REVIEW PAPER

Contribution to the red list of plants of Pakistan: A Review

Rabia Shabbir*, **Asma Jabeen**

Department of Environmental Sciences, Fatima Jinnah Women University, Rawalpindi, Pakistan

Abstract

Pakistan is blessed with a variety of plants that are being used for multiple purposes. The properties and proper uses of a small friction of these plants are known at community level and end users but many have still to be explored for their values. Due to population explosion, poverty and ignorance, the comparatively richer cover of the herbaceous flora has vanished from about 60% of their habitats. The total flora of Pakistan which is threatened is more than 15% which includes many endemic species. These plants need to be preserved before they disappear because of excessive commercial harvest and local uses. Different efforts are required for the proper documentation of plants including the identification of endangered, endemic and threatened flora of the country which collectively forms the Red List. It would further help to properly train local people, to reduce the anthropogenic pressure and to point out different methods for the conservation of endangered flora.

***Corresponding Author:** Rabia Shabbir ⌧ ubania_khan@yahoo.com

Introduction

Plants are considered as an essential component of global sustainability due to different ecosystem services of plants like provision of fuel, food, medicine and shelter. Healthy ecosystems with plant diversity are vital for the livelihoods and well-being of all humankind. The tremendous increase in human population, urbanization, habitat fragmentation and the increased dependency of poor's on natural resources has put a great stress on wild plants which are rapidly disappearing (Western, 2001; Woodruff, 2001). The rate of plant extinction has reached to specie per day and this rate is considered to be 1000-10000 times rapid than the natural extinction rate (Hilton-Taylor, 2000). According to Pujol et al. (2006), if the trend remains constant, 60,000 to 100,000 species would disappear during the next 50 years. Almost half of the world's plant species are likely to be threatened by extinction if assessment is made according to the categories and criteria of IUCN (Pitman and Jorgensen, 2002).

The precise evaluation of the conservation status of a plant is one of the most important steps (Vischi et al. 2004), in order to successfully prevent a plant from extinction. IUCN red list criteria and categories (IUCN 2001) are adapted worldwide for the evaluation of conservation status of taxon in the wild, which is an approach for assessing and monitoring the status of biodiversity. These red data list categories are only applicable to wild populations of a taxon inside their natural range of occurrence. Furthermore, the conservation status is applicable within a specified geographical or political area, because these categories belong to specific or infra specific level. Therefore, IUCN separately developed protocols for regional Red Data List assessments (IUCN, 2003).

The major problem for the determination of conservation status, the data of all the described plant taxa is either limited or inappropriate, therefore, plants are considered poorly evaluated as compared to animals. According to some estimates,

the extinction risk of about 96% of all the described taxa are yet to be determined (Sheth et al., 2008). The IUCN Red List contains record of almost 12,000 plant species representing only 4% of global plant diversity. All the major taxonomic groups of plants have their representatives among these evaluated species. But the gymnosperms (cycads and conifers) is the only major plant group which is almost fully evaluated. Total of 33,798 vascular plants making the 12.5% of the world flora are listed as threatened at global level (Walter and Gillet, 1998). In contrast to this according to current red list data, only 19 taxa are listed for Pakistan (IUCN, 2009). Of these, *Asparagus gharoensis* was found extinct; *Scaevola plumierii* (L.) and *Scaevola taccada* regionally extinct; *Allium gilgiticum*, *Arabidopsis brevicaulis*, *Christolea mirabilis*, *Consolida schlagintweitii*, *Elymus russellii*, *Mattiastrum karakoricum*, *Plantago baltistanica* and *Saxifraga duthiei* were observed to be possibly extinct; *Androsace russellii*, *Asperula oppositifolia* subsp. *Baltistanica*, *Astragalus clarkeanus*, *Berberis pseudumbellata* subsp. *gilgitica*, *Haplophyllum gilesii* and *Tanacetum baltistanicum* critically endangered, while the remaining two taxa i.e., *Aconitum violaceum* and *Rhodiola saxifragoides* were found vulnerable (Alam and Ali, 2010), but this figure seems to be an underestimation and clearly indicates lack of information.

In view of biodiversity loss, Pakistan is also under tremendous pressure of extinction. The reduction in the number of plant species may be attributed to a number of factors like population expansion, deforestation and high rates of habitat modification, over-exploitation, introduction of invasive alien species, pollution, soil erosion, salinity and water logging and climate change (Ali, 2000; Eberhardt et al., 2006; Schickhoff, 2006). The continuous loss of habitats along with its flora and fauna is seriously affecting other natural ecosystems.

Unfortunately less critical work on threatened plants of Pakistan has been conducted therefore; less information is available (Alam and Ali, 2009). Only

few reports available which have indicated the conservation status of some plant species. Nasir (1991) mentioned conservation status of 14 threatened plants for Pakistan and according to his research 580-650 species of flowering plants or 12% of the total were expected to be threatened. Chaudhri and Qureshi (1991) prepared a list of 709 threatened taxa based on herbarium specimens. Out of which 249 were endangered, 331 rare while the remaining 129 taxa were vulnerable. But due to herbarium based work, the classification of different taxa into various categories of threatened plants was rather doubtful, because only herbarium based estimation cannot be useful to evaluate current status of taxon unless accompanied by field studies continuously taken for a number of years (Gracia et al., 2002).

Walter and Gillet (1998) have listed only 16 flowering plant species as threatened from Pakistan. Of these, 2 are said to be already extinct, 2 endangered, 2 vulnerable, 5 are rare and 5 indeterminate. However, in the current red list (IUCN, 2009), 19 flowering plant species are listed from Pakistan. Of these, 2 are vulnerable, 13 lower risks least concern, 1 near threatened and remaining 3 were classified as data deficient.

Shinwari et al. (2002) reviewed floral diversity in Pakistan. Careful estimates show that the total species of vascular plants in Pakistan so far been recorded is 6,000 (Ahmad, 2003; Stewart, 1972) with 400 endemic species, out of which 90% occur in the western and northern mountains at an altitude of over 1,200 m. The endangered plants of Pakistan with their area wise distribution are shown in Tables1 and 2 respectively.

Ibrar (2003) worked to find out the conservation status of 8 Himalayan medicinal plants, but this approach is totally based on the availability and rate of consumption of these medicinal plants in the market. No data has been given regarding population size, extent of occurrence and area of occupancy in

its actual habitat. On the other hand majority of the medicinal plants given are widespread across the Himalayas and Hindu Kush.

The floristic studies of Chitral was undertaken to prepare a red list data. The conservation status of 17 taxa was determined using IUCN red data list categories and criteria. *Allium barszczewskiim A, chitralicum, Androsace harrissii, Arnebia grandiflora, Astragalus affghanus, A. chitralense, Astragalus gahiratensis, A. stantonianus, Campanula tristis, Delphinium mordhagenii, Gaillonia chitralensis and Oxytropis gloriosa were* critically endangered. Five taxa i.e. *Anaphalis chitralensis, Delphinium chitralensis, Galium chitralensis, Polygonum cognatum subsp. Chitralicum and Silene longisepala* were endangered whereas, 10 taxa were categorized as data deficient (Ali and Qaiser, 2010a).

Different plant taxa were classified in Gilgit and Baltistan area according to IUCN Red list Categories and Criteria (2001). *Astragalus gilgitensis, A. clarkeanus, Asperula oppositifolia* subsp. *baltistanica, Berberis pseudoumbellata* subsp. *gilgitica, Haplophyllum gilesii* and *Tanacetum baltistanicum* were found critically endangered, *Aconitum violaceum* var. *weileri* and *Rhodiola saxifragoides* were vulnerable and *Androsace russellii* was found data deficient (Alam and Ali, 2009).

According to Ali and Qaiser (2010b), 21 flowering plants are threatened in Pakistan in contrast to the IUCN Red list of 2008. In order to determine the conservation status of a taxon, it is necessary to determine the fluctuation in its population size, the area that it occupies and to maintain long lasting observation. Such studies have never been done in Pakistan (Alam and Ali, 2009).

Endemic and rare taxa of an area are most vulnerable because they occupy small geographic ranges and specific habitats. Endemic and rare

species, particularly species with a narrow area of distribution in Pakistan deserve immediate attention. Nandiar Khuwar is a very important mountain territory with respect to plant diversity. Haq et al. (2010) worked on species diversity of vascular plants and reported 380 species from tropical sub humid forests to alpine pastures (Ahmad et al., 2010).

Plant diversity in Pakistan

Pakistan has wide floral biodiversity and a large variety of species due to the country's diverse topographic, geographic and climatic conditions containing about 6000 taxa. There are 128 pteridophytes, 23 gymnosperms, 1140 monocots including 576 grasses and 4492 taxa of dicots. The forest cover of Pakistan is very low and only 4% of total land area is covered by forests 5% of which is protected. The forests of the country are of different types such as a) tropical dry deciduous forests, b) littoral and swamp forests, c) sub tropical broad leaved evergreen forests, d) tropical thorn forests, e) sub tropical pine forests, f) Himalayan dry temperate forests, g) Himalayan moist temperate forests, h) sub alpine forests and alpine scrub. The coniferous species are predominating and about 40% of Pakistan's forests lie in Khyber Pakhtunkhwah. An important source of wood in Pakistan is manmade forests. These are of four main types: farmland trees, irrigated plantations, linear and miscellaneous planting. About 90% of wood produced in country is used as fuel (Ilyas, 2006).

Major threats to biodiversity

The biggest concern of ecologists in Pakistan regarding ecosystems is the continuous degradation of natural habitats and fragmentation. This is affecting equally rangelands, forests, freshwater and marine ecosystems. The continuous decline in many native species of plants and animals is of equal concern. These all factors have made some species extinct, many are internationally threatened and more still are of national concern. This is leading to the continuous loss of domestic genetic diversity

with the degradation of agro-ecosystems. Therefore, these are the areas that strongly need attention.

According to Biodiversity Action Plan Pakistan 1997, 4.8% or 4.2 million ha of the country are covered by scrub, forests, planted trees on farmlands. The total covered area may fall to 2.4 million ha (2.7% coverage) after the exclusion of scrub forests and plantations. More than 9/10 of remaining coniferous forests have less than 50% canopy cover. Less than 400,000 ha are covered by good quality coverage forests (GoP and IUCN, 2000). The declining rate of woody biomass is 4-6% per year. It is expected that within the next ten years this biomass could be consumed totally, because the biomass consumption increases or decrease with the increase or decrease in population. Jabeen (2006) found that the forests and rangelands are directly degraded by rapidly increasing demand of fodder collection.

Rehman and Ghafoor (2000) studied the human influence on the natural resources of Mount Elum, Swat. Analysis of the socio-economic profile revealed that land tenure and ownership conflict were the basic causes of the depletion of natural resources and ecological degradation other than deforestation, fuel wood collection, forest fires, tourism, overgrazing, terracing, poverty, ignorance, lack of development initiatives and the ruthless exploitation of wildlife.

In a study about status of 37 vascular plants belonging to 31 families in, it was noted that: 7 species were confined to a single locality, exclusively in patches in a highly specific habitat, while 12 species were only rarely distributed in more than single locality and still 18 species could be found in whole tract. A decline was observed in the population size of these species due to the factors such as decline in the area of occupancy, extent of occurrence, loss of habitat, actual or potential level of exploitation, effects of introduced taxa and attack of pathogens (Haq, 2011).

Moreover, another important factor of biodiversity loss in Pakistan includes lack of basic facilities like education and roads etc. in remote areas. Therefore, the literacy rate is very low with negligible female education. This low literacy rate have greatly contributed to lack of awareness on the part of local people as they are unaware about the importance of these indigenous forests to them and to the ecosystem. Illiteracy has greatly contributed to the unsustainable use of forest resources in the area (Jabeen, 1999).

Conservation priorities

On one side, forest cover constitutes 5.2% (4.58million ha) of the country's area, but to the other, the country is highly dependent on trees as well as on non timber forest products (Shinwari et al., 2002). A major portion of the country's population is dependent upon the biological resources, therefore the biological resources scarcity is a major concern for the country. Fuel wood still has an important place as main source of energy in Pakistan with 50% of the urban population and 90% of the rural population mainly relaying on it.

Conservation Status

Over the past three decades, conservationists, natural resource managers and policy makers have recognized that the conservation of biological diversity depends upon protecting and managing intact natural habitats. Such recognition has given greater importance and urgency to the international efforts to establish and maintain biospheres reserves, wildlife sanctuaries, national parks, forest reserves and other protected areas.

Ex-situ conservation

The removal of plants from their native habitats, for translocation off site to intensively managed facilities, represent ex situ conservation. This conservation strategy may use botanical gardens, seed banks or more sophisticated green houses. For several decades now ex situ conservation has been pursued internationally in a highly organized fashion through government support and institutional collaborations. Most of their attention has been directed at agricultural phytogenetic resources but wild plants also are being maintained ex situ on an increasingly large scale (Tuxill and Nabha, 1998). World over different ex-situ conservation efforts are carried out. One major effort is the Millennium Seed Bank at the Royal Botanic Gardens, Kew, UK. An ex-situ conservation effort was made by cultivating 18 threatened plant species in lower Swat. Only 10 plant species i.e. *Bergenia ciliata, Dioscorea deltoidea, Bistorta amplexicaulis, Primula denticulate, Valeriana jalamansa, Valeriana pyrolifolia, Viola biflora, Viola canescens, Salvia lanata and Berberis lyceum* survived and acclimatized to new habitat, while 8 species *Colchicum luteum, Acorus calamus, Canha alba, Podophyllum emodi, Polygonatum verticilatum, Aconitum heterophyllum, Paeonia emodi and Geranium wallichianum* failed to germinate (Hamayun, 2004).

In-situ conservation

The protection of plants in their native habitats, termed in situ conservation is aimed at keeping intact the ecological relationships between species and in some cases cultural relationship between people and wild species. This kind of strategy may involve formal protected area recognized by governments, such as sacred groves, springs and mountains and reserves for medicinal plants where communities have decided that no other extractive activities are allowed. In most part of the world, in situ conservation for useful plants has tended to be locally and informally organized. Efforts by governments or international organizations to promote in situ plant conservation are expanding.

This is the best method for conserving genetic and plant resources but its execution is not easy due to population pressure and resource constraints. The most effective way to conserve plants in their own environment and ensure sustainable use of plant resources is to educate the people and provide them opportunities and better living standards. Ahmad et al. (2010) conducted a study about the ethno

medicinal uses of grasses in Salt Range Region of Northern Pakistan and they recommended that indigenous communities should be trained to protect the endemic grass species by using In situ strategies for long term sustainability.

Table 1. Endangered plants of Pakistan (Chaudhri and Qureshi, 1991)

Plant Type	Angiosperms	Gymnosperms	Pteridophyta	Total
Endangered	641 (11%)	1(4%)	28(18%)	660 (13.3%)
Total	5850	25	140	6015

Table 2. Area wise Endangerment in Pakistan (Chaudhri and Qureshi, 1991; WWFP, 2003)

Area	Endangered Plants
Balochistan	168
Chitral	140
Northern Pakistan	104
Kurram Valley	80
Azad Kashmir	46
Kaghan/Hazara	38

Past and present conservation scenario of Pakistan
The record of conservation of natural resources in Pakistan is linked with its history of colonization and conquest. Over the past millennia, indigenous populations were forced into the mountains and foothills after the migration of invaders into the fertile plains of the sub continent into the southeast which entailed clearing of forests for grazing and agriculture (Kothari, 1998).

An economic acceleration and social transformations took place in the post colonization era. The industrial growth, population explosion and agricultural commercialization continued to exert pressure on the overall stock of natural capital. The physical threats to the environment especially the forest and river ecosystems were further worsen by the collapse of customary social structures. The economic opportunities were diversified by a combination of poverty and the natural resource use was encouraged by the increased commercial value instead of conservation.

The designed management system for specific purpose of conservation was unable to handle these changes. The multiple but conflicting interests of private developers, commercial loggers, hunters, governments, military agencies, hunters and impoverished communities placed even more stress. The administration tended to select the least resistant path with a strict hand on the poor local communities colliding for personal profits and gains. Rising prices of timber, fuel wood and forest products, an erosion in the standard of living of the forest custodians, fines and penalties that were selectively applied combined to create a complex of perverse incentives antithetical to conservation. The key inroads into forest resources began to be made by commercial and development groups which management was not in a position to oppose and in fact cooperated with. On the other hand, it targeted communities, whose needs were of an essentially subsistence nature and who had their rights and traditions been honored could have collaborated with the authorities in the sustainable management of forest resources.

Protected area management initiatives
The conservation movement was started in late sixties and the forestry acts set the context for it. This movement was initiated by WWF and the study conformed high degradation levels and threats to wildlife. Reduction in habitats was recognized as the other major threat to the survival of species. The ineffectiveness of existent game laws against transgressors was also observed belonging to the higher social strata. The recommendations made were extensions of the forestry acts but they led to the creation of game reserves, wildlife sanctuaries and national parks across the country. From 1970-1995, a number of international biodiversity governing conventions has been signed by Pakistan. These are i) The Convention on Biological Diversity ii) CITES iii) RAMSAR Convention iv) World

Heritage Convention v) Convention on The Conservation of Migratory Species vi) International Waterfowl and Wetland bureau.

Over the last three decades, a total of 99 wildlife sanctuaries, 14 national parks and 96 game reserves have been established, covering 9.17 million ha or 10.40% of the total land area (GoP and IUCN, 2000). In this respect, Pakistan lags behind many Asian countries including Sri Lanka, Nepal and Bhutan in terms of the designed national land area for conservation. Different measures resulting from national and international efforts did achieve results in terms of increasing awareness and reducing threats to species. But the results of the above mentioned efforts was not according to the desired outcomes, as there was continuous decline in habitats as well as the species diversity. This failure is due to lack of acknowledgement of the rights of communities as well as their potential role in biodiversity conservation as well as inadequate resource allocation, shortage of suitably trained personnel, inadequate research and resource inventory etc.

Legislation

Plant conservation is highly valued in most of the Asian countries, and relevant laws and policies are in place to protect trade plants, endangered plants and plants of economic importance (Ma et al., 2010). A wide range of laws have been implemented in provinces of Pakistan for the conservation of components of biodiversity, including fisheries, forests and wildlife. Relevant legislation is divided between the federal and provincial governments. Forestry including the wildlife parks, freshwater and near-shore fisheries is under provincial jurisdiction and is covered by various acts and ordinances. Provincial Wildlife Boards have been set up to provide policy for and supervision of wildlife conservation and management.

The Pakistan Environmental Protection Ordinance of 1983 was the first relevant federal legislation targeting environmental conservation as a whole.

This was replaced in 1997 by the Pakistan Environmental Protection Act. The Act's relevance to biodiversity conservation is primarily through its environmental assessment screening process for proposed projects. While IEE and EIA processes have been put into place and do address some biodiversity considerations, federal and provincial EPA staff do not have the expertise or resources to effectively undertake IEEs or EIAs.

Related strategies and plans

The government adopted National Conservation Strategy in 1992 and accepted by the World Bank as a National Environmental Action Plan. There are 14 core programs in the NCS, many of which touch upon biodiversity issues. As a whole, however, the document does not provide comprehensive actions specifically related to biodiversity loss. The main planning instruments in Pakistan are the Perspective Plan, the Five-Year Plan, and Annual Development Plans. Although these instruments have traditionally paid scant attention to environmental concerns, the Eighth Five-Year Plan (1993–1997) identifies the need to develop provincial conservation strategies to carry through with NCS recommendations (Anwar and Shank, 2002).

Development of the Biodiversity Action Plan (BAP)

Pakistan was one of the first nations to sign the Convention on Biological Diversity (CBD) in 1992. Cabinet subsequently ratified the CBD in 1994. In July 1996, funds were provided by the Global Environmental Facility (GEF) through the World Bank to develop the BAP along with a proposal for a protected areas initiative. BAP preparation was therefore linked with planning for the Protected Areas Management Project (PAMP). The BAP provides a brief assessment of the status and trends of biodiversity, outlines strategic goals and objectives, and identifies a plan of action (GoP and IUCN, 2000).

Discussion

Plants and plant resources are always indispensible for any region as they show immense impact on the ecosystem and socio economic conditions of the people inhabiting that region. Conservation of plants involves more than plant protection and controlling access to plant resources. Conservation also demands collection of baseline data on social, economic, and ecological parameters, to be incorporated into a comprehensive management strategy. Effective conservation also requires extension activities and education about the importance of plants as well as strategic cultivation initiatives. Moreover, conservation requires the involvement and support of the communities that ultimately depend on these plant resources. To reduce pressure on plant resources, complementary activities such as encouragement of fodder crops e.g. multipurpose fast-growing fodder trees, fuel efficient stoves, improved crops and livestock management must be initiated but a notable lack of available information on propagation and management of important species limits the increased cultivation of plants.

Pakistan has attempted to protect its biological resources for posterity as well as for more immediate functional benefits. First, Federal and Provincial authorities have made significant attempts to protect biodiversity and natural capital. A network of national parks, wildlife sanctuaries and game reserves has been established which cover about nine million hectares. Secondly, Pakistan is a signatory to virtually all the important international agreements such as the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), The Convention on Wetlands of International Importance (RAMSAR), the World Heritage Convention and the Convention on the Conservation of Migratory species of Wild Animals. In addition Pakistan is a member of International Union for Conservation of Nature (IUCN). These and other measures, including conservation education programmes and initiatives, the activities of non-government organizations, legal instruments and research and management activities have given several previously endangered species of animals like Indus dolphin, marine turtle, the Sindh Ibex, Markhor, one horned Rhino, Cheer pheasant etc. a new lease of life and now the focus of conservation has been shifted towards the plants.

Rehman and Kane (1996) made efforts to document indigenous knowledge by the Inter-regional Project for Participatory Upland Conservation and Development, Kanak Valley, Mastung. To start with, collection of participatory information on the most commonly used medicinal plants was taken up. The exercise with the women, who in fact are real user, has emerged to be extremely interesting. Women from the six Village Associations in Noza Sub watershed were persuaded to speak on local use of the medicinal plants. Their discussion was recorded on audio tape. This tape was copied and was then kept in each village association. The information was updated with further exchange among the local women.

Shinwari *et al.* (2000) surveyed the Astore area, Gilgit to provide information for the conservation of plant biodiversity, provide potential income to local people, and to determine and monitor harvest levels of medicinal plants. They mentioned that rapid decline of plant resources due to their conventional use needs ex-situ and in-situ conservation, training of the community regarding collection of medicinal plants and their marketing. 5 species out of 34 medicinal plants were found to be endangered 18 species vulnerable and 19 species rare. The major threat of endangerment was noted to *Betula utilis, Ferula narthex, Podophyllum hexandrum, Saussurea lappa* and *Tamarix gallica.*

The moist temperate Himalaya of Pakistan requires special attention for the conservation of environment and the sustainable use of natural resources. The decrease in forest cover and associated major changes in community composition has led to the

decline of indigenous medicinal plants resources and their traditional knowledge (Ibrar, 2003).

The conservation status of *Cadaba heterotricha* stocks in Pakistan was determined according to IUCN (2001), Red Data List Categories and Criteria. Based extensive field studies including population size, geographic range and habitat, *Cadaba heterotricha* was classified as Endangered (EN) species in Pakistan. Jafri (1958 & 1974) considered it as a rare species due to its narrow distribution in Pakistan. While, Nasir (1991) classified it as an endangered species for Pakistan (Abbas et al., 2010). Over exploitation, loss of habitat, attack of pathogens, effect of introduced taxa and change in environments were responsible for making these species either endangered or critically endangered species. Extensive grazing and deforestation which have led to forest fragmentation and degradation of the habitat are the primary causes of species extinction in the area (Haq et al., 2010; Sala et al., 2000; Muhammad, 2003). Immediate conservation measures are urgently necessary in order to protect the taxon from extinction. Some of the recommendations for conservation measures are as follows

i) Proper documentation and conservation of indigenous knowledge

ii) Proper training of the local communities about the conservation of Flora

iii) Anthropogenic impacts like overgrazing and deforestation should be reduced.

iv) These threatened taxa should be conserved in Botanical gardens.

v) Socio-economic conditions of the locals should be upgraded by providing alternate lively resources in order to reduce their dependency upon the threatened plants

vi) Developmental activities should be planned on sustainable basis in order to reduce loss of biodiversity.

vii) In order to ensure peace among the locals, sectarian violence should be eradicated, which will indirectly affect the socioeconomic uplift of the locals

and their dependency upon these delicate natural resources.

viii) Human population should be controlled on sustainable basis for reducing pressure on natural resources.

Conclusion

The exploration of plant diversity beyond the community level for multiple purposes has threatened the plants as well as the whole ecosystem in different parts of Pakistan like other countries of the world. There is need to conserve these plants by proper documentation, monitoring, proper training of the locals and reducing anthropogenic pressure on these plant resources for sustainability of nature and protection of ecological regions is one of the powerful methods for biodiversity conservation.

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