Ecology and conservation of endangered Alpine musk deer in Northwestern China: population, habitat, eco-tourism and integrated nature conservation

(RSG -Booster-Ref: 79.08.09)

Final Report

Submitted by

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CONTENTS

0 Summary

1. Studying area and working site

2. Aline musk deer (Moschus sifanicus)

3 Habitat surveying of Alpine musk deer in XNNR

3.1 General methods

3.2 Seasonal habitat surveying of Alpine musk deer in XNNR

3.3 Seasonal Patterns of Habitat Selection and the potential Ecological Drive in Alpine musk deer

4 Population surveying of Alpine musk deer in XNNR

5 Threats to alpine musk deer in XNNR

5.1 Deforestation and marginal agriculture in XNNR

5.2 Illegal hunting and steel-snares in XNNR

5.3 Livestock

5.4 Inappropriate management measures

6 Ecotourism and the potential impacts on XNNR

7. Education improving

8. Social economical surveying in local communities

9 Published paper and submitted report

10. Financial report

11 Acknowledgement

12 Main References
0. Summary

This report derives from the field project generously supported by Rufford Small Grant (Booster) program (Ref: 79.08.09, ) which was implemented in one year, from Jan 2010 to Jan. 2011. The aim of project was to quantify the population, general habitat status, seasonal habitat utilization patterns of alpine musk deer (*Moschus sifanicus*), moreover, the booming eco-tourism, traffic status in reserve, illegal poaching in the local area. Based on the field surveying and collected data, this project determined the relations among the above factors, from which, the XNNR Bureau was advised how to develop the more scientific managing system, and help local authority to allot the limited managing human, financial resources more reasonably.

Through the field working, we have surveyed seasonal sampling belts, in which the cues of musk deer (eg. Latrines sites, pasting site, footprint and bedding site) were found, and the general average population density was 1.8 deer/ Km², but the density was 7.43 deer/ Km² in core area with preferred habitats, and the total population of musk deer was 600.

When the incidence of musk deer was identified, the characteristics of habitat were quantified, including 23 variables such as slope, canopy, elevation etc., on the basis of which, the data of utilized habitat and non-used habitat in wild alpine musk deer was collected and analyzed. The results showed that, excepted the preferences of preferred ecological characteristics of habitats, there existed very strong habitat selection in all seasons, and musk deer was not
inclined to select the habitats close to eco-tourism activities and communities. Overgrazing by domestic livestock and farming in local communities were widespread problems throughout the XNNR, which has resulted in severe depletion of the forest understorey, leaving no shrubs for alpine musk deer to browse during winter when snow covers the ground. Furthermore, the conflict among wildlife conservation, local Hui Nationality community and the managing authority was very severe because of the un damage from the flourish wild pig population.

Throughout public community presenting work, we publicized the concept of nature conservation, the value of endangered animals etc. We visited 200 local households door by door to collect the information about their living and production system, and discuss with them to explore the potential substitute production styles to reduce the pressure on the musk deer population and its habitat from their conventional production.

We surveyed 400 tourists and officials to collect eco-tourism data. Moreover, the education improvement had been conducted for months, through which, the pupils were influenced to value and conserve wildlife and its habitat, and team members had publicized the conservation of musk deer and habitat in local community.

(Newborn Alpine musk deer, photo by Mr Pan)
1. Studying area and working site

This project was carried out in 2010 in Xinglongshan National Natural Reserve (XNNR) located in Gansu Province, Northwest China (Fig 1 and Fig 2).

XNNR of Gansu Province is in mountainous region of northwest China (Fig. 1, Fig. 2, Fig. 3), which is is the forests and wild animals types of national nature reserve. Its areas is widely and there are many kinds of plants and animals, so it is important to the country and the region. The forest ecosystem has many serve values, the values are producing organism, conserving water, soils, fixing carbon synchronously releasing oxygen and cleaning air. The results indicated that conserving soils, stagnating dust and producing organism are dominating functions in XNNR and the conserving water is significant to the region.
XNNR is a science and nature reserve with an area of 33301 ha and with altitude from 2000~3600 meter, and locates from 103°50′ to 104°10′ E and from 35°38′ to 35°58′, which was established in Yuzhong County, Gansu Province with ratification of the State Council in 1978. The annual average temperature is 3-7° C, with an annual rainfall of 340 to 520 mm, most of which happens in summer (July, Aug. and Sept.), and the frost-free period is 103 days.

Moreover, XNNR is very special that there are totally 6000 Hui Peoples distributed in more than 8 towns located in the nature reserve (Hui People is one of the 55 minorities in China). Hui People is the native nationality to the Northwestern region. For a long time, however, the potential impacts from the conventional production of Hui People has been not been assessed.
2. Aline musk deer (*Moschus sifanicus*)

2.1 Musk deer

Musk deer (*Moschus spp.*) are solitary ruminants, they distribute throughout the forest and mountainous parts of Asia, from just north of the Arctic southward to the northern edge of Mongolia and to Korea. Further south, avoiding the Gobi desert, the musk deer occurs in China, Burma, Northern India, Northern Vietnam and the Himalayan region (Flerov 1952; Green, 1986). The taxonomy of musk deer remains debatable for a long time, but so far, four or more species of musk deer have been recognized and all species included in the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) since 1979.

China is one of the largest range countries of musk deer distribution, and sorts of classification system were established by different experts on musk deer, however, most of them increasingly believed that there are five musk deer species in China, i.e., Forest musk deer *M. berezovskii*, Alpine musk deer *M. sifanicus*, Black musk deer *M. fuscus*, Himalayan musk deer *M. chrysogaste* and Siberian musk deer *M. moschiferus*, which disconnectedly occur in most of China and are all protected in the second category of the Chinese State Key Protected Wildlife List in 1998 (CSKFWL 98) (Fig. 8).

Musk deer (*Moschus spp.*) are shy, solitary animals famous for the musk secreted by the adult male. Musk has been one of the oldest raw materials used in perfumery and traditional medicine in Asia, representing one of the most valuable scented animal products, even more expensive than gold (Green, 1986; Shrestha, 1998).

In the 1970s and 1980s, especially after the 1980s, due to the dramatic increase in demand for musk, coupled with high international smuggling, alpine musk deer hunting in the distributive area has increased. The vicious killing of years has made wild alpine musk deer resources to be seriously damaged. At present, the wild alpine musk deer has been endangered world-wide because of hunting and habitat loss (Homes, 1999, 2004), and nowadays all 5 species of musk deer have been classified in China as Category I protected animals, and listed in the IUCN Red List of Threatened Species and in Appendix II of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora).

(Fig.8 Current distribution of alpine musk deer (*M. sifanicus*) in China)
2.2 About alpine musk deer in XNNR

Alpine musk deer (*M. sifanicus*) (Fig. 9, Fig.10), commonly known as Zhang Zi in Gansu Province, is a small solitary forest ungulates, which is also the largest population of 6 species of musk deer, a body length 600–800mm, average weight about 7 kg, the adult male musk deer have the musk pod. Musk is not only an most important component of traditional medicine in China and some other Southeast Asian countries, but also were the high valued raw material for the production of perfume and the same time.

Alpine musk deer is an endemic species of Qinghai-Xizang Plateau, mainly scattered in plateau and mountainous regions in western China, including Xizang, Qinghai, western Sichuan, northwestern Yunnan, Ningxia and Xingjiang, it has been historically abundant in such ethnic minority regions as Qinghai, Xizang and northwestern Sichuan. According to the survey conducted by the Company of Chinese traditional Medicine (CCTM) in 1961, there were about 180,000 alpine musk deer in Qinghai Province in 1960s, but only 30,000 survived in 1970s. Sheng (1998) estimated the population in XNNR in Gansu Province and reported that the number stood 4000 to 5000 with density of 23-51km-2 at the beginning of 1990s, but Kang (personal communication) counted again in the same region in 2001 and found that the population has declined to only 800 or so. The above trends of the partial population indicated that the population has been declining. Now the total population of alpine musk deer is no more than 100,000, and XNNR is one of the main distribution areas, and the typic summer habitat is showed in Fig 11.

(Fig.9 Captive adult Alpine musk deer)

(Qinghai-Xizang Plateau, mainly scattered in plateau and mountainous regions in western China, including Xizang, Qinghai, western Sichuan, northwestern Yunnan, Ningxia and Xingjiang, it has been historically abundant in such ethnic minority regions as Qinghai, Xizang and northwestern Sichuan. According to the survey conducted by the Company of Chinese traditional Medicine (CCTM) in 1961, there were about 180,000 alpine musk deer in Qinghai Province in 1960s, but only 30,000 survived in 1970s. Sheng (1998) estimated the population in XNNR in Gansu Province and reported that the number stood 4000 to 5000 with density of 23-51km-2 at the beginning of 1990s, but Kang (personal communication) counted again in the same region in 2001 and found that the population has declined to only 800 or so. The above trends of the partial population indicated that the population has been declining. Now the total population of alpine musk deer is no more than 100,000, and XNNR is one of the main distribution areas, and the typic summer habitat is showed in Fig 11.

(Fig.11 Summer habitat of alpine musk deer in XNNR)
3 Habitat surveying of Alpine musk deer in XNNR

3.1 General methods

Alpine musk deer is typical forested ungulates and is very shy, solitary, and lives in mountainous terrain covered by dense forests, which makes it very difficult to observe and survey directly in the field, however, the feces that it left are an effective indicator of habitat selection and population surveying (Fig.12, Fig.13).

Dueser and Shugart (1978) created a detailed sampling technique combining plots of various sizes and shapes, as well as small transects, which later proved to be applicable for most terrestrial vertebrates (Morrison et al. 1992), so we adopted this method to quantify the habitat of alpine musk deer and made some modifications in design variables, and the 23 quantified variables listed as following:

1. Canopy: Canopy of overstory vegetation in the 400-m² plot;
2. Slope: Slope of the plot, from 0° to 90°; every 10° is a category;
3. Slope aspect: Aspect of the plot, four categories: east-facing (45–135°), south-facing (135–225°), west-facing (225–315°), and north-facing (315–45°)
4. Slope position: Position of the plot on the hillside; three categories: upper (>2700 m), middle (2000~2700 m), and lower (<2000 m);
5. Vegetation type: Six categories: mixed evergreen and deciduous broadleaf forest, mixed conifer and broadleaf forest, conifer forest, shrub, grassland, and bare land
6. Bamboo density: Average number of culms in bamboo plots;
7. Bamboo height (cm): Average height of culms plots
8. Tree density: Average number of trees in two 20-m² rectangular transects;
9. Tree size (cm): Average diameter at breast height (DBH) of the trees nearest the center in each plot;
10. Tree dispersion (m): Average distance to the trees nearest the center in each plot;
11. Shrub density: Average number of shrubs in transects;
12. Shrub size (cm): Average DBH of the shrubs nearest the center in each plot;
13. Shrub dispersion (m): Average distance to the shrubs nearest the center in each plot;
14. Tree-stump density: Average number of tree stumps (>15 cm in diameter) in each plot;
15. Tree-stump size (cm): Average diameter of the tree stumps (>15 cm in diameter) nearest the center in each plot;
16. Tree-stump dispersion (m): Average distance to the tree stumps (>15 cm in diameter) nearest the center in each plot;
17. Fallen-log density: Average number of fallen logs (>15 cm in diameter) in each plot;
18. Fallen-log size (cm): Average diameter of the fallen logs (>15 cm in diameter) nearest the center in each plot;
19. Fallen log dispersion (m): Average distance of the fallen logs (>15 cm in diameter) nearest the center in each plot;
20. Herb-cover proportion (%): Proportion of herb-cover area in the plot;
21. Water-source dispersion (m): Estimated straight-line distance from the sampling plot to the nearest water source;
22. Concealing condition (m): Mean greatest distance looking eastward, southward, westward, and northward at a height of 1.0 m at the center of the sampling plots;
23. Open-land proportion (%): Proportion of land area without bamboo cover in the plot;

During field surveying, when some cues such as pellets, footprint, tail-rubbing sites etc were quantified, a sampling plot (400 m²) would be designed and all the above variables would be quantified and recorded (Fig.14-16).

(Fig.14 Line transect system of habitat surveying)
Data analyses were done with SPSS 11.0, and some nonparametric methods such as the Kruskal–Wallis test were utilized to explore the potential differences in habitat selection of alpine musk deer populations, and PCA (Principal Component Analysis) was used to decide the main influencing factors which impose the huge impacts upon the habitat utilization of wild alpine musk deer in XNNR.

3.2 Seasonal habitat surveying of Alpine musk deer in XNNR

**In Spring**, 23 ecological factors were assessed for 383 sites in Xinglongshan National Nature Reserve in northwestern China. Of the measured sites, 72 were designated as being used by musk deer as compared with 312 sites designated as random plots. Results indicated musk deer selected spring habitat at lower altitude with increasing arbor canopy, arbor DBH and higher ground-plant covering, moreover, deer selected habitat on intermediate or upper slope position in south and west slope with relatively bad concealment and lee condition but lower water and anthropogenic disturbance dispersion. Principal component analysis showed “arbor factors” (consisting of arbor canopy, arbor height, arbor DBH and arbor density), “water factors” (consisting of anthropogenic-disturbance dispersion, water dispersion and altitude), “shrub factors” (consisting of shrub canopy), “arbor factor” (consist of arbor canopy and arbor density), “food factor” (consist of slope position, arbor height and food abundance) and “concealment factor” (consist of vegetation type and concealment) were the most important ecological factors influencing the habitat selection of alpine musk deer in spring. The typical Spring of alpine musk deer in XNNR showed in Fig 17-18.
In summer, Alpine musk deer preferred habitat with taller arbor height (7.57±0.83 m), higher food-plants abundance (12.97±1.80), increasing foliage cover for concealment, lower water dispersion, higher anthropogenic disturbance. Furthermore, PCA results showed that the factors such as forest type, water dispersion, concealment, food-plant abundance, shrub-slope-gradient and arbor-slope-position influenced the summer habitat selection patterns of alpine musk deer in Xinglongshan National Nature Reserve. The general patterns of summer habitat utilization and selection of alpine musk deer is the general adaptation to the changing food, concealment, water source and the physical condition of summer habitat. The typic Spring of alpine musk deer in XNNR and working pics of team members were showed in Fig 19-21.
In autumn, Alpine musk deer in XNNR preferred autumn habitats with higher arbor density, shrub height and lower water dispersion and anthropogenic disturbance dispersion. The principal component analysis showed that “geographic factor” (consisting of altitude, water dispersion, vegetation type and slope aspect) was the most important factor to influence musk deer’s habitat selection in autumn. Other important factors which influence habitat selection included “canopy factors” (consisting of arbor canopy and slope gradient), “food factors” (consisting of food abundance and arbor DBH), and “concealment factors” (consist of concealment and lee condition) were the important ecological factors influencing the habitat selection of alpine musk deer in autumn.
In winter, Alpine musk deer preferred winter habitats which were with lower altitude, arbor canopy, arbor height and DBH, with preference for habitat on eastern and southern lower slope with lower gradient and lower anthropogenic disturbance dispersion. Moreover, musk deer sites were located within conifer broadleaved forest and shrub habitat with lower water dispersion, reduced concealment and on the lee side. The principal component analysis showed that such factors as “arbor factor” (consisting of arbor canopy, arbor height, arbor DBH and arbor density), “water factor” (consisting of anthropogenic-disturbance dispersion, water dispersion and altitude), “food factor” (vegetation type and food abundance), “slope gradient factor” (consisting of slope gradient) and “topographic factor” (consist of snow depth and ground-plant canopy) were the most important ecological factors influencing the habitat selection of alpine musk deer in winter in Xinglongshan National Nature Reserve.
3.3 Seasonal Patterns of Habitat Selection and the potential Ecological Drive in Alpine musk deer

On the bases of the collected habitat data, the comparison was made to determine the potential differences of habitat preferences between seasons. Results showed that the habitat utilization was strongly influenced by season, with significant differences in 17 of the 18 ecological factors. Alpine musk deer select different altitude habitat for different seasons, with a altitude range of 293 meters. By selecting habitat on the basis of ecological variables such as altitude and food abundance, alpine musk deer select seasonally specific habitats based on availability of resources such as food, water and concealment. Principle component analysis indicates that eight ecological variables (food abundance, arbor canopy, vegetation type, concealment, slope position, shrub canopy, altitude and arbor DBH) were in principal factors in at least three seasons, and variables (arbor density, water dispersion, slope gradient and slope aspect) which determine the water-heat characteristics of a habitat, were in principal factors in 2 seasons. Furthermore five variables (arbor height, ground plants cover, anthropogenic dispersion, snow depth and lee condition) were in principal factors for at least one season, which decides the ground characteristics of selected habitat. Musk deer habitat selection patterns indicated that there are many ecological variables could influence the final habitat selection and utilization in alpine musk deer. This selection indicates that musk deer could adapt to the changing ecological needs for food, concealment, water-heat and habitat ground. We hypothesize that the ecological needs of food and concealment is the most important factor to drive the
seasonal habitat selection of musk deer, which will be tested in the coming study. The detailed information was showed in the following Table 1-3 and Fig 28-37.

Table 1 Seasonal comparison on the continuous variables in habitat of Alpine musk deer

<table>
<thead>
<tr>
<th>Variable</th>
<th>Spring</th>
<th>Summer</th>
<th>Autumn</th>
<th>Winter</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altitude</td>
<td>2280.94±17.06</td>
<td>2319.02±9.31</td>
<td>2331.58±21.54</td>
<td>2038.43±6.88</td>
<td>**</td>
</tr>
<tr>
<td>Arbor canopy</td>
<td>33.85±3.94</td>
<td>53.87±3.09</td>
<td>30.18±3.49</td>
<td>17.14±1.62</td>
<td>**</td>
</tr>
<tr>
<td>Arbor height</td>
<td>9.36±1.21</td>
<td>7.51±0.83</td>
<td>5.51±0.49</td>
<td>3.12±0.48</td>
<td>**</td>
</tr>
<tr>
<td>Arbor DBH</td>
<td>10.24±1.42</td>
<td>11.82±1.32</td>
<td>14.96±2.49</td>
<td>8.97±1.54</td>
<td>**</td>
</tr>
<tr>
<td>Arbor density</td>
<td>1.64±0.18</td>
<td>1.64±0.14</td>
<td>0.90±0.14</td>
<td>1.09±0.12</td>
<td>**</td>
</tr>
<tr>
<td>Shrub height</td>
<td>1.58±0.11</td>
<td>3.73±1.53</td>
<td>1.92±0.53</td>
<td>1.51±0.08</td>
<td>**</td>
</tr>
<tr>
<td>Shrub canopy</td>
<td>34.13±3.76</td>
<td>46.76±3.31</td>
<td>29.73±2.99</td>
<td>21.76±1.54</td>
<td>**</td>
</tr>
<tr>
<td>Ground-plant cover</td>
<td>26.67±3.27</td>
<td>26.51±2.76</td>
<td>2.65±2.68</td>
<td>1.38±0.45</td>
<td>**</td>
</tr>
<tr>
<td>Food-plant abundance</td>
<td>33.31±6.90</td>
<td>12.97±1.80</td>
<td>33.82±5.20</td>
<td>35.01±3.73</td>
<td>**</td>
</tr>
</tbody>
</table>

Note: Data showed as mean ± S.E; **: High significantly different (P<0.01).

Table 2 Seasonal patterns of the discrete variables in habitat of wild alpine musk deer

<table>
<thead>
<tr>
<th>Variable</th>
<th>Item</th>
<th>Spring</th>
<th>Summer</th>
<th>Autumn</th>
<th>Winter</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope aspect</td>
<td>East</td>
<td>11.54</td>
<td>------</td>
<td>14.55</td>
<td>26.37</td>
<td>**</td>
</tr>
<tr>
<td></td>
<td>South</td>
<td>44.23</td>
<td>30.99</td>
<td>40.00</td>
<td>53.85</td>
<td>**</td>
</tr>
<tr>
<td></td>
<td>West</td>
<td>36.54</td>
<td>36.62</td>
<td>27.27</td>
<td>9.89</td>
<td>**</td>
</tr>
<tr>
<td></td>
<td>North</td>
<td>7.69</td>
<td>32.39</td>
<td>18.18</td>
<td>9.89</td>
<td>**</td>
</tr>
<tr>
<td>Slope position</td>
<td>1</td>
<td>51.92</td>
<td>29.58</td>
<td>41.82</td>
<td>90.11</td>
<td>**</td>
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<tr>
<td></td>
<td>2</td>
<td>34.62</td>
<td>46.48</td>
<td>40.00</td>
<td>8.79</td>
<td>**</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>13.46</td>
<td>23.94</td>
<td>18.18</td>
<td>1.10</td>
<td>**</td>
</tr>
<tr>
<td>Slope gradient</td>
<td>&lt;30°</td>
<td>26.92</td>
<td>19.72</td>
<td>41.82</td>
<td>41.11</td>
<td>**</td>
</tr>
<tr>
<td></td>
<td>30°~60°</td>
<td>55.77</td>
<td>67.61</td>
<td>47.27</td>
<td>46.67</td>
<td>**</td>
</tr>
<tr>
<td></td>
<td>&gt;60°</td>
<td>17.31</td>
<td>12.68</td>
<td>10.91</td>
<td>12.22</td>
<td>**</td>
</tr>
<tr>
<td>Vegetation type</td>
<td>COF</td>
<td>28.85</td>
<td>8.45</td>
<td>25.45</td>
<td>13.19</td>
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<tr>
<td></td>
<td>CB</td>
<td>25.00</td>
<td>54.93</td>
<td>21.82</td>
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<td>19.23</td>
<td>35.21</td>
<td>21.82</td>
<td>15.38</td>
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<tr>
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<td>SHR</td>
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<td>1.41</td>
<td>27.27</td>
<td>34.07</td>
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</tr>
<tr>
<td></td>
<td>GRL</td>
<td>1.92</td>
<td>---</td>
<td>3.64</td>
<td>5.49</td>
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<tr>
<td>Water dispersion</td>
<td>&lt;500</td>
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<td>49.30</td>
<td>32.73</td>
<td>51.11</td>
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</tr>
<tr>
<td></td>
<td>500~1000</td>
<td>46.15</td>
<td>28.17</td>
<td>43.64</td>
<td>24.44</td>
<td>**</td>
</tr>
<tr>
<td></td>
<td>&gt;1000</td>
<td>19.23</td>
<td>22.54</td>
<td>23.64</td>
<td>24.44</td>
<td>**</td>
</tr>
<tr>
<td>Concealment</td>
<td>Good</td>
<td>23.1</td>
<td>50.0</td>
<td>30.9</td>
<td>8.79</td>
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<tr>
<td></td>
<td>Medium</td>
<td>28.8</td>
<td>38.6</td>
<td>29.1</td>
<td>31.87</td>
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</tr>
<tr>
<td></td>
<td>Bad</td>
<td>48.1</td>
<td>11.4</td>
<td>40.0</td>
<td>59.34</td>
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<td>Lee condition</td>
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<td>36.54</td>
<td>51.43</td>
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<tr>
<td></td>
<td>Medium</td>
<td>17.31</td>
<td>38.57</td>
<td>34.55</td>
<td>54.17</td>
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</tr>
<tr>
<td></td>
<td>Bad</td>
<td>46.15</td>
<td>10.00</td>
<td>32.73</td>
<td>18.75</td>
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<tr>
<td>Anthropogenic dispersion</td>
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<td>49.09</td>
<td>41.76</td>
<td>**</td>
</tr>
<tr>
<td></td>
<td>&gt;1000</td>
<td>23.08</td>
<td>42.25</td>
<td>23.64</td>
<td>53.84</td>
<td>**</td>
</tr>
</tbody>
</table>

Note: Data showed as mean ± S.E; *: Significantly different (P<0.05); **: High significantly different (P<0.01).
Table 3 Comparison of variables in habitat of wild alpine musk deer between seasons

<table>
<thead>
<tr>
<th>Variable</th>
<th>SU-AU</th>
<th>SP-AU</th>
<th>AU-WI</th>
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<td>0.000**</td>
<td>0.000**</td>
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<td>0.049*</td>
<td>0.000**</td>
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<td>0.530 ns</td>
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<td>Shrub canopy</td>
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Note: Data showed as mean ± S.E; *: Significantly different (P<0.05); **: High significantly different (P <0.01), SP spring, SU summer, AU autumn, WI winter.
Fig. 28 Distribution of slope aspect selected by alpine musk deer in seasons

Fig. 29 Distribution of slope position selected by alpine musk deer in seasons
Fig. 30 Distribution of slope gradient selected by alpine musk deer in seasons

Fig. 31 Distribution of vegetation type selected by alpine musk deer in seasons

Fig. 32 Distribution of water-dispersion selected by alpine musk deer in seasons

Fig. 33 Distribution of concealment selected by alpine musk deer in seasons
Fig. 34 Distribution of lee-condition selected by alpine musk deer in seasons

Fig. 35 Distribution of anthropogenic-disturbance dispersion selected by alpine musk deer in seasons
Fig. 36 Scanned data sheet of habitat surveying (Made by Mr Wang and Mr Ma)

| No. | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V |
| 1   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10| 11| 12| 13| 14| 15| 16| 17| 18| 19| 20| 21| 22|
| 2   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10| 11| 12| 13| 14| 15| 16| 17| 18| 19| 20| 21| 22|
| 3   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10| 11| 12| 13| 14| 15| 16| 17| 18| 19| 20| 21| 22|
| 4   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10| 11| 12| 13| 14| 15| 16| 17| 18| 19| 20| 21| 22|
| 5   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10| 11| 12| 13| 14| 15| 16| 17| 18| 19| 20| 21| 22|
| 6   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10| 11| 12| 13| 14| 15| 16| 17| 18| 19| 20| 21| 22|
| 7   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10| 11| 12| 13| 14| 15| 16| 17| 18| 19| 20| 21| 22|

Fig. 37 Data set of habitat surveying (Made by Ms Gong)
4 Population surveying of Alpine musk deer in XNNR

The alpine musk deer surveying was conducted at Mapo, Yaogou, Xinglong and Xingzhuanggou to compute the alpine musk deer population in XNNR (Fig. 38), and the sampling line method and inverse line transect method (Fig. 39) were used to decide the density of alpine musk deer population. The field work resulted in the discovery of the approximate number of Alpine musk deer in XNNR is 600 (in 333.2 Km²), the density was 1.80 deer/Km², and the density in core area was 7.43 deer/Km², where there are the most preferable habitat of musk deer (Fig 40-43).

(Fig. 38. The distribution of working sites in alpine musk deer population surveying)

(Fig. 39. The surveying method of population surveying)

(Fig. 40 Population surveying in XNNR)

(Fig. 41 Preferred habitat with highest musk deer density in XNNR)

(Fig. 42 Preparing for the population surveying by team members, officials and local guides)

(Fig. 43 Check the sampling line and belts)
5 Threats to alpine musk deer in XNNR

5.1 Deforestation and marginal agriculture in XNNR

Alpine musk deer inhabit forested mountainous landscapes, and nearly all the activities occur in forest. Deforestation causing forest fragmentation is a severe threat to the musk deer’s long-term survival. Forest fragmentation not only restricts the available habitats, but weakens the viability of isolated metapopulations. Deforestation causing forest fragmentation is a severe threat to the musk deer’s long-term survival. In XNNR, the habitat destruction has undoubtedly influenced the survival of alpine musk deer of XNNR, and contributed to the reduction of some populations and, in the long term, may be as serious a threat.

Although the Deforestation and plant-collecting have been forbidden in XNNR (Fig 44), which should be positive step improving the prospects for musk deer survival over its entire range. However, the conventional productive efficiency of local peoples in XNNR has been very low and locales live in relative poverty, so that local peoples have been exploring reserve to support their life (Fig 45-46) and the marginal agricultural activities has been existing (Fig 47). Therefore, if the impacts from the local communities remains, the core region of natural reserve will have been coming to be reduced and the habitat of musk deer has became degraded, fragmented, even lost.

(Fig.44. No Entry, Propagandizing by reserve managing bureau)

(Fig.45. Bamboo cutting by locals)  (Fig 46. Collected Pilose Asiabell Codonopsis lanceolata for sale)
5.2 Illegal hunting and steel-snares in XNNR

The Chinese government now pays much more attention to wildlife protection. It has launched a series of laws and regulations to preserve rare animals and their habitats, such as the Wildlife Protection Law, the Forestry Law and the Environmental Protection Law and so forth. The enacted laws protect musk deer populations to a certain extent. However, illegal hunting has been existing in distributive area including XNNR. Musk deer was illegally killed to harvest the musk sac which is of high market value.

Relatively, the poaching pressure in XNNR is strong, and there exist the illegal secret musk trading at the local timed market. Traditionally, musk deer are hunted with hand-made guns, traps and dogs in order to obtain the male’s musk sac. In the last two decades, poachers have begun to use modern guns and snares and the usual snare consists of a simple iron or steel wire laid in a circle (Fig 48), which is set along the path in an area of known musk deer activity, and tightens when the animal steps on it. In this way, large numbers of males, females and fawns are killed by snares, even though only males in breeding condition have any musk. With the expansion of snare use, the death rate of musk deer has shot up (Fig 49), and all species have been forced to the edge of extinction. During surveying, team members, local peoples and officials cleared up the snares in the belts(Fig 50).

Fig. 49 The debris of alpine musk deer in XNNR.

Fig. 50 Member was clearing away steel-snares established by poacher in XNNR.
5.3 Livestock

Furthermore, musk deer habitat degradation in XNNR also results from agricultural or animal husbandry activities (Fig.51). These human activities can impose disturbance to musk deer, and the livestocks can compete the resources with musk deer, and so can affect the musk deer’s normal behaviors such as seasonal migration. In XNNR, the nomadic husbandry practices play a key role in influencing the seasonal migrations of alpine musk deer.

(Fig.51. Livestocks in nature reserves)

5.4 Inappropriate management measures

5.4.1 Road and heavy traffic in XNNR

XNNR locates in counties, towns and villages, and is traffic core in surroundings. The blacktop from Yuzhong to Mapo lie through the whole nature reserve, and cut the whole core habitat into two parts. Traffic is very heavy especially in weekends and prime season of tourism (summer) (Fig 52).

(Fig.52. The blacktop road in XNNR)
XXNR locates in the arid area of northwestern China and the creek run along the road was the only water source for the wildlife there, including alpine musk deer. Therefore, musk deer was killed often by the traffic when it cross the road for water (Fig 53-55).

(Fig.53 Heavy traffic in XXNR)                                    (Fig.54 Snak killed by traffic)

(Fig.55 Killed by traffic)
5.42 Metal-mesh along the road

As XXNR is one of the famous scenic site in Gansu Province and the tourists swarm into reserve in weekends, holiday time and vacation season, esp. summer vacation, and all the tourists should buy the tickets of RMB 60 for reserve entry. However, XXNR is very spacious and it is very difficult to let every tourist buy tickets, therefore, local ministrative established meta-mesh along the road, which should be more than twenty Km. Metal-mesh made habitat cut as the same as the road, and prevent musk deer crossing the road and mesh for winter (Fig 56-58).

(Fig.56 Metal mesh in XNNR)                                (Fig.57Metal mesh along the road in XNNR)

(Fig.58 The small gate on the metal-msh for wildlife)
6 Ecotourism and the potential impacts on XNNR

XNNR is the forests and wild animals types of national nature reserve. Its areas is widely and there are many kinds of plants and animals, so it is important to the country and the region. The forest ecosystem has many serve values, the values are producing organism, conserving water, soils, fixing carbon synchronously releasing oxygen and cleaning air. The results indicated that conserving soils, stagnating dust and producing organism are dominating functions in Xinglongshan mountain nature reserve and the conserving water is significant to the region.

XNNR is called “the Most Famous Mountain of Gansu Province”. It consists of two mountains and a valley, namely Xinglong Mt. (east peak), Qiyun Mt (west peak) and Xinglong Valley between the two peaks. The peaks are high and grand covered with flourishing trees, brooks also run over it. Qiyun Mt is like a fairyland and is called Little Penglai in which the immortals inhabit in the myths. There are many cultural relics such as Grand Buddha Palace, Guansheng Palace, Shenmu Palace, etc. Genghis Khan’s coffin is also set there which adds the fame and mystery of Xinglong Mountain. Moreover, as Xinglongshan is one of the origin of Daojiao in China, so part of tourists would come to XNNR to enjoy the real culture of Daojiao (Fig 59-61).

![Fig 59 Front gate of XNNR, the scenic site](image1)

![Fig 60 Temple with Genghis Khan’s coffin](image2)

![Fig 61 Taoist was showing along the touring route to attract donation](image3)
Team members surveyed stall-keeper, tourists, local officials and peasants in XNNR by questionnaire, structured interviewing and semi-structured interviewing (Fig 62-63).

**Fig 62 Interviewing the taoist from outside of Gansu Province**

**Fig 63 Collected data of Eco-tourism in XNNR**
Eco-tourism surveying showed that the tourists are mainly middle aged and young men who have a middle or higher educational level, and that the tourists' sources are concentrated, they come from Lanzhou city, Chengguan town in Yuzhong county and the city of Baiyin or Dingxi; it is a good tour time from May to August and till October; the tour level is lower; the tourists' travel time concentrates one week or two days, and the tourists' travel time concentrates one day who arrived directly; the traffic tools are mainly cars, buses and taxies; the cost in the beauty spot is not too high (Fig 64-66).

As eco-tourism develops, the eco-awareness of the tourists becomes more and more important. Most of the tourists of Xinglongshan have strong eco-awareness, they thought the protection of musk deer is necessary and important. Some tourists demands a lot about the comfort level of the tour. they want the Scenic Area provide enough service to make them feel comfortable. Because of the booming tourism in XNNR, local communities benefit a lot and improve their living (Fig 67-72), however, the local people disagreed with economic construction and eco-
tourism development. They thought the national reserve affected local economy, for example, the wood harvesting became harder and harder, it affected some people’s income. On the subject of eco-tourism, the community residents knew little about it, they did not understand the related policy.

XNNR locates in western China, the relative poor undeveloped area of China. Under the economic pressure, the local government and reserve managing bureau need to develop tourism to increase income, from which, however, the local communities could not get the direct ecological compensation.
Furthermore, the tourism, especially in prime tourism season, could impose impacts on the wildlife, eg, the noise, litters, plant collecting, and after some tourists know about the value of musk and musk deer, more danger will be befallen for endangered musk deer (Fig 73-77).

Fig 73 Business showing in XNNR during tourism season

Fig 74 Business propagandizing

Fig 75 Skiing site of XNNR in winter
The protection of wildlife should involve people, involve ways that people are making their living, link people to nature, make them realize protect natural resources is to protect their living environment. Make Biodiversity Conservation publicly known, improve environmental awareness, educate the purpose of environment protection to management, residents and children, make environment protection of people's free will (Fig 78).
7. Education improving

The education improvement was conducted from during Sept to Dec. 2010, based on the musk deer farm located inside the XNNR (Fig.79). Four of team members participated in this voluntary teaching project, and all four were ecology graduate students of Central Minzu University. The purpose of this project was to tutor the local kids with their study, make their English and mandarin pronunciation better, encourage them to talk and communicate with other people, and to learn and understand more about the outside world. More important, we integrated the knowledge of nature conservation into the education activities, and aimed to improve the environmental consciousness level. We did our tutoring on nights, and in total, 30 children from the local families joined this activities (Fig.80-81).

*Fig 79 Musk deer farm located in XNNR*  
*Fig 80 Local pupils*

> Fig 81 One member was tutoring English pronunciation

English lesson: one of us was responsible for the phonogram, grammar and everyday English (Fig 81-82), the rest of us listen to the class, ask some heuristic questions, discuss some related questions to motivate the enthusiasm of the students. We involved the kids to the discussion so they can work on their response and their communication skills. Our classroom atmosphere was good, active and alive, the kids were not as serious as they usually behaved.
during their school time, they could issue their opinions and questions, and the teaching effect was really good.

*Fig 82 Education improving*

The Q&A section was next to the English section, when their enthusiasm was high, they brought their questions from their schools and homework to ask for our answers, as we answered those questions, we review the basic knowledge involved to ensure the students can understand those knowledge.

Beside all of those above, we always organize the local communities, team members and pupils to sit together to communicate the pupils’ recent study issues, locals can talk about their own opinions to find a better suited way for their kids (Fig 83).

*Fig 83 Team member, local pupil and education improving*

In our lessons, we mix the environment protection and biodiversity conservation awareness to pupils, and we tried to improve their environmental knowledge, methods of nature conservation and the value of their environment, ie XNNR.

More often than not, the local kids can find teacher and ask their questions any time they want, we tried to tell them about city and college lives, encourage them to study hard and cherish their beautiful environment and value wildlife. Those personal communications made us very good friends.
Fig 84 Local environment and wildlife

Fig 85 Publicizing in the field

Fig 86 Propagandizing on site
8. Social economical surveying in local communities

The surveys were conducted by the integrated methods of ethnological, anthropological, economical and human ecological methods, in which door by door semi-structured surveying, inquiring at the local tourism market and interviewing with local peoples and local authorities etc were utilized to collect the information and data of the social economical structure and status in XNNR (Fig 87).
Extensive surveying was conducted in local authorities, and partly focus on middle and lower level management personnel, most of them have been working there for decades (10-30 years) with lots of experiences. The result showed that more than 70% people knew that Alpine musk deer needed protection through policy improving and management staff meetings (Fig.88-91).

From what we saw, although there were some protective measures in XNNR. There were fences to stop trespassing, there were billboards to attract people’s attentions, there were specialized personnel handled public broadcasting from village to village, specialized personnel did perambulation of the whole reserve area regularly. In XNNR, however, the public environmental propaganda was not really developed, and the effect of the protecting measures existed were very limited. All the personnel involved in this research agreed that they, the administration should take the main responsibility of musk deer protection with the help of people who is living there.
There also were rewards for protectors and punishments for poachers. But the measures still need some work, for example, one of the measures, the protective fences were built to stop trespassing, which also made one big protect area became two parts, in some areas, only one of two parts has water, it changed the regular routes of musk deer and separated them from water (Fig 93).

Therefore, despite the responsible thought, due to reasons like lack of publicity, lack of advanced research, lack of special fund support and the negative effect of publicity, etc. The protection of musk deer still needs a lot of work.
We also did our research in the musk deer domestication company (musk deer farm), which was established in 1990 for the ex situ protection of musk deer and the sustainable musk extracting (Fig 94). We interviewed the manager, staff and keepers from the local communities (Fig 95), who worked with musk deer and made a living out of it, even so. The interviewees thought that the purposes of musk deer farming were to increase the number of musk deer, explore new research methods and for company’s development.

Fig. 94 Musk deer farm and captive musk deer located in XXNR

Fig. 95 Interviewing with musk deer keepers

All musk deer keepers did not think the domestication can help local economy, they didn’t think the domestication can help making other people’s lives better. They thought the domestication of musk deer was hard enough due to reasons like sickness, musk production and farrowing rate, etc. Because of economic benefit reasons, they like their domesticate methods instead of domestication based on community involvement. And the company management cared more about the economic benefit factors than the actual protection factors.
In our social-economical surveying in communities, we visited local people door by door to collect the information about their living, production etc., and discuss the potential substitute production style with them to reduce the pressure on musk deer from their conventional production, and our team members used to participate into the local productivities to find the influencing factors limited the local economical development, and investigations were combined by means of questionnaire surveying to find relevant information of local households (Fig. 96), and the results showed that most local residents knew musk deer was protected by law, from the ways they knew about it, most of them learnt this information by news media, mainly TV, government broadcasting, a few of them learnt it by book.

Fig. 96 Interviewing with local peasants
Most of the interviewees were local peasants, so in order to make good community involvement, the public broadcasting, educating and economic development toward peasants should be the priority. They can fully support the development of the reserve area when their economy level and education level went higher. Most of the community residents had great natural protection consciousness, 85% people thought it was necessary to protect wildlife, especially wild musk deer. 70% Individual businessmen believe the development of technology can support environment protection (Fig 97-98).

Fig 97  Interviewing at Xiakou, buffering area of XNNR

Fig 98  Interviewing on the topic of local livelihood in local Hui Peoples

As the knowledge of the interviewee about the function of the reserve area, most people thought it was important to protect nature, environment and wildlife, some people thought the reserve area could not support and help the development of local economy. They knew even less about entertainment area and teaching program. It probably related to the limited publicization of local government and officials.

Because of the abundant flowering-plant resources, the bee-breeding (apiculture) has been very popular in XNNR, and the breeding methods is very primitive, so the efficiencies and production scale is low, but the honey is of very high quanlity, which was sold to the tourists and the local people (Fig.99). As the low impacts on the habitats and population of musk deer, added that the methods and production of bee breeding could be improved, then bee-breeding could be profitable to develop the local communities. However, the local stock-breeding and agricultural activities pay huge influences to the local nature conservation, which should be managed with more scientific mode (Fig.100-104).

**Fig 99** Bee farming and honey sale in core area XNNR

**Fig 100** Local stock-breeding and agriculture

**Fig 101** Member and local guide
**Fig 102 One of the system data sheets (Community surveying)**
Above all, though the improvement of residents’ educational level was very positive towards the protection of musk deer, the local government should use various methods that based on the differences of the recipients during their promotion of new protection policies and laws. It can help them get their ideal effect.

The management of the reserve area should make their policies based on the actual conditions, raise funds in various ways, make anti-poaching socialization become more and more real, make resource protection Popularized.
9 Published paper and submitted report

- We collected related data and analysed the information, on the bases of which, two academic paper have been composing and the the final report has been submitted to local managing bureau of XNNR/ Report: Habitat, population and sustainable conservation of Alpine musk deer in Xinglongshan National Nature Reserve;
- Furthermore, 6 public presebtations were made (Fig 105).

10. Financial report

Detailed financial expending is listed in following table:

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<tr>
<td>Traffic in the reserve and surrounding areas</td>
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<td>Rent jeep, tractor and motor;</td>
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<tr>
<td>Fee for Guide</td>
<td>£3000</td>
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<tr>
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<td>£1,000</td>
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**TOTAL**                                    | **£ 15,000** | £12000 was funded by RSG, and other £3000.00 was funded by “985 Research Project” of Minzu University of Chian. |

11 Acknowledgement

This research was supported by The Rufford Small Grants for Nature Conservation (RSG).