6.7 Landscape Ecology

The term “landscape ecology” was first introduced in 1939 by Carl Troll, a German bio-geographer who was interested in understanding the spatial perspectives offered by aerial photography. Landscape ecology represents a branch of ecology which deals with the relationship between spatial patterns of interacting landscape systems and their impacts on ecological phenomena. The underlying premise is that the landscape mosaics affect ecological systems in a manner that is driven by their spatial pattern and configuration. The impact would be different if the composition or spatial arrangement of these mosaics were different. This is in contrast to much previous understanding of ecological systems, which tended to focus on spatially homogeneous areas, such as a forest stand or a wetland patch, without considering their position within a larger, interacting ecological mosaic. Thus, landscape ecology often focuses on spatial extents that are much larger than those traditionally studied in ecology. The field of landscape ecology is closely linked with those of geography (which offers the spatial perspective), and ecology (which offers the functional perspective). Thus, landscape ecology represents an inherently inter-disciplinary science.

Scale is a concept central to the study of landscapes, as the insights obtained into particular ecological issues depend critically upon the scale of observation. Scale can be defined by two separate, but linked attributes. The first, extent, refers to the spatial size of the landscape units under study. The second, grain, describes the maximum resolution with which the landscape can be observed – often described by the size of the minimum mapping unit which can be used to spatially map the landscape into its constituent parts. The spatial and temporal scales that are important to, and apparent to humans need not necessarily be those that are relevant to different organisms such as small ranging beetles, or large ranging eagles. Most landscapes are used by, and changed by humans. Landscapes are therefore often defined at the scale of human observation, from tens to hundreds of square kilometres. Nevertheless, landscapes can also be defined from the point of view of other organisms, from ants to tigers. Central to all definitions, however, is the fact that landscapes need to be heterogeneous in at least one factor of interest (usually, this means that there

should be more than one habitat type distributed within a landscape).

A landscape is typically considered as being composed of patches—distinct, spatially contiguous habitats that are spatially distinct from their surroundings, such as a wetland or a forest grove; corridors – linear elements such as roads or rivers; and the matrix – the dominant habitat type within which other patches and corridors are embedded. The size, shape and spatial distribution of each of these components can be quantified by landscape spatial metrics and related with attributes such as biodiversity and ecological function. Satellite remote sensing and Geographical Information Systems have been particularly useful for this purpose, and the discipline of landscape ecology has expanded rapidly in the past 30 years, following the rapid development of these techniques for landscape mapping and assessment.

6.8 India as a Mega Diversity Nation

India is one of the 12 megadiverse areas of the world. With only 2.5 per cent of the land area, India already accounts for 7.8 per cent of the recorded species of the world. Biodiversity also includes countless millions of races, subspecies and local variants of species and the ecological processes and cycles that link organisms to populations, communities, ecosystems and ultimately the entire biosphere. A more easily recognised element of biological diversity is the distinct species. An association of species in an area is another recognisable element of biological diversity which is termed as community. Communities form the biotic components of ecosystems.

Biodiversity in India is mainly recognised at three levels, namely genetic level, species level and ecosystem level which have already been discussed in 6.6. Biodiversity is dynamic at all the three levels. The genetic composition of species changes over time in response to natural and human-induced selection pressures. Occurrence and relative abundance of species in ecological communities changes as a result of ecological and physical factors. Ecosystems strongly respond to external dynamics and internal pressures.

Bio-geographically, India is situated at the tri-junction of the Afro-tropical, the Indo-Malayan and the Palearctic realms. Because of its proximity to all three realms, India possesses a unique assemblage of characteristic elements of biodiversity of each of them. Based on available data, India ranks tenth in the world and fourth in Asia in plant diversity. According to surveys conducted so far, 47,000+ species of plants and 90,000+ species of animals are found in India. India is an acknowledged centre of rich crop diversity. It is considered to be home to 167 important cultivated plant species and 320 species of their wild relatives. India is considered to be the centre of the origin of 30,000 to 50,000 varieties of rice, pigeon pea, mango, turmeric, ginger, pepper, banana, bitter gourd, okra, coconut, cardamom, jack fruit, sugarcane, bamboo, taro, indigo, sun hemp, amaranthus, goose berries, etc. There are several hundred species of wild crop relatives distributed all over the country. India's domesticated animals consist of diverse livestock including poultry and other animal breeds.

The 34 biodiversity hotspots identified so far hold especially high numbers of endemic species covering only 2.3 per cent of their combined area of remaining habitat in the world. India has two hotspots, namely, the Himalaya and the Western Ghats.

The efforts of *in situ* conservation in India are mainly concentrated in 605 protected areas (505 wildlife sanctuaries and 100 national parks) as of 2007. In addition, India has 14 biosphere reserves, spread across various bio-geographic zones of the country where the Sundarbans, Gulf of Mannar, and the Nilgiri are now included in the international network of biosphere reserves recognised by United Nations Education Scientific and Cultural Organisation (UNESCO). India also has 6 World Heritage Sites of UNESCO. Till date 25 wetlands have been designated as Ramsar sites.

In terms of cultural perspective India has about 40,000 to 50,000 endogamous groups of people suggesting very high level of diversity of languages, culture, knowledge of ecosystems and so on. In India, more than 400,000 practitioners of traditional medicinal systems are using 80 per cent of plant based raw material for drugs.

The innumerable water bodies in India contain bewildering diversity of fish species in them. The ichthyo species (fish) in the Indian Freshwater (FW) bodies total to 2500 species out of a global total of 8411 FW fish species. The Marine biodiversity in the Indian Maritime region total to 1570 species out of a global total of 11650 species of marine fishes. The fresh water fish diversity in the lentic and lotic systems of the North-Eastern Region of India totals around 267 species; thus, qualifying it as one of the 'Hotspots' of fish biodiversity in the World.

Unless this biodiversity is used sustainably, the future generations of India will not enjoy the benefit. There are many human pressures exerted on the biodiversity that exists, in India's forests, grasslands, wetlands, mountains, deserts and marine ecosystems. One of the major causes for the loss of biological diversity in India has been the extensive depletion of vegetative cover to make way for expanding agriculture. Since most of the forests rich in biodiversity also contain the maximum amount of mineral wealth and are also the best sites for water impoundment and mining, development projects in these areas have often led to destruction of habitats. Poaching and illegal trade of wild life products have also threatened biological diversity. The major threat to species and genetic diversity in India are similar to those found elsewhere in the world.

It has been observed that biodiversity is distributed in a heterogeneous fashion on the earth. This accumulation of species in selected regions of the world has prompted the concept of megadiverse country. The concept was put forward in 1988 in a conference organised by the Smithsonian Institution in Washington D.C.

But considering the conservation and trade importance of biodiversity along with the associated knowledge, there have been political conglomeration of selected countries at international forum such as Convention on Biological Diversity. Seventeen countries rich in biological diversity and associated traditional knowledge have formed a group known as the Like Minded Megadiverse Countries (LMMC). The members of LMMC group are mainly from developing and tropical countries. The LMMC group has been created to provide a forum to jointly promote their interests regarding biological diversity and in particular the protection of traditional knowledge, access to genetic resources and the fair and equitable sharing of benefits derived from their use. India became the President of LMMC group during 2004 to 2006. The activities of LMMC group can be checked and accessed at *http://www.lmmc.nic.in*. The review of world data on species richness suggests that LMMC countries hold top four positions in mammals, birds, amphibians, reptiles and higher plants.

In a nutshell, the mega diversity nature of India needs to be understood in terms of diversity of flora, fauna, ecosystems and traditional knowledge of people associated with the biodiversity.

6.9 Economic Potential of Biodiversity

Decisions on protecting species, communities and genetic variation often come down to arguments over money: how much will it cost? And how much is it worth? The economic value of something is most often considered to be the amount of money people are willing to pay for it. An estimated 40 per cent of the world trade is based on biological products or processes.

Standard economics has tended to ignore the costs of environmental damage and the depletion of natural resources. While some conservation biologists argue that biological diversity is priceless and should not be assigned economic values, economic justification for biological diversity will play an increasingly important role in debates on the issue of natural resources.

Many countries that show annual increases in their Gross Domestic Product may actually have stagnant or even declining economies when depletion of natural resources and damage to the environment are included in the calculations. Large development projects are being increasingly analysed by environment impact assessments and cost benefit analysis are carried out before being approved.

A number of methods have been developed to assign economic value to biological diversity. In one method, values are divided between direct values, which are assigned to products harvested by people and indirect values are assigned to benefits provided by biological diversity that do not involve harvesting or destroying the resource.

Direct values can be further divided into consumptive use value and productive use value. Consumptive use value is assigned to products that are locally consumed such as fuel wood, local medicines and building materials. These goods can be valued by determining how much money people would have to pay for them if they were unavailable in the wild. If over-exploitation makes these wild products unavailable, then the living standard of people that will depend on them will decline.

Productive use value can be assigned to products harvested in the wild and sold in markets such as commercial timber, fish, shellfish and meat. Species collected in the wild have great productive use value in their ability to provide genetic material for domestic species and for the genetic improvement of agricultural crops. Wild species have also been a major source of new medicines. For example, the annual value of trade in oceanic fisheries is valued at 4.5 billion euros – a six-fold increase from the 1976 levels. However, catch rates are in continuous decline, and almost 75 per cent of the world's fish stocks are already fished upto or beyond their sustainable limit. Without sound conservation and management measures, fisheries will quickly become depleted and a basic component of global food security will be lost.

Indirect values can be assigned to aspects of biological diversity that provide economic benefits to people but are not harvested or damaged during use. Non-consumptive use values of ecosystems include ecosystem productivity, important as the starting point or all food chains; protection of soil and water resources, the interactions of wild species with commercial crops and the regulation of climate. Biodiversity is also the foundation of a growing recreation and ecotourism industry. The numbers of people involved and the amount of money spent on such activities are surprisingly large. In many countries, particularly in the developing world, ecotourism represents one of the major sources of foreign income. Biodiversity also has an option value in terms of its potential to provide future benefits to human society such as new medicines, biological control agents and new crops. The biotechnology industry is developing innovative techniques to take advantage of new products and biochemical processes found in the living world.

People are often willing to pay money in the form of voluntary contributions to ensure the continued existence of a unique species, biological communities and landscapes (e.g., the tiger, panda, etc.). This amount represents the existence value of biological diversity.

It is not possible to figure out the true economic value of any piece of biological diversity. We do not know enough about any gene, species or ecosystem to be able to calculate its ecological and economic worth in the larger scheme of things. Can we really assign numbers to many of the values of biodiversity? For example, we may be able to figure out the value in terms of lost fishermen days when rivers are destroyed by pollution. However, what sort of value do we assign to the loss of the community when a whole generation of its children can never experience the streams in their environment as amenities? How can we deal with values of organisms whose very existence escapes our notice? Before we fully appreciated the vital role that mycorrhizal symbiosis plays in the lives of many plants what kind of value would we have assigned to the tiny, threadlike fungi in the soil that make those relationships possible?

We can only thus try to understand the economic potential of biodiversity by assigning notional values.

Economic Potential of Biodiversity (BD)

1. The globe has been very rich in BD, particularly in the developing countries in the tropics which have so far been harvested at ease without much restrictions.
2. Now, many developing countries have started realising the economic and commercial value of the BD; particularly, the tropical hardwoods, fisheries, game viewing and tourism. These have led to growing change in the concept of recognition of BD as available bioresources and people have started working towards commercial exploitation of BD.
3. So far, the developed nations have been harvesting the BD even of the developing nations, in addition to their own, mainly for agricultural and pharmaceutical purposes, mostly at their own advantage.
4. With gradual awareness, now, the developing nations have started imposing restrictions on the developed nations with regard to harvest of BD. They also started demanding for greater share of the financial benefits arising from the harvest of BD. Thus, a global awareness was evident regarding the economic potential of BD.
5. Today, economic potential of BD is dealt with under different aspects, notably, Biotechnology, Industry, Agriculture and Aquaculture.

6. Significantly, the economic potential of Fish BD is a prominent subject matter of Aquaculture.
7. Scientific Pisciculture could lead to the production of around 3000 kg of fish per hectare per year which could give an earning of Rs 1,50,000.00 per hectare per year to a fish farmer.
8. Similarly, other items of aquaculture, like prawn culture, pearl culture, mariculture are also profitable, if done scientifically.

6.10 Loss of Biodiversity — Threatened, Endangered and Extinct Species

We live in a period today where there are more species on earth at the present geological time than in any other period and yet as a result of human activity the current rate of species extinction is so rapid that it can be compared to the five episodes of natural mass extinction found at intervals in the geological record.

Since 1600, 2.1 per cent of the world's mammal species and 1.3 per cent of the bird species have gone extinct. The rate of extinction is accelerating and many extant species are teetering on the brink of extinction. The current observed rate of extinction for birds and mammals is between 100 and 1000 times greater than would be expected to occur naturally. Species that occupy islands are the most vulnerable to extinction because these species occupy only a small area and they are often unable to defend themselves against humans and exotic species and diseases humans bring to the islands. Individuals of long-lived species that remain alive in severely disturbed and fragmented habitats can be considered 'the living dead'. The individuals may persist for many years, but the species will eventually die out due to lack of reproduction.

A species may be considered rare if it has one of the following characteristics: if it occupies a narrow geographical range, if it occupies only one or a few specialised habitats or if it is always found in small populations. Isolated habitats such as islands, lakes and mountain tops may have many endemic species that are found nowhere else.


Sangai (Dancing deer or Brow antlered deer of Manipur)

Species most vulnerable to extinction have one or more of the following characteristics: a very narrow range; one or only few populations; and/or small population size. Additional risk factors include low population density; a large home range; large body size; low rate of population increase; poor dispersal ability; a need to migrate among different habitats, little genetic variability; specialised niche requirements; a need for a stable environment; and large aggregations. An extinction prone species may display several of these characteristics.

To highlight the status of species for conservation purposes, the International Union for the Conservation of Nature (IUCN) has established five main conservation categories:

Extinct: Species that are no longer known to exist in the wild.

Endangered: Species that have a high likelihood of going extinct in the near future and include species whose numbers of individuals have been reduced to the point that the survival of the species is unlikely if the present trends continue.

Vulnerable: Species that may become endangered in the near future because populations of the species are decreasing in size throughout its range.

Rare: Species that have small total number of individuals often due to limited geographical ranges or low population densities. Although these species may not face any immediate danger, their small numbers make them likely candidates to become endangered.

Insufficiently known: Species that probably belong in one of the conservation categories but are not sufficiently well known to be assigned to a specific category.

This system of classification is now widely used to evaluate the status of the species and establish conservation priorities. However, due to the subjective nature of this classification, some scientists have recommended a more quantitative three category system:

Critical species have a 50 per cent or greater probability of extinction within 5 years or 2 generations whichever is longer.

Endangered species have a 20 per cent probability of extinction within 20 years or ten generations.

Vulnerable species have a 10 per cent probability of extinction within 100 years.

Massive disturbances to the environment caused by human activities are driving species and even communities to the point of extinction. The major threat to biological diversity is the loss of habitat. It is predicted that by the year 2040 very little undisturbed rain forest will exist outside Protected Areas. Overgrazing, unsustainable agriculture and burning also lead to soil erosion and desertification. Habitat fragmentation can also lead to rapid loss of species remaining in the area as it creates barriers to the normal process for dispersal, colonisation and foraging.

Environmental pollution also causes extinction of species. Pesticides used to control insects become concentrated in the bodies of birds of prey leading to a decline in populations. Water pollution by petroleum products, sewage and industrial wastes can kill species outright or eliminate them gradually. Increased sediment loads caused by soil erosion and excess nutrient inputs from sewage are particularly harmful to some aquatic communities. Acid rain, high ozone concentrations at the earth's surface and airborne toxic metals are aspects of air pollution that damage communities. Temperature changes due to global climate change will also cause mass extinctions as species will be unable to adjust their ranges and low-lying coastal communities may be submerged.

Humans have deliberately and accidentally moved thousands of species to new regions of the world. Some of these exotic species grow aggressively and eliminate native species thus contributing to extinction. Similarly, human activities also increase the incidence of disease in wild species. Animals are more prone to diseases and susceptible to infection if they are under stress and held in captivity. Over-exploitation threatens about one-third of the endangered vertebrates as well as other species. Growing poverty, increasingly efficient methods of harvesting and the globalisation of the economy combine to exploit species to the point of extinction. Breakdown of traditional societies has ensured loss of customs that were in place for preventing over harvesting of resources.

So far, 484 species of animal and 654 plants have become extinct since 1600 AD. IUCN considers that one in eight plant species is at risk of extinction. Resulting from this array of human threats, rates of extinction are now estimated to be between 1,000 and 10,000 times greater than in the recent past. Tropical forests are being destroyed at the rate of 0.8 to 2.0 per cent per annum, sending some of their estimated 5 million species into extinction.

Domestic animals make a major contribution to human requirements for food in the form of meat, milk, milk products, eggs, fibre, fertiliser for crops as well as draught power. This major contribution is made by some 4,500 breeds drawn from 40 or more animal species. These breeds, developed over the past 12,000 years, represent the remaining pool of genetic diversity from which future demands must be met. However, they are currently dying out at a rate of six breeds per month. Latest information suggests that 30 per cent of the world's breeds are at risk of extinction.

The current extinction rate is nearly 1,000 times the background rate and may climb to 10,000 times the background rate towards the end of the 21st century. At this rate, 30 per cent to 60 per cent of all species of plants, animals and other organisms would be lost during the 2nd half of the 21st century, a loss that would easily equal those of past extinctions.

Millenium Ecosystem Assessment has estimated about 10-30 per cent of the mammal, bird and amphibian species currently threatened with extinction, all due to human actions.

World Wide Fund for Nature (WWFN) in a 2002 report found that vertebrate species populations have declined by about 30 per cent in 33 years from 1970 to 2003 and 25 per cent of the world's species might be nearly extinct by 2050 as a result of global warming. In India, about 215 vertebrate species and 3,000 flowering plant species are threatened.

These impacts will aggravate in the future as the human population increases especially in species rich tropical countries. Slowing human population growth is part of the solution to this crisis. The other most important means of protecting biological diversity is preserving habitat.

6.11 Strategies for Conservation of Biodiversity – *In situ* and *Ex situ*

The conservation of biodiversity can take place in two basic ways: *in situ* and *ex situ*. *In situ* (which means "at the site") conservation takes place where taxa (species and varieties or subspecies, and their populations) are protected and/or sustainably used in their natural surrounds (for micro-organisms, wild plants and wild animals), or at their sites of domestication and diversification (for agricultural crops and livestock).

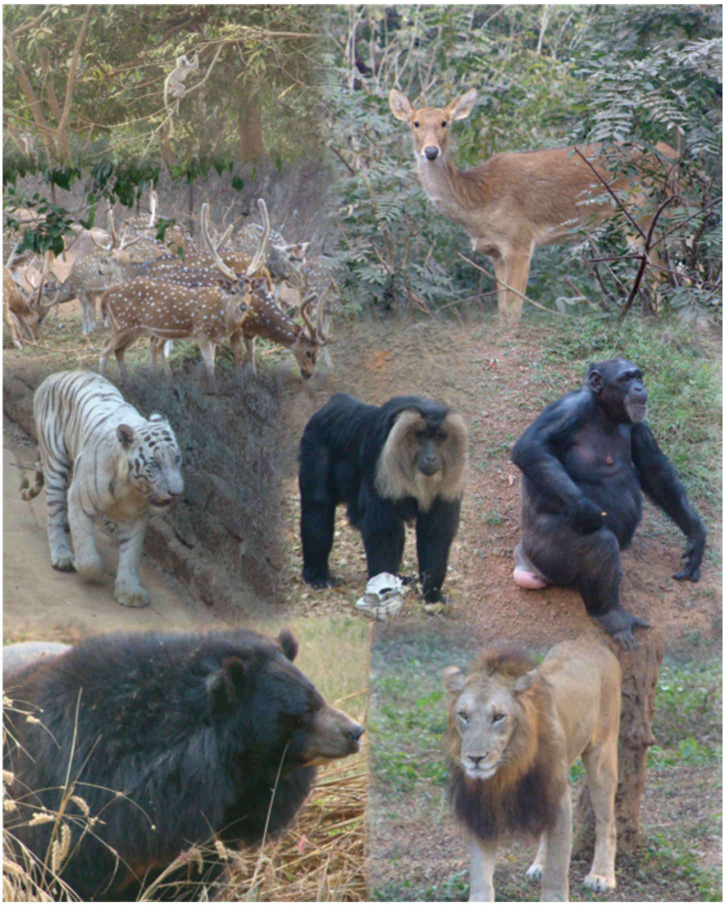
For wildlife, this would be through giving special protection to the habitats they live or feed in, such as forests, wetlands, grasslands, coastal and marine areas, and deserts. In India, there are over 600 'protected areas' (PAs) declared by the government, within which wildlife is supposed to be given protection from any threat. These PAs cover a little less than 5 per cent of India's territory. But even older and more numerous than this, are 'community conserved areas' (CCAs), where *adivasi* and other communities have been conserving ecosystems and species for social, cultural, economic, or other reasons. Usually such CCAs are smaller than PAs, since local communities cannot manage very large areas, but occasionally they can be quite large (several hundred sq. km in size).

In situ conservation of wildlife can also take place through providing legal, cultural and other forms of protection to species, wherever they exist. For instance, in India several species are listed in the Wild Life (Protection) Act and thereby given protection against hunting or capture for trade anywhere in the country. Several species are also culturally protected across the landscape by communities, because they are considered sacred, such as the *Langur*, Blackbuck, the Sarus crane, several species of the fig (*Ficus*) family, and others.

In situ conservation of agricultural plants and animals is usually done by farmers, pastoralists (herders), and fisher people. These communities have for thousands of years bred and used a diversity of crops and livestock, and maintained them on fields or pastures, or in water bodies. A number of farmers' movements and NGOs are today trying to spread this form of conservation.

Ex situ (which means "outside the site") conservation takes place where taxa are protected and managed in artificial conditions, for instance zoos and aquaria for animals, and gene banks for crops and livestock. India has several such facilities, managed by government bodies (like the forest and agricultural departments, or the Zoological and Botanical Surveys of India) or in some cases by independent institutions such as universities. For


Jim Corbett National Park



micro-organisms too, there are *ex situ* facilities, called 'culture collections'. India has 165 zoos, 33 botanical gardens and over 20 major microbial culture collections, according to government statistics. Communities too have *ex situ* facilities, in the form of herbal home gardens, village grain banks, and the like.

Usually *ex situ* conservation is meant as a supplement to *in situ* conservation, to ensure that some taxa that may not survive in the wild or on farms do not get totally wiped out, or to provide breeding facilities from which plants or animals can be reintroduced into *in situ* conditions. It is important not to consider *ex situ* as a substitute to *in situ*. This is because the evolutionary factors that are so important in keeping alive biodiversity, providing unique characteristics to each taxa, and maintaining the health of the ecosystem, are available only in *in situ* conditions. In addition, *ex situ* conservation is typically very expensive, and prone to all kinds of failures.

Strategies for Conservation: *In situ* and *Ex situ* Conservation: Fish BD

Fish sustenance is in threat due to:

(a) Siltation, Eutrophication and pollution of the water bodies

(b) Fish disease, notably, Epizootic Ulcerative Syndrome (EUS).

It is, perhaps, the wisest strategy to conserve fish in its own home in the particular waterbody, i.e., *in situ*, where a fish would certainly be at home. However, the above two factors are to be taken care of, with due prudence.

It would, perhaps, be little unwise to address all the problems at the same time. Rather, it would be frugal, beneficial and pragmatic, if we, as a pilot strategy, take up renovation/reclamation of the water bodies which are in the less polluted and more nature-friendly areas and which are victims of only few problems resulting mostly due to natural successional process, lime siltation and eutrophication. Such water bodies are found in the largely virgin North-East India.

The waterbodies could be desilted gradually and mechanically by employing innumerable unemployed labourers under `Food for Work' Programme; and, further siltation of water bodies could be prevented by putting mechanical silt traps, particularly, in the small torrential hill streams, which are mostly victims of siltation. In this way, the depth of the water bodies, particularly the rivers, could be increased gradually, through desiltation. The breeding grounds of Large Growing Fishes (LGF) could thus be revived and the population of fishes in the water bodies would be on the rise.

Nevertheless, some of the critically endangered fish species could be transferred to 'Aquatic sanctuaries' for their *ex situ* conservation.

6.12 Mitigating the People—Wildlife Conflict

Humans evolved in the African savannahs but populated rest of the world over the last 60,000 years or so. During their range expansion, they competed with and extirpated many wildlife species that were not evolutionarily adapted to face such a new, resourceful adversary. Although many wildlife species survived human invasion of their habitats, their distributional range shrank by over

90 per cent, as with tigers, elephants, lions and cheetahs. The issue of mitigating conflict between people and wildlife now must be seen in this context, particularly because the popular media tends to misrepresent wildlife species as aggressive intruders when conflict occurs. 'Conflict', here, is defined to exclude crop damage or spread of diseases (e.g., rabies, anthrax) by smaller life forms such as rodents, birds or insects, and focused on the conflict between humans and larger vertebrates.

People-wildlife conflicts are rooted in the fact that we humans are also large-bodied vertebrates who try to exploit the land for the same resources that wildlife requires for survival. Humans raise nutritious crops such as rice and sugarcane: if there are elephants or wild pigs in the surroundings they will raid these riches. Humans also raise cattle or sheep for meat and dairy products. If there are tigers, leopards or wolves they naturally attack such easy prey. The consequences of the ensuing conflict may include loss of crops, livestock, livelihood opportunities and sometimes even human lives.

Numerous tactics are employed by people to mitigate conflicts with wildlife, depending on local ecological and social conditions. These may range all the way from the 'soft' option of simply tolerating conflict to the 'hard' option of extirpating wildlife. However, most such mitigation tactics involve either modifying human behaviour or modifying wildlife behaviour.

In parts of north-western India, people tolerate wildlife damage stoically out of deep-rooted cultural traditions. To some degree, education can be used to inculcate tolerance as well as to teach appropriate behaviour in the presence of dangerous wildlife (e.g., not crowding around a cornered big cat). Another form of human behaviour modification occurs when people change cropping patterns (e.g., switch from planting sugarcane to cotton to avoid elephants) or change livestock rearing practices (e.g., from free-range grazing to stall feeding to avoid predators). Schemes that insure crops or livestock against losses, or *post-facto* payment of compensation, are examples of tactics that can modify human behaviour. Prominently demarcating legal boundaries of wildlife habitats (e.g., to keep out herders), providing government assistance in driving away wildlife, and legally punishing people who retaliate against wildlife, can also mitigate conflict under appropriate circumstances.

Another set of conflict mitigation tactics involves modifying the behaviour of wildlife species to deter them from raiding crops or killing livestock. Establishing physical barriers between human settlements and wildlife by means of trenches, fences, walls and stockades, or by using repellents such as noise, light or chemicals, are perhaps some of the most widely used mitigation measures that alter wildlife behaviour. Employing human watchers or guard-dogs is another common tactic. In some cases, where specialised resources and skills are available and ecological conditions suitable, problem animals involved in conflict can be captured, sedated and taken away from the conflict zone. In many cases, animals involved in conflict are simply killed off (either legally or illegally). In the case of large carnivores that become confirmed man-eaters, this extreme measure sometimes becomes the only practical option.

All the above measures, however, try to mitigate people-wildlife conflicts after the stage is set for them. Some of these methods are unacceptable, particularly inside protected areas that provide the last refuges for wildlife. Under such circumstances, proactively preventing outbreaks of conflicts between people and wildlife through voluntary relocation of human settlements away from the conflict zone can often be an attractive win-win solution.