



## ALIEN MAMMAL SPECIES IN FLOODPLAIN HABITATS OF THE SIVERSKY DONETS BASIN (UKRAINE)

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### Key words

Alien species, semi-aquatic mammals, range dynamics, population dynamics, invasions, expansions, eastern part of Ukraine

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### Abstract

An analysis of invasions and expansions of mammals in the Siversky Donets basin and adjacent areas is presented. Data on population and range dynamics of semi-aquatic mammals of two groups are given. The first group includes alien species that were introduced and had previously been unknown in the fauna of not only the region, but also Ukraine in general: muskrat (*Ondatra zibethicus*), coypu (*Myocastor coypus*), American mink (*Neogale vison*), and raccoon dog (*Nyctereutes procyonoides*). The second group includes local invaders, which nowadays are expanding their range, inhabiting the river and its tributaries: Eurasian beaver (*Castor fiber*) and Eurasian otter (*Lutra lutra*). The maps presented show the process of animal spread in the region, indicating the places of introduction, directions of expansion, and known registrations. For local invaders, the territory of their natural habitat at the time of the start of acclimatisation (for *Castor fiber*) or expansion to steppe regions (for *Lutra lutra*) is indicated. Population dynamics of all the species considered was analysed using data from the State Statistical Reporting, for the period from 1984 to 2021, and also monitoring data of other investigators for the pre-war period (until February 2022). The results of the statistical analysis show that populations of the introduced species of mammals increased rapidly from the time of their appearance in the composition of the fauna, after which their numbers began to decrease. Also, a number of factors were noted that over a certain period of time had an additional influence on the population dynamics of several alien mammal species. Data on long term dynamics of local invaders show that, along with the expansion of animals to new areas and increase in their abundance, a decrease of their numbers in areas of their historical distribution took place, such as in the case of *Lutra lutra*. Concerning the distribution and abundance of *Castor fiber*, an ambiguous situation has appeared: the state of its populations in some steppe areas is better than in the forest areas, where its abundance is decreasing. Information on the distribution and population state of the studied species based on OSINT-analysis, author's data and questionnaire surveys are presented. The results of introduction of the studied species are discussed.

### Cite as

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## Чужорідні види ссавців у прирічкових місцезнаходженнях басейну Сіверського Дінця

Денис Лазарєв

Резюме. Представлено аналіз інвазій та експансії ссавців у басейні Сіверського Дінця і прилеглих районів. Наведено дані щодо динаміки ареалів та чисельності коловодних ссавців двох груп. Перша включає інтродуцентів, раніше не відомих для фауни України загалом: ондатру (*Ondatra zibethicus*) нутрію (*Myocastor coypus*), візона річкового (*Neogale vison*); єнота уссурійського (*Nyctereutes procyonoides*). Друга група включає локальних інвайдерів, які в наш час розширюють свій ареал, заселяючи басейн Дінця — бобра європейського (*Castor fiber*) та видру річкову (*Lutra lutra*). За допомогою карт відтворено процес поширення тварин у регіоні зі зазначенням місць інтродукції, напрямків експансії та відомих рестрацій. Для локальних інвайдерів зазначено території їхнього природного ареалу на час інтродукції (*Castor fiber*) чи експансії у степові райони (*Lutra lutra*). Динаміку чисельності всіх цих видів проаналізовано на основі даних державної статистичної звітності (ЗТЗ) за період з 1984 по 2021 рр. та узагальнення даних моніторингу, отриманих іншими науковцями у довоєнний час (до лютого 2022 р.). Результати аналізу статистики показують, що чисельність інтродукованих видів ссавців стрімко зростає з моменту їх включення до складу фауни, після чого відбувається зниження чисельності. Також, відмічено низку факторів які протягом певного часу здійснили додатковий вплив на динаміку чисельності окремих чужорідних видів ссавців. Дані щодо багаторічної динаміки чисельності локальних інвайдерів свідчать, що поряд із поширенням тварин в нові райони і ростом їхньої чисельності відбувається зниження кількості тварин в районах їх історичного поширення, зокрема у випадку з *Lutra lutra*. Щодо поширення і чисельності *Castor fiber* склалася неоднозначна ситуація: стан популяції цього виду у низці степових районів є набагато кращим, ніж у лісових районах, де чисельність бобрів знижується. Наведено відомості про конкретні знахідки і стан популяцій досліджених видів на основі OSINT-аналізу, власних спостережень автора і даних анкетних опитувань. Обговорено наслідки вселення досліджуваних видів.

Ключові слова: чужорідні види, коловодні ссавці, динаміка ареалу, зміни чисельності, інвазії, експансії, східна частина України.

### Introduction

Alien mammal species are one of the main factors that influence changes in species composition within the fauna and pose a threat to biodiversity [Genovesi *et al.* 2012; Tedeschi *et al.* 2021; Dziech *et al.* 2023]. River networks accumulate the largest number of alien animals and facilitate their spread within river basins, which is also typical for the vertebrate fauna of Ukraine [Zagorodniuk 2023]. This issue is also relevant to the Siversky Donets River basin, which has become an arena for the spread of animals, including alien invasive species, within the region [Lazariiev 2023]. All alien species have dynamic ranges, and the boundaries of their distribution are constantly changing [Zagorodniuk 2012a]. The group of fur animals has also long been a subject of attention by many researchers [Sokur 1961; Berestennikov *et al.* 1969; Panov 2002; Sakhno 2015]. This attention was associated with the ‘improvement’ program of hunting grounds, particularly due to the extremely high demand for fur in the 1950s and 1980s [Panov 2002]. Semi-aquatic mammals in floodplain ecosystems of the Siversky Donets primarily are represented by adventive species.

Some information about alien mammals is presented in reviews of the mammal fauna of eastern regions of Ukraine [Zagorodniuk 2006a, 2012a], where these species are classified into different groups based on their alien status, and some of them include information on sightings and population size. However, only a small portion of the eastern Ukrainian fauna has been thoroughly described [Zagorodniuk & Korobchenko 2008; Taranenko *et al.* 2008]. Information regarding the occurrence, distribution, and dynamics of semi-aquatic mammals in eastern Ukraine is available in the works of various researchers [Sakhno & Simonov 1956; Berestennikov *et al.* 1969; Skorobogatov & Atemasova 2001; Panov 2002; Sakhno 2015]. Additional information can be found in descriptions of the fauna of mustelids [Kondratenko & Kolesnikov 2006; Lytvynenko & Yevtushenko 2015]. However,

the remaining information is extremely fragmentary. A history of research and of the appearance of alien mammal species in eastern Ukraine was presented by author earlier [Lazariev 2022].

The aim of this study is to analyse the historical changes in the geographic range, population dynamics, and current distribution of semi-aquatic mammals in the Siversky Donets River basin.

## Materials and Methods

The work has been conducted based on data obtained from several sources: scientific publications, survey materials, analysis of open-source data (OSINT), and examination of museum collections. Internet resources (online publications, blogs, and citizen media) and open data from the State Statistics Service were used for the analysis of open-source data.

This study focuses on the portion of the Siversky Donets basin that is located in three oblasts in eastern Ukraine: Donetsk, Luhansk, and Kharkiv. Data are also presented for regions of Russia that are partially covered by the Siversky Donets basin, as well as Ukrainian regions that border with the study area.

The questionnaire was delivered to 30 respondents from the eastern regions of Ukraine and neighbouring areas. The majority of respondents were hunters and fishermen (19 individuals), while a smaller portion were local residents (11 individuals).

To analyse open sources, we utilised various internet resources, including photos and videos from social networks, as well as discussions on forums. For data verification purposes, we contacted the authors of relevant publications. To analyse population dynamics, we utilised information from the statistical compendium provided by the State Statistics Service of Ukraine, covering the period from 1984 to 2021. The collected data were generalised and analysed to clarify the population dynamics of animals in each of the three administrative oblasts: Kharkiv, Luhansk, and Donetsk.

A large portion of information was collected by analysing labels of specimens from collections of the Zoological Museum of Luhansk Taras Shevchenko National University, which were collected up until 2014.

The group of mammal species that are alien to any regional fauna can be divided into two sub-groups: close invaders and introduced species [Zagorodniuk 2006b]. The review of research results for each species includes three steps: 1) assessment of the species' status in the region, description of its history of dispersal, and the means of its introduction or expansion; 2) analysis of the species' population dynamics; 3) analysis of current data on the numbers and distribution of the species, including cartographic materials and their description.

For each species, information on animal findings is presented in the form of an inventory, including the place of discovery, date, number of individuals, and the source of information. The findings are categorised into two groups: 1) findings from the 20th century; 2) findings from the 21st century. Each group separately presents findings from Donetsk, Luhansk, and Kharkiv oblasts.

The following abbreviations are used in this article:

LNR—Luhansk Nature Reserve; LNU—Luhansk Taras Shevchenko National University; LP—landscape park; NNP—national nature park; NR—nature reserve; ZM LNU—Zoological Museum of Luhansk Taras Shevchenko National University.

## Study region

The Siversky Donets is the largest river in eastern Ukraine and the largest tributary of the Don River. The total length of the river is 1053 km, with approximately 718 km located within Ukraine. The Donets basin covers an area of 98 900 km<sup>2</sup> [Bliznyak 1945]. The territory of eastern Ukraine, which largely corresponds to the geographical location of the Donets Basin (Fig. 1), has attracted the attention of numerous scientists, including mammalogists, who have studied the structure and historical changes in the region's fauna of semi-aquatic species [Sahno 1956; Zagorodniuk 2006a; Kondratenko & Kolesnikov 2006].

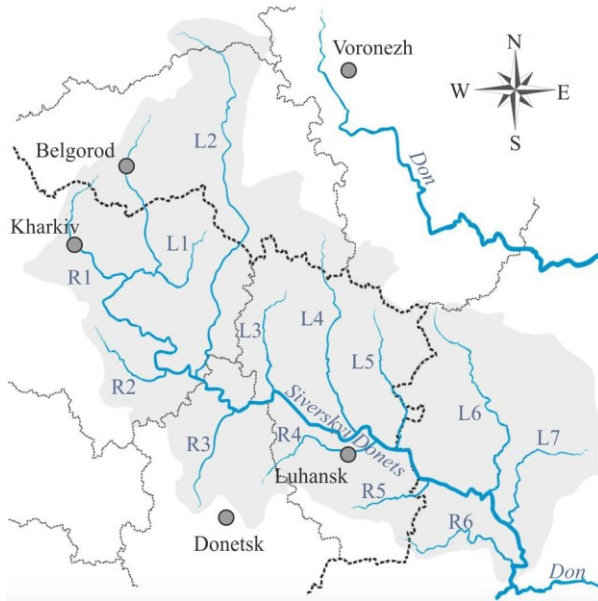


Fig. 1. The Siversky Donets basin as an arena of expansions and invasions of a number of mammal species described in the text. Designation of key tributaries: left tributaries: L1, Velikiy Burluk River; L2, Oskol River; L3, Krasna River, L4, Aidar River; L5, Derkul River; L6, Kalitva River; L7, Bystraya River; right tributaries: R1, Udy River; R2, Bereka River; R3, Kazenny Torets; R4, Luhan River; R5, Velyka Kamianka River; R6, Kundryucha River. The author's drawing is based on the scheme by A. Safonov (Wikipedia: <https://goo.su/o6sbUb>).

Рис. 1. Басейн Сіверського Дінця як арена експансії та інвазій низки видів ссавців, описаних у тексті. Позначення ключових приток: ліві притоки: L1, р. Великий Бурлук; L2, р. Оскіл; L3, р. Красна; L4, р. Айдар; L5, р. Деркул; L6, р. Калитва; L7, р. Бистра; праві притоки: R1, р. Уди; R2, р. Берека; R3, Казенний Торєць; R4, р. Лугань; R5, р. Велика Кам'янка; R6, р. Кундрюча. Рисунок автора на основі схеми А. Сафронова (Wikipedia: <https://goo.su/o6sbUb>).

The middle reaches of the Siversky Donets have been the focal point for the introduction and acclimatisation of adventive mammal species, which has led to changes in the composition of the local fauna. A new factor influencing these changes is the ongoing military conflict, which directly affects a significant part of eastern Ukraine, including the study area, and has an impact on the mammal fauna. The river acts as a natural barrier for military units, resulting in significant disturbance to river habitats due to hostilities and unregulated use of natural resources, including animals.

Mammals inhabiting the river ecosystems in the region include the following alien species: muskrat (*Ondatra zibethicus*), coypu (*Myocastor coypus*), American mink (*Neogale vison*), and raccoon dog (*Nyctereutes procyonoides*). Local invaders include the European beaver (*Castor fiber*) and Eurasian otter (*Lutra lutra*). The composition of this group of animals is a result of numerous experiments conducted during the 20th century to enrich the game fauna, and the successful expansion of both introduced and native animals from neighbouring regions.

The Siversky Donets River begins in Belgorod Oblast of Russia and flows into the Don River in the Rostov Oblast of Russia. However, the majority of its basin and tributaries are situated in the Donetsk, Luhansk, and Kharkiv oblasts of Ukraine, which are in the focus of this study.

### Introduced species

The term 'introduced' or 'introduced species' is used to describe alien organisms that, unlike native species, exist outside their natural habitats and are brought into a specific region by humans [Zagorodniuk 2006b; Antonets 2012; Ivanko *et al.* 2022]. Within the group of semi-aquatic mammals, there are four species in regional fauna that fit this definition: muskrat, coypu, American mink, and raccoon dog. These species are described in detail below. All of these animals have established themselves in the region with the intentional or unintentional assistance of humans.

#### *Muskrat (Ondatra zibethicus Linnaeus 1766)*

An alien species in the fauna of Ukraine, which appeared in the region as a result of synthetic dispersal [Panov 2002]. The first attempts to introduce muskrats were made in the early 20th century. In 1929, 36 animals were released into one of the ponds near Kharkiv, but the experiment was unsuccessful [Kolosov & Lavrov 1968]. In the territory of the region, the first successful introduction of animals took place in Kreminna Raion, on the Krasna and Siversky Donets rivers [Lavrov 1957]. Muskrats first introduced in Ukraine were captured in Kurgan Oblast, Russia. Between 1945 and 1947, a total of 161 individuals were released in Luhansk Oblast.

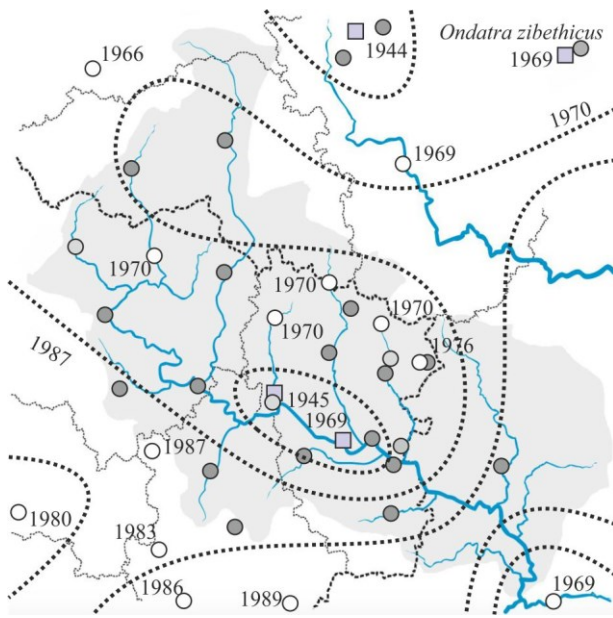


Fig. 2. Distribution of *Ondatra zibethicus* in the Siverskyi Donets basin and adjacent areas. Squares mark the main locations of 'successful' introductions. Unshaded dots show the oldest records of animals, light grey dots show finds from the 20th century, dark grey dots mark records from the 21st century.

Рис 2. Поширення *Ondatra zibethicus* в басейні Сіверського Дінця та прилеглих районах. Квадратними значками показані основні місця "вдалих" інтродукцій. Незамальовані точки показують найдавніші знахідки тварин, світло-сірі — знахідки тварин в XX ст., темно-сірі точки — знахідки XXI ст. Ізолініями об'єднано точки, що показують експансію ондатри.

The efforts to distribute this species became more extensive between 1947 and 1969. Since the beginning of the introduction, the largest number of muskrats (707 individuals) has been released in the steppe zone. The muskrat is characterised by a high rate of expansion (about 70 km per year). The animals spread rapidly across the Donets basin, and by the 1970s, they had even inhabited the most remote tributaries in the north of Luhansk Oblast [Volokh 2014]. The distribution of muskrats in the Siverskyi Donets basin is shown in Fig. 2.

It should be noted that until the 1980s, muskrats were not as popular in the Donetsk Oblast as they were in the Luhansk and Kharkiv oblasts. During the years when active work on the dispersal of this species was underway, animals of the given species were not released in the Donetsk Oblast. They were almost absent in the rivers of the Azov Sea region, and only in 1980 did they begin to migrate to the territory of the Donetsk Oblast along the tributaries of the Dnipro. Later, they began to appear in the rivers of the Azov Sea basin. For example, in the Kamiany Mohyly Reserve (Karatysh River), these animals were first recorded in 1989 [Volokh 2014].

Beginning in the mid-1990s, according to the State Statistics Service of Ukraine, the population of animals started to increase in all these three eastern regions of Ukraine. In 2005, the population reached its maximum in the Kharkiv Oblast. In 2008, it reached its maximum in the Luhansk Oblast. Such a rapid increase in the population (over 10 000 in Luhansk and over 8 000 in Kharkiv) may be due to the decrease in demand for fur at that time and the restriction of hunting limits, which allowed the population to increase. Over the past 10–15 years, there has been a decrease in the number of muskrats in the Luhansk and Kharkiv oblasts, as evident from the official population dynamics (Fig. 3). The negative population dynamics is also confirmed by reports from hunters. During 2018–2021, local residents of Kharkiv Oblast noted a decrease in the number of muskrats in the areas where the American mink appeared<sup>1</sup>. The decline in populations is particularly noticeable in marshes, which is explained by the localisation of populations that cannot recover quickly and the gradual change in the hydrological conditions—drying up and draining of marshes. The situation with the number of muskrats in Luhansk Oblast is likely to have the same reasons, but it is worth noting that the rapid decline in the graph in 2014 is also explained by the fact that since that year, the number of animals has been recorded without taking into account the temporarily occupied territories (south of Luhansk Oblast, right bank).

<sup>1</sup> The issue of muskrat population decline and possible reasons for this phenomenon were discussed on the webforum of the Ukrainian Society of Hunters and Fishermen (<https://www.uoor.com.ua/>) in 2018: <https://goo.su/O9lc> in 2021: <https://goo.su/DORIInV>

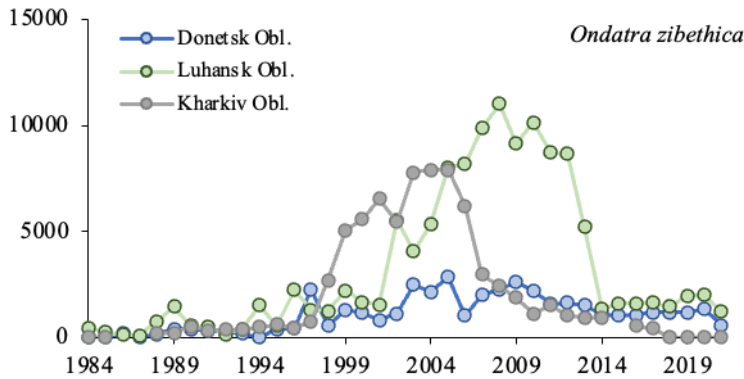


Fig. 3. Population dynamics of *Ondatra zibethica* according to the data of state statistical reporting.

Рис. 3. Динаміка чисельності *Ondatra zibethica* за даними статистичної звітності "2тп-мисливство".

Although their population has declined, muskrats are still distributed throughout the Siversky Donets basin, including its most remote tributaries (see the list below). The only exceptions are artificial reservoirs and marshes, where the animals periodically appear or disappear (for example, marshes in Iziium Raion of Kharkiv Oblast and artificial reservoirs in Sieverodonetsk).

#### 20th century

*Donetsk Oblast:* ♦ Solona River, 1983 [Volokh 2002]; ♦ Velykyi Utliuk River, 1986 [Volokh 2002]; ♦ Malyi Utliuk River, 1986 [Volokh 2002]; ♦ Kamiani Mohyly NR, Karatysh River, 1989 [Volokh 2014]. *Luhansk Oblast:* ♦ Kreminna forests, 1945, introduction; ♦ Siversky Donets River (middle reaches), 1969, introduction [Volokh 2014]; ♦ Northern parts of the oblast, tributaries of the Donets, 1970, expansion [Volokh 2014]; ♦ Milove Raion, Komysyna, Milova, and Cherepakha rivers, 1976, numerous records (questionnaire survey data); ♦ Kreminna Raion, Serebrianka forestry, shore of Kleshnia Lake, 03.07.1994, n = 1, ZM LNU: leg. O. Kondratenko; ♦ Bilovodsk Raion, Horodyshe, lake near the Derkul River, spring of 1995, n = 1, ZM LNU; ♦ Stanytsia-Luhanska Raion, near Herasymivka, 07.04.1998, n = 1, ZM LNU: leg. O. Kondratenko. *Kharkiv Oblast:* ♦ around Kharkiv, 1929, unsuccessful introduction, n = 36 [Kolosov & Lavrov 1968].

#### 21th century

*Donetsk Oblast:* ♦ Donetsk, Tekstilnyk neighbourhood, June 2016, n = 2 (based on video materials from youtube.com). ♦ Donetsk, Kalmius River, 15.05.2023, n = 1 (N. Dodoenkova, social network). *Luhansk Oblast:* ♦ Novoposkov Raion, Kamianka River, near Kamianka village, July 2017, several settlements (author's data); ♦ Stanytsia-Luhanska Raion, Stanychno-Luhanskyi fish farm, 2013 n = 1, ZM LNU; ♦ Novoposkov Raion, Kamianka River, near Kamianka village, 2018, several settlements (author's data); ♦ Milove Raion, Striltsivskyi Steppe NR, Cherepakha River, 18.03.2019, n = 1 (author's data); ♦ Siverodonetsk, Chyste Lake, 14.07.2020, n = 1 (author's data); ♦ Stanytsia-Luhanska Raion, Stanytsia-Luhanska, Rubizhne Lake, 04.10.2020, n = 1 (Chronicles of LNR: data by V. Moroz); ♦ Starobilsk, Aidar River, September 2021, n = 1 (author's data); ♦ Starobilsk Raion, near Starobilsk city, Aidar River, numerous settlements, 2022 (author's data). *Kharkiv Oblast:* ♦ Lozova Raion, Brytai River, 2013 ♦ Iziium city, Siversky Donets River, 30.06.2020, n = 1 (D. Abdieva, social network); ♦ Kharkiv city, Studenok River, 19.05.2019 n = 1 (I. Kozytzkyi, social network); ♦ Zmiiv Raion, Siversky Donets River, 2021 (author's data); ♦ Dvorichanskyi NNP, Oskil River, 2003 [Naglov 2003]; ♦ Kazenny Torets river, Donetsk Oblast, Luhan and Velyka Kamianka rivers, Luhansk Oblast (questionnaire survey data).

#### Neighbouring territories (RF)

*Voronezh Oblast:* ♦ Voronezh, Voronezh River, 23.03.2023 (data from volunteers of the 'Heart of the Forest' group); ♦ Voronezh Nature Reserve, 14.12.2020, n = 1 (A. Mishin, social network); ♦ Borisoglebsk, 14.04.2022 (according to the publication in 'Vesti Voronezha' vestivrn.ru); ♦ Middle reaches of the Don River, 2001 [Prostakov 2001] ♦ Khopersky Nature Reserve, 1969, introduction [Prostakov 2001]. *Belgorod Oblast:* ♦ Belgorod, Sosnovka, Siversky Donets River, May 2022 (based on youtube.com); ♦ Oskil River, 2008 (social network).

### *Coypu (Myocastor coypus Molina 1782)*

An alien species that does not form permanent natural populations in the region. Starting in the 1930s, the USSR carried out acclimatisation work on coypu, which covered the southern regions. The animals were introduced to areas close to the study area, particularly in Dnipropetrovsk Oblast in 1971 and in 1990 to the Orel River and Krasynske Reservoir [Volokh 2014]. Due to the fact that unplanned introductions (dispersal of animals by hunters, coypu farmers, escape of animals from culture) often occurred during the dispersal of game species, it is likely that the coypu has been released in the Siversky Donets basin on several occasions. This is supported by data on the occurrence of this species in 1982 in the protected area of the Striltsivsky Steppe NR [Skokov *et al.* 1992] and other, including relatively recent, cases of coypu occurrence in the natural environment (Fig. 4), also given in the inventory below.

#### 20th century

*Donetsk Oblast:* ♦ Hruzkyi Yelanchyk River, 1980 [Martynov & Nikulina 2021]; ♦ Oleksandrivka, 1990 (O. Reznik, pers. comm.). *Luhansk Oblast:* ♦ Striltsivsky Steppe NR, 1982, n = 1, the animal was observed during summer and winter (Chronicle of LNR).

#### 21st century

*Donetsk Oblast:* ♦ Khomutovsky Steppe NR, Hruzkyi Yelanchyk River, 2002 (questionnaire survey data) [Kondratenko 2002]; ♦ Chalk Flora NR, 2002 [Limansky & Kondratenko 2002] ♦ Donetsk, Bagrationa street, 17.04.2023, n = 1 (social networks). *Luhansk Oblast:* ♦ Siverodonetsk, Parkove Lake, 29.01.2021, n = 1, albino (social network); ♦ Striltsivsky Steppe NR, 2020, n = 1 (author's data). *Kharkiv Oblast:* ♦ Kharkiv, Studenok River, 28.08.2021, n = 1 (I. Kozitskyi, social network); ♦ Kharkiv, Studenok River, 02.11.2021, n = 1 (ibid.); ♦ Bohodukhiv Raion, Valky, runaways from farms (social network); ♦ Krasnohrad Raion, Kehychivka, runaways from farms (social network).

*Neighbouring territories (RF):* ♦ Belgorod, Siverskyi Donets River, 3.05.2023 (social network).

It is possible that these animals escape into the wild or are deliberately imported, because a large number of private coypu farms still exist in Donetsk and Kharkiv oblasts, as evidenced by data from private advertisements (olx.ua). To date, there has been no long-term monitoring of the population of these animals in the region. The State Statistics Service of Ukraine has information on the number of coypu at 35 individuals in 2002 in hunting grounds of Donetsk Oblast, according to statistical reports of hunting farms.

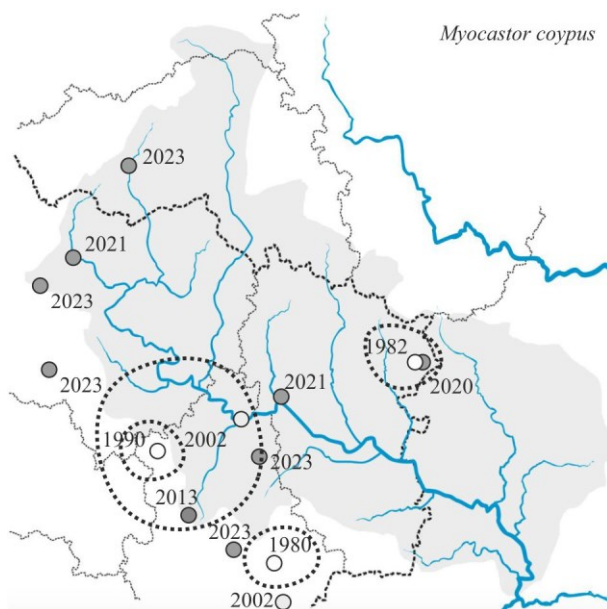


Fig. 4. Finds of the coypu (*Myocastor coypus*) in the Siversky Donets basin and adjacent areas. Unfilled dots show ancient finds (20th century), light grey dots show findings before 2010, dark grey dots mark records after 2010. Numbers indicate the years of registration of animal finds.

Рис. 4. Знахідки нутрії болотяної (*Myocastor coypus*) в басейні Сіверського Дінця та прилеглих районах. Незамальовані точки показують давні знахідки (XX ст.), світло-сірі точки показують знахідки до 2010 року, темно-сірі — знахідки після 2010 р. Цифрами позначено роки реєстрацій знахідок тварин.

This mammal species has a tendency to naturalise [Zagorodniuk 2012b]. Some of the monitored muskrat communities in southern Ukraine have existed in the wild for several months to several years [Dulitsky 2001]. The 1982 Chronicle of Nature of the Luhansk NR contains recorded sightings of coypu on the Cherepakha River, within the protected zone of the reserve. Traces of the animal were found in the river valley even after the formation of the ice cover. Taking into account climatic changes, in case of warm winters, there is a possibility of naturalisation of this species.

### *American mink (Neogale vison Schreber 1777)<sup>2</sup>*

An alien species that became part of the local fauna as a result of escapes from farms in the 1950s in the north-east of Donetsk Oblast. During the 1960s and 1970s, the species formed natural populations [Panov 2002] in the region, which raised serious concerns in the field of environmental protection [Zagorodniuk 2006b].

Although the species quickly spread along the Siversky Donets, animals appeared later in the areas of remote tributaries. In the early 2000s, scientists recorded the native European mink (*Mustela lutreola* Linnaeus, 1758) more frequently in this area and on the Derkul River (Bilovodsk Raion) [Kondratenko & Kolesnikov 2006; Melezhyk 2015]. It was only in 2004 that specialists from the Striltsivsky Steppe NR confirmed the presence of *Neogale vison* here<sup>3</sup> (Fig. 5). As of 2005, the American mink was moderately common but not abundant in Kharkiv Oblast, and it was noted that this invasive species was putting pressure on the native mink [Zorya 2005].

According to the State Statistics Service of Ukraine, until 2011, the two main species of mink—the native European mink and the introduced American mink—were accounted for as one species, collectively called ‘free mink’ [Zagorodniuk & Kharchuk 2020]. Given that, by that time, the invasive mink species had already displaced the European mink in many areas or notably reduced their numbers, the majority of recorded animals of ‘free mink’ category belonged to the American mink.

The American mink as a separate species has been recorded since 2011, but the dynamics of the ‘free mink’ population before 2011 and the current dynamics of American mink indicate a constant upward trend in their population.

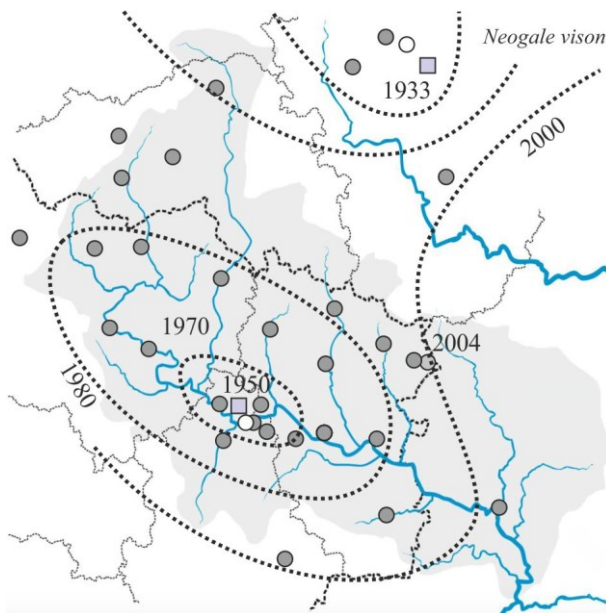


Fig. 5. Distribution of *Neogale vison* in the Siversky Donets basin and adjacent areas. Numbers indicate the years of occurrence of animals within certain bodies of water. Squares mark places of introduction, unshaded dots note places of the earliest animal records, and shaded dots mark findings in the 21st century.

Рис. 5. Поширення *Neogale vison* в басейні Сіверського Дінця та прилеглих районах. Цифрами позначено роки появи тварин в межах певних акваторій. Квадратні значки показують місця інтродукції, незамальовані точки — місця найдавніших реєстрацій тварин, замальовані точки — знахідки тварин протягом XXI ст. Ізолінії об'єднують точки експансії рівнозначні за роками.

<sup>2</sup> This mammal is known in older literature on regional mammal fauna as *Mustela vison* or *Neovison vison*. The current name is adopted in accordance with the latest revisions to the checklist of the mammal fauna of Ukraine [Zagorodniuk & Kharchuk 2020].

<sup>3</sup> Chronicles of the Nature of the Luhansk Natural Reserve (LNR) for 2004. Scientific archives of LNR (ms).



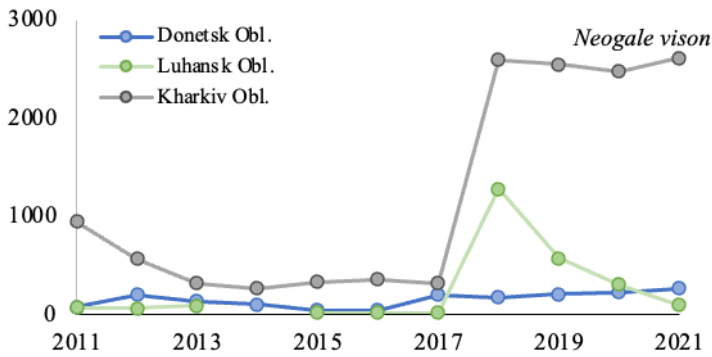


Fig. 6. Population dynamics of *Neogale vison* according to the data of state statistical reporting.

Рис. 6. Динаміка чисельності *Neogale vison* за даними статистичної звітності "ЗП-мисливство".

This growth pattern (Fig. 6) shows that after 2017, the number of the American mink in Luhansk and Kharkiv oblasts has been growing rapidly. This dynamics is confirmed by the distribution pattern of the species in recent years. According to the author's data and open sources (see inventory below), the species is quite abundant in the Siversky Donets valley and has recently become more widespread in remote tributaries, such as the Komyschna River basin.

#### 20th century

◆ Most records reported in 1970–1980 [Zagorodniuk 2006a].

*Donetsk Oblast*: ◆ North-eastern raions of the oblast, escape from culture, 1950 [Panov 2002].

*Neighbouring territories*: ◆ Voronezh Oblast, introduction, n = 19, 1933 [Kolosov & Lavrov 1968].

#### 21st century

*Donetsk Oblast*: ◆ Bakhmut Raion, Dronivka, a forest stream, 27.10.2013, n = 1 [Yarotsky 2023]; ◆ Lyman Raion, Shchurove, 2015, n = 1, (Y. Prokhorin, social network); ◆ Kramatorsk city, 31.02.2020, n = 1 (Y. Prokhorin, social network); ◆ Kramatorsk Raion, near the Brusino railway station, n = 1, 2020 (Y. Prokhorin, social network); ◆ Sviatohirsk, 2020, n = 1, (Y. Prokhorin, social network); ◆ Zuivskiy Landscape Park, 25.04.2023 (V. Telyaha, social network). *Luhansk Oblast*: ◆ Svatove Raion, near the town of Svatove, n = 1 (specimen in the collection of I. Zagorodniuk); ◆ Novopskov Raion, Osynove natural monument, 2–3.07.2004, American mink hunting muskrat (M. Kolesnikov, pers. comm.); ◆ Slovianoserbsk, November 2008, n = 1 (det. S. Lytvynenko); ◆ Slovianoserbsk, October 2009, n = 1, ZM LNU (det. I. Zagorodniuk); ◆ Slovianoserbsk Raion, Kriakivka, 2012, n = 1 [Lytvynenko & Yevtushenko 2015]; ◆ Starobilsk, until 2014, n = 1, ZM LNU; ◆ Streltsivskiy Steppe NR, 5.09.2019, n = 1 (author's data); ◆ Stanytsia-Luhanska, Rubizhne Lake, 23.03.2020, n = 1 (Chronicle of LNR, V. Moroz data); ◆ Milove Raion, Streltsivka, Komyschna River, 7.08.2020, n = 1 (author's data); ◆ Stanytsia-Luhanska, Hlyboke Lake, 06.05.2021, n = 1 (V. Holovko, social network); ◆ Bilovodska Raion, Derkul River, 2019 (I. Zagorodniuk, pers. comm.); ◆ Sorokyne, Velyka Kamianka River, n = 1, autumn 2018 (author's data).

*Kharkiv Oblast*: ◆ Slobzhanskyi NNP, 2019, registration with a camera trap (social network); ◆ Pechenihy Reservoir, 2013, n = 1 (social network); ◆ Siversky Donets River, confluence with the Oskol River, spring 2013, n = 1 (reports in social networks); ◆ Balakliia Raion, Andriika, shore of oxbow lake, 04.04.2021, recorded with a camera trap [Yarotsky 2023]; ◆ Chuhuiv, Siversky Donets River, left bank, 26.02.2014, n = 1 [Yarotsky 2023]; ◆ Homilshanski Lisnyy NNP, 04.12.2014, n = 2 [Yarotsky 2023]; ◆ Balakliia Raion, Andriivka, 17.04.2016 [Yarotsky 2023]. ◆ Slobzhanskyi NNP, Merchyk River, n = 6–7 finds reported in 2012–2017 [Bondarenko et al. 2023]; ◆ Dvorichanskyi NNP, 2014 [Tokarsky 2014].

*Neighbouring territories (RF)*. *Belgorod Oblast*: ◆ Belgorod, Korocha, Starooskolsky, and Yakovlevsky districts, 18.03.2022 (social network). *Voronezh Oblast*: ◆ Voronezh NR, 2019 (social network); ◆ Shilovo, 14.10.2021 (social network); ◆ Bobrovsky district, Bytyug River, 16.09.2020 (based on moe-online.ru). *Rostov Oblast*: ◆ Bila Kalytva, Siversky Donets River, n = 1, 21.04.2023 (author's data).

In the area of Pryderkulie, the European mink was last recorded in 2019 (I. Zagorodniuk, pers. comm.). For the observation period from 2019 to 2023, the author is not aware of any sightings of this animal. It is highly likely that the native mink species has remained only in peripheral areas of the Donets basin.

### ***Common raccoon dog (*Nyctereutes procyonoides* Gray, 1834)***

Work on the acclimatisation of this species in the region began in 1935. Over a period of five years, the animals were introduced in all three eastern regions of Ukraine: 24 animals in Donetsk Oblast, 53 in Luhansk Oblast, and 92 in Kharkiv Oblast [Kolosov & Lavrov 1968]. The process of introducing these animals, as well as the distribution range of other invasive species, are described in the work by I. Sokur 'Acclimatisation and Breeding of Fur Animals in Ukraine' [Sokur 1953]. As a result of mass introductions, this species has become completely naturalised in Ukraine over the past 2–3 decades. By the end of the 1960s, the raccoon dog was recorded in all protected areas of the region that existed at that time, although its abundance was low. According to the Chronicle of Nature of LNR, the frequency of sightings of this animal increased considerably during 1977–1982.

According to the State Statistics Service of Ukraine, there were no notable fluctuations in the numbers of raccoon dogs in the following decades. The results of surveys and the author's own observations suggest that the raccoon dog is a fairly common species in the region, but not very abundant. It should be noted that only within the territories of nature reserves, the number of encounters was limited to 2–3 visual observations of the species per year (author's data). As in other regions of Ukraine, the dynamics of the raccoon dog population have a wave-like nature with a large amplitude of fluctuations, occurring in 5–10-year cycles (Fig. 7).

#### *20th century*

*Donetsk Oblast:* ♦ Avdiivka and Selydove raions, 1945 p., n = 24, introduction [Korneev 1954]; ♦ As of 1946, animal skins came from all administrative districts of the region [Volokh 2014]. *Luhansk Oblast:* ♦ Kreminna Raion, 1935, n = 40, introduction [Volokh 2014]; ♦ Kreminna Raion, 1937, n = 13, introduction [Volokh 2014]. *Kharkiv Oblast:* ♦ formation of the north-eastern range of the species, 1935–1941 [Volokh 2014].

#### *Neighbouring territories (RF)*

*Voronezh Oblast:* ♦ Voronezh NR, 1936, n = 3, introduction [Barabash-Nikiforov 1957]; ♦ Introduction in Voronezh Oblast lasted until 1947 [Kolosov & Lavrov 1968].

#### *21st century*

*Donetsk Oblast:* ♦ Meotyda NNP, 09.02.2011, n = 1 (social network); ♦ Yampil forestry, swamp, July 2017, n = 1 (O. Zakharov, social network); ♦ Polovetskyi Steppe LP, 29.06.2020, n = 1 (social network); ♦ Meotyda NNP, 2019 (social network); ♦ outskirts of Selydove, n = 1 (questionnaire survey data).

*Luhansk Oblast:* ♦ n = 1, ZM LNU (det. I. Zagorodniuk); ♦ Sverdlovsk Raion, Provalskyi Steppe NR, 2001, skeletal fragments found, n = 1 (I. Zagorodniuk, pers. comm.); ♦ Stanytsia-Luhanska Raion, Novo-Iliencko biological station of LNU, 2008, n = 1, an animal with signs of rabies was killed in a basement by local residents (I. Zagorodniuk, pers. comm.); ♦ Stanytsia-Luhanska Raion, Novo-Iliencko biostation, 2010, several times animals were observed coming to the territory of the estate attracted by the feeding of domestic dogs (I. Zagorodniuk, pers. comm.); ♦ Stanytsia-Luhanska Raion, territory of Stanychno-Luhanskyi fish farm. 29.05.2012, n = 1 ZM LNU; ♦ Slovianoserbsk Raion, 20.10.2012, n = 1, ZM LNU (leg. P. Foroshchuk); ♦ Stanytsia-Luhanska Raion, Plotina village, 24.10.2012, n = 1, ZM LNU (det. S. Lytvynenko); ♦ Lutuhyno Raion, vicinity of Luhansk airport, October 2012, ZM LNU (det. S. Filipenko); ♦ Lutuhyno Raion, vicinity of Luhansk airport, 20.03.2013, ZM LNU (leg. S. Lytvynenko); ♦ Stanytsia-

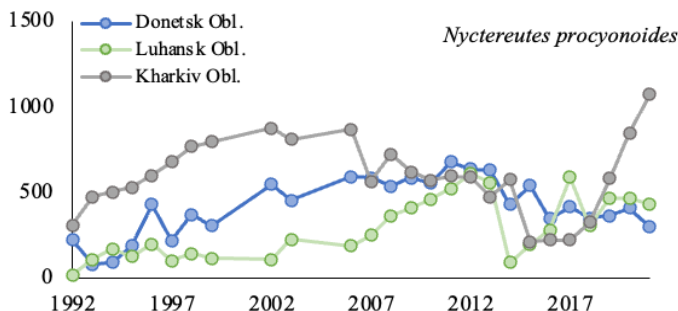


Fig. 7. Population dynamics of *Nyctereutes procyonoides* according to the data of state statistical reporting.

Рис. 7. Динаміка чисельності *Nyctereutes procyonoides* за даними статистичної звітності "2п-мисливство".

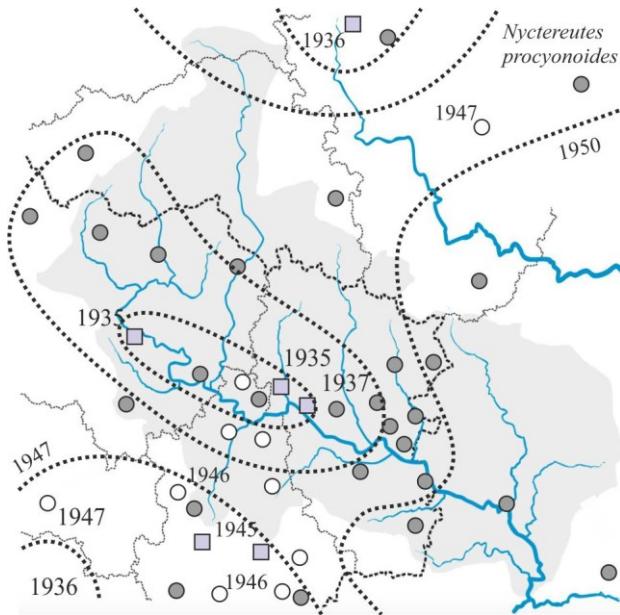


Fig. 8. Distribution of *Nyctereutes procyonoides* in the Siversky Donets basin and adjacent areas. Shaded dots indicate current finds of the species (21st century). Numbers and unshaded dots mark the years and places in which work on the introduction of this species was started. Isolines connect the points of the earliest finds, which are equivalent in years.

Рис. 8. Поширення *Nyctereutes procyonoides* в басейні Сіверського Дінця та прилеглих районах. Зафарбованими точками позначені сучасні знахідки тварин (XXI ст.). Цифри і незафарбовані точки показують роки і місця в яких було розпочато роботи з інтродукції цього виду. Ізолінії об'єднують рівнозначні за роками точки найдавніших знахідок.

Luhanska Raion, Plotyna village, March 2013, ZM LNU (leg. V. Vetrov); ♦ Stanytsia-Luhanska Raion, near Zolotarivka, 28.10.2014, ZM LNU (leg. V. Vetrov); ♦ Sorokinsky Raion, Kruzhylivka village, autumn 2018 (questionnaire survey data); ♦ Striltsivsky Steppe NR, outskirts of Krynychne village, n = 1, 1.08.2019 (author's data). *Kharkiv Oblast*: ♦ Slobozhanskyi NNP, Parkhomivske department, 11.05.2015 (recorded by O. Horovyi) [Brusentsova & Bondarenko 2019]; ♦ Iziium Raion, 05.06.2017, registration with a camera trap (V. Lovchynovskiy, social network); ♦ Kharkiv, northern outskirts of the city (questionnaire survey data); ♦ Derkul River (Bilovodsk Raion) [Melezhyk 2015].

*Neighbouring territories (RF)*. *Belgorod Oblast*: ♦ Alekseevsky district, n = 1, dead animal (rabies), 11.2020 (according to bel.ru); ♦ Forest on Vorskla NR, 2020 (according to the Chronicle of Nature of the Belogorie NR). *Voronezh Oblast*: ♦ Khopersky NR, 6.06.2020, n = 1, recorded by a camera trap (according to tv-gubernia.ru); ♦ Bogucharsky district, regular animal sightings (social network). *Rostov Oblast*: ♦ Tsymlyansky district, 2020 (social media data); ♦ Bila Kalytva, n = 1 (questionnaire survey data).

A large body of information regarding the occurrences of the raccoon dog in the region is present in the ZM LNU collections. Specimens have been found in the middle reaches of the Donets, in particular in Stanytsia-Luhanska Raion of Luhansk Oblast, Iziium Raion of Kharkiv Oblast, and Yampilskyi forestry of Donetsk Oblast. Additionally, specimens have been found in the vicinity of the nearby tributaries, such as in Lutuhyne and Sverdlovsk raions of Luhansk Oblast, suggesting a potentially higher concentration of this species in that area (see Fig. 8).

Based on the data on the introduction and population dynamics of this species in the three eastern regions of Ukraine, it is difficult to say the direction of expansion of the animals, as they were released almost simultaneously in all three regions. However, the largest number of animals released was recorded in Kharkiv Oblast, and statistics on the number of animals show that this region has the largest number of animals. Given that the path of expansion of animals, as for other species studied, is the Donets basin, it can be assumed that the expansion of the raccoon dogs in the region occurred in the direction from north-west to south-east, up to the southern raions of Luhansk and Donetsk oblasts, where the smallest number of animals was released during the fauna restoration work.

### Local invaders

This group includes species that have substantially altered their distribution within the region but have not formally changed their affiliation with the regional fauna. They are as part of the aborigine fauna of Ukraine; however in certain areas they are considered alien due to range expansion

[Zagorodniuk 2006a]. Among the semi-aquatic mammals inhabiting basin of the Siversky Donets, there are two such species: the Eurasian beaver (*Castor fiber*) and the Eurasian otter (*Lutra lutra*).

### ***Eurasian beaver (Castor fiber Linnaeus 1758)***

The species used to be widespread throughout Ukraine, with the exception of the Crimea and the mountainous regions of the Carpathians. However, due to unregulated hunting in the late 19th century, only small groups of beavers remained in the country. As of 1930, beavers were found in three regions of the forest zone: Kyiv, Zhytomyr, and Chernihiv oblasts. The total number of individuals did not exceed 100 [Miliutin 1932]. At this time, the first attempts were made to restore the beaver population in Ukraine. In 1929, five beavers caught on the Irsha and Viznia rivers, tributaries of the Teteriv, were introduced to the area of the modern Pechenizhske Reservoir in Kharkiv Oblast. However, the attempts of the introduction were unsuccessful [Panov 2002].

Re-acclimatisation was both planned and uncontrolled—the latter was carried out by individual hunting groups and hunters. According to forestry officials, there were cases of beaver re-introduction by hunters in the 1960s in Sumy and Luhansk oblasts, where the animals successfully established themselves [Skorobogatov & Atevasova 2001]. In Luhansk Oblast, re-acclimatisation work covered the middle reaches of the Siversky Donets River, including the territory of the Kreminna Forestry. Re-acclimatisation work became especially widespread in the early 1970s [Tokarsky *et al.* 2002; Zorya 2005]. In nine years, the number of beavers increased more than five times [Panov 2002]. Beavers have inhabited almost the entire Siversky Donets basin (including the Aidar, Zherebets, and Krasna rivers). Beavers are also known to have settled in the north-east of Luhansk Oblast. In August 1981, one beaver family was released into the Cherepakha River [Skokov *et al.* 1992]. In Sumy Oblast, beaver settlements were concentrated in the rivers of the Vorskla basin.

The geographical location of Kharkiv Oblast and its connection by river networks with Luhansk and Sumy oblasts have led to the expansion of beavers into the area [Tokarsky *et al.*, 2012]. In 1982, beaver settlements were discovered on the tributaries of the Vorskla River (Merla, Ryabina, and Berizivka) and the Siversky Donets River. Since 1992, the species has been observed in a large part of the north-west of Kharkiv Oblast, specifically on the tributaries of the Merla, Merchyk, and Sukhyi Merchyk rivers. In 1998, beavers were also observed settling along the Udy River and the Siversky Donets, and in 1999, sightings of this species were recorded in the outskirts of Kharkiv [Skorobogatov & Atevasova, 2001].

As of the early 2000s, beavers have occupied the entire channel of the Siversky Donets, most of the floodplain lakes, and the largest tributaries. However, there are still areas where beavers continue to establish presence (see Fig. 9). For example, according to open sources, beavers have recently been found in small rivers in the Kramatorskyi Landscape Park area between 2020 and 2023, such as the Sukhyi Torets and Bilenka rivers. The presence of beavers in the latter river was unknown earlier (reported by O. Pohrebniak). The animals are also exploring the waters of the Donetsk Kryazh Landscape Park and were first recorded in small rivers near Belgorod, Russia (see the inventory).

#### *20th century*

*Luhansk Oblast:* ♦ Kreminna forests, 1970, introduction [Tokarsky *et al.* 2002; Zorya 2005]; ♦ Striltsivsky Steppe Nature Reserve, Cherepakha River, August 1981, introduction [Skokov 1992]. *Kharkiv Oblast:* ♦ In 1982, beavers began to be recorded on the Siverskyi Donets and its tributaries [Skorobogatov & Atevasova 2002]; ♦ Nyzhnia Dvurichna River, the 1980s, expansion [Tokarsky 2014]; ♦ Uda River, near the city of Kharkiv, 2000, expansion [Skorobogatov & Atevasova 2002].

#### *Neighbouring territories (RF)*

*Voronezh Oblast:* Data from [Barabash-Nikiforov *et al.* 1961]: ♦ Voronezh Nature Reserve, n = 4, 1886, introduction; ♦ Khopra River, 1937, n = 7, introduction; ♦ Bitiug River, Anninsky District, n = 58, 1946; ♦ Talovsky ('Chigolsky') District, n = 18, 1946; ♦ In 1961, researchers noted the beaver's dispersal along the Don River.

*Rostov Oblast:* ♦ Verkhnedonsky district, n = 10, introduction, 1973 [Stakheev *et al.* 2018].

## 21th century

*Donetsk Oblast:* ♦ Sviati Hory NNP, 13.08.2013 (according to fakty.com.ua); ♦ near the city of Siversk, Bakhmutivka River, 15.10.2016, n = 1 (V. Parkhomenko, social network); ♦ Donetsk Kriazh LP, Karinka River, 1.03.2019, first registration (social network); ♦ Kramatorsk LP, Bilenka River, 19.03.2020, first record (O. Pohrebniak, report on the Suspilne Donbas portal); ♦ Kramatorskyi LP, Sukhyi Torets River, 10.06.2023, species was recorded (O. Pohrebniak, report on the Free Radio portal). *Luhansk Oblast:* ♦ Shchastia, 2008, n = 1 (leg. S. Lytvynenko); ♦ Krasnodonsk Raion, Kruzhylivka, October 2018, n = 1, animal captured in the Siversky Donets River (author's data); ♦ Bilovodsk Raion, southern outskirts of Bilovodsk, 2016, numerous settlements (author's data); ♦ Novopskov Raion, Kamianka River, vicinity of Kamianka village, 2018 (author's data); ♦ Kadiyivka, Komyshevukha river, 2020, n = 1, (questionnaire survey data); ♦ Milove Raion, Krynychne, Cherepakha River, 2023 (author's data); ♦ Milove Raion, Velykotsk, Milova River, 2022, numerous settlements (author's data); ♦ Milove Raion, Striltsivka, Komysheva River, 2022, numerous settlements (author's data); ♦ Luhansk, Zhovtnevy Raion, Luhanka River, n = 1, the animal got lost in the private sector, was caught and released into the river, 18.03.2019 (report of the Realna Gazeta publishing house); ♦ Starobilsk, spring 2021, several settlements (author's data). *Kharkiv Oblast:* ♦ Udy River, near the city of Kharkiv, 2000, species expansion [Skorobogatov & Ateasova 2001]; ♦ near the town of Derhachi, Lopan River, 2018, n = 1 (author's data); ♦ Slobozhanskyi NNP, 29.11.2019, n = 1 (author's data).

*Neighbouring territories (RF). Belgorod Oblast:* ♦ Korochansky district, Velyka Kholan, Kholan River, 1.06.2022 (according to bel.ru, observer L. Koleva); ♦ Gubkin, Oskolets River, June 2023, expansion (social media data); ♦ near the city of Belgorod, Veselka River, expansion, March 2023 (according to belpressa.ru); ♦ Ivnyansky district, 10.03.2023, poaching (according to the website of the city of Belgorod: go31.ru); ♦ Stary Oskol district, Chufinka River, 2017 [Petina et al. 2017]; ♦ Chornaya Kalitva, Tikha Sosna, and Potudan rivers, numerous settlements. *Rostov Oblast:* ♦ Bila Kolutva, Kalitva River, May 2023, numerous settlements (questionnaire survey data).

Some parts of the largest tributaries of the Siversky Donets, particularly the Derkul River, are not fully utilised by beavers. The author is not aware of any beaver colonies on the river north of Bilovodsk. Between 2019 and 2022, the author monitored the beaver population on the Cherepakha River, within the Striltsivsky Steppe protected area. Several cases of beaver dispersal were documented. In 2023, local residents in the raion reported new beaver colonies on the Cherepakha River, within the protected area of the Striltsivsky Steppe (Krynychne village), and on the Milova River (Velykotsk village).

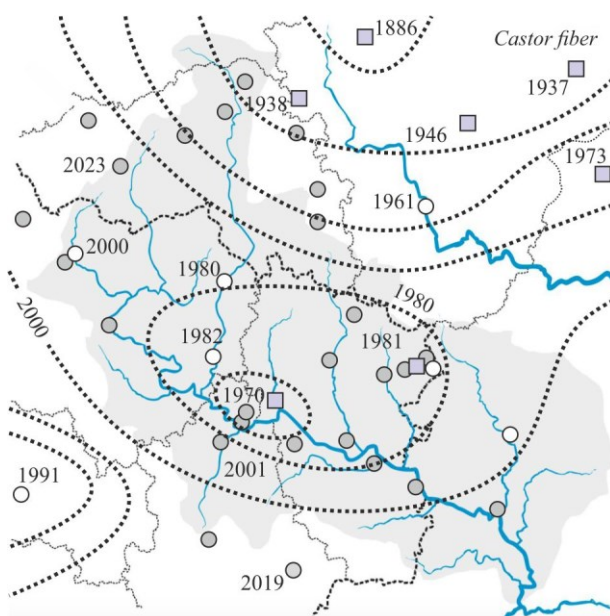


Fig. 9. Acclimatization and distribution of *Castor fiber* in the Siversky Donets basin and adjacent areas. Numbers indicate the years of appearance of animals within certain watercourses. Squares show places of introduction, or natural distribution and breeding of beavers. Shaded dots indicate the main modern finds (21st century), and unshaded dots mark older finds (20th century). Isolines unite the points of the oldest finds equivalent in age.

Рис. 9. Акліматизація та поширення *Castor fiber* в басейні Сіверського Дінця та прилеглих районах. Цифрами позначено роки появи тварин в межах певних акваторій. Квадратні значки показують місця інтродукції, або природного поширення і розведення бобрів. Замальованими точками позначено основні сучасні знахідки (XXI ст.), незамальованими — давні (XX ст.). Ізолінії об'єднують рівнозначні за роками точки найдавніших знахідок.

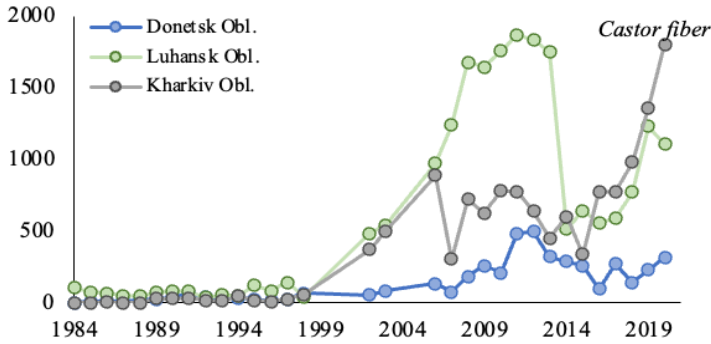


Fig. 10. Population dynamics of *Castor fiber* according to the data of state statistical reporting.

Рис. 10. Динаміка чисельності *Castor fiber* за даними статистичної звітності "ЗТП-мисливство".

The population dynamics confirms the process of beaver dispersal in the eastern regions of Ukraine (Fig. 10). A significant increase in the beaver population was observed in Luhansk and Kharkiv oblasts in the early 2000s, by which time the species had already established itself in the main tributaries of the Donets in the region. It should be noted that the sharp decline in numbers after 2014 can be attributed to the fact that population estimates were made without considering the territories that were not under Ukrainian government control between 2014 and 2022. Given the aforementioned information, beavers have settled in the Siversky Donets basin and are forming stable populations. Negative population trends are observed in drying lakes and swamps, particularly in Kharkiv Oblast and in areas outside the Donets basin, such as the Slobozhansky NNP.

#### *Eurasian otter (Lutra lutra Linnaeus 1758)*

An indigenous species of the Ukrainian fauna, the otter became rare in the 19th century due to excessive hunting. In the mid-20th century, the primary distribution of otters in eastern Ukraine was concentrated in the south-east of Kharkiv Oblast [Korneev 1959]. By 1968, V. Abelentsev discovered the southernmost limits of the species' range in Ukraine, specifically in the floodplain of the Siversky Donets, spanning Kharkiv, Donetsk, and Luhansk oblasts. It later extended to adjacent steppe areas [Abelentsev 1968; Volokh 2003]. The otter's range experienced substantial expansion between 1990 and 2002 (Fig. 11), which can be attributed to independent colonisation of numerous water bodies in steppe regions. Presently, the species has largely extended its range and occupies most southern rivers [Zagorodniuk & Dykyi 2002].

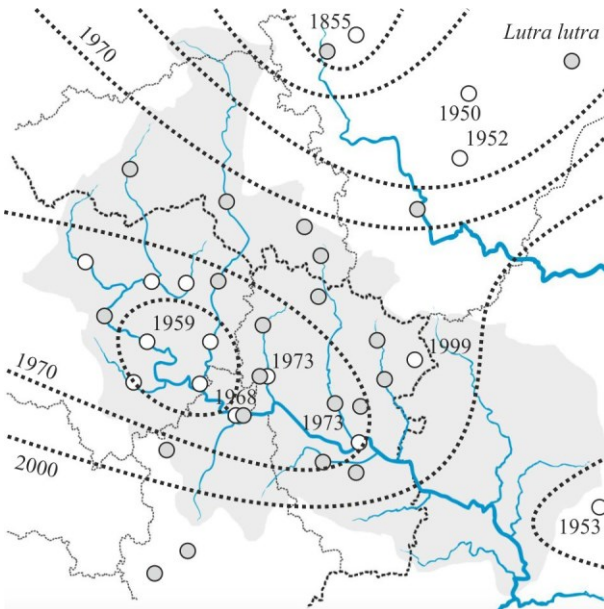


Fig. 11. Distribution of the otter (*Lutra lutra*) in the basin of the Siversky Donets and adjacent areas. Numbers indicate the years of registration or occurrence of animals within certain bodies of water. Shaded dots represent finds of the 21st century, unshaded dots mark old finds. Isolines unite the points of the oldest finds equivalent in age.

Рис. 11. Поширення видри (*Lutra lutra*) в басейні Сіверського Дінця та прилеглих районах. Цифрами позначено роки реєстрації, або появи тварин в межах певних акваторій. Замальовані точки показують знахідки ХХІ ст., незамальовані — давні знахідки. Ізолінії об'єднують рівнозначні за роками точки найдавніших знахідок.

Currently, otters are predominantly found in habitats near the Siversky Donets, as evidenced by reported sightings of the species. However, there are literature reports suggesting that otters have penetrated deeper into steppe areas in the early 2000s [Abelentsev 1968; Kondratenko & Kolesnikov 2006]. Based on the provided data, it can be inferred that the species is primarily concentrated in the Siversky Donets and the waters close to the main watercourse of the region. The author has no knowledge of recent otter sightings in the northern parts of Luhansk Oblast, and such information was not obtained from the questionnaire surveys.

20th century

◆ Middle reaches of the Donets River, border of Kharkiv, Donetsk, and Luhansk oblasts [Abelentsev 1968]. *Luhansk Oblast*: ◆ Serebriansky forestry, 1973; ◆ Stanytsia-Luhanska Raion, Bolotiane village, 1973 [Panchenko 1973] ◆ Milove Raion, Milova River, 1999, n = 2 [Borovyk 1999]. *Kharkiv Oblast*: ◆ The otter's range in the Kharkiv region was concentrated within the Donets basin and its nearest tributaries. Points marked '1959' in Kharkiv Oblast are given after O. P. Korneev [Korneev 1959].

Neighbouring territories (RF)

*Voronezh Oblast*: ◆ Usman River, 1855; ◆ Chigla River, 1950; ◆ Osered River, 1952 [Barabash-Nikiforov 1957]. *Rostov Oblast*: ◆ Skosyrskaya village, Tatsinsky District, 1953 [Rall 1953].

21st century

*Donetsk Oblast*: ◆ Sviati Hory NNP, 2021, n = 1 (local residents' data); ◆ Oleksandrivka, the upper reaches of the Samara River and fish farm, observations of hunters (according to O. Reznik) [Zagorodniuk & Korobchenko 2008]; ◆ the upper reaches of the Solona River [Volokh 2003]; ◆ the upper reaches of the Mokri Yaly River [Volokh 2003]. *Luhansk Oblast*: ◆ Svatove, Krasna River (according to S. Zaika) [Zagorodniuk & Korobchenko 2008]; ◆ Kreminna Raion, floodplain lakes Chernikove and Chernecha (according to O. Kondratenko) [Volokh 2003]; ◆ Bilokurakyn Raion, Lozna River, 2008 (according to Y. Artuschenko) [Zagorodniuk & Korobchenko 2008]; ◆ Slovianoserbsk Raion, Bilyaevskoye Lake (according to O. Kondratenko) [Volokh 2003]; ◆ Markivka (O. Reznik, according to O. Dvytskyi) [Zagorodniuk & Korobchenko 2008] ◆ Bilovodsk, 2007, (O. Reznik, according to hunters); ◆ Lutuhyn Raion, Heorhiivka, Olkhova River (tributary of Luhan River), 2002, n = 1 [Kolesnikov & Kondratenko 2006]; ◆ near the town of Kreminna, Krasna River, 2015, n = 1 (S. Lytvynenko, pers. comm.); ◆ Stanytsia-Luhanska Raion, Derkul River, near the village of Herasymivka, 'about 10 years ago', n = 1 (S. Lytvynenko, pers. comm.); ◆ Shchastia Raion, near the village of Velyka Chernihivka, Kovsuh River, about 2013, n = 1 (S. Lytvynenko, pers. comm.); ◆ Stanytsia-Luhanska Raion, Verkhniy Minchenok village, Tepla River, 28.12.2011, n = 1, ZM LNU (leg. G. Dedov); ◆ ibid., 20.12.2012, n = 1, ZM LNU (leg. G. Dedov); ◆ ibid., 23.01.2013, n = 1, ZM LNU (det. S. Filipenko); ◆ Stanytsia-Luhanska Raion, Stary Aidar, Aidar River, first reservoir, January 2013, n = 1, ZM LNU (det. S. Filipenko). *Kharkiv Oblast*: ◆ Siversky Donets River, December 2013, n = 1 (social network, confirmed by photo). ◆ Dvorichanskyi NNP [Tokarsky 2014]; ◆ Slobozhanskyi NNP; ◆ Homilsha Wood NNP (www.nationalparks.in.ua).

*Neighbouring territories (RF)*. *Belgorod Oblast*: ◆ Belgorodsky, Korochansky, Valuysky, and Starooskolsky Districts, 2022 (according to <https://oskol.city>). *Voronezh Oblast*: ◆ Voronezh and Khopersky Nature Reserve, Don River, 2022–2023 (social network); ◆ Don River, 2023 (social network).

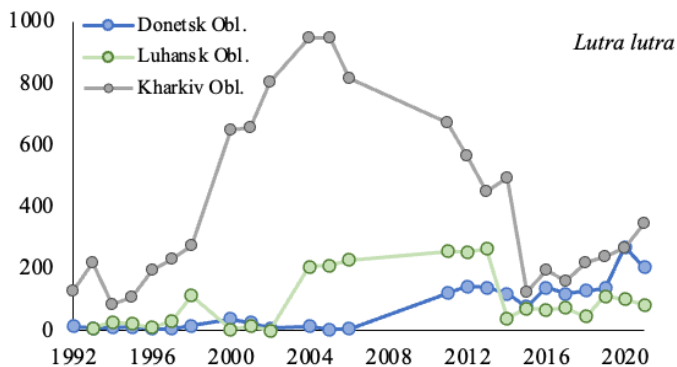


Fig. 12. Population dynamics of *Lutra lutra* according to the data of state statistical reporting.

Рис. 12. Динаміка чисельності *Lutra lutra* за даними статистичної звітності "2ТП-мисливство".

The dynamics of otter numbers in Ukraine, in general, show a constant increase. However, the data on otter numbers in eastern Ukraine (Fig. 12) reveals considerable fluctuations in all three regions. Kharkiv Oblast has the highest otter population, as the species prefers forest and forest-steppe areas. We hypothesise that fluctuations in numbers may be attributed to the hydrological regime and the availability of food resources. The impact of the hydrological regime is particularly evident in Kharkiv Oblast, primarily due to the construction of pond systems and reclamation canals.

## Discussion

### *Fauna composition*

The introduction of alien invasive species into new habitats often leads to changes in the local biota and landscapes. The idea of enriching the game fauna, which was popular in the mid-20th century [Kolosov & Lavrov 1968; Kiris 1973], eventually caused changes in the local biota [Kolosov & Lavrov 1968; Kiris 1973] and led to losses in regional biodiversity. Such changes are also evident in the species composition of semi-aquatic mammals of the region. Such species as the Russian desman (*Desmana moschata* L., 1758) have completely disappeared in the Donets basin [Zagorodniuk *et al.*, 2002]. The European mink (*Mustela lutreola*) is observed only in some areas, as described in this publication. Other rare species of floodplain mammals in the region are the Eurasian water shrew (*Neomys fodiens* Pennant, 1771) [Kondratenko & Zagorodniuk, 2002] and the Tundra vole (*Alexandromys oeconomus* Pallas, 1776) [*ibid.*].

Among the semi-aquatic mammals of the region, 66% of the total species composition consists of alien species. However, it should be noted that native species are more often characterised as rare, or their population dynamics shows a decrease, as in the case of mammals of floodplain assemblages consisting of voles (Rodentia: Arvicolidae) [Zagorodniuk 2008]. The species composition of semi-aquatic mammals of the region and information on their local status are presented in Table 1.

### *Impacts*

The displacement of native mammals by alien species was confirmed by observations in the mid-20th century when the first results of introducing new species became visible. Specifically, cases of Russian desman displacement by muskrat have been documented in different regions [Borodin 1963]. However, it cannot be argued that the muskrat caused the extinction of the Russian desman in the Donets River Basin. The decline in the number of this species in the river basin has been confirmed for the early 20th century [Zagorodniuk *et al.* 2002].

Nonetheless, the introduction of this invasive species could have been an additional contributing factor, along with human settlement, natural resource use, the introduction of alien species (raccoon dog and American mink), and the lack of protection [Kolosov & Lavrov 1968].

Predatory representatives of the studied animal group pose a serious threat to small amphibious mammals of the local fauna. The introduction of the American mink has raised considerable concerns in the field of nature conservation [Zagorodniuk 2006b].

Table 1. Population status of semi-aquatic mammal species in the Siversky Donets basin

Таблиця 1. Стан популяцій коловодних видів ссавців в басейні Сіверського Дінця

Species	Status in region	Species	Status in region
A. Alien species		B2. <i>Lutra lutra</i>	Least endangered
A1. <i>Ondatra zibethicus</i>	Least endangered	C. Native species	
A2. <i>Neogale vison</i>	Range expansion	C1. <i>Arvicola amphibius</i>	Stable
A3. <i>Nyctereutes procyonoides</i>	Range expansion	C2. <i>Alexandromys oeconomus</i>	Sporadic
A4. <i>Myocastor coypus</i>	Does not form stable populations	C3. <i>Mustela lutreola</i>	Rare
B. Regional expansion		C4. <i>Desmana moschata</i>	Rare
B1. <i>Castor fiber</i>	Range expansion	C5. <i>Neomys fodiens</i>	Sporadic



Both the American mink and the raccoon dog may have, to some extent, contributed to the decline of small mammals. This is because both species are carnivorous and non-selective in their choice of food resources, primarily preying on less competitive small mammals.

### ***Expected alien mammal species***

Prey for golden jackals (*Canis aureus* Linnaeus, 1758) often include myomorph rodents and water voles. This species is a typical inhabitant of floodplains, as confirmed by frequent findings of aquatic and semi-aquatic animals in the stomach of jackals [Rozhenko 2006]. Since 2003, this species has been recorded in the Donets basin [Zagorodniuk 2014]. The presence of the species is also confirmed by relatively recent findings in Luhansk Oblast. From the analysis of open sources, we learned about the capture of a jackal near the village of Diakove, Antratsyt Raion, on 10 September 2019 (V. Prsalov, social network), as well as other numerous discoveries [Zagorodniuk 2014].

The raccoon (*Procyon lotor* Linnaeus, 1758) may become another introduced representative of the regional carnivoran assemblage. There are known breeding sites of raccoons near the town of Sorokine and cases of pet raccoons escaping from households, particularly in the village of Samsonivka, Sorokinsky Raion (7 individuals, summer 2017) and in the village of Kosiora (5 individuals, autumn 2017). The fate of these raccoons is unknown [Nikolaichuk & Zagorodniuk 2019].

### ***'Post-introduction syndrome'***

The number of animals occupying new biotopes increases substantially. Almost all species of alien animals in the Donets basin have demonstrate such dynamics. After a period of growth in the numbers, usually there is a certain decline and stabilisation of the population size, which is also evident from the abundance dynamics of species considered in this article.

A striking example demonstrating a similar tendency is the muskrat. According to the results of a survey conducted by hunters, its numbers have decreased over the last 10–15 years. This process is particularly noticeable in places where the American mink has become widespread. The latter completely eradicates young muskrats and other less competitive species of mammals in some areas. Based on the dynamics and factors affecting the population of muskrats, it is anticipated that the numbers of this species may reach a more stable level in the near future, comparable to local animals such as the European water vole (*Arvicola amphibius* Linnaeus, 1758) and others.

Over the past few years, beaver expansion has been observed in small rivers where it was not previously detected or which had long existed without its presence. Cases of expansion have been recorded in all administrative regions of Ukraine and Russia, but the results of the study suggest that the process of expansion of this species is not completed and may continue in the future.

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### **References**

- Abelentsev, V. I. 1968. *Mustelidae. Fauna of Ukraine. Mammals*. Naukova Dumka, Kyiv, 1 (3): 1–280. [In Russian]
- Antonets, N. V. 2012. Dynamics of the species composition of faunal complexes small mammals of the Dnipro-Oril Reserve. *Novitates Theriologicae*, 8: 13. [In Ukrainian] <https://shorturl.at/tHM39>
- Barabash-Nikiforov, I. I. 1957. *Mammals of the South-Eastern Part of the Chernozem Centre*. Voronezh book publishing

- house. Voronezh, 1–337. [In Russian]
- Barabash-Nikiforov, I. I., V. V. Dezhkin, Y. V. Dyakov. 1961. Beavers of the Don basin. Ecology and questions of economy (Monographic sketch). *Proceedings of the Khopersky State Reserve*, 5: 1–115. [In Russian]
- Berestennikov, D. S., A. I. Gizenko, V. M. Samosh. 1969. *Muskrat*. Naukova Dumka, Kyiv, 1–90. [In Russian]
- Bliznyak, E. V., K. M. Ovchinnikov, V. D. Bykov. 1945. *Hydrography of the Rivers of the USSR*. Gidrometeoizdat, Leningrad, 1–615. [In Russian]
- Bondarenko, Z. S., N. O. Brusentsova, Y. E. Skrilnik. 2023. Alien species of animals of the 'Slobzhansky' national nature park and its environs. *Records of alien plant and animal species in Ukraine*. DrukArt, Kyiv, Chernivtsi, 78–80. [In Ukrainian] <https://goo.su/PecGXh2>
- Borodin, A. P. 1963. *Russian Desman*. Mordovian Book Publishing House, Saransk, 1–302. [In Russian]
- Borovyk, E. N. 1999. The number of rare and protected species of mammals in the Streltsovskaya steppe reserve. *Vestnik zoologii*, 33 (4–5): 80 [In Russian]
- Brusentsova, N. O., Z. S. Bondarenko. 2019. Finds of mammals in National Natural Park "Slobzhansky" and its surroundings. *Mammals on the map of Ukraine. Proc. of Conf.* Kyiv, 25–37. [In Ukrainian]
- Dulitsky, A. I. 2001. *Mammals of the Crimea*. Simferopol, Krymchpedgiz, 1–224. [In Russian]
- Dziech, A., H. Wierzbicki, M. Moska, M. Zatoń-Dobrowolska. 2023. Invasive and alien mammal species in Poland—a review. *Diversity*, 15: 1–19. [CrossRef](#)
- Genovesi, P., L. Carnevali, A. Alonzi, R. Scalera. 2012. Alien mammals in Europe: updated numbers and trends, and assessment of the effects on biodiversity. *Integrative Zoology*, 7: 247–253. [CrossRef](#)
- Ivanko, I. A., A. F. Kulik, V. V. Nikolaieva. 2022. Assessment of the allelopathic potential of some naturalized tree and shrubby introducents under conditions of the northern steppe Dnipro region. *Issues of Steppe Forestry and Forest Land Reclamation*, 51: 29–41. [In Ukrainian] [CrossRef](#)
- Kiris, I. D. 1973. *Acclimatization of hunting animals and birds in the USSR. Part 1*. Volgo-Vyatka book publishing house, Kirov branch, 1–537. [In Russian]
- Kolosov, A. M., N. P. Lavrov. 1968. *Enrichment of the commercial fauna of the USSR*. Publishing 'Forest industry'. Moscow, 1–256. [In Russian]
- Kondratenko, O. V., I. V. Zagorodniuk. 2002. Findings of Neomys fodiens in the "Provalskaya steppe" (Eastern Ukraine). *Vestnik zoologii*, 36 (4) 78. [In Russian]
- Kondratenko, O., M. Kolesnikov. 2006. Current state of populations of rare species of carnivore mammals of family Mustelidae in the south-eastern part of Ukraine. *Proceedings of the Theriological School*, 7: 55–62. [In Russian] <https://shorturl.at/fgzA4>
- Korneev, A. P. 1954. The raccoon dog in Ukraine. *Proceedings of the Zoological Museum of the Kyiv State University*, 4: 13–72. [In Russian]
- Korneev, O. P. 1959. River Otter in Ukraine, its ecology and ways of sustainable use. *Proceedings of the Zoological Museum, Kyiv T. G. Shevchenko State University*, 18 (6): 9–58. [In Ukrainian]
- Lavrov, N. P. 1957. *Acclimatization of the Muskrat in the USSR*. Tsentrsoyuz, Moscow, 1–531. [In Russian]
- Lazariev, D. 2022. Alien mammals in ecosystems of eastern Ukraine: a history of research and appearance of species. *Therologia Ukrainica*, 24: 216–228. [In Ukrainian] [Cross-Ref](#)
- Lazariev, D. 2023. 2023. Aquatic complexes of eastern Ukraine as an arena for expansion of alien mammal species. *Environment for the Future through Science Education: Proceedings of Internat. Conf.* Uzhhorod, 109–110. [In Ukrainian]
- Limansky, S., O. Kondratenko. 2002. Modern state of the mammal fauna of the natural reserve 'Kreydiana flora'. *Bulletin of Luhansk Taras Shevchenko National Pedagogical University*, 1 (48): 25–28. [In Russian]
- Lytvynenko, S. P., G. O. Yevtushenko. 2015. To the fauna of the family Mustelidae of the Luhansk region. *Novitates Theriologicae*, 9: 32–36. [In Ukrainian]
- Martynov, V. V., T. V. Nikulina. 2021. Biological invasions of animals into the ecosystems of the Northern Cis-Azov Region (case study of the 'Khomutovsky Steppe' nature reserve). *Industrial Botany*, 21 (3): 140–161. [In Russian]
- Melezhyk, O. 2015. Rare species of medium-sized mammals of the Derkul river region (Luhansk Oblast) and the state of their populations. *Novitates Theriologicae*, 9: 154–159. [In Ukrainian] <https://shorturl.at/DIQW2>
- Miliutin, H. M. 1932. To the issue of repopulation of the Eurasian beaver on Donets. *Ukrainian Hunter and Fisherman*, No. 8–9: 7–9. [In Ukrainian]
- Nikolaichuk, O., Zagorodniuk, I. 2019. The northern raccoon (Procyon lotor) in urban environment of Kyiv and perspectives of formation of its wild populations in Ukraine. *Therologia Ukrainica*, 18: 108–112. [CrossRef](#)
- Panov, G. M. 2002. Dynamics of ranges and of abundances of semi-water fur-bearing mammals in Ukraine during second of the 20th century. *Bulletin of Lviv University. Biological series*, 30: 119–132. [In Ukrainian]
- Petina, V. I., L. I. Belousova, N. I. Gaivoronskaya, T. N. Furmanova, O. S. Tolstopiatova. 2017. Biogenic morphogenesis on the territory of Belgorod Oblast. *Sciences of Europe*, 15: 28–34. [In Russian]
- Rall, Y. M. 1953. Mammals and lower terrestrial vertebrates of the Rostov region. *Scientific Notes of the Biology and Soil Faculty of the Rostov-on-Don State University*, 19 (3): 115–126. [In Russian]
- Rozhenko, N. 2006. Feeding of some carnivorous mammals in anthropogenic landscape of the Black Sea region. *Proceedings of Theriological School*, 8: 191–200. [In Ukrainian] <https://shorturl.at/zBSUX>
- Sakhno, I. 2015. Changes in the composition of the mammal fauna of Luhansk Oblast (as of 1969). *Novitates Theriologicae*, 9: 49–57. [In Ukrainian]
- Sakhno, I. I., M. A. Simonov. 1956. Results of acclimatization of industrial animals in the Voroshilovgrad region. *Series of Physics and Mathematical and Natural Sciences*, 6: 16–30. [In Ukrainian]
- Shchekalo, M. V. 2021. Current state of the European beaver (Castor fiber L.) Population in the Chufichka river basin. In: *Actual Problems of Biological and Chemical Ecology*. Materials of VII International Scientific and Practical Conference. Moscow, 214–219. [In Russian]
- Skokov, A. P., V. L. Kochegura, V. A. Timoshenkov. 1992. *Vertebrate Animals of Lugansk Natural Reserve (Annotated lists of species)*. Moscow, 1–56. (Series: Flora and fauna of the USSR reserves; Issue 48). [In Russian]
- Skorobogatov, E. V., T. A. Ateasova. 2001. The area dynamics of European Beaver (Castor fiber Linnaeus) population in Ukraine. New finds in the North-Eastern part of Ukraine. *Biologicheskij vestnik. Kharkiv*, 5 (1–2): 119–123. [In Russian]
- Sokur, I. T. 1953. *Acclimatization and Breeding of Fur Animals in Ukraine*. Radyanska Shkola, Kyiv, 1–72. [In Ukrainian]
- Sokur, I. T. 1961. *Historical changes and use of the mammalian fauna of Ukraine*. Edition of the Academy of Sciences of the Ukrainian SSR, Kyiv, 1–84. [In Ukrainian] <http://terioshkola.org.ua/library/classic/sokur-1961.pdf>
- Stakheev, V. V., V. Yu. Shmatko, N. V. Panasyuk, A. V. Kleshchenkov. 2018. Current status of population and ecological peculiarities of the Eurasian beaver Castor fiber L. in Rostov region. *South of Russia: Ecology, Development*, 13 (2): 196–

202. [In Russian] [CrossRef](#)
- Taranenko, L., B. Melnichenko, D. Pilipenko, V. Diyakov. 2008. Rare species of terrestrial mammals in the Donetsk province: current state and perspectives of protection. *Proceedings of the Theriological School*, **9**: 187–198. [In Russian]
- Tedeschi, L., D. Biancolini, C. Capinha, C. Rondinini, F. Essl. 2021. Introduction, spread, and impacts of invasive alien mammal species in Europe. *Mammal Review*, **52** (2): 1–15. [CrossRef](#)
- Timoshenkov, V., O. Kondratenko. 2006. Study of mammal fauna in natural reserve 'Khomutovsky steppe'. *Proceedings of Theriological School*. **7**: 33–37. [In Russian]
- Tokarsky, V. A., A. V. Kartashov, Yu. M. Zubatov, P. S. Kozyra. 2002. Eurasian beaver (*Castor fiber* L.) settlements in northeastern Ukraine. *Bulletin of the Luhansk Pedagogical University, Series biology*, No. 1 (45): 104–109. [In Russian]
- Tokarsky, V. A., A. M. Volokh, N. V. Tokarskaya, Ye. V. Skorobogatov. 2012. Renewal of beaver (*Castor fiber* L.) population in left-banked Ukraine. *Journal of V. Karazin Kharkiv National University. Series biology*, **16**: 114–124. [In Russian]
- Tokarsky, V. A. 2014. Species composition of mammals of the 'Dvorichanskyi' National Nature Park. *The Journal of V. N. Karazin Kharkiv National University. Series Biology*, **19** (1097): 81–89. [In Russian] <https://cutt.ly/OwpGoy1r>
- Volokh, A. M. 2002. A role of muskrat migration in forming of Priazovskiy part of its area in Ukraine. *Bulletin of the Luhansk Taras Shevchenko State Pedagogical University*, **1** (45): 38–42. [In Ukrainian]
- Volokh, A. M. 2003. Modern distribution of the otter (*Lutra lutra* L., 1758) in Ukraine and its population. *Bulletin of Zaporizhzhya State University. Series Phys.-Math. and Biol. Science*, **1**: 1–7. [In Ukrainian]
- Volokh, A. M. 2014. *Hunting animals of the Steppe Ukraine. Book 1*. FLP Grin D. S., Kherson, 1–412. [In Russian]
- Yarotsky, V. U. 2023. Findings of *Neogale vison* (schreber, 1777) in the valley of Siversky Donets. *Records of alien plant and animal species in Ukraine*. Druk Art, Kyiv; Chernivtsi, 506–507. (Series: Conservation Biology in Ukraine, Issue 29). [In Ukrainian] <https://goo.su/PecGXh2>
- Zagorodniuk, I. V., I. V. Dykyy. 2002. IX International Theriological School-Seminar "Methods of Mammal Fauna Census". *Vestnik zoologii*, **36** (6): 97–98. [In Ukrainian]
- Zagorodniuk, I., O. Kondratenko, V. Domashlinets. 2002. *Russian Desman (Desmana moschata) in the Siversky Donets Basin*. Kyiv, 1–64. (Series: Proceedings of the Theriological School; Vol. 4). [In Ukrainian] <https://shorturl.at/bcdHY>
- Zagorodniuk, I. 2006a. Mammals of eastern provinces of Ukraine: composition and historical changes of the fauna. In: *Mammal fauna of Eastern Ukraine*. Luhansk, 216–259. (Series: Proceedings of the Theriological School; Vol. 7). [In Ukrainian] <https://bit.ly/2zEofz1>
- Zagorodniuk, I. 2006b. Adventive mammal fauna of Ukraine and a significance of invasions in historical changes of fauna and communities. In: *Fauna in the Anthropogenic Environment*, NMNH of Ukraine, Luhansk, 18–47. (Series: Proceedings of the Theriological School; Vol. 8). [In Ukrainian]
- Zagorodniuk, I. V. 2008. Voles (Rodentia: Arvicolidae) in the Siversky Donets Basin: biotope preferences, changes of geographical ranges, and species identification. *Bulletin of V. N. Karazin Kharkiv National University. Series: Biology*, **7** (814): 74–93. [In Ukrainian] <https://shorturl.at/wBHS6>
- Zagorodniuk, I., M. Korobchenko. 2008. Rare fauna of Eastern Ukraine: its composition and distribution of rare species. *Proceedings of the Theriological School*, **9**: 107–156. [In Ukrainian]
- Zagorodniuk, I. 2012a. Mammals of the Eastern Ukraine: changes in species list and abundance since I. Sakhno review (1963) to now. *Journal of V. N. Karazin Kharkiv National University. Series Biology*, **16** (1035): 97–108. [In Ukrainian] <https://bit.ly/3lnoJCg>
- Zagorodniuk, I. 2012b. Distant diagnostics of large-size semiaquatic mammals of Ukraine. *Proceedings of the Theriological School*, **11**: 58–62. [In Ukrainian] [CrossRef](#)
- Zagorodniuk, I. 2014. Golden Jackal (*Canis aureus*) in Ukraine: Modern Expansion and Status of Species. *Proceedings of the National Museum of Natural History*, **12**: 100–105. [In Ukrainian]
- Zagorodniuk, I., S. Kharchuk. 2020. List of mammals of Ukraine 2020: additions and clarifications. *Theriologia Ukrainica*, **20**: 10–28. [In Ukrainian] [CrossRef](#)
- Zagorodniuk, I. 2023. *Terrestrial Vertebrates of Ukraine: Adventive Component*. NAS of Ukraine, National Museum of Natural History, Kyiv, 1–62. [In Ukrainian]
- Zorya, A. 2005. Mammals of the Kharkiv province and species richness. *Scientific Bulletin of Uzhhorod University. Series Biology*, **17**: 155–164. [In Ukrainian] <https://shorturl.at/cprfZ>