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The current state of the saiga (*Saiga tatarica* L.) population in Betpak-Dala (Kazakhstan)

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ABSTRACT. The objective of this research is to address saiga conservation challenges amid significant anthropogenic pressures through a population model-based approach. The study involved an analysis of herd composition in terms of sex, age, and size over the years 2019-2022, with a focus on lamb weight measurements in 2022. Notably, 2021 witnessed a substantial decline in offspring numbers, with lambs being three times scarcer compared to 2020 and 5.2 times fewer than in 2022 ($p \leqslant 0.05$). Male saigas exhibited a 3.1-fold reduction in birth rates in 2021 relative to 2020 and a 5.6-fold decrease compared to 2022 ($p < 0.05$). The fluctuations in the number of females and males across the three years were found to be statistically comparable ($p \geqslant 0.05$). Since 2022, there has been a notable increase in the size of saiga herds, with counts reaching 450-500 animals compared to 2019-2020 ($p \leqslant 0.05$). The observation identified a total of 93 saiga herds, with six of them consisting of more than 1,000 antelopes. The augmentation of male presence within herds is anticipated to contribute to sustaining saiga population growth. Achieving this outcome may necessitate the implementation of captive breeding initiatives or an integrated approach.

Keywords: saiga; cubs; population; herds; model population.

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Introduction

Saigas are critically endangered antelopes belonging to the Artiodactyla order. They inhabit the steppes and semi-desert regions of five countries: Russia, Kazakhstan, Uzbekistan, Turkmenistan, and Mongolia (Saiga tatarica), as well as China and Mongolia (Saiga mongolica). These mammals exhibit distinctive features with thin legs and robust bodies, and their physical characteristics vary in heights ranging from 0.60 to 0.80 m, body lengths from 1.1 to 1.4 m, tail lengths from 0.08 to 0.12 m, and weights between 22 and 56 kilograms. Notably, males are slightly larger than females. In the wild, male saigas have an average lifespan of about 7 years, while females can reach 9-10 years. Under captive conditions, their life expectancy can extend up to 12 years (Milner-Gulland & Philipson, 2023).

Saigas live in steppe and semi-desert zones and tend to favour areas with hard stone or clay soils that facilitate their movements. They are known to form herds, often ranging from 40 to 1000 individuals, with no apparent hierarchical leadership. These herds engage in activities such as grazing, visiting watering holes, and seasonal migrations driven by rainfall patterns in search of greener pastures (Milner-Gulland, 2003; Basybekov et al., 2018).

Despite their adaptability, saigas face severe threats to their survival. Human activities, including habitat degradation due to land use changes, climate change, and rampant poaching, have taken a toll on their populations. Climate-related challenges such as harsh winters with heavy snow cover and deadly summer droughts further compound their struggles. Additionally, diseases and parasites have also been observed to affect saiga populations (Milner-Gulland et al., 2020; Abisheva et al., 2022).

The International Union for Conservation of Nature (IUCN) recognizes the critical status of saiga antelopes, highlighting the urgent need for conservation efforts (IUCN Red List). The IUCN has classified saiga antelopes as critically endangered (International Union for Conservation of Nature [IUCN], 2008), underlining

the urgency of conservation efforts. The Betpak-Dala population, residing within the Aktobe region of Kazakhstan, has been particularly susceptible to these challenges, and its conservation status mirrors the broader predicament of saiga antelopes (IUCN, 2008; CMS, 2010; 2023).

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To address this concern, countries within the saiga's range have signed a Memorandum of Understanding under the Convention on Conservation of Migratory Species of Animals (CMS, 2010; 2023; Kashinina, Lushchekina, Sorokin, Tarasyan, & Kholodova, 2023).

Several hypotheses attempt to explain the saiga population decline. Some suggest cyclical population fluctuations occurring over extended periods (Rey-Iglesia et al., 2022), while others attribute it to insufficient protection and uncontrolled hunting (Liu et al., 2019). Changes in vegetation cover within saiga habitats have also been proposed as a contributing factor (Abaturov, Dzhapova, Kazmin, Ajusheva, & Dzhapova, 2019; Maikanov et al., 2020a). These hypotheses necessitate empirical data to evaluate their validity.

Uncontrolled poaching stands out as the primary threat to saiga populations, particularly in the Northwestern Caspian region of Russia. The reduction in agricultural subsidies following the Soviet Union's collapse and the lack of alternative livelihoods have driven local residents to poaching for sustenance (Wang & Jin, 2019). Similar trends are observed in Kazakhstan and Uzbekistan (Myrzabaev, Gongalsky, Ibraibekov, Britko, & Kinayatov, 2019). However, changes in vegetation cover and an increase in the frequency of fires over the past two decades also pose significant challenges to saiga habitats.

Saiga populations endure various stressors, including natural and climatic factors such as droughts and the obstruction of migration routes by dams, biological factors like diseases, parasites, and predators, and anthropogenic pressures stemming from poaching and commercial activities (Ding, Zheng, Jin, & Liu, 2020). Furthermore, contaminated pastures may expose herbivores to parasite eggs, with the environmental conditions affecting infection dynamics (Milner-Gulland et al., 2020).

The steppe region's weather instability, characterized by abrupt temperature fluctuations and daily weather changes, poses additional challenges (Grachev, Meldebekov, & Bekenov, 2009). Preserving this unique steppe landscape is crucial for saiga conservation.

Saiga population monitoring presents a complex challenge due to their mobility and migratory behaviour (Ventsova & Safonov, 2021; Safonov, 2022). Accurate and complete data collection is hindered by the potential for saigas to leave their native territories. Addressing these issues requires ongoing monitoring and habitat preservation efforts (IUCN, 2008; CMS, 2010; 2023).

Several unresolved issues complicate saiga population monitoring and protection (Fereidouni et al., 2019; Rduch & Sliwa, 2019):

- Insufficient monitoring data: Limited access to saiga habitats and the complexity of field research result in incomplete information regarding population numbers and dynamics.
- Insufficient funding and organizational support: Adequate resources for equipment, personnel, and conservation projects are often lacking.
- Poaching: Illegal hunting significantly impacts saiga populations.
- Habitat loss and pollution: Industrial development and land use changes threaten saiga habitats.
- Climate change: Global climate shifts affect saiga life cycles, including breeding and migration.
- Diseases: Infections can harm saiga populations, particularly in close-knit social settings.
- Insufficient local involvement: Greater community engagement can enhance protection and monitoring efforts.

Solutions to these issues may involve cooperation between government authorities, non-governmental organizations, local communities, and scientists, alongside increased funding and organizational support (IUCN, 2008; CMS, 2010; 2023). Combining various approaches to saiga population management is essential, with a focus on model populations observed over a minimum of five years.

Kazakhstan, the primary habitat for saigas with three out of five current populations, offers a convenient model territory for monitoring efforts (Grachev et al., 2009). The Betpak-Dala saiga population, among the most significant in Kazakhstan and globally, experiences population fluctuations driven by multiple negative factors. This study's relevance arises from the need to address these dynamics comprehensively.

Understanding saiga population structure, including sex and age ratios, migration patterns, herd sizes, and population density per unit of territory, is crucial for their conservation. An integrated approach, utilizing experimental data, can inform behavioral models of large mammals in the face of growing anthropogenic pressures.

Research objectives

This study aims to address the challenge of saiga conservation in the context of anthropogenic pressures using a population model. The specific objectives are as follows: Analyze the saiga calving process; Identify saiga population fluctuations across different seasons of 2022; Compare saiga population numbers between different study years (2019-2022); Estimate saiga population density per unit of territory in 2022; Evaluate the number of saigas per herd; Determine herd size classes and the sex composition of animals within them.

Material and methods

Study area and species

The study focused on the Betpak-Dala saiga population in Kazakhstan. This population inhabits the Aktobe region and the Alakolsky area within the Irgiz-Turgay State Nature Reserve. The saiga population in this region has been closely monitored, and the study area is characterized by diverse habitats, including the Irgiz-Turgay steppe.

1. Aktobe Region is one of the regional administrative units in Kazakhstan. This region constitutes a significant territory for the saiga antelope distribution in Kazakhstan. Aktobe Region encompasses diverse biotopes, including steppes, semi-deserts, and agricultural areas.

2. Irgiz-Turgay State Nature Reserve: Located in the Aktobe Region of Kazakhstan, this reserve is a vital natural institution contributing to the preservation of local fauna and flora, including saiga antelopes. The reserve encompasses various biotopes, such as steppes.

3. Alakolsky District: Situated in the Aktobe Region, this district comprises steppe landscapes.

The research was conducted in these regions to study and monitor the population of Betpak-Dala saiga antelopes and their ecosystems. These regions are of interest for scientific research and the conservation of saiga antelopes due to their significant role in the biodiversity of the steppes of Kazakhstan.

UAV monitoring

The UAV (Unmanned Aerial Vehicle) monitoring was conducted from April 9 to April 20, 2022. This monitoring covered the Betpak-Dala saiga population and aimed to collect essential data on saiga numbers, behaviour, and habitat use. The UAV monitoring period totalled 21 hours and 45 minutes, excluding extrapolation.

Data collection

Observations were carried out along 15 transects in the Irgiz-Turgay steppe during the monitoring period. To aid data collection, various equipment was employed, including:

- Bushnell 10×50 mm binoculars and Garmin eTrex 10 GPS Map for detecting saigas from the air and marking their locations on maps.
- Telescope Vista Pix IS70 for detecting saigas.
- Nikon cameras paired with binoculars for photographing small herds (comprising up to 50 animals) to facilitate counting.
- Canon video cameras for video recording, allowing for the determination of the age composition of herds, including the number of adults and cubs.

Capture and tagging of saigas

Saiga cubs were captured for weighing and measuring morphometric indicators. The capture process involved the use of vehicles, specifically the UAZ Patriot 744 AF 04 and the UAZ 433 AF 04. The researchers followed saigas for approximately 75 kilometres along the designated transects and attached tags to 220 saiga antelopes.

Morphometric measurements

Various morphometric measurements, including height body length, and weight, were recorded during the capture process. Tranquilizers were used to ensure the safe measurement of weight and morphometric param. After measurement, the cubs were released back to their herds. These procedures were conducted daily throughout the observation period.

To anaesthetize the saigas, xylazine was used at a dosage of 0.1 mL per 1 kg of body weight. Weighing the saigas after anaesthesia is typically performed using specialized scales, which can be medical scales or animal scales. The weighing procedure can be carried out as follows:

1. Preparation of the animal: Initially, the saiga is anaesthetized using an anaesthetic such as xylazine. The weight of the animal should be recorded before the administration of the anaesthetic to accurately determine the change in body mass after anaesthesia.
2. Supporting the animal: After the saiga is anaesthetized, it is transferred to the scales and gently placed on the scale platform. It is important to ensure that the animal is in a safe position and cannot harm itself or others during weighing.
3. Weighing: The scale platform is sensitive to changes in mass and registers the mass of the animal in kilograms or other units of measurement. The results of the weighing are recorded.
4. Monitoring the condition: During weighing, specialists may also monitor the saiga's condition, including its pulse, respiration, and other important health param.
5. Recovery: After weighing, the animal is carefully moved to a safe location, and its recovery from anaesthesia is monitored. This includes ensuring warmth and the safety of the animal.

It is important to conduct saiga weighing with the utmost care and consider their well-being throughout the entire procedure. This helps gather important data about the population's condition and facilitates conservation and monitoring efforts.

Ethical considerations

This study adhered to international standards for the ethical treatment of animals. All procedures were carried out using officially approved drugs and were approved by the Ethics Committee of the Karaganda University named after E.A. Buketov (Protocol No. 221 dated from 02/02/2022).

Monitoring periods

The study included several monitoring periods, which were as follows:

- The first observation period: April 9 to April 20, 2022.
- The second observation period: During the breeding season, from May 8 to May 19, 2022.
- The third observation period: During the migration of the Betpak-Dala saiga population in a northward direction, from June 9 to June 13.
- Autumn monitoring: November 14 to November 16.
- Winter monitoring: December 10 to December 16, 2022.
- Data for weight and morphometric indicators of saigas for 2020-2021 were also included for comparative analysis.

Population surveys

The study involved population surveys to assess saiga numbers and size categories. The surveys were conducted during the transect observations. Saiga population numbers were compared based on data collected from 2019 to 2022.

Satellite observation collars

In September 2022, satellite observation collars were installed on 11 saigas from the Betpak-Dala population and 9 saigas from the Irgiz-Turgay Reserve. These collars allowed for tracking saiga movements and behaviour.

Data analysis

Statistical analysis was performed using the Statistics program (version 10). To identify possible differences in the number of female and male young saigas in different years of registration, a Student's t-test was employed, with differences considered significant at $p \leq 0.05$.

Results and discussion

The lambing of saigas

In the Irgiz-Turgay Reserve, during 2022, the lambing period occurred from May 6 to May 15, with the peak of lambing observed from May 12 to May 15. This lambing event encompassed approximately 250,000 hectares within the Betpak-Dala Reserve.

Weather conditions during the lambing period were characterized by cloud cover, with temperatures ranging between 15 and 21°C. The average humidity levels fluctuated between 53 and 61%. Atmospheric pressure maintained a range of 1017-1031 hPa, and average wind speeds measured between 3-8 m/s. Importantly, no precipitation occurred during this period.

For control observation of young saiga, we established the 1st transect 20 km east of Kosbuirek in the north direction, covering 10 km and maintaining a distance of 10 to 500 m from the herd. In this transect, 1,000 adult saigas were observed, with 12 saiga lambs (6 females and 6 males), all tagged for identification.

The 2nd transect spanned 20 km, with a distance range of 10 to 500 m. Here, a total of 115 saigas were observed, with 84 individuals tagged. Researchers collected data on gender and height, noting the presence of 52 saiga cubs (32 females and 20 males), each tagged for tracking. The weight of these young saigas ranged from 2.11 to 4.17 kg.

During the entire observation period, 10 deceased saigas were discovered, consisting of 3 adult saigas and 7 newborns. Mass breeding of saigas was observed in the eastern part of Kosbuirek, where more than 10,000 saigas were present. The majority of female saigas gave birth between May 11 and May 13.

Notably, the saiga offspring demonstrated healthy growth with no reports of mass mortality. The weight of female newborns ranged from 2.11 to 4.01 kg, while male newborns exhibited weights between 2.72 and 4.7 kg. A monitoring map, summarized in Supplementary Table 1, provides data on the age composition, weight, and body length of young saigas.

For the years 2020-2022, the weight of young saigas displayed minimal variation, with no significant statistical differences observed ($p \geqslant 0.05$) for both females and males. However, as indicated in Table 1, there were significant variations in the number of newborn saigas between the years. Notably, the lowest number of female saiga lambs was recorded in 2021, marking a threefold reduction compared to 2020 and a 5.2-fold decrease compared to 2022 ($p \leqslant 0.05$). Male saigas exhibited similar trends, with a 3.1-fold decrease in 2021 compared to 2020 and a 5.6-fold reduction compared to 2022 ($p \leqslant 0.05$). Importantly, fluctuations in the number of females and males over the three-year monitoring period remained comparable ($p \geqslant 0.05$).

Table 1. The average weight of young saiga and their number according to observations of 2020-2022.

Year	Number of Young Saigas	Average Weight (kg)
2020	33	3.18
2021	11	3.3
2022	57	3.3
2020	31	3.5
2021	10	3.6
2022	56	3.4

Monitoring of saiga population in 2022

UAV monitoring conducted from April 15 to 17 in the Irgiz-Turgay area of the state natural reserve recorded a total of 8,908 saigas without extrapolation. This population consisted of 8,181 saigas in the Aktobe region and 728 in the Kostanay region (Figure 1).

In November, researchers recorded saiga populations of 8,590 and 20,470 in two separate locations. Weather conditions during this phase were favorable, with no precipitation. The total saiga population recorded during this period amounted to 42,300 (Table 2, Figure 2).

Table 2 provides data on the observation of 93 saiga herds throughout November 2022. The total saiga population in these herds reached 42,300, with an average herd size of 455 individuals. Binoculars were employed to ensure adequate visibility, resulting in a visible distance of 3 km between groups. The entire monitoring area spanned 244,020 hectares (813.4 km x 3 km^2 = 244,020 ha), housing 52,000 saigas.

Table 2. The number of saigas during the autumn monitoring of 2022.

Studied Days	Number of Herds	Number of Saigas	Average Number of Saigas in a Herd	Coverage Area (km^2)	Density (1 km^2/the number of saigas)	Route	Intervals between the First and the Last Saiga Group
14.11	40	8,590	215	384	220	22	39
15.11	20	13,240	662	207	145	64	91
16.11	33	20,470	620	295	155	69	132
3 days	93	42,300	455	886	520	48	81

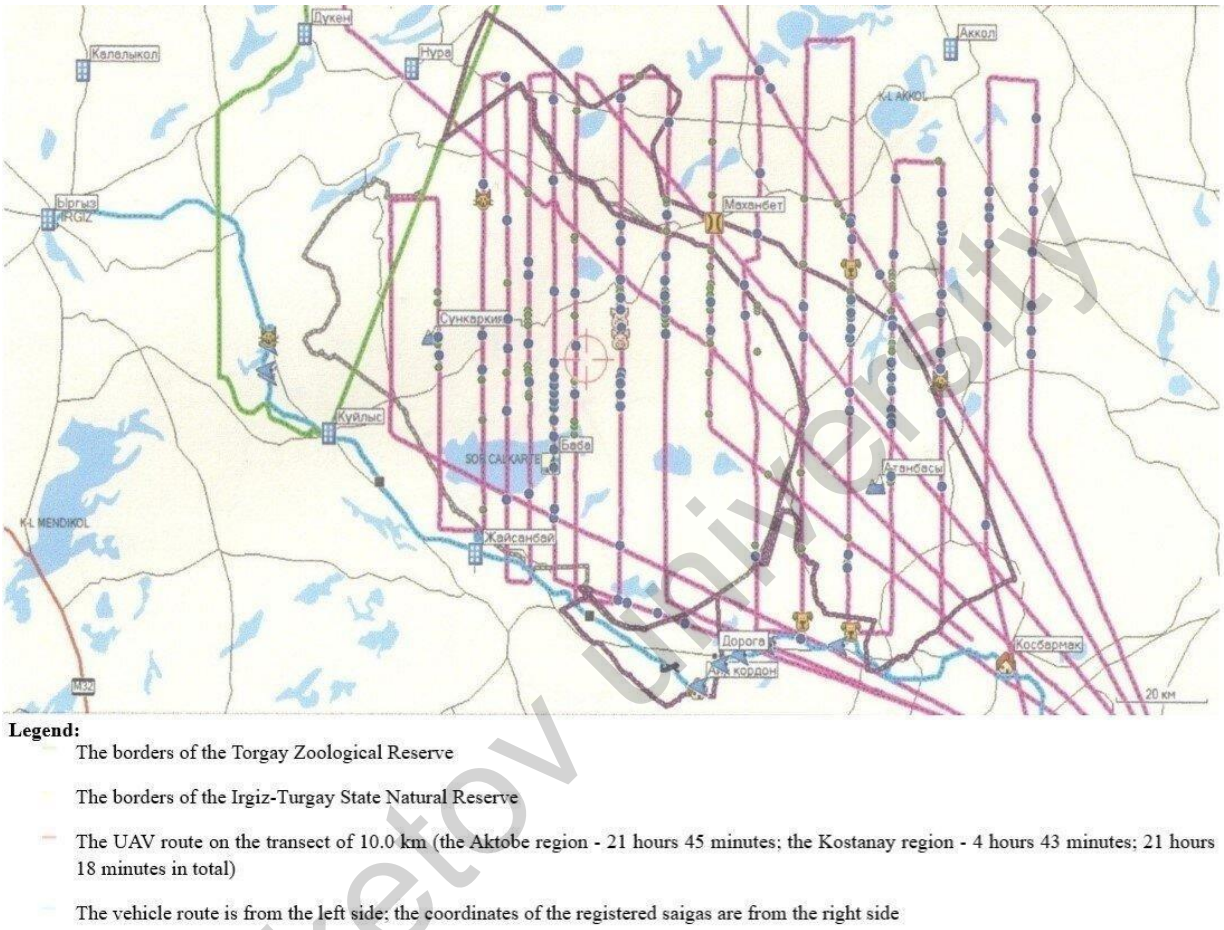

Figure 1. The number of saigas according to UAV records on April 15-17, 2022 at the Atanbasy area No. 1 of the Irgiz-Turgay State Natural Reserve.

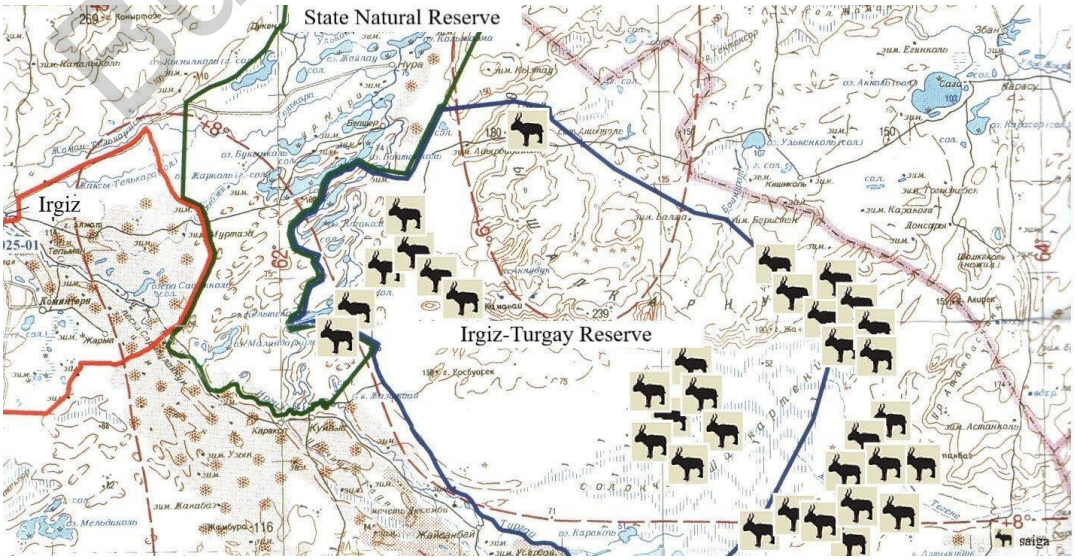

Figure 2. The habitat scheme of recorded saigas from November 14 to November 16, 2022.

Winter monitoring of saigas

Winter monitoring of saigas was conducted from December 10 to December 16, 2022. The first day yielded 1,650 saigas within the Betpak-Dala territory, while the second day recorded 13,142 animals. On the third day, 14,279 saigas were documented, and on the fourth day, 2,032 individuals were observed. In total, the winter monitoring identified 31,103 saigas in the area (Table 3).

Table 3. The number of saigas during the monitoring in winter, 2022.

Studied Days	Number of Herds	Number of Saigas	Average Number of Saigas in a Herd	Coverage Area (km^2)	Density (1 km^2/the number of saigas)	Route	Intervals between the First and the Last Saiga Group
10.12	4	1,650	413	98	29	17	57
11.12	25	13,142	526	96	78	137	168
12.12	27	14,279	529	140	73	100	191
13.12	11	2,032	185	238	27	8	67
4 days	67	31,103	489	572	207	53	147

Comparative analysis of saiga population numbers

Table 4 presents data on the Betpak-Dala saiga population in Kazakhstan based on UAV monitoring results from 2019 to 2022.

The population reached its peak in 2019. Subsequently, there was a nearly sevenfold decrease compared to 2019 ($p \leqslant 0.01$) from 2018 onwards. However, since 2019, there has been a gradual recovery in the population size. Specifically, the saiga population increased by over two times in 2019 compared to 2021 ($p \leqslant 0.05$) and by 1.5 times in 2022 compared to 2021 ($p \leqslant 0.05$).

Table 4. The number of the Betpak-Dala saiga population in different studied years.

Year	Number of Saigas (thousand)
2019	242.5
2020	36.2
2021	51.7
2022	76.4
Total	406.8

Saiga density per territory

Table 5 reveals fluctuations in saiga density across protected areas throughout the spring and summer months, with 29 animals per territory. The density of simultaneous saiga presence in the reserve and sanctuary areas exhibited variability, with no fixed values.

Table 5. The density of the saiga population in 2022.

№	Indicators	Unit of Measurement	SPNA	Reserve	Sanctuary
1	The coverage area	ha	1,469,511	1,173,511	296,000
2	The number of saigas	animal	42,300	38,500	3,800
3	The density of saigas	1000 ha saigas^{-1}	29	32.8	13

Number of saigas per herd

The number of saiga herds and their group composition were contingent on the total population. In 2019, the average number of saigas per herd ranged from 30 to 100. In 2020, this range expanded to 50 to 200. Subsequently, the number of herds shifted after the saiga population decline in 2020.

In 2022, the number of saiga herds increased (up to 450-500 animals, $p \leqslant 0.05$) compared to 2019-2020. Herd sizes varied seasonally, with larger groups forming during migration in the autumn-winter period, as well as before mating and during the breeding season.

Sizes of saiga herds

During November 14 to November 16, 2022, 42,300 saigas congregated into 93 herds within protected areas (Table 6). These herds exhibited diverse sizes, with 25 herds comprising 1 to 50 animals (26.8%). Additionally, 20 herds consisted of 51 to 100 animals (21.5%), 17 herds included 101 to 200 individuals (18.3%), and 16 herds ranged from 200 to 500 saigas (17.2%). Large herds were also observed, with 9 herds containing 500 to 1000 animals (9.8%), and 6 herds composed of more than 1000 individuals (6.5%).

Table 6. The analysis of saiga herds (groups) recorded during the autumn monitoring.

Indicators	Date	From 1 to 50	From 51 to 100	From 101 to 200	From 201 to 500	From 501 to 1000	More than 1001	Total
The number of the groups	14.11.22	8	12	9	9	2	1	40
	15.11.22	6	5	3	3	1	2	20
	16.11.22	12	3	5	4	6	3	33
		25	20	17	16	9	6	93
The total number of saigas		770	1,580	3,250	5,700	7,500	23,500	42,300
The average number of saigas		30	79	191	356	833	3,916	455

Sex composition of adult animals in herds

Throughout the monitoring period, the number of male saigas was recorded in all herds. In total, 42,300 saigas were documented during autumn monitoring, and 31,103 during the winter phase. The monitoring facilitated the identification of 1,467 males (4.9%) in 53 herds among 29,353 saigas, with an average of 20 females for every male.

On the first day of observation, researchers identified 45 males among 1,150 saigas in 5 herds. The second day revealed 607 males in 20 herds among 12,102 saigas. On the third day, 701 male saigas were counted in 26 herds among 14,279 animals. Finally, the fourth day yielded 114 males in 4 herds among 1,822 saigas (Table 7).

Table 7. The proportion of males in the herds.

Date	The number of herds with male saigas	The number of identified saigas	The proportion of males (%)	Females per one male	Total
	Total	Males			
		Autumn monitoring			
14.11.22	7	1,030	55	5.3	8,293
15.11.22	4	720	23	3.2	13,137
16.11.22	10	12,380	162	1.3	20,257
Total	21	14,310	240	2	41,687
		Winter monitoring			
10.12.22	3	1,150	45	4	1,643
11.12.22	20	12,102	607	5	12,854
12.12.22	26	14,279	701	5	12,751
13.12.22	4	1,822	114	6	1,773
Total	53	29,353	1,467	4.9	29,021

The analysis of changes in saiga habitats revealed an increase in the frequency of fires since the 1980s, particularly after 1997. These fires are primarily attributed to human activities that lead to an accumulation of phytomass in grasslands, subsequently creating conditions conducive to wildfires. As a consequence, up to 20% of saiga habitat has been affected by fire-related disturbances (Dzhapova, Bembeeva, Ayusheva, & Dzhapova, 2021).

Fires exert a dual influence on saiga populations. On one hand, they harm the animals by destroying the preferred plants of saigas, leading to potential starvation. On the other hand, fires can have positive effects on saiga diets by promoting vegetation growth and development. These fires bring about changes in vegetation cover, such as the expansion of areas dominated by long-lived grasses. Nevertheless, they may also deplete saiga-preferred habitats, potentially causing a decline in saiga populations (Jiang et al., 2020a).

One of the foremost challenges in saiga conservation pertains to the reduction in available habitat area and carrying capacity. This issue poses a greater challenge compared to poaching. Studies have shown that saigas prefer habitats near water sources due to the arid climate in the region (Yang et al., 2022). Despite the presence of numerous artificial reservoirs and canals in the territory, their construction has transformed natural landscapes and narrowed saiga habitats (Jiang et al., 2020b). Our research on vegetation corroborates saiga's preference for cereal consumption during the breeding season. The current distribution of saiga populations during the rutting and lambing seasons is contingent on food availability in their respective habitats (Karimova, Lushchekina, Neronov, Pyurvenova, & Arylov, 2020).

The majority (80-85%) of the global saiga population is situated within Kazakhstan's borders (Grachev et al., 2009). Nevertheless, saigas are also found in smaller areas in Russia, Uzbekistan, Turkmenistan, and Mongolia (Francfort, 2020). Three distinct geographical populations of saigas exist in Kazakhstan: Betpak-Dala, Ustyurt, and Ural. A portion of the Ustyurt population migrates to Uzbekistan and Turkmenistan during winter, while some individuals from the Ural population venture into Russian regions. Come spring, saigas return to Kazakhstan (Grachev et al., 2009). Over the past two decades, the saiga's range has markedly diminished.

It is unlikely to find them in the Moiynkum desert, the Northern and Southern Balkhash regions, and most of the Aral Karakum and Mangistau. The three saiga populations in Kazakhstan differ from each other and are in a constant state of migration, never staying in one territory for an extended period (IUCN, 2008; Robinson, 2018).

Our present study supports the aforementioned findings by offering insights into saiga migration patterns, exemplified by the Irgiz-Turgay population. Unlike previous studies, our research employed a multifaceted approach to assess herd numerical, age, and sex compositions. Researchers combined visual observations with the use of numbered ear tags, enabling the tracking of herd migrations. The data we obtained confirmed the fluctuations in saiga populations across different years, a trend consistent with other saiga populations. Furthermore, we observed simultaneous recovery processes within the model population, including an increase in herd numbers and total saiga populations, alongside a rise in the average number of saigas per herd, including the number of males per herd. However, the male population remained relatively low. Given the observed trend of increasing male numbers, we recommend continued monitoring to assess sex ratios. In addition to conservation efforts practiced in Kazakhstan and neighboring countries, there is a practical necessity for saiga breeding within the confines of nature reserves located in regions where saigas once thrived centuries ago. As of 2022, the Askania-Nova Nature Reserve in Ukraine had successfully maintained a stable saiga population (Gavrilenko, Dudok, Mezinov, & Yasinetskaya, 2022), although the current status of this population remains unknown.

The size of a saiga herd fluctuates according to the season and the overall saiga population. During the cold season, herds segregate into harems, while in summer and spring, following the breeding season, saigas congregate into large herds for their summer pastures (Abaturov, Gorbunov, & Koshkina, 2021). In the 1970s, saiga herds comprised small, medium, and large groups. However, in the 2000s, due to the saiga population decline, herds predominantly consisted of small groups, with large herds becoming rare. Furthermore, the size of saiga clusters in lambing areas also decreased (Pruvot et al., 2020).

We recorded an increase in saiga density per unit of territory, as well as an increase in the number of large herds, comprising thousands of animals. These findings suggest an improvement in the condition of the model population (Khanyari et al., 2021; Khanyari, Robinson, Morgan, Salemgareyev, & Milner-Gulland, 2022). Nevertheless, significant inbreeding has been observed in saiga populations, rendering the descendants more susceptible to epizootics and resulting in higher morbidity rates, especially in conditions of increased density and herd size (Glázer, 2017).

In recent years, the saiga population has experienced changes in its sex structure due to heightened poaching activities. These changes have led to a reduction in the number of males, as poachers target adult males for their valuable horns, which are in high demand on the international market (Ussenbekov et al., 2022). Consequently, only a few males can be found in saiga groups, with some groups lacking males altogether. This has significantly altered the sex and age compositions of saiga populations, and although there has been an increase in the proportion of males in herds, their numbers remain insufficient (Maikanov, Zabolotnykh, Auteleyeva, & Seidenova, 2020b). On average, there are 20 females for every male, a ratio 2-3 times higher than the norm (Syrym et al., 2019; Ubushaev et al., 2022).

Despite consuming a minimal amount of vegetation throughout the year, approximately 12-23 kg per hectare (equivalent to approximately 1.5-2% of the crop), saigas contribute to the pollination of numerous rare plants endemic to the steppe through their hoof movements (Abaturov et al., 2021). Domestic animals, on the other hand, consume 100 kg or more per hectare (12-18%), indicating that pastures are not overloaded with animals. Calculations further reveal that pastures within the republic can adequately sustain 1-3 million saigas per year without adverse environmental impacts.

The study of various biological param of saigas has shown that continuous hunting of adult males had a significant negative impact, altering the sex and age structure of the population and subsequently leading to a decrease in female reproduction, as well as the number of newborn saigas. However, the weight of newborn saigas remained nearly unchanged when the population was high or average (Glázer, 2017). Thus, the feeding conditions in saiga habitats, particularly in the model population, have remained stable.

Numerous programs, memoranda, and conservation concepts have been developed to safeguard saiga populations, with various conferences dedicated to their conservation. However, effective solutions have yet to be realized. It is imperative to establish clear boundaries and delineate saiga habitats along their migration routes, wintering grounds, and summering areas, designating these regions as protected reserves (Milner-Gulland & Kühl, 2006; IUCN, 2008; CMS, 2010; 2023). Nevertheless, this issue remains unresolved. Authors from neighboring countries, such as China, underscore the critical need for cooperation in saiga conservation

(Jiang et al., 2020b). Kazakhstan, along with its central Betpak-Dala saiga population, plays a pivotal role in saiga conservation and monitoring efforts.

Conclusion

Our research has provided valuable data on the current state of the saiga population in the Betpak-Dala region. We monitored population size, age, and gender among herds, employing modern methods of visual observation and animal marking. The results we obtained confirmed the tendency of sharp fluctuations in population size in different years.

We also acknowledge the importance of additional research and enhanced conservation measures for the saiga population. In the future, our work will be supplemented with a section dedicated to practical measures for conservation, monitoring, and engaging local communities in saiga and habitat preservation efforts.

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