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Wildlife Corridors: a conservation tool

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Abstract

The concept of corridors for conservation is increasing despite a lack of consensus on their efficacy. Though there are several studies demonstrating functionality of corridors in providing dispersal ability to plants and animals between habitat fragments, among these studies itself many are inflicted with design flaws and whose result can't be generalized to other cases.There is a need to analyze use of corridor as an effective conservation tool and whether it's the only judicial way of using the resources available for conservation. In present paper I have done a review of existing literature on use of corridors. The paper shows that where on one hand the importance of corridor in landscape level conservation approach can't be denied, but in order to prove or even improve its merit many studies still need to be done and in a better designed way. The corridor, even if they are acting as a conservation tool, its value can be increased by incorporating other conservation measures. We have also presented a case study on use of these corridors by tiger in India.

INTRODUCTION

The 21st century has brought many conservation challenges to the fore. One very important and significant challenge that has evoked considerable scientific interest is the fragmentation of wildlife habitat. In recent decades habitat fragmentation created naturally or artificially has led to changes in structure of landscape (Saunder *et al*. 1991) and has affected ecological processes at many spatial scales (Simberloff 1988, Kareiva 1990, Soule *et al*. 1992). Since habitat of many organisms get altered in this process it is essential to explore and understand mechanism of how these organisms adapt to their new disjoint habitat before planning for their conservation. Habitat fragmentation and reduction at various spatial scales has been widely acknowledged as a primary cause of the decline of many species worldwide (Lovejoy *et al*. 1986; Harris 1984; MacDonald 2003).

There are many other impacts of habitat fragmentation apart from reducing total habitat area into small discrete patches (Rolstad 1991) like changes in abiotic character of ecosystem (Saunder *et al*. 1991), alteration of population dynamics (Pullian 1988; Pullian & Danielson 1992), impactson community composition (Diffendorfer *et al*. 1996; Turner 1996)increase in external influences (invasion, predation), increase in isolation from other areas (Saunders *et al*. 1991) and inbreeding depression, reduction in gene flow resulting into loss of genetic variation in small populations (Wid,n & Svensson 1992, Ellstrand& Elam 1993, Young *et al*. 1996). Habitat fragmentation can disrupt natural population dynamics by reducing species dispersal and even causing local extinctions. But the vulnerability of species towards extinction also depends on the species' characteristics (Purvis *et al.* 2000).

Although studies have documented cases of small populations successfully surviving over many decades (Curtis & McGough 1988, Simberloff *et al.* 1992, Wid,n&Svensson 1992), there are studies which shows small populations going extinct (Forney & Gilpin 1989, de Vries & den Boer 1990) as they generally face a higher risk of extinction owing to demographic stochasticity (Lande 1988, Shafer 1987, Hansson *et al*. 1992, Celada *et al*. 1994, Bolger *et al*. 1997).

There has to be a mechanism to reconnect discrete patches, to connect disjoint population and mitigate negative impact of habitat fragmentation. Where on one hand the idea of connected landscape is luring, the ways of preventing fragmentation and conserving connectivity is quite a complex matter. Conservationists often fail to arrive at a consensus even while defining connectivity and articulating clearly about their efforts to protect it. They even misinterpret the logistical and economic cost associated with conserving landscape connections.

The need of landscape connectivity is not only because of habitat fragmentation but even the space of protected areas where the focus of conservation efforts for protecting and maximizing biodiversity mainly lies is limited, small and even inadequate for most taxa. The impacts of these reserves will be enhanced if their benefits and their promotion of biodiversity can be extended beyond their borders into surrounding areas.

Above mentioned concerns have motivated conservation biologists to come up with plans to increase the effective size of local populations and enhance connectivity between such populations. One of the major recommendation has been inclusion of corridors in conservation plans to increase the connectivity of small isolated patches. Restoration of corridors has become the most popular landscape strategy for mitigating effects of habitat fragmentation (Hilty *et al*. 2006). The studies have already pointed out importance of corridor effects on movement and their further effects on persistence and maintenance of local and regional biodiversity. But still there is scarcity of studies on population and community effects of corridors, its exact mechanism.In this paper we would try to elaborate on different aspects of corridors and would also highlight deficiencies in the existing literature along with conditions under which corridor effects are expected.

Methods

We searched for studies that examined the relationship between corridors and movement of species, which have demonstrated the use of corridors by species by conducting keyword searches in database of different journals, google and Web of Science (ISI). We used different combinations of the keywords *corridor*, *movement*, *effectiveness*, *connectivity*, and *habitat connectivity*. We found additional studies through cited references.

Corridors: Definition and Function

In 1991, Soulé and Gilpin defined wildlife corridor as 'a two-dimensional landscape element that connects two or more patches of wildlife (animal) habitat that have been connected in historical time'. Corridor can be defined in many ways either on the basis of its physical structure or on the basis of its functionality. In terms of physical structure, it is generally considered to be a linear patch of habitat having primary purpose of connecting more than 2 other significant patches of habitat areas (Harris & Gallagher 1989).

In particular, conservation corridor is a relatively constricted area managed and protected to establish connection between protected areas or other substantial habitat patches (Beier *et al*. 2011). Therefore, a corridor apart from being an animal movement path is also a conservation intervention areas where land protection, restoration and management can be applied to a portion of the potential movement area between substantial habitat patches to achieve specific connectivity goals in landscapes that would otherwise be fragmented by urban, rural, agricultural, or industrial land uses (Gregory & Beier, 2014).
Even though many studies describe corridor on the basis of their physical features like length or width but more important is how beautiful this piece of land fulfills providing habitat along which

1. Species can travel safely, can avoid predation and take part in reproduction (Baumgartner 1943, Wegner and Merriam 1979, Nixon *et al*. 1980, Farhig & Merriam 1985, Redford & da Fonesca 1986, Soule *et al*. 1988, Bennett 1990, Bleich *et al*. 1990, Johnsingh *et al*. 1990, Beier 1993)
2. Propagation of plants can occur (Harlan 1963, Jain & Martins 1979, Levenson 1981, Noss 1983)
3. Exchange of genes can take place (Ralls *et al*. 1988, Harris & Gallagher 1989, Bennett 1990, Bleich *et al*. 1990).
4. In case of any catastrophic situation like natural disaster or climate change dispersal of species can occur (McEuen 1993; Noss 1983, Redford & da Fonesca 1986, Harris & Gallagher 1989).
5. Individuals can recolonize habitats from which populations have been locally extirpated (Baumgartner 1943, Nixon *et al*. 1980, Diamond 1984, Farhig& Merriam 1985, Henderson *et al*. 1985, Redford & da Fonesca 1986, Diamond *et al*. 1987, Soule *et al*. 1988, Bleich *et al*. 1990, Dodd 1990, Henein & Merriam 1990).

Any evaluation of working of corridors should be done on the basis of these functions. But while doing all these checks, one thing to keep in mind is the species for which this corridor has been designed. A target species for conservation purpose which can use corridor can be any species that either definitely and strongly need corridor for its survival or it can also be some umbrella species whose protection will provide protection to other species coming under its umbrella.

Species using corridors can be categorized either as "passage species" or as "corridor dwellers". Passage species need corridors for a brief period of time while passing between two areas like during seasonal migration, moving between parts of a large home range etc. Corridors have to be suitable enough to at least provide these animals conditions that motivate them to use the corridor. Corridor dwellers, on the other hand, are generally plants, animals with limited dispersal ability and often take several days to several generations to move through the corridor. All species does not respond in same manner to corridors. Certain species, generally habitat generalist, will perceive corridor habitat as being of equal or lesser quality than other surrounding habitat. In short run, corridors are effective for species with fast growing populations that have low survivorship while moving through unsuitable habitat. Emigration rates and habitat specific mortality rates are key determinants of the effects of corridors on their population size. In long run, corridors are effective for species with slow growing populations that have low survivorship while moving through unsuitable habitat. Thus even if experiments are conducted at the same scale or they are controlled and replicated, all species do not respond in same manner to a corridor.

Specie's use of a corridor is also affected by its trophic level (Burkey 1997). Species like top predators which are higher on the food chain are more vulnerable to extinction as they rely on survival of other species; species requiring large territories and occurring at low densities (Saunders *et al*. 1991); highly endemic species, sedentary in life style with low mobility and specialized species having specific habitat requirements are found to be most negatively affected by fragmentation (Wynhoff *et al*. 1996). K-selected species producing fewer offspring are more vulnerable to extinction, so are the species that have a large body size as they tend to be K-specialist, have large home ranges and low population densities (Saunders *et al*. 1991). Species with a large habitat range are especially vulnerable to habitat degradation and loss because their fragmented habitat exposes them significantly to the negative impacts of edge effects.

Corridors not only function to regulate dispersal between larger patches of habitat, they also modify structure of landscape by altering patch area and shape, which facilitates colonization by recruiting organisms (Haddad & Baum 1999; Tewksbury *et al*. 2002), which can further affect population sizes and diversity (Harrison & Bruna 1999; Orrock *et al.* 2003).

There are many studies citing importance of habitat corridors in terrestrial systems both theoretically and empirically (Fahrig & Merriam 1985; Henein & Merriam 1990;Merriam & Lanoue 1990; Haddad 1999a, b; Haddad & Baum 1999; Tewksbury *et al*. 2002). Studies have also shown more movement between patches in presence of a corridor than in the absence of a corridor. Movement of butterfly species (Haddad 1999a, 1999b; Haddad & Baum 1999), small mammals (Fahrig & Merriam 1985; Merriam & Lanoue 1990; Coffman *et al*. 2001), as well as pollen and seeds (Tewksbury *et al*. 2002) was greater between patches in the presence of a habitat corridor than in the absence of a corridor (Darcy & Eggleston 2005).The study (Gilbert-Norton *et al*. 2010) have indicated that natural corridors are more effective in increasing movement between patches than the created ones.

(Haddad *et al*. 2003) showed that corridors even if does not increase emigration from a patch, movements of different taxa with different historical roles and functional roles are directed by corridors. There are many studies that have demonstrated that corridors can increase movement between patches (Haas 1995; Sutcliffe & Thomas 1996; Gonzalez *et al*. 1998; Haddad 1999a; Mech & Hallet 2001), increase population sizes (Fahrig & Merriam 1985; Haddad & Baum 1999), increase gene flow (Mech & Hallet 2001). (Tewksbury *et al*. 2002) demonstrated that corridors along with increasing the exchange of animals between patches also facilitate pollination and seed dispersal, two important plant animal interactions. Corridors not only add area to the existing habitat but increased plant and animal movement also positively influence community interactions in the concerned landscape. The study also showed that there was no evidence of drift fence. (Metro 2010) showed that corridors have an impact on wind dispersed species in comparison to animal dispersed species and where connectivity and patch shape increases the richness of former, the latter is influenced only by connectivity and not patch shape. Empirical studies have shown that habitat corridors do benefit populations by facilitating movement of a variety of organisms (Haddad *et al*. 2003, Gilbert-Norton *et al*. 2010).

There are also studies where no such effects were seen as part of a corridor (Collinge 2000, Danielson & Hubbard 2000).

Questions to be answered before design and plan of corridors

There are certain questions that need to be answered before planning and implementing any corridors:

1) Target species for which corridor has to be planned. Till now most corridor studies have been focused on either single or a group of related species (Rosenberg *et al*. 1997; Beier & Noss 1998; Hess & Fisiher 2001). Where some studies have shown it to be providing a movement conduits for certain species of frugivorous birds (Tewksbury *et al*. 2002), mammals (Bennett 1990; La Polla & Barrett 1993; Bennett *et al*. 1994; Brown *et al*. 1999; Caffman *et al*. 2001; Haddad *et al*. 2003), invertebrates (Haddad 1999,2000; Haddad & Baum 1999, Collinge 2000) & butterflies (Haas 1995; Beier 1995; Sutcliffe & Thomas 1996; Haddad 1999a), there are also studies which shows corridors do not support or facilitate movement for other species of birds, small mammals, salamander species (Date *et al*. 1991; Haddad 1999b; Suckling 1984; Henderson *et al*. 1985; Bowne *et al*. 1999; Rosenberg *et al*. 1998).
2) Time scale of the conservation goal. Corridors have different effect on different suites of species in the short and long term. Answer to this question will determine the species likely to benefit from corridors.
3) Effect of corridors on movement for exotic species and disease as well as for native target species
4) Fraction of species moving through the corridor and successfully immigrating to another patch
5) Effect of corridors on ecological interactions.
6) Whether corridors are a cost-effective option in comparison with other ways of using scarce conservation resources.
7) Information on increased movement of animals between the patches of habitat through corridor actually has an impact on its population.

Downfalls of corridors

Critics of corridors feel that the corridor concept has been accepted despite the scarcity of data on corridor use, inconclusive corridor research with lack of sufficient controls in field studies, and the failure to consider possible negative impacts of corridors. Even same set of criteria can't be used for assessing its effectiveness as different species respond differently towards its use (Gustafsson & Hansson 1997). There are questions on the scientific evidence towards use of corridors being ambiguous and lacking (Simberloff *et al.* 1992). Certain points are often raised against corridors being considered as a conservation tool like high rates of poaching in corridors, mismatch between habitat and requirements of species using that habitat, facilitating spread of catastrophes like fire, invasive species, exotic, weedy species, introduced species, diseases, pathogens, pest etc. and reduction of resources available for alternative conservation measures (Simberloff & Cox 1987, Bennett 1999, Plantegenest *et al*. 2007) between habitat patch whose frequency and severity increases with greater connectivity both at small scale and across large landscapes (e.g., Thrall *et al*. 2003, Laine & Hanski 2006). Low quality habitat of corridors could make it a genetic sink resulting in local extinctions and decrease in the size of population.

Though corridors may have several benefits that make them essential for conservation (Rosenberg *et al*. 1997; Haddad 1999; Tewksbury *et al*. 2002) but it also affect multiple species in different ways within a given trophic level. (Orrock 2004) showed its effect on altering predator prey interactions when predators differ greatly in their response to corridors and in their impacts on prey. Empirical studies on effects of corridors are either done at small scale - the level of fencerows, roadsides and hedgerows – dealing with small populations that are generally separated by distances of a kilometer or less.It is at this scale that much of the evidence for the use and benefits of linkages has been obtained and, likewise, knowledge of the factors influencing design and management of linkages. Even at this scale, experimental studies pose extraordinary difficulties (Nicholls & Margules 1991) and a long time scale is required to obtain meaningful results. However, from a conservation perspective, many important opportunities to protect and manage linkages are at the landscape or regional scale, such as major links between conservation reserves to assist their long term viability. It is impossible to carry out experimental studies at this scale and the time frame over which the benefits of connectivity to conservation reserves must be assessed is decades and centuries, not years.Some studies (Fahrig & Merriam 1985; Mansergh & Scotts 1989;Dunning *et al*. 1995) were unreplicated and others (Burkey 1997; Schmiegelow *et al*.1997; Haddad & Baum 1999; Schmiegelow & Monkkonen 2002) observed corridor effects that may have been caused by patch shapes, edges, or habitat types that were confounded with corridor effects.

The whole concept of corridors providing connection between habitat patches and how it fulfills its several functions has been doubted because still the mechanism behind corridor effects are unknown (Simberloff *et al*.

1992). Any studies on effect of corridors often focus upon the population increase or decrease but these studies are ignoring the rest of ecological interactions having unknown consequences from this corridor. Having limited taxonomic focus on few species of animals, the importance of corridors is largely limited on terrestrial animals and its scope or concept have not been included in estuarine and marine systems (Hagen *et al*. 2012). No generalization can be made on effect of corridors plus there is dearth of studies on effects of corridors on plant animal interactions (Tewksbury *et al*. 2002). Corridors can also act as drift fences diverting animals into connected patches rather than moving through matrix habitat.Corridors alone does not impact or provide any conservation value and sometimes may also prove detrimental to conservation efforts (Simberloff & Cox 1987; Simberloff *et al*. 1992).

Corridors may have costs aswell as potential benefits not only in terms ecology but also in financial terms. Per unit area management costs for corridor may be much larger than that for refuges. Rather than maintaining corridors, it may be easy and cheap to manage some species by shifting them between refuges (Simberloff & Cox 1987). Batten *et al*. (1996) also recommended site enlargement and buffering against external impacts where the surrounding landscape is developed.

Corridor: Effective Design

One of the key concernstowards scientific understanding of function and role of corridor is identifying different qualities of a corridor essential for particular species. Till now three main parameters of corridors - habitat, width, and linear continuity—are found to be primary influencer on its use by animals (Forman & Godron, 1986; Recher *et al*. 1987; Bennett 1990a; Harris & Scheck, 1991; Harrison 1992).

While designing corridor where some studies (Noss 1987) suggest it to be as wide as possible, some claims that these parameters should be on the basis of dispersal ability and the home range of target species (Noss 1987; Harrison 1992) whose age, sex, life history can further modify the requirements (Ims 1995). Studies have shown that increased corridor width can increase bird species richness, bird density and frequency of area-dependent bird species in several studies (Keller *et al.* 1993; Spackman & Hughes 1995; Croonquist & Brooks 1993). Other taxa, including insects (Hill 1997) and perennial grassland plants (van Dorp*et et al*. 1997) have also shown positive relationships with corridor width. Andreassen *et al*. (1996), however, found that wider corridors did not necessarily facilitate movement any more than narrower ones, provided that the corridors were not so narrow that they were avoided as movement pathways. While wide corridors are often more expensive in terms of land acquisition too, it is generally recognized that broad strips of land are more effective as corridors than narrow strips (e.g. Keals & Majer1991, Tischendorf & Wissel 1997). The latter are dominated by physical and biological 'edge effects' due to microclimate changes (especially in forests) (Margules 1996), hydrological changes, increased predation (Simberloff & Cox 1987) and competition from species invading from surrounding land (Bauer 1989). Maximizing width has often been suggested as a practical way to reduce this edge effect such as invasion of exotics and altered microclimate (Yahner 1988) which comes into picture due to linearity of corridors.

Corridor length which is the spatial continuity of a corridor in the landscape has not been as thoroughly investigated as corridor width, but optimalcorridor length has been considered to be a function of species-specific behavior and habitat quality. Length of corridor, presence of different type of gaps, barriers, alternative paths further influences passage of an animal through the landscape.Minimising corridor length, especially when animals do notbreed within the corridors, is often recommended (Wilson & Lindenmayer 1995).

Another characteristic that influences the value of a corridor is its position in thelandscape and its own habitat quality (Harrison 1992; Bennett *et al.* 1994). Corridor location in landscape and its design should be part of the ecology of that area (Harrison & Voller (1998)). Bennett (1999) considered that, in order to maintain habitat continuity it should be located along the environmental contours. Habitat quality is important in its own right, and has been shown to influence the effective connectivity of corridors. Habitat of a corridor determines the availability and abundance of essential resources such as food, shelter, refuge from predators, and breeding sites.

While designing corridors, landscape variability also needs to be considered. They may show no effect on populations in a long time when dispersal of population is quite high , when habitat is in stable position, but same corridor can prove effective during time of lower reproduction and limited dispersal or during time of disturbance (Shirley & Sibley 2001). It is also important to assure that while considering effect of corridor on population the study does not get confounded by other factors. The value of corridor is, therefore, decided not only by its spatial configuration, length, width but also landscape context, habitat type, scale, nature of the connected areas and the target species.

Recommendation

Simberloff *et al.* (1992) criticize the conclusion that, in the absence of reliable information, corridors should be retained or created on the basis of the precautionary principle, or because action cannot wait for evidence (Noss 1987, Forman & Collinge 1996). They emphasize cost-benefit analysis of corridors in each specific situation, in comparison to other competing demands for financial resources. Corridors are not a quick fix solution (Plummer & Mann 1995) and alternative options may achieve conservation objectives more successfully.Corridors will also involve ongoing management costs such as weed control, fire control, fence repair, etc. (Panetta & Hopkins 1991).

Questions have often been raised on the value of corridors as a conservation tool (Simberloff *et al.* 1992; Rosenberg *et al.* 1997). However, a number of studies have supported the proposal that, on the whole, corridors are beneficial to the conservation of wildlife and/or vegetation.

Nevertheless, there is strong evidence to suggest that corridors are an effectivesupplementary conservation measure—they must accompany other conservationsolutions such as reservation of extensive forested areas, manipulation of fire regimesand specific logging prescriptions (Recher 1991).

Corridor effectiveness will be determined in part by habitat-specific demography, such as relative mortality rates in patch and matrix habitats. How much a corridor benefit a population is decided by time scale under consideration, the population growth rate, the carrying capacity, the emigration rate and the dispersal success rate of the target species.

Since different taxa respond different to corridors, while planning for conservation of species, this has to be kept in mind.There is a need for greater empirical efforts to determine the effectiveness of corridors at preventing dispersal related loss by reducing migrant mortality.

Nevertheless, the one point that remains clear is that the concern for connecting landscapes is increasingly becoming a part of land management worldwide. Despite its importance, however, the concept of connectivity is currently a loose amalgamation of related topics with little synthesis between them.

Wildlife corridors are not proposed as mitigation for loss of core habitat. However, withcareful planning and design, wildlife corridors can help reduce the negative effects ofhabitat fragmentation by allowing dispersal of individuals between large patches ofremaining habitat. While additional study on the efficacy of wildlife corridors isnecessary, some general principles of evaluation and design are available and should beimplemented. Monitoring the use of corridors by target wildlife species is an importantstep in corridor planning, to allow for adaptive management.

The concept of corridors should not be allowed to overshadow other important processes of restoration like dispersal. Habitat fragmentation and dispersal management should be considered on a case by case basis comparing the cost benefit of the range of available options.

Moreover the studies are conducted on common and mobile species. The main constraint on studies at large scales is the difficulty in replication and controlling for variables that may confound corridor effects. Most corridor studies are small in scale, compared with the scales of landscape.

Acceptance of corridors may also create perception that small sites are adequate if connected or are preferable to one or two large sites. In case of financial and other resource constraints, site enlargement and maintenance and restoration of existing landscape and developing surrounding of this landscape should be done.

The link between corridor effects on movement and their effects on the demography and persistence of populations, and ultimately, the maintenance of local and regional biodiversity, is critical for the appropriate use of corridors in management. Yet, there is currently a paucity of studies addressing population or community effects of corridors. Consistent empirical evidence regarding population and community effects of corridors would support their expanded implementation in conservation.

Case Study: Corridors for tigers in India

India is home to over 60% of world's tigers, currently estimated at 2226 individuals. The government of India has not only granted the highest protection under Schedule I of Wildlife (Protection) Act of India, 1972 (Johnsingh *et al*. 2010; Jhala *et al*. 2011) but also amended Wildlife (Protection) Act of India, 1972 by creating NTCA establishing core areas in Tiger reserves and promoted voluntary relocation programs. Being on the top of trophic level, it is vital in maintaining andregulating ecological processes and systems (Terborgh 1991; Sunquist *et al*. 1999;Jhala *et al*.

2011). Even though the numbers have increased in past decade, but unless we increase our concern outside protected areas which are rarely large enough, we won't be able to protect it in long term(Woodroffe & Ginsberg 1998, Karanth & Nichols 1998, Johnsingh *et al*. 2004, Wikramanayake *et al*. 2004).The chances for long term survival of mega fauna in many of these protected areas are slim unless they are linked by natural habitat corridors to permit dispersal of large mammals like tigers and their prey, and are buffered to minimize impacts from other land uses. Therefore, a landscape level approach accommodating corridors and buffer zones is essential to a long term tiger conservation strategy (Karanth 1991).

With increasing habitat fragmentation, the Protected Areas established to conservethe species have become separated and mixed within matrices of human landuse (Johnsingh *et al*. 2004, Wikramanayake *et al*. 2004, Ranganathan *et al*. 2008).The long-term survival of a large-bodied, far-ranging animal such as the tiger can be ensured only through maintaining viable populations within viable habitats. For maintaining such habitats it is vital that we maintain large, continuous landscapes.

As a result conservation biologists have started incorporating meta-population concept for protecting this wide-ranging species (McCullough 1996; Mech & Hallett 2001). In the recent years, there has been considerable advocacy for planning dispersal corridors for wildlife in the Indian subcontinent.

There are some well-established corridors in India supporting a good tiger population like KanhaPench corridor in central India; the whole complex supports a population of about 120 tigers (Jena *et al.* 2011). Another example comes from the Terai Arc Landscape which spans the base of the Himalayanfoothills in northwestern India and southern Nepal, where conservationistsare working to restore, reconnect, and manage wildlife corridors to link 12 important wildlife reserves and national parks that harbor wild tigers across the 49,000 km² landscape (Wikramanayake *et al*. 2004; Dinerstein *et al*. 2007).

There is another study that shows use of islands dotted on the Brahmaputra River by the tigers and other wildlife to move from one place to another in Assam (Borah *et al*. 2010). The study identified the islands and river banks that are being used by tigers to move within and from one island to another or to nearby protected area in the landscape, particularly the four closely placed protected areas (PAs), viz. Kaziranga, Orang, Laokhowa and Burhachapori. Besides tigers other large mammals like rhinos and elephants also use these islands to reside and move.

The Kosi River corridor provides connection between the Corbett Tiger Reserve and the forests of Ramnagar ForestDivision. This corridor serves as a vital link between the source population of tigersin Corbett and the adjoining forest areas and enables them to move across. The study demonstrated the functionalityof the Kosi River corridor with reference to tigersand in addition it recorded the corridor being usedby 20 other wild mammal species (Anwar *et al.* 2014).

All these studies show that fortunately, India still have a few areas where the functionality of corridor has been maintained and is helping in achieving a landscape level conservation of target species. The problem is that even here the options of keeping these landscapes without disintegrating further are fast disappearing. As the country moves into the high gear of economic growth, the symbols of development - roads, railway lines, dams and canals, pipelines, mines, expansion of settlement and cultivation - threaten to permanently rip apart the tattered habitat fabric. In many places, the linkages literally hang by a thread.In order to enhance effectiveness of corridor many steps need to be taken like 1) framing of a corridor management plan for managing corridor to ensure that wildlife movement doesn't get affected by any further development along the corridor, 2) increasing protection inside corridor, 3) ways to minimize impact of commercial developments in corridor and also strategies for reducing pressure from human settlements in the corridor.

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