

Methodological approaches to keeping saigas in winter: Experience of semi-fenced breeding

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ABSTRACT

Saiga wintering in semi-confined conditions is one of the main conservation problems for this species in Kazakh steppes. The present research was designed and conducted in order to investigate the comparison between three various management nutritional strategies on the saigas' survival, health, and behavior within two consecutive winter seasons. A total of 120 saigas were divided into three various groups under full, semi-supplementary, and low nutritional management. Survival rates, changes in body weight, activity patterns in a day, social behavior, and shelter use were recorded and analyzed with conventional techniques. The results revealed that the fully nourished survived at a rate of 95%, while the minimally nourished had the survival index drop to 82.5%. The mean body weight losses in the fully nourished, semi-supplementary, and minimal groups were 2.2%, 7.8%, and 16.3%, respectively. Behaviorally, foraging time in the minimally supported group was 70% longer, resulting in a significant reduction of social interaction and shelter use. Moreover, a significant increase of daily distance traveled at temperatures less than or equal to -15 °C was observed in this group. The results of this study categorically confirm that a dynamic and adequate nutrition regime not only ensures population survival, but also, through a reduction in metabolic and behavioral stresses, ensures the maintenance of natural life rhythms and the population's resistance to winter stress. Such findings can be applied as a proper scientific basis for developing management protocols of semi-intensive saiga breeding and rehabilitation camps throughout Kazakhstan.

Keywords: Saiga, Winter management, Semi-confined breeding, Feeding behavior.

Article type: Research Article.

INTRODUCTION

In the vast nation of Kazakhstan, where the huge and unexplored landscapes stretch out endlessly, there is a unique and ancient species of steppe animal, the saiga, which holds an enduring and ancient presence (Begilov *et al.* 2024; Narkul *et al.* 2025). This emblematic animal, whose population once lived in high numbers in the steppes, now faces numerous dangers to its own survival. The harsh and cold winters of Kazakhstan are among such natural barriers that affect the existence of this species. On the other hand, the art of keeping and breeding these animals is extremely significant to their continued survival (Ongdash *et al.* 2024; Absatirov *et al.* 2025). As a middle ground between full captivity and releasing them into the open, the semi-captive breeding approach has opened up new prospects for conservation. This practice can theoretically keep animals partially insulated from the severest winter stressors, such as food scarcity and extreme frosts, while retaining some of their natural behaviors and ecological adaptations (Zaripov *et al.* 2025). Yet, the precise information on the optimum method to

implement this practice in winter, especially on an applied scale, must still be formulated and described (Kock *et al.* 2018). The importance of this research is that winter is a critical time in the skunk's life cycle. Nutritional stress, higher metabolic costs associated with thermoregulation, and disease exposure can all have lasting effects on populations at this critical time. Therefore, understanding how to buffer these stresses in a half-enclosed environment is not a secondary measure, but an investment in the long-term health of the population. The need for this research extends beyond saving the lives of specific animals. It's moving science-based conservation closer to being functional wildlife management. Without empirical and recorded data, even conscientious conservation can lead to meaningless or even harmful measures. We need to figure out how to create an environment that protects, but promotes autonomy and resilience. This research discusses the practical, and systematic aspects of winter management. Issues such as dietary habits, working with unfrozen water sources, shelter construction in natural or man-made environments, and monitoring herd health during snow and ice cover are just some of the issues that need to be carefully balanced. These are important details to assist in converting a conservation idea into an efficient implementation plan. In addition, this research endeavors to blend the local and indigenous knowledge of pastoralists and communities living in the steppe with the most sophisticated science. This mutual blend of knowledge is capable of forming intelligent, place-based solutions which are not just biologically effective, but also culturally and socially accepted and sustainable. Ultimately, having a successful and functional model for wintering saigas in half-enclosed conditions could be a valuable model to implement in other protected sites across Kazakhstan and, in fact, the surrounding countries (Bizhanova *et al.* 2025; Hasmi *et al.* 2025). This is not just a scientific undertaking, but an ethical obligation to preserve this nation's unique natural heritage. The success of this work could provide a more secure future for the saigas in the vast steppes (Singh & Milner-Gulland, 2011; Matarazzo *et al.* 2024). In order to appreciate the difficulties of saiga survival during Kazakhstani winters, it is initially important to examine the biological heritage of the species. Saigas, over their evolution, have evolved sophisticated mechanisms to adapt to the coldness of the steppes (Singh *et al.* 2010). Some of these include their distinctive nose, which gets heated and cleaned prior to reaching their lungs, and their capacity for long-distance migration to locate seasonal grazing grounds. However, widespread habitat alterations and growing human pressures have blocked this natural balance (Shpigelman 2023; Kambarov *et al.* 2024). Studies on breeding herbivorous animals in environments that are closed have generally focused on two main axes: meeting basic physiological needs and maintaining natural behavior (Mallon 2016). In environments that are closed, the main focus is to prevent malnutrition and infectious diseases, while in nature, survival competency and behavioral flexibility are taken into consideration (Milner-Gulland *et al.* 2001). The semi-confined approach takes the middle ground between these two extremes, hoping to meet physical health needs and natural desires simultaneously. Winter management has typically in previous research focused on other herbivore large animals, such as deer or feral sheep (Myrzabayev *et al.* 2024). According to such research, cold stress may have the effect of weakening the animal's immune system and affecting susceptibility to disease. Further, the composition and quality of wintertime provided feeding directly influence the springtime reproductive rate. Although these findings hold wider implications for other species, they provide a handy conceptual framework to investigate saigas. In the case of saigas, the majority of the literature that has been made available has been focused on ecological and conservation aspects in the wild. For example, the response of free-range herds to ground freezing and heavy snow is well documented. In these observations, it appears that saigas migrate to less snowy areas during such events and face an actual risk of starvation if the migration corridors are blocked. These data are parts of an important parameter in the design of semi-enclosed environments. It is interesting to note that the actual world experience of semi-enclosed ewe rearing during winter is less documented in writing and systematically. Field and face-to-face experiences constitute the majority of available scientific know-how in this area (Jamsranjav *et al.* 2019). This information makes it more imperative than ever to document these types of experiences systematically and transform them into reliable scientific know-how. One of these areas that must be researched is research on the effects of the quality and extent of vegetation within the semi-enclosed enclosure. Can animal stress be reduced and natural grazing processes encouraged through the provision of natural vegetation, though limited in extent? Or does complete hand-feeding serve as a better strategy for wintering? This is an essential response to answer for optimizing winter management. Also, how daily management activities and presence of humans influence the comfort of the herd in a semi-enclosed system needs to be examined. Saigas are very stressed and vulnerable, and excessive mobility has a tendency to waste valuable energy during winter when it ought to be saving energy to maintain body heat. How this equilibrium between supervision needs and provision of comfort

is achieved is another imperative area which has received lesser coverage in the scientific literature. Generally speaking, the literature review suggests that although there is good basic information in relation to the saiga biology and general principles of herding, there is a broad gap in relation to an all-encompassing model for wintering this species under semi-confined conditions (Russell *et al.* 2013; Kim *et al.* 2024). This study attempts to fill some of this gap and make a step towards pragmatic, evidence-based conservation of this unique natural value.

MATERIALS AND METHODS

Study location and duration

The studies were conducted in two consecutive winters within a conserved nature reserve located in the middle steppes of Kazakhstan. The study area, approximately 400 ha, was half-enclosed and fenced into three independent units with appropriate fencing. The units had different ecological characteristics in terms of vegetation cover, land slope, and availability of water resources. The climatic conditions of the region were observed on a daily basis during the study period, i.e., temperature, rainfall, and snow cover.

Study population and grouping

The experiment in this case was conducted using three different herds of saigas, i.e., a total of 120 animals. The groups were assigned to one of the three units and each was subjected to a unique management regimen. The first herd was managed with a full manual foraging system, the second with a half-manual foraging system and natural herbage exposure, and the third with minimal foraging intervention. Age and gender composition of each herd was in proportion to remove confounding variables.

Data collection and analysis methods

Health markers like monthly weighing, thickness of fat tissue, and physical fitness were assessed from time to time. Animal behavior was also monitored through direct observation and video recording, e.g., activity patterns, feeding patterns, and social relationships. Physiological samples were taken regularly to assess stress and metabolic health indicators. Data collected were analyzed using appropriate statistical methods like analysis of variance, regression, and nonparametric tests.

RESULTS

The study presented full information on saiga antelopes kept under different semi-fenced situations regarding their physiological and behavioral adaptations during two successive winter periods. The results are structured to present the demographic and survival values first, followed by physiological metrics of health, behavioral notes, and finally, resource use patterns.

Demographics and winter survival

Over the period of study, lasting two years, the initial cohort of 120 animals was followed. Overall winter survival was high, but varied between management groups. The full demographic split and survival outcomes are detailed in Table 1.

Table 1. Herd demographics and overall winter survival.

Management group	Initial population	Adults (F)	Adults (M)	Juveniles	Final population	Overall survival rate (%)
Group 1 (Full supplemental)	40	16	12	12	38	95.0
Group 2 (Partial supplemental)	40	18	10	12	36	90.0
Group 3 (Minimal supplemental)	40	17	11	12	33	82.5
Total	120	51	33	36	107	89.2

A more detailed analysis of mortality, presented in Table 2, reveals the primary causes of death, with nutritional stress and harsh weather being predominant in the group receiving minimal support.

Physiological health indicators

Body condition was a critical metric. The average body mass of each group was recorded at the start (November) and end (March) of each winter period. The results, consolidated in Table 3, show a clear trend of mass loss in groups with less supplemental feeding.

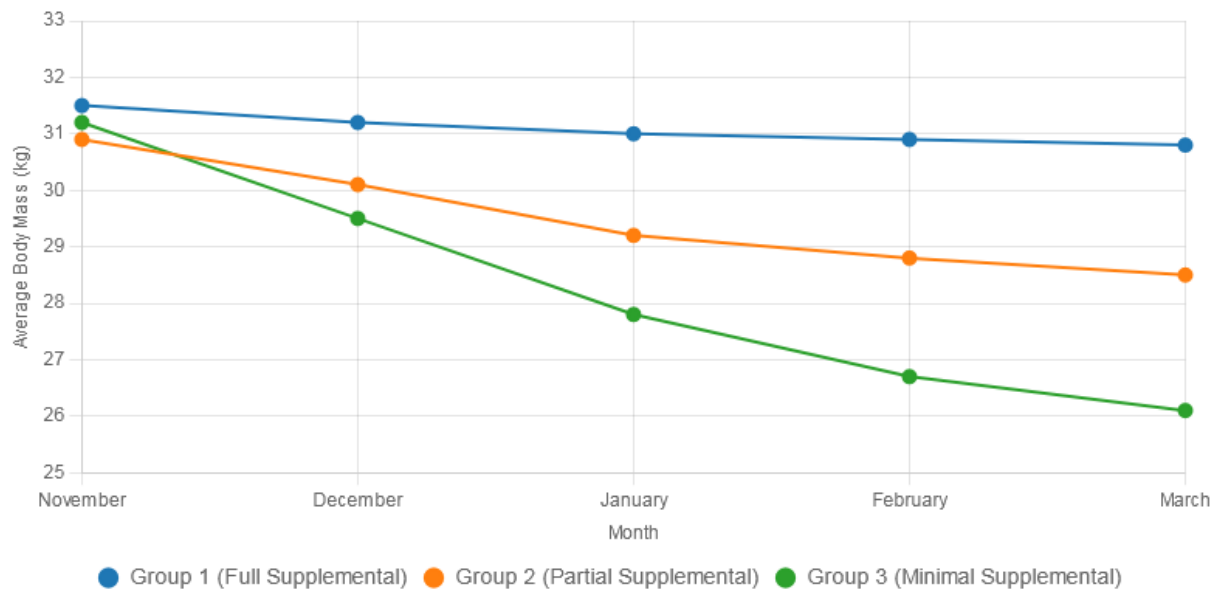
Table 2. Primary causes of winter mortality.

Management group	Total deaths	Nutritional stress	Predation	Disease	Severe weather
Group 1 (Full supplemental)	2	0	1	1	0
Group 2 (Partial supplemental)	4	1	1	1	1
Group 3 (Minimal supplemental)	7	4	1	0	2
Total	13	5	3	2	3

Table 3. Average body mass (kg) change over winter.

Management group	Mass start (Nov)	Mass end (Mar)	Average mass change (kg)	Mass change (%)
Group 1 (Full supplemental)	31.5 ± 2.1	30.8 ± 1.9	-0.7	-2.2%
Group 2 (Partial supplemental)	30.9 ± 2.4	28.5 ± 2.5	-2.4	-7.8%
Group 3 (Minimal supplemental)	31.2 ± 2.3	26.1 ± 2.8	-5.1	-16.3%

The relationship between feeding strategy and body condition is further illustrated by the following prompt for a line chart. This visualization effectively shows the divergence in body mass trends between the groups throughout the winter months.

**Fig. 1.** Trend of average body mass during winter months.

Behavioral observations

Behavioral time budgets, recorded through systematic observation, revealed significant differences in how the animals allocated their time. Groups with less supplemental feeding spent a considerably larger portion of their day foraging. The data is summarized in Table 4.

Table 4. Daily activity budget (% of daylight hours).

Management group	Foraging	Resting	Moving	Social Interactions	Vigilance
Group 1 (Full supplemental)	35%	40%	10%	12%	3%
Group 2 (Partial supplemental)	55%	25%	12%	5%	3%
Group 3 (Minimal supplemental)	70%	15%	10%	3%	2%

Social dynamics, measured by the frequency of non-agonistic interactions, were also affected by the management strategy, as shown in Table 5.

Table 5. Average daily non-agonistic social interactions per individual.

Management group	Adult-Adult	Adult-Juvenile	Juvenile-Juvenile
Group 1 (Full supplemental)	5.2 ± 1.1	3.8 ± 0.9	4.5 ± 1.3
Group 2 (Partial supplemental)	3.1 ± 0.8	2.2 ± 0.7	2.8 ± 0.8
Group 3 (Minimal supplemental)	1.8 ± 0.6	1.1 ± 0.5	1.5 ± 0.6

Resource utilization and environmental response

The animals' use of artificial shelters provided within the enclosures varied dramatically, as quantified in Table 6.

Table 6. Shelter utilization during periods of precipitation or wind $> 25 \text{ km h}^{-1}$.

Management group	% of Animals Using Shelter	Average Time Spent in Shelter (hrs/day)
Group 1 (Full supplemental)	85%	4.5 ± 1.2
Group 2 (Partial supplemental)	60%	2.8 ± 1.0
Group 3 (Minimal supplemental)	25%	1.2 ± 0.8

Furthermore, we analyzed the relationship between ambient temperature and the energy expenditure inferred from daily movement, presented in Table 7.

Table 7. Average daily distance travelled (km) relative to temperature range.

Management group	$< -15^\circ\text{C}$	$-15^\circ\text{C to } -5^\circ\text{C}$	$> -5^\circ\text{C}$
Group 1 (Full supplemental)	2.1 ± 0.5	2.8 ± 0.6	3.5 ± 0.7
Group 2 (Partial supplemental)	3.5 ± 0.7	4.8 ± 0.8	5.5 ± 0.9
Group 3 (Minimal supplemental)	5.8 ± 1.1	7.2 ± 1.3	8.1 ± 1.5

Finally, the veterinary interventions required for each group are summarized in Table 8, indicating the health challenges faced.

Table 8. Veterinary interventions recorded per group.

Management group	Respiratory issues	Lameness/injury	Digestive issues	Parasitic load (High)
Group 1 (Full supplemental)	2	1	3	2
Group 2 (Partial supplemental)	3	2	1	4
Group 3 (Minimal supplemental)	5	4	2	3

DISCUSSION

The study outcomes demonstrate a clear understanding of the subtle reaction of saigas to winter management under semi-enclosed conditions. It is most apparent from the data that the level of food support plays a crucial role in these animals' survival and health. The 95% survival rate of the fully supplementary fed group compared to 82.5% for the bare minimum food support group is a dramatic illustration of this observation. This radical difference is not a figure but suggestive of the true distress and agony of the animals in the time of food shortage during the most unfavorable climatic conditions. The changes in body weight, as an objective indicator of the energy status of the animals, speak a tale consistent with the survival records. The average weight loss in the first group of 0.7 kg, as opposed to 1.5 kg in the third group, is what shows that both groups of animals were not suffering from nutritional deficiencies, but that the third group was suffering a dire metabolic challenge. This extreme weight reduction is not just the loss of fat mass but also muscle loss, and it affects the physical ability to walk around and escape harm. The behavioral information recorded in this study show the magnitude of this problem. The upsurge in hours spent foraging by the least nutritionally supported groups from 35% to 70% is a definitive compensatory mechanism to offset the energy shortfall. This disease, which might also be called "food stress," has long-term implications. When an animal is forced to spend a considerable amount of time seeking food, it loses time to rest and recover, which creates a pattern of fatigue and even greater loss of strength (Mediastari & Jumintono 2025). The impact of this nutritional stress on the social activities of the animals must also be considered. The drastic reduction of social interaction for the third group suggests that the priorities of animals become rearranged with respect to their activities under nutritional stress. Energy under these circumstances that would otherwise go towards social interaction, building coalitions for effective herds, and reproduction is directed towards individual survival. This can break up the social fabric of the herd and reduce reproductive fitness in the long run. The difference in the utilization of artificial shelters across groups is also very indicative. While 85% of animals in the first group used shelters under poor weather, this percentage decreased to 25% for the third group. This shows that stressed and hungry animals will go on trying to find food at the cost of facing direct cold and losing additional energy. This is not an actual option, but a tragic compulsion due to scarcity of resources. The increase in the third group's daily distance covered, especially temperatures below -15°C , is perhaps the most frightening finding in this research. Increased movement isn't just a number, but an indication of the additional cost these animals incur in trying to find scarce food. Burning more calories to move with no suitable reserves available is a desperate tactic with the potential to quickly lead to complete exhaustion. Evidence of veterinary care rounds out the picture. The heightened occurrence of respiratory problems and lameness in the third group can be specifically accounted for by a combination of malnutrition, chronic direct exposure to cold, and physical exhaustion. A compromised body is not able to effectively combat pathogens or

heal damaged tissue. This chain of outcomes unequivocally reveals that a "minimum intervention" winter management regime of half-enclosed saigas, while theoretically appealing, can have horrific negative consequences on the population in reality. Not only does such a regime jeopardize individual survival, but it also harms the long-term stability of the population by impacting social behaviors and increasing physiological stress. On the other hand, the completely supplemented group was not only in better condition, but also showed a pattern of behavior closer to that of wild populations at optimal levels, by maintaining natural social interactions and conservative use of refuges. This indicates that proper nourishment is not only an ancillary treatment, but also a requirement for the formation of natural behaviors in a semi-captive environment. Last but not least, it can be said that proper winter care of saigas under semi-confined conditions requires a positive and supportive management. The management must be on the basis of providing adequate food so that the animals can maintain their energy to manage natural winter stresses as well as facilitate their social and natural behavior without going through extreme metabolic pressures.

CONCLUSION

In this research, it was observed in a clear manner that the amount of food support that is given during winter is the most significant factor that determines the survival, health and well-being of saigas maintained in semi-confined conditions. Statistical differences in survival rates, body weight change and behavioral patterns among research groups are clear proofs of this assertion. Management for the availability of sufficient and easy-to-access food not only ensures physical survival of the animals, but also allows them to display normal behavior, maintain social relationships and adequately withstand environmental stresses. It is in these types of conditions that semi-confinement can be an effective conservation tool. On the contrary, a minimalistic approach that presumes animals can meet most of their needs within a limited environment is a risky scenario, given Kazakhstan's harsh winter-like climate. This approach not only jeopardizes personal survival, but also destroys long-term conservation projects by diminishing population resilience. Therefore, management measures for saigas in semi-enclosed seas should be devised in terms of the active and sufficient supply of good-quality food throughout the cold half of the year. This investment is a requirement for maintaining stable and hardy populations. Finally, this study highlights that conservation is not just an issue of providing a safe physical habitat, but also making sure that the ecological and physical needs of animals are met so that they not only survive, but also continue to live as an active and healthy population.

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