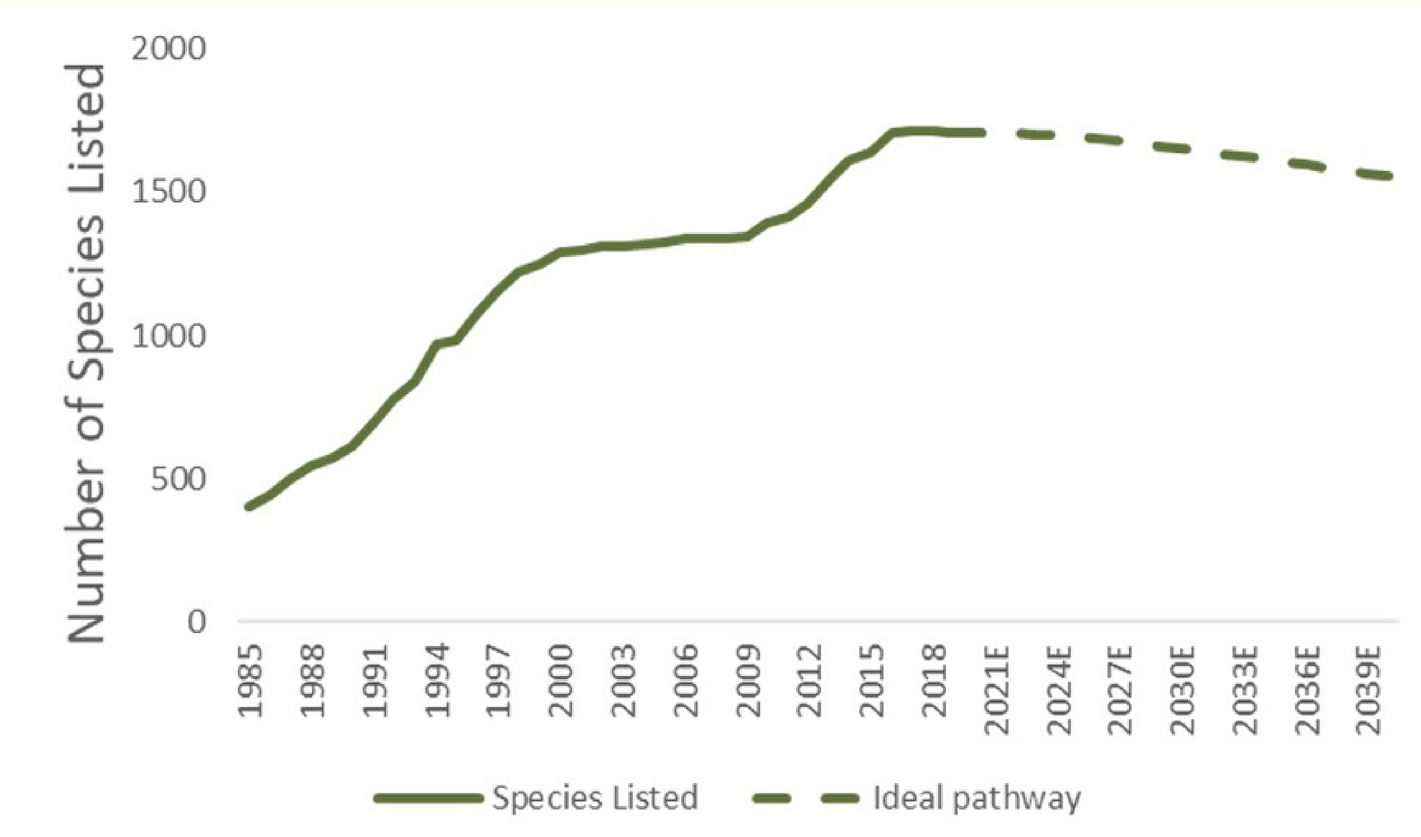


Figure 13. Number of Species listed in Endangered Species Act

Wildlife conservation and the prevention of extinction is a highly complex endeavor that involves many stakeholders and actors as well as interagency collaboration. Setting and aligning objective and measurable key performance metrics on the conservation activities is the first step to establishing a robust, performance-driven program and will greatly improve the chances of the program's success.

Sea turtle, *Chelonioidea*

Conclusion

Fountain thistle, *Cirsium fontinale*

The Recovering America's Wildlife Act of 2022 aims to protect endangered species by allocating funds to bridge the existing shortfall in funding for wildlife management, conservation, and education that would prevent common or declining species from becoming endangered in the first place. Early intervention in managing wildlife populations will lead to better outcomes in preserving biodiversity. If passed, the resulting funding increase could be the difference between achieving recovery progress for imperiled species or watching them go extinct.

Conservation planning can take place on a timescale of 50 or more years, and access to consistent levels of funding provides a basis for long-term planning. A steady source of funding allows for more comprehensive recovery plans and habitat management, which will ensure the recovery of more species. Additionally, agencies like the National Oceanic and Atmospheric Administration and the U.S. Fish and Wildlife Service can better strategize and implement protection for species in the long term. More effective habitat restoration and protection, as well as a greater number of breeding programs, will be possible because of Recovering America's Wildlife Act of 2022.

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