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Research Paper

# ECOLOGICAL IMPACTS FROM TRANSPORTATION CORRIDOR NH-44 AND MITIGATION MEASURES (NAGROTA TO DOMEL)

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Roads are amongst the most ubiquitous human infrastructure and their interaction with the natural habitat of wild animals is all pervasive. The environmental impacts of road are numerous and include direct effects on wild animal population, whose home ranges are split by road and where individuals suffer mortality and death due to collision with vehicles. Vehicle collisions with wild animals are serious problem that justifies the widespread application of mitigation measures. National Highway-44 in between Jammu and Katra (50 km) caters the need of high volume of pilgrims to the world famous Indian shrine – Vaishno Devi located in Trikuta hills. The study area has a length of 30 kms of NH-44 from Nagrota to Domel junction. The highway is being constructed and maintained by National Highway Authority of India and Border Roads Organization. Large scale road widening activities are in progress for the last two years on NH-44 in Jammu and Kashmir. This highway has also a strategic importance, as it connects with Srinagar, Kargil, Leh and Ladakh. The entire study area was thoroughly surveyed. Specific feeding grounds, crossing zones, cause of conflicts, spots of accidental deaths in vehicle accidents of monkeys were thoroughly investigated. Impact of NH-44 and its widening on primates was resulted in the form of habitat fragmentation and modifications, restriction of movement, injury and mortality, soil erosion and hydrological alterations and environmental contamination. NH-44 has turned a natural habitat area into isolated small patches of habitats. The increasing public demand on mitigation and prevention of environmental impacts strongly requires the development of evaluation tools for civil engineers and ecologists to apply in the planning and construction of transport infrastructure.

**Keywords:** Ecological impacts, Transportation, Mitigation measures

## INTRODUCTION

The construction of highways can have a substantial impact on the degradation and loss of natural ecosystems, especially in less

developed areas. Although the actual areas converted by highways, railways, and power line right-of-ways may cover only a small proportion of a region. Perhaps more importantly, the

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fragmentation of habitats caused by highway development is often severe. Transportation routes can be described as “disturbance corridors” that disrupt the natural, more homogeneous landscape. In forested environments, these disturbances can cause (1) dramatic physical disruption to the continuous vegetative community; (2) disruption to the structure and function of habitat; and (3) impacts to resident wildlife, which must negotiate, tolerate, and cope with the habitat barriers. In addition, disturbance corridors created by forest fragmentation alter the natural mix of habitats and species by providing conditions suitable for early successional plants and animals. They replace forest trees with grasses and shrubs, eliminating nesting habitat for forest-interior species. While they provide dispersal routes for certain small mammals, they present barriers to many species. The scale of both the habitat conversion and habitat fragmentation effects caused by highway development varies with the size of the project. The impacts of projects also vary according to the environmental setting, especially the degree of naturalness in the local and regional ecosystems. In many cases, small individual highway projects may have little or no impact on natural ecosystems. In this report, I have analyzed the ecological effects such as habitat loss, disturbance, corridor, mortality and barrier of NH-44 (30 km stretch from Nagrota to Domel) and discussed the mitigation measures. The purpose of this paper is to provide guidance for the analysis of ecological impacts from highway development activities and the evaluation of related ecosystem mitigation measures. This guidance will support reviewers in providing informed comments for project scoping, analysis regarding the issue of ecological degradation

resulting from highway development and similar activities. A primary focus of this paper are the potential mitigations that may be implemented during highway planning, design, construction, and operation. Many of the degrading activities and accompanying ecological impacts associated with highway development are also relevant to other construction-based projects such as power generation and industrial or residential development. By providing detailed guidance on both ecological analysis and mitigation, this paper should improve the environmental impact assessments for a wide range of development activities.

## **DEFINITION OF TRANSPORTATION CORRIDOR**

A transportation corridor is a generally linear tract of land that contains lines of transportation like highways, railroads, or canals. Often, new transport lines are built alongside existing ones to minimize pollution.

## **NATIONAL HIGHWAY (INDIA)**

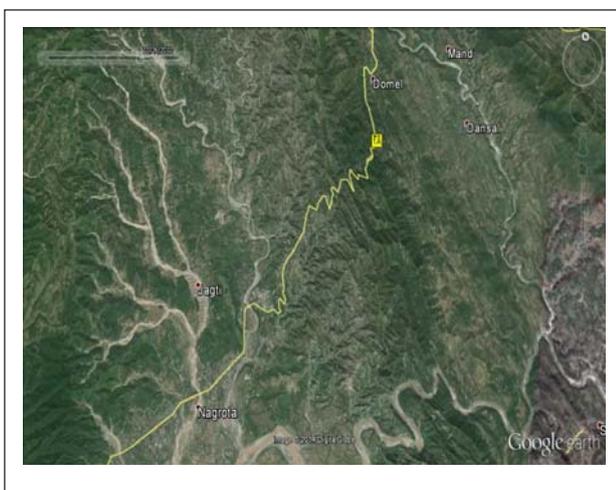
The National Highways Network of India, is a network of highways that is managed and maintained by agencies of the Government. These highways measured over 79,243 km (49,239 mi) as of 2014, including over 1,000 km (620 mi) of limited Expressways. Out of 71,000 km of National Highways 15,000 plus km are 4 or 6 laned and remaining 50,000 km are 2 laned. The National Highways Authority of India (NHAI) is the nodal agency responsible for building, upgrading and maintaining most of the national highways network. It operates under the Ministry of Road Transport and Highways.

The National Highways Development Project (NHDP) is a major effort to expand and upgrade the network of highways. NHAI often uses a public-private partnership model for highway development, maintenance and toll-collection. National highways constituted about 2% of all the roads in India, but carried about 40% of the total road traffic as of 2010. The majority of existing national highways are two-lane roads (one lane in each direction), though much of this is being expanded to four-lanes, and some to six or eight lanes. Some sections of the network are toll roads. Over 30,000 km (19,000 mi) of new highways are planned or under construction as part of the NHDP, as of 2011. This includes over 2,600 km (1,600 mi) of Expressways currently under construction. (Reference : Wikipedia)

## LOCATION

The study area is located in lower Trikuta hills (part of Shivalik ranges) . The region of study is located in between Nagrota (32.81667 N, 74.91667 E) and Domel ( 32.5350 N, 74.580 E ). The entire region is bestowed with rich biodiversity including wildlife.

## LOCATION MAP OF THE STUDY AREA



Salient features of NH-44 (Nagrota to Domel)

- Gateway to Kashmir.
- Starting point of pilgrimage to Vaishno Devi.
- Nandini wildlife Sanctuary.
- Rich in forest cover vegetation consisting of composite vegetation like Kail, Chir, Ber, Arjuna, peepal, bor, etc., and different type of grasses.
- The area of study consists of Nandini Wildlife Sanctuary which is rich in wild fauna like rhesus monkeys, grey langurs, leopards, bears, deers, snakes, flying foxes, etc.

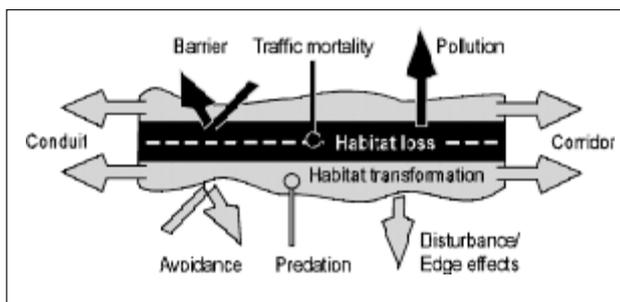
## PRIMARY ECOLOGICAL EFFECTS OF NH-44 (NAGROTA TO DOMEL, 30 KM STRETCH)

Infrastructure affects nature in both direct and indirect ways: The physical presence of roads in the landscape creates new habitat edges, alters hydrological dynamics, and disrupts natural processes and habitats. Road maintenance and traffic contaminate the surrounding environment with a variety of chemical pollutants and noise. In addition, infrastructure and traffic impose dispersal barriers to most non- flying terrestrial animals, and vehicle traffic causes the death of millions of individual animals per year. The various biotic and abiotic factors operate in a synergetic way across several scales, and cause not only an overall loss and isolation of wildlife habitat, but also splits up the landscape in a literal sense. This review focuses on the primary effects of infrastructure on nature and wildlife, as these effects are usually the responsibility of the transport sector. Secondary effects, such as changes in land use, human settlement or

industrial development, or resource exploitation, which may be induced by the construction of new roads or railroads, are outside the scope of this review. Most empirical data on the effects of infrastructure on wildlife refers to primary effects that derive from a single road, are easily measurable and matter to the organisms directly and at a local scale. We can distinguish between five major categories of primary ecological effects (Figure 1; compare also: Van der Zande *et al.*, 1980; Bennett, 1991; Forman, 1995):

1. Habitat loss
2. Disturbance
3. Corridor
4. Mortality
5. Barrier

Figure 1 Schematic representation of the five primary ecological effects of infrastructure: Habitat loss and transformation, disturbance due to pollution and edge effects, barrier and avoidance, mortality due to traffic and predation, and the conduit or corridor effect. Together, the various primary effects lead to a fragmentation of habitat. Modified after Van der Zande *et al.* (1980).



Habitat loss, disturbance, barrier and mortality effects usually refer to single infrastructure links, yet their long-term impact on populations and ecosystem depends on the type of infrastructure, landscape, or species considered.

## EDGE EFFECTS AND POLLUTION

- Road construction affects the immediate environment due to the need to clear, level, fill, and cut.
- Construction work changes soil density, landscape relief, surface and ground water flows. This, in turn, can affect ecosystems, vegetation and fauna in the wider landscape. Wetlands and riparian habitats are especially sensitive to changes in hydrology as caused by road embankments.
- Road cuttings through slopes may drain aquifers, increase the risk of soil erosion and modify disturbance regimes in riparian networks.
- Where roads cut through forested habitats, microclimatic conditions are strongly altered. Increased wind and light intensity, reduced air humidity and temperature disfavor forest interior species such as lichens or mosses. Traffic noise and other disturbances
- Traffic noise is another agent of disturbance that spreads far into the environment. Although disturbance effects by noise more difficult to measure and less understood than pollution with toxins or dust, it is considered as one of the major factors polluting natural environments.
- Whether wildlife is similarly stressed by noise is questionable, however, timid species might read traffic noise as a token for the human presence and consequently avoid noisy areas.

Species respond very differently to the disturbance and change of habitat alongside roads. To better understand the pattern and develop tools for the assessment and evaluation

of disturbance effects, we need research that specifically addresses dose-effect thresholds in wildlife.

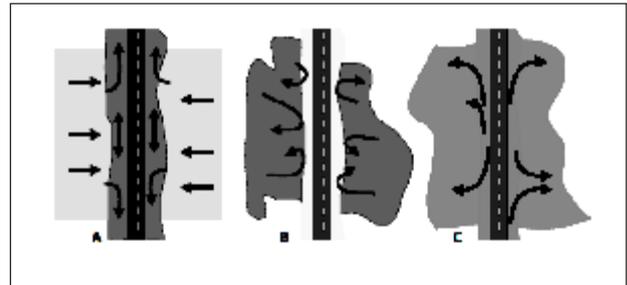
## CORRIDOR FUNCTION

Areas adjacent to infrastructure are highly disturbed environments and often even hostile for many wildlife species. Yet, they can still provide attractive resources such as shelter, food or nesting sites, and facilitate the spread of species along with the direction of the road. In heavily exploited landscapes, roadsides can provide valuable refuges for species that otherwise could not survive. Roadsides are strips of land adjacent to roads or railroads that are usually under responsibility of the transport sector and vary in width from some few meters up to several tens of meters. Roadsides are multipurpose areas and have to fulfill several technical requirements as well, such as to provide free sight for drivers, increase road safety, and screen the road from the surrounding landscape. Typically, traffic safety requires that the vegetation adjacent to roads is kept open and grassy. Farther away from the road, roadsides are often planted with bushes and shrubs for aesthetic reasons or to buffer the spread of noise .

## ROADSIDES AS MOVEMENT CORRIDORS FOR WILDLIFE

The corridor function of roads differs with respect to the surrounding landscape: (A) In open, agricultural landscapes, richly vegetated roadsides can provide a valuable habitat for wildlife and facilitate their movements along with the roads. (B) In forested landscapes, open and grassy road verges introduce new edges and can increase the road's barrier effect on forest interior species. (C) Road verges may also serve as

sources of – wanted and unwanted- species spreading into new habitats or re-colonizing vacant areas adjacent to roads (Modified after Mader, 1987b).



## FAUNA CASUALTIES ON NH-44

Road mortality is probably the most acknowledged effect of traffic on wildlife, as carcasses of dead are a common view along trafficked roads. Roadside counts of Rhesus monkey and Hanuman langur were made at all the three sampling sites covering all major micro habitats assuming a sighting distance of 25 m on each side of the NH-44.

## HABITAT FRAGMENTATION AND MODIFICATIONS

Impacts of NH-44 and its widening were observed in the form of wildlife habitat fragmentation and modifications. Fragmentation of large wildlife habitat at both sides of NH-44 into smaller patches in the study area was observed. Several small patches of habitat of Rhesus monkey and Hanuman langur even if collectively equivalent in the study area to the original larger patch are not its functional equivalent.

Gaps between habitats prevent dispersal and recruitment of Rhesus monkey and Hanuman langur. The nature of the habitats is itself changed by the creation of new ecotone along new patch

borders. NH-44 is acting as barriers to the movement of Rhesus monkey and Hanuman langur. Widening of NH-44 has contributed a lot into large scale modifications of natural habitat of Rhesus monkey and Hanuman langur.

## **INJURY AND MORTALITY**

NH-44 has a high volume of traffic during pilgrim season (May-December) in the study area. A significant number of animals are injured or killed by passing vehicles. Improvements and widening of NH-44 permit higher average speed (60-70 km per hour), which contributes increasing chances of fatal wildlife – vehicle collision. Rhesus monkeys and Hanuman langurs are attracted to road to exploit food resources and sun warming. Monkeys and langurs also utilize roads for walking, juveniles playing, running and foraging on vegetation available along the roadsides. The comparatively higher mortality of monkeys and langurs due to road accidents is because of their diurnal habits. The NH-44 is used by a large number of pilgrims for visiting world famous shrine of Vaishno Devi, Katra. These pilgrims offer food to monkeys and langurs seen around on the NH-44 due to religious sentiments. Thus, the monkeys and langurs have developed habit of keeping them close to the road and also expect food from every vehicle and do not bother much to speedy vehicles passing through. These vehicles often hit monkeys and langurs and kill or injure them.

To conclude, the spatio-temporal pattern of road casualties is influenced by various factors, such as the species' biology, traffic and road characteristics, and landscape and habitat composition . These different factors must be understood before the local need for mitigation can be evaluated, effective measures be

designed and put in place. GIS-based analysis of traffic kills and wildlife movements in relation to roads and landscape features may provide the necessary insight to develop predictive models for impact assessment and the localization of mitigation measures.

## **BARRIER EFFECT**

As per the analysis I suggest distinguishing between five categories of infrastructure/traffic intensity with respect to their barrier impact on wildlife :

1. Local access and service roads with very light traffic can serve as partial filters on wildlife movements. They may have limited barrier impact on invertebrates and eventually repel small mammals from crossing the open space. Larger wildlife may use these roads as corridors, if they not avoid habitat close to roads .
2. Minor public roads with traffic below 1000 vehicles per day may cause incidental traffic mortality and exert a stronger barrier / avoidance effect on small species, but crossing movements will still frequently occur.
3. Intermediate link roads with up to 5,000 vehicles per day may already comprise a serious barrier to certain species. Traffic noise and vehicle movement are likely to have a major deterrent effect on small mammals and some larger mammals. Due to this repulsion, the increase in the overall barrier impact is not proportional to the increase in traffic volume.
4. Arterial roads with heavy traffic between 5,000 and 10,000 vehicles per day cause a significant barrier to many terrestrial species, but due to the strong repulsion by the traffic, the number of road kills is levelling out. Road kills and traffic

safety are probably important issues to be solved in this category.

5. Motorways and highways with traffic above 10,000 vehicles per day impose an impermeable barrier to almost any wildlife species, as the dense traffic repels most species approaching the road and kills those that still attempt to cross.

## **SOIL EROSION AND SEDIMENTATION**

Construction and widening of National Highway-44 has caused adverse impacts on soil and land stability. Instability of slopes tends to be most pronounced in hilly areas, where geological features exacerbate construction related destabilization. Creation of steep cuts in rapidly weathering rock removal of basal support of slopes, loading of unstable surfaces, inadequate drainage provisions, removal of vegetation and vibration from blasting and heavy traffic may lead to slope failure and erosion. Construction of drains, embankments, cuts and fills can affect local hydrology both within and beyond the boundaries of the NH-44. The water sources of springs and streams are adversely affected. The poor construction practices, improper disposal of debris and massive landslides on NH-44 have caused large scale soil erosion and sedimentation into small streams.

## **MITIGATION MEASURES FOR ECOLOGICAL IMPACTS OF HIGHWAYS**

Mitigation measures be considered even for impacts that are not themselves "significant" once the proposal as a whole is considered to have significant effects. In the case of highway development impacts, these measures must

include both specific design alternatives (that could decrease pollution emissions, construction impacts, and aesthetic intrusion) and other mitigation activities such as relocation assistance and possible land use controls that could be enacted. To adequately consider ecological impacts of highway development, mitigation measures should be developed within the ecosystem framework and should consider the possible impacts of the mitigation itself.

## **ECOSYSTEM APPROACH TO MITIGATION**

Mitigation for ecosystem protection should address the cumulative impacts of all activities within the landscape (which, depending on the scale of the project, may vary from small watersheds to areas exceeding several thousand acres) to ensure that ecosystem integrity and health are maintained.

The two most important methods for maintaining the integrity of fragmented habitats are (1) the provision of buffer areas; and (2) the creation of habitat corridors. Buffers represent the principal method of avoiding impacts to sensitive areas, and habitat corridors provide the best means of mitigating habitat isolation. The most common means of creating both buffer areas and corridors is the preservation of natural habitat along streams, steep slopes, and other sensitive areas.

## **HABITAT BUFFERS**

The preservation of a sensitive habitat includes both the avoidance of direct conversion of the area and the maintenance of adequate buffer areas so that edge effects and other negative impacts do not affect the sites. For example, highway corridors through forests can be "feathered" to

avoid some edge effects . Additional areas adjacent to the corridor can be cut to create successional bands of vegetation parallel to the corridor opening; this reduces predation rates at the edge and minimizes the barrier effects. However, a wider edge results in less forest interior. Research into the impacts on benthic invertebrate communities indicates that buffer strips between roadways and streams of at least 30 m are required to prevent alteration in invertebrate diversity and ecological structure .These buffer strips serve to maintain the riparian canopy and to stabilize the stream channel.

## HABITAT CORRIDORS

Mitigation of habitat fragmentation involves the maintenance or restoration of habitat “connectivity” . One way to address the fragmentation caused by highway construction is to reduce the effective width of a highway corridor and decrease the barrier effect. In addition to reducing the number of lanes or roadside area, providing wide, densely vegetated medians can facilitate movement of some species across the highway. However, road kills due to collisions remains problematic. For those species that cannot cross highways of any size, fragmentation must be addressed by the provision of habitat corridor underpasses. Corridors have been used successfully in wildlife management for 50 years. Corridors provide for the movement of animals, serve as a population source, contain whole communities, and withstand natural disturbance events, but they also provide for contamination transmission. Unfortunately, because edge effects reach 200 to 600 m into the forest , optimal corridors widths cannot be achieved with highway bridges and must be addressed when siting the highway. The following general mitigation principles apply to ecosystem protection efforts:

1. Base mitigation goals and objectives on a landscape-scale analysis that considers the needs of the region.
2. Mimic natural processes and promote native species.
3. Protect rare and ecologically important species and communities.
4. Minimize fragmentation of habitat and promote connectivity of natural areas.
5. Maintain structural diversity of habitats and, where appropriate, species diversity to promote the natural variety of the area.
6. Tailor management to site-specific environmental conditions and to the unique impacts of the specific degrading activity.
7. Monitor for ecological impacts and revise mitigation plans as necessary.

Other Mitigation measures

### Animal- Detection Warning System

Several designs for animal detection warning system have been developed using motion sensors or detectors wired to signs that flash when large animals are detected on the road. It will alert the driver for avoiding any vehicle-animal collision.

### Speed Limit Reduction

High traffic speed or rash driving is generally considered a primary cause of animal-vehicle collision. So speed limits can effectively reduce Hanuman langur-vehicle collision. A maximum of 30 km per hour is recommended on NH-44 due to several sharp turns and spiral nature of road.

### Lighting

The wildlife-vehicle collisions are six times higher at night than the collisions during the day time.

So, lighting reflectors are very important for mitigation the vehicle-wildlife collisions.

### **Automated Speed Detectors**

The automated speed detecting devices have a proven effectiveness in getting people to abide by a speed limit at least temporarily thereby improving a driver's ability to avoid hitting on animal. This measure could be used periodically in combination with speed unit limit reductions and sign indicating why speed limits have been reduced.

### **Public Education and Awareness**

Public service announcements, educational campaigns and poster-sized hot spot maps are believed to be effective in reducing animal-vehicle collisions. This mitigation measure should be implemented in conjunction with other measure to minimize its potential efficacy. For example, seasonal speed limit reduction could be combined with public service announcements of where, when and why the speed reductions are being implemented.

### **Culverts/Tunnels**

To reduce mortality and facilitate movement of wild animals across NH-44, culverts/tunnels have been recommended to install in areas with the highest incidence of road kills. These culverts should be placed at frequent intervals and vegetation cover should be developed in culvert approach area to provide security for passing the animals. The area under road bridges can also provide important crossing zones for wild animals including monkeys and Hanuman langur.

### **Innovative Vegetative Overpasses**

Keeping in the view the arboreal nature of monkeys and langurs, an innovative vegetative overpasses connecting vegetation of both sides

of the NH-44 at frequent intervals are very effective in mitigation of impacts of vehicles. The study area has many sites, where the canopy of trees of both the sites of the road is very close. These long branches of the trees at canopy level (6-10 m tall) can easily be connected for designing a vegetative suspended bridge of 1.0 m width and 25 m length with the additional tree branches. These suspended vegetative overpasses are used by Hanuman langur for crossing the roads in search of food, water and seeking shelter and finding mates.

### **Fences**

Numerous types, lengths and heights of fences have been used to keep wildlife of roadways and reduce animal-vehicle collisions. Fencing of various types of structures will be useful for reducing animal-vehicle collisions.

## **CONCLUSION**

Sustainable transportation aims at promoting better and healthier ways of meeting individual and community needs while reducing the social impacts of current mobility practices. It attempts to achieve these through reducing resource inputs, whole outputs and minimizing transportation's often deleterious effects on the public realm (Schiller *et al.*, 2010). The best way is to adopt the relevant mitigation measures whenever a transportation corridor is proposed through forest areas and that also in proper phases as narrated above in the report. People should not throw and feed monkeys and langurs on the road from their vehicles passing through the National Highway-44. Use and designing of innovative vegetative overpasses connecting vegetation of both sides of the road at frequent intervals are very effective in mitigation the impact of transportation on arboreal wildlife. Also, over

bridges and tunnels are the best way to avoid ecological impact as it saves the ground cover at larger extent. Also, the tunnels might intercept some aquifers or water channels in the construction of this stretch which may be diverted by using innovative techniques. In this stretch four tunnels are coming up of different lengths which have reduced lot of ecological impact.

Use and designing of innovative vegetative overpasses connecting vegetation of both sides of the road at frequent intervals are very effective in mitigation the impact of transportation on arboreal wildlife.

## REFERENCES

1. Annual report of J&K Wildlife Protection Department (2012), Govt. of J&K.
2. Case R M (1978), "Interstate highway road-killed animals: a data source for biologists", *Wildlife Society Bulletin*, Vol. 6, pp. 8-13
3. Csuti B (1991), "Introduction to Conservation Corridors: Countering Habitat Fragmentation", In: W E Hudson, *Landscape Linkages and Biodiversity*, Island Press, Washington, DC, pp. 81-89.
4. De Vore I (1977), Forward In: Roonwal M L and Mohnot S M (1977), *Primates of South Asia: Ecology, Sociobiology and Behaviour*, Harvard University Press, Cambridge & London
5. Forman R T T and Alexander L E (1998), "Roads and their major ecological effects", *Annu. Rev. Ecol. Syst.*, Vol. 29, pp. 207-231.
6. Internet / Wikipedia, 2014.
7. Spellerberg I F (1998), "Ecological effects of roads and traffic: a literature review", *Global Ecology and Bibliography Letters*, Vol. 7, pp. 317-333.



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