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RESEARCH ARTICLE

Population dynamics and synurbanization of the common hamster (*Cricetus cricetus* L., 1758) in the Tyumen Region, Western Siberia

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Abstract

This study evaluates the population status of the common hamster (*Cricetus cricetus* L., 1758) in the Tyumen Region, Western Siberia, in both natural habitats and urban environments. We analyzed population dynamics from the mid-20th century to the present, documenting a sharp decline in the early 2000s followed by a significant, exponential recovery between 2021 and 2025. Furthermore, we document pronounced synurbanization, evidenced by the species increasingly establishing viable populations within major urban centers. We hypothesize that groundwater level instability may play a sub-

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stantial role in these long-term population fluctuations, as it is intrinsically linked to regional climatic shifts, specifically rising mean annual air temperatures and altered precipitation regimes.

Keywords
Common hamster, Tyumen Region, population dynamics, population status, synurbanization, climate change, groundwater levels

Introduction

The subspecific taxonomy, population status, and abundance of the common hamster (*Cricetus cricetus* L., 1758) across its range have been the subject of intense debate within the global academic community since the late 20th century (Nechay 2000; Ziomek and Banaszek 2007; Rusin et al. 2013; Kryštufek et al. 2016), including in Russia (Surov et al. 2016; Surov and Feoktistova 2023). However, the population status of this species in the Urals and Western Siberia remains poorly documented (Berdyugin and Bolshakov 1998; Moskvitina et al. 2016, 2022), and published data regarding its abundance in the Tyumen Region during the first quarter of the 21st century are particularly scarce.

Historically, Pleistocene skeletal remains of the species have been identified in areas adjacent to the Northern Urals (Kosintsev 2001). The subspecies *Cricetus cricetus rufescens* Nehring, 1899 (Sayan et al. 2019; Feoktistova et al. 2019) was common and at times abundant, within the agricultural zones adjacent to the southern borders of the Tyumen Region until the late 20th century (Gashev et al. 2006; Gashev 2008). The northern boundary of its range historically extended north of Tobolsk (Bobrinsky et al. 1965), and Laptev (1958) noted its presence further north in the Uvatsky District along the Irtysh River valley. On the contrary, Yegorin (1939a) rightly suggested that the species' distribution in the taiga zone of Western Siberia was largely anthropogenic. Historically, the average abundance of hamsters captured in tube traps in southern Western Siberia was approximately 0.01 individuals per 100 trap-nights (Ravkin et al. 1996). During the mid-20th century, the common hamster was a prevalent agricultural pest and was even harvested for its pelt (Fig. 1), with population cycles lasting approximately 7 to 10 years.

However, since the early 21st century common hamster numbers have declined throughout much of their range, including the Tyumen Region. In the western part of the range, this decline began even earlier, with reports of local extirpations emerging in the literature by the late 1950s (Neumann et al. 2004, 2005; La Haye et al. 2012). In Europe, brief periods of population growth in the 1970s were followed by a severe, range-wide decline (Poplavskaya et al. 2015). Until recently, the consensus was that the species was experiencing a continuous decline and range contraction. For exampe, by the 2020s, the common hamster was absent from the southern taiga of the Tyumen Region (Tobolsk District, see Promotorova 2022), and in the neighboring Tomsk Region, it was restricted to the southern Ob River floodplain

(Starikov et al. 2024), despite historical records extending to the middle reaches of the Vasyugan and Tyma river basins (Yegorin 1939b; Igolkin 1978).

Consequently, the common hamster has been listed in various national and regional Red Data Books, and is classified as Critically Endangered (CR) on the IUCN Red List. Despite numerous hypotheses, researchers have yet to reach a consensus on the primary drivers of this recent decline. Paradoxically, against the backdrop of this decline in natural habitats, the abundance has begun to increase in urban environments.

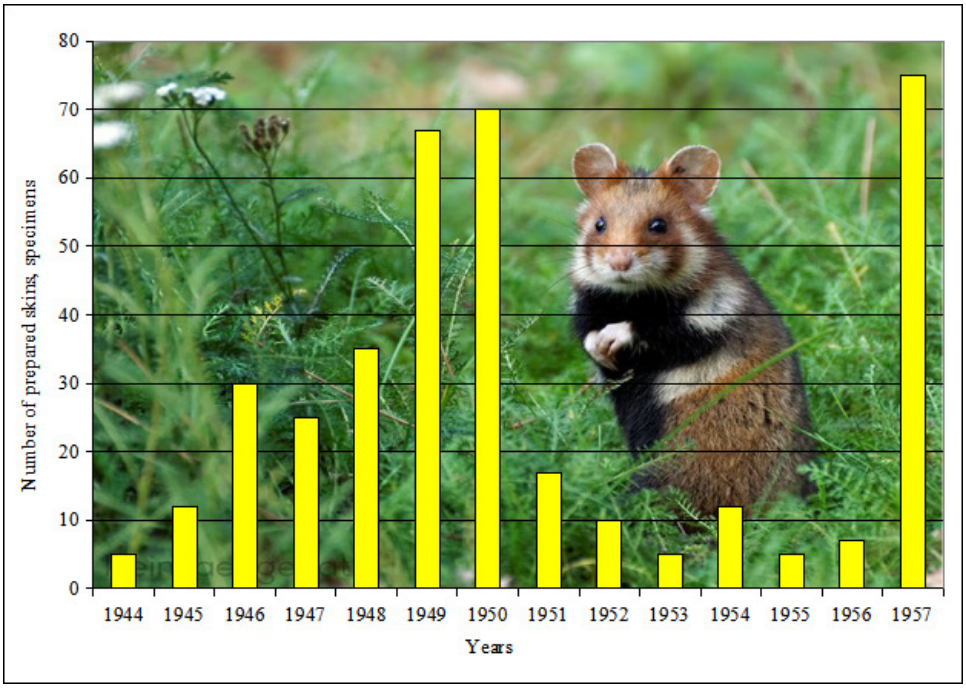


Figure 1. Dynamics of common hamster (*Cricetus cricetus*) harvesting in the Tyumen Region (1944–1957). The bar chart illustrates the annual number of pelts harvested, reflecting historical population peaks and cyclicality prior to the severe, range-wide decline observed in the late 20th and early 21st centuries. Data sourced from the archival records of the Tyumen Regional Sanitary-Epidemiological Service (SES) and Moskvitina et al. 2022.

Urban populations of the common hamster are now well documented in the suburbs and peripheries of several major Central European cities, including Mainz, Mannheim, Hanover, Frankfurt, Göttingen, Braunschweig (Niethammer 1982; Endres 1999; Kupfernagel 2003; Feoktistova et al. 2013b), and most notably, Vienna (Schmelzer and Millesi 2008; Flamand et al. 2019). Similar urban settlements have been recorded in Brno (Pelicán et al. 1983), Prague (Vohralík 2011), and Olomouc (Losík et al. 2007; Petrova et al. 2018) in the Czech Republic; Košice, Slovakia (Čanády 2013); and Lublin, Poland (Łopucki and Szeląg 2011).

In Russia, one of the oldest urban populations inhabits Moscow and the surrounding region, probably expanding from the city into suburban zones (Surov et al. 2023). Recent data indicate that the hamster has become a typical component of urban fauna. Burrows have been recorded in the private housing sectors of Vladimir, and individuals have been captured in the Akademgorodok of Novosibirsk, as well as in Omsk (Sidorov et al. 2011), Barnaul, Kazan, Tula, Nalchik, Kislovodsk, Grozny, Vladikavkaz (Feoktistova et al. 2019) and Sevastopol. Reliable evidence also confirms their presence within the urban boundaries of Nizhny Novgorod, Perm, and several other cities.

Recent field studies and citizen science data, including those from the Tyumen Region, demonstrate drastic changes in the species' population status, with numbers beginning to grow exponentially. The animal is increasingly recorded not only in its typical habitats but also in novel environments, including residential areas and multi-story buildings in large cities (Feoktistova et al. 2020; Surov et al. 2023). Much like the preceding population decline, this recent urban population growth lacks a comprehensive explanatory framework.

Materials and methods

Our study of the common hamster in the Tyumen Region spans the period 1995 to 2025. Research was carried out in a gradient of habitat types, ranging from the southern taiga to the forest steppe zone in the Tyumen and neighboring Kurgan Regions.

To assess the status and dynamics, we employed multiple methodologies. The most objective measure of abundance was live trapping using wire mesh traps arranged along transects or within defined plots. This method was utilized during the initial phase (1995–2004) and the final phase (2025) of the study period. The captured animals were classified by sex and age class. A total of 32 individuals were captured over 16,886 trap nights.

In addition to live-trapping, we conducted abundance surveys in the city of Tyumen and its environs using camera traps (accumulating 38 camera-trap nights). We also compiled all verifiable records of live individuals or carcasses obtained directly by researchers, or via photographs, geolocations, the iNaturalist platform (https://www.inaturalist.org) and media reports. This yielded a total of 168 confirmed records during the study period, the locations of which are mapped in Figure 2.

Furthermore, we systematically surveyed and mapped occupied and abandoned burrows to calculate burrow density per hectare along transects or within plots, identifying a total of 75 burrows associated with the species. Habitats were classified into 10 distinct categories: (1) multistory building zones; (2) low-rise residential and cottage zones; (3) gardens, parks, cemeteries, and shelterbelts; (4) industrial zones and roadsides; (5) wastelands and fallows; (6) agricultural fields (specifically those with earth heaps); (7) forest parks; (8) suburban forests; (9) meadows; and (10) riverbanks and lake shores.

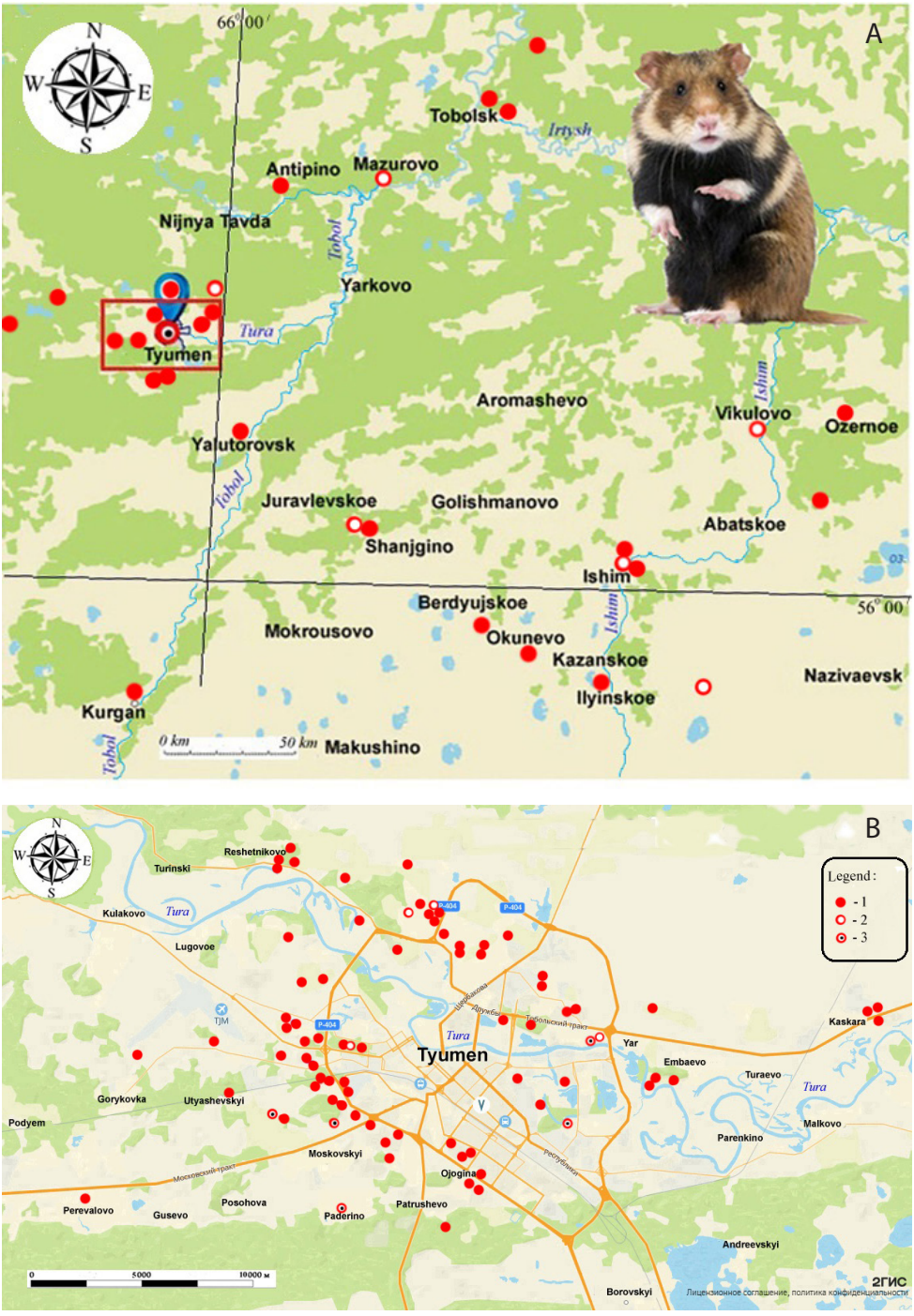


Figure 2. Spatial distribution of surveyed sites and confirmed common hamster records in the Tyumen Region. (Caption continued on the next page)

Figure 2. (continued) (**A**) Overview of the southern Tyumen Region, indicating the broader geographic scope of the study across natural and forest-steppe zones. (**B**) Detailed map of the vicinity of Tyumen city, highlighting specific habitat types and record locations. Distinct symbols denote different survey methodologies (legend for the map: **1** – citizen science records (e.g., our data, iNaturalist, verifiable media reports); **2** – snap-traps and live-trapping sites; **3** – camera-trap locations).

Finally, we incorporated archival data from the Tyumen Regional Sanitary-Epidemiological Service (SES), collected by A. P. Zuyevsky in 1962. According to these records, 73 common hamsters were captured over 3,266 trap nights in 56 human settlements in the southern administrative districts of the Tyumen Region between 1962 and 2025.

Results

Long-term trapping data indicate that over the past 60 years, the common hamster population in Western Siberia has experienced at least two distinct peaks (early 1960s to early 1990s (according to Tyumen Regional SES data), and 2015 to 2025 (according to our data), reaching a relative abundance of approximately 3.0 individuals per 100 trap-nights. This period was interrupted by a significant population decline in the late 20th and early 21st centuries (1987–2015), during which relative abundance dropped sharply to 0.07 individuals per 100 trap-nights (according to Moskvitina et al. 2022). This decline coincides temporally with the collapse of the population across the range, although explanatory models and forecasts remain divergent.

Archival data from the Tyumen Regional SES reveal that even during historical population peaks, relative abundance varied significantly between habitats and years. Over six decades of observation, the abundance ranged from 0 to 1 to 16 individuals per 100 trap nights (recorded in 1987 on the outskirts of Tyumen).

In habitats surveyed between 1995 and 2025, relative abundance ranged from 0.01 individuals per 100 trap nights in private cottage areas to 0.23 individuals per 100 trap-nights in fallow lands. A record abundance was registered in 2025, exceeding 3.00 individuals per 100 trap nights in fallows and agricultural fields in and around the cities of Tyumen and Ishim.

Given the volatility of annual data, analyzing the population dynamics over 5- and 10-year intervals provides a clearer trend (Fig. 3). These smoothed data reveal that the most severe decline occurred between 2005 and 2014. Following this trough, populations in Western Siberia and the Tyumen Region began a gradual recovery around 2015. Between 2015 and 2024, average annual records doubled compared to the predecline peaks, culminating in a record high in 2025. Notably, interannual variability persists within this growth phase, with a localized dip in 2021 followed by a sharp increase in 2025.

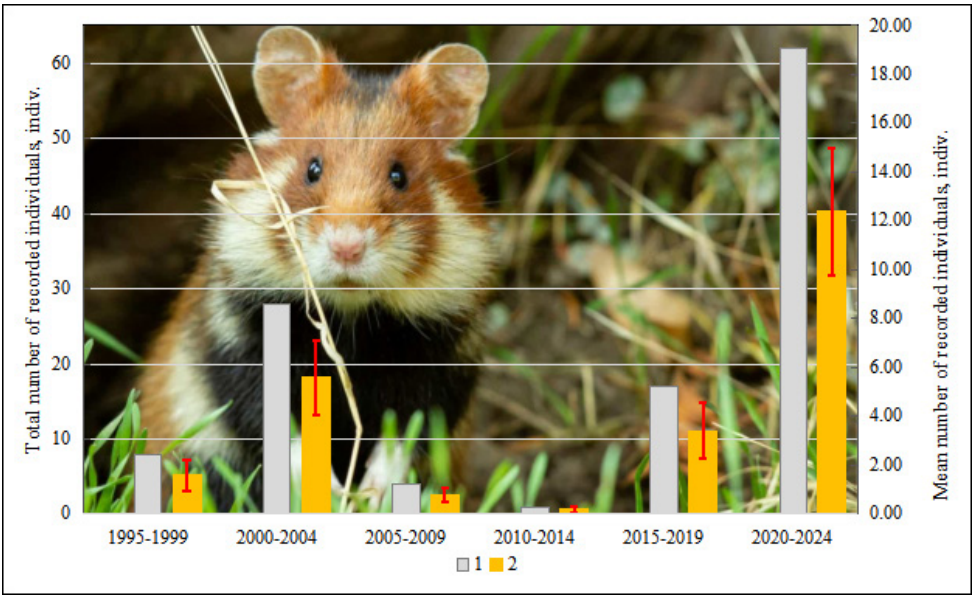


Figure 3. Temporal dynamics of the total number of recorded individuals of the common hamster (*Cricetus cricetus*) in the Tyumen Region over 5-year intervals (1) and their mean abundance during the same periods (2). Error bars represent the standard error (SE) within each 5-year bin, illustrating the variance in survey effort and detection probability. A statistically significant difference in the mean number of recorded individuals was detected compared to the previous period ($P < 0.05$).

Since 2021, the population growth in the Tyumen Region has followed an exponential trajectory, modeled by the equation $y = 3.59\ e^{(0.47x)}$, where e is the base of the natural logarithm.

Surveys on the outskirts of Tyumen (Paderino and Plekhanovo villages, Gilevskaya Grove) identified 75 burrows, 72% of which were occupied. The burrow distribution was highly heterogeneous. The density was lowest in the urban park zone (Gilevskaya Grove) at 3.6 burrows/ha, and highest (20.0 burrows/ha) in a fallow field near Plekhanovo village, which lies within the urban perimeter. This high-density field remained unflooded during the 2025 survey season (June), likely facilitating the high burrow concentration. The burrows possessed 1 to 6 entrances, and 56% having 1 to 3 entrances. In particular, 39% of the burrows with the fewest entrances were located in anthropogenic earth piles, indicating that common hamsters actively use, and may even prefer, these artificial structures for burrow construction in urban landscapes.

The sex and age structure of the population varied significantly depending on the phase of population dynamics (Fig. 4). During the population decline phase, the demographic structure was heavily skewed toward young individuals. On the contrary, during the population high-density phases, the proportion of juveniles

and subadults was markedly lower. Although the adaptive significance of this phenomenon requires further study, data from Zaytseva et al. (2024) suggest that the predominance of young individuals in suboptimal habitats indicates environmental stress. In the Tyumen Region, this demographic shift during low abundance periods likely reflects an upregulated reproductive effort to ensure population persistence under critical conditions. This is further supported by the dynamics of the sexual structure: the proportion of females was highest during years of low abundance and decreased as the population recovered, representing a logical adaptive mechanism to maximize reproductive output during demographic bottlenecks.

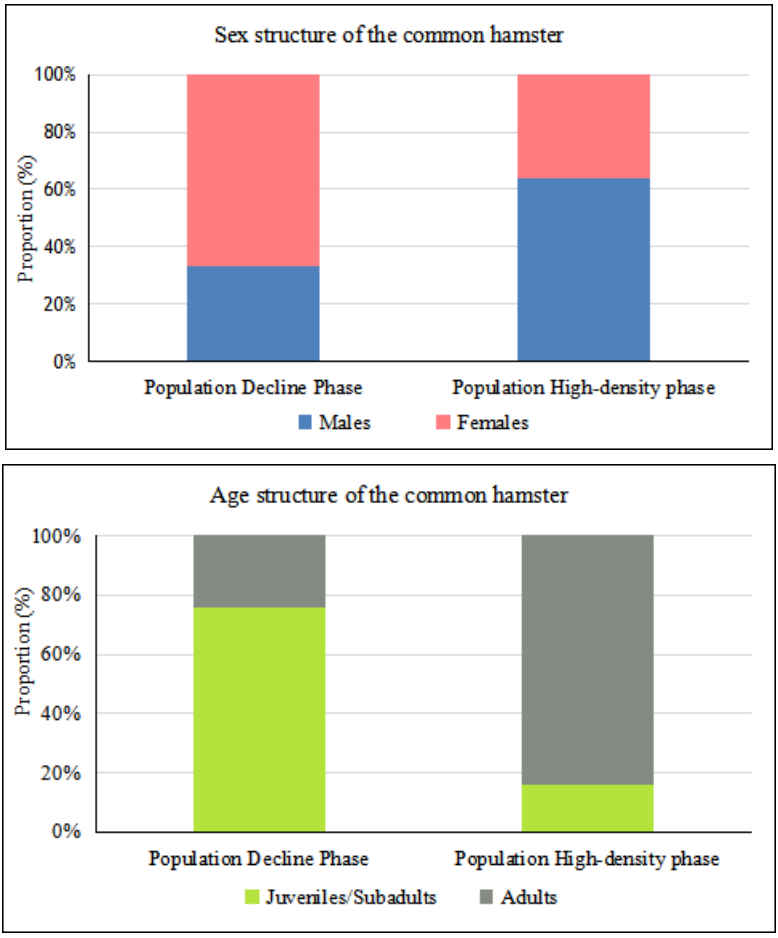


Figure 4. Sex and age structures of the common hamster population across different demographic phases. The 100% stacked bar charts compare the proportional composition of (**A**) sex (Males vs. Females) and (**B**) age class (Adults vs. Juveniles) during the Population Decline Phase versus the Population High-density Phase. The pronounced shift toward a higher proportion of females and juveniles during the decline phase indicates an adaptive upregulation of reproductive effort to ensure population persistence under environmental stress and suboptimal habitat conditions.

Analysis of spatial distribution during the recent population high (Fig. 5) reveals that nearly one-third of all recorded individuals and burrows are located in low-rise residential and suburban cottage zones. These are followed by urban wastelands and suburban abandoned structures. Interestingly, 14% of people inhabit agricultural fields, including plowed fields, where they build burrows in earth heaps. Furthermore, multistory building zones have emerged as the fourth most common habitat type, a novel phenomenon coinciding with the recent population surge. Hamsters have been observed penetrating these structures, occupying basements and first floors, and beginning to construct burrows in the soil along the foundations of buildings (Fig. 6). Consequently, in urban ecosystems, the common hamster is encroaching on the ecological niche of the brown rat (*Rattus norvegicus*) and may be initiating competitive interactions.

Natural and seminatural habitats, such as forest parks, suburban forests, meadows, and riparian zones, collectively accounted for only 19% of the records. This distribution strongly indicates that current common hamster habitats in the region are predominantly associated with heavily transformed anthropogenic landscapes.

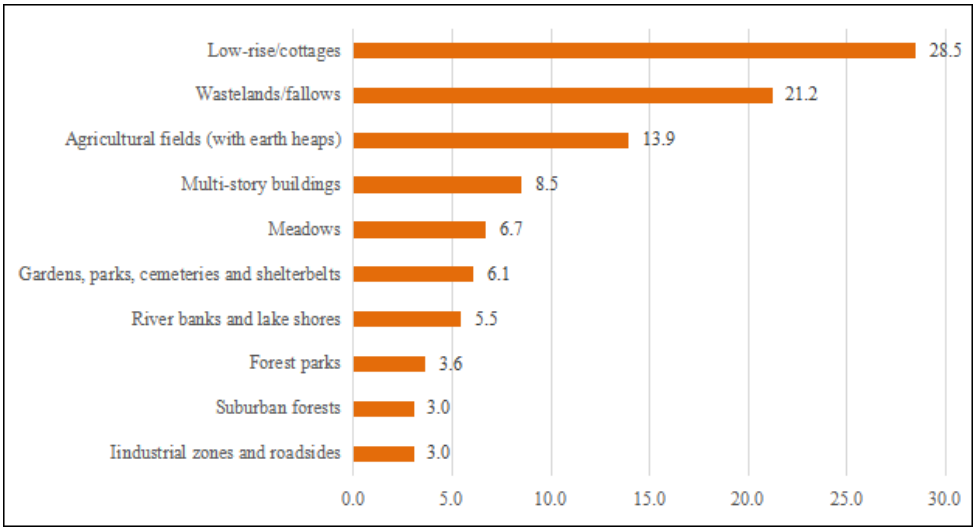


Figure 5. Distribution of recorded common hamster individuals and burrows by habitat type in the Tyumen Region. The horizontal bar chart displays the percentage of total records across 10 classified habitat categories, sorted in descending order. The data highlight a pronounced preference for heavily transformed anthropogenic landscapes. Low-rise residential zones, wastelands/fallows, and agricultural fields (specifically those utilizing earth heaps for burrowing) comprise the majority of records. Notably, multi-story building zones have emerged as a novel, highly utilized urban habitat, indicating active niche expansion.



Figure 6. Evidence of common hamster synurbanization in novel urban microhabitats. (**A**) A burrow entrance excavated directly into the soil adjacent to the concrete foundation of a multi-story residential building, highlighting the species' adaptation to anthropogenic structures. (**B**) An individual hamster observed inside the basement of an urban structure. These observations demonstrate the species' aggressive colonization of the ecological niche typically occupied by the brown rat (*Rattus norvegicus*) and its profound adaptation to urban infrastructure.

Discussion

Our findings generally corroborate previous studies on common hamster urban habitats (Surov et al. 2015), while also revealing distinct regional patterns. In the broader literature, hamsters are recorded most frequently in green residential areas (Buczek 2019; Franceschini and Millesi 2001; Flamand et al. 2019), followed by riparian zones, gullies, and cemeteries (Hoffmann 2010; Čanády 2013). Low-rise residential areas typically rank third (Surov et al. 2016), with industrial zones and wastelands fourth (Weinhold 2008). Although hamsters do occur in high-rise zones, they are usually reported in low numbers.

Some authors argue that large cities represent a fundamentally novel habitat type, positioning the common hamster as a biological invader (Khlyap et al. 2010; Surov et al. 2015). This adaptation to urban conditions is a clear example of synurbanization (Surov and Feoktostova 2023; Surov et al. 2023). However, we strongly disagree with the assertion that the species has developed tolerance or "friendliness" toward humans. Our field observations frequently documented high levels of aggression, with individuals actively attacking and chasing researchers.

Nevertheless, Surov et al. (2015) correctly posit that the hamster's colonization of urban green and residential spaces may limit the seasonal retreat of brown rats from human dwellings. This ecological displacement is so pronounced that some

European conservationists have proposed the intentional introduction of common hamsters into cities as a conservation strategy (Surov et al. 2016).

The burrow density observed in the field near Plekhanovo (up to 20 burrows/ha) is comparable to the highest densities recorded in Nur-Sultan's Presidential Park (14 burrows/ha; Feoktistova et al. 2020) and Simferopol's Gagarin Park (20 burrows/ha), although half the density of tape-like colonies along major urban highways in Simferopol (up to 40 burrows/ha; Surov and Feoktistova 2023). The primary driver of this high density is likely the presence of soil piles and power transmission pole bases, which act as unplowed "refugia islands" (Seluga and Stubbe 1994). Surov et al. (2023) similarly noted high local densities within anthropogenic soil piles (eg, highway embankments, construction dumps), which constitute 34% of the burrows studied in their research. These sites offer friable soil ideal for excavation, while surrounding dense vegetation provides cover from urban predators. In fact, our camera traps documented both stray dogs and cats successfully hunting hamsters in open urban areas.

Additionally, the construction of burrows in elevated earth piles mitigates the risk of flooding, a critical advantage in Western Siberia, where groundwater tables are typically high. Katsman et al. (2018, 2022) identified shrub cover as the leading factor influencing burrow abundance in Simferopol, but in our region, hydrological avoidance is paramount.

Synthesizing our data with existing literature, we propose a primary hypothesis for the long-term population dynamics observed in the late 20th and early 21st centuries. Although urban-specific factors (eg thermal pollution, extended activity seasons, altered diets rich in "fast carbohydrates," and modified intraspecific tolerance) undoubtedly influence urban population viability (Surov and Feoktistova 2023), they are unlikely to be the primary drivers of the range-wide fluctuations. We also find the hypotheses linking decline to historical harvesting or agricultural plowing unconvincing; the population crash occurred long after harvesting ceased, and our data show hamsters successfully utilizing plowed fields provided that earth piles are present.

Instead, we posit that the abiotic factors related to climate change are the main drivers. Specifically, we hypothesize that groundwater level fluctuations directly dictate burrowing viability and winter survival. Based on Grulich's (1981) findings that common hamster burrows typically range from 0.5 to 2.5 m deep (most often 1.0–1.5 m), we analyzed regional groundwater data. During the population decline phase, the maximum spring groundwater level in the studied region ranged from 0.07–0.36 m to 1.46–1.69 m below the surface, creating highly unfavorable, flood-prone conditions for burrow construction. On the contrary, during the recent population growth phase, maximum spring groundwater levels dropped to a range of 1.33–1.48 m to 3.32–3.36 m below the surface. A similar trend was observed during low-water autumn and winter periods.

This 1.5 to 2-fold decrease in groundwater levels between 2023 and 2025 has expanded the area of suitable well-drained habitat. According to Updated forecast of

autumn-winter lowest groundwater levels (FSBI "Gidrospetsgeologiya" 2022, 2023a, b, c, 2024a, b, c, 2025a, b), maximum spring groundwater levels in southern Western Siberia have remained 10% to 30% below the historical average, with actual relative indices in the Tyumen Region falling below 0.10 in 2024 and 2025. This sustained drop in the water table reduces intraspecific competition for dry burrowing sites and minimizes the flooding of wintering chambers, thus decreasing juvenile mortality and facilitating population expansion. Our observations support this, as hamsters consistently avoid flood-prone areas, preferentially building in elevated earth piles or on drained gully slopes within river floodplains, habitats they have increasingly occupied over the last five years.

In turn, groundwater levels are directly governed by two key abiotic factors: precipitation and temperature. Analysis of the dynamics of these variables, based on data from the Tyumen meteorological station, reveals a steady downward trend in precipitation from 2000 to 2025 (linear trend equation: $y = 500.61 – 2.78x$), whereas mean annual air temperature showed an upward trend over the same period ($y = 2.4 + 0.04x$) (Kazantseva 2025). Furthermore, the number of hamster detections between 1995 and 2025 showed a highly significant nonlinear correlation with both climatic variables. Specifically, the correlation ratio (η) for the number of individuals detected against the temperature trend was 0.95 ± 0.13 ($P < 0.001$), and against precipitation it was 0.96 ± 0.13 ($P < 0.001$). This robust correlation strongly supports the hypothesis that regional climate change, leading to a more continental weather pattern and lower groundwater tables, has created favorable conditions for burrow construction, manifesting itself in the exponential population growth observed over the past five years.

Conclusion

From the mid-20th century to the present, the population dynamics of the common hamster in the Tyumen Region, particularly during the first quarter of the 21st century, reveal a pattern of natural, albeit extreme, fluctuations. Following a prolonged and sharp decline between 2005 and 2015, the population has experienced a strong and exponential recovery through 2025. This analysis allowed us to hypothesize the underlying drivers of the observed population fluctuations and the current status of the studied population. Among these, variations in groundwater levels represent a significant factor, driven by the dynamics of key climatic variables, specifically mean annual air temperature and precipitation.

Demographic analysis further reveals that the structures of sex and age during decline phases mirror those documented by other authors for populations under environmental stress, characterized by a high proportion of females and juveniles as an adaptive reproductive response. Finally, the colonization of urban landscapes, including multistory residential zones and industrial foundations, highlights a profound process of synurbanization. In these anthropogenic environments, the com-

mon hamster is establishing new ecological roles, integrating into urban food webs and potentially influencing the sanitary and epidemiological dynamics of human settlements.

Acknowledgements

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