Conservation Biology: Protecting Species and Habitats

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SUMMARY

Biodiversity comprises all the different life forms on Earth, including plants, animals, microorganisms, and their genetic information. Biodiversity also includes the genetic and species diversity of a specific region, biome, or planet. Biodiversity is therefore important as it encompasses the aesthetic perspective that increases the beauty of nature while contributing to human well-being in the form of resources such as food, fuel, medicines and feed. Despite the advantages of biodiversity, threats to species and ecosystems are growing at an alarming rate today and almost all of which are the result of human mismanagement of biological resources, often caused by climate change, pollution, bad institutions negligence and economic policies. Biodiversity conservation is critical to ensuring equity within and between generations. Reforestation, zoological and botanical gardens, national parks, biosphere reserves, germplasm banks, adoption of breeding and tissue culture techniques, and social forestry to reduce the pressure of overexploitation of forest resources are some of the current approaches to conserving biodiversity.

INTRODUCTION

Human activities to get better life standards have affected badly to biodiversity globally and resulted in the extinction of many key species. It has been noted that, over the past 2000 years, numerous species have become extinct from the earth. Some reasons can be attributed to climate change, and some have been due to the activities of human to get their medicine, food, shelter, clothing, etc. It is also anticipated that with proper strategies for conservation, much more biodiversity will be recovered in the future. Consequently, international organizations have come together to protect biodiversity and their environment by creating biosphere reserves, national parks, and wildlife sanctuaries with the help of legislation and national acts (Nielsen et al., 2021; Wang et al., 2020).

Conservation biology is a leading discipline in Biology that focuses on the conservation of the earth's biodiversity and nature aimed at the protection of species and their ecosystem, and it also includes the development of different strategies to preserve biodiversity from the excessive rate of extinction (Sahney & Benton, 2008; Soulé, 1985). Conservation biology is a mission-driven field based on the social and natural sciences, which also emphasizes the practice of natural resource management (Soulé, 1985). The concept of conservation biology is fairly new. Its concept as a new discipline originated from the first International Conservation Biology Research Conference held in 1978 by American scientists Michael E. Soule and Bruce A. Wilcox at the University of California, California. In addition, the meeting also held important discussions on issues such as the erosion of genetic diversity within species, species extinction and tropical deforestation. (Douglas, 1978). The Proceedings that resulted seek to close this gap by convening leading researchers in evolutionary genetics with theory in ecology and conservation practice and policymakers.

The concept of biological diversity in relation to conservation biology is synonymous, and it has shaped the science of the modern era and its associated conservation policy. The underlying principle of this discipline is the development of new subdisciplines like conservation physiology, behavior, and social science (Cooke et al., 2013). The preliminary aim of this discipline is to bring about homeostasis between human development and the preservation of key species. Thus, the protection of our habitat is important for the well-being of the ecosystem and for the benefit of humans. Here are some reasons why conservation biology is significant:

SIGNIFICANCE OF CONSERVATION BIOLOGY

Numerous plant and animal species play an essential role in the development of various medications and pharmaceuticals. So, preserving these vital species can promotes the sustainable use of natural resources. The loss of ecosystems and species, including species extinction, maybe the source of the irreversible effects. A species cannot be resurrected after it becomes extinct. Preventing these types of losses requires the protection of endangered species and their habitats (Robinson, 2006). Habitats and species

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contribute to biodiversity, which is crucial for an ecosystem's resilience and stability. Biodiversity ensures that different species adapt to their environment and helps to maintain a stable ecosystem. There are many industries, including fisheries, agriculture, and forestry, which rely on natural resources. So, the protection of these natural resources ensures sustainable use and supports long-term economic stability (Naidoo & Ricketts, 2006).

Climate change mitigation and state of biodiversity

Healthy ecosystems play a role in mitigating climate change by sequestering carbon dioxide and other greenhouse gases. Forests, for example, act as carbon sinks, helping to regulate the Earth's climate. The vast number of living forms that exist on Earth, including various flora, animals, microbes, genetic makeup, and ecosystems, are together referred to as biodiversity. It includes species richness, ecological diversity, and genetic variety within a certain biome, geographic area, or planetary scale. The basis of life support systems is biodiversity, which is necessary for the supply of basic resources like water, food, and oxygen that are necessary for organism existence and ecological equilibrium (Rawat & Agarwal, 2015).

GLOBAL BIODIVERSITY ASSESSMENT

Global biodiversity encompasses the complete range of life forms on Earth and arises from a comprehensive evaluation of biological diversity. As of 2018, approximately 1.74 million species have been identified, more than 80% of which await official description (Mora et al., 2011). According to a study conducted in 2015, the total genetic information in the biosphere is estimated to be 5.3 × 1031 (±3.6 × 1031) megabases (Mb) of DNA, which was determined by combining analyses and estimates of whole organism genomes. Biomass. Prokaryotes predate plants and animals by at least 3 billion years, although their genetic makeup appears to be similar to modern plants and animals (Landenmark et al., 2015). There are an estimated 8.75 million species of organisms on Earth, approximately 80% of which are hypothetical (Wiens, 2023).

CURRENT EXTINCTION RATES

About half of the planet's plant and animal species may go extinct in a century if current rates of anthropogenic biosphere degradation continue. In addition, the present rate of species extinction around the world is projected to be 100 to 1,000 times faster as compared to the past extinction rates, which are the historical averages spanning evolutionary periods (De Vos et al., 2015). Extinction rates have never increased so quickly in human history, and they might rise up to 10,000 times higher in the future (De Vos et al., 2015). Notably, losses in certain taxonomic groupings are happening significantly faster than in others. According to biologists, the main causes of the current extinction problem are unsustainable levels of consumption and human population increase (Pimm et al., 2014; Ceballos et al., 2017). A comprehensive analysis of 177 mammal species discovered significant declines in range, with each species experiencing at least a 30% decrease and over a third facing declines exceeding 80% (Ceballos et al., 2017).

HOTSPOTS OF BIODIVERSITY

Regions on earth that harbor an extraordinarily high number of species, many of which are endemic species, are known as biodiversity hotspots. These regions are characterized by their rich biological diversity and frequently face threats by invasive species, climate change, and habitat destruction. Norman Myers originated the concept of biodiversity hotspot in the late 1980s. He selected these areas based on two main factors:

Richness of Species: Hotspots are rich in species, particularly rare or endemic ones.

Threatened Habitats: Due to human activities, including deforestation, urbanization, agriculture, and pollution, these places are seriously threatened.

THREATS TO SPECIES AND HABITATS

Since 1970, almost 48% of world biodiversity has been lost. The Living Planet Report shows that, on average, about half of the world's population of fish, amphibians, birds, reptiles, and mammals has disappeared (Ceballos et al., 2017). More specifically, 76% of freshwater species, 39% of marine species, and 39% of terrestrial species have disappeared. Ecosystem losses disproportionately affect low-income countries due to the outsourcing of resources, despite high-income countries consuming five times more ecological resources compared to their low-income counterparts. Concerns regarding the wider impact on ecosystems were raised by research that found a 76% drop in insect biomass over 27 years (Hallmann et al., 2020).

HABITAT LOSS AND FRAGMENTATION

"Habitat fragmentation" refers to the creation of gaps within the preferred ecological surroundings of an organism, potentially causing the division of populations and deterioration of ecosystems. The fundamental reasons include both natural geological occurrences that modify the physical landscape over time and are associated with speciation processes, as well as human actions like land conversion that alter the environment quickly and lead to the extinction of species (Fahrig, 2003; Fahrig, 2019). Habitat fragmentation is a ubiquitous threat to biodiversity because it may affect a wider range of species than pollution, overexploitation, and biological invasions (Haddad et al., 2015).

OVEREXPLOITATION

A resource is overexploited when it is used at an unsustainable rate. On land, this takes the form of excessive hunting, deforestation, inadequate agricultural soil management, and the illicit wildlife trade. Resource devastation, even extinction, can result from overexploitation. Megafaunal extinctions can occur over a short period of time and could be explained by the overhunting hypothesis, a trend in large animal extinctions linked to human migration patterns (Burney & Flannery, 2005).

OVERPOPULATION AND OVERCONSUMPTION OF RESOURCES

As of mid-2017, there were approximately 7.6 billion people on Earth. This number is expected to peak at 10-12 billion by the end of the 21st century. Scientists have emphasized that overconsumption, population increase, and size are important contributors to soil degradation and biodiversity loss (Bradshaw et al., 2021; Crist et al., 2017; Ceballos et al., 2017). IPBES report of 2019 also mentioned overconsumption and population as important factors leading to species decline (Stokstad, 2019; Pimm et al., 2014). Research issued a warning, stating that if the main causes of biodiversity loss, population numbers, and growth are not addressed, conservation efforts will not succeed (Cafaro et al., 2022). Pollution, overuse of resources, and habitat modification are some of the ways that human populations contribute to biodiversity loss (Harfoot et al., 2018).

INVASIVE SPECIES

Worldwide, invasive species have deteriorated many ecosystems and have a significant impact on the loss of biodiversity. The term "invasive species" refers to migratory species that have replaced and outcompeted native species, modified the food webs and species richness, and altered the services and functions of ecosystems (Molnar et al., 2008; Mazza et al., 2014). One of the top five reasons contributing to biodiversity loss is considered invasive species (Pyšek & Richardson, 2010). Due to economic globalization, biological invasions have increased dramatically over the past 50 years, leading to biodiversity loss (Mazza et al., 2014). Ecosystems like freshwater environments, coastal regions, islands, and regions with Mediterranean climates are particularly vulnerable to biological invasions. A meta-analysis investigating the effects of invasive species in areas such as the Mediterranean has demonstrated notable reductions in the diversity of native species (Pyšek & Richardson, 2010). Over the past few decades, forests have seen an increase in invasive species and other disturbances. These often have detrimental effects on forest ecosystems and are linked, either directly or indirectly, to climate change (Pyšek & Richardson, 2010).

CLIMATE CHANGE

A further danger to world biodiversity is climate change (Kannan & James, 2009). For instance, if global warming keeps at its current pace, coral reef's hotspots for biodiversity will disappear within a century (Aldred, 2014). But rather than climate change, the more important factor now contributing to the loss of biodiversity in the modern era is habitat damage, such as that caused by the development of agriculture (Caro et al., 2022). Biodiversity degradation and climate change must be tackled concurrently since they are inextricably connected and have comparable consequences on human welfare.

POLLUTION

Numerous contaminants have a detrimental effect on wildlife health. For certain contaminants (like pesticides), harm can be caused by just exposure. For others, it occurs by consumption (toxic metals) or inhalation (air pollution, for example). Various species are affected by pollutants in various ways. Therefore, a contaminant that harms one species may not impact another (Syuhada et al., 2023). Burning fossil fuels and industrial emissions are the main sources of air pollutants (Nyashina et al., 2020). Since there are many different hazardous compounds, there are many different detrimental impacts on health. Persistent organic pollutants include things like industrial chemicals and artificial insecticides. These persistent pollutants have been linked to the immune system, neurological issues, cancer, and reproductive issues (Segovia et al., 2020).

CONSERVATION STRATEGIES

On the Earth the variety of life is represented by biodiversity. It may be maintained using the following techniques:

- In-situ Conservation, or Conservation within Natural Habitats.
- Ex-situ conservation, or conservation outside of natural habitats (Zegeye, 2017).

In-situ conservation

By maintaining species in their original environments, in-situ biodiversity conservation helps to protect the ecosystem (Rotach, 2005). There are a few advantages associated with in-situ conservation:

- It is an economical and useful strategy for protecting biodiversity.
- Multiple living organisms can be protected at the same time.

Living organisms in their native habitats have a greater capacity for evolution and the potential to quickly adjust to a wide range of environmental circumstances (Rotach, 2005). **Protected areas:** A clearly defined part of a precisely circumscribed geographical area is recognized, legally or by other effective means, to ensure that nature, its functions, and cultural values are preserved in the long term. Natural, ecological, or cultural value areas are defined for protection or conservation. It was characterized into three classes: no human habitations, very sparse human habitations, and lastly, having isolated human habitations (Lele et al., 2010). It is a special kind of protected area, including those that have a large area under forests. This could apply to the whole area or just a part of it. Globally, over seven hundred million hectares, which account for 18% of the total area of the world's forests, fall under the protected categories of national parks, conservation areas, and wildlife reserves (Wani et al., 2021).

National parks: A national park is a large natural or nearly natural region designated for the preservation of large-scale biological processes. These areas also serve as a base for activities related to science, education, enjoyment, spirituality, and environmental and cultural harmony. Governments or private groups have chosen these locations to facilitate education and enjoyment while preserving the natural biodiversity of the region and its underlying biological structure and supporting environmental processes. WCPA (The World Commission on Protected Areas) classified the national parks as category II type of protected areas (Ferretti et al., 2021).

Habitat restoration: The primary goal of habitat restoration is to enhance resources and habitats for different species (Hall et al., 1997). An international scientific and policy working group states that restoration helps restore ecosystems that have been damaged or destroyed. Habitat restoration projects can range from small-scale initiatives to extensive programs (Miller & Hobbs, 2007). The essential components for the restoration of habitat include creating a detailed strategy with goals contained in it and conducting species assessments and monitoring. Such initiatives require careful planning, taking into account variables such as species variety, ambient conditions, and larger contextual components (Miller & Hobbs, 2007). An international effort has begun to counteract the impacts of habitat degradation by restoring habitats that have been affected by human activity (Suding, 2011; Hale et al., 2019). Miller and Hobbs identify three main challenges to restoration attempts: social, economic, and ecological considerations. Marine debris mitigation at Isla Navassa National Wildlife Refuge in Haiti and habitat restoration at Lemon Bay Refuge in Florida are two examples of habitat restoration initiatives (Hale et al., 2019).

Ex-situ conservation

Breeding and maintaining endangered species in lab-created settings such as zoos, nurseries, botanical gardens, and gene banks are known as ex-situ biodiversity conservation. These environments lessen competition amongst species for resources, including food, water, and available space (Braverman, 2014). Ex-situ conservation has a number of advantages.

- Extended lifespan and breeding opportunities for animals (Müller et al., 2011).
- Utilization of genetic methods to conserve threatened species (Müller et al., 2011).

Aquariums, botanical gardens, and zoos: Aquariums, zoos, and botanical gardens are the most typical examples of ex-situ conservation. Additionally, all types of ex-situ-conservation facilities store intact, protected species for reproduction and, if required and feasible, release into the wild. These establishments serve as both a haven and a source of instruction for specimens of endangered species. There are an estimated 2,107 zoos and aquariums in 125 countries worldwide. In addition, a large number of non-profit organizations and private collectors keep species and work toward conservation or reintroduction. In a similar vein, 148 counties are home to almost 2,000 botanical gardens that grow or preserve an estimated 80,000 different species of plants (Müller et al., 2011).

Cryopreservation: Liquid nitrogen is used to store seeds, pollen, tissue, and embryos in the process of plant cryopreservation. As compared to all the given ex-situ methods of conservation, this one allows for the preservation of materials for almost infinite periods without any degradation. Cryopreservation of animal genetic resources is also utilized to preserve cattle genetics (Jang et al., 2017; Isachenko et al., 2003). Many species cannot be cryopreserved due to technical constraints; however, cryobiology is an area of ongoing study, with several plant-related studies now under progress. Comparable methods are used to protect endangered animal species and breeds. Gene banks, which are comprised of cryogenic facilities used to store live sperm, eggs, or embryos, can conserve animal species. For instance, the Zoological Society of San Diego has created a "frozen zoo" to hold samples of over 355 species, including birds, reptiles, and mammals, using cryopreservation methods. Interspecific gestation, where an embryo of an endangered species is introduced into the uterus of a female of a similar species, and the child is carried to term, is a method that can be used to aid reproduction in endangered species (Niasari et al., 2009). This study has been conducted on Spanish ibex (Fernández et al., 1999).

Community-based Conservation: The 1980s marked the emergence of the community-based conservation movement, which was triggered by growing demonstrations and discussions with local groups impacted by global efforts to preserve the planet's biodiversity. Co-management combines scientists' most recent scientific understanding with local people's traditional environmental expertise, and it is regarded as an excellent approach to community-based conservation (Ward et al., 2018). This combination might lead to better management of protected areas and increased biodiversity (Fig. 1).

CHALLENGES IN CONSERVATION BIOLOGY

Conservation biology addresses major challenges such as habitat degradation, human-wildlife conflict, illegal wildlife trading, invasive species proliferation, a shortage of water for ecological needs, and climate change adaptations.

Human-wildlife conflict

Human-wildlife conflicts pose significant challenges to global food security, sustainable development, and conservation efforts in both urban and rural settings. These conflicts can lead to crop destruction, reduced agricultural productivity, competition for grazing land and water resources, and attacks on livestock. Additionally, such conflicts often result in human injuries or fatalities, damage to infrastructure, and an increased risk of disease spread among both wild and domestic animals (Redpath et al., 2015; Nyhus, 2016.

Elephants, both African (Loxodonta africana) and Asian (Elephas maximus), are particularly known for causing significant damage and posing threats to people and crops in their native regions (Sitati et al., 2003; Gadd, 2005; Sarker & Røskaft, 2014). Predators such as wolves (Canis lupus), lions

(Panthera leo), tigers (Panthera tigris), and brown bears (Ursus arctos) also frequently attack humans and domestic animals around the world, leading to injuries or deaths. These interactions highlight the ongoing struggles between wildlife conservation and human activities (Patterson, 2007; Loe & Røskaft, 2004; Kolowski & Holekamp, 2006).

Illegal wildlife trade

The illegal purchase and trading of protected wildlife, including plants and animals, as well as their byproducts, is referred to as wildlife smuggling or wildlife trafficking. The smuggling of animals is the 4th greatest illegal activity in the world, behind the smuggling of drugs, weapons, and people. Among the goods that are sought after in this trade are exotic pets, bushmeat, ivory, and traditional medicines. Illegal smuggling of wildlife sometimes involves some additional actions, such as the tranquilization of animals without a license (Zimmerman, 2003).

The purchasing of bushmeat also plays an important role in the illegal smuggling of animals. In the urban areas of Africa, bushmeat is a sign of luxury life and social standing, while in rural areas, it is included in the staple diet, where food insecurity and poverty are common (Van Vliet & Mbazza, 2011). In addition, the demand for African ivory in global markets is still high, even with the alarming statistic that several African elephants are poached every day for their tusks. Furthermore, because it can aid in the spread of dangerous illnesses, wildlife smuggling raises serious issues about public health (Travis et al., 2011).

Climate Change Adaptation

The success of traditional conservation methods in the wake of challenges posed by climate change is an ongoing debate. Some approaches for measures such as assisted migration to help species adapt, while others question the effectiveness of existing conservation frameworks, like protected areas. Predictions of widespread extinction focusing solely on changes in species ranges might not capture the full impact on biodiversity. There is a growing trend towards using integrated vulnerability assessments to understand and predict the effects of climate change on biodiversity more effectively. These approaches combine various data sources and models to provide a more comprehensive analysis (Bellard et al., 2012). Because it affects species ranges, community compositions, and ecosystem functioning, climate change presents significant challenges to the conservation of biodiversity (Walther, 2010). Tropical regions are particularly susceptible to the combined effects of climate change because of the low-temperature tolerance of their vast biodiversity. Modern conservation initiatives, however, typically focus on temperate regions, which adds to the worldwide problem of biodiversity loss (Newbold et al., 2020). Conservation management must adjust to climate change by placing functions ahead of species and environmental changes. The key components of good decision-making include methods that target climate uncertainty, such as adaptive management and scenario planning (Millar et al., 2007; Hallegatte, 2009).

Numerous species are at risk due to the degradation of certain ecosystems brought about by climate change. As an illustration:

- Sea levels are increasing due to climate change, endangering animals and their natural habitats worldwide (Baker et al., 2006).
- Melting sea ice destroys certain animals' habitats. For instance, the Arctic's sea ice loss has been increasing in the early 21st century, falling at a pace of 4.7% per ten years (having decreased by more than 50% since the first satellite data were made (Senftleben et al., 2020; Huang et al., 2019).

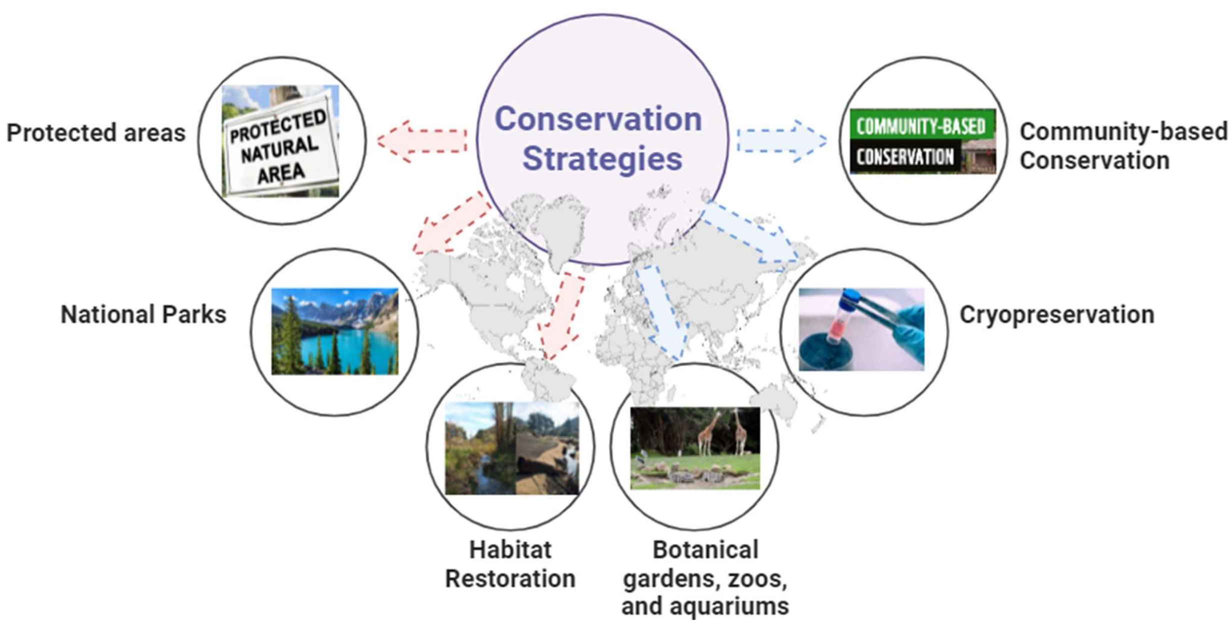

Fig 1. Various conservation strategies to maintain the sustainable ecosystem

- Warm-water coral reefs particularly feel the effects of ocean acidification and global warming. Thousands of species have a home on coral reefs. They offer food and coastal protection, among other ecological services. For example, if global warming keeps at its current pace (Fig. 2), the Caribbean's coral reefs' hotspots for biodiversity will disappear within a century (Aldred, 2014).

SUCCESS STORIES AND CASE STUDIES

A species recovery plan is a written document that describes the present situation of affairs, potential hazards, and recommended measures for recovering rare and endangered species populations. It is also referred to as an endangered species action plan, conservation action plan, and simply recovery plan. Recovery plans are the cornerstones around which a conservation effort aimed at saving endangered or rare species is built (Walsh et al., 2013).

Bald eagle recovery

The bald eagle, which was formerly widespread over the continent, had a dramatic drop in the middle of the 20th century, mostly as a result of the chemical DDT usage, which caused eggshells to weaken. Due to its tendency to biomagnify, this insecticide caused severe harm to birds such as bald eagles. Even while DDT did not directly kill adult eagles, it did interfere with their calcium metabolism, which made them sterile or prevented them from laying eggs (Jagannath et al., 2008). The Bald and Golden Eagle Protection Act of 1940 was prompted by the population's decline to only 412 nesting pairs in the contiguous 48 states by the 1950s. After being listed as an endangered species in 1967, the species were able to recover because of additional rules and the DDT ban. Bald eagle breeding pairs increased from 30 to 1,052, and nest buffer land area increased from 384 to 10,670 hectares, with more than 80 percent of the buffer land on privately held territory. Private property "under guidelines" had an increase in value of nearly 900 times. The vast majority of this impact occurred after the eagles had met recovery targets, with more than 94% of the burden imposed subsequently (Watts & Byrd, 2022).

Giant panda conservation

Threats to the giant panda species include habitat degradation, fragmentation, and low birth rates in both the wild and in captivity (Wei et al., 2015). Only a small portion of its former habitat remains in western China, where it is now restricted in its distribution. In an attempt to preserve the declining panda population, Wolong National Nature Reserve was created in 1963 (Guan et al., 2016). Since its introduction to the West, the giant panda has been the subject of poachers by both foreigners and natives since ancient times. Due to the Second Sino-Japanese War and the Chinese Civil War, outsiders were prohibited from poaching giant pandas in China starting in the 1930s, but locals continued to exploit pandas as a source of soft furs. After 1949, China's population explosion put stress on the pandas' habitat, and the subsequent famines escalated the killing of animals, including pandas (Allan, 2008; Xu et al., 2009). To unite the fragmented forest regions, the Chinese government has built the bamboo corridors in partnership with the WWF. By using these corridors, pandas may get more access to food supplies and may also find possible mates easily; china has now a large number of conservation reservoirs (Wei et al., 2015; Wei et al., 2018).

Fig 2. Conservation biology challenges

As of 2020, around 80 percent of all pandas in China reside in a new national park, home to more than 1,800 of these animals. This park, established in Sichuan Province, provides a sanctuary for pandas and enhances living conditions for other vulnerable species, including the Siberian tiger (Cheng et al., 2023). Following extensive conservation efforts, in July 2021, Chinese officials announced that giant pandas are no longer considered endangered in the wild, citing a stable population of over 1,800. This achievement has garnered international acclaim, positioning China as a leader in wildlife conservation animals (Yang et al., 2018).

Ecosystem restoration projects

The need to restore damaged ecosystems is becoming ever more important on a global scale as people realize that maintaining ecosystem structure, function, and variety is essential to human well-being. As long as human populations continue to rise, our world will bear a progressively larger human footprint, making restoration increasingly crucial (Jones, 2017). The UN has designated 2021–2030 as the decade of ecosystem restoration (Dudley et al., 2020). In the last several years, there has been exponential growth in the quantity and scope of ecological restoration initiatives (Young et al., 2005). Restoration initiatives in the United States are increasingly driven by the need to address significant environmental issues or to support the return of iconic species like the monarch butterfly or those that provide important ecosystem services like hymenopteran pollinators (Jones, 2017).

Florida everglades restoration

The largest and most expensive environmental rehabilitation project to date is the restoration of the Everglades, a major tropical wetland area in southern Florida. In the early 1970s, proposals to build an airport in the Big Cypress Swamp sparked concerns after studies indicated that such a development would lead to environmental destruction. State and federal authorities are attempting to strike a balance between the demands of South Florida's natural ecosystem and the rapidly growing urban and agricultural regions surrounding the Everglades due to decades of detrimental activities. In order to create flood control infrastructure in the wake of hurricane-induced flooding, the Central and Southern Florida Flood Control Project (C&SF) was started in 1947.

The Comprehensive Everglades Restoration Plan (CERP), approved by Congress in 2000, was originally estimated to cost $8.2 billion and take 30 years; however, owing to inflation adjustments, the project is now expected to take 50 years and cost $1.63 billion more (Steinman & Kindervater, 2022). With an emphasis on modernizing the Central and Southern Florida Project, it seeks to restore, preserve, and maintain water resources over 16 counties covering 18,000 square miles in central and southern Florida. The goal of CERP, which is being carried out by the U.S. Army Corps of Engineers and the State of Florida, is to control the amount, quality, timing, and distribution of water to South Florida and the Everglades. The main goal is to hold onto the freshwater that is now released into the Atlantic and Gulf of Mexico and divert it south to the Everglades National Park, which has seen a decrease in inflows since 20th-century drainage. The majority of the water will be used to restore the environment and rejuvenate damaged ecosystems; the remaining portion will be used to meet the water demands of agriculture and cities, therefore boosting South Florida's economy (Wilhelm, 2022).

PROTECTION AND RESTORATION TECHNIQUES

Removing invasive species can help restore native species that have been displaced from their ecological roles. These invasive species, often identified taxonomically using tools like the Barcode of Life and the Digital Automated Identification System (DAISY), can become significant pests. However, the financial costs mean that only substantial populations can typically be targeted for removal. Databases like the Encyclopedia of Life and the Global Biodiversity Information Facility are crucial tools for reintroducing species that have vanished from specific regions. These databases help identify species that could potentially be reintroduced once stable populations of existing native species are confirmed (Gupta, 2015).

Gene bank

Specimens and genetic resources are stored in gene banks. Certain repositories, like arboreal nurseries, work toward the reintegration of conserved species into ecosystems (Rao, 2004). In the mid-1900s, cryopreserved germplasm gained prominence in the domains of agriculture, aquaculture, and medicine when a technique for preserving viable spermatozoa after freezing and thawing was developed in the late 1940s. The notion of Genetic Resource Banks (GRBs) successfully eliminates the time and spatial limits in cow breeding, as stated by Sir Alan Parkes, a pioneer in cryobiology, underlining the potential benefit across all species (Holt & Comizzoli, 2021). This claim was based on the knowledge that spermatozoa might survive for lengthy time periods, enabling fruitful conceptions even after the donor's death. It is now feasible to preserve live mammalian embryos, amphibian sperm, and cultured somatic cells for future use in conservation breeding programs. These programs attempt to lessen the negative impacts of inbreeding on population survival and fitness. Additionally, innovative advancements in the cryobiology of coral spermatozoa, embryos, and larvae are helping to mitigate the detrimental impacts of toxic substances and climate change on coral reef ecosystems (Holt & Comizzoli, 2021).

Citizen science

According to research by (Amano et al., 2016; Chandler et al., 2012; Theobald et al., 2015), citizen science is a valuable resource in the collection of data on biodiversity throughout the world. Still, there is a great deal of unrealized potential for increasing its contributions. Globally, citizen science is a vital means for gathering large amounts of data as well as for encouraging public participation in environmental concerns, which may lead to changes in behavior (McKinley et al., 2017). It also establishes collaborations between local people and scientists (Funder et al., 2013; Toomey & Domroese, 2013). These cooperative projects have the potential to improve the effectiveness of conservation and biodiversity studies on a larger scale.

Species reintroduction

Reintroducing a species to its natural habitat after purposefully removing it from captivity or other suitable places is known as species reintroduction (Campbell-Palmer & Rosell, 2010). The main goal is to restore or enhance populations that are already there by establishing strong, genetically varied populations that can support themselves in locations where the species has been locally exterminated. Species that face threats or extinction in their native habitats are usually considered as potential candidates for reintroduction (Seddon et al., 2014). Reintroductions are sometimes done, nevertheless, to control pests. Some supporters prefer the word "re-establishment," as reintroduction frequently involves the return of native species to regions where they were previously absent. While humans have long used the reintroduction of animals for pest management and subsistence throughout millennia, the use of reintroduction for conservation objectives became more widespread in the 20th century (Seddon et al., 2007).

CONCLUSION

It seems obvious that maintaining biodiversity is crucial, if not necessary, for enabling humans to live long and fulfilling lives. Human activity and progress, together with the preservation of biodiversity, are frequently perceived as being at odds with one another. This chapter provides a concise analysis of the main opportunities and challenges in biodiversity conservation and assesses the various strategies for conservation such as habitat restoration, protected areas, and community-based programs. Furthermore, it emphasizes the challenges including insufficient governance, climate change, and habitat loss. Conservation biology as a discipline must produce results in the scientific knowledge, organize scientific inquiry around policies and arguments that shape our values as conservationists, transcend the biological sciences' certainty into the social sciences' more contextualized discussions, engage in scientific inquiry into humandominated landscapes, and address the question of how conservation can enhance human livelihoods and life quality. This chapter also reports how conservation initiatives combine with innovative policymaking and scientific research and how urgent it is necessary to take a step toward coordinated action.

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