Approaches to Conservation and Sustainable Use of Biodiversity- A Review

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Abstract: Biodiversity holds multiple values which include direct (subsistence and tradable) and indirect (watershed protection, nutrient recycling, climate regulation and many other ecosystem services). These resources often act as an economic "buffer" supplying alternative biological resources for the rural and urban community. However, in recent time very little of the world's biodiversity remains unaffected by human activity. Loss of biodiversity directly affects the stability of the ecosystem. This indicates the demand of urgent intervention to readdress the many negative impacts of biodiversity manipulation, and move away from focusing on short-term gains, to prevent those who are subsistence dependent, or derive income from trading biodiversity. Therefore it is important to review and analyse an approaches for the conservation and sustainable use of biodiversity for the benefits of the community and the nature itself. The aim of this paper was to review different articles related to the conservation of biodiversity and select the best options and approaches that can help to maintain the potential of biological resources while keeping the needs and aspiration of the community. In this regard, based on the site condition different biodiversity conservation approaches were identified which include: *in-situ* conservation, *ex-situ* conservation, *circa-situ* conservation and complementary conservation. Conservation based on the biodiversity components was also another approaches used to analyse and identify the appropriate conservation approach at a larger scale. This component based biodiversity conservation approach includes: the genetic-based conservation, species-based conservation, ecosystem-based conservation and landscape level conservation approach. From this synthesis it has been learnt that, the ecosystem approach has been remarked as the best approach for the conservation of biodiversity. Because, ecosystem approach is operated based on (i) the application of scientific methodologies, (ii) human beings are an integral part of many ecosystems, and (iii) using adaptive management to deal with the complex and dynamic nature of ecosystems. Therefore, because of its holistic nature, the ecosystem approach has the potential to mainstream conservation into general human affairs and used as the best option for the conservation and sustainable use of biodiversity.

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1. Introduction

In the recent decades, biodiversity conservation and sustainable use of natural resources has become a main global concern. For instance, the Convention on Biological Diversity (CBD), agreed at the 1992 Earth Summit in Rio, is the main international convention focusing on biodiversity conservation and sustainable use (UNEP, 1992; Koziell, 2001; Newton, 2007). The reason for taking biodiversity conservation as a basic topic of environmental agenda is that human activities accelerate biodiversity losses, degrade ecosystems and affect the climate. Environmental degradation also affects the ecosystems' functioning both in the natural and built-up environment (Brandon *et al*., 1998; Salafsky *et al.,* 2002). The loss of biological diversity may take many forms but at its most fundamental and irreversible it involves the extinction of species. A species goes extinct if all its populations in the world disappear. IUCN has estimated that 23 % of mammal species, 11 % of all bird species and 14 % of all plant species are threatened with extinction. Species with small geographical ranges are particularly vulnerable. As a result, many species will disappear before they have been described by science (IUCN, 2005).

Therefore, when we deal with biodiversity, it is very essential to define what conservation is with respect to biological diversity. It is the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations. This was the first modern attempt to recognize that conservation of renewable resources, including biological diversity, involves wise dynamic use and not just static preservation or protection but paves the way for the sustainable utilization of biological resources (WWF, 1998).

1.1 Causes for the losses of biodiversity

Species may be exterminated by man through a series of effects and agencies which may be largely attributed to two broad categories (Slingenberg *et al*., 2009). These effects include (i) direct effects (hunting, collection and persecution) and (ii) indirect effects (habitat destruction and modification). Over hunting is the most obvious direct cause of extinction in animals but far less important in terms of overall loss of biodiversity than habitat modification and loss. Land use change is widely agreed to be the strongest catalyst for changes. Furthermore, nearly half of areas currently protected for biodiversity are themselves heavily used for agriculture, and many of them are located in regions where agriculture is major land use. The following are the main causes for the loss of biological diversity:

(i) Habitat destruction: the primary cause for the loss of biodiversity is not direct human exploitation but the habitat destruction that inevitably results from the expansion of human populations and human activities (Kideghesho, 2001; Brawn *et al.,* 2001; Hanski, 2005).

(ii) Habitat fragmentation: habitat that formerly occupied wide areas are now often divided up in to pieces by roads, fields, towns, canals, power lines *etc*. habitat fragmentation is the process where a large, continuous area of habitat is both reduced in area and divided in to two or more fragments (Fahring, 2003). When habitat is destroyed there is often a patchwork of habitat fragments left behind. These fragments are often isolated from one another by a highly modified or degraded landscape.

Habitat fragments differ from the original habitat in two ways: One, fragments have a greater amount of edge for the area of habitat, and second, the center of each habitat fragment is closer to an edge. Habitat fragmentation may limit the potential of species for dispersal and colonization. It also reduces the foraging ability of animals. Habitat fragmentation causes such edge effects as microclimatic changes in light, temperature, wind, *etc.*

(iii) Habitat degradation and pollution: Some activities my not affect the dominant species in the community, but other species are greatly affected by such habitat degradation. For example, physical degradation of forest habitat by uncontrolled ground fires might not kill the trees, but the rich perennial wild plant community and insect fauna on the forest floor would be greatly affected (Hurbert and Haskell, 2003).

(iv) Introduction of exotic species: Significant losses can be taking place due to changes caused by human activities. The great majority of the exotic species do not become established in the introduced new places. However, some of the species are able to establish in other new area. Such successful exotic species may kill or eat native species to the point of extinction, or may so later the habitat that many native species are no longer able to persist (Stohlgren *et al.,* 1999; Stohlgren, 2007).

1.2 Impacts of the loss of biological diversity

Loss of biodiversity affects both the stability and function of ecosystem (Ruijven and Berendse, 2010). Ecosystem stability can be thought of as having two components. These are (i) resistance which is the 'shock-absorbing' capacity of an ecosystem- its ability to stay as it is in the face of some environmental changes and (ii) resilience is the ability of an ecosystem to 'bounce back' after it has been severely disturbed. Loss of biodiversity (loss of species) is assumed to affect both of these things. The conservation of biological resources depends on the continuous health and productivity of local ecosystems hence both biological diversity and biological resources need to be conserved.

1.3 The Need for Conserving Biodiversity

Preserving biodiversity means preserving the ecosystem services, and directly provides things of pragmatic value to us (Alcamo and Elena, 2003; Randolph, 2004). Hence, the following goals are some of the reason why we need to conserve the biological resources: (i) the present and potential use of elements of biodiversity as biological resources, (ii) the maintenance of the biosphere in a state supportive of human life, and (iii) the maintenance of biological diversity per second, in particular of all presently living species.

Therefore, it is evident that a certain level of biological diversity is necessary to provide the material basis of human life: at one level to maintain the biosphere as a functioning system and, at another, to provide the basic materials for agriculture and other utilitarian needs. Hence, there are four basic justifications for the conservation of biodiversity which include:

(i) The utilitarian justification: biological diversity benefits humanity in various ways. We depend on animal, plant, fungal, and microbial species for food, fuel, fiber, medicines and raw materials for many manufacturing technologies. The productivity of agricultural systems depends on interactions of diverse organisms with in agro ecosystems.

(ii)The moral justification: refers to the belief that species have a moral right to exist. Consequently, in their role as global stewards, people have an obligation to assist the continued existence of species, that is, to conserve biological diversity.

(iii)The aesthetic justification: refers to the value that people place on seeing, hearing, touching, experiencing nature and its diversity of life forms.

Aesthetic interest, of course leads to tourism, film making, and other activities from which an economic return can be obtained. Aesthetic appreciation of nature is physiologically deeply rooted in people.

(iv)The ecological justification: means that diversity is important to the persistence of ecological systems, including forest ecosystems. Moreover, we can consider the role of forests in watershed regulation and stabilization of soils in erosion-prone areas.

2. Biodiversity Conservation Approaches

2.1 In situ conservation

The maintenance of viable populations of species in their natural habitat is identified as a fundamental requirement for the conservation of biological diversity by the Convention on Biological Diversity (CBD). One option used to conserve the biodiversity is through the technology of *in-situ* conservation which means the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticates or cultivated species, in the surroundings where they have developed their distinctive properties (UNEP, 1992; Heywood, 2004). *In-situ* conservation primarily focuses on the conservation of natural habitats, notably protected areas and other kinds of reserves, and the conservation, maintenance or recovery of viable population of species in their natural habitats. The *in-situ* techniques include:

(i) Genetic reserve conservation: the location, management and monitoring of genetic diversity in natural wild populations within defined areas designated for active, long-term conservation.

(ii) On-farm conservation: the sustainable management of genetic diversity of locally developed traditional crop varieties with associated wild and weedy species or forms by farmers within traditional agricultural, horticultural or agri-silvicultural cultivation systems.

(iii) Home garden conservation: the sustainable management of genetic diversity of minor crops, condiments and medicinal plants that are grown in backyard gardens for home consumption.

(iv) Ecosystem conservation: the maintenance of the diversity of living organisms, their habitats and the interrelationships between organisms and their environment.

2.1.1 Advantages and risks of *in-situ* conservation

In-situ maintenance of biodiversity through the establishment of conservation and multiple-use areas offers distinct advantages over off-site methods in terms of coverage, viability of the resource, and the economic sustainability of the methods.

(1) *Coverage*: *in-situ* approach can cover a wide area and would allow a significant number of indigenous species and systems to be protected, thus taking care of the unknowns until such time as methods are found for their investigation and utilization (Burley, 1986).

(2) *Viability*: as a result of *in-situ* conservation, natural selection and community evolution continue and new communities, systems, and genetic material are produced (Soule, 1986).

(3) *Economic sustainability*: when an area is set aside as an *in-situ* conservation approach, a country can maintain specific examples of biodiversity stores up future economic benefits. When the need develops and this diversity is thoroughly examined, commercially valuable genetic and biochemical materials may be found (Eisner, 1990)

However, it is not sufficient to establish a conservation area and then assume its biodiversity is automatically protected and without risk. Many risks, both natural and anthropogenic, remain in place as Shaffer (1981) cited four broad categories of natural risks. These risks include: (i) demographic uncertainty, resulting from random events in the survival and reproduction of individuals, (ii) environmental uncertainty which is due to random, or at least unpredictable, changes in weather, food supply, and the populations of competitors, predators, parasites, etc., (iii) natural catastrophes such as floods, fires, or droughts, which may occur at random intervals, and (iv) genetic uncertainty or random changes in genetic make-up due to genetic drift or inbreeding that alter the survival and reproductive probabilities of individuals.

The greatest uncertainties, however, are often human created. Habitat destruction for human settlement and associated development interventions is the most important factor contributing to the diminishing mosaic of biodiversity. These uncertainties can only be met with a full array of conservation programs, including those that use *ex-situ* methods.

2.2 Ex situ conservation

Ex-situ conservation means the conservation of species outside their natural range such as in zoos, botanic gardens, aquaria and seed banks. It is a last resort, which is used only after it is evident that it is impossible to preserve the ecosystems or habitat (UNEP, 1992; Theilade and Petri, 2003; Michael *et al*., 2010).

The Convention on Biological Diversity specifically recommends that *ex-situ* measures be adopted as necessary in situations where *in-situ* conservation program do not prove to be adequate. These measures have most extensively been applied to conserve cultivated and domesticated agro biodiversity, employing techniques such as botanical gardens, zoos, seed banks, field gene banks, in-vitro storage, and captive breeding measures (UNEP, 1992).

2.2.1 Gene Banks

Plant genetic resources gene banks store, maintain and reproduce living samples of the world's huge diversity of crop varieties and their wild relatives. They ensure that the varieties and landraces of the crops and their wild relatives that underpin our food supply are both secure in the long term and available for use by farmers, plant breeders and researchers.

2.2.2 Community seed banks

In many developing countries, farmers rely on informal seed systems based on local growers retention of seed from previous harvests, storage, treatment and exchange of this seed within and between communities. The informal seed sector is typically based on indigenous structures for information flow and exchange of seed. Seed banks managed within this local seed system operate on a small scale at the community level with few resources.

2.2.3 Botanical gardens and Zoos

Botanical gardens and zoos are the most conventional methods of *ex-situ* conservation, all of which house whole, protected specimens for breeding and reintroduction into the wild when necessary and possible. These facilities provide not only housing and care for specimens of endangered species, but also have an educational value.

2.2.4 Field Gene banks

Field gene banks or living collections are the main conservation strategy for long-lived perennials, recalcitrant species and vegetative propagated species. Their main limitation is that they take a great deal of space and are difficult to maintain and protect from natural disasters. They are susceptible to the spread of diseases and may suffer from neglect.

2.2.5 In-vitro Conservation

In-vitro conservation of plant genetic resource is becoming a complementary approach to the conventional conservation methods. It is used to save plant material for short, medium and long- term time in a small place and in a controlled condition. It is cost effective and can be simply transferred from one country to other country and it is used to as a tool to implement the Convention of Biological Diversity through the equitable share of the products of genetic resources (Shabil *et al*., 2006).

Conservation *in-vitro* is wholly dependent upon the techniques of plant cell, tissue and organ culture, and is appropriate in situations where conventional seed storage cannot or is not to be employed. The material stored *in-vitro* may be protoplast, isolated cells grown in suspension or on semi-solid medium, meristem cultures at various stages of development or organized plantlet. It can be assumed that genetic stability within the in-vitro systems increase as the complexity of the cultured material, with completely differentiated plantlets in culture having the least risk of genetic alteration during an in-vitro excursion (Engelmann, 1991; Sarwar and Siddiqui, 2004).

In-vitro conservation is the most useful and efficient way to distribute clonal materials. It facilitates the availability of planting materials at any time; avoid the transfer of major pests and pathogens and makes virus eradication through meristem culture (Georg, 1993).

2.2.6 Captive breeding

Habitat protection alone is not sufficient if the expressed goal of the World Conservation Strategy, the maintenance of biotic diversity, is to be achieved. Establishment of self-sustaining captive populations and other supportive intervention will be needed to avoid the loss of many species, especially those at high risk in greatly reduced, highly fragmented, and disturbed habitats. Captive breeding programs need to be established before species are reduced to critically low numbers, and thereafter need to be coordinated internationally according to sound biological principles, with a view to the maintaining or re-establishment of viable populations in the wild (Huntley and Langton, 1994).

Many endangered species are being bred in zoos, to boost populations and reintroduce them into the wild. This introduction should be compatible with the wild ecosystem and should not be with potential harm with the wild flora and fauna. Otherwise, this is worthless if there is not adequate habitat left in the wild (Miller *et al*., 2010).

In general, captive breeding approach becomes necessary (Michael *et al*., 2010):

(i) when populations in the wild have declined to such low levels that they may not be self-sustaining,
(ii) where threats to populations and/or their habitats are so severe that extinction is deemed likely, and/or
(iii) where captive individuals and their off spring can be protected from natural enemies or other factors causing high mortality, so that numbers can be built up either to augment source populations or to found new populations by translocation or other controlled release.

Having all the above advantages, undertaking, captive breeding can also cause several problems (Thomson, 2008):

(i) potential for disease transmission from captive animals to both humans and wild species;
(ii) potential for loss of genetic integrity amongst populations of wild species should they breed

with escaped captive animals, which are often non-indigenous or hybridized;

(iii) questionable caring treatment of the animals in captivity; and

(iv) Reduced incentive to conserve wild populations and their habitats.

2.2.7 Advantage and risks of Ex-situ conservation

- *Ex-situ* conservation is complementary to the rehabilitation and restoration of degraded ecosystems, and the recovery of threatened species.
- *Ex-situ* conservation facilities provide excellent opportunities for researchers to study plants, animals, and microorganisms in controlled conditions, and to improve collection, storage and regeneration techniques.
- *Ex-situ* facilities can also be used for germplasm evaluation, as centers for documentation and information systems and for providing information on genetic resources on a commercial basis.
- Captive breeding of wild animals can be used to restore endangered species populations.
- It is important to increase populations as quickly as possible and reintroduce the animals back to their original habitat to minimize genetic erosion.
- Plants can also be re-introduced to their natural areas of occurrence.

Ex-situ conservation approach has also its own risk unless the re-introductions are performed in such a way that other indigenous species are not harmed or adversely affected. Similarly, care must be taken while collecting material/animals for *ex-situ* conservation not to endanger other native species and genetic resources. The regulation and management of such transactions requires accurate information to determine the impact of collection on populations and ecosystems.

2.3 Complementary conservation

A complementary conservation strategy can be defined as the combination of different conservation actions (*e.g. in-situ* and *ex-situ* conservations), which together lead to an optimum sustainable use of genetic diversity existing in a target gene pool, in the present and future. It is an approach which involves striking the right balance between different methods employed. It depends on the species being conserved, the local infrastructure and human resources, the number of accessions in a given collection, its geographic site and intended use of the conserved germplasm. This approach offers a criterion for choice, and is basic to general procedures for priority setting in relation to explicit goals (Watson and Eyzaguirre, 2002).

2.4 Circa situ conservation

The term circa-situ conservation is the conservation of components of biological diversity outside their natural habitats but within managed within traditional systems by local farmers. It has been used for a range of practices commonly associated especially with more traditional (and biodiversity-rich) agricultural systems (Hawkes *et al*., 2001). They include the deliberate encouragement of certain species of 'wild' plants in 'natural' habitats, the retention of valued 'wild' plants when land is cleared for agriculture or crops are weeded, the growing of valued 'wild' plants in home gardens, and the selection and storage of seed at household level for later replanting (Hamilton, 2004).

2.5 Habitat-based conservation approach

The most important direct drivers of biodiversity loss and ecosystem change are habitat change for other competing land uses such as conversion of biodiversity rich areas in to agriculture, settlement, infrastructure and other investments. Climate change, invasive alien species, overexploitation of species, and pollution are also equally affecting the ecosystem concerned. Hence, habitat protection is now recognised as a prerequisite for species survival and it is very essential to identify and map habitats with large numbers of endemic species (UNEP, 2006).

2.6 Protected Area Management Approach

The term protected areas encompasses the range of landscapes and seascapes that are managed to conserve and maintain elements of biodiversity and natural habitat. They have long been one of the main strategies for safeguarding the world's biodiversity (Graham, 2004; Rodrigues *et al*., 2004; USAID, 2005). They play a central role in conservation strategies and they provide a multiple flow of benefits to society and may be established to protect a wide variety of features such as: characteristic or unique ecosystem, special species of interest, value, rarity or under threat (*e.g.* Rhinoceros, Walia Ibex), sites of unusual species diversity, landscape or geographical features of aesthetic or scientific value, hydrological protective functions, soil, water, local climate, facilities for natural recreation, tourism (*e.g.* lakes, beaches, mountain views, wildlife spectacles), sites of special scientific interest (*e.g.* areas of longstanding research) and cultural sites (*e.g.* Temples and Archaeological excavations).

The relative value and importance of each feature will need to be considered to establish a protected area.

In Ethiopia**,** to improve the management of protected areas, the new Ethiopian wildlife proclamation of 2007 creates four types of administration approaches for effective management which include:

(i) *The federal government administers areas:* these conservation areas are nationally and globally significant because of the representative ecological zones they represent and those with immense diversity of wildlife; national parks and wildlife sanctuaries where endangered and endemic species lives; wildlife conservation areas that straddles two or more regions in Ethiopia; and finally any wildlife conservation areas transcending the national border (FDRE Proclamation No. 541/ 2007: article 4).

(ii) *The Regional State Administer Conservation Areas:* Conservation areas such as wildlife conservation parks, wildlife sanctuaries, wildlife reserves and wildlife controlled hunting areas which are not designated and administered by the Federal Government pursuant to Article 4 of the proclamation 541/2007 are decided to be administered under the regional states (FDRE Proclamation No. 541/ 2007: article 5).

(iii) *Private investors administer conservation areas:* Private investors may be authorized to administer the wildlife conservation areas under either the federal or regional governments by the concession agreements to be concluded with the federal or the concerned regional governments (FDRE Proclamation No. 541/ 2007: article 6).

(iv) *Local Communities Administer Conservation Areas*: Wildlife habitats other than the conservation areas referred to in Articles 4, 5 and 6 of this Proclamation can be administered by the local communities (FDRE Proclamation No. 541/ 2007: article7).

Considerations to be included in taking protection measures:

- Area coverage of protected areas should be proportional to high biological diversity and diverse habitats based on situations in a particular country.
- Strictly protected areas should not be islands or degraded lands.
- Establishment of policy for intact forests and areas hot spots of biodiversity.
- Incorporation of protection measures with measures to provide benefits to local people and governments.
- A combination of approaches that stabilize or reduce the human population pressure and reduce pressures on forest areas by providing alternatives of food and fuel production elsewhere.

3. Conservation Based on Components

3.1 The Genetic-Based Conservation Approach

The term genetic conservation is used for the maintenance and utilization of genetic diversity. A genetic reserve (or gene management zone) is a protected area managed in such a way as to maintain suitable ecological conditions and the conservation needs of one or more target species (Frankel, 1974).

The specific actions that apply to genetic resource conservation are:

- Minimize the risk of genetic erosion from demographic fluctuations, environmental variation and catastrophes.
- Minimize human threats to genetic diversity.
- Support actions that promote genetic diversity in target populations.
- Ensure access to populations for research and plant breeding.
- Ensure availability of material of target populations that are exploited and/or cultivated by local people.

3.2 Species-Based Conservation Approach

Many conservation efforts are explicitly concerned with the population status of particular species or groups of species. Others are focused on the conservation of overall species diversity. Both approaches require an understanding of the habitat requirements that support either particular species of concern or the habitat features associated with a high level of species diversity.

A species-based approach confers some important advantages in that species which are economically important and have large public constituencies provide considerable support to conservation efforts. Species-based approaches also can provide specific, measurable targets (*e.g.*, species persistence, increased abundance and distribution) to evaluate the success of the conservation action. The following conservation measures are the most important sub sets of conserving biodiversity at species level (Caro, 2010).

3.2.1 Process- and Services-based Species Conservation

As an alternative to species-based conservation planning, process- and services-based approaches focus on conserving or restoring critical processes and habitat conditions that have been altered by human activity. In this approach, the explicit goal is the process (*e.g.*, sediment balance, flow regime, longitudinal connectivity) with the implicit assumption that these processes, if restored to their natural state, will help conserve species of concern and biological diversity at multiple spatial scales. It is based on the assumption that protecting key processes has an impact on the protection of key ecosystem services derived from freshwaters, including protection of water supply and mitigation of catastrophic floods, along with recreational and associated economic opportunities (Tim *et al*., 2001; Caro, 2010).

3.2.2 Umbrella species conservation

When habitat is preserved to meet the needs of an "*umbrella species*," it helps preserve habitat for many other species. Thus, primary species serve as an *"umbrella"* for others. Large species with large home ranges (like tigers and other top predators) are good umbrella species (Hess and King, 2002; Caro, 2010). The umbrella species concept is very simple. By protecting areas large enough to maintain a viable population of (usually a single) large-bodied and wide-ranging species, sufficient habitat can also be maintained which ensures the viability of most other species in that area (Wilcox, 1984). The expectation for umbrella species conservation approach is that:

- Managers will focus conservation actions according to umbrella schemes, which are the areas or sites supporting one or more potential umbrella species. For example, if a top umbrella species is found in 20 out of 25 sites in a planning area, then those 20 sites (80% effort) are where conservation actions should be focused. However, if 80% effort proves too costly, then a representative subset of these sites or umbrella species occupying fewer sites may be used (Berger 1997; Bried *et al*., 2007).
- Species whose conservation provides protection for many co-occurring species.
- Traditionally, umbrella species have had large area requirements (large animals and carnivores).
- Idea is that if we conserve enough habitats for the umbrella species, then other species should be covered as well.

The conservation umbrella approach focuses management effort according to individual species that may confer protection to a larger community. This approach can help guide the management agenda towards attainable goals by maximizing conservation returns per unit effort. It also allows managers to focus on a small number of species as proxies for protecting a larger community (Bried *et al*., 2007).

3.2.3 Endangered species conservation

An endangered species is any species that is in danger of extinction throughout all or a significant portion of its range. Trying to preserve single species threatened with extinction may also used to achieve umbrella conservation and their habitat together. This can be done by listing of endangered species which are critical foci of conservation attention and receive special attention in priority-devising systems for conservation, both at national and international level.

The world conservation union for nature and natural resources, the IUCN has various editions of the *Red List of Threatened Species* which are the only available global factual summary of threatened species, although seriously incomplete in their coverage, and serve as an indicator of likely species' loss (Heywood, 2004).

3.2.4 Biodiversity indicators conservation

An indicator species is an organism whose presence or absence, population density or dispersion, or reproductive success can indicate habitat conditions that are too difficult to measure for other species. Indicator species are used to indicate effects of contamination, population trends, and habitat quality. The assumption is that if the habitat is suitable for the indicator species, it is suitable for others. However, each species is different in its habitat needs and habitat niche, so the effectiveness of indicator species to fully represent a wide range of species and habitats is limited (Randolph, 2004).

Indicators can measure and monitor impacts on species, habitats and ecosystems, as well as management commitment and process, impact reduction and positive action. Biodiversity indicators are not an end in themselves, but an input into an adaptive management system. The following terms are examples of biodiversity indicators:

(a) Biodiversity Indicator Species: Globally threatened and data deficient species in area; restricted-range species; invasive non-native species that are threatening to ecosystems, habitats or species; species used by local populations (Araújo *et al*., 2001). Indicator species can tell about (i) presence of one species indicates presence of other species, and (ii) measure richness of well-known taxonomic group and use as surrogate for sympatric, poorly-known group.

Hence, the use of biological surrogates as proxies for biodiversity patterns are gaining popularity, particularly in marine systems where field surveys can be expensive and species richness. It is also an important approach for selecting sites for conservation planning. For example, prioritizing habitats for conservation based on species richness only, observed or predicted, at particular sites (*i.e.* alpha diversity) might result in a selection of species-rich sites containing similar subsets of species. If so, rare species, or those only present in species-poor sites, could be excluded from protection (Mellin *et al*., 2011). These authors also showed that the type of surrogate used, defined by its relationship with the target (Type: higher-taxa, where a taxon acts as a surrogate for taxa at lower taxonomic levels; cross-taxa, where a taxon acts as a surrogate for another taxon at the same taxonomic level, or; subset-taxa surrogate, where a taxon acts as a surrogate for the entire target community.

(b) Habitat or ecosystem indicators: Operational site overlap with conservation priority areas containing globally threatened or restricted-range species; amount of land within the operational site that has a management plan with a biodiversity conservation focus; contribution to habitat conservation. These types of indicators can tell about the health of the ecosystem thorough providing information about the species used to indicate environmental conditions and species that are most sensitive to disturbance or stressor of interest in the ecosystem or in the specific habitat (Johnson *et al*., *2003;* Randolph, 2004).

3.2.5 Biodiversity hotspots conservation

Biodiversity hotspots are areas that support an especially high concentration of species endemic to the area, found nowhere else in the world and experiencing rapid habitat loss. These areas are the world's most biologically rich areas hence recognized as important ecosystems and they are important not only for the rich biodiversity but equally important for the human survival as these are the homes for more than 20% of the world's population. Hence hotspots are characterized by both exceptional levels of plant endemism and by serious levels of habitat loss. To qualify as a "Hotspot", two strict criteria must be met (Myers, *et al*., 2000). These criteria include (i) it contains at least 5% of endemic species of vascular plants and (ii) to have lost at least 70% of its original habitat.

3.3 Ecosystem Service Conservation Approach

Ecosystem approach is an essential tool for biodiversity conservation and an important concept to convince people about the necessity of nature conservation. It is a method for sustaining or restoring natural systems and their functions and values. An ecosystem approach is goal-driven, and it is based on a collaboratively developed vision of desired future conditions that integrates ecological, economic, and social factors (Gary *et al*., 2002).

Therefore, ecosystem services need to be protected together with species and habitats because, (i) they are essential for human well-being, (ii) they are a currency to value ecosystems and promote their sustainable use, and (iii) they offer a value-added strategy to supplement presently established biodiversity conservation.

3.3.1 Ecosystem approach in relation to other components of Biodiversity

Biodiversity conservation is achieved through integrating gene, species and ecosystem conservation. However the species and gene approach focus on particular component of biodiversity, and these alone couldn't address biodiversity conservation. The following are some of the limitations of the species and gene approaches of conservation leading us to pay attention for the application of the ecosystem approach to biodiversity conservation (Smith and Maltby, 2003).

(i) Inadequate recognition of vitality of ecosystem function for biodiversity
(ii) Too site-specific management without considering interlinking with other sites;
(iii) Failure to integrate cultural, economical and social factors in biodiversity conservation;
(iv) Failure to value public goods and services obtainable from ecosystem such as: services like ecosystems are home for wild genes, maintain hydrological cycles, generate and maintain soil, provide sources of beauty and inspiration regulate climate, store and recycle nutrients and many others which could not be valued in marketplace.
(v) Inabilities to coordinate with relevant sectoral interests like agriculture, environment, forestry, fisheries, health, nature conservation etc.

On the other hand ecosystem approach has the following distinctive features (Smith and Maltby, 2003):

(i) Ecosystem approach is an integrated strategy for management of land, water, and life resources.
(ii) Ecosystem approach has a comprehensive nature to protect, preserve and utilize ecological resources, communities, and economies sustainably.
(iii) It provides a framework for planning and decision-making that balances the three objectives of the CBD of conservation, sustainable use and equitable sharing of benefits.
(iv) In ecosystem approach people are placed at the centre of biodiversity management.
(v) The flexibility of the approach with respect to scale and purpose makes it a versatile framework for biodiversity management.
(vi) The Ecosystem approach underlines the importance of inter-sectoral cooperation, which is essential for better management of natural resources.
(vii) The Ecosystem approach can help policy-makers appreciate the importance of the vital ecosystem services that depend on biodiversity.
(viii) The ecosystem approach stresses that local people should be involved in decisions about natural resource management
(ix) The ecosystem approach is a liberating concept for the conservationist, because of its

potential to mainstream conservation into human affairs.

(x) It is an integrated approach that it considers the entire range of possible goods and services and attempts to optimize the mix of benefits for a given ecosystem and also across ecosystems.

(xi) It emphasizes a systemic approach, recognizing that ecosystems function as whole entities and need to be managed as such, not in pieces.

(xii) An ecosystem approach takes the long view that it respects ecosystem processes at the micro-level, but sees them in the larger frame of landscapes and decades, working across a variety of scales and time dimensions.

(xiii) An ecosystem approach includes people that it explicitly links human needs to the biological capacity of ecosystems to fulfill those needs. Although it is attentive to ecosystem processes and biological thresholds, it acknowledges an appropriate place for human modification of ecosystems.

(xiv) An ecosystem approach maintains the productive potential of ecosystems, because it does not focused on production alone but views production of goods and services as the natural product of a healthy ecosystem.

(xv) In general, an ecosystem approach does not prevent other management or conservation approaches such as single-species or genetic conservation programs but could in fact integrate them (Heywood, 2004).

3.3.2 Ecosystem approach principles

The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way (UNEP, 1992). It is based on (i) the application of scientific methodologies, (ii) human beings an integral part of many ecosystems, and (iii) using adaptive management to deal with the complex and dynamic nature of ecosystems.

Therefore, because of its holistic nature, the ecosystem approach has the potential to mainstream conservation into general human affairs. However, this does not mean at the expense of conservationists losing sight of their own priorities rather it integrates all aspects of conservation endeavors.

3.4 Landscape and Eco-Regional Scale Conservation Approach

A landscape is composed of a heterogeneous area with a mosaic of patches with interacting elements. Some patches may be discrete with clear boundaries, whilst others grade into each other and this approach includes the study of the dynamics of these systems and the movement and persistence of species within them. It combines and is relevant both to natural systems and those heavily influenced by human activity (Hong *et al*., 2007).

An eco-region approach has been also developed by WWF in the late 1990s that is being applied to the task of conserving 'eco-regions' – that is, relatively large units of land or water that is biologically distinctive and harbors a characteristic set of species, ecosystems, dynamics and environmental conditions (WWF, 1998). This approach has been developed based on the recognition that small scale and site-specific approaches to conservation do not achieve full conservation results.

Therefore, landscape and eco-region approaches are useful scales to assess threats for conservation planning purposes. This is because the focus of these approaches is to cover a wider area of conservation interest at multiple scales. In this regard, a conservation planning of this type can invite all stakeholder groups to come together, learn what can be done locally, and act with shared vision (Trombulak and Baldwin, 2010).

4 Integrated Approach to Conservation Planning

A single or an individual method can not address the management of biological resources. However, it can be achieved through an integrated approach balancing all available approaches depending on their area of interest. For instance, an approach of conserving the habitat has an input for the conservation of single species or genetic resources on their area of occurrence. In the same manner conserving the ecosystem as a whole has a great significance for the maintenance of the structure and function of the ecosystem including the human settings (Tim *et al*., 2001; Cohn and Jeffrey, 2003).

The preservation of species on their natural habitat offers all the advantages of allowing natural selection to act, which cannot be recreated *ex-situ* conservation. The maintenance of viable and self-sustainable populations of wild species in their natural state represents the ultimate goal, but habitat destruction is inevitable and endangered species need to be preserved before they become extinct which needs off-site conservation approach.

The e*x-situ* conservation on the other hand provides the opportunity to study the biology of, and understand the threats to, endangered species in order to eventually consider successful species recovery programs, which would include restoration and reintroduction of the species concerned.

5 Conclusions

From this review, it has been learnt that that integrative methods for identifying conservation strategies should be utilized to achieve sound conservation and sustainable utilization of the resources of biodiversity. Depending on the circumstances, certain scientific and social techniques or approaches (such as *in-situ, ex-situ, circa-situ*, ecosystem based, and landscape-scale) should be adopted and integrated when they become harmonious with the conservation objects.

The CBD and many other literatures promote the ecosystem approach, because it aims to put people and their natural resource use practices at the centre of decision-making and to seek a balance between the conservation and use of biological diversity in areas where there are both multiple resource users and important natural values.

Therefore, the ecosystem approach has been remarked as the best approach for the conservation of biodiversity, but it does not mean that it excludes the application of other conservation approaches; rather it integrates within the nature and human systems.

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