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Anthropogenic activities led impact on Biodiversity and need of proactive endeavours towards sustainable ecosystems through life diversity conservation

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ABSTRACT

Ecosystems continue to be influenced by human activities, there is a need to acknowledge the benefits of biodiversity and take preventive steps from destroying the biodiversity permanently. The rapid growth of human population has caused exploitation of Earths biological diversity in very unsustainable manner. This has led to lot of changes, like a shift in the climate, ocean acidification and various anthropogenic activities including environmental impacts. We must realize this as a point, that conservation of biodiversity is very important for human survival and continuity of ecosystems. However, some conservational approaches and growth in public as well as government keenness in sustainability of biodiversity is still on the lower side. Conservation strategies need to be implemented together with broader institutional and societal changes enabled effective implementation of the policy. In addition, conservation should clearly be proactive as well as ongoing, to as far an extent that is feasible. Climate change will certainly become one of the outcomes of the human activities and poses a great threat to Biodiversity. This paper encompasses the study of protected areas in relation to geopolitical and habitat coverage, also considers the numbers as a worldwide indicator of conservation standards. Role of protected areas, in preserving biodiversity as well as quality control in such areas are discussed. *Ex-situ* along with *in-situ* conservation methods are taken into consideration.

Keywords:Environment, Biodiversity, Ecosystem, Protection, Scenario, Climate Change.

Introduction

Biodiversity, a term that first emerged around twenty years ago (Lovejoy, 1980; Wilson, 1985; Norse 1986; Wilson, 1988; Reid, 1989; McNeely 1990; Chauvet, 1993), discuss the variety and variability of life on Earth. It consists all forms of terrestrial and aquatic plants and animals and microorganisms, their genetic material and the ecosystem to which they belong. Biodiversity is overly critical to human wellbeing, economics of the world and livelihood of this planet. Humans have impacted the biodiversity in several ways and become a reason for loss of 83% of all wild animals and almost half of the plants. Biodiversity dissipation and ecosystem break down have been on a report on the top risks in the World Economic Forum 2020. Biodiversity supports global nutrition and food security. Millions of species collectively give us variety of products that we use in daily life, be it the large variety of fruits and vegetables, animal products like milk, which make for a healthy balanced diet. All areas across the world have enough indigenous produce of wild plants which are particular to the respective areas and have taken ages to adapt to the conditions they are in. Micronutrient needs of the masses have been taken care of by the diversity of plant produce (Lakra et al. 2016). In recent years, with the changes in the eating patterns, simplification of diet, increase in processed food and limited access to food have resulted in the decline in the quality of diets. Conclusively, one third of the human populations have been diagnosed with micronutrient deficiencies Cereals provide around 60% of the total plant-based calories that humans consume. At one time, the human population was sensitive to conservation of species and looked at it with utter seriousness, for maintaining a healthy society and an ecosystem. This should be ensured now as well as going forward as it is only going to be of critical importance.

Increasing loss to biodiversity has been related to human health issues as well. Plants are needed for medicinal purposes, 25% of the drugs used in modern medicine are derived from the rainforest plants and 70% of the drugs for the treatment of cancer are natural (Chandra Prasad Giri et al). This hints that with every species getting extinct, we might be losing access to a potential medicine of the future. Human activities like encroachments into the natural world through deforestation and urbanization, have led to reduction in the size and numbers of the ecosystem. Consequentially, animal population has come to be more congested in the reducing space, increasing the chances of zoonotic diseases. World Economic Forums Recent Nature Risk Rising Report, states

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that half of the *world's* GDP is highly dependent on the nature. Economy can also be improved by becoming stronger, ensuring that conservation of biodiversity is prioritized, and right action is taken in that direction, nature can help economy reach a new level, there is a lot of potential unexplored as of now. Almost 125 Trillion dollars' worth value is derived from natural ecosystems every year and the numbers tend to only increase with time (Pretty et al. 2004). Hence, ecosystems must be protected and maintained for the good of nature, which will also support the part of the society living dependent on it. Biodiversity makes the earth livable and these ecosystems provide nature-based solutions that we need to regulate and keep in control the natural disasters like floods, storms and filter out unwanted substances out of our lives. The clearance of 35% of the *world's* mangroves through human activities has posed a threat to people and the infrastructure around them due to risk of floods and rise in sea levels. If all the mangrove forests are wiped off this planet, approximately 18 million or more people will be flooded annually, and the damage inflicted would increase to approximately 16% of the current. Protection and safeguarding of natural ecosystems are very crucial in fighting climatic changes as well. Natural ecosystems provide the foundation to economic growth, human welfare and in general, prosperity. For example, if ecosystems are conserved in large areas, the majority of species and much of their genetic diversity will be protected. In addition, ecological system nutrient sequencing, hydrological regulation, micro-and macroclimatic regulation and the maintenance of concern regimes upon which many species are essential to the survival of many species. Only ecosystem-based approaches are likely to ensure the protection of these vital links to biodiversity-based approaches help conservation to protect biodiversity across a full range of habitats and across a wide geographic stretch that species-based perspective to conservation may overlook.

Biodiversity

Earth is a unique planet with great heterogeneity in the nature. There is a strong synergy between atmosphere, hydrosphere and lithosphere which bring about certain conditions where biosphere exists. Because of this there is diversity among organisms also. The term biodiversity in itself is a complex term. It includes variety of different life forms present in a particular ecosystem. It also includes species present in a particular geographical region. "Without biodiversity, there is no future for humanity", says Professor David Macdonald, at Oxford University. There are three categories of diversity- ecosystem diversity, genetic diversity and species diversity.

Genetic Diversity: The diversity also known as biological diversity and it is present at all the levels of biological organization spread across populations in the ecosystem. It represents the variations inherited among the populations and these variations in individuals arise by the recombination and spread through the population. Genetic variations have their own role as they alleviate both the natural gauging and artificial selective breeding to happen that is critical for the survival of life on the Earth.

Species Diversity: species can have a control on community structure and thus on overall biodiversity. Species diversity is the variety of different kinds of organism that make up a community. There are different components which make up species diversity.

• Species richness (No. of different species that live within a community).

• Relative abundance species evenness. It refers to proportion of each species.

• Community stability

For example - tropical rain forest tree species supports endemic invertebrate fauna of a hundred species evidently makes a greater contribution towards global biological diversity than a European alpine plant which may have no other species wholly dependent on it.

Ecosystem Diversity: It can be viewed as the variety of ecosystems present on the planet Earth, be it a forest, prairies, deserts, coral reefs, lakes or any of the other ecosystems on this planet. Every species has its own role in the ecology and the composition of the species varies as we move across regions, regrouping usually taking place in areas like grassland, are the only interactions which occurs within and between these systems. Diversity in landscapes is also included in the ecosystem diversity, like the landscapes in biomass and of the biomass of the planet. Conservation strategies that follow ecosystem-based approaches have strength. Ecosystem based approaches also bring along variety in nutrient cycling, micro and macro climatic regulations, which become a factor in their survival in that ecosystem. 'Biodiversity parks program' in Delhi exemplifies this approach. Yamuna Biodiversity parks and Aravalli Biodiversity Park are two prominent names. These parks are safeguarding the species of Yamuna flood plain and Aravalli Hills using manmade ecosystems.

Need of Biodiversity

Biodiversity is a necessity, not a luxury: Recent loss of species and natural regions has been caused majorly due to human activity and has been happening at an accelerated rate now. Species are getting extinct and this brings about the irreversible loss of unique genetic codes, which often lead to development of medicines, food and in turn jobs. Life Support System is provided by this Biodiversity and every element of it is critically important. Fixing of carbon, oxygen and nitrogen is done which is maintained for a specific balance because of the Biodiversity prevailing. Mitigation of pollution, protecting water sheds and fighting against soil erosion are some of the other way in which biodiversity plays its role. When we are overexploiting the living resources, we are putting a threat to our own survival. We must safeguard the biological diversity by a variety means.

Biodiversity is essential for securing food supply. All scientists and farmers rely on the genetic diversity of crops and live stocks to speed up the yields and adapt to changing environmental conditions. Water bodies on the earth have an abundance of food assets. Food from the wild stocks is the single largest source of animal protein for the *world's* increasing population. Biodiversity and food security are interrelated, and biodiversity helps in regulation of the nutrient cycle and water (flood) and mitigate the effect of climate change. Food safety faces many hurdles as population grows, poverty grows, globalization, climate change and other factors supplying health food to all citizen is crucial for global development to reach it not only food production but also address equitable access to food for all people. Biodiversity loss as well as global food security are thus two main threats of over time. The most commonly used definition of food security states that "Food security is present when all people,

always have physical, social and economic access to sufficient, safe and nutrients food that meets their dietary requirements and food choices for an active and healthy life. Household food security is an extension of this concept to the family level, with individuals as the focus of concern" (FAO, 2003). Peoples from developing and developed countries, depend on forest products to meet some part of their food, nutritional health and livelihood needs. Although forest foods seldom providing stable items of diets, and rarely make up the majority of items in diet. Forest are crucial in maintaining the biodiversity that underpins crop and livestock agriculture and area an underdeveloped repository of food and other reasons that play a major role in food security and human health (Sunderland, 2009).

For Agriculture: "Agricultural biodiversity is crucial for food security throughout the world. At the genetic, species, and farming systems levels, biodiversity provides valuable ecosystems services for functions for agricultural production." (Thrupp 2000).Food comes from our environment only. People either grow, gather it, or fish or hunt it. Regular food supplies depend upon healthy environment and upon wide range of plants and animals available to us to make it possible to keep breeding varieties that can cope with the market and organizing to be active in it. (Tansey, 2008).

Biodiversity is important to the global economy: The economic value of biodiversity is a well-known fact. New age agriculture depends on new genetic stock from ecological system which is now a 3 Trillion-dollar global business. Nature tourism generates around 12 Billion Dollars worldwide on an annual basis. Biodiversity may be a source of energy like biomass. Industrial products include oils, lubricants, perfumes, fragrances, dyes, paper, waxes, rubber, latexes, poisons and cork can all be derived from various plant species. Fibers for clothing, wood for shelters and warmth. Supplies from animal origin are wool, silk, fur, leather, waxes. Animals may be used as a mode of transportation.

Biodiversity provides recreational opportunities: Additionally, protecting our future food supply, health and environment, biodiversity supports an array of recreational opportunities and has its own aesthetic value. Saltwater recreational fishing in the U.S. produces more than $ 15 billion every year in economic activity and creates over 200,000 full time jobs.

Biodiversity safeguards human health: Out of the top selling 150 prescription drugs in the US, 79% have been made through nature. Around 199 pure Traditional medicine, which rely on species of wild and cultivated plants, form firm stance of primary health care for about 80% of the population living in developing countries (Farhana2017). Every year, the US imports upwards of $ 20 million of rain forest plants for their medicinal properties. According to National Cancer Institute of the USA, about 70% of the promising anti-cancer drugs originate from plants in the tropical rain forest. There are multiple health benefits we get from biodiversity. Climate Change causes serious health implications on plants and animals, which range from direct effects like progressive temperature rise from global warming (Chandra Prasad Giri et al.1993). Increasing numbers of people and extreme climate like heat waves, droughts or flooding, threaten human health and well-being, through impaired ecosystem functioning and reduced ecosystem services. Climate change poses significant risks to human health and biodiversity. Increase in the number of heat waves, drought, and flooding events due to climate change have negative consequences for both human health and biodiversity (IPCC 2007). The frequency and severity of heat waves and other weather-related events are expected to increase in Europe with a changing climate. this will have a significant impact on biodiversity and ecosystem functioning by worsening habitat conditions (EEA 2012).

How can we conserve BIODIVERSITY?

Conserving wild species of plants is very important for the present population to be survived. This is done by various in situ techniques. With the help of scientific researches several iinnvestigations and demographic processes has come up with different causes explaining the decline in population and increased in number of population extinction (Soule 1980; Soule 1986; Lande 1987; Barret 1991; Lande 1993, 1994; Higgins 2001). A detailed portion of this work was devoted to questions related to optimal conservation, such as the importance of inbreeding depression (Hedrick 2000; Keller 2002), population size (Barrett 1991; Ellustrand 1993; Schemske (1994), isolation (Newman 2001), genetic diversity (Lande 1987; Newman 1997) and outbreeding depression (Hufford 2003; Tallmon 2004).

Ex situ conservation methods collects genetic diversity of species used by certain criteria and store/propagate the collected material in their outside native habitat (Heywood 2003). Some germplasm preservation techniques include seed banks, pollen and tissue storage, vegetative cloning and maintaining whole plants. A comparative assessment of these methods is described elsewhere (Hawkes 1987; Lynch 1999; Benson 1999; Eberhart et al. 1991; Fay 1992, 1994; Sarasan et al. 2006 Engelmann and Engels 2002; Walters 2004). For example, Seed banks/Gene banks provide facility to store seeds, under cold and dry conditions, are the most popular way of preserving germplasm of plants, including wild species (Schoen and Brown 2001; Linington and Pritchard 2001). seed banks are popular way of storage of seeds because of many reasons.They provide easy storage access ,less space , low cost of maintenance , immunty to predation and infestation (Ashton 1987; Roberts 1991; Schoen and Brown 2001). However, this technique is not suitable for all the seed types. Seeds with very slow rate of germination, or seeds which grow germinate immediately are not suitable for this type. An alternative Ex - situ method for this is to keep living collections in the form of botanical gardens. Many of the botanical garden collections were and continue to be samples of horticulturally amenable taxa (Cohen 1991; Linington 2001; Maunder et al. 2004a). During the last two decades there is rise in acceptance of Ex-situ conservations methods in protecting endangered plant species or specifically managed for conservation purposes (Gomez-Campo 1985; Maunder 2001; Wyse Jackson 2001; Smith 2003; Cohrane 2004; Havens 2006).

The thought of role of botanical gardens in conservation of endangered plant species has been expressed at both first and second International Congresses for Nature Protection held in 1923 and 1931 (Heywood 1991). The development of this idea of creating botanical gardens for the purpose of conservation of plant species has been done by Cugnac (1953), who suggested creation of specific ex situ conservation facilities, closely associated with protected areas. There is a need for a conceptually sound link between conservation-oriented ecological and genetic research, and its routine application to ex situ management has been recognized (Maunder et al. 2004a). Plant conservation urgently needs a concept that would unite different aspects of population viability as parts of

conservation methodology. In Ex situ conservation this unification is strongly lacking (Sergei 2010).

Conservation implies that we need to make the judicious use of natural resources while keeping wastage and degradation to the minimum. Two important objectives of conservation are as follows:

• Safeguarding the quality and purity of Environment.

• Setting up a balanced cycle of harvest and renewal making sure that a continuous supply of natural resources is ensured which implies that if we cut trees, we should plant an equal number of trees.

The maintenance of biological diversity at all levels is fundamentally the maintenance of viable populations of species or identifiable population this can be carried out either on site (*in-situ* conservation) or off site(*Ex-situ* conservation).

In situ conservation the maintenance of a significant proportion of the world's biological diversity at present only appears feasible by maintaining organisms in their wild state and within their existing range. This is generally preferable to other course of action because it allows for continuing adaptation of wild populations by natural evolutionary processes. Benefits of *in-situ* conservation include maintenance of recovering populations in the environment where they have evolved their distinctive properties. Another benefit is that this strategy will help us to ensure the ongoing processes of evolution and adaptation within their environments. Ex situ conservation may be used on some or all of the population, when in situ conservation is too far from achievable. The species then get adjusted to the natural calamity like drought, floods, forest fires and this method is very efficient and convenient.

Ex-situ conservation: Viable populations of many organisms can be maintained in cultivation. Plants can be be maintained in seed banks as well as germplasm collections; similar techniques are under development for animals (storage of embryo, eggs, sperm) but are problematic.

In situ conservations: planned in two ways: habitual/ecosystem based, and species based. An Ecosystem approach to conservation aims to ensure the representative samples of ecosystems or important habitat types are maintained through the definition of network of protected areas or through the other controls on land use. In doing so, the species which inhabit these ecosystems will be preserved. The prime advantage of this approach is that it does not need detailed knowledge of the status and spread of all species. The most critical way in which plant species can be conserved is by protecting their habitat through regulations on land use. There is a considerable diversity in countries in terms of the mechanisms used to create and maintain the systems under protected areas. The IUCN, through its commission on National parks and protected areas, has cultivated a system of segregation for different types of protected area, based on their management objectives. This system has 7 different classes of protected areas, two of these, World Heritage site and Biosphere reserves are considered international designations. (IUCN 2001)

Protected Areas: A protected area is defined by the convention on biological diversity as 'a geographically designed area which is designated or regulated and managed to attain specific conservation objectives'. At the fourth world Congress on national parks and protected areas, held in Caracas, Venezuela, in 1992 (IUCN, 1994), protected areas were marked as areas 'of land and / or sea specially allocated for the protection of biological diversity, and of the natural and associated cultural resources, and managed through legal or other effective means'. The world's protected areas have grown rapidly over the years, particularly in developing countries where biodiversity is greatest. Concurrently, the missing of protected areas has expanded from biodiversity conservation to improving human welfare (Lisa 2005). Protected areas are a cornerstone of regional and global strategies for the conservation of biodiversity. However, the ecological performance of these areas, both in terms of the representation and the maintenance of key biodiversity features. Protected area only provides a unidimensional indicator of political commitment to biodiversity conservation (S. Chape et al, 2005). IUCN defines a protected area as "An area of land and / or sea specially dedicated to the protection of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means". (IUCN 1994).

"IUCN Protected Area management Categories (IUCN, 2001) are following:

Category I a : Strict Nature Reserve

Category I b : Wilderness Area

Category II : National Parks

Category III : Natural Monument or Feature

Category IV : Habitat /Species Management Area

Category V : Protected Landscape / Seascape

Category VI : Protected area with sustainable use of natural resources"

The enlisting of such areas is part of a strategy being used towards the conservation of the world's natural environment and biodiversity. The IUCN has developed the protected area management categories system to keep record, and enlist the wide variety of specific aims and concerns when categorizing protected areas and their objective. "Supervising protected areas and their vicinity at local to regional scale is essential given their Vulnerability to anthropogenic pressures, including those associated with climate fluctuation and important for management and fulfillment of national and international directives and agreements. (Nagendra, 2013)". Freshwater protected areas have got little attention, despite the distinction of protected areas as conservation interventions for terrestrial and more recently marine factors. (Abell 2006). Climate change in predicted to become a major threat to biodiversity in the 21st century but accurate predictions and effective solution have proved difficult to formulate (Dawson 2011). Biodiversity loss is a great concern among conservation scientist, but it is difficult to reverse this trend because half of the world population live in urban areas and are increasingly disconnected from nature (Miller 2005). Efficient global diversity conservation should be focus on a two sharp strategy targeting the 60% of the land's surface covered by the five high-biodiversity wilderness areas as well as the 1.4% covered by the hotspots (Mittermeier, 2003).

THE REVISED IUCN RED LIST CATEGORIES (IUCN2001)

Red List Category	Definition
Extinct	The last individual of the taxon has died.
Extinct in the	The taxon is known to survive in cultivation

Wild	only. In captivity or as naturalized population/ populations well outside the past range. A taxon is presumed extinct in the wild.
Critically Endangered	The taxon is facing extremely high risk of extinction in the wild in the immediate future.
Endangered	The taxon is not in category of Critically Endangered but in the near future there are chances of facing a very high risk of extinction in the wild.
Vulnerable	Endangered and there are chances of facing a high risk of extinction in the wild in the medium-term future.
Near Threatened	The taxon is not Critically Endangered, Endangered, Vulnerable or Conservation Dependent but is close to qualifying for Vulnerable.
Least Concern	The taxon is not Critically Endangered, Endangered or Vulnerable and does not qualify for Conservation Dependent or Near Threatened.
Data Deficient	There is inadequate available data to make a direct, or indirect estimation of the risk of extinction on the basis of distribution and/or population status of the taxon.

GUIDELINES common to all six protected area categories:

Managing Biodiversity in protected areas: Protected areas are designated based on legal, policy or traditional standards, by which the society can create parts of land, sea management to work and take care of the plant, animal, and cultural resources associated with it which has a particular value. Packaging devices to assemble and make use of the necessary means to achieve a definite target. There are 6 types of such areas as categorized by the IUCN, which provides diverse management systems that help in biodiversity conservation, while helping in other objectives as well. Protected area types, category 6 particularly, maintain a complete set of ecosystems which has been created by people over a course of time, making it of high cultural value. A new classification was added, Managed Resources Protected Areas in 1993, to address those a lot of areas are secured to maintain the capability of traditional and local communities to sustain with the use of biological resources while keeping the natural landscape unaffected.

Effectiveness of protected areas for maintaining biodiversity: Contemplating on the biological impact of a protected area network need a backup of the information on the diversity of biodiversity elements in that area and on the number and type of management support around protected areas management. More accurate and specific information on the contribution of protected areas in the conservation of the elements of biodiversity is usually not available and even for the nations that have well established protected areas, lack such data. India has a protected area network of around 500 National Parks and natural resources taking up 5% of the land. There were a couple of nationwide surveys that were conducted to evaluate the effectiveness of the measures. Socio-economic measures are being taken to enhance the credibility of biodiversity management in the protected areas for the success of these regions and the longevity of the biodiversity. The presence of species in a protected area is not a definite guarantee that the species will be secure for the long term. Such areas, though secure, but are vulnerable to encroachments causing hunting and degradation of the protected areas. In some cases, the protected areas are so small that it is not viable to be able to maintain the population of the species as the density of the population is highly low.

Protecting species and population genetic resources: There are different programs for the management of the species that have been developed. These include in situ and ex situ conservation programs. The IUCN formed the species survival commission about 30 years ago and it contained several categories of threat that classify the species but their level of the potential risk to extinction. The recent version of this system includes 10 categories: Extinct, extinct in the wild, critically endangered, endangered vulnerable, conservation, dependent, near threatened, least concern, data deficient and the ones not evaluated. Each category respectively uses the same criteria:

- Population and habitat decline
- Habitat Area
- Population and habitat decline
- Population Size
- Population Viability Analysis

There are a variety of quantitative thresholds that are set for these categories. Irrespective of the classification, the Red Lists are the main resource for the species known to be threatened.

Management Plans: Species based approach to establish a well-defined plan is to aim at identifying the species which are a high priority for safeguarding as they are a higher risk of extinction. Most of the species are under management plans at both the international as well as national level. The national-level legislation would have been enacted in most the countries and this would be the legal basis for the sustainability of the management regimes and hence protection of the biodiversity. Management plans come into action most likely when the species is perceived to be at risk as it is economically valuable as well. Some of the management plans have not worked in the way that they were expected and majorly due to misalignment with the aim. Management plans under CITES (Convention on Trade in Endangered Species of Wild Fauna and Flora) have generally had export quotas or ranching programmers that are designed to make sure that uses of the species in concern are sustainable and minimize harm to the biodiversity.

Recovery Plans: These plans are aimed at threatened and endangered species and have been developed under the legislation and have been designated special status. Reasons for the decline of these populations have been talked about in the introduction. The aim is to achieve an adequate amount of recovery of the species in consideration and the goal is to help the species change to a non-threatened category. These plans have a list of measures that must be followed to help in the recovery of the species. Captive breeding, reinforcement of the natural habitat, restructuring of harvesting and reduction in the level of toxic materials introduced into the system are some of these measures when looked at from far. Detailed measures will be taken care of when the areas are managed and taken care of in practice.

In Situ Conservation of species, population, and genetic resources: These are usually the measure that is to emphasize

on the protection and management of ecosystem in communities to prevent the damage to the resident species. Kemp Et Al (1993) stated that even if the objectives remain to be the conservation of particularly targeted species or that of the population, it might need the protection of the community on the whole until the time, the complexities and interactions across ecosystems and species are known to the fullest. Complex food web systems are composed of other species as well, which cannot be ignored as they cannot be excluded. It is overly critical to managing the species as genetic resources to make sure that the range of genetic variations that are necessary to make through the changing environment. The changes have a potential value to human economic activities as well. The programs of and around the ecosystem protection and management are addressed to the level of biotic communities and their interrelation, however, a program of the genetic pool use and protection is aimed toward making genetic variation between and with a population more sustainable and safeguard them as far as possible. Ecologists and genetic resource specialists have been interested in species conservation, how to go about the methods and strategies by which genetic diversity is maintained. But this does not come as a replacement for each other, every individual specie and type is of high importance and should be counted separately. In Situ Management for the protection of genetic resources are popular, while few areas have been able to see the results. Garo Hills of India, have gene sanctuaries for the wild relative of citrus crops which has also promoted the safeguarding three more establishments like this in other parts of India as well.

Effectively, the *in-situ* advancements for the conservation of species include legal safeguarding of the endangered species, formalization, and preparation of management and recovery routes. It must be made sure that it becomes next to impossible to break into these protected areas and these are far from the sight and approach of hunters. The unique genetic resources need to be protected and should be the priority for these protected areas, the rest of the advantages follow. There are two major fallbacks that are experienced:

•Lack of information on the status of conservation and the status of habitat needs to be of individual species to track the pool better.

•The economic and opportunity cost of conserving individual species and populations must be realized to make this whole regime efficient.

Ex Situ Conservation: When we talk about conservation, only In situ programmes are not sufficient to maintain diversity of species, their populations and genetic resources. We need to have more options in the form of Ex situ so that conservation and restoration can be done more efficiently.

In earlier times our ancient rulers were much more interested in giving pleasant aesthetic look to their city. They created many parks and gardens which are world famous and exist till date. These gardens are designed in a very systematic way with keeping in mind the role and need of native trees. Till date we can find some of the oldest trees of our city in these parks or gardens which are now homes for thousands of small creatures and birds. For a modern society they fulfill a more practical purpose. They now act as centers for the propagation and acclimatization of collected plants and animals. These plants and animals are valuable to humans for different purposes. A number of Ex situ conservation strategies are in use today which are helpful in conservation and restoration of species. We can conserve our biodiversity by *Ex-situ* methods in following ways:

• **Botanical Gardens**: In the earlier 20th century the role of botanical gardens in conservation was seen with very little or no economic value. With the change of time, the need of botanical gardens was realized and now they are seen as the largest assemblages of plant species with an objective of conservation, education, recreation and also historical interpretations. According to IUCN, the number of extinct plant species would be 34% higher if there were no botanical gardens. Also, botanical gardens help in recovery programmes for endangered species and degraded ecosystems. They provide a critical link between Ex situ and In situ efforts towards sustainability and to protect biodiversity.

•**Zoo/ Aquaria**: The abbreviation Zoo was first used at London for a Zoological garden which was opened for scientific study in 1828. Here, wild animals and in some instances domestic animals also are exhibited in captivity. The primary objective of the zoo was to understand the basic physiology of the animals and to give good care to the homeless and sick animals too. Today the opportunities for scientific researchers are much wider than before. There are many researches on animal behavior, their captive breeding and also on their illness. Zoo's also release periodicals and journals along with educational programmes for school children and for common public. Post-World War II many threatened species have been saved by breeding in captivity. They are also based on the captive breeding efforts which include large number of aquatic animals majorly fishes. These creatures are mainly from wild and are at risk of extinction. In the modern world there are many aquaria in the big cities which full filling multiple purposes. They do captive breeding and save the wild as well as cultivated species. They also educate school and college students by giving them opportunities to do researches. They are also seen as places of recreation for the general public.

Ex situ conservation of animal is expensive zoos that do not simultaneously invest in habitat conservation, while raising large amounts of funding to develop, new captive breeding technologies and facilities in habitat conservation, may do little to enhance the survival prospects of endangered species. According to Muckinmon and Mackinnon (1991) captive breeding programmes are ignoring the fundamental causes of species endangerment and thereby limiting the potential effectiveness of reintroduction programmes. They suggest that 'zoos' 'adopt' protected areas and help raise funds for the protection and management of these sites in addition to developing captive breeding programmes.

• **Seed Banks / Gene Banks**: Seed banks and gene banks allows the advantage of storing large amount of plant genetic material both cultivated and wild in a very small space. Here, the fear from habitat destruction, climatic change or any other human interference is very less. Many of the plant species which were threatened have been saved at these gene banks. Modern gene banks allow researches and journals to come up with new information. They also give scope and opportunities to many scientists who are working to give best quality seeds and healthy verities of plants. More than 100 seed collections called seed banks exit around the world and collectively hold more than 3 million samples at very low temperature They offer the advantage of storing a large amount of plant genetic material in a very small space. Seeds stored in seed banks are safe from habitat destruction, climate warming, and general neglect. There have even been some instances of seeds from

seed banks being used to reintroduce to nature a plant species that had become extinct. Some disadvantage to seed banks exist, however. First, many types of plants, such as avocados and coconuts, cannot be stored as seeds. Second, seeds do not remain alive for infinite period of time or endless time and must be germinated regularly so that new seeds can be collected. Growing, harvesting, and returning seeds to storage is most expensive. Cryopreservation is new aspect of storing plant material in seed banks. In Cryopreservation plant parts or seeds are kept at -160°C'., or -256°F in liquid nitrogen. Seeds stored at this temperature are able to survive for longer periods of time than seeds stored at normal temperatures. Because incidents such as fires or power failures can result in the permanent loss of the genetic diversity possessed by the seeds. To avoid this biologist categorized seed samples and store them in many different seed banks. The most important drawbacks of seed banks is that plant stored in this manner remain static in an evolutionary sense. They do not evolve in response to change in their natural environments. As a result, they may be less fit for survival when they are reintroduced into nature. Despite their shortcomings, seed banks are increasingly viewed as an important method of safeguarding seeds for future generations. The germination and viability of a range of seed accession, of various ages and stored under different conditions in the NSW Seedbanks, was determined through germination and cell tests. The result indicates that many species can be stored at 5 to 10% moisture content at 5ºC for up to 10 years without significant loss of viability to medium term storage (Offord C.A. et al. 2004).

Gene Banks: Gene Banks in institutions deal only with the genetic supports of certain commercial crop and livestock species. A number of factors, including genetic vulnerability, the high environmental costs linked with the use of high - yielding varieties, and limited or exhausted soil and water resources, which inspire these institutions to search for new uses for species which are utilized in the past and probable uses for some of the thousands of plant and animal species that are hardly known to science. For the major crops, a large amount of germplasm is available ex situ, and it represents a fairly high percentage of the cultivars known to exist. The same is true for breeds of the major groups of domestic animals. Assuming these gene banks are effective in maintaining viable germplasm, it would be appear that the genetic resources of the most important crop and animal species for human food consumption are not seriously endangered. During the 1970s and early 1980s, collecting germplasm and adding accession were the highest priorities for many gene banks. The characterization and evaluation of the accessions lagged far behind the collecting, and still does, Therefore, a low percentage of the stored germplasm has actually been incorporated into breeding progammes, and complete characterization and evaluation of the existing accessions is probably impossible. To overcome this problem associated with the gap between collection size and capacity for characterization and evaluation, it has been suggested that representative samples - between 10 and 20% of the large collections should be taken and characterized to form smaller 'core collection' (Lleras 1994; Hodgkin 1995). The germ plasm collections must capture the original genetic variation, must be stored in a way that maintain viability for years or decades, must be appropriate to the sites where reintroduction will take place (Guerrant Jr 2004). Lleras (1994) also proposed that in situ or field gene banks should be established for Biodiversity conservation areas (Protected areas: key areas). These could serve core collections for plant species associated with the individual conservation areas, giving rise to and in situ core collection strategy.

• **Biodiversity Parks**: Introduction of biodiversity parks is also an achievement in conservation of a degraded ecosystem. It started as an Ex-situ programme where native species of plants were brought from nearby areas and were planted in a systematic approach to form different forest communities and ecosystems. Later, these parks now follow In situ conservation strategy. With the establishment of native ecosystems of Yamuna flood plains and Aravalli hills the fauna get attracted from the nearby area and developed their habitat here. Started from the tiniest microbes these parks are now homes for thousands of species including large mammals. Biodiversity parks allow students from varied educational institutes and budding researchers to conduct researches and develop more strategies of restoration. These parks provide recreation to the nearby community and give countless ecosystem services.

Studbooks: A studbook is an international register which lists all individual of a taxon of conservation concern. Official studbooks are those identified by the Species Survival Commission (SSC) of IUCN and the international union of Director of zoological Gardens. Studbooks are published every three years, and regular update are available. Studbooks are the most important tool in managing ex-situ conservation of wild animals, ensuring their size, numbers, demographic stability and genetic diversity.

Ex Situ Technologies: In vitro Storage of cytoplasm: germplasm refers to conservation of plants in lab condition. In vitro methods are particularly suited to long term storage of propagules of species with recalcitrant seeds which cannot otherwise be maintained in seed bank. In vitro storage is high - cost and labour intensive, as sub culturing is needed after a certain period. hypothetically, cultures can be stored indefinitely using cryogenic techniques which would reduce labour requirements. However, in practice only a few species have yet been successfully preserved in this way. Raven and Havenst (2014) explained the execution of modern techniques of cryopreservation for long term storage of plants that produce "recalcitrant" seeds.

Cryopreservation is a latest technique which have been developed during the last years. Biotechnology has given us many new conservation tools. In Cryopreservation both plant and animal species are kept in liquid nitrogen at 196°C .It is a good alternative for preservation of biodiversity (both plant and animal species). The major benefits of cryopreservation over standard techniques are an absence of problematic temperature and humidity controls, freedom from pest & pathogen damage, and indefinite viability with no genetic damage. For animal species embryo and semen are preserved in Cryopreservation. Seeds, embryos or tissues are utilized in plant cryopreservation. Cryopreservation may be turn out to be cheaper than the maintenance of growing cultures since it will make long-term even infinite, conservation feasible.

Conservation and isolation of DNA: It is a emerging and a very promising technique for the conservation of isolated DNA. Among its advantage are that only minute number of materials are needed for conservation and the possibility of re-introducing the material into known genotypes or species. It is applicable for endangered or even extinct species by taking sample of material from hair, bones herbarium specimen or other material of target species (Wang et al, 1993) However, in present situation this approach is even more experimental

than cryopreservation and should be only viewed only as a future alternative for the conservation of genetic diversity.

Restoration and rehabilitation of species populations and ecosystems: Widespread degradation of natural ecosystems is occurring world-wide as a result of human-induced activities such as fragmentation, livestock grazing, logging and invasions by animals and plants. These factors often result directly in declines in populations, extirpation or extinction of species, and can eventually cause the disappearance of entire ecosystems. There is an increasing recognition world-wide that reintroducing endangered species and restoring and rehabilitation degraded ecosystems will play a vital part in maintaining and enhancing biodiversity \ Saunders et al. 1993; Olney et al. 1994). Reproduction of captive-bred species is often the justification for and logical end point of many ex situ conservation efforts. Three basic approaches are used to establish new population of plants and animals (Primack 1995).

Reintroduction programmes release captive-bred or wild-collected species into an area of their historic range where the species no longer occurs. The objective of these types of programmes is to create a new population in the original environment.

Augmentation programmes seek to release individuals into an existing population to increase its size and genetic diversity.). This is not normally recommended by IUCN (1994c) because of the possibilities of introducing disease and reducing the genetic fitness of the existing population.

Introduction programmes establish animal or plant populations outside their historic ranges. This may be appropriate where habitat conditions in historic ranges are very badly degraded and the species can no longer survive there or when the factor causing the loss of the species is still present, making are introduction programme impossible. The risks of such efforts, both to the introduced animals and to other species with which they would interact, need to be studied carefully.

Ecosystem and landscape restoration: Restoration ecology is one of the newest and most challenging disciplines in ecology, although some ecological restoration efforts have been ongoing for decades. The definition of terms for restoration and rehabilitation vary considerably, and different terms are often used synonymously. Rehabilitation involves the repair - not the re-creation - of damaged ecosystems, while restoration usually involves the reconstruction of a natural of semi-natural ecosystem on degraded or modified land; Rehabilitation of degraded ecosystems involves two major components. First, the factors leading to degradation must be treated. Second, components of the ecosystem that have disappeared have to be replaced. Ecosystem restoration has mostly been practiced on extremely degraded site such as mine sites, spoil heaps and municipal dumps (Bradshaw 1980; Majer 1989; Ward 1990).

What can we do about the issue of declining Biological Diversity?

Although our children and grandchildren are going to face a biologically impoverished world, we should view this problem as a challenge. People who are devoted to preserving our biological heritage can reverse the trend toward extinction. It is important to realize that you do not have to be a biologist to make a contribution; some of the most important contributions come from outside the biological arena. We can maintain biodiversity of our heritage by taking following actions.

Increase Public Awareness: The consciousness of both the public and legislators must be increased so that they understand the importance of biological diversity. A political commitment to protect organism is necessary because no immediate or short-term economic benefit is obtained from conserving species. This commitment must take place at all political levels, from local to international. Law making will not ensure the protection of organisms without strong public support.

Support Research in Conservation Biology: Before an endangered species can be saved, its numbers range, ecology, biological nature, and vulnerability to changes in its environment must be studied. Basic research provides this information. We cannot preserve a given species effectively until we know how large a protected habitat must be established and what characteristics are essential in its design. For this we need trained specialist in tropical forestry, conservation genetics, taxonomy, resource management, and similar disciplines.

Support the International System of Parks: A worldwide system of protected parks and reserves that includes every major ecosystem must be accepted. The protected land would provide humans with other benefits in addition to the preservation of biological diversity. You would also provide people with unspoiled lands for aesthetic and recreational enjoyment. In addition to the establishment of new parks and reserves, particularly in developing nations, park and reserves in highly developed nations must be expanded.

Control Pollution: The establishment of parks and refuges will not be enough to prevent biological impoverishment if we continue to pollute the Earth, because it is impossible to protect parks and refuges from threats such as acid rain ozone depletion, and climate warming. Strong steps must be taken to curb the toxins we dump into the air, soil, and water - not only for human health and well-being but also for the well-being of the organism that are so important to ecosystem stability.

Provide economic incentives: A few innovative economic incentives encourage the preservation of biological diversity. Economic incentives are particularly critical because developing nations in the tropics, the repositories of most of the Earth's genetic diversity, do not have much money to spend on conservation. One way to help such countries appreciate the importance of the biological resources they possess is to allow them to charge fees for the use, of genetic material. Much of the money earned could be used to help solve human problems. And some of the money generated by genetic resources could be used to provide protection for organisms, thus preserving biological diversity for continued, sustained exploitation. The knowledge and values of local communities are now being acknowledged as valuable for biodiversity conservation. None the less, attention to the value of social relations, in the form of trust, reciprocal arrangements, locally developed rules, norms and sanctions, and emergent institutions, has clearly been shown to deliver a biodiversity divided into many contexts. This suggests a need to blend both the biological and social elements of conservation (Pretty and Smith, 2004). Agri-environment Schemes (AES), where farmers receive payments in exchange for providing pubic goods and services such as biodiversity, account for a landscape around the world. (Dean Ansell et al,

Protected Areas of India from 2000 to 2019 (December, 2019)

Year	No. of National Parks	Area Under National Parks (km^2)	No. of Wild Life Sanctuaries	Area Under Wild Life Sanctuaries (km^2)	No. of Community Reserves	Area Under Community Reserves (km^2)	No. of Conservation Reserves	Area Under Conservation Reserves (km^2)	No. of Protected Areas	Total Area under Protected Areas (km^2)
2000	89	37803.10	485	108862.50	-	-	-	-	574	146665.60
2006	96	38392.12	503	111229.48	1	0.31	4	42.87	604	149664.78
2007	98	38428.88	507	111529.04	5	21	7	94.82	617	150073.74
2008	99	39441.74	510	113123.35	5	21	45	1259.84	659	153845.93
2009	99	39441.74	512	113395.36	5	21	45	1259.84	661	154117.94
2010	102	40283.62	516	113842.87	5	21	47	1382.28	670	155529.77
2011	102	40283.62	518	113998.75	5	21	52	1801.29	677	156104.66
2012	103	40500.13	526	114933.44	5	21	59	2012.93	693	157467.50
2013	102	40500.13	532	117123.63	19	30.94	64	2232.61	717	159887.31
2014	103	40500.13	535	118290.66	43	58.22	64	2232.61	745	161081.62
2015	103	40500.13	541	118866.44	44	59.51	71	2548.82	759	161974.90
2016	103	40500.13	543	118917.71	45	59.66	72	2566.20	763	162043.70
2017	103	40500.13	544	118931.80	46	72.61	76	2587.95	769	162092.49
2018	104	40501.13	544	118931.80	46	72.61	77	2594.03	771	162099.47
2019	101*	40,564.03	553	119,756.97	163	833.34	86	3,858.25	903	1,65,012.59

** Three Button Islands National Parks (North Button Island, Middle Button Island & South Button Island) of Andaman & Nicobar Islands have been merged with Rani Jhansi Marine National Park.* ***Source: National Wildlife Database, Wildlife Institute of India***

Protected Areas of India (As on December, 2019)

	No.	Total Area (km^2)	Coverage % of Country
National Parks (NPs)	101*	40,564.03	1.23
Wildlife Sanctuaries (WLSs)	553	119,756.97	3.64
Conservation Reserves (CRs)	86	3,858.25	0.12
Community Reserves	163	833.34	0.03
Protected Areas (PAs)	**903**	**1,65,012.59**	**5.02**

** Three Button Islands National Parks (North Button Island, Middle Button Island & South Button Island) of Andaman & Nicobar Islands have been merged with Rani Jhansi Marine National Park.*

Geographical Area of India (http://knowindia.gov.in/)	=	32,87,263 km^2
Forest cover of India (FSI, 2017)	=	7,08,273 km^2
Percentage Area under Forest cover	=	21.54 % of Geographical Area of India

Source: National Wildlife Database, Wildlife Institute of India

2016). Promoting ecotourism is a second way that people can benefit financially by protecting their biological resources. Ecotourism is a tourism in which people pay to visit natural environments and view native species. It is done properly; ecotourism can conserve natural areas and improves the well-being of local people. Another way to provide economic incentives to landowners would be for governments to cost-share habitat improvements for wildlife and to reduce the property taxes on such wildlife habitat. Other incentives include payments to landowners who protect endangered species by restoring native plant communities.

Biodiversity conservation scenario in India: Our country India is a big diverse country with only 2.4% of the world's land area, and accounts for 7-8% of all recorded species. This includes over 45,000 species of plants and 91,000 species of animals. India is blessed with diverse physical features and climatic conditions due to which there is a variety of ecosystems like forests, wetlands, grasslands, desert, coastal and marine ecosystems which sustain high biodiversity. It is also four of 34 globally identified biodiversity hotspots: The Himalayas, the Western Ghats, the North-East, and the Nicobar Islands, can be found in India. These hotspots act as a house of important gene pool of medicinal plants, wild varieties of cultivated crops and species of economic importance as well. But due to anthropogenic activities India is losing its biodiversity year by year. Several acts and laws have been framed and implemented in the past to conserve the existing biodiversity of the country. Among these the 'National Biodiversity Authority' comes on first and most important. The National Biodiversity Authority (NBA) was established by the Central Government in 2003 to implement India's Biological Diversity Act (2002). The NBA is a Statutory Body that performs beneficial, regulatory and advisory functions for the our government on issues of conservation, sustainable use of biological resources along with fair and equitable sharing of benefits due to the use of biological resources. Next we have 'The State Biodiversity Boards (SBBs)' focus on suggesting the State Governments, subject to any guidelines given by the Central Government, on the issues relating to the conservation of biodiversity, sustainable role of its components and equitable sharing of the benefits arising out of the utilization of biological resources. There are also many protected areas in our country, where human occupation and exploitation of resources is limited

There are also many states taken initiatives which are either conserving or restoring the biodiversity of any particular area

by manmade interventions. For example the network of Biodiversity Parks in Delhi is unique landscape that harbours a diversity of plants, animals and microbes surviving in ecologically sustainable biotic communities. They provide multiple ecological services including Carbon sequestration and recharge of ground water aquifers and educational and recreation benefits to the urban society including school and college students. Similarly Pune's Wajre urban forest' is the best example of people's participation and collaboration between the forest department, municipalities, NGOs, Corporate and local residents of that area. Recently on World Environment Day, it was announced by Honorable Minister of Environment to introduce 'Nagar Van scheme' to every town and state. This will surely help in conserving and restoring the local flora and fauna of that area.

Conclusion

Human activities have put a lot of species and the whole ecosystem at risk with the rapid increase in population as well as continual efforts to exploit the nature. Conservation efforts must be prioritized and should be made on a proactive basis whenever and wherever possible. The impact of human induced climate change is very evident, and the changes are not for any good to us or the environment. The nature of climate change will be evident across all the areas of the world over a course of time. The results cannot be predicted yet as if not controlled this can become an ongoing process. Protected areas must be safeguarded with proper measures to make sure foul play is not involved. Natural migrants and climate induced range shifts must also be accommodated along with these measures to make the most of the efforts to safeguard the biodiversity.

Ex-situ conservation is aimed at preserving the habitat of the biodiversity. In agriculture, ex situ conservation methods would maintain domesticated plants which would otherwise not be able to survive in the nature without this aid. Excellent research avenues get opened for these components of biological diversity and appropriate plan of action must be devised to handle this situation better.

Ex situ mechanisms must also support in situ conservation measures. Both of which are good to follow, they are very questionable and have been a controversy in the society. Scientific and social issues are characterized by the serious conflicts happening between the local communities and the state, which dissipates the rate at which biodiversity is preserved. Conservation must be made the central point and both the parties must be working together in the same direction. Protected areas is one such scenario where conflicts occur, as the local communities do not pose any harm to the biodiversity, they must be allowed to stay as they used to as they know better of the regimes around that area and also might help the government in devising requisite measures, collaborating to the common goal. The niche areas will be a key to mitigate the losses inflicted to biodiversity due to the global climate change as rapid temporal changes take place. Protection of biodiversity cannot be achieved at static spatial scales and rather, the areas need to be used to conserve biodiversity overall. Riverside striped and best planning are two of the practices that help in reduction of nutrient and sediment losses of agricultural areas and thereby limit the effects of agriculture on biogeochemical regimes.

References and notes

Ashton PS (1987) Biological considerations in in situ vs ex situ plant conservation. In: Bramwell D, Hamann O, Heywood VH, Synge H (eds) Botanic gardens and world conservation strategy. Academic Press, London, pp 117–130.

B. Blom, T. Sunderland, D Murdiyarso (2010) : Getting REDD to work locally : lessons learned from integrated conservation and development projects; Environmental science & policy, 2010 - Elsevier.

Barrett SC, Kohn JR (1991) Genetic and evolutionary consequences of small population size in plants: implications for conservation. In: Falk DA, Holsinger KE (eds) Genetics and conservation of rare plants. Oxford University Press, New York, pp 3–30.

Benson EE (1999) Cryopreservation. In: Benson EE (ed) Plant conservation biotechnology. Taylor & Francis, London, pp 83–95.

Bradshaw & Chadwick (1980) : Underlying principles of restoration; Can. J. Fish. Aquat.Sci. Vol. 53(Suppl. 1), 1996.

Cameron, E. K., Martins, I. S., Lavelle, P., Mathieu, J., Tedersoo, L., Bahram, M., Siebert, J. (2019). Global mismatches in aboveground and belowground biodiversity. Conservation Biology, 33(5), 1187-1192.

CA Offord, M.L. Mckeney and P.V. Cuneo (2004) : Critical review of threatened species collections in the new South Wales Seedbank, implications for *Ex-situ* conservation of biodiversity. Pacific Conservation Biology 10(4) 221-236 Published 2004.

Chauvet, M., Oliver, L., 1993. La biodiversiteEnjeuplanetaire. Preserver notrepatrimoinegenetique.Editions Sang de la Terre, Paris.

Cohen JI, Williams JT, Plucknett DL, Shands HL (1991) Ex situ conservation of plant genetic resources: global development and environmental concerns. Science 253:866–872.

Dean Ansell, David Freudenberqer, Nicola Munro, Philip Gibbons (2016) : The cost effectiveness of agri-environment Schemes for biodiversity conservation : A quantitative review : https://doi. org/10.1016/j. agee. 2016.04.008.

Di Marco, M., Ferrier, S., Harwood, T. D., Hoskins, A. J., Watson, J. E. (2019). Wilderness areas halve the extinction risk of terrestrial biodiversity. Nature, 573(7775), 582-585.

Eberhart SA, Roos EE, Towill LE (1991) Strategies for long-term management of germplasm collections. In: Falk DA, Holsinger KE (eds) Genetics and conservation of rare plants. Oxford University Press, Oxford, pp 133–145.

Edward O. Guerrant Jr., Kay Havens, and Mike Maunder, (2004) *Ex-situ* Plant Conservation: Supporting species survival in the wild. Edward O. Guerrant Jr. Kay Havens, and Mike maunder, eds, Island Press, Washington, DC, 2004. 504 pp. illus (ISB No. 1559638745).

Ellstrand NC, Elam DR (1993) Population genetic consequences of small population size: implications for plant conservation. Annu Rev EcolSyst 24:217–242

FarhanaIjaz, Z.I., Inayat U.R., Niaz A. et. al. (2017) The role of plants in Human Welfare J. Traditional Med. Clin. Naturopathy 2017, 6:2.

Fay JC (1994) In what situations is in vitro culture appropriate to plant conservations? Biodivers Conserv 3:176–183

Fay MF (1992) Conservation of rare and endangered plants using in vitro methods. In Vitro Cell Dev Biol 28:1–4

García-Palacios, P., Gross, N., Gaitán, J., Maestre, F. T. (2018). Climate mediates the biodiversity–ecosystem stability relationship globally. Proceedings of the National Academy of Sciences, 115(33), 8400-8405.

Geoff Transey and TasminRajotte, 2008: A Guide to International Negotiations and Rules on intellectural property, biodiversity and food security (2008).

Harini Nagendra, Richard Lucas, Joao PradinhoHonrado Rob H.G. Jongman, Cristina Taratino Maria Adamo Paola Mairota (2013) Remote Sensing for Conservation Monitoring: Assessing protected areas, habitat extent, habitual condition, species diversity and threats. Ecological Indicators Vol. 33, october 2013 page 45-59.

Havens K, Vitt P, Maunder M, Guerrant EOJ, Dixon K (2006) Ex situ plant conservation and beyond. Bioscience 56:525–531

Hawkes JG (1987) A strategy for seed banking in botanic gardens. In: Bramwell D, Hamann O, Heywood VH, Synge H (eds) Botanic gardens and the world conservation strategy. Academic Press, London, pp 131–149

Hedrick PW, Kalinowski ST (2000) Inbreeding depression in conservation biology. Annu Rev EcolSyst 31:139–162

Heywood V (1991) Botanic gardens and the conservation of medicinal plants. In: Akerele O, Heywood V, Synge H (eds) Conservation of medicinal plants. Cambridge University Press, Cambridge, pp 213–228
Heywood VH, Iriondo JM (2003) Plant conservation: old problems, new perspectives. BiolConserv 113:321–335
Hufford KM, Mazer SJ (2003) Plant ecotypes: genetic differentiation in the age of ecological restoration. Trends EcolEvol 18:147–155
IUCN (International Union for Conservation of Nature and Natural Resouces) 1998.1997 United Nations List of Protected Areas.Prepared by WCMC and WCPA.IUCN, Gland, Switzerland and Cambridge, UK.1xii + 412pp.
IUCN (International Union for Conservation of Nature and Natural Resouces), 1994.IUCN Red List Categoeis. IUCN, Gland.
James R. Miller: Trends in Ecology & Evolution. Volu 20 Issue 8 august, 2005, Pages 43-434. science direct.com Science/article/abs/ii/SOI 695347; https:doi.org/10.1016/j. tree.2005. 05.013.
Jarvis A and Upadhyaya, H.D. and Gowda, CLL and Agrawal, P.K. and Fujisaka, S and Anderson B (2008). Monograph food and Agriculture Organization of the United Nations, U.K.
Jules Preety, David Smith (2004) : Social Capital in Biodiversity Conservation and Management Capital Social en la Conservación y Gestión de la Biodiversidad, https://doi.org/10.1111/j.1523-1739.2004.00126.x
Jules Pretty and David Smith (2004) Social Capital in Biodiversity Conservation and Management Capital Social en la Conservation y Gestion de la Biodiversidad. https:/doi.org/16.1111/i. 1523-1739-2004.00126.X
Keller LF, Waller DM (2002) Inbreeding effects in wild populations. Trends EcolEvol 17:230–241
Kevin J. Gaston, Sarah F. jackson, Lisette Cantu-Scalazar and Gabriela Cruz-Pinton (2008). The Ecological performance of protected areas.Annual Reviw of Ecology, Evolution, and Systematics. Vol 39:93-113 volume publication date Dec. 2008. https://doi.org/10.11.4611 annure v. ecology. 39.110707. 173529.
Lakra, P., NashierGahlawat, I. (2016). The role of Nutrition in the Immune system functions. Integrated Journal of Social Sciences, 3(1), 30-33.
Lakra, P., Sehgal, S., NashierGahlawat, I., Wadhwa Nee Dabas, M. (2018). Use of products developed from potato flour, defatted soy flour and corn flour in combating malnutrition. Integrated Journal of Social Sciences, 5(1), 47-50.
Lakra, P., Sehgal, S., Gahlawat, I. (2020). Effect of processing on total and extractable mineral content of products developed using potato flour, defatted soy flour and corn flour. Journal of Integrated Science and Technology, 8(1), 6-11.
Lakra, P., NashierGahlawat, I. (2015). Prospective Phytochemicals for alleviation of different chronic ailments.Integrated Journal of Social Sciences, 2(1), 36-39.
Lande R (1993) Risks of population extinction from demographic and environmental stochasticity and random catastrophes. Am Nat 142:911–927
Linington SH, Pritchard HW (2001) Gene banks. In: Levin SA (ed) Encyclopedia of biodiversity. Academic Press, San Francisco, pp 165–181
Lisa Naughton - traeves, Margaret Buck Holland, Katrina Brandon (2005) the role of protected area in conserving Biodiversity and Sustaining Local Livelihoods, Annual Review of Environment and Resources Volu 30:219-252/Volume publication date Nov. 2005, https://doi org/10.1146/annurev. energy. 30.050504. 164507.
Lori Ann Thrupp (2000) Linking Agricultural Biodiversity and food security: The Valuable Role of Agro biodiversity for Sustainable Agriculture. International Affairs, 76, 2, 265-281. https://doi.org/10.1111/1468-2346.00133.
Lovejoy, T.E., 1980b. Changes in Biological Diversity.The Global 2000 report to the president.Vol. 2 (the technical report), Penguin Books, USA.
Lynch PT (1999) Tissue culture techniques in in vitro plant conservation. In: Benson EE (ed) Plant conservation biotechnology. Taylor & Francis, London
M. Arnold, B. Powell, P. Shanley and T.C.H. Sunderland : Forest, biodiversity and food security; International Forestry Review Vol. 13(3), 2011.
MacKinnon and MacKinnon (1991): Carnivore reintroduction and translocation programs.
Majer (1989): Loss of Biological Diversity : A Global Crisis Requiring International Solutons; (Additional copies of this report (NSB-89-171) are available from Forms and Publications, National Science Foundation, Washington, DC 20550 (202) 357-7861.
Maunder M, Hughes C, Hawkins JA, Culham A (2004b) Hybridization in ex situ plant collections: conservation concerns, liabilities, and opportunities. In: Guerrant EOJ, Havens K, Maunder M (eds) Ex situ plant conservation: supporting species survival in the wild. Island Press, Washington, pp 325–364
McNeely, J.A., Miller, K.R., Reid, W. Mittermeier, R. and Werner, T., 1990.Conserving the World's Biological Diversity.IUCN, WRI, World Bank, WWF-US, CI, USA.
Melissa R. Marselle. Jutta Standler, Horst Korn, Katherine N. Irvine, and Aletta Bonn (2019) Biodiversity and Health in the face of climate change I SBN 978-3-030-02317-1. http://doi. org/10.1007/978-3-030-02318-8 (2010) open access.
Michael R. W. Rands; William M. Adams, Leon Bennun, Stuart H.M. Butchart, Andrew Clements, David Coomer, A big Biodiversity Conservation : Challenges Beyond 2010. Science 2010 Vol. 329 Issue 5997 pp-1298-1303.DOI.10.1126/Science 1189138.
NashierGahlawat, I. (2019).Emerging new insights into significance and applications of Plant Pigments.Journal of Integrated Science and Technology, 7(2), 29-34.
NashierGahlawat, I. (2017). A feasibility and viability analysis of Biomass combustion products with implied impact on health as well as environment. Integrated Journal of Social Sciences, 4(1), 26-31.
NashierGahlawat, I., Lakra, P. (2017). Contextual implicit role of PROBIOTICS in improving the Human Health. Journal of Integrated Science and Technology, 5(2), 50-53.
Newman D, Pilson D (1997) Increased probability of extinction due to decreased genetic effective population size: experimental populations of Clarkia pulchella. Evolution 51:354–362
Newman D, Tallmon DA (2001) Experimental evidence for beneficial fitness effects of gene flow in recently isolated populations. ConservBiol 15:1054–1063
Norse, E.A., Rosenbaum, K.L., Wilcove, D.S., Wilcox, B.A., Romme, W.H., Johnston, D.W., and Stout, M.L., 1986. Conserving Biological Diversity in our Natural Forests.The Wilderness Society, Washington, USA.
P.E. Rajasekharan and S. Ganeshan (2007) : Conservation of Medicinal Plant biodiversity - an Indian perspective Journal of Medicine and Aromatic Plant Sciences 34 (2002). 132-147.
Peter Ravan and Kayri Harvest (2014) *Ex-situ* Plant Conservation and Cryopreservation: Break through in Tropical Plant Conservation. Int. J. Plant Sci. 175(1): 2.
R.A. Mittermeier, C. G Mittermeir, T.M. Brooks, I.D. Pilgrim, W.R. Konstant, G.A.B. da Fonseca, and C. Kormos. Wilderness and Biodiversity Conservation PNAS Sept. 2, 2003 100(18) 10309 - 10313. http:/doi.org/10.1073/pnas. 1732458100.
Reid, W.V., and Miller, M.R., 1989. Keeping Options Alive. World Resources Institute, Washington, USA.
Richard B. Primack (1995) : A Primer of Conservation Biology, Sinauer Associates Inc.
Roberts EH (1991) Genetic conservation in seed banks.Biol J Linn Soc 43:23–29
Robin Abell, J. David Allan. Bernhard lehner (2006) Unlocking the potential of protected areas for freshwaters.https://doi org/10.1016/j. biocon. 2006.08017.
S. Chape, J. Harrison, M. Spaiding and I. Lysenko. Measuring the extent and effectiveness of protected areas as an indicator for meeting global biodiversity target 2005 https://doi.org/10.1098/rtsb.2004, 1592.
Sarasan V, Cripps R, Ramsay MM, Atherton C, McMichen M, Prendergast G, Rowntree JK (2006) Conservation in vitro of threatened plants—progress in the past decade. In Vitro Cell Dev Biol 42:206–214.
Schmeller, D. S., Weatherdon, L. V., Loyau, A., Bondeau, A., Brotons, L., Brummitt, N.,Mihoub, J. B. (2018). A suite of essential biodiversity variables for detecting critical biodiversity change. Biological Reviews, 93(1), 55-71.
Schoen DJ, Brown ADH (2001) The conservation of wild plant species in seed banks. Bioscience 51:960–966
Sergei Volis, Michael Blecher (2010) : Quasi in situ : a bridge between ex situ and in situ conservation of plants; Biodiverse Conserv DOI 10.1007/s10531-010-9849-2.
Sigwart, J. D., Chen, C., Thomas, E. A., Allcock, A. L., Böhm, M., Seddon, M. (2019). Red Listing can protect deep-sea biodiversity. Nature ecology and evolution, 3(8), 1134-1134.
Smith RD, Hawtin G (2003) The future of seed banks. In: Smith RD, Dickie JB, Linington SH, Pritchard HW, Probert RJ (eds) Seed conservation: turning science into practice. The Royal Botanic Gardens, Kew, pp 981–992

Soulé M (1980) Thresholds for survival: maintaining fitness and evolutionary potential. In: Soulé M, Wilcox BA (eds) Conservation biology: an evolutionary-ecological perspective. Sinauer Associates, Sunderland, pp 151-169.

Soulé M, Simberloff D (1986). What do genetics and ecology tell us about the design of nature reserves? BiolConserv 35:18-40.

T. Sunderland, J. Sunderland - Groves, P. Shanley_Biotropica, 2009: Bridging the gap : how can information access and exchange between conservation biologists and field practitioners be improved for better conservation outcomes ? - Willey Online Library

T.M. Brooks, R.A. Mittermittermeier, G.A.B. da Fonseca, J. Gerlach, M. Hoffman, J.F. Lamoreux, C.G. Mittermeier (2006) : Global Biodiversity Conservation Priorities; Science 07 Jul 2006 : Vol. 313, Issue 5783, pp. 58-61. DOI: 10.1126/science.1127609

Tallmon DA, Luikart G, Waples RS (2004) The alluring simplicity and complex reality of genetic rescue. Trends EcolEvol 19:489–496

Terena P. Dawson, Stephen T. Jackson, Jonna I. House, Ian Colin Prentice, Georgina. M. Mace : Beyond Predictions : Biodiversity Conservation in a changing climate. Science 01 April 2011 Volu 332 Issue 6025 pp 53-58, DOI 10.1126/Science 1200303.

Transey and TasminRajotte, 2008 : A Guide to International Negotiations and Rules on intellectural property, biodiversity and food security (2008).

van der Plas, F. (2019). Biodiversity and ecosystem functioning in naturally assembled communities. Biological Reviews, 94(4), 1220-1245.

Walters C (2004) Principles for preserving germplasm in gene banks. In: Guerrant EOJ, Havens K, Maunder M (eds) Ex situ plant conservation: supporting species survival in the wild. Island Press, Washington, pp 113-138.

Wilson, E.O., and Peters, F.M., (eds), 1988. Biodiversity.National Academy Press, Washington DC. USA.

Wadhwa, M., NashierGahlawat, I., Lakra, P., Nischal, S. (2018). Children's Questions in Science Classrooms: A Potential Source of Learning. Integrated Journal of Social Sciences, 5(1), 41-46.

Wadhwa, M., NashierGahlawat, I., Chhikara, A. (2020).Understanding Students' Alternative Conceptions: A Mirror to their Thinking.Integrated Journal of Social Sciences, 7(1), 9-13.

Wang, R., Gamon, J. A. (2019). Remote sensing of terrestrial plant biodiversity.Remote Sensing of Environment, 231, 111218.

Wolfgang Cramer, Emilie Egea, Joren fisher, Alexandra Lux, Jean-Michael Salles, Josef Settele, Muriel Tichit (2017) : Biodiversity and food security from trade-offs to synergies; Reg Environ change (2017) 17; 1257-1259.