

Dynamic Research on the Habitat and Population Quantity of Mongolian Wild Ass (*Equus Hemionus*) in Eastern Jungar Basin

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Abstract. The Mongolian wild ass is the wildlife under National key protection in class 1. The Xinjiang Kalamaili Mountain Ungulate Nature Reserve in the east of the Jungar basin is the largest distribution area of Mongolian wild ass in China. Due to historical reasons, human activities in the reserve are increasing, which has a great adverse effect on wildlife including Mongolian wild ass. With the increasing attention of the state to the protection of wildlife resources and the ecological environment, more strict protection measures have been implemented in the reserve, and comprehensive improvement has been carried out. To intuitively show the implementation effect of these protective measures and work, the habitat suitability of Mongolian wild ass in reserve was evaluated in 2016 and early 2020. In addition, a systematic investigation was conducted on the population of Mongolian wild asses in the reserve. The results show that the suitable and sub-suitable habitats of Mongolian wild ass increased the 3720.51 km² in 2020 compared with 2016, with the area proportion of reserve increasing from 83.3% to 97.9%, and the population quantity increased from 2144 ± 562 to 3197 ± 842, reflecting the influencing factors of Mongolian wild ass population change, which is of great significance for the future to formulate scientific and reasonable protection countermeasures, and it plays an important role in promoting the construction of the Kalamaili National Park.

Keywords: Kashan Reserve, Mongolian wild ass, Population quantity, Habitat

Mongolian wild ass belongs to Mammalia, Perissodactyla and Equidae. It is National key protection wildlife and is listed as endangered (EN) in the Red List of the World Conservation Union (IUCN). Listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Mongolian wild asses are mainly distributed in Central and West Asian countries, and in China, they are mainly distributed in Inner Mongolia, Gansu, and Xinjiang, among which the Kalamaili Mountain Ungulate Wildlife Nature Reserve in Xinjiang (hereinafter referred to as 'Kashan Reserve') in the eastern Jungar Basin is the largest distribution area of Mongolian wild asses in China[1-4]. Kashan Reserve is on the eastern margin of Jungar Basin, with the geographical coordinates of 88°30' -90°03' E and 44°40' -46°00' N, with a total area of 14856.48 km² (Figure 1). Kashan Reserve was established in 1982 with the approval of the People's Government of Xinjiang Uygur Autonomous Region. It is a super-large reserve. Kashan Reserve is in the middle latitude region of the northern hemisphere, the hinterland of the Eurasian continent, affected by the north temperate climate and the cold air of the Arctic Ocean, in the climate of the middle temperate continental dry climate. Because of the deep inland, compared with other areas of the same latitude, the continental climate is very significant, showing temperature extremes, characterized by cold and long winters, hot and short summers, dry and rainy spring, and warm and cool autumn. The annual average temperature is between 2.5 and 8°C, and the frost-free period is 117 days. The annual precipitation of the reserve is 159mm, and the evaporation is 2090mm. The ratio of precipitation to evaporation is 1:13, and the minimum humidity of each month is lower than 20%. Kashan Reserve is a temperate desert area with sparse vegetation, which is mainly composed of ultra-xerophytic, xerophytic shrubs, small semi-shrubs, and xerophytic annual and perennial herbs[5]. The main plant species are Chenopodiaceae, Asteraceae, Legumes, Polygonaceous, Gramineae, Tamariaceae, Ephedraceae, and etc. The dominant species that could form large communities were *Haloxylon ammodendron*, *Ceratoides latens*, *Anabasis salsa*, *Seriphidium terrae-albae*, *Stipa glareosa*, *Reaumuria songarica*, and etc., which are also important food sources for ungulate wild animals such as Mongolian wild ass[5-6].

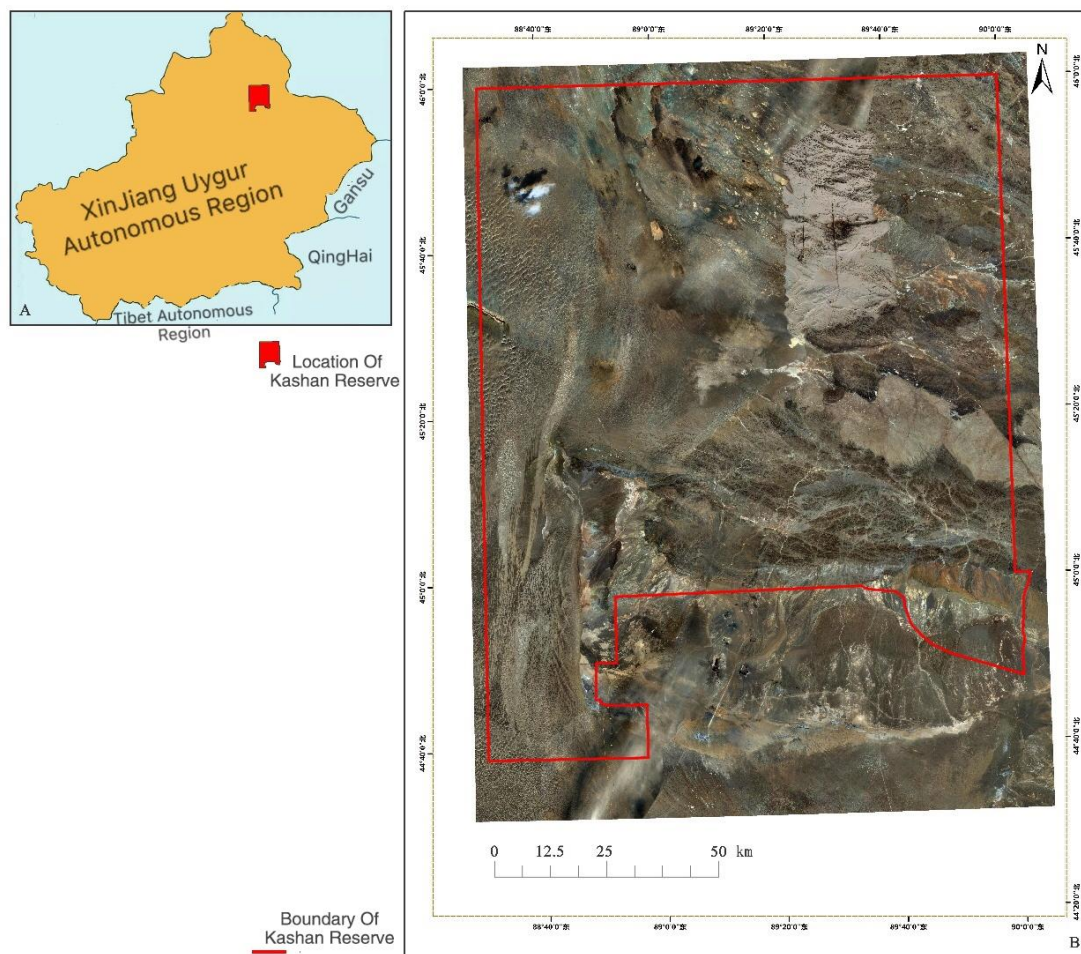


Figure 1. Location of Kashan Reserve: regional position (A) and satellite remote sensing imagery (B)

Habitat is a place for wild animals to survive and reproduce. It provides them with essential materials for life activities such as food and water and space for various activities. Therefore, the quality of habitat can directly affect the geographical distribution and population changes of wild animals. The habitat of the Mongolian wild ass is mainly in the Gobi hilly area with a water source, and its food includes *Stipa* and *Ceratoides*[3,6,8]. Lin Jie and others[9] conducted field investigations in Kashan Reserve every month from 2005 to 2011, combined with the research of other ungulates[10]. Through the direct observation of Mongolian wild asses and the identification of footprints, feces, plant eating traces and etc, The preference of Mongolian wild ass for natural environmental conditions and human disturbance in habitat was determined, and the spatial activity information database of Mongolian wild ass was established. Based on the analysis of the frequency of Mongolian wild asses in different distances from water sources, different vegetation types and different areas affected by human activities, the habitat suitability of this region was evaluated, and the evaluation criteria for the habitat quality of Mongolian wild asses were established[9,11].

For historical reasons, there are also several human settlements within the Kashan Reserve, as well as a wintering ground for livestock used by local herders. With the development of the local economy, human activities in the Kashan Reserve have intensified, causing a great negative impact on wildlife, including the Mongolian wild ass. A systematic survey of the number of Mongolian wild asses in Kashan Reserve showed that the number of Mongolian wild asses decreased significantly. In May 2001, the distribution of Mongolian wild asses was investigated, and the population was estimated to be 2632-4200[12-13]. From September to October 2005, Yue Jianbing and Hu Defu et al. conducted a line transect survey on Mongolian wild asses in Kashan Reserve, and the estimated number was 4,400 to 6,068[14]. From September 2006 to the beginning of

December 2007, Chu Hongjun, Jiang Zhigang, Ge Yan, et al. conducted a cross-sectional sampling survey and estimated the number of Mongolian wild asses to be 3379-5318[15]. From April to May and August to September 2011, Peng Xiangqian conducted a line transect survey on Mongolian wild asses in Kashan Reserve and estimated that the number of Mongolian wild asses was 1592 to 2201[13].

In recent years, the state has paid increasing attention to the protection of wild animal and plant resources and the ecological environment. Since 2015, the local government has gradually closed the mining and related industries in the reserve and designated the Kamust industrial park in the reserve and the dinosaur silicon wood garden in the Zhundong industrial park to the southeast of the reserve (a total area of 1851.83 km²) as the Kashan Reserve, while canceling the related human settlements. By the beginning of 2020, only a small number of herdsmen were left in the Kashan Reserve to care for their livestock in winter. To understand the effectiveness of these conservation measures, we evaluated the habitat suitability of Mongolian wild asses in Kashan Reserve based on data from 2016 and late 2019 to early 2020 and conducted two systematic surveys of the Mongolian wild asses' population in Kashan Reserve in 2016 and late 2019 to early 2020. Through these evaluations, we hope to explain the influencing factors of the population change of the Mongolian wild ass, which is of great significance for the development of scientific and reasonable conservation strategies in the future.

1. Research Methods

1.1 Habitat Analysis

According to the habitat suitability analysis model and method established in previous scientific studies for Kashan Reserve[9,11], the slope is an important influencing factor. The slope in this study was analyzed according to the topographic data of ASTER GDEM. The slope threshold was set as 0°-5° as suitable habitat, 5°-15° as sub-suitable habitat, and greater than 15° as not suitable habitat. Another major factor is the distance to the water source. The data of water sources in the Kashan Reserve were confirmed and set according to the statistical data of investigation and monitoring provided by the Kashan protection and management center, and the corresponding thresholds were defined as suitable habitat, sub-suitable habitat, and unsuitable habitat within 15 km, 15-30 km and more than 30 km from the nearest water source. The vegetation type is an important biological factor affecting the habitat selection of wild animals. Vegetation types in the Kashan Reserve refer to the classification principles of 'Vegetation in China' and 'Vegetation and Its Utilization in Xinjiang'. According to previous research results[9,11], as well as the comprehensive scientific investigation report of 2016 and the comprehensive assessment data of 2020 in Kashan Reserve, it can be summarized into six vegetation formations: Form. *Stipa capillata*, Form. *Haloxylon ammodendron*, Form. *Ceratoides latens*, Form. *Haloxylon persicum*, Form. *Anabasis salsa* and Form. *Ephedra sinica*. Relevant thresholds are set according to the food preference of Mongolian wild asses: Form. *Stipa capillata* and Form. *Haloxylon ammodendron* are suitable habitats, Form. *Ceratoides latens* is sub-suitable habitats, other formations are not suitable habitat.

Based on the clear slope, vegetation type, water source, and other basic data, ArcGIS software is used as a tool, and evaluation criteria are used for calculation and analysis[16]. The Kashan Reserve was divided into grids with a spatial resolution of 30m×30m, and habitat suitability status was analyzed for each grid. Firstly, single factor factors such as water source point, slope, and vegetation type were assigned values of 2, 1 and 0 respectively according to suitability, sub-suitability, unsuitability, and assigned weights. The weight of the water source point was 1, the weight of vegetation type was 0.5, and the weight of slope was 0.75. Then the factors were multiplied and re-graded according to the results. The maximum value was 2 (suitable), 0 was still 0 (not suitable), and the rest was 1 (sub-suitable). The potential habitat distribution map was calculated and superimposed. According to data in the 2016-2020 period, the mountain refuge no obvious changes, such as climate, rainfall, and human activities have also been strict management,

reserve overall maintained a more natural state, protect the distribution of vegetation types in the area there is no obvious change; According to the statistics of the management center of Kashan Reserve, there were 60 water source sites in Kashan Reserve in 2016. By 2020, 7 new water source sites will be added within the Kashan Reserve and 13 new water source sites will be added outside the reserve, which will further expand the suitable habitat for Mongolian wild asses.

Human activities are also important factors affecting wildlife. Human activities in Kashan Reserve mainly come from roads/railways, various mining sites, related facilities and buildings, winter herdsman's residential sites, etc. In the habitat evaluation, the corresponding threshold will be set according to the distance from various human activity sites: within 1200m, there is a disturbance, and above 1200m, there is no disturbance. The influence intensity of human activity interference factors was analyzed, and the spatial distribution characteristics of human activity influence intensity were determined. Firstly, the distance between the discovery sites of wild animals such as Mongolian wild asses and human activity areas was obtained according to the distribution of roads, winter grazing sites, and mining sites. Then, the influence intensity of different human activities was assigned to 0 (human interference) and 1 (no human interference), respectively. The spatial distribution characteristics of the actual habitat of the Mongolian wild ass in Kashan Reserve were obtained by superposition analysis of the potential habitat distribution map and the comprehensive map of human activities.

1.2 Population survey method

According to previous research work[13,17-20], the line transect method was determined to be used for field investigation. A total of 150 random transect lines were laid in the survey from May to June 2016. With the expansion of the Kashan Reserve and the reduction of human disturbance factors, 210 random transect lines were set in the survey from December 2019 to January 2020 to cover various habitat types and important habitats as much as possible. The average length of the transect line is 20km, and the total length of the two surveys is 3000km and 4200km respectively. According to the behavior and distribution characteristics of the Mongolian wild ass[12-14,21-23] and the overall distribution of the habitat in Kashan reserve[9,11], the two surveys of the Mongolian wild ass population were conducted in Kashan reserve and the former industrial park of Kamust, etc. That is, the total area of the Mongolian wild ass population was calculated from the end of 2019 to the beginning of 2020 within the protection and management scope of Kashan Reserve.

The survey area was relatively flat and accessible to vehicles, and the investigators were divided into two groups, traveling at a relatively constant speed (about 30 km/h) along a predetermined sample line, using binoculars, we observed the Mongolian wild ass within 3 km on both sides of the sample line, recorded and counted the times of finding the target animals, and recorded the number, age, and sex of the individuals in each group, the distance between the Laser rangefinder and the observers was measured, and if the distance was beyond the range of the Laser rangefinder, the distance was judged empirically by visual observation. The Angle between the forward direction of the line transect and the target animal was measured using a compass instrument. For indoor analysis, the Angle was converted to a vertical distance according to the observed distance and Angle. Environmental factors such as weather conditions and the location of target animals were also recorded.

The daily recorded and statistical data were collected and sorted, and the data processing and analysis were carried out by using the software Distance, which has been widely used in the wild animal quantity survey[24]. The population density of Mongolian wild ass in Kashan Reserve was estimated, and the calculation formula was as follows:

$$D = \frac{nf(0)E(s)}{2L}$$

Where: D is the population density, that is, the number of individuals of Mongolian wild ass per km²; n is the number of animal groups or individuals of Mongolian wild ass observed; f(0) is the

probability density function with a vertical distance equal to zero; $E(s)$ is the size of animal groups of Mongolian wild ass observed; L is the total length of transect lines.

2. Research Results

2.1 Habitat change

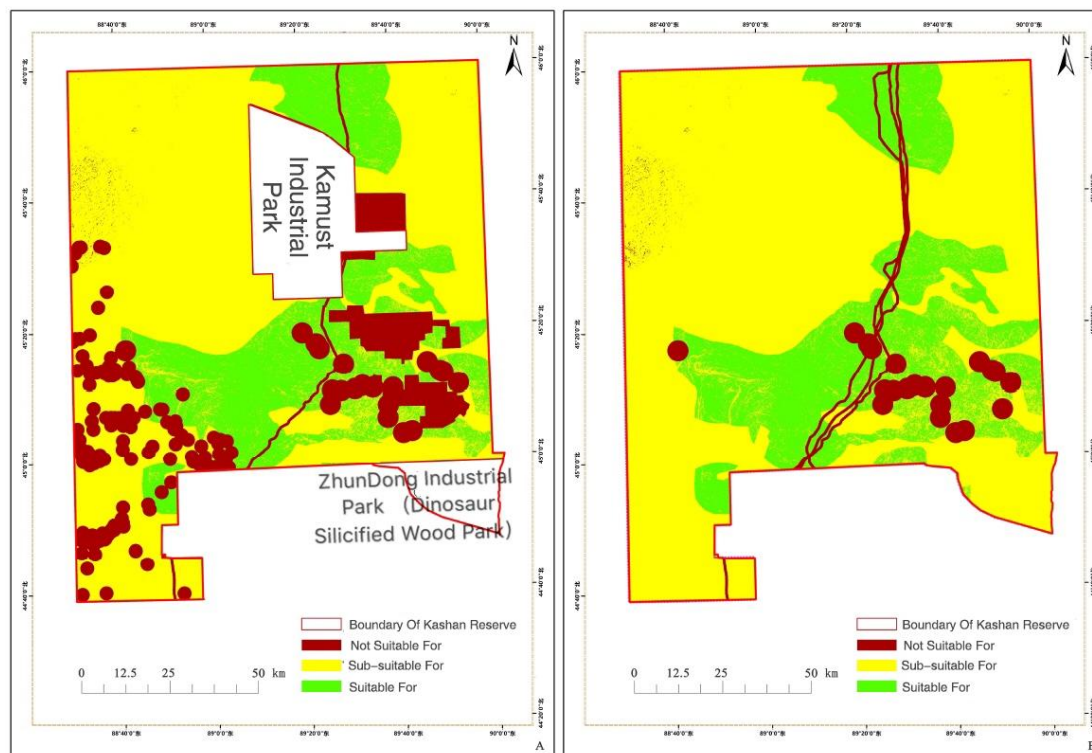


Figure 2. Habitat suitability and human disturbance in 2016 (A) and in 2020 (B)

By figure 2, you can see that the Kashan Reserve in the absence of human activities interferes with ideally in 2016 and 2020, habitat suitability of distribution, the main change is in the south of Kashan Reserve, because of the new construction of wildlife protection facilities, expansion in the scope of water elements such as radiation, a part of sub-suitable habitats into the suitable habitat, The total area is about 47 km². The area affected by human activities differed significantly between 2016 and 2020 (Figure 2) when all industrial activities such as mining ceased, and only a few pastoralist wintering grounds remained in the reserve. Compared with 2016, the total proportion of suitable and sub-suitable habitats increased from 83.3% to 97.9% in 2020 (Table 1).

Table 1. Statistic of habitat area in Kashan Nature Reserve

Year	Area/km ²			
	Reserve	Suitable for	Sub-suitable for	Not suitable for
In 2016,	13004.65	2742.74	8086.42	2175.49
In 2020,	14856.48	3555.73	10993.94	306.81

2.2 Population changes

During the field survey from May to June 2016, a total of 68 wild asses populations were observed, with the largest population number of 300. A total of 2360 wild asses were observed and recorded in the survey. The density of Mongolian wild asses in Kashan Reserve in 2016 was $0.144 \pm 0.038 / \text{km}^2$. It can be calculated that the population of Mongolia wild asses in Kashan Reserve is about 2144 ± 562 . In the winter field survey from the end of 2019 to the beginning of 2020, 110 wild ass populations were observed, with the largest population reaching 523. A total of 5693 wild asses were observed and recorded in the survey, and the density of wild asses was $0.215 \pm 0.057 / \text{km}^2$ calculated by the model. Therefore, the population number of wild asses in Kashan Reserve was 3197 ± 842 , which was significantly increased compared with that in 2016. See Table 2 for the data of the two surveys.

Table 2. Statistic of Mongolian wild ass survey data

Survey content	The survey of time	
	From May to June 2016	From December 2019 to January 2020
Transect line number	150.	210.
Sample line length	About 3000 km	About 4200 km
Record the numbers of Mongolian wild ass	2360	5693
The number of Mongolian wild ass population was recorded	68	110
A single transect line was used to record the number of Mongolian wild asses	15.73 unit/line	27.11 unit/line
A single transect was used to record the population number	0.45	0.52
Maximum population size	300	523
The number of each group was recorded daily	1.0 times	1.3 times
Density of Mongolian wild asses	$0.144 \pm 0.038 / \text{km}^2$	$0.215 \pm 0.057 / \text{km}^2$
Mongolian wild ass number	2144 ± 562	3197 ± 842

In the survey in 2016, Mongolian wild asses were mainly distributed on the east and west sides of the middle and north of G216 road and the grasslands with high vegetation coverage around the industrial park of Kamust. The main ground cover plants included *Stipa capillata*, *Haloxylon ammodron*, etc., with vegetation coverage ranging from 7% to 36%. In the habitats with low vegetation coverage and few water sources, such as Gobi and desert, the population number of Mongolian wild asses was significantly lower than that in the areas with high vegetation coverage, which indicated the dependence of Mongolian wild asses on food sources and drinking water sources in the typical desert ecosystem of Kashan Reserve. At the same time 2016 survey time is in late May and early June, this time is in Mongolia wild ass breeding period, so in the process of investigation Mongolia wild ass shows high alertness, its warning distance is 2 km above. At the end of the investigation, with the increase of temperature and the decrease of precipitation, as well as the emergence of newborn asses, the demand and dependence of Mongolian wild asses on water sources increased, and there was an obvious trend to move to water sources.

In the winter field survey from the end of 2019 to the beginning of 2020, because the population of Mongolian wild asses is relatively more concentrated in winter, it is easier to form a large population, so the size of the largest population recorded increased significantly. At the same time, the population number of Mongolian wild asses was close to the data of other studies in the summer of 2019 (3246 ± 575)[22], which showed the stability of the population number of Mongolian wild asses in the Kashan Reserve in different seasons. On the other hand, it also shows that the Mongolian wild ass population is gradually recovering and can further form a large-scale group

after the improvement, adjustment, and construction of the Kashan Reserve in recent years. In the field survey from the end of 2019 to the beginning of 2020, the main distribution area of Mongolian wild ass is consistent with the description in previous studies[12-13,15], obviously shifted to the southern of Kashan Reserve. In this investigation, the Mongolian wild ass observation records appeared in the former Kamust industrial park and even further north of Kashan Reserve, The results showed that the habitat range of the Mongolian wild ass in the reserve had a certain tendency to expand northward in winter.

3. Discussion

3.1 Seasonal distribution of Mongolian wild ass population

According to the long-term survey and monitoring study of Kashan Reserve[12-13,15], as well as the comprehensive scientific investigation and assessment data in Kashan Reserve, it is shown that: The activity range of Mongolian wild asses in spring is more closely related to a water source, mainly near the former industrial park of Kamust and the east of G216 road in the north of Kashan Reserve, and the area of frequent activities of Mongolian wild asses in the northwest of Kamust industrial park. Mongolian wild ass populations in summer activities are relatively scattered, because summer green plants are rich, the relationship between the range of activities and the location of water sources is not as close as that before the vegetation returns to green in spring. In autumn, Mongolian wild asses migrated to Kalamaili Mountain in the southeast of Kashan Reserve, but the migration channel of Mongolian wild asses was wide and the route fidelity was poor. The activities of Mongolian wild asses were relatively frequent in the areas on both sides of G216 road, and a large population of Mongolian wild asses could be found. Mongolian wild asses mainly lived in the desert in the south of Kashan Reserve in winter. After the development and construction of Zhundong industrial park, the winter activities of Mongolian wild asses are mainly distributed in the north of the development zone.

The activity distribution of Mongolia wild ass in this study, compared with previous findings and infrared cameras monitoring results[23], and the distribution of the four seasons of Mongolia wild ass populations, the main distribution area is consistent. In spring and summer, activity rate of Mongolia wild ass in the former industrial park of Kamust and the surrounding areas is bigger, and the main distribution area has a more obvious trend to the south and east, which is mainly due to the increase of summer temperature, the Mongolian wild ass has a more obvious tendency to the water source. Other studies also found that the Kashan Reserve suitability habitat area is mainly distributed in northern and central on both sides of G216 road[11], showed that the utilization rate of Mongolian wild ass in this area is high in spring, and this period is important breed season of Mongolia wild ass, so this region as the areas with the highest suitable habitat, need to ensure the integrity of the breeding habitat of the Mongolian wild ass in spring and summer, and prevent the threat of external human disturbance to the breeding and giving birth of the Mongolian wild ass.

According to the previous survey data and the results of this field survey, it can be found that after the breeding of wild asses in spring, with the arrival of summer and the rise of temperature, the tropism and dependence of Mongolian wild asses on water sources are enhanced, and the population of Mongolian wild asses begins to move to the main distribution points of water sources. At the same time, the winter field survey from 2019 to 2020 in this study also found that the population of Mongolian wild asses was more distributed in the southern area of Kashan Reserve in winter, indicating that this area was mainly used as a temporary habitat for Mongolian wild asses to overwinter. From the population distribution of Mongolia wild ass in autumn and winter, can be found because the ZhunDong industrial park, industrial and mining enterprises, railway, and highway construction cause certain influence on Mongolia wild ass population migration, it needs through the construction and improvement of the ecological corridors, safeguard Mongolia wild seasonal migration channels unblocked.

3.2 Habitat Impact

Habitat destruction is one of the important factors leading to the decline and even extinction of wild animal populations[25]. Mongolian wild asses mainly live in the Gobi hilly areas with a gentle slope, feeding on plants such as stipa and ceratioids, and water source is also essential for their survival[3,6,8]. Human activities will have a negative impact on wildlife. Compared with 2020, there were many human activities (mining industry, settlements, etc.) in Kashan Reserve in 2016, which directly affected the population of Mongolian wild asses. In 2016, the population of Mongolian wild asses was 2144 ± 562 , and the density was $0.144 / \text{km}^2$. From the end of 2019 to the beginning of 2020, the number of Mongolian wild asses was 3197 ± 842 , and the density reached $0.215 / \text{km}^2$. According to previous studies[26] and the results of investigations[12-15] over the years (Figure 3), it can also be seen that human activities have adverse effects on wild animals such as the Mongolian wild ass. Before 2005, the population of Mongolian wild asses showed an overall upward trend, while from 2005 to 2011, there was a significant decline in the population of Mongolian wild asses (Figure 3). The period 2005-2011 is the period of industrial park construction and mineral and oil exploration and exploitation in and around the Kashan reserve. From 2016 to 2020, the increase in the number of Mongolian wild asses benefited from the stop of relevant engineering construction, and the habitat environment was better improved[27]. At present, there are also wintering spots for herdsmen's livestock in Kashan Reserve. With the gradual implementation of the grazing ban policy in the future, the number of Mongolian wild asses in the Kashan Reserve is expected to rise further. There are also several rare ungulates in the Kashan Reserve, such as Przewalski's horse (*Equus ferus*) and Goitered gazelle (*Gazella subgutturosa*)[28-31]. Their lifestyle is like that of the Mongolian wild ass, and the decline in human activities will undoubtedly provide a favorable environment for the development of their populations.

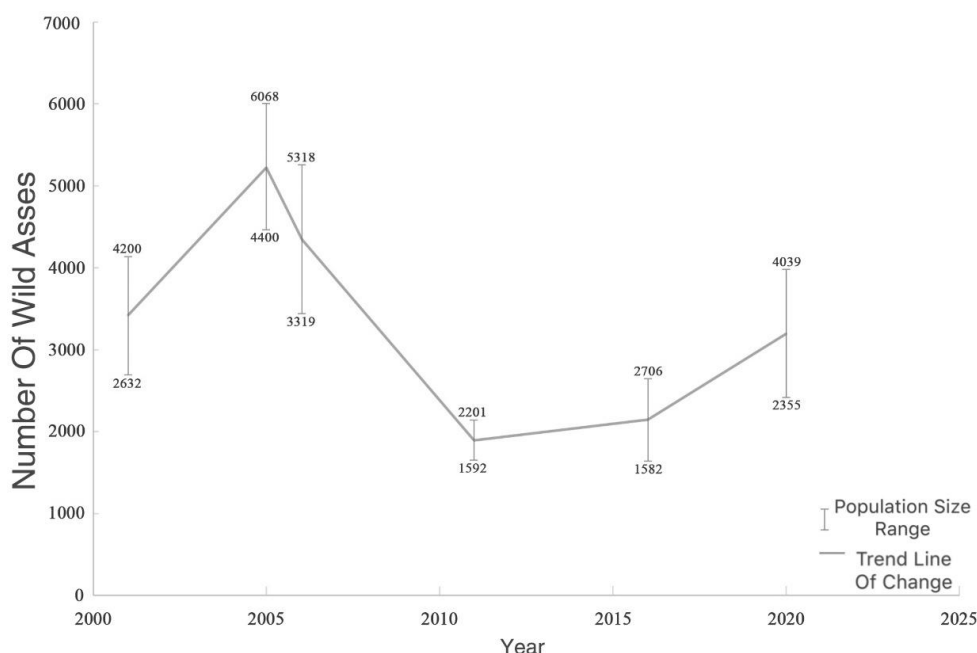


Figure 3. Changes of Mongolian wild ass population quantity

In conclusion, the main threat factors of ungulate wildlife such as Mongolian wild asses in Kashan Reserve come from the disturbance of human activities. In May 2022, the National Park Administration officially approved the creation of Kalamaili National Park, and the protection and management of Kashan Reserve will be further promoted. Therefore, strengthening the supervision and management of Kashan Reserve according to law, strengthening the supervision of human activities, and restricting the human activities around the Kashan Reserve should be the focus of

protection at this stage. In the future, the gradual promotion of grazing prohibition measures and the moderate construction of water sources in Kashan Reserve can provide a habitat and living space for the survival and reproduction of wild animals and the population development and will also play a very positive role in the construction, protection, and management of national parks.

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