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# Wildlife Protection Along the Karakorum Highway in Khunjerab National Park

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**Abstract.-** The Karakorum Highway (KKH) which connects Pakistan and China passes through Khunjerab National Park in Pakistan. The park has extremely rich wildlife diversity. The potential adverse impacts of KKH improvement project on wildlife were analyzed with field surveys, interviews and secondary data for the period from 2009 to 2011. Protective measures were developed and used to guide highway construction. Study results indicated that 147 wildlife species exist along the KKH. Twenty-four of these have international protective value. The most obvious impact of the KKH improvement project on wildlife was habitat loss. Eleven locations of Himalayan Ibex (*Capra ibex sibirica*) safe passages along the KKH were identified and protected with a number of innovative construction measures and practices that proved effective.

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**Key words:** Biodiversity conservation; road ecology; Himalayan Ibex; Pakistan

The Pakistan-China Karakorum Highway (KKH) is an international highway connecting Kashgar (historical city located in western China) with Islamabad (capital of Pakistan). It is the only overland route between Pakistan and China, built along the historic silk route. The highway was constructed under a mutual construction program between Chinese and Pakistani Governments during 1966 to 1978. The KKH passes through some of the most famous highest mountain ranges in the world (Himalayas, Hindu Kush, and Karakorum), and is generally known as the "Eighth Wonder of the World." In October 2005, a devastating earthquake occurred, causing severe destruction along the KKH. In February 2006, Pakistan and China signed a Memorandum of Understanding which initiated the improvement of the highway between Raikot Bridge and Khunjerab Pass during first phase of project (Tao *et al*., 2010).

The section of the KKH from K753+800 to K811+343 (kilometer markers) bisects Khunjerab National Park (KNP). The KNP was built in 1975 with the primary objective of protecting the threatened species Marco Polo sheep (*Ovis ammon polii*) and its natural habitat. Other protected species found in the KNP include: the snow leopard (*Uncia uncia*) and the brown bear (*Ursus arctos*). These species of wildlife make the KNP one of the most important centers for biodiversity in Pakistan (Qureshi *et al*., 2011).

The impact of highway construction on wildlife and the need to protect wildlife are becoming critical issues for zoologists throughout the world (Forman and Alexander, 1998). The primary impacts to wildlife include: road mortality (Bujoczek *et al*., 2011), the road effect-zone (Forman and Deblinger, 2000), and habitat loss and degradation (Parris and Schneider, 2009). To date, no research on the impacts of highway construction on wildlife has been done in Pakistan. This study is focusing for the first time on methods to protect wildlife during highway construction in Pakistan.

*Materials and methods*

Before KKH improvement project initiation, traffic volume of K753+800 to K811+343 was about 723 vehicles/day (2002, 24h), the width of road was 6.5m and speed of vehicles was about 20km/h. After KKH improvement project completion, traffic volume will arrive at 1363 vehicles/day in 2015, the width of road will be 8.5m and speed of vehicles will reach 30km/h.

We drove at low speed (10-20km/h) along the KKH in the KNP(about 58km) during daylight and used line transect methods for recording all wildlife species visually identified using binoculars and a high powered telescope. From June-September 2009-2011, we investigated at least once each year, 3 days for each time, from 10am to 6.00pm every day. Width of the transect is about 200m. Meantime we searched for any wildlife fatality on the

highway. If a dead animal was observed on the highway, we stopped to record the species, number of individuals, and also took photos. The study was restricted to amphibians, reptiles, birds and mammals. The data were systematically recorded on standard sheets designed for this study.

Along KKH in KNP the plant coverage is very low, only on the bottom of valley there are some spares plant communities distributed along KKH, including *Myricaria elegans, Ephedera intermedia, and Salix* spp. All of these plant species are palatable and favorite for many protective species, such as Marco Polo sheep, Ibex (Qureshi *et al*., 2011). The specific kilometer markers of start point and end point of plant community along KKH were distinguished through design drawing provided by China Road and Bridge Corporation.

Concerning the protective significance of plant community along these road sections, we worked with highway engineers together to provide creative adjusted designs of ecological drainage ditch. Meantime, we provided the construction regimes of ecological drainage ditch.

In addition, we interviewed the policeman responsible for security matters in this area. The policeman is stationed along the KKH in the KNP and is responsible for inspecting and protecting the biodiversity, year-round, except during periods of heavy snowfall. The interviewed question mainly concentrated on species, number, time, location of wildlife emerged on roadside, crossing highway, road kill by vehicles etc.

Since the natural habitat and wildlife species were similar between the KNP and a number of natural reserves in Xinjiang Uygur Autonomous Region of China, we consulted wildlife biologists from the Xinjiang Uygur Autonomous Region and conducted a review of pertinent Chinese scientific publications.

*Results*

According to our surveys and preliminary classification results: there are 22 orders□51 families, 105 genera and 147 species of wild animals distributed along the KKH. These include: 8 species of reptiles, 103 species of birds and 36 species of mammals. Notably, 24 of these species are listed as international precious, endangered, protective significance (Table I).

**Table I.- Valuable/Significant and endangered wildlife species along KKH in KNP.**

| English name | Scientific name | IUCN | CITES |
|---|---|---|---|
| Black kite | *Milvus korschun(migrans)* | VU | II |
| Sparrow-hawk | *Accipiter nisus* | | II |
| Crested goshawk | *Accipiter trivirgatus* | | II |
| Golden eagle | *Aquila chrysaetos* | | II |
| European black vulture | *Aegypius monachus* | | II |
| Griffon vulture | *Gyps fulvus* | | II |
| Himalayan griffon | *Gyps himalayensis* | | II |
| Bearded vulture | *Gypaetus barbatus* | | II |
| Marsh harrier | *Circus aeruginosus* | | II |
| Saker falcon | *Falco cherrug* | | II |
| Lesser kestrel | *Falco naumanni* | | II |
| Peregrine falcon | *Falco peregrinus* | | I |
| Common kestrel | *Falco tinnunculus* | | II |
| Tibetan snowcock | *Tetraogallus tibetanus* | | I |
| Great eagle-owl | *Bubo bubo* | | II |
| Indian wolf | *Canis lupus* | VU | II |
| Dhole | *Cuon alpinus* | | II |
| Brown bear | *Ursus arctos* | | I |
| Pallas'cat | *Felis manul* | LR | II |
| Lynx | *Lynx lynx* | | II |
| Snow leopard | *Uncia uncia* | EN | I |
| Kiang | *Equus kiang* | DD | II |
| Marco polo sheep | *Ovis ammon polii* | VU | I&II |
| Blue sheep | *Pseudois nayaur* | LR | |

IUCN, EN, Endangered; VU, Vulnerable; LR, Lower Risk; DD,Data Deficient.
CITES: Appendix I – I, Appendix II – II

We did not observe the road mortality along the KKH. During our field survey, raptors were seen flying in the sky and stopping near the KKH. Himalayan Ibex were found feeding on vegetation along KKH and drinking water in the Khunjerab River. From our observations, it appears wildlife survive in close proximity to the KKH.

It is estimated that at least 10,600 $m^2$ habitat will be lost to road improvement construction. We selected 11 locations of preferred habitat/safe passages for Himalaya Ibex along the KKH as key protective areas (Table II). These locations were improved for Himalaya Ibex use by modifying the highway cross-section designs and optimizing construction regimes (Figs. 1, 2). For the perfection of cross-section designs, we selected K757+550-750, K759+500-K760Dehee Valley, K766+200-600, K776-K777 to adjust original designs without

influencing the safety and drainage function of road, means improved from concrete rectangular ditch to pateriform ecological ditch (Fig. 1); for the optimizing construction regimes, five processes were provided: 1) defining the area of permanently occupied habitat and right-of-way of pateriform ecological ditch; 2) clearing the vegetation of permanently occupied habitat, while stripping humus soil 10cm of surface layer to deposit the shady environment; 3) adopting the method of artificial clearance in right-of-way of pateriform ecological ditch, making endeavor to keep original vegetation will not be disturbed and retain in the ditch, meantime stripping humus soil 10cm of surface layer to deposit the shady environment; 4) constructing the pateriform ecological ditch as soon as possible, and backfilling the humus soil; 5)watering the pateriform ecological ditch three times to keep the moist micro-habitat.

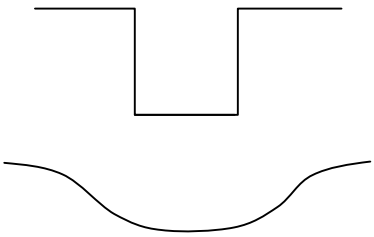

Fig. 1. Sketch map of modifying the highway cross-section designs, concrete rectangular ditch (up, original design), pateriform ecological ditch (down, improvement design)

Fig 2. Roadside vegetation was protected entirely by modifying the highway cross-section designs and optimizing construction regimes (kilometer markers K757+550 along KKH in KNP, a is before KKH improvement project, b is after)

*Discussion*

Many studies have found wildlife species richness is high along roadsides (Way, 1977; Wang *et al*., 2011). In Australia, the giant green network is composed of roadside natural vegetation and has become the key habitat to protect wildlife (Bennett, 1991). Many protective species exist on KKH roadside. Consequently, it is vital to protect biodiversity during construction activities on the KKH.

The KKH is located at high altitude and is subject to snow and low temperatures. The highway grade is low and the road width is narrow. The design speed of the highway is only 30km/h. Our field records indicate traffic volume is less than 600 vehicle/day. Wildlife found along the KKH is fast moving and respond quickly to oncoming motor vehicles. As a consequence of the highway geometrics and wildlife characteristics, there appears to be no motor vehicle related mortality on the highway at this time.

The brown bear, an important protected species in the KNP, was reported in the Khunjerab Pass (Nawaz, 2007). The brown bear population was reported to have declined quickly because of noise generated by heavy vehicles operating along the KKH in the KNP (Shafiq and Ali, 1998).

However, according to our field inspection, we believe the noise effect is rather limited, due to low traffic volume and low traffic speed. As the Khunjerab Pass remained opened only from May 1 to October 31; we suspect the decline of brown bear population was not entirely caused by the noise of heavy vehicles, and that there must be other factors involved. Behavioral responses to roads will have the greatest impact on species and will increase the barrier effect of a road (Eigenbrod *et al*., 2009). Wildlife movement across roads can be correlated with species-specific behavior characteristics, traffic flow, and environment (Forman *et al*., 2003). Due to the extreme conditions of the road and the arid environment along the KKH, we did not conduct quantitative research on road effect-zone for wildlife in KNP. In the future, through our primary research specific species will be selected to quantify the road effect-zone.

At this time, the impact of KKH construction on wildlife is expected to be limited to habitat loss due to increases in the highway footprint. While the population of Himalaya Ibex appears to be growing (Shafiq and Ali, 1998), the Himalaya Ibex remains the primary food source for large carnivores, such as the snow leopard (*Uncia uncia)* and wolf (*Canis lupus*). Consequently, to ensure the long-term survival of large carnivores and Marco Polo sheep in the KHP, it is vital to protect the habitat of Himalaya Ibex. Marco Polo sheep also inhabit this habitat due to vast amount of *Myricaria elegans* found there. Research has found *Myricaria elegans* is an important food source for herbivores in the area, including Marco Polo sheep (Qureshi *et al*., 2011). The population of Marco Polo sheep was

**Table II.- Eleven locations of potential habitat/safe passages of Himalaya Ibex along KKH**

| Kilometer markers | GPS | Altitude (m) | Width of passage (m) | Important Habitat plant (vegetation coverage %) | No. of Ibex crossing KKH (by estimate) |
|---|---|---|---|---|---|
| K753+800-1300 | N36°49′06.2" E74°57′49.9" | 3174 | 500 | *Myricaria elegans* (35%) | 30-40 |
| K755+30-800 | N36°49′37.6" E 74°58′22.0" | 3200 | 500 | *Ephedra intermedia* (35%) | 15-20 |
| K756+100-400 | N36°50′31.8" E74°59′03.4" | 3240 | 300 | *Ephedra intermedia (*35%) | 10-15 |
| K757+550-750 | N36°51′14.4" E74°59′13.6" | 3278 | 200 | *Ephedra intermedia* (15%) | 20-25 |
| K759+500-K760Dehee Valley | N36°51′44.2" E74°59′59.0" | 3314 | 600 | *Salix* spp. *Populus afghanica, Myricaria elegans* (80%) | 35-40 |
| K761+700-K762+240 | N36°51′37.2" E75°01′04.4" | 3338 | 540 | *Salix* spp, *Myricaria elegans, Ephedra intermedia* (35%) | 40-50 |
| K762+740-K763+300 | N36°51′30.0" E75°02′04.0" | 3361 | 260 | *Salix* spp, *Ephedra intermedia (*30%) | 10-15 |
| K766+200-600 | N36°51′27.4" E75°03′49.5" | 3415 | 600 | *Salix* spp, *Ephedra intermedia (*15%) | 20-25 |
| K770+800-K771+300 | N36°52′01.3" E75°06′41.5" | 3490 | 700 | *Salix* spp, *Ephedra intermedia* (15%) | 30-40 |
| K773+860-K774+050 | N36°52′18.6" E75°08′22.0" | 3554 | 400 | *Salix* spp, *Ephedra intermedia, Myricaria elegans* (10%) | 5-10 |
| K776-K777Barkhon Valley | N36°52′33.8" E75°09′47.8" | 3604 | 700 | *Salix* spp, *Ephedra intermedia* (45%) | 70-80 |

found to have decreased quickly after recent KKH construction as compared with previous KKH construction. The main reason for the population decrease was found to be poaching by humans (Schaller, 2007). The construction of the KKH dramatically facilitates access to the national park for visitors. The need to protect wildlife in the KNP has recently attracted international attention (Schaller, 2007). Following the park management strategies employed in Canada and the USA (Eagles and McCool, 2002; Eagles *et al*., 2001) visitors to the KNP should be limited to protect the wildlife

inhabiting the KNP. Our continued studies of wildlife found along the KKH in the KNP will provide the research necessary to support this aim.

The method of modifying the highway cross-section designs and optimizing construction regimes has been used in Ji-yan expressway in Jilin Province, China successfully (Lu and Chen, 2010), by use of which along KKH in KNP, at least 4,200$m^2$ habitat/vegetation has been reserved in the pateriform ecological ditch, we recommend that this method should be spread in similar environmental condition in Northern area in Pakistan.

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