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GAME MAMMALS OF PODILLIA: REGIONAL TRENDS AND LOCAL CHARACTERISTICS (A CASE STUDY OF THE CHORTKIV FORESTRY)

Liubov Shevchyk[1], Inna Grod[1], Nataliia Kravets[2]

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Affiliations

[1] Ternopil Volodymyr Hnatiuk National Pedagogical University (Ternopil, Ukraine);
[2] I. Horbachevsky Ternopil National Medical University (Ternopil, Ukraine)

Correspondence

Liubov Shevchyk; Ternopil Volodymyr Hnatiuk National Pedagogical University, 2 Maksyma Kryvonosa Street, Ternopil, 46027 Ukraine;
Email: shevchyk.lubov@i.ua;
orcid: 0000-0003-0755-2193

Abstract

Analysis of temporal changes in the area of hunting grounds and the abundance of game mammals in Ternopil Oblast (Podillia region) during 2007–2020 revealed a generally stable hunting land resource, despite periods of both expansion and contraction. The high proportion of hunting grounds (66–70% of the total area of the oblast) indicates the important role of game management in regional land use. As of 2020, the game mammal fauna of the region comprised only about half of the game mammal species recorded in Ukraine, including four ungulate species and eleven fur-bearing species. The main groups of game mammals exhibited a relatively stable population status despite fluctuations in abundance and population density. In the hunting grounds of the Chortkiv Forestry Enterprise, communities were dominated by the principal harvested game species, indicating a well-established assemblage adapted to local environmental conditions. The density of ungulates was associated with habitat conditions, although deterioration of these conditions was not always reflected in habitat quality assessments. A statistically significant negative relationship was found between the density of *Lepus europaeus* and habitat quality indices, as well as between its abundance and that of *Vulpes vulpes*. Strong positive correlations were recorded between species occupying similar ecological niches, particularly the *Sciurus vulgaris* and the *Martes martes*. Records of the *Canis lupus* were sporadic and had no detectable influence on the overall community structure. As of 2020, the actual abundance of the principal game species reached only 49.7% of the estimated optimal population size. The smallest discrepancy between actual and optimal abundance was recorded for the *Sus scrofa*, whereas the *Capreolus capreolus* and *Lepus europaeus* showed substantial negative deviations from scientifically estimated optimum levels. The highest percentages of optimal abundance (>70%) were observed in the Kopychyntsi, Biletske, and Ulashkivtsi forest districts, whereas the lowest values were recorded in the Hermakivske, Skala-Podilska, Husiatyn, and Naddnistrianske forest districts, indicating the need for population recovery measures.

Cite as

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Мисливська теріофауна Поділля: регіональні тенденції та локальні особливості (на прикладі лісового господарства «Чортківське»)

Любов Шевчик, Інна Грод, Наталія Кравець

Резюме. Аналіз територіальної динаміки обсягу мисливських угідь та чисельності мисливської теріофауни Тернопільської обл. упродовж 2007–2020 рр. показав відносну стабільність мисливського фонду регіону при наявності періодів зростання та скорочення площ угідь. Висока частка мисливських угідь (66–70 % від загальної площі області) свідчить про вагому роль мисливського господарства у природокористуванні регіону. Аналіз видового складу мисливської фауни станом на 2020 р. показав наявність у її складі близько половини видового багатства мисливських звірів України, у тому числі 4 видів ратичних та 11 видів хутрових тварин. Виявлено відносно стабільний стан основних груп мисливських тварин, незважаючи на коливання їх чисельності та щільності. Динаміка популяцій загалом відповідала довготривалим змінам умов існування та особливостям ведення господарства в окремих лісництвах. У мисливських угіддях ДП «Чортківський лісгосп» домінування господарсько важливих видів свідчить про сформовану та адаптовану до місцевих умов структуру угруповань. Підтверджено залежність щільності ратичних від умов існування, хоча погіршення цих умов не завжди відображається у показниках бонітування. Встановлено статистично значимий негативний зв'язок між щільністю зайця сірого та показниками бонітету угідь, а також між чисельністю зайця і лисиці звичайної. Позитивні кореляції між видами зі схожими екологічними нішами, зокрема між вивіркою та куницею, вказують на важливість спільних вимог до середовища у формуванні структури угруповань. Фіксації вовка є епізодичними і не впливають на загальну структуру угруповання. Сумарна фактична чисельність основних видів мисливських звірів станом на 2020 р. становила лише 49,7 % від оптимальної. Найбільша відповідність фактичної чисельності до оптимальної зафіксована для *Sus scrofa*, тоді як для *Capreolus capreolus* та *Lepus europaeus* встановлено суттєвий дефіцит чисельності. Найвищі показники забезпеченості оптимальної чисельності (>70 %) відзначено у Копичинецькому, Білецькому та Улашківському лісництвах, а найнижчі — у Гермаківському, Скала-Подільському, Гусятинському та Наддністрянському, що свідчить про необхідність відновлювальних заходів.

Ключові слова: мисливська фауна, чисельність, щільність, оптимальна ємність угідь, Поділля.

Introduction

The issue of rational breeding, sustainable use, and conservation of game fauna resources is becoming particularly pressing in the context of significant environmental transformations caused by shifting land-use practices and global warming. Concurrently, the lack of effective legal regulation and proper monitoring of compliance with legislation governing the hunting sector significantly hinders efforts to ensure the sustainable management and conservation of game resources [Volokh 2014].

Assessing the status of game fauna is crucial for monitoring the impact of environmental factors, identifying trends in population dynamics, detecting risks, and justifying measures to optimise game management [Sheihas & Hudz 2008; Shevchyk *et al.* 2023]. Active regional and local faunistic research is impossible without first defining the species composition of communities. In particular, this involves determining the role of ungulates, rodents and predators in forest biocenoses, compiling lists of native and introduced species, and tracking escapees from domesticated populations that form viable wild strains and exert a significant impact on the ecosystem [Zagorodniuk 2006; Zagorodniuk & Kharchuk 2022].

The development of the forestry sector in Ukraine is aimed at conserving and restoring biodiversity, being inextricably linked to the implementation of sustainable forest management principles and the expansion of protected and recreational areas [Maurer & Kolodii 2005]. The effective fulfilment of these functions is only possible if game management transitions to population-based management principles, founded on the recognition of populations as the basic natural unit in the system for regulating the status of game resources [Bondarenko & Khoietskyi 2000; Rizun & Bondarenko 2016; Sheihas & Gulyk 2024].

This approach makes it possible to account for population dynamics, spatial structure and ecological characteristics, which are essential for ensuring the sustainable use of game fauna [Rizun & Bondarenko 2016; Novytskyi 2016; Novytskyi *et al.* 2017]. In contemporary research, increasing attention is being paid to aligning hunting quotas with the ecological potential of habitats [Muzyka & Gonta 2020]. Particular emphasis is placed on the need to assess the carrying capacity of different habitat types suitable for game species by comparing the optimal carrying capacity of hunting grounds with the actual population sizes of the main game species [Volokh 2018; Sheihas 2023].

Today, there is an urgent need to introduce modelling as a theoretical and methodological framework for identifying key priorities in monitoring population dynamics and forecasting the status of game populations over specific timeframes [Grod *et al.* 2023]. An important prerequisite for the scientifically sound management of game resources is the classification of hunting grounds according to their ecological value, which provides the basis for planning management measures in accordance with biocoenotic conditions [Sheihas & Gulyk 2024]. The application of a phytocoenotic approach when assessing habitat suitability for game species ensures the ecological soundness and spatial balance of land use within hunting estates [Rizun 2019]. In the context of implementing the government's directive 'Strategy for the Development of Ukraine's Hunting Sector until 2035', there is a growing need to evaluate the status of the game fauna of Podillia during the pre-crisis period from the perspectives of ecology and game management science.

The aim of this study is to assess the status, trends, and characteristics of game management between 2007 and 2020 based on a comprehensive analysis of statistical data regarding the species composition, population sizes and density of game animals.

Materials and Methods

The monitoring of game fauna covers two key areas: recording species composition and estimating animal abundances. These indicators are dynamic, varying over time and space, particularly from a historical perspective, and are influenced by anthropogenic factors [Delegan *et al.* 2005]. The current mammal fauna of Ukraine comprises about 152 species [Zagorodniuk & Emelianov 2012]. The number of species classified as game varies depending on the researchers' approach and, according to various sources, ranges from 31 to 34 species [Sokur 1961; Zagorodniuk & Dykyy 2012; Khoetskyi & Pokhaliuk 2014; Zagorodniuk 2025]. In accordance with Ukrainian legislation and hunting management practice, the category of game mammals includes all species legally classified as game, irrespective of whether hunting is currently permitted for a particular species or within a particular region.

In this study, data were obtained by analysing official records of the Main Statistical Office in Ternopil Oblast concerning the management of hunting grounds (2007–2020), as well as departmental materials provided by the structural unit of the State Enterprise 'Chortkiv Forestry' (currently reorganised as the Chortkiv Forest District, part of the Podillia Forest Office of the State Specialised Economic Enterprise 'Forests of Ukraine' under the State Agency of Forest Resources of Ukraine), collected using generally accepted methods for surveying game species in forest areas [Bondarenko *et al.* 1989]. Data on the abundance of the main game species (categorised into fur-bearing and ungulate groups) were compiled based on official state records and the framework of the 'Strategy for the Development of the Hunting Industry in Ukraine for the Period up to 2035.'

In order to assess the ecological characteristics of game fauna communities in the forest management area, the following five key indicators of abundance were characterised:

- number of species (N);
- total population size of the game fauna (thousands of individuals);
- population size of particular game species (individuals per survey area);
- population density within the specific forest management units (individuals per 1000 ha of suitable habitat),
- population density across the region's hunting grounds (individuals per 1000 ha of total hunting area).

In accordance with established practice, ranger beats (obhody) are regarded as the minimum territorial unit within forest districts for assessing the impact of factors affecting the status of game fauna. The study area comprises 11 ranger beats.

The study areas encompass various types of habitats suitable for game fauna. The average habitat quality class (bonitet) for the main game species is presented according to the gamekeeper's patrols, based on data from the 2020 project on the organisation and development of the Ternopil Oblast Forestry and Hunting Management hunting estate [Pipa & Siletskyi 2021].

Correlation analysis between the density of the main fur-bearing species (*Sciurus vulgaris* and *Martes martes*; *Lepus europaeus* and *Vulpes vulpes*) was carried out using the parametric Pearson's correlation coefficient (r). The strength of the relationship was interpreted on the following scale: 0.00–0.19 (very weak); 0.20–0.39 (weak); 0.40–0.59 (moderate); 0.60–0.79 (high); 0.80–1.00 (very high). The normality of the data distribution was verified using the Shapiro–Wilk and Kolmogorov–Smirnov tests. Statistical significance of all analyses was set at $p < 0.05$.

Results

The status of the regional game fauna in Ternopil Oblast

As of 2025, the area of hunting grounds in Ternopil Oblast covers 984.2 thousand hectares, of which 173.5 thousand hectares are forest hunting grounds, 793.4 thousand hectares are field hunting grounds, and 17.3 thousand hectares are wetland hunting grounds. Currently, there are 26 organisations utilising these hunting grounds.

During the studied period (2007–2020), the area of hunting grounds underwent significant changes, varying in scale and duration (Fig. 1). Whilst in 2007–2008 the area of hunting grounds comprised 912.1 thousand hectares, an increase of 6.7% had been recorded by 2009–2011, reaching a peak of 972.9 thousand hectares. In 2012, there was a slight reduction, and between 2013 and 2020 the area stabilised at 943–950 thousand hectares. The proportion of hunting grounds relative to the total area of Ternopil Oblast during this period was quite high, ranging between 66% and 70%.

The statistical report on the region's list of game animals as of 2020 listed only 15 (50%) of the 30 species officially recorded in Ukraine[1]. Specifically, these included 4 species of ungulates (*Dama dama*, *Cervus nippon*, *Sus scrofa*, and *Capreolus capreolus*) and 11 fur-bearing species (*Lepus europaeus*, *Vulpes vulpes*, *Sciurus vulgaris*, *Ondatra zibethicus*, *Castor fiber*, *Canis lupus*, *Meles meles*, *Lutra lutra*, *Martes foina*, *M. martes*, and *Mustela putorius*).

An important indicator of the state of the hunting industry in Ternopil Oblast is the dynamic trend in animal populations. According to official statistical records, the population of ungulates in 2007–2020 fluctuated between 3.4 and 4.5 thousand individuals (Fig. 2). A marked decline in 2012–2016 and 2018–2020 (by 11.1%) concluded at 3.9 thousand individuals. Compared with ungulates, the total population of fur-bearing species was significantly higher, ranging between 56.8 and 64.9 thousand individuals. An increase (by 10.2%) to a peak of 64.9 thousand individuals in 2010 was followed by a decline (by 12.5%) in 2011–2012, with the population subsequently stabilising after 2013 at 60.8–62.2 thousand individuals. Since the statistical data from the state register of game animals do not reflect the actual population size with absolute accuracy, the population density of game fauna was additionally analysed per 1000 ha of hunting grounds [Rizun & Bondarenko 2016].

In regard of ungulates, the highest density (4.7 ind./1000 ha) was recorded in 2017, representing an increase of 27.0% compared to 2007 (Fig. 3). By 2020, a decline of 12.8% was observed, resulting in a density of 4.1 ind./1000 ha. The density of fur-bearing species fluctuated between 58.8 and 68.2 ind./1000 ha. The highest value was recorded in 2008, followed by a 13.8% decrease by 2012. Subsequently, by 2020, the density had risen again to 64.0 ind./1000 ha. This analysis was carried out for the principal group of game species (those that are hunted), and allows for a comprehensive assessment of overall changes in the regional game population.

[1] State Statistics Service of Ukraine. Main Department of Statistics in Ternopil Oblast. 2026. Form No. 2-TP (Hunting) (Annual). Ternopil. URL: https://www.te.ukrstat.gov.ua/statinfoSG.html (accessed 27 May 2026). [Ukrainian]

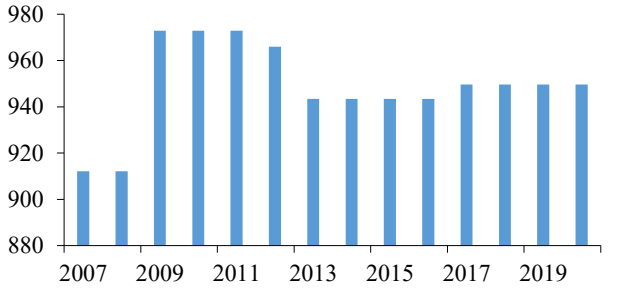

Fig. 1. Area of hunting grounds in Ternopil Oblast, 2007–2020. Numbers given in thousand ha.

Рис. 1. Площа мисливських угідь у Тернопільській обл. станом на 2007–2020 рр. Цифри наведено у тисячах га.

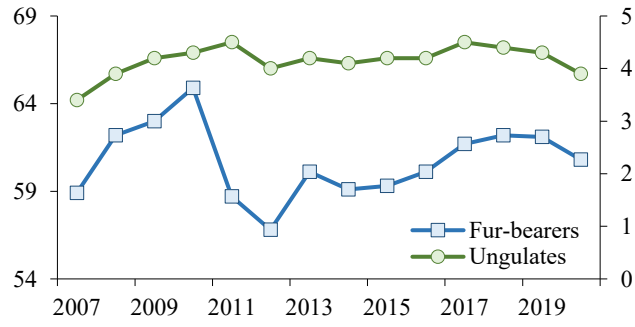

Fig. 2. Population dynamics of ungulates (right axis) and fur-bearing (left axis) species in Ternopil Oblast, 2007–2020. Numbers given in thousand individuals.

Рис. 2. Динаміка чисельності ратичних (права вісь) і хутрових (ліва вісь) звірів у Тернопільській обл. в 2007–2020 рр. Цифри наведено у тисячах осіб.

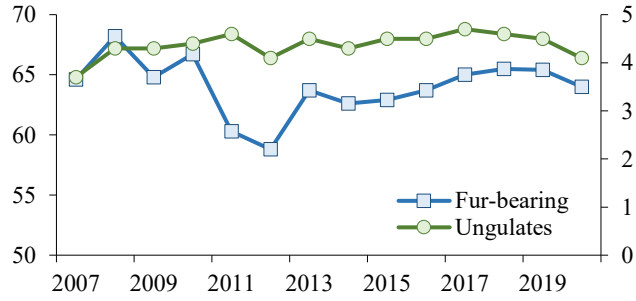

Fig. 3. Population density dynamics of ungulates (right axis) and fur-bearing species (left axis) in Ternopil Oblast, 2007–2020. Numbers given as ind./1000 ha.

Рис. 3. Динаміка щільності ратичних (права вісь) та хутрових (ліва вісь) звірів у Тернопільській області, 2007–2020 рр. Цифри наведено як особин на тис. га.

Overall, between 2007 and 2020, Ternopil Oblast was characterised by a high proportion of hunting grounds within the land use structure and a relatively stable status of the main groups of game animals, despite localised fluctuations in their numbers and density.

Brief description of the study area and forest conditions

The hunting grounds of the Chortkiv Forest District (covering an area of 49.0 thousand hectares) form part of the Forest-Steppe (Right-Bank) Forestry and Hunting Region. The forest district is situated in the south of Ternopil Oblast, within Chortkiv Raion. The hunting estate comprises 11 forest districts: Husiatyn, Kopychyntsi, Biletske, Kolyndiany, Ulashkivtsi, Skala-Podilska, Borshchiv, Zalishchytske, Naddnistrianske, Hermakivske, and Bilche-Zolotetske. The climate of the area where the hunting estate is located is temperate continental, characterised by mild winters and warm summers, without significant fluctuations, sufficient rainfall, and prevailing westerly and north-westerly winds.

The terrain of the hunting enstate is hilly, forming part of the western section of the right-bank forest-steppe within the Volyn–Podillia Ridge, specifically in the Podillia Upland. The landscape consists of a high, highly dissected plateau. Most of the territory is covered by loess-like loam deposits, upon which highly fertile chernozems have developed. The predominant soil types include grey forest soils, chernozems, and sod-podzolic soils.

The hunting estate has a dense hydrographic network of rivers and ponds. The primary watercourses are the Seret and Nichlava rivers and their tributaries. The considerable length of the river network and the presence of ponds fully satisfy the drinking water requirements of the game fauna.

The landscape features fragmented forest tracts interspersed with agricultural lands and human settlements. The largest proportion of the estate's forest vegetation consists of middle-aged stands (30–40 years old). Hardwood species predominate, with oak stands (*Quercus* spp.) covering 22.7 thousand hectares, hornbeam (*Carpinus betulus*) covering 3.99 thousand hectares, and ash (*Fraxinus excelsior*) covering 1.79 thousand hectares. Coniferous tree species (including pine, larch, and cedar) occupy a significantly smaller area of 2.47 thousand hectares [Pytuliak *et al.* 2020].

Composition of the game fauna and population sizes of the main species

The mammal fauna of the study area includes species with varying degrees of exploitation by the hunting sector (*Sus scrofa*, *Capreolus capreolus*, *Vulpes vulpes*, and *Lepus europaeus*), alongside other resident mammal species (*Meles meles*, *Martes martes*, *Mustela putorius*, and *Sciurus vulgaris*). Accordingly, when analysing the status of game animal populations, it is not only the absolute abundance of species that is informative, but also their spatial density across the specific survey sites.

The spatial distribution and prevalence of game animals vary across the territory, decreasing progressively across the forest districts: Kolyndiany (20.1%), Ulashkivtsi (17.0%), Biletske (14.0%), Kopychyntsi (13.4%), Hermakivske (9.8 %), Naddnistrianske (9.1 %), Borshchiv (7.4 %), Bilche-Zolotetske (4.7%), Skala-Podilska (4.3%), Zalishchytske and Husiatyn (0.2% each) (Table 1). The total population of harvested game animals within the Chortkiv Forestry in 2019 comprised of 1738 individuals, accounting for 74.6% of the cumulative abundance of all tracked species (nine species).

The total population of harvested game animals within the hunting grounds of the Chortkiv Forestry in 2019 comprised of 1738 individuals, accounting for 74.6% of the cumulative abundance of all tracked species (nine species). By contrast, those game species that were protected or not actively hunted during the studied period for various ecological reasons were represented in significantly smaller numbers (591 individuals; 25.4 %).

As of 2019, the most abundant game species were *L. europaeus* (49.7%), *C. capreolus* (15.4%), *S. scrofa* (6.0%), and *V. vulpes* (3.5%). The relatively high population figures for the European hare are evidently due to a combination of natural and anthropogenic factors, including low predator numbers, favourable winter weather conditions, and specific agricultural practices in adjacent fields [Domnich 2010]. Concurrently, periodic epizootics, which are not always fatal, can exert a significant impact on the long-term population dynamics of this species [Haerer 2001; Vlasiuk 2015].

Concerning other game mammals recorded within the forest districts, their relative abundance decreases progressively in the following order: *Sciurus vulgaris* (10.6%), *Martes martes* (6.7%), *Meles meles* (5.7%), and *Mustela putorius* (2.5%).

Table 1. Number and distribution of game mammals in the forest districts of the SE 'Chortkiv Forestry' (2019)
Таблиця 1. Чисельність мисливських звірів у лісництвах ДП «Чортківське лісове господарство» (2019)

Forest district	Total area, ha	Surveyed area, ha	Game species									
			S. scrofa		*C. capreolus*		*L. europaeus*		*V. vulpes*		*C. lupus*	
			ind.	%	ind.	%	ind.	%	ind.	%	ind.	%
Kopychyntsi	4712	1690	3	0.9	25	8.0	187	59.9	12	3.8	0	0
Biletske	3244	1338	52	15.9	62	19.0	125	38.2	7	2.1	0	0
Ulashkivtsi	4522	1797	8	2.0	83	20.9	180	45.3	15	3.8	0	0
Kolyndiany	6746	2358	1	0.2	48	10.3	297	63.6	13	2.8	0	0
Skala-Podilska	1198	436	4	4.0	15	15.2	42	42.4	4	4.0	0	0
Borshchiv	1480	538	14	8.3	40	23.7	55	32.3	6	3.6	0	0
Hermakivske	2392	905	29	13.0	40	17.5	90	39.5	12	5.3	0	0
Bilche-Zolotetske	1902	600	7	6.4	12	11.0	66	60.6	6	5.5	0	0
Naddnistrianske	3001	1033	12	5.7	34	16.1	116	55.0	6	2.9	0	0
Zalishchytske	2079	1005	5	100	0	0.0	0	0.0	0	0.0	0	0
Husiatyn	2830	1005	5	100	0	0.0	0	0.0	0	0.0	0	0
Total	29197	12705	140	6.0	359	15.4	1158	49.7	81	3.5	0	0

Table 1 (Continuation). Other game mammal species recorded in forest districts (2019)
Таблиця 1. (Продовження). Інші види мисливських звірів, зафіксовані на території лісництв (2019)

Forest district	Surveyed area (ha)	Non-harvested mammal species*									
		M. meles		*S. vulgaris*		*M. martes*		*M. putorius*		Total	
		ind.	%	ind.	%	ind.	%	ind.	%	ind.	%
Kopychyntsi	1690	9	2.9	28	9,0	33	10.6	15	4.8	312	13.4
Biletske	1338	27	8.3	20	6.1	21	6.4	13	4.0	327	14.0
Ulashkivtsi	1797	23	6.0	49	12.3	26	6.5	13	3.3	397	17.0
Kolyndiany	2358	34	7.3	40	8.6	18	3.9	16	3.4	467	20.1
Skala-Podilska	436	3	3.0	17	17.2	14	14.4	0	0	99	4.3
Borshchiv	538	9	5.3	33	19.5	12	7.1	0	0	169	7.4
Hermakivske	905	16	7.0	32	14.0	9	4.0	0	0	228	9.8
Bilche-Zolotetske	600	3	2.8	6	5.5	9	8.3	0	0	109	4.7
Naddnistrianske	1033	8	3.8	22	10.4	13	6.2	0	0	211	9.1
Zalishchytske	1005	0	0.0	0	0.0	0	0.0	0	0	5	0.2
Husiatyn	1005	0	0.0	0	0.0	0	0.0	0	0	5	0.2
Total	12705	132	5.7	247	10.6	155	6.7	57	2.5	2329	100.0

*Note**: The proportion of the species was calculated as a percentage of the total number of animals recorded during censuses within the forest districts.

The sighting of a wolf (*Canis lupus*) in the Biletske Forest District in 2020 indicates an isolated incursion of the species, which has no significant impact on the overall structure of the community. The results obtained emphasise the need for a differentiated approach to regulating game species populations, fully accounting for account the local characteristics of each individual forest district.

Changes in the population density in the pre-war period

In terms of their forage and shelter conditions, different types of hunting grounds hold varying significance for individual game species, while their quality class (bonitet) determines the habitat's potential productivity and carrying capacity.

The regulation of game animal density is governed by a range of factors. Amongst these, a key role is played by the consistent implementation of biotechnical measures aimed at increasing the productivity of hunting grounds, combating poaching, and controlling excessive pressure from predators (such as wolves, foxes, and stray dogs). At the same time, effective population management requires a shift towards scientifically grounded game management, particularly the optimisation and balancing of the sex and age structure of populations [Witmer 2005].

Each species of game animal is characterised by habitat selectivity, which results in spatial heterogeneity in their distribution [Instruction... 2002]. For instance, the highest wild boar density was recorded in the Biletske (38.9 ind./1000 ha), Hermakivske (32.0 ind./1000 ha), and Borshchiv (26.0 ind./1000 ha) forest districts (Fig. 4), where sufficient habitats meet the species' requirements, with average site indices of 2.8, 3.0, and 2.9 respectively (Table 2).

In other forest districts (with average site index 2.9–3.0), a gradual decrease in wild boar density was observed: Bilche-Zolotetske (11.7 ind./1000 ha), Naddnistrianske (11.6 ind./1000 ha), Skala-Podilska (9.2 ind./1000 ha), Zalishchytske and Husiatyn (5.0 ind./1000 ha each), Ulashkivtsi (4.5 ind./1000 ha), and Kopychyntsi (1.8 ind./1000 ha).

The lowest figure (0.4 ind./1000 ha) was recorded in the Kolyndiany forest district, despite a site class score of 2.8. This spatial distribution of *S. scrofa* populations is likely driven by differences in land use structure, moisture levels and the food supply, which remain decisive even against the backdrop of a relatively uniform site index and the growing influence of anthropogenic factors.

The habitat rating for *C. capreolus* (with average scores 2.2 to 3.0) indicates that the land is of good quality. At the same time, spatial variations in roe deer population density are driven by local land characteristics, which are not always fully captured by the general bonitet scores.

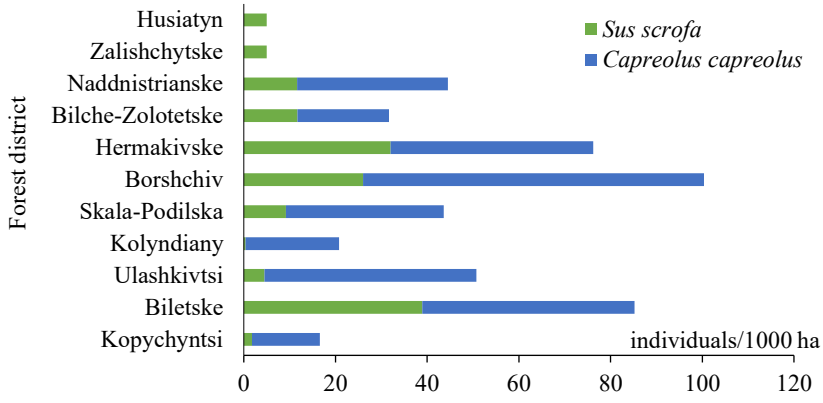

Fig. 4. Population density (ind./1000 ha) of the main wild ungulate species in forest districts of SE 'Chortkiv Forestry'.

Рис. 4. Щільність населення (ос./1000 га угідь) основних видів диких ратичних у лісництвах ДП «Чортківський лісгосп».

Table 2. Comparison of the optimal carrying capacity and actual abundance of the main game species across 11 ranger beats of the Chortkiv Forestry (as of 2020)*

Таблиця 2. Порівняння оптимальної ємності мисливських угідь і фактичної чисельності основних видів мисливських звірів у 11 єгерських обходах Чортківського лісгоспу (дані за 2020 р.)*

Species	Ranger beat											Total
	1	2	3	4	5	6	7	8	9	10	11	
	Mean bonitet index (adjusted)											
Capreolus capreolus	3.0	2.9	2.3	2.2	2.6	2.5	2.7	2.7	2.8	2.4	2.4	2.6
Sus scrofa	3.0	3.0	2.8	3.0	2.8	2.9	3.0	2.9	3.0	2.9	2.7	2.9
Lepus europaeus	3.0	2.9	2.5	2.7	2.5	2.9	3.0	2.9	2.7	2.9	2.5	2.7
Mean value	3.0	2.9	2.5	2.6	2.6	2.8	2.9	2.8	2.8	2.8	2.5	2.7
	Optimal carrying capacity											
Capreolus capreolus	64	65	131	128	100	112	79	55	51	134	86	1005
Sus scrofa	18	17	26	22	23	23	18	13	12	26	18	216
Lepus europaeus	127	105	316	250	372	138	102	77	150	555	247	2439
Total	209	187	473	400	495	273	199	145	213	715	351	3660
	Actual population											
Capreolus capreolus	45	47	115	88	56	46	52	31	23	61	51	615
Sus scrofa	6	4	64	10	1	7	11	12	5	21	16	157
Lepus europaeus	106	30	153	186	252	31	27	33	77	66	85	1046
Total	157	81	332	284	309	84	90	76	105	148	152	1818
	Actual population as a percentage of optimal (%)											
Capreolus capreolus	70.3	72.3	87.8	68.8	56.0	41.1	65.8	56.4	45.1	45.5	59.3	61.2
Sus scrofa	33.3	23.5	246.1	45.5	4.3	30.4	61.1	92.3	41.6	80.8	88.9	72.7
Lepus europaeus	83.5	28.6	48.4	74.4	67.7	22.5	26.5	42.9	51.3	11.9	34.4	42.9
Total	75.1	43.3	70.2	71.0	62.4	30.8	45.2	52.4	49.3	20.7	43.3	49.7

*Note**: Data on habitat types and baseline population estimates were compiled from [Pipa & Siletskyi 2021]. The authors structured the source data and calculated the ratio of actual abundance to optimal carrying capacity.

The highest population density of the species was recorded in the Borshchiv (74.3 ind./1000 ha; bonitet 2.7) forest district. Moderate densities (46.3–32.9 ind./1000 ha) were typical for the Biletske (bonitet 2.3), Ulashkivtsi (bonitet 2.2), Hermakivske (bonitet 2.4), Skala-Podilska (bonitet 2.5), and Naddnistrianske (bonitet 2.4) districts, which generally corresponds to the high forage and cover value of these areas.

The lowest population densities of European roe deer were recorded in the Kolyndiany (bonitet 2.6), Bilche-Zolotetske (bonitet 2.8), and Kopychyntsi (bonitet 3.0) forest districts: 20.4, 20.0, and 14.8 ind./1000 ha, respectively. This trend may indicate less optimal local living conditions caused by

a shortage of forage resources, reduced protective properties of the habitat, or increased anthropogenic pressure, none of which are fully reflected in the baseline bonitet indices.

The census data for fur-bearing species, when presented solely in absolute numbers, can be somewhat unreliable [Rizun & Bondarenko 2016]. Consequently, the calculated population density of fur-bearing species across the forest districts exhibits noticeable variations for the vast majority of species. An exception is *Lepus europaeus*, as tracking this species by its footprints is highly accessible and, therefore, yields the most accurate census results (Fig. 5).

Analysis revealed a strong, significant negative correlation (r = -0.69; $p < 0.05$) between the population density of *L. europaeus* and the habitat bonitet index (which ranges from 2.5 to 3.0) across the forest districts. Thus, environmental quality and habitat factors exert a decisive influence on the spatial density of this species.

In addition, statistical data were also obtained for other mammal species recorded within the forest districts, specifically the red squirrel, pine marten, polecat, and badger. A correlation analysis of the population densities of the principal fur-bearing species across the hunting estate revealed both positive and negative relationships. The most pronounced positive correlation was observed between species sharing similar ecological requirements and habitat preferences notably within the 'squirrel/marten' pair (r = 0.82; $p < 0.01$). This ecological relationship has been repeatedly confirmed by previous studies [Zizda 2012]. At the same time, a significant negative correlation was found between the hare and the fox (r = -0.72; $p < 0.05$), which further confirms the regulatory pressure of the red fox on the abundance of small game species in agricultural landscapes of Ukraine [Novytskyi *et al.* 2015].

Estimating the optimal carrying capacity of hunting grounds

Since habitat conditions influencing optimal game populations change dynamically under the impact of various factors, there is a clear need to refine habitat suitability assessments and recalculate the optimal carrying capacity for game species. This is particularly relevant for forest hunting grounds, as such environmental shifts are typically negligible in other habitat types [Sheihas & Gulyk 2024]. Pronounced differences exist among all 11 forest districts of the Chortkiv Forest Enterprise regarding both the actual abundance and optimal carrying capacity for the principal game species (Table 2).

As of 2020, the cumulative actual abundance of these main game species within the studied districts was 1818 individuals, which corresponds to only 49.7% of the calculated optimal carrying capacity (3660 individuals).

The wild boar population proved to be the most stable with its actual abundance reaching 72.7% of the optimal level. The highest exceedance of the optimal population size for this species was recorded in the Biletske forest district, where the actual population reached 246.1% of the optimum.

The *Sus scrofa* population figures closest to the calculated optimum were recorded in three forest districts of the Chortkiv Forest Enterprise: Zalishchytske (92.3%), Naddnistrianske (88.9%), and Hermakivske (80.8%). Conversely, the lowest actual abundance relative to the optimal capacity (only 4.3%) was observed in the Kolyndiany forest district.

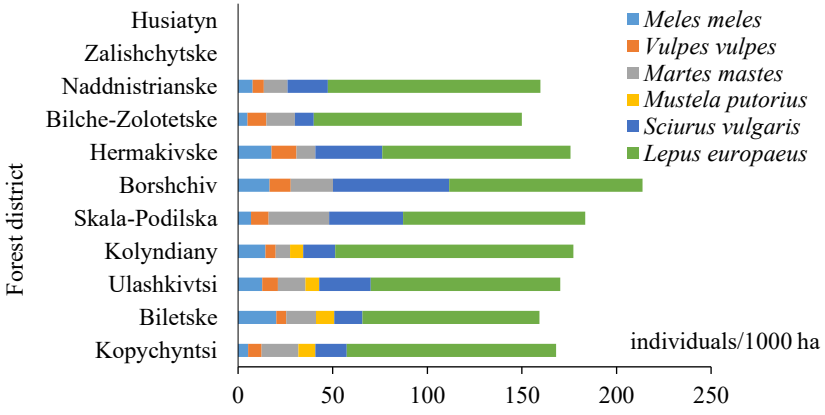

Fig. 5. Population density (ind./1000 ha) of furbearers in forest districts of SE 'Chortkiv Forestry.'

Рис. 5. Щільність хутрових звірів (екз. / 1000 га угідь) у лісництвах ДП «Чортківський лісгосп».

The population of *C. capreolus* showed a markedly greater shortfall, reaching only 61.2% of the optimal level. In fact, the actual population of this species does not reach the optimal value in any of the forest districts. The greatest negative deviation from the optimal level (with an actual population of only 42.9%) was recorded for *L. europaeus.* Significant fluctuations in this indicator were noted, ranging from relatively high values (83.5–67.7%) in the Kopychyntsi, Ulashkivtsi, and Kolyndiany forest districts to a very low level (11.9%) in the Hermakivske forest district.

Overall, a relatively high percentage of the actual population relative to the optimal level was recorded in the Kopychyntsi (ranger beat 1), Biletske (ranger beat 3), and Ulashkivtsi (ranger beat 4) forest districts, where this indicator exceeded 70%. At the same time, the Hermakivske, Skala-Podilska, Husiatyn, and Naddnistrianske forest districts (ranger beats 10, 6, 2, and 11, respectively) demonstrated the lowest figures (20.7%–43.3%), indicating a significant population decline and highlighting the urgent need for restoration measures.

Discussion

In the context of profound environmental transformations driven by climate change, military conflicts, and shifting natural resource management practices within the hunting sector, the systematic monitoring of game fauna has become increasingly critical. This includes regular assessments of the status of major game populations (their abundance and the carrying capacity of hunting grounds) and detailed analyses of their habitats [Volokh 2014].

An analysis of the game fauna of Ukraine, using Ternopil Oblast as a case study, demonstrated a relatively stable species composition and positive trends in the population dynamics of key groups of game mammals. The state forest–hunting enterprises of the region, located within the Right-Bank Forest-Steppe Forest–Hunting Zone, are situated under highly favourable environmental conditions for both ungulates and fur-bearing species. Species subject to hunting predominated (74.6%), whereas game species for which hunting was not permitted accounted for only 25.4%. This distribution reflects the typical structure of the local game fauna under the region's environmental and forest management conditions.

An analysis of trends in the total area of hunting grounds and game mammal populations within Ternopil Oblast in 2007–2020 revealed the relative stability of the region’s hunting resources, despite occasional periods of both expansion and contraction in the managed territory. The proportion of hunting grounds relative to the oblast’s total area remained consistently high (66–70%), underscoring the significant role of the hunting industry in regional natural resource management. It was established that the region’s checklist of game fauna comprises approximately half of Ukraine’s total game species diversity, specifically 4 ungulates species and 11 fur-bearing species. An analysis of population dynamics for the primary groups of game animals revealed stability, despite minor fluctuations in overall population size and density.

The highest density indices for *S. scrofa* and *C. capreolus* were recorded in forest districts offering superior foraging and protective conditions. Conversely, a decline in their density across certain areas indicates habitat deterioration and increased anthropogenic pressure, which are not always fully captured by standard habitat quality assessment.

For fur-bearing species, both positive and negative correlations were identified depending on the nature of their interspecific interactions and habitat specificity. In particular, a statistically significant negative correlation was established between the density of *L. europaeus* and habitat suitability indices, as well as between the abundance of *L. europaeus* and *V. vulpes*. This confirms the substantial regulatory pressure exerted by predators on game animal populations within the agricultural landscapes of Ukraine. Conversely, a strong positive correlation between population data for *S. vulgaris* and *M. martes* points to their similar ecological requirements and shared habitat preferences.

An analysis of the optimal and actual populations of the primary game species revealed significant spatial heterogeneity in their distribution across the forest districts of the Chortkiv Forestry State Enterprise. As of 2020, the total actual abundance of the main species was only 49.7% of the scientifically

established optimal level. The actual population of *S. scrofa* proved to be the most stable, whereas a significant negative deviation from the optimal was observed in *C. capreolus* and *L. europaeus*.

The identified regional differences are driven by the quality of foraging and cover conditions in the habitats, the intensity of anthropogenic pressure, and the influence of natural factors—specifically, predators and epizootics—which underscores the critical need to improve biotechnical and conservation measures in regional forest management.

Conclusions

Based on the assessment of the game fauna status and a qualitative evaluation of hunting grounds during the pre-crisis period, the following conclusions can be drawn:

1. The dynamics of the area of hunting grounds in Ternopil Oblast in 2007–2020 were characterised by moderate variability without significant long-term trends. The consistently high proportion of hunting grounds (66–70% of the oblast's total territory) underscores the prominent role of hunting management within the regional structure of land use and natural resource management.

2. According to official records from the Main Statistical Office in Ternopil Oblast, it was established that the game fauna is characterised by a stable species composition (approximately 50% of Ukraine's game fauna species diversity) and positive trends in the population sizes of the main groups of game animals.

3. The game fauna of the Chortkiv Forest Enterprise is characterised by the clear predominance of *C. capreolus*, *S. scrofa*, *L. europaeus*, and *V. vulpes*, which together account for 74.6% of the total population. A distinct gradient of decreasing game populations was observed across the forest districts from north to south. The density indices of *S. scrofa* and *C. capreolus*, coupled with the identified negative correlations (between *L. europaeus* and habitat suitability, as well as between *L. europaeus* and *V. vulpes*), reflect the strong combined influence of environmental conditions and predation pressure, which are not always fully captured by standard habitat quality assessments.

4. As of 2020, the total actual abundance of the main game species accounted for 49.7% of the optimal level, indicating a substantial shortfall from scientifically based targets. The population of *S. scrofa* proved to be the most stable, whereas significant negative deviations from the optimum were observed for *C. capreolus* and *L. europaeus*. These spatial and population differences are driven by habitat quality, anthropogenic pressure, and natural factors, which underscores the urgent need to improve biotechnical and conservation measures within the forest enterprise.

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Author Contributions

Project administration: L. Shevchyk. Methodology development: I. Grod, N. Kravets, L. Shevchyk. Data collection: L. Shevchyk, N. Kravets. Graphic and visuals: N. Kravets, I. Grod. Writing original draft: L. Shevchyk, I. Grod, N. Kravets. Translation: N. Kravets.

Declarations

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Conflict of interest: The authors have no conflicts of interest that could have influenced the content of this article.

Handling of materials. The study did not involve working with live animals or collection material.

Use of artificial intelligence: No generative artificial intelligence tools were utilised during the preparation of the manuscript.

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