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Short Communication

The Overlapping Impact of Qinghai-Tibet Highway and Railway on Ungulates

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Authors' Contributions

YW, YK and JC conceived and designed the field studies. YW, LG and LS executed the field studies. YW, LG and AS analyzed the data. YW wrote the article.

Key words

Tibetan antelope, Tibetan gazelle, Wild yak, Kiang road ecology.

ABSTRACT

Qinghai to Tibet highway (QTH) and railway (QTR) tracks are running parallel to each other with an in between distance of 0 to 2.5 km from Kunlunshankou to Wudaoliang sections which is about 107 km. An expressway will be built along these two lines in the near future to improve further accessibility between Qinghai and Tibet. Understanding the overlapping impact of QTH and QTR on ungulates will facilitates locating the route selection parameters for the proposed upcoming expressway. Using the procedures of field investigation along QTH during months of May, August and December in 2014 and 2015, we recorded the occurrence frequency, number of ungulates, and the perpendicular distance between QTH and QTR. To improve the protection mechanism for the four large ungulates *viz.*, Tibetan antelope *Pantholops hodgsonii*, Tibetan gazelle *Procapra picticaudata*, Kiang *Equus kiang*) and Wild Yak *Bos grunniens*; we suggest that the distance between the proposed route for the expressway and the present highway and railway should at least be 1500m, and ideally, it should be 2500m.

The sheltering function of Tibetan Plateau has an important impact on the ecological security of China, and even for overall Asian region. Additionally, this area is rich in distinctive and endangered wildlife species (Sun et al., 2012; Yang et al., 2014). Current advancement in the Tibetan economic development is immensely enhancing the infrastructure and roads network construction in the region. According to Chinese highway plan, the Qinghai-Tibet Expressway (QTE) will be built in the next several years, which will be parallel to the existing Qinghai-Tibet Highway (QTH) and Qinghai-Tibet Railway (QTR). Presently, research has found that QTH is negatively impacting the endangered Tibetan antelope's (*Pantholops hodgsonii*) risk-avoidance behavior with varied distance and traffic levels (Lian et al., 2011). The QTH has already been a barrier for Tibetan antelope migration, and the construction of QTR has further narrowed down the migration passage for the Tibetan antelope (Qiu and Feng, 2004). In 2006, around 98.17% of Tibetan antelopes had crossed through the newly constructed wildlife underpasses, which showed that the animals had readily adapted to these underpasses (Yang and Xia, 2008). However, current research focuses only on the impact of single linear infrastructure on wildlife movement, and lacks the research data collection parallel to the QTH and QTR, and the type of methodology to be adopted for route selection and construction is of vital importance to protect the wildlife.

The present study aims at determining find the threshold value of distance between QTH and QTR (running parallel to each other with the distance from 0 to 2.5 km), based on the ungulates occurrence which may guide the route selection of QTE.

Methods

The study was conducted between Kunlunshankou (2900 milestone) and Wudaoliang (3007 milestone), about 107 km section along Qinghai-Tibet Highway (QTH), which was built in 1950s and marked the boundary between Kekexili National Nature Reserve and Sanjiangyuan National Nature Reserve. The section is located at an altitude of about 4600m, with no human settlements along the roadside. Four large ungulates occur in this area including Tibetan antelope (*Pantholops hodgsonii*), Tibetan gazelle (*Procapra picticaudata*), Kiang (*Equus kiang*) and Wild Yak (*Bos grunniens*). Among them, Tibetan antelope migrates westward in spring and eastward in August (Yang and Xia, 2008).

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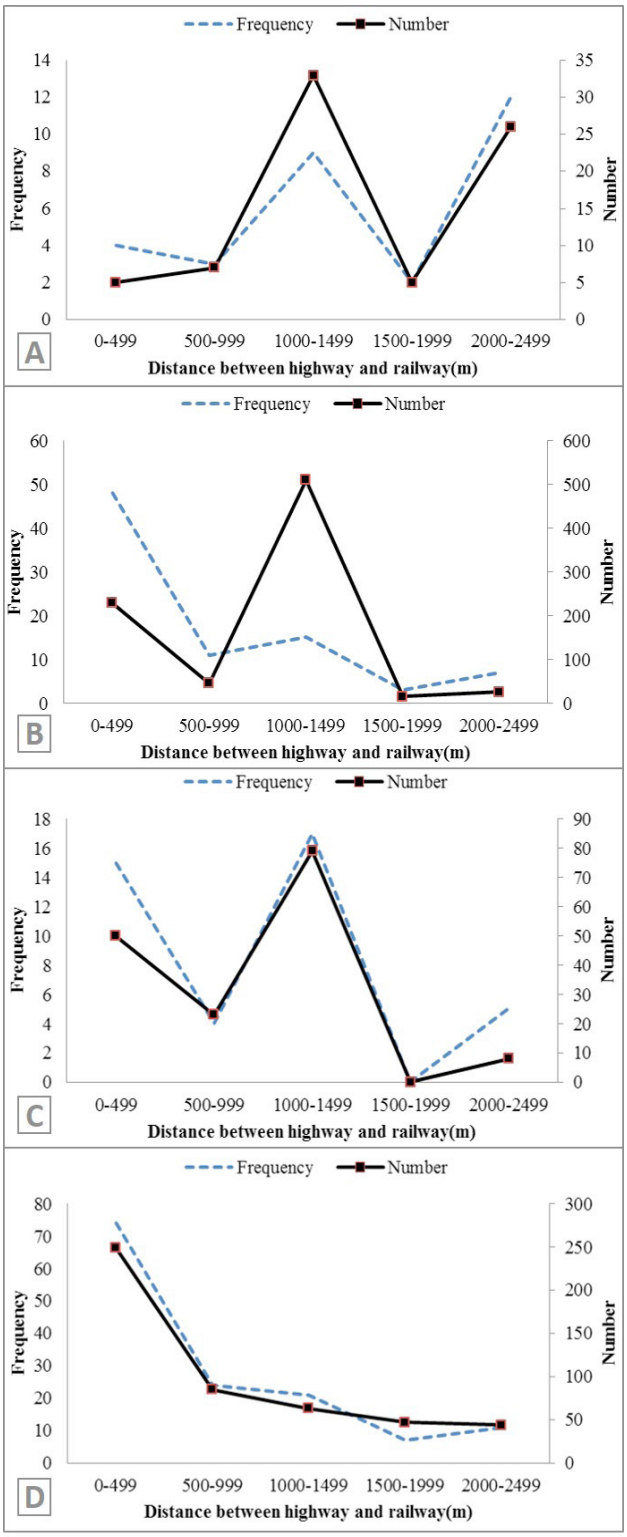

Fig. 1. Relationship among frequency, number of Yak (A), Tibetan antelope (B), Kiang (C) and Tibetan Gazelle (D) and the distance between highway and railway track.

By driving along QTH at moderate speed (about 50km/h) during months of May, August, December in 2014 and 2015, we searched for ungulate by eyesight, when we found them we stopped on the road with the nearest distance between wildlife and road, then we recorded data on ungulate species, occurrence frequency (the times that we found the ungulates), number of ungulates, milestone location and the perpendicular distance between QTH and QTR (by range finder "Onick6000", with measure furthest distance of 9999 m).

Chi-square test was used for statistical analysis to determine the difference among the frequency and number of ungulates crossing at different distance points between QTH and QTR. Pearson correlation coefficients were used to assess the correlations between occurrence frequency and number of ungulates. All data were analyzed using SPSS 16.0 and Excel 2010, and P-value <0.05 was considered statistically significant under the study.

Results

As shown in Figure 1A, occurrence frequency and number of Wild Yak showed positive correlation ($r=0.979$, $p=0.004$), and the distance between QTH and QTR significantly influenced the occurrence frequency and number ($X^2=14.000$, $df=4$, $p=0.007$, $X^2=68.435$, $df=4$, $p=0.000$). The occurrence frequency of Wild Yak was 13.33%, 10%, 30%, 6.67% and 40% at the distance 0-499m, 500-999m, 1000-1499m, 1500-1999m, and 2000-2499m. Therefore, the highest occurrence frequency was at the distance between 2000-2499m, making 40% of total population. The number of wild yak was 6.58%, 9.21%, 43.42%, 6.58% and 34.21 at the distance 0-499m, 500-999m, 1000-1499m, 1500-1999m and 2000-2499m, respectively. Therefore, the number was most at the distance 1000-1499m, making 43.42% of total population.

Figure 1B reveals a positive correlation and non-significant difference between occurrence frequency and number of Tibetan antelope ($r=0.361$, $p=0.550$). The distance between QTH and QTR has significantly influenced the occurrence frequency and number ($X^2=77.190$, $df=4$, $p=0.000$, $X^2=1089.932$, $df=4$, $p=0.000$). The occurrence frequency of antelope was 57.14%, 13.10%, 17.86%, 3.57% and 8.33% at the distance 0-499, 500-999, 1000-1499, 1500-1999, 2000-2499m, respectively. Therefore, the occurrence frequency was highest at the distance 0-499m, occupying 57.14% of total population. The number of Tibetan antelope was 27.79%, 5.46%, 61.89%, 1.82% and 3.03% at the distance 0-499, 500-999, 1000-1499, 1500-1999 and 2000-2499m, respectively. Therefore, the number was highest at the distance 1000-1499m, occupying 61.89% of total number.

As shown in Figure 1C, occurrence frequency and

number of Kiang were positively correlated (r=0.951, p=0.013). The distance between QTH and QTR has influenced the occurrence frequency and number significantly (X^2=13.146, df=3, p=0.004, X^2=73.350, df=3, p=0.000). The occurrence frequency of Kiang was 36.59%, 9.76%, 41.46%, 0% and 12.20% at the distance 0-499, 500-999, 1000-1499, 1500-1999 and 2000-2499m, respectively. Therefore, the occurrence frequency was highest at the distance 1000-1499m, occupying 41.46% of total frequency. The number of Kiang was 31.25%, 14.38%, 49.38%, 0% and 5% at the distance 0-499, 500-999, 1000-1499, 1500-1999 and 2000-2499m, respectively. Therefore, the number was highest at the distance 1000-1499m, occupying 49.38% of total number.

Both the occurrence frequency and number were the highest at the distance 1000-1499m, occupying 41.46% of total frequency and 49.38% of total number, respectively.

Figure 1D explains that occurrence frequency and number of Tibetan Gazelle were positively correlated to each other (r=0.951, p=0.013). Similarly, the distance between QTH and QTR has significant impacted the occurrence frequency and number X^2=13.146, df=3, p=0.004, X^2=73.350, df=3, p=0.000. The occurrence frequency of Tibetan Gazelle was 54.01%, 17.52%, 15.33%, 5.11% and 8.03% at the distance 0-499, 500-999, 1000-1499, 1500-1999 and 2000-2499m, respectively. Therefore, the occurrence frequency was highest at the distance 0-499m, occupying 54.01% of total frequency. The number of Tibetan Gazelle was 51.02%, 17.42%, 12.91%, 9.63% and 9.02% at the distance 0-499, 500-999, 1000-1499, 1500-1999 and 2000-2499m, respectively. Therefore, the number was highest at the distance 0-499m, occupying 51.02% of total number.

Both the occurrence frequency and number were found at peak levels at the distance 0-499m, amounting to 54.01% of total frequency and 51.02% of total number, respectively.

Discussion

Earlier studies have found the avoidance distance for Wild Yak and Kiang as about 1000m and 500m, respectively to QTH. Both the species are large sized mammals, hence needed to avoid QTH with further distance to acquire enough food (Lian et al., 2012). Present research concludes similar results, the number of Wild Yak and Kiang, and the occurrence frequency of Kiang were the highest when the distance between QTH and QTR was 1000-1499m, and the frequency of Wild Yak was the most when the distance was between 2000-2499m.

Due to small sized body within all ungulates in Tibet, Tibetan Gazelle has the highest frequency of vigilant activity and can adapt to high predation risk environment, therefore, the avoidance of which is the least (Lian et al., 2012). The population density of Tibetan gazelle was significantly higher within the area of 0-500m than of 501-3000m from QTH, and the barrier effect of highway on Tibetan gazelle was obvious for the time spent to cross highway much longer (Yin et al., 2007). This study also supports these findings, the frequency and number of Tibetan gazelle was the most when the distance between QTH and QTR was 0-499m.

Tibetan antelope has the habit of migrating more frequently (Lian et al., 2007), hence it frequently crosses the area between highway and railway. The maximum numbers were recorded within a wide area (distance is 1000m to 1499m). Presently, Tibetan antelopes cross QTR mostly through Kekexili passage (K2998), and the usage rate is 84.64 (westward), 82.10 (eastward) (Li et al, 2008). The reason is that the distance between QTH and QTR is 1270m and also the hump landform blocks the visual disturbance of traffic flow for Tibetan antelope (Lian et al., 2012).

Considering all these findings and the four large sized ungulates, the route of expressway in the future should locate at least 1500m away from the present highway and railway but it would be ideally if built at 2500m distance from QTH and QTR. However, during the route selection of expressway some other parameters should also be considered, such as investment in infrastructure, feasibility of construction, plan of land usability, and vegetation protection.

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Statement of conflict of interest

Authors have declared no conflict of interest.

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