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LONG-TERM POPULATION DYNAMICS OF THE ELK (*ALCES ALCES*) IN SOUTH-WEST POLAND FROM THE EARLIEST TIMES UNTIL 2025

Grzegorz Kopij

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Affiliations

Wrocław University of Environmental and Life Sciences (Wrocław, Poland)

Correspondence

Grzegorz Kopij; Department of Animal Biology and Ecology, Wrocław University of Environmental and Life Sciences; 5b Kożuchowska Street, 51-631 Wrocław, Poland;
Email: grzegorz.kopij@upwr.edu.pl;
orcid: 0000-0001-7614-1983

Abstract

At the beginning of the third millennium, one of the most fascinating features of the European nature is its re-wilding. Especially promising is the return of giants, such as the wolf, lynx, brown bear, and elk. The latter is becoming widespread and common over most of its former range in Poland. In this paper, long-term population dynamic of this species in south-west Poland is traced from the earliest times to 2025. In the upper Palaeolithic (10 000–5500 BCE) and in the Neolithic era (5500–2100 BCE in south-west Poland), it was probably a widespread and common animal in south-west Poland, possibly the most common ungulate. Throughout the Middle Ages, the elk was one of the most important game animals in this region. However, hunting, especially intense during the Thiry Years War (1618–1648) eventually caused a sharp decline, so much that at the end of the 17th century the elk became extirpated in south-west Poland. After an absence in this region as a resident animal for nearly 300 years (1680–1980), the elk began to re-occupy its home ranges. By the end of 2000, eight such ranges could have been re-occupied. The total number of animals in these ranges is estimated at 24–48 individuals. However, 25 years later, at least 19 have been identified, including six ranges/sites where the species was evidently resident. In each such area, the number of resident elk could range between 5 and 10, giving a total of 100–200 resident animals. The areas possibly and confirmedly inhabited by elk are concentrated in the vicinity of Zielona Gora, Bory Dolnośląskie (Lower Silesian Forest), Western Sudety Mts, northern part of Wrocław hunting region, Central Opole province, and southern and northern parts of Upper Silesia. Remarkably, no resident elk have ever been recorded in the vast Stobrawa Forests (in Opole province and Upper Silesia). Most of the recorded animals were single wandering individuals (85.4%), occasionally two (11.5%), and only sporadically (3.1% of records) more than two individuals. The largest recorded herd was composed of six animals. Sex was determined in 58 cases; the sex ratio was therefore 0.59 : 0 41 (bulls to cows). In the near future, areas of confirmed occurrence of the elk may be established in these as well as in other regions of south-west Poland.

Cite as

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Довгострокова динаміка чисельності лося (*Alces alces*) у південно-західній Польщі від найдавніших часів до 2025 року

Гжегож Копій

Резюме. На початку ІІІ тисячоліття однією з найцікавіших рис європейської природи є її повернення до дикого стану. Особливо перспективним є повернення гігантів, таких як вовк, рись, ведмідь бурий та лось. Останній стає широко поширеним і звичайним на більшій частині свого колишнього ареалу в Польщі. У цій статті простежується довгострокова динаміка чисельності цього виду в південно-західній Польщі з найдавніших часів до 2025 р. У верхньому палеоліті (10 000–5 500 рр. до н. е.) та в епоху неоліту (5 500–2 100 рр. до н. е. у південно-західній Польщі) він, ймовірно, був поширеною та звичайною твариною в південно-західній Польщі, можливо, найпоширенішим копитним. Протягом Середньовіччя лось був однією з найважливіших мисливських тварин у цьому регіоні. Однак полювання, особливо інтенсивне під час Тридцятилітньої війни (1618–1648), призвело до різкого скорочення популяції, настільки, що наприкінці 17 ст. лось був повністю винищений у південно-західній Польщі. Після майже 300 років відсутності в цьому регіоні як постійно присутнього виду (1680–1980), лось почав знову займати свої покинуті ареали проживання. До кінця 2000 р. вісім таких ареалів могли бути знову зайняті. Загальна кількість тварин у цих ареалах оцінюється в 24–48 особин. Однак, через 25 років виявлено щонайменше 19, включаючи шість ареалів/місць, де вид явно мешкав. У кожному такому районі кількість лосів-резидентів могла коливатися від 5 до 10, що дає загалом 100–200 постійно присутніх тварин. Райони можливих та підтверджених ареалів проживання лосів зосереджені в околицях Зеленої Гори, Нижньосілезьких Борів, західних Судетів, північної частини Вроцлавського мисливського регіону, центрального Опольського воєводства та південної та північної частин Верхньої Сілезії. Примітно, що у величезних Стобравських лісах (в Опольському воєводстві та Верхній Сілезії) ніколи не було зареєстровано жодного лося. Більшість зареєстрованих тварин були поодинокими мандрівними особинами (85,4%), зрідка двома (11,5%) і лише спорадично (3,1% записів) відмічали більше двох особин. Найбільше зареєстроване стадо складалося з 6 особин. Стать була визначена у 58 випадках, в на основі цих даних співвідношення статей становило 0,59 : 0,41. Найближчим часом у цих та інших регіонах південно-західної Польщі можуть сформуватися райони стабільного проживання лося.

Ключові слова: лось (*Alces alces*), реінтродукція в Європі, дичина, полювання, вимирання, відновлення популяції, оцінка чисельності популяції.

Introduction

The elk (*Alces alces* L. 1758) is the largest species of the family Cervidae in the world; adult animals weigh 200–550 kg. Its range extends over the entire northern Holarctic, mostly occupying the boreal zone. At present, it lives in Europe in large numbers almost over the whole territory of Russia (c. 600 000, including the Asian part), Fenno-Scandia, without Denmark (500 000–600 000), the Baltic countries (c. 40 000) and Poland (28 000). Much lower numbers are present also in Belarus and northern Ukraine [Zhyla 2023], and isolated populations exist in the Šumava Forest, south-west Czech Republic [Červený *et al.* 2001; Janik *et al.* 2021] and in Bavaria, southern Germany [Schönfeld 2009].

The elk is a browser. Its main diet consists of shoots of willows, birches, and other tree species, as well as forbs and aquatic plants. Despite its large body, it reaches maturity already in the second (female) or in third (male) year of life, and may live for 15–25 years. Unlike most cervid species, it does not form large herds. In spring/summer, it lives solitarily or in families (female and its offspring from 1–2 generations) within a home range of c. 10–15 km^2 [Bobek *et al.* 2021, Niedziałkowska *et al.* 2022].

The rut takes place from late August to mid-October, mostly in September. After gestation lasting eight months cows give birth to 1–3 calves. It becomes fertile at an age of 1.5–2.5 years, females earlier than males. Populations become stable at 25 calves for every 100 cows in their first year of reproduction. With the availability of adequate nutrition, mild weather, and low predation, the elk have a huge potential for population expansion [Niedziałkowska *et al.* 2022].

The elk often migrates, which depends on the animal's age, snow cover, predation risk, human hunting and road infrastructure. There is no difference in the migratory behaviour between males and females, but migration parameters differ markedly between particular populations [Bobek *et al.* 2021; Niedziałkowska *et al.* 2022].

In this paper, the elk's status in south-west Poland is traced from the earliest times until present. Both published and unpublished sources were used to trace its population's recovery in this region, which began at the end of 20th century and continues to date.

Material and Methods

The changes in the elk's status until 1980 are reconstructed based on literature sources; in 1981–2000 mostly on observations and interviews; 2001–2010 on observations, interviews, and game statistics; and in 2011–2020 mostly on game statistics, local press and observations (Table 1).

Records of the elk are presented on maps with points (N = 871) representing sites of the office building of a particular forest district within a forest inspectorate encompassing a dozen or so forest districts [cf. Kopij 2017]. The forest inspectorates in south-west Poland fall within three Regional Directorships of the State Forests: Katowice, Wrocław, and Zielona Góra. Katowice RDSF is divided here into two parts: eastern, roughly corresponding to Upper Silesia, and western, corresponding to Opole Silesia. Wrocław RDSF (Lower Silesia) is divided into four parts, which roughly conforms to the former voivodeships (provinces): Wrocław, Wałbrzych, Legnica, and Jelenia Góra. Zielona Góra RDSF include here only part of Lubuskie province situated south of the Odra River (Fig. 1).

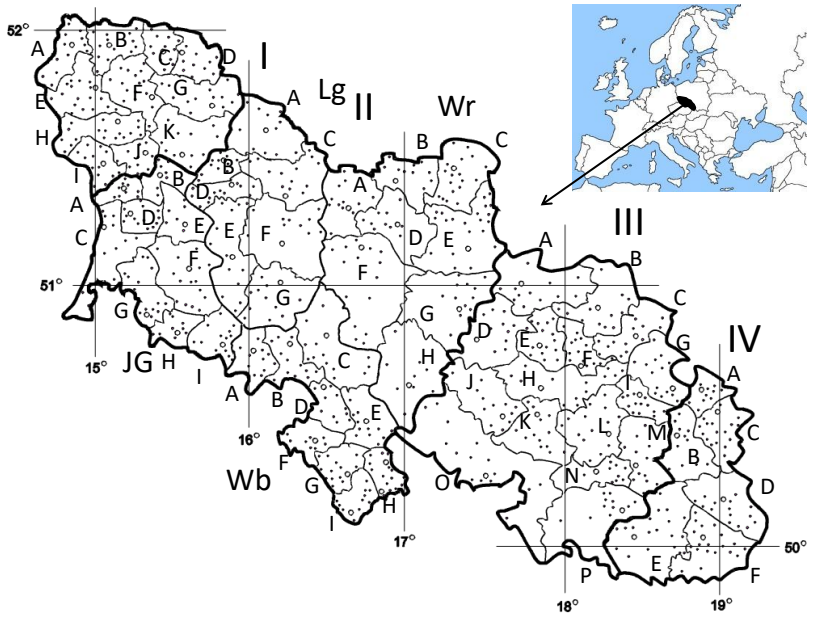

Fig. 1. A map of the study area. Legend: small dots: seats of forest districts, small open circles: seats of forest district inspectorates, thick lines: province boundaries (I, II, III, IV), medium lines: region boundaries within Lower Silesia province (Wr, Wb, Lg, JG), thin lines: boundaries of forest district inspectorates (A, B, C...).

Рис. 1. Карта дослідженої території. Легенда: маленькі крапки: місцезнаходження лісництва, маленькі відкриті кола: місцезнаходження інспекції лісництва, товсті лінії: межі воєводств (I, II, III, IV), середні лінії: межі регіонів у межах Нижньосілезького воєводства (Wr, Wb, Lg, JG), тонкі лінії: межі інспекцій лісництва (A, B, C...).

I: Zielonogórskie (the southern part of the Lubuskie province): A: Gubin, B: Brzózka, C: Zielona Góra, D: Przytok, E: Lubsko, F: Krzystkowice, G: Nowa Sól, H: Lipinki, I: Wymiarki, J: Żagań, K: Szprotawa; II: Lower Silesia: Wr – Wrocław region: A: Wołów, B: Żmigród, C: Milicz, D: Oborniki, E: Oleśnica, F: Miękinia, G: Oława, H: Henryków; Wb – Wałbrzych region: A: Kamienna Góra, B: Wałbrzych, C: Świdnica, D: Jugów, E: Bardo, F: Zdroje, G: Bystrzyca Kłodzka, H: Lądek Zdrój, I: Międzylesie; Lg – Legnica region: A: Głogów, B: Przemków, C: Lubin, D: Chocianów, E: Złotoryja, F: Legnica, G: Jawor; JG – Jelenia Góra region: A: Ruszów, B: Świętoszów, C: Pieńsk, D: Węgliniec, E: Bolesławiec, F: Lwówek, G: Świeradów; H: Szklarska Poręba, I: Śnieżka; III: Opole Silesia: A: Namysłów, B: Kluczbork, C: Olesno, D: Brzeg, E: Kup, F: Turawa, G: Lubliniec, H: Opole, I: Zawadzkie, J: Tułowice, K: Prószków, L: Strzelce Opolskie, M: Rudzieniec, N: Kędzierzyn, O: Prudnik, P: Rudy; IV: Upper Silesia: A: Koszęcin, B: Brynek, C: Świerklaniec, D: Katowice, E: Rybnik, F: Kobiór.

Table 1. Sources used to reconstruct the long-term population dynamics of the elk in south-west Poland

Таблиця 1. Джерела, використані для реконструкції довгострокової динаміки чисельності лосів у південно-західній Польщі

Period	Literature data	Unpublished data
Before 500 CE	[Gumiński 2003; Schmölcke & Zachos 2005]	—
500–1500	[Wyrost 1993, Makowiecki 2003, Pax 1925]	—
1501–1900	[Schwenkfeld 1603; Göppert 1870; Pax 1925, 1955]	—
1991–1980	[Pax 1925; Pucek & Raczyński 1983; Stajszczyk 2014, 2015]	game statistics
1981–2000	[Brzuski 1995; Kopij 2007, 2013, 2016; Marciszak et al. 2023]	game statistics
2001–2010	[Ważna *et al.* 2014; Kopij 2016; Marciszak *et al.* 2023]	game statistics, field observations
2011–2020	[Marciszak *et al.* 2023]	game statistics, field observations
2021–2025	[Marciszak *et al.* 2023]	local press, field observations

An attempt was undertaken to identify elk residency areas. Two categories were distinguished in this regard: areas of confirmed residency and areas of possible residency. The first one refers to areas where females with calf were recorded, the former one where individuals were recorded at least four times (exceptionally three) over 2–3 decades.

Results

1. Prehistory (10 000 BC–500 CE)

Besides the reindeer *Rangifer tarandus*, the elk was among the first ungulates to re-colonise south-west Poland after the end of the Ice Age in the final stage of the Pleistocene [Gumiński 2003; Schmölcke and Zachos 2005]. The re-colonisation had proceeded northwards. In the upper Palaeolithic (10 000–5500 BCE) and in the Neolithic era (5500–2100 BCE in south-west Poland), it was probably a widespread and common animal in the whole area, possibly the most common ungulate. However, with the encroachment of another large ungulate species, the red deer *Cervus elaphus*, it was probably dislocated from drier places occupied by hornbeam forests.

In the Younger Dryas of the late Pleistocene (12 700–11 500 BCE), their distribution range extended from the Pyrenees to Denmark and from Austria to Great Britain, and also covered eastern Central Europe where they still occur today. In the Preboreal (11 500–10 000 BCE), it slowly disappeared from the south-western parts of its range, becoming extinct in southern France and England in the Atlantic period (9100–5600 BCE), as well as in western Germany in the Subboral period about 4000 BCE.

During the Atlantic period, the elk population densities apparently decreased in the rest of Central Europe as well. In Roman times, it was still native to most temperate areas with suitable habitats, but around the beginning of the Common Era only relict populations remained in western Central Europe [Schmölcke & Zachos 2005]. The population in south-west Poland was stable in that period.

2. Middle Ages (501–1500)

As the Roman era faded into Medieval times, the elk slowly disappeared from the western part of Central Europe: from France and Switzerland in the 10th century, from the western Czech Republic by 1300, and from north-east Germany by c. 1600. In Thuringia and in the region north-east of the Elbe River as well as in central Poland, it occurred until the high and late Middle Ages [Schmölcke & Zachos 2005].

With the arrival of Slavic people in the 6th century to south-west Poland, the elk was still one of the most important game animals in this region [Wyrost 1993; Makowiecki 2003]. Even few centuries later in the Middle Ages, it appeared to still be a common species. For instance, in 1186 Prince Bolesław I (1127–1201) organised a two-days hunting (no firearms were available at that time) in his Opole Principality (about 5000 km^2 of mostly afforested [80–90%] area), during which 860 elk were

harvested [Pax 1925, 1955]. It had still been widespread and fairly common in south-west Poland until the end of the 16th century [Schwenkfeld 1603].

3. Years 1501–1900

The elk appears to be especially excessively hunted during the Thirty Years War (1618–1648). As an outcome, it had become very rare by the end of that war [Pax 1925], and finally extirpated in south-west Poland by the end of the century [cf. Hepnter 1966 vs. Willms 1987]. In the 17th century, only single animals were reported on five occasions (Fig. 2): 1 ex. from heathland near Przemków in 1645, 1 ex. captured in Oleśnica Principality in 1661; 1 ex. shot in Raków near Wrocław in 1663; 1 ex. shot in Modła near Bolesławiec in 1675; and 1 ex. recorded in Chocianów in 1675 [Pax 1925, 1955]. It appears, therefore, that in south-west Poland the elk survived for the longest time in the forests between Oleśnica and Wrocław [Pax 1925].

In the 18th century and until the second half of the 20th century, only single elk were recorded on eight occasions on a passage characteristic of this species: Kamień near Syców (1 ex. shot in 1725), Mikowice near Namysłów (1 ex. killed in 1743); near Racibórz (1 ex. killed in 1774), Draliny near Lubliniec (1 ex. killed in 1776), Różanka near Wrocław (1 ex. in 1879), Skarszyn, Trzebnica district (a male shot on 28.10.1888), near Gliwice (1 ex. shot on 13.10.1888), Rędziny near Wrocław (1 ex. recorded in 1894) [Kaluza 1825; Gloger 1833; Göppert 1870; König von & zu Warthausen 1890; Pax 1925, 1955; Prell 1941].

4. Years 1901–1980

The elk survived in Poland in the Biebrza River valley, mostly in the Rajgród forest inspectorate [Dzięciołowski & Pielowski 1975]. Five animals from Belarus were also introduced in 1951 to Kampinos National Park near Warsaw [Gębczyńska & Raczyński 2002]. Soon after World War II, the elk population experienced a strong increase of its numbers, from a dozen or so to 6.2 thousand individuals in the 1980s. Since1952, it has been legally protected, but in 1959 it was listed as a game animal, and starting from 1967 it has been harvested. About 1.3 thousand animals per year were eliminated by this way.

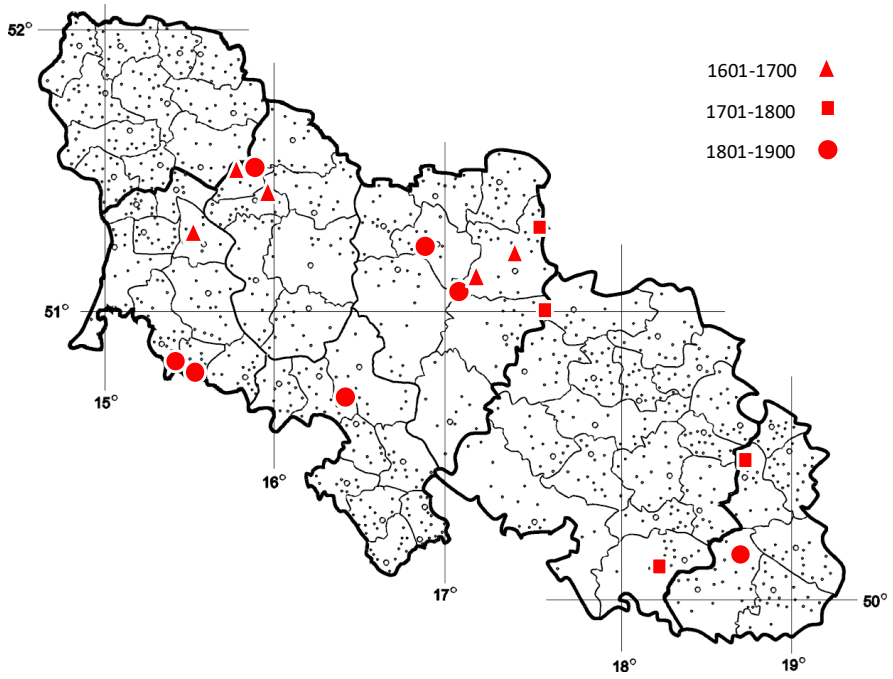

Fig. 2. Distribution of elk records in south-west Poland in 1601–1900.

Рис. 2. Розподіл знахідок лосів у південно-західній Польщі протягом 1601–1900 рр.

However, in south-west Poland, the elk still remained only a sporadic visitor during that period. Graczyk & Kaniewski [1978] and Pucek & Raczyński [1983] provided only one record for the period between 1945 and 1980: 1 ex. observed in a heathland near Przemków in 1979. However, Stajszczyk [2014] provided three other records: 1 ex. shot near Wałbrzych in 1965; 1 ex. recorded in Karkonosze Mts. in 1965 and again in the same area in 1967 (Fig. 3).

5. Years 1981–1990

In the 1980s, the elk occupied almost all suitable habitats in Poland east of the Vistula River, whereas migrating animals were recorded all over the country. In the early 1980s, there were 6.2 thousand elk in Poland, and about 1.2–1.3 thousand animals were harvested annually [Szukiel & Nasiadka 1993; Bobek *et al.* 2005].

In south-west Poland, the elk was only a rare visitor (5 records) in forests on the border of the north-eastern part of Wrocław Hunting Region and the north-western part of Opole Hunting Region [Stajszczyk 1994, 2014, 2015]:

1) near Legnica, 1987, a female shot [Golisz 2008];
2) Wrocław: Kwidzyńska Str., 14.06.1988, a female was recorded [Stajszczyk 1994, 2014];
3) near Nowe Kolnie (Lubsza county), 1988, a female was recorded [Stajszczyk 1994, 2014];
4) between Minkowice Oławskie and Wójcice (Jelcz-Laskowice county), between December 1989 and January1990, 2 exx. remained [Stajszczyk 1994, 2014];
5) between Błota and Ryczyn (Lubsza county), August 1990, two females recorded [Stajszczyk 2014].

At the beginning of the 1980s, a herd of 12–14 elk resided in forests near Lubań (mostly in 'Wielki Las Lubański'). This was apparently a first residency of this species in south-west Poland after its extinction in the 17th century [Marciszak *et al.* 2025].

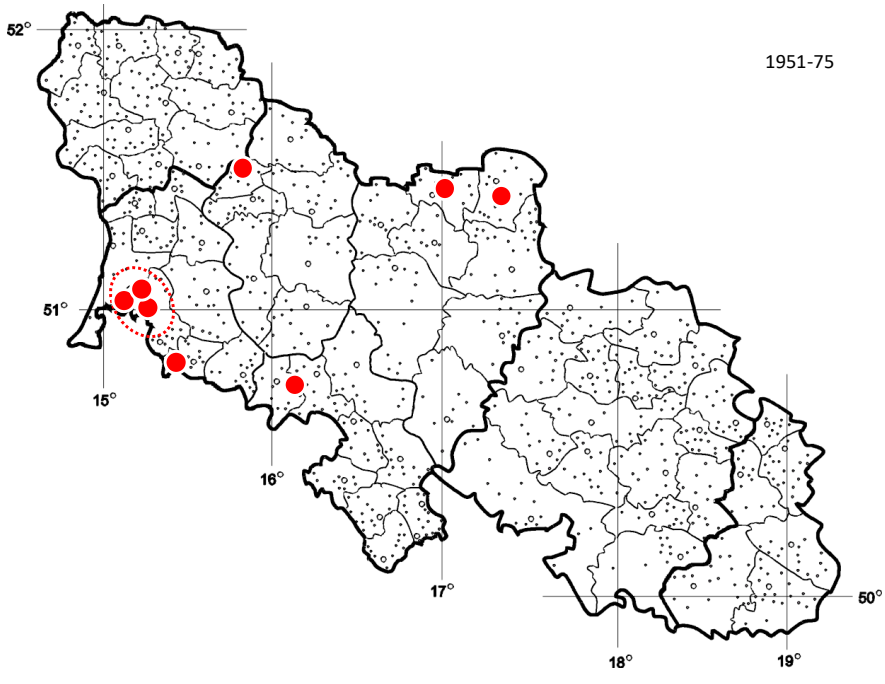

Fig. 3. Distribution of elk records in south-west Poland in 1901–1975 (records encircled with a dotted line indicate possible areas of residency; no elk was recorded in 1901–1950).

Рис. 3. Розподіл знахідок про лося на південному заході Польщі протягом 1901–1975 рр. (знахідки, обведені пунктирною лінією, вказують на можливий район проживання; протягом 1901–1950 рр. лося не зареєстровано).

6. Years 1991–2000

After 1990, a sharp decline in harvesting took place. The Polish population has been estimated at 1.5–2.0 animals in 1995–2000 [Gębczyńska & Raczyński 2001]. In south-west Poland, the elk was still a visitor in these years, recorded on passage only [Marciszak *et al.* 2023], mostly in the north-eastern part of Wrocław Hunting Region (Fig. 4):

1) Borucice (Lubsza county), 1991, a bull [Stajszczyk 1994, 2014];
2) near Jelcz Laskowice, 1991, a bull [Stajszczyk 1994, 2014];
3) Wrocław: Kiełczowska Str., June 1992, a young bull [Stajszczyk 1994, 2014];
4) near Janików (Oława county) and Nowy Dwór (Jelcz-Laskowice county), November 1993, a female [Stajszczyk 1994, 2014];
5) near Masłów (Trzebnica county), March 1994, a young bull [Marciszak *et al.* 2023];
6) near Olszówka (Twardogóra county), August 1994, a young bull [Walaszek 1994];
7) near Żarska Wieś (Zgorzelec county), 1995, a roadkill female [Bena & Paczos 2009];
8) near Dłużec, Sobota and Pieszków (Lwówek Śląski county), 1996–1997, 4–5 exx. remained for a longer period [Doroszko 2000];
9) near Winna Góra (Jordanów Śląski county), June 1997, a young bull [Marciszak *et al.* 2023].

In the 1990s, the elk resided in forests near Górażdże and Miedziana in Opole Silesia. Apparently, females with calf were recorded there. However, after 1997, they disappeared from this area [Marciszewski *et al.* 2023]. In the 1990/91 hunting season, 3 exx. were shot in Zielona Góra RDLP (male and 2 females), 5 exx. in Lower Silesia RDLP (3 males, 2 females), and 17 exx. in Katowice RDLP (7 males, 7 females, 3 juveniles) [Szukiel & Nasiadka 1993]. Therefore, a total of 25 exx.

According to Brzuski et al. [1995], a total of 50 exx. of the elk occurred in eight forest inspectorates (FI) in south-west Poland in 1995: Lubuskie: Zielona Góra FI: 5–7 exx., Nowa Sól FI: 6 exx.; Lower Silesia: Milicz FI: 15 exx.; Oława FI: 2 exx.; Świeradów FI: 2 exx.; Węgliniec FI: 2 exx.; Opole Silesia: Brzeg FI: 5 exx; Upper Silesia: Katowice FI: 10–14 exx. Therefore, a total of 50 exx. in 8 FI.

7. Years 2001–2010

In the early 1980s a decrease in the number of the elk caused by hunting was evident and in 2001 the species was again legally protected. As a result of this protection, its population immediately started to recover. In 2001–2010, it was recorded on as many as 27 occasions in south-west Poland, mainly in Zielonogórskie Hunting Region (Fig. 5).

Zielongórskie

In 2001–2010, the elk was recorded at 13 sites [Ważna *et al.* 2014]:

1) Dąbrowa FD (Przytok FI), 02.07.2001, a young ex.;
2) Wężyska FD (Brzózka FI), 13.09.2002, a roadkill female;
3) Suchleb FD (Lipinki FI), September 2002, a bull;
4) Grotów, FD (Lipinki FI), November 2002, a bull.;
5) Kotowice FD (Krzystkowice FI), 2004, 1 ex.;
6) Krzywaniec FD (Krzystkowice FI), 1 ex. in 2004-2008;
7) Brzózka FD (Zielona Góra FI), 1 ex. in 2004-2008;
8) Wełmice FD (Brzózka FI), August 2007, 1 ex.;
9) Łąkowa FD (Brzózka FI), May 2008, footprints, 1 ex.;
10) Bronków forest district (Brzózka FI), September/October 2008, footprints;
11) Świdnica FD (Zielona Góra FI), 2009, a female with a young;
12) Dąbrowa forest district (Przytok FI), June 2009, a female with a young;
13) Żarków FD (Krzystkowice FI), 2010, footprints, 1 ex.

Lower Silesia

In 2004–2008, the species was recorded at 4 sites [Kopij 2016]:
1) Jelcz FD and Kopalina FD (Oława FI), 1 ex.;
2) Prusice FD (Oborniki FI), 1 ex.;
3) Świętoszów FD (Rudawica FI), 1 ex.;

4) near Gniewomierz (Legnickie Pole county), April–October 2008, a female remained for a longer time [Golisz 2008*][1].

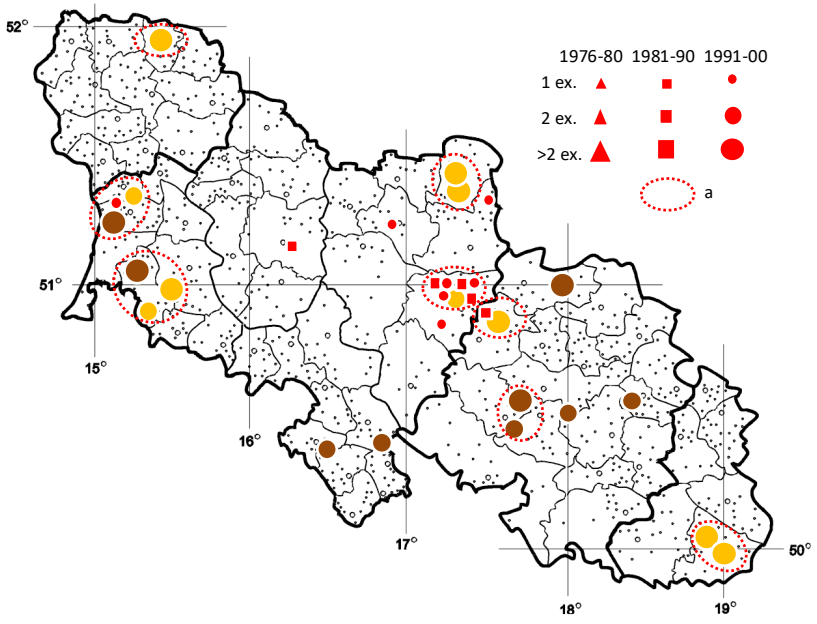

Fig. 4. Distribution of elk records in south-west Poland in 1976–2000.

Sighting records are indicated with red signs, records from hunting game statistics with dark brown signs, records from forest inspectorates with light brown signs. Records encircled with red continuous line (*a*) are areas of residency; records encircled with red broken line are areas of possible residency.

Рис. 4. Розподіл записів про лосів на південному заході Польщі протягом 1976–2000 років. Записи спостережень позначені червоними позначками, записи зі статистики полювання — темно-коричневими позначками, записи з лісових інспекцій — світло-коричневими позначками. Записи, обведені суцільною червоною лінією (*a*), — райони проживання; записи, обведені пунктирною червоною лінією, — райони можливого проживання.

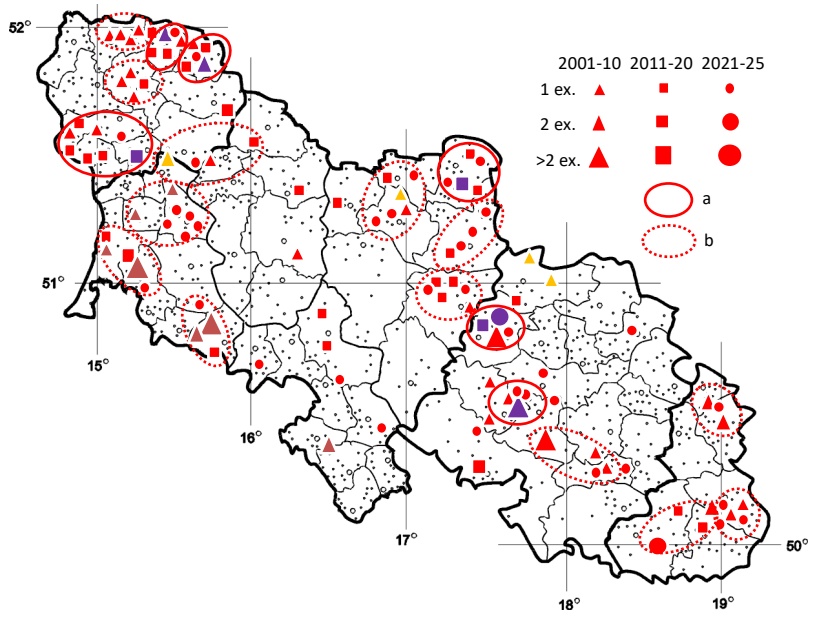

Fig. 5. Distribution of elk records in south-west Poland in 2001–2025.

Sighting records are indicated with red signs, records from hunting game statistics with dark brown signs, records from forest inspectorates with light brown signs; (*a*) records encircled with red continuous line are areas of residency; (*b*) records encircled with red broken line are areas of possible residency.

Рис. 5. Розподіл записів про лосів на південному заході Польщі протягом 2001–2025 років. Записи спостережень позначені червоними знаками, записи зі статистики полювання — темно-коричневими знаками, записи з лісових інспекцій — світло-коричневими знаками; (*a*) записи, обведені суцільною червоною лінією – райони проживання; (*b*) записи, обведені пунктирною червоною лінією — райони можливого проживання.

[1] Here and throughout the text, additional sources not found in academic publications but on hunting websites and other online publications are marked with an asterisk. A list of these sources is given before the References.

Opole Silesia

In 2001–2004, the elk was recorded on several occasions in Opole Silesia:

1) boggy forests between Olszowy and Loża fish-ponds near Lipno, Niemodlin county, throughout the years 2000–2001, one animal remained for a longer time [Kopij 2003];
2) forests between Brzeg and Namysłów, 2000–2004, a few animals recorded [Kopij 2007];
3) Czarny fish-pond near Niemodlin, 2001, a female seen around [Kopij 2013];
4) Przecza FD near Lewin Brzeski, 2004, 1 ex. recorded [Kopij 2013];
5) Prószków forest sub-inspectorate, 2004, 3 exx. occurred [Kopij 2013];
6) Sosnówka FD (Opole FI), 2005, 2 males, 2 females and 2 juveniles [Kopij 2007];
7) Kępa (Strzelce FI), 2004–2008, 1 ex. ([Kopij 2016];
8) Góra Świętej Anny, 14.09.2006, a roadkill bull on the A4 highway [Polak 2006].

Upper Silesia

In 2004–2008, the elk was recorded in 5 forest districts [Kopij 2016]:

1) Klaty FD (Koszęcin FI), 2 exx.;
2) Świerklaniec FD (Świerklaniec FI), 2 exx.;
3) Lędziny FD (Katowice FI), 2 exx.;
4) Śmiłowice FD (Katowice FI), 1 ex.;
5) Murcki FD (Katowice FI), 1 ex.

According to information obtained from state forests [Kopij 2016], in 2004–2008, in the whole of south-west Poland the elk was recorded in 15 forest districts within 11 forest inspectorates. These records were clumped in four areas:

I. near Zielona Góra (Zielona Góra FI: Brzózka FD; Krzystkowice FI: Krzywaniec FD);
II. Oława–Brzeg–Namysłów forest inspectorates (Oława FI: Jelcz, Kopalina FD; Namysłów FI: Smogorzów FD, Polkowice FD; Brzeg FI: Roszkowice FD);
III. Niemodlin forest–fish-ponds complex;
IV. the northern part of Upper Silesia (Koszęcin FI: Klaty FD; Świerklaniec FI: Świerklaniec; Katowice FI: Lędziny FD, Śmiłowice FD, Murcki FD).

It is possible that these four areas represented elk home ranges (residency). The resident population could be estimated at 50–100 exx.

8. Years 2011–2020

In the next decade, the elk shown further increase in numbers in south-west Poland, especially in Zielonogórskie and in Lower Silesia (see: Fig. 5).

Zielonogórskie

The elk was recorded in 13 forest districts [Ważna *et al.* 2014]:

1) Nietków FD, Zielona Góra FI, September 2011, female;
2) Łęczyca FD, Zielona Góra FI, 18.07.2012, 1 ex. photographed;
3) Kowalice FD, Żagań FI, September 2012, bull;
4) Siedlisko FD, Nowa Sól FI, May 2012–February 2013, male and female;
5) Olbrachtów FD, Lipinki FI, November 2013, bull;
6) Lutynka FD, Wymiarki FI, 22.05–13.06.2013, female;
7) Dąbrowa FD, Przytok FI, August–October 2013, bull;
8) Mirostowice FD, Żagań FI, July–September 2014, a female with young;
9) Jamno FD, Wymiarki FI, 2.9.2014, bull;
10) Racula FD, Przytok FI, September 2014, bull;
11) Marszów FD, Lipinki FI, September 2014, bull;
12) Nowe Czaple FD, 20.09.2014, bull;
13) Zielona Góra, 30.09.2019, a bull [Marciszak *et al.* 2023].

Therefore, 2–3 areas of establishing residency (home ranges) can be distinguished:

I. Zielona Góra FI / Przytok FI;
II. Żagań FI / Lipinki FI;
III. Nowa Sól FI / Wymiarki FI?

Lower Silesia

Several records of the elk were made in 2011–2020 in Lower Silesia [Marciszak *et al.* 2023]:

1) near Tarchalice (Wołów county), 2013, a female recorded;
2) Krośnice near Milicz, 04.2013, a female with a young recorded;
3) Świdnica, 28.08.2014, young bull recorded;
4) near Wyręba on DK30 road (gm. Siekierczyn, pow. Lubań); 02.05.2017, a bull and female recorded;
5) between Jędrychów and Szklary Górne (Lubin county), 25.06.2017, a female recorded;
6) Długołęka near Wrocław, 01.08.2017, a female photographed;
7) Wrocławiu-Kowale, 18.09.2017, young bull phototrapped;
8) near Potoczek on DK3 road (Jerzmanowa county, Głogów district), 08.05.2018, a roadkill female;
9) Zgorzelec: Skultetusa, Prusa and Iwaszkiewicza streets, 21.09.2018, a female photographed;
10) near Żmigród, 01.03.2019, a female photographed;
11) between Dziadkowo and Rakłowice (Cieszków county, Milicz district), 14.05.2019, a young bull phototrapped;
12) Wierzchowice (Krośnice county), 16.04.2019, a young bull collided with a train;
13) Wrocław: Krzyki (Wietrzna and Skarbowców streets), 25.07.2019, a young bull recorded;
14) near Karpacz and Śnieżka foothills, 7.11.2019, a bull photographed;
15) Wrocław: Spółdzielcza street (earlier in Tołpa's Park), 11.05.2020, a female recorded;
16) Wierzbno (Żarów county, Świdnica district), 24.09.2020, a young bull photographed.

Areas of possible emerging residency:

I. Barycz Valley;
II. Forests near Długołęka and Odra Valley below Wrocław.

Opole Sielesia

1) near Borucice (Lubsza county), 07.2013, a female with a young recorded [Stajszczyk 2014]; this may represent an emerging residency area (home range);
2) Młyńskie Stawy (Namysłów county), 05.2014, a bull recorded;
3) Szybowice (Prudnik county), 3.08.2019, 2 exx. phototrapped [Dereń 2019*].

Upper Silesia

1) near Mikołów-Jamna train station, 09.05.2013, 1 ex. collided with a train [Kucharczyk 2013*];
2) Gliwice, on DK88 road near Cmentarz Centralny, 16.09.2018, a young bull photographed; seen also in Ostrop, 15.08.2018.

Possible area of residency in forests around Świerklaniec.

According to GUS (2017), in 2017 there were about 5 animals in Zielonogórskie, c. 130 exx. in Upper Silesia, and none in Opole Silesia and Lower Silesia (Table 2).

According to DGLP (2016), in RDLP Zielona Góra, in 2012–2016 elk were recorded only in Żagań Forest Inspectorate: 2012: 0, 2013: 0, 2014: 3, 2015: 5, 2016: 5 exx.; RDLP Wrocław: none (evidently unrecorded); RDLP Opole: none (unrecorded) and RDLP Katowice in 8 forest inspectorates, but only in Świerklaniec FI within the study area. All these areas refer to probably resident animals.

9. Years 2021–2025

In the last five years, the number of elk records exceeded the number of records made during the 400 years of the Second Millenium (see: Fig. 5).

Zielonogórskie

1) Nietków FD (Zielona Góra FI), VII-VIII.2022, a bull [Marciszak *et al.* 2023];

Table 2. The number of elk in south-west Poland reported by hunting clubs in 2011–2020 [Panek & Budry 2023]

Таблиця 2. Кількість лосів на південному заході Польщі, про яку повідомляли мисливські клуби у 2011–2020 роках [Panek & Budry 2023]

District	Hunting district	Hunting years	Number of individuals recorded in particular hunting year
Zielonogórskie			
Żagań	221	2013/14–2019/20	5,5,6,3,2,0
Lower Silesia			
Bolesławiec	115	2015/16–2018/19	1,1,1,1
Lubań	204 (35)	1999/00–2001/02	1,1,2
Oleśnica	139	2019/20	1
Upper Silesia			
Tarnowskie Góry	87	2014/14–2019/20	5,3,0,1,3,4
Tarnowskie Góry	99	2004/05	1
Tarnowskie Góry	99	2019/20	3
Tarnowskie Góry	100	2019/20	3
Gliwice	106	2016/17–2017/18	6,2
Gliwice	115	2016/17	5
Siemianowice	119	2019/20	4
Jaworzno	125	2017/18–2019/20	2,3,5
Jaworzno	135	2008/09–2019/20	1,0,2,3,5,5,4,5,7
Bieruń	136	2019/20	2
Tychy	137	1999/00–2003/04	2,3,2,2,2,1
Dąbrowa Górnicza	116	1999/00–2019/20	4,3,3,4,5,7,3,3,3,3,3,3,8,7,8,8,10,12,14
Dąbrowa Górnicza	117	2001/02–2019/20	4,4,5,5,0,4,5,3,4,0,5,3,4,4,4,4,4,4,4,6,4,0,0,0

2) Szprotawa, Zespół Przyrodniczo-Krajobrazowy Potok Sucha, 2022 and 18.03.2023, 1 ex. [Marciszak *et al.* 2023];
3) Przytok near Zielona Góra, 13.04.2024, phototrapped 1 ex. [Kalinowski 2024*];
4) Żary, on A18 highway near Żary-Południe, 2025, a bull photographed [Sós 2025*].

The records indicate that the elk was resident in Zielona Góra/Przytok FI.

Lower Silesia

1) near Oleśnica, 01.09.2021, young bull phototrapped [Anonymous 2021b*];
2) between Osiecznica and Bolesławiec, 15.09.2021, a roadkill female collided with a track [Orlik 2021*];
3) near Wilków (Milicz county), 14.01.2022, a male recorded [Anonymous 2022a*];
4) near Wszemirów (Prusice county), 08.02.2022, footprints [Anonymous 2022a*];
5) near Prusice (Trzebnica district), 23.03.2022, a bull recorded [Anonymous 2022a*] near Sanie (Żmigród county), 04.07.2022, 2 exx. (B. Orłowska);
6) near Stawno (Milicz county), 11.08.2022, young bull phototrapped [Waś 2022*];
7) Krępnica near Bolesławiec, 05.09.2022, young bull photographed [Kwiatek 2022*], 13.09.2022, the same individual found dead in Krępnica [Anonymous 2022e*];
8) Krępnica near Bolesławiec, 05.10.2022, 1 ex. (K. Kwiatek);
9) near Oleśnica, 29.07.2022, young bull phototrapped, probably the same as in 11 [Anonymous 2022d*];
10) Mlądz (Mirsk county, Świeradów forest inspectorate), 20.10.2023, 1 ex.;
11) near Bielawa, Sowie Mts., 20.04.2024, 1 ex. (D. Raszewski);
12) Wrocław: Krzyki: Jagodno, and Iwiny village, 05.06.2024, 1 ex.; the same: Krzyki: Klimasa Str., 06.06.2024, 1 ex. [Marciszak *et al.* 2023];
13) Krzeszów (Kamienna Góra county), 05-06.05.2024, 1 ex. (A. Gierak);
14) Bolesławiec forest inspectorate, 17.10.2024, 1 ex. (M. Krzak);
15) Syców FI, 04.02.2025, 1 ex. [Zapart 2026*];
16) near Ząbkowice, Kamień Ząbkowicki and Wałbrzych, 08.05.2024, 1 ex. (K. Marcińczyk);
17) Budczyce FD (Oleśnica FI), 16.10.2025, 2 exx. photographed (URL);
18) Oława FI, 03.10.2025, a bull [Marciszak *et al.* 2023];

19) Łupki (Wleń county), 20.10.2023, 1 ex. [Marciszak *et al.* 2023].

The elk is therefore probably a resident species in:

I. Barycz Valley;
II. Oleśnica FI / Oława FI;
III. Bolesławiec FI.

Opole Silesia

1) Brzeg forest inspectorate, 2022: male and female, 2025 a pair with young;
2) Dąbrowa Niemodlińska near Opole, 30.07.2021, a female [Anonymous 2021a*];
3) between Opole and Dąbrowa Niemodlińska, 14.07.2021, 1 ex. (J. Boczar);
4) near Azoty in Kędzierzyn-Koźle, 03.05.2022, a young bull photographed [Anonymous 2022b*];
5) between Piotrówka and Łaziska (Jemielnica county), 15.07.2022, a female photographed [Anonymous 2022c*];
6) near Opole: Grotowice FD and Chrząstowice FD, 11.07.2024, 1 ex. (J. Boczar);
7) around the Turawa Reservoir, 2025, 1 ex. (J. Boczar);
8) Jasienica Dolna (Łambinowice county), 12.03.2025, a female passing the village toward Włodary (K. Strauchmann);
8) Olesno, ul. Gorzowska on S-11 road, 28.06.2025; 1 ex. phototrapped (J. Bonczar).

There are 2–3 areas where the elk is resident:

I. Brzeg FI;
II. forest-fish-pond complex in Niemodlin (Opole FI and Tułowice FI);
III. Strzelce Opolskie FI?

Upper Silesia

1) Gierszowiec FD in Katowice, 2023, 1 ex. phototrapped; also recorded in Tarnowskie Góry and Ruda Śląska [Romańczuk 2023*];
2) Kobiór, on DK-1 road, 05.05.2023, 1 ex. collided with a car. [Wosion 2023*];
3) Zwonowice near Wodzislaw Śląski, 06.10.2024, 2 exx. recorded [Kmiaciak 2024*];
4) Masłowice-Tychy, 01.07.2025, 1 ex. collided with a car; [Szymczak 2025*];
5) Mikołów, 27.06.2025, young bull photographed [Szymczak 2025*].

The elk is therefore resident in 1–2 areas:

I. Świerklaniec FI;
II. Kobiór FI?

According to Panek i Budry [2023], in 2001 there were 2 thousand elk in Poland, 10 thousand in 2012, and 34.5 thousand in 2023. In south-west Poland, no elk were recorded in in 2023 in Jelenia Góra, Legnica, and Wałbrzych hunting regions. In the remaining regions, the population density was calculated as follow: Zielonogórskie: 0.1, Opole Silesia: 0.1, Wrocław Hunting Region: 0.1, Częstochowa HR: c. 0.5, Katowice HR: c. 1.0 exx. per 1000 ha forested area. Therefore, the numbers were greatly unrecorded, if compared with other data.

Based on GUS [2017], Dzik-Michalska et al. [2019] reported about 100 elk only from Upper Silesia and none from Opole, Lower Silesia, and Zielona Góra regions. Based on information obtained from the Directorate of State Forests, Wawrzyniak [2016] recorded the presence of elk only in five forest inspectorates (in each with less than 6 animals) in south-west Poland: Świerklaniec (Upper Silesia), Wołów, Złotoryja, Węgliniec, and Bolesławiec (Lower Silesia). No records from Opole Silesia and Zielona Góra hunting regions. Therefore, the numbers were also greatly unrecorded.

Discussion

Number of recorded animals and their sex ratio

Most recorded animals were single wandering individuals (85.4%), occasionally two (11.5%) and only sporadically (3.1% of records) more than two individuals (Table 3).

Table 3. Number of animals recorded in a given period

Таблиця 3. Кількість тварин, зареєстрованих за певний період

Period	1 ex.	2 exx.	3 exx.	>3 exx.	Mean
1601–1900	13	0	0	0	1.00
1901–1990	7	2	0	0	1.22
1991–2000	8	0	0	1(4)	1.33
2001–2010	22	5	2	1(6)	1.40
2011–2020	28	4	0	0	1.13
2021–2025	33	4	0	0	1.11
Total, n	111	15	2	2	**1.20**
%	85.3	11.5	1.5	1.5	–

The largest recorded herd was composed of six animals, two males, two females and two juveniles, and was recorded in 2005 in Sosnówka forest district, Tułowice forest inspectorate, Opole province [Kopij 2007]. Sex was determined in 58 cases of single wanderers: males (n = 34, usually young bulls) were more often encountered than females (n = 24). The sex ratio was therefore 0.59 : 0.41.

Overall trends in abundance and distribution in 1981–2025

After its nearly 300 years of absence as a resident animal in south-west Poland, the elk has returned to this region and established a first home range in the 1980s. The number of elk records significantly increased in 1981–2025 (Fig. 6).

By the end of the 20th century, possibly eight home ranges had been established in this region; each one with 3–6 animals (Fig. 7); therefore, a total of 24–48 exx. At the end of the first quarter of the 21st century, there were 19 areas with possibly resident animals and six areas with confirmed residency (Fig. 7). In each such area, the number of elk could range between 5 and 10, giving a total of 100–200 resident animals. In Augustów Forest, north-east Poland, an increase was estimated at 10% per annum in 2001–2020 [Bobek *et al.* 2024]. In south-west Poland, the increase was very similar (9.6%). This increase in south-west Poland is somehow contrary to expectations, as with the climate change the elk, given its heat-sensitivity, is expected to withdraw from the most southern limits of its wide geographical rage. In south-west Poland, the last elk refugia were located around Oleśnica and in the southern parts of Bory Dolnośląskie (see: Fig. 2).

At the end of 20th and the beginning of the 21st century, the elk returned to the same areas and their close vicinities (see: Figs. 4–5). It seems, however, that Bory Stobrawskie in Opole Silesia, and the East and Central Sudety Mts. are now avoided (see: Fig. 5). It is possible that today the elk has re-occupied in south-west Poland only areas of afforested marshlands in river valleys or around lakes and fish-ponds, in a close proximity to young successional pine forests. Bory Stobrawskie, and the Central and Eastern Sudety Mts. may no longer offer such habitats.

It has been shown that at a landscape level the elk selects areas with low-quality of food, whereas within its home range it prefers areas with high-quality of forage and low human disturbance [Van Beest *et al.* 2010]. In spring, elk, especially females with calves, will concentrate in semi-open marshlands, which provide high-quality forage rich in sodium, low predation risk, and the possibility to cool by wallowing in the water [Gębczyńska & Raczyński 1984]. In winter, they may benefit in intensively-managed young successional forests, which provide abundant high-quality forage (young shoots of pines and other conifers) [Niedziałkowska *et al.* 2022].

Competition with other deer species may also play a role in distribution and abundance of the elk in south-west Poland. It is sympatric there with three other ungulate species, namely the roe deer *Capreolus capreolus*, red deer *C. elaphus*, and fallow deer *Dama dama*. Food niche overlap was recorded between all of them, but was the highest between the elk and roe deer [Mysterud *et al.* 2000], especially over the browse of *Vaccinum* spp. [Spitzer *et al.* 2020, 2021]. Bory Stobrawskie are abundant of the *Vaccinum* spp. and have high density of both the roe deer and red deer [Kopij 2023], and possibly this may prevent the elk to re-occupy this area.

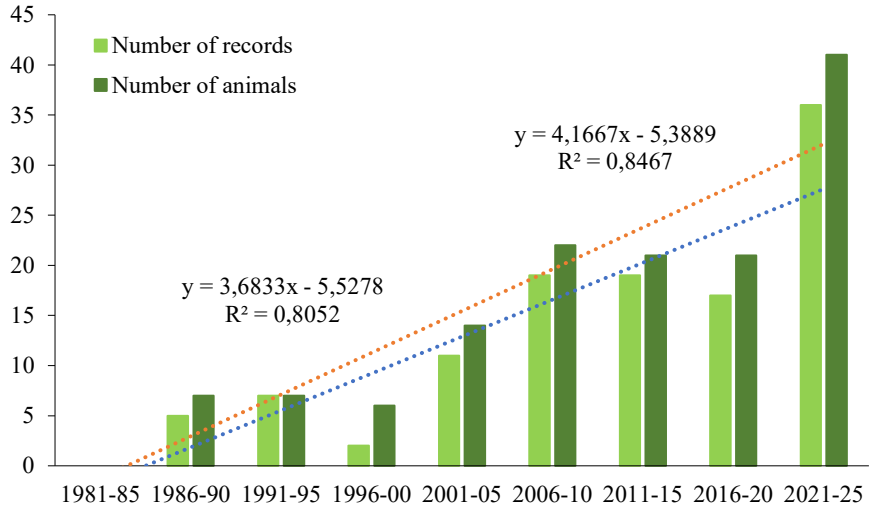

Fig. 6. Number of elk records over the last 40 years (1986–2005) in south-west Poland.

Рис. 6. Кількість спостережень за лосями за останні 40 років (1986–2005) на південному заході Польщі.

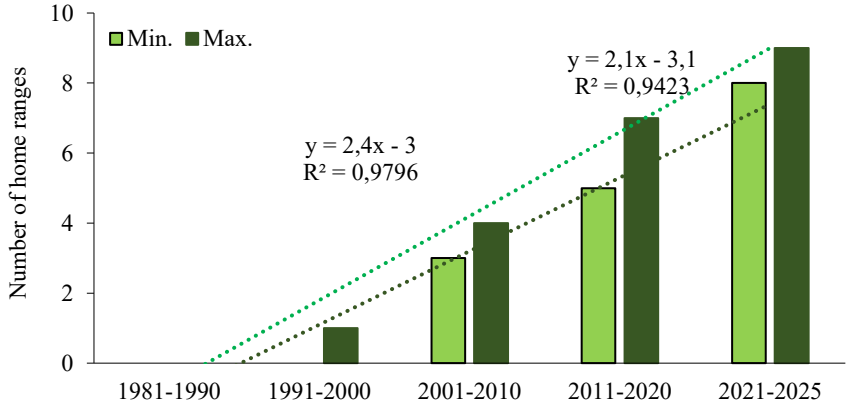

Fig. 7. Number of emerging elk home ranges established in south-west Poland in 1980–2025.

Рис. 7. Кількість нових угідь для проживання лосів, створених на південному заході Польщі у 1980–2025 рр.

Situation in Poland

After World War II, the elk population in Poland experienced a strong increase in numbers, from a dozen or so at the beginning of the second half of the 20th century to 6.2 thousand individuals in the 1980s. By the end of this decade, most suitable habitats in Poland east of the Vistula River had been re-occupied. In 1967–2000, the elk was a hunted game in Poland. About 1.3 thousand elk were harvested at that time: 425 in 1966, 1424 in 1971, and 3862 in 1976. In 1991, the estimate for Poland was 5901 individuals, but only 1718 in 2000 [Szukiel & Nasiadka 1993; Bobek *et al*. 2005]. After the ban on hunting in 2001, the number of elk rapidly increased.

Based on hunting statistics, Wawrzyniak [2016] estimated the total number of elk in Poland at c. 5 thousand individuals in 1990 and 2 thousand in 2000, but as many as 8 thousand in 2010, and 17 thousand in 2015. Furthermore, based on direct counts in the field, the numbers in 2015 were estimated at 28 thousand. In 2020, the number was estimated at 60.9 ± 11.9 thousand individuals [Bobek *et al.* 2021], or at 41 thousand according to GUS (2024). Clearly, there is a significant discrepancy between these estimates, with a tendency for overestimations. There is, therefore, a need for a more reliable survey method of elk numbers [Dzik-Michalska *et al.* 2019].

Conclusions

After almost three centuries of absence as a resident animal, the elk has returned to south-west Poland, and at the end of the 20th century had shown signs of residency in eight areas. The number of such areas have increased to 13 in the first quarter of the 21st century. Furthermore, in six other areas, females with calf were recorded, which indicates residential status. The areas of possible and confirmed elk residential areas concentrate in the vicinity of Zielona Góra, Bory Dolnośląskie (Lower Silesian Forest), the Western Sudety Mts., the northern part of Wrocław hunting region, the central Opole province, and the southern and northern parts of Upper Silesia. Remarkably, no resident elk have ever been recorded in the vast Stobrawa Forests in Opole province and Upper Silesia. In the near future, areas of confirmed residency of the elk may be established in these as well as in other regions of south-west Poland.

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Declarations

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Handling of materials. The study was conducted in compliance with the current legislation in regard to working in protected areas and with live animals.

Use of artificial intelligence. No generative artificial intelligence systems were used in the preparation of this manuscript. All scientific results, interpretations, and text are original contributions of the author.

Additional sources [marked in the text with *]

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