

Article

Trophy Value as a Driver of Sustainable Game Management and Hunting Tourism in Croatia

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Abstract

Analysis of game management and trophy game populations in Osijek-Baranja County shows that this region is one of the most valuable hunting areas in Croatia, with rich populations of red deer, roe deer, and wild boar, as well as stable annual population growth. The methodological framework included products and services in hunting based on data analysis from the Croatian Hunting Association, big-game trophy records (ETD forms), the Central Hunting Register, and the official price list of game culling and hunting services. Data on harvests and trophy values indicate long-term population stability and high economic potential of hunting, with red deer generating the highest total revenue (EUR 7.29 million), while roe deer and wild boar contribute to overall stability and harvest volume. The total trophy value over 12 hunting seasons reaches EUR 11.99 million, underscoring the economic importance of hunting tourism for local communities. Differences among hunting ground users suggest that private companies and the state company Croatian Forests Ltd. often achieve higher trophy values, while county hunting associations report more modest results. However, regression analysis shows there is not a strong statistical correlation between management structure and trophy outcomes, highlighting the significant influence of ecological and spatial factors on game quality. International hunters, primarily from Germany and Austria, represent a key segment of demand, confirming the market potential for further development of hunting tourism. Despite the rich natural base, results indicate the need for better marketing approach, digital visibility, and integration of hunting products with other forms of tourism, such as gastronomic, wine, and nature tourism. Effective positioning of Croatia as a competitive hunting destination requires adaptation to contemporary market trends and adherence to international sustainable management guidelines (FAO, ELC, CBD). In conclusion, hunting in Croatia represents an important non-wood forest product and a vital resource for rural and economic development. Sustainable population management, quality promotion, and integration of traditional and innovative practices are essential for reinforcing biodiversity conservation, supporting community livelihoods, and strengthening Croatia's role in the European and global hunting-tourism market.

Keywords: sustainable game management; trophy value; hunting tourism; non-wood forest products; biodiversity conservation; rural development

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1. Introduction

The modern approach to natural resource management emphasizes the importance of non-timber forest products, which often remain underestimated but have exceptional potential. The extraction of non-timber forest products contributes to the development of rural areas and encourages organized collection, processing, and development of new business activities, especially among small- and medium-sized enterprises [1]. According to the FAO (Food and Agriculture Organization of the United Nations), non-timber forest products are defined as “products of biological origin, other than wood, originating from forests, other forest lands and from trees outside forests.” Within the non-wood forest functions, forest products constitute renewable and non-renewable goods, and are divided into main and secondary [2]. The most important forest product is wood, from which the greatest value is realized when using a forest, while secondary products are all the goods and benefits that a forest brings to humans that are not wood products, which include sustainable wildlife management and hunting tourism. Sustainable wildlife management (SWM) is defined as “the sound management of wildlife species to sustain their populations and habitats over time, taking into account the socioeconomic needs of human populations” [3].

Generally, the legal framework for NWFPs is regulated by national laws, such as National Forest Acts, hunting legislation, environmental protection laws, and nature conservation laws. Most legal acts make direct references to NWFPs in the context of forest management, as well as access to forests and harvesting rights of NWFPs or specific rules to be applied in the context of nature conservation (e.g., usually stricter rules for the collection of specified NWFPs). Wolfslehner, B. et al. [4] and Lovrić et al. [5] estimate that collected NWFPs represent a total economic value of EUR 23.3 billion per year in Europe, which amounts to EUR 20.5 per hectare of forest and other wooded land, and represents an economic value that is comparable to 70.7% of annual roundwood removals value in Europe. The use of non-timber forest products in Croatia is partly under the jurisdiction of the state-owned company Croatian Forests Ltd., which manages 73% of forests and forest land, and partly under the management of natural or legal persons. According to the Forest Act [6], forest products are all products of forests and forest land and include the following: forest trees and shrubs; biomass of total forest vegetation (flowers, seeds, fruits, tree bark, roots); moss, ferns, grass, reeds, flowers, medicinal, aromatic and edible herbs, and other plants; mushrooms; honey and resin; leaves, grass, or pasture cover; game and other animals living in the forest; and peat and humus.

Game and its derivatives are included in the category of non-timber forest products of animal origin because they represent a natural resource of the forest ecosystem that is not related to wood, but has significant economic, nutritional, and social value. This primarily includes meat, skin, fur, antlers, horns, and other products of animal origin.

Wildlife management is defined as the application of science-based and local knowledge in the stewardship of wild animal populations (including game) and their habitats in a manner that is beneficial to the environment and to society [3].

Hunting, as an economic activity, ensures the sustainable use of natural resources through breeding and protection of game populations, in order to ensure their regeneration and permanent availability, as well as the possibility of their economic value. According to the State of Europe's Forests 2015 report [7], products of animal origin, among which game products play an important role, account for a significant share of the total reported value of non-timber forest products in Europe.

Hunting management encompasses planning, organization, financing, and evaluation of all activities related to game and hunting grounds. This includes development of hunting management plans, provision of habitat and food, investments in hunting management and hunting technical facilities (e.g., feeding places, water ponds, observation

points), implementation of breeding measures, and organization of hunting and touristic offers.

Regulation (EC) No 853/2004 [8] considers game meat as meat obtained from wild birds, ungulates, and lagomorphs, as well as other land mammals that are hunted for human consumption, including animals living in enclosed territory under conditions of freedom similar to those of wild game [9].

According to the UN Tourism barometer report [10], international tourist arrivals (overnight visitors) grew by 5% in the first six months of the year 2025 compared to 2024, or 4% compared to pre-pandemic year 2019. This comes after the full recovery of international tourism in 2024 when arrivals reached 1.5 billion. Almost 690 million tourists traveled internationally between January and June 2025, about 33 million more than in the same period in 2024.

In the literature [11], there are several classifications of hunters depending on their motivation and type of hunting:

- Subsistence hunting—hunting primarily for food, survival, and local consumption
- Recreational (sport) hunting as non-commercial hunting performed for leisure, challenge, and tradition
- Trophy hunting—selective hunting of specific animals, often targeting animals with large antlers, horns, or other distinguishing features, where the trophy (e.g., antlers, horns, skin) is preserved as a souvenir
- Commercial hunting—conducted for the sale of animal products such as meat, fur, or other body parts. It is often regulated or prohibited in many countries due to conservation concerns
- Population control (management) hunting—regulating wildlife populations to prevent overgrazing, crop damage, or ecological imbalance. It is integrated into forestry and wildlife management programs
- Culling—the removal of specific individuals or groups of animals (often diseased, invasive, or overpopulated) to improve the health of ecosystems or reduce human–wildlife conflicts
- Traditional and cultural hunting—hunting associated with cultural, spiritual, or ceremonial practices, in relation with indigenous or local traditions.

A study by Musso et al. [12], presented in the European Parliament, shows that hunting, sports shooting, and related sectors contribute EUR 180 billion annually to Europe's economy, supporting more than 1.1 million jobs across 30 countries including all EU Member States, Norway, Switzerland, and the United Kingdom. The study shows that the sector, together with its related services, supply chains, and induced effects, represents an average of 0.99% of Gross Domestic Product (GDP). Combined annual expenditure of Europe's hunters and sports shooters, excluding the purchase of firearms and ammunition, amounts to EUR 96.3 billion. Employment linked to this final demand represents 84,691 employees in production and 490,936 employees in services. The study also underlines the strong trade performance of the sector, with the European firearms industry recording a EUR 1.36 billion trade surplus and the ammunition industry adding another EUR 399 million.

Hunting is an important socioeconomic activity. According to the research reports [13], apart from direct economic activities, there are also environmental and social benefits through social and cultural activities in rural areas. The European Federation for Hunting and Conservation (FACE), whose members are national hunting associations from 37 European countries, including the EU-28, currently represents more than seven million hunters in Europe [14]. The EU-funded 'Hunting for sustainability' (HUNT) FP7 project in 2011 assessed the social, cultural, economic, and ecological functions and impacts of hunting across a range of contexts. The Croatian result, consisting of a hedonic price exercise for

bear hunting trophies, shows that on average, hunters from outside Croatia spend EUR 135 extra per bear hunted than the Croatian nationals. In a discrete-choice experiment for driven hunts in southern Europe [15], the authors took into account the number of deer that could be hunted, the possibility of free-range wild boar hunting, the presence of trophies, and other characteristics of driven hunts. The European Commission regulates hunting management and activities to ensure sustainability and achievement of environmental protection goals through the Birds Directive and the Habitats Directive. They are the legal basis for Natura 2000—the largest coordinated network of protected areas in the world. As part of the European Green Deal, the biodiversity strategy for 2030 is the EU's plan to put biodiversity on the path to recovery by 2030. It contains specific commitments and actions to protect nature and reverse the degradation of ecosystems, building on existing nature laws [16].

Revenues from hunting can be divided into direct and indirect. Direct revenues include fees for shooting game, sale of trophies, sale of game meat and other derivatives (hides, antlers), and filming and observation of game. Indirect revenues arise from accommodation and catering, cultural and sporting events, and contributions to environmental conservation. According to research by Krapinec et al. [17], in terms of trophies, game breeds in Croatia are red deer (*Cervus elaphus* L.), European mouflon (*Ovis orientalis musimon* Pall.), and brown bear (*Ursus arctos* L.), which makes hunting in our country an important part of the international hunting-tourism offer. At the European level, hunting has a distinct economic dimension. Croatia sees this as an opportunity, especially in regions such as Slavonija and Baranja, which have rich sources of big game and a long tradition of hunting management [18,19]. Thus, the economics of hunting become not only a matter of national resources, but also of Croatia's international recognition. The Hunting Act stipulates that hunting ground and game management activities have an economic, touristic, and recreational function and that game has the status of a good of interest for the Republic of Croatia, with special protection [20].

In order to determine the customs value of a hunting trophy under the fallback method, all costs directly connected with obtaining the hunting trophy and preparing it for export to the customs territory of the European Union should be taken into account, mainly including the following: trophy fee, field preparation of the trophy, costs of dip and pack and taxidermy services, costs of medallion/wooden base, and transportation costs to a secured facility before the trophy's departure to the customs territory of the EU (European Commission, 2020). Trophy hunting generates revenue through a number of channels: direct revenue is accrued through the levying of various government fees, such as game fees, observer fees, conservation fees, permit fees, and trophy handling fees, as well as safari operator daily rates, which cover such things as accommodation, subsistence, and the services of a professional hunter [21].

Most studies on trophy hunting and hunting tourism in Europe and the wider region focus on specific species, populations, or habitat conditions that differ from those in Croatia. Examples from Vojvodina and the Balkans [22,23] cannot fully reflect the habitat conditions, population densities, and demographic trends characteristic of Croatia, especially Osijek-Baranja County with its large hunting grounds and specific combination of game species. Croatia has its own model of hunting ground management, culling quotas, and regulations, which differ from neighboring countries or other regions. Existing research is often focused on the economic aspect of trophy hunting. Croatia has a combination of state and private hunting grounds, a diverse game population, and mass-tourism issues that require locally specific data for shaping sustainable management policies. Without data related to local demographics, habitat conditions, and the economic aspects of hunting tourism, it is difficult to develop operational recommendations for sustainable management and species conservation.

Trophy hunting and hunting tourism are a significant part of the rural economy and recreational activities, particularly in regions with rich wildlife habitats such as Croatia and Southeast Europe. The trophy value of harvested game represents not only a status symbol but also an important economic resource that can be reinvested in the sustainable management of habitats and wildlife populations [24,25]. Systematic harvest planning, selective culling of individuals, and regulation of hunting quotas enable control of population density, preservation of reproductively important individuals, and reduction of negative impacts associated with habitat overpopulation, all of which represent key mechanisms of sustainable species management [26].

Despite the great potential, hunting management in Croatia faces numerous challenges. One of the key problems is the disparity between the potential of hunting grounds and their actual utilization. Although Croatia has more than 1000 hunting grounds, some of them are not sufficiently equipped or organized to attract foreign hunters or generate more income. In addition, smaller hunting associations often struggle with financial difficulties, because the costs of maintaining hunting grounds (e.g., feeding, crop protection, game guard service) exceed the income they generate. Damage caused by game in agriculture is a constant source of conflict between hunting associations and farmers, especially concerning wild boar and deer. Climate change also brings new challenges. Changes in habitats [27] and more frequent floods or droughts [28–30] affect the availability of food and water, while mild winters increase the abundance of some species and thus create pressure on habitats [31,32]. Migration routes of game are changing, which requires adaptation of hunting management. Depopulation of rural areas leads to reduced interest among people in engaging in hunting and volunteer work in hunting societies. All of the above-mentioned issues show that the problems of hunting management are not only biological or technical, but also socioeconomic. Solving them requires an integrated approach—from strengthening the legislative framework, through education of hunters and strengthening the game guard service, to development of new forms of cooperation between hunters, farmers, and the local community.

However, there are also significant shortcomings in the existing literature. Most studies in the region focus on the economic aspects of trophy hunting, such as assessment of trophy value or hunting ground revenues, while comparatively less attention is paid to direct impacts of hunting on population demography, long-term species sustainability, or biodiversity conservation [22,23]. Without adequate population monitoring, planned quotas, and scientifically grounded management, trophy hunting may have negative effects on wildlife populations and habitats, despite the financial benefits it provides to local communities [22].

Therefore, the integration of economic, ecological, and social components in trophy hunting research is essential. This includes monitoring habitat quality, population demographic structure, and harvest trends to ensure long-term sustainability of populations and conservation of nature, while simultaneously promoting development of hunting tourism as a source of income. This paper seeks to contribute to this scientific framework by analyzing trophy value and hunting tourism in Osijek-Baranja County, with emphasis on the interrelationship between the economic and ecological aspects of sustainable wildlife management.

The paper will analyze the economic role and value of the market of hunting trophies as secondary forest products in Europe, with a special focus on hunting tourism at the selected research site of Osijek-Baranja County. The culling of big game by species—red deer, fallow deer (*Dama dama* L.), roe deer (*Capreolus capreolus* L.), European mouflon, and wild boar (*Sus scrofa* L.)—depending on the carrying capacity of wild ungulates and their offspring will be analyzed in order to ensure sustainable management of hunting grounds without endangering the stability of the population. On the basis of the collected data, the

procedure for evaluating the trophies shot using the CIC (International Council for Game and Wildlife Conservation) trophy scoring system will be applied for 12 hunting years (2007/2008–2018/2019), in order to determine the economic value of hunting and attractiveness of selected hunting grounds for analysis.

In order to gain insight into the importance of the international hunting market in Osijek-Baranja County, data was processed by countries from which foreign hunters come. The economic value and quality of hunting products were calculated by comparing the culling numbers of individual game species and the value of trophies in the analyzed period, in order to determine and highlight the role of hunting management in the Republic of Croatia.

2. Materials and Methods

2.1. Research Area

The research area is Osijek-Baranja County, located in the far northeastern part of the Republic of Croatia. The county covers an area of approximately 4150 km² and consists of 7 cities and 35 municipalities. The largest city and administrative center is Osijek [33]. The geographical position of the county is characterized by large rivers—Drava in the north and Danube in the east, while in the south it connects to the Sava. This area is characterized by a distinct diversity of relief and habitats: from lowland forests and fertile arable land in the Slavonian part, through Baranja wetlands, to protected areas such as Kopački rit Nature Park. It is precisely the diversity of ecosystems that ensures a high level of biodiversity and favorable conditions for breeding and management of various species of game [34].

According to the Central Hunting Register, which is maintained by the Forestry, Hunting and Wood Industry Directorate within the Ministry of Agriculture, Forestry and Fisheries, at the time of the beginning of the study (2007–2008), there were 20 state-owned hunting grounds and 85 county-managed hunting grounds [35]. The most important species of big game are red deer, fallow deer, roe deer, European mouflon, and wild boar. In addition to big game, small game is also managed in the researched hunting grounds (e.g., grey partridge—*Perdix perdix* L., brown hare—*Lepus europaeus* Pall., pheasant—*Phasianus* spp.), but its numbers have been showing declining trends for a long time. The trophy quality of red deer is particularly noteworthy; red deer trophies are often ranked at the very top of European and world standards in international evaluations [36,37].

Osijek-Baranja County was chosen as the object of the research because it has one of the richest wild ungulate reserves in Croatia, a developed hunting infrastructure, and a significant international reputation in the field of hunting tourism. This makes it an ideal example for analyzing the economic significance of hunting and the possibilities of its connection with marketing and rural development. The county also has a long history of hunting. The Baranja region was known for its large noble hunting grounds, and Kopački rit was used as an imperial hunting ground by the Habsburg family since the 17th century. It is precisely this historical continuity that makes hunting part of the identity and cultural heritage of the region. In addition to its economic and ecological significance, hunting in the county also has an important socio-developmental function. The organization of hunts and hunting-tourism arrangements contributes to the employment of the local population—from gamekeepers and guides to catering staff and accommodation providers. The connection between hunting, tourism, and gastronomy should be particularly emphasized. Game meat has been increasingly included in the offer of restaurants and wine cellars, which creates added value for regional tourism. Slavonia and Baranja are known for their enology and gastronomy offers, and game dishes represent a specific segment that can distinguish the county in the domestic and international market. Hunting management in Osijek-Baranja County is aligned with national legislation, but also with European

directives, especially those related to the conservation of biodiversity. A large part of the area (Figure 1) is included in the Natura 2000 network, which means that hunting activities must be carried out in compliance with strict ecological criteria [38]. This ensures that hunting remains a sustainable activity that protects nature while at the same time bringing economic benefits.

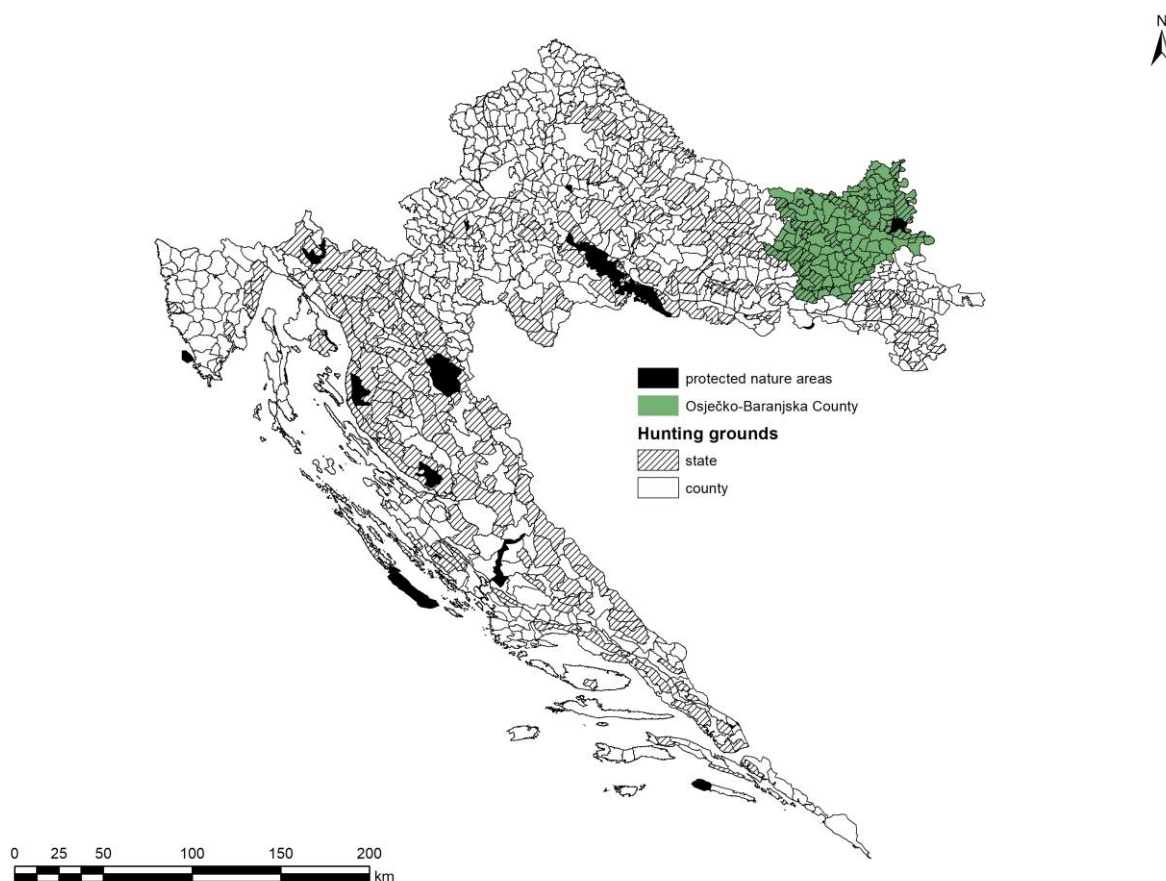


Figure 1. Hunting grounds in Osječko-baranjska County in Croatia.

2.2. Data Sources

Data on population of game species and planned hunting bag (according to growing rate) for 105 hunting grounds were taken from the Central Hunting Register [35]. Data on trophies were collected from the game trophy record (ETD) forms. In accordance with the rules on hunting trophies evaluation, the trophy measurement form, records of hunting trophies, the report on evaluated hunting trophies [39], and the rules on hunting trophies [40], hunting rights holders must submit the ETD forms to the Croatian Hunting Association and to the Central Hunting Register by 31 May for the previous hunting season. The trophies were assessed according to the CIC rules [41], and according to the aforementioned rules, users of hunting grounds were obliged to evaluate all wild ungulate game trophies for animals older than the yearling age class. Trophy data were collected for twelve hunting seasons—2007/2008–2018/2019, after which the obligation to send ETD forms to the Croatian Hunting Association was annulled, so the database is incomplete after that period.

For each hunting ground and hunting season, total number of trophies and total trophy value in CIC points were calculated. Relative hunting harvest of trophy animals per year (trophies/100 ha), relative trophy value (CIC points/100 ha), and relative trophy value per stag, buck, or boar (CIC points/trophy 100 ha) were calculated by dividing total

number of trophies and total trophy values by hunting area. Hunting areas comprise all arable land, meadows, pastures, and forests in one hunting area according to national vector habitat databases [42].

Hunting grounds are divided by status (state, county) and users (Croatian Forests—CF, hunting clubs—HC and private companies). For the purposes of the analysis, the primary data include data from the Croatian Hunting Association on the arrivals of foreign hunters and data on the growth of game taken from the Central Hunting Register [35]. Secondary data includes professional literature, legal regulations, international sources (FACE), and data from the official websites of the company Croatian Forests Ltd. and the Croatian Hunting Association [43–45].

2.3. Data Analysis

The abundance and the quality of biota (game, wildlife) are fundamental for hunting planning [46]. In this regard we aimed to establish the potential of game species (their quality), find out differences in quality of management (status of hunting ground and type of user), and detect trends of trophy values. In the period between the years 2007 and 2018, hunting rules and regulations in Croatia gradually became stricter toward control of hunting ground users. For this reason, we used the aforementioned time span to investigate the quality and trends of trophy game species. The research results allow us to predict the development of hunting tourism based on trophy game species and to make conclusions about its sustainability.

Normality of data distribution was tested with the Shapiro–Wilk test. Pearson’s and Kendall’s tau coefficients were utilized for the correlation computations, and the Kruskal–Wallis test was applied for testing differences in trophies/100 ha, relative trophy value (CIC points/100 ha), and relative trophy value per stag, buck, or boar (CIC points/trophy 100 ha) among users and status of hunting grounds. The data analyses were performed using the Statistica 14.0.0.15 package [47].

3. Results

3.1. Planned Hunting Bag and Trends of Hunting Trophies

Based on data for all 105 hunting grounds, the total planned hunting bag in big game is 10,611 animals. Of this, the largest share is made up of wild boar with 6164 animals, or 58.09% of the total increase (Figure 2). This is followed by roe deer with 1955 animals (18.42%) and red deer with 1912 animals (18.02%). A significantly smaller share is made up of fallow deer with 170 animals (1.60%) and mouflon with 40 animals (0.38%). In game breeding grounds, an increase of 153 red deer (1.44%), 159 wild boars (1.50%), 40 fallow deer (0.38%), and 18 mouflons (0.17%) is planned. Thus, fenced hunting grounds contribute a total of 3.49% to the increase, while 96.51% is accounted for by open hunting grounds. The largest planned hunting bag in wild boar is a consequence of the extremely high reproductive potential of this species (for neighboring Hungary it is 6.7 piglets per female) [48]. For this reason, wild boar is the most demanding species for population regulation, since overpopulation can cause significant damage to agriculture and forestry. Roe deer and red deer have an almost equal representation in the hunting bag, with approximately 18% each, and are the main big game species in the study area. Their management requires careful selective shooting in accordance with the sex–age structure, as well as ensuring quiet zones and quality habitats. Fallow deer and mouflon make up a smaller share of the total hunting bag, but are of considerable importance from the viewpoint of hunting tourism and trophy value. Although fenced hunting grounds contribute a smaller percentage to the total increase, they represent a specific management segment

because they enable controlled breeding and targeted production of trophy game, with greater investments in feeding and veterinary supervision.

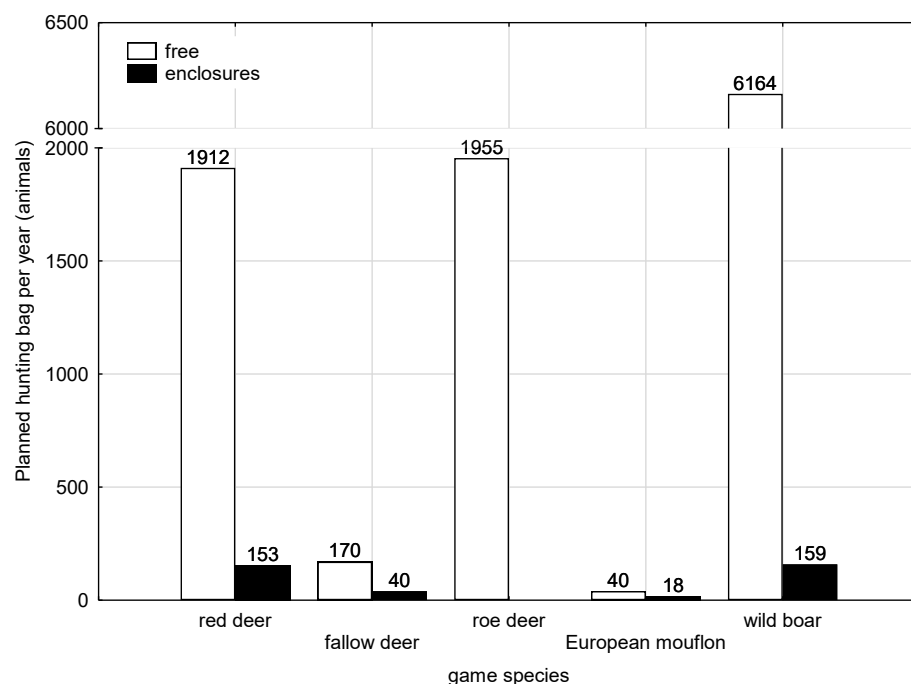


Figure 2. Structure of yearly planned hunting bag according to big game species in Osijek-Baranja County (source: <https://sle.mps.hr/>, accessed on 10 September 2025) [35].

Regarding hunting trophies, during the 12-year period in the hunting grounds of Osijek-Baranja County, five species of big game were hunted: red deer, fallow deer, roe deer, European mouflon, and wild boar. Fallow deer were hunted in 6 hunting grounds—4 state-owned and 2 counties. European mouflon was only hunted in 3 state hunting grounds. Generally, both the fallow deer and mouflon are mainly hunted in areas managed by private companies, where they are bred in enclosures, and if they reach the wild, they must be eradicated, as prescribed by hunting management plans. According to the current hunting legislation, management of big game in open hunting grounds (free-living) must be based on native game species. These include red deer, roe deer, and wild boar.

Considering the aforementioned native game species, no significant changes were recorded in the relative number of acquired trophies in state hunting grounds managed by hunting associations or private companies during the observed period (Table 1). In contrast, both the relative number of trophies and the relative trophy value of red deer increased significantly in hunting grounds managed by Croatian Forests Ltd. ($\tau = 0.243$ and $\tau = 0.270$, respectively), as well as in county hunting grounds managed by hunting associations ($\tau = 0.246$ and $\tau = 0.283$, respectively). Additionally, county hunting grounds also show an increase in relative trophy values per acquired red deer trophy ($\tau = 0.283$).

Table 1. Results of regression analysis for relative harvest of trophies, relative trophy value, and relative trophy value per animal according to users and status of hunting grounds in the period 2007–2018. Values in red indicate statistically significant correlation at $p < 0.01$.

Users	Status of Hunting Grounds	Red Deer			Roe Deer			Wild Boar		
		Relative Harvest of Trophies (Trophy/100 ha)	Relative Trophy Value (CIC Points/100 ha)	Relative Trophy Value per Stag (CIC Points/Stag 100 ha)	Relative Harvest of Trophies (Trophy/100 ha)	Relative Trophy Value (CIC Points/100 ha)	Relative Trophy Value per Buck (CIC Points/Buck 100 ha)	Relative Harvest of Trophies (Trophy/100 ha)	Relative Trophy Value (CIC Points/100 ha)	Relative Trophy Value per Boar (CIC Points/Boar 100 ha)
Croatian Forests	state	$\tau = 0.243$	$\tau = 0.270$	$\tau = 0.163$	$r = -0.292$	$r = -0.213$	$r = -0.107$	$\tau = -0.061$	$\tau = -0.053$	$\tau = -0.195$
Hunting clubs	state	$\tau = 0.108$	$\tau = 0.155$	$\tau = 0.202$	$r = -0.181$	$r = -0.096$	$\tau = 0.184$	$r = -0.037$	$r = 0.006$	$\tau = 0.201$
Hunting clubs	county	$\tau = 0.246$	$\tau = 0.283$	$\tau = 0.283$	$\tau = 0.12$	$\tau = 0.16$	$\tau = 0.043$	$\tau = 0.138$	$\tau = 0.142$	$\tau = 0.159$
Private firms	state	$\tau = 0.086$	$\tau = 0.083$	$\tau = 0.006$	$\tau = -0.023$	$\tau = 0.007$	$\tau = -0.011$	$\tau = 0.059$	$\tau = 0.064$	$\tau = 0.007$

An examination of Table 1 reveals that the most rapid changes in ungulate harvest trends occurred in county hunting grounds managed by hunting associations. In these areas, besides red deer, a statistically significant increase was recorded in the relative number of acquired roe deer and wild boar trophies ($\tau = 0.283$ and $\tau = 0.138$, respectively), in the relative trophy values of roe deer and wild boars ($\tau = 0.16$ and $\tau = 0.142$, respectively), and in the relative trophy values per individual wild boar ($\tau = 0.159$). A significant increase in the relative number of trophies and in relative trophy values, without a corresponding increase in relative trophy value per individual trophy, suggests that hunting rights holders (users) are harvesting an increasing number of younger individuals. If a significant increase was also observed in the relative trophy value per individual trophy (for red deer, roe deer, or wild boar), this indicates that the increase in harvest has also occurred within older age classes.

The results of the comparison of the values of the studied parameters show that in the hunting grounds managed by private companies, there is a significantly higher relative number of trophies of red deer acquired annually (0.383 trophy/100 ha, $\chi^2 = 94.89863$, $p < 0.0001$), as well as the highest relative trophy values for red deer (64.20 CIC points/100 ha, $\chi^2 = 92.3007$, $p < 0.0001$). However, this difference is not significant compared to the same values in the hunting grounds managed by Croatian Forests. Despite the relatively higher relative number of trophies acquired in the hunting grounds managed by Croatian Forests compared to those managed by hunting associations, the relative trophy value per harvested red deer is significantly the lowest in the hunting grounds managed by Croatian Forests (1.52 CIC points/stag 100 ha, $\chi^2 = 24.281$, $p < 0.0001$).

For the values of roe deer harvest obtained, these differences are even more pronounced, as the relative number of trophies (0.08 trophies/100 ha, $\chi^2 = 92.277$, $p < 0.0001$), relative trophy value (5.30 CIC points/100 ha, $\chi^2 = 94.633$, $p < 0.0001$), and relative trophy value per roe deer (0.71 CIC points/buck 100 ha, $\chi^2 = 148.177$, $p < 0.0001$) are significantly the lowest in the hunting grounds managed by Croatian Forests. Although the highest relative number of roe deer trophies (0.26 trophies/100 ha) is acquired annually in the hunting grounds managed by private companies, it is approximately equal to the relative number of trophies in state hunting grounds managed by hunting associations (0.28 trophies/100 ha), and significantly higher than the relative number of trophies acquired in county hunting grounds managed by hunting companies (0.191 CIC trophies/100 ha, $\chi^2 = 92.277$, $p < 0.0001$). The difference in the studied parameters is greatest in the relative trophy values per individual. The lowest relative trophy values per roe deer are found in the hunting grounds managed by Croatian Forests; relative trophy values are significantly higher in the hunting grounds managed by private companies (2.14 CIC points/buck 100 ha), and the highest in the hunting grounds managed by hunting associations, whether county (3.21 CIC points/buck 100 ha) or state hunting grounds (3.34 CIC points/buck 100 ha, $\chi^2 = 148.177$, $p < 0.0001$).

In relation to wild ruminants, wild boar shows the highest annual relative number of trophies, but it also shows differences depending on the type of hunting ground and hunting rights holder (Table 2). The significantly lowest annual relative number of trophies and relative trophy value are in county hunting grounds (0.043 trophies/100 ha and 4.48 CIC points/100 ha, respectively). However, the relative trophy value per boar is approximately the same in county hunting grounds and in hunting grounds managed by Croatian Forests (2.27 CIC points/boar 100 ha and 2.86 CIC points/boar 100 ha, respectively), but both values are significantly lower than in hunting grounds managed by private companies and state hunting grounds managed by associations (21.56 CIC points/boar 100 ha and 4.08 CIC points/boar 100 ha, respectively).

Table 2. Comparison of relative harvest of trophies, relative trophy value, and relative trophy value per animal among users and status of hunting grounds. Different letters in columns indicate significant differences.

Users	Status of Hunting Grounds	Red Deer			Roe Deer			Wild Boar		
		Relative Harvest of Trophies (Trophy/100 ha)	Relative Trophy Value (CIC Points/100 ha)	Relative Trophy Value per Stag (CIC Points/Stag 100 ha)	Relative Harvest of Trophies (Trophy/100 ha)	Relative Trophy Value (CIC Points/100 ha)	Relative Trophy Value per Buck (CIC Points/Buck 100 ha)	Relative Harvest of Trophies (Trophy/100 ha)	Relative Trophy Value (CIC Points/100 ha)	Relative Trophy Value per Wild Boar (CIC Points/Boar 100 ha)
Croatian Forests	state	0.165 ^{ac}	24.84 ^{ac}	1.52 ^a	0.08 ^a	5.30 ^a	0.71 ^a	0.513 ^a	52.99 ^a	2.86 ^a
Hunting clubs	state	0.057 ^{ab}	9.04 ^{ab}	5.56 ^b	0.28 ^{bc}	22.26 ^{bc}	3.34 ^c	0.139 ^a	13.84 ^a	4.08 ^b
Hunting clubs	county	0.060 ^b	10.43 ^b	4.42 ^b	0.191 ^b	15.69 ^b	3.21 ^c	0.043 ^b	4.48 ^b	2.27 ^a
Private companies	state	0.383 ^c	64.20 ^c	4.35 ^b	0.26 ^c	19.78 ^c	2.14 ^b	0.51 ^a	50.74 ^a	21.56 ^b

3.2. Structure of Visits by Foreign Hunters

The Croatian Hunting Association keeps records of issued hunting cards, which creates a transparent system of control and security. In this way, it is ensured that hunting is carried out in accordance with legal provisions, but also with the rules of hunting ethics, which is particularly important in the context of sustainable game management and preserving the reputation of Croatian hunting tourism. In the observed period, the largest number of foreign hunters came from Germany, with a total of 351 hunters. This makes German hunters the most significant group within Croatian hunting tourism, which is the result of the long-standing tradition of hunting tourism between the two countries, but also the purchasing power and interest of German hunters in trophy game in Croatia. Austria is in second place with 242 hunters, which confirms the geographical and cultural connection between Croatia and Austria. Italy follows with a total of 177 hunters, while 139 arrived from Hungary, and 126 from Slovenia. These countries, together with Germany and Austria, form the core of the Croatian hunting-tourism market, which is not surprising given their geographical proximity and developed hunting tradition. Among other countries, the arrivals of hunters from Great Britain (107), Bosnia and Herzegovina (101), Serbia (90), France (78), and Slovakia (69) are also significant [38].

In addition to the costs related to hunting itself and to obtaining the necessary hunting tourist permits in Croatia, there are also a number of other expenses that significantly contribute to the overall economic value of hunting tourism. On top of basic costs, foreign hunters often pay for the services of hunting guides, rental of vehicles or equipment, processing and preparation of trophies, and the costs of exporting trophies to the home country. In many cases, travel arrangements are extended to include other tourist offers in addition to the hunting packages.

In a paper by Kuprent et al. [49], the authors analyze the average hunter's expenditures in Europe, which range from EUR 2800 in France, GBP 2000 in the United Kingdom, and EUR 4340 in Germany to approximately EUR 640 in Poland. In Italy, recent years have seen a notable increase in the popularity of hunted wild game meat (HWGM) among consumers. This has led to a growing number of emerging markets for HWGM in Europe [50]. A total of 1750 foreign hunters came to Croatia in the five-year period (2018–2022). The largest share is held by Central European countries. Other countries had even smaller shares and together made up about 6% of the total number. The significant decline in the number of foreign hunters recorded in 2020 is related to the COVID-19 pandemic and movement restrictions.

Figure 3 shows the share and number of foreign hunters in Croatia by country of origin in the period from 2018 to 2022 [38]. This structure clearly shows that Croatian hunting tourism is largely based on the markets of neighboring and Central European countries, while the share of more distant countries remains smaller, but still indicates the potential for future market expansion and diversification.

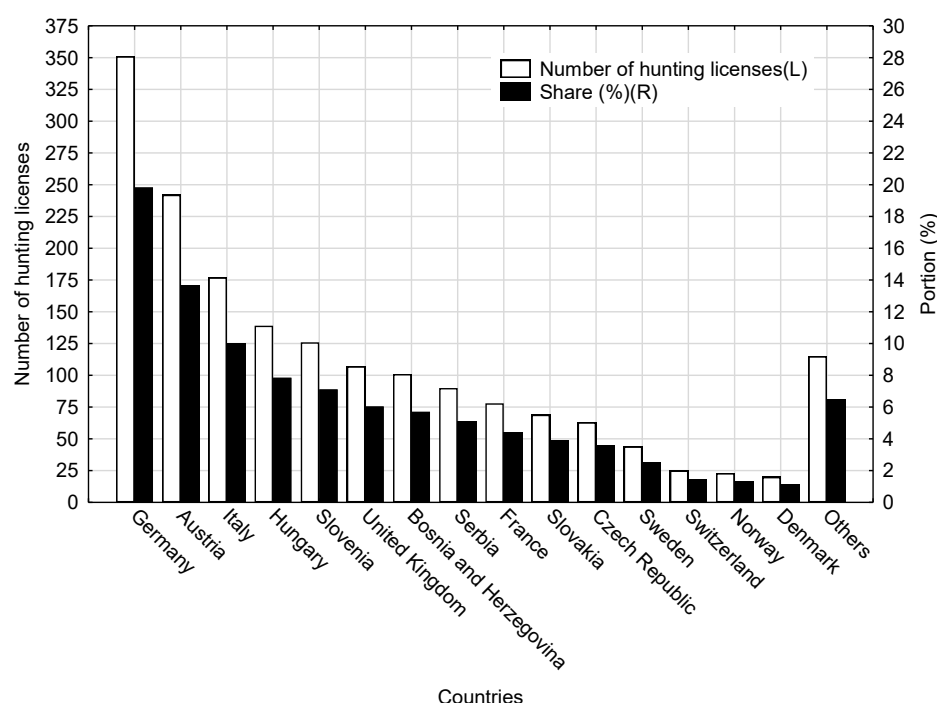


Figure 3. Number of hunting licenses and share in total amount of hunting license for foreign hunters in Osječko-Baranjska County (source: Hunting federation of Osječko-Baranjska County).

3.3. Comparison of Trophy Values by Year

According to the analysis of acquired trophies of big game in Osijek-Baranja County (Figure 4), the trophy structure is dominated by roe deer (555 acquired trophies per year), followed by red deer (277 acquired trophies per year) and wild boar (253 acquired trophies per year). European mouflon and fallow deer have a very small share in the trophy structure. They are shot in only a few state hunting grounds (enclosures).

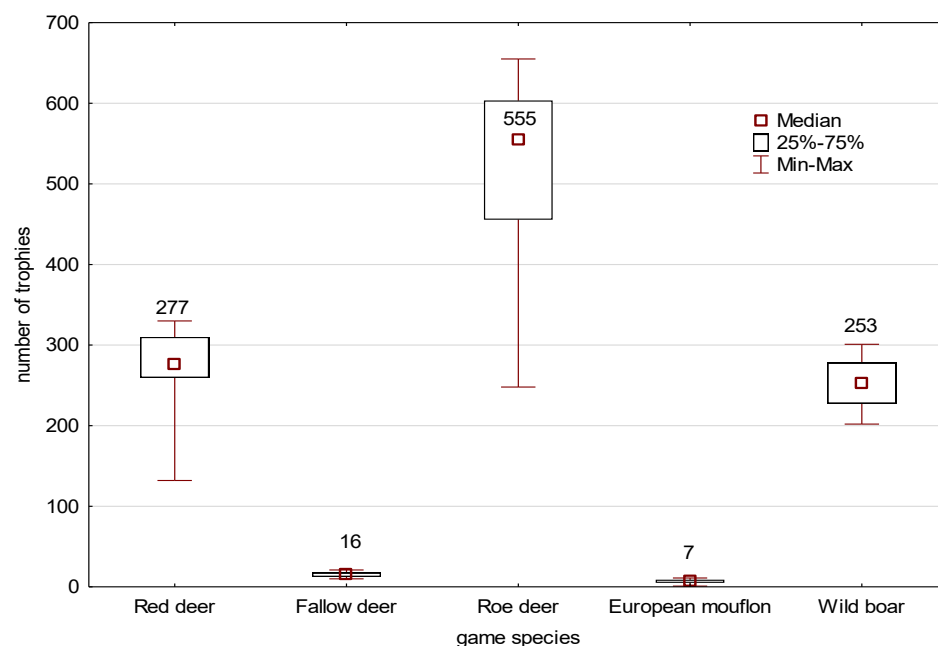


Figure 4. Medians of the number of trophies gained in Osječko-Baranjska County in the period 2007–2018.

Although the roe deer bucks share almost half of the trophy structure of all big game species, their average trophy value is relatively low (EUR 380 per trophy, Figure 5). The most expensive average trophy value is of red deer stags (EUR 2.346 per trophy), after which is the value of European mouflon trophy at EUR 913 per trophy, followed by fallow deer (EUR 796 per trophy) and wild boar (EUR 689 per trophy). When we compare average trophy values according to the trophy type, it can be concluded that wild boar trophies (tusks) are generally cheaper than antlers and horns of most wild ruminant species. An exception is roe deer antlers.

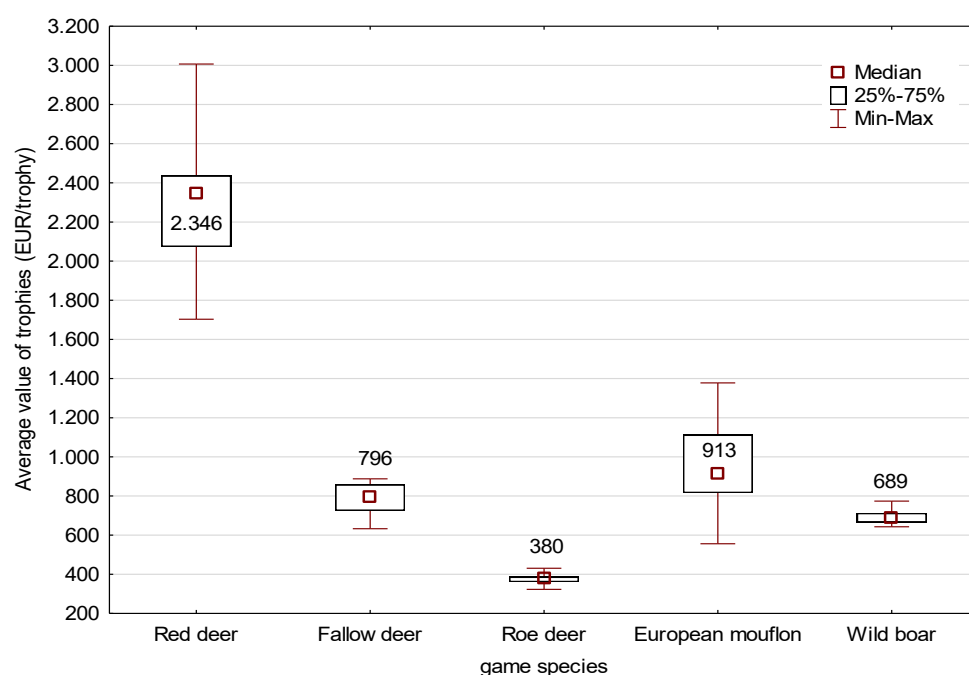


Figure 5. Medians of average value of trophies gained in Osječko-Baranjska County in the period 2007–2018.

During the study period (2007–2018), total values of trophies varied from EUR 629,552 (in year 2007) to EUR 1,156,033 (in year 2016). The general trend of total trophy values is stable, without increases or decreases ($\tau = 0.424$, $p = \text{n.s.}$). Thus, the average total value of trophies is EUR 1,001,021 per year (Table 3), with the largest share of the economic value carried by red deer, with a share of 62.6%. The second-largest share is roe deer (20.6%), followed by wild boar (17.6%). Fallow deer and European mouflon contribute minimally to the trophy structure (1.1% and 0.7%, respectively). This means that hunting management in the study area is based on native species, while non-native species are represented only in very low hunting supplies.

Table 3. Total trophy values in the period 2007–2018.

Year	Red Deer	Fallow Deer	Roe Deer	European Mouflon	Wild Boar	Total (EUR)
2007	316,379	10,459	148,602	1055	153,057	629,552
2008	586,424	15,100	219,552	7157	133,518	961,751
2009	578,077	7794	215,935	8193	182,005	992,004
2010	571,506	14,037	206,010	9091	167,828	968,472
2011	645,179	9078	186,813	3598	169,688	1,014,356
2012	608,978	10,546	229,374	4269	233,084	1,086,251
2013	562,083	10,322	239,405	3471	192,178	1,007,459
2014	656,343	12,174	253,855	3334	193,831	1,119,537
2015	663,585	9489	170,081	5021	146,406	994,582
2016	761,756	12,166	179,024	10,586	192,501	1,156,033
2017	670,737	17,975	205,792	7408	205,027	1,106,939
2018	666,959	16,243	95,357	15,160	159,959	953,678
Total (EUR)	7,288,006	145,383	2,349,800	78,343	2,129,082	11,990,614
Median (%)	627,079	11,356	205,901	6089	175,847	1,001,021
Share (%)	62.6	1.1	20.6	0.6	17.6	100.0

4. Discussion

Hunting grounds in the Republic of Croatia are classified into three status categories: state-owned, county, and private. Regardless of the category, hunting grounds can be given for a 10-year lease and exceptionally for a 30-year concession through a public bidding call. Hunting grounds are managed based on hunting management plans that are made for 10-year periods [51].

The status category of a hunting ground in the Republic of Croatia actually indicates habitat characteristics. State-owned hunting grounds are instituted by the Ministry, whose jurisdiction comprises hunting on state-owned land [51]. These are mainly state-owned forest areas. County hunting grounds are instituted by the counties and are predominantly agricultural land owned by a number of private landowners. Forests on these hunting grounds account for less than 50% of land. Regarding the quality of habitats, county hunting grounds represent higher site classes, but their capacity is limited by crop damage; therefore, the population density of big game is lower. In the structure of state hunting grounds, there are also some agricultural areas, but in a significantly lower proportion. The game breeding is focused on larger forest areas in which supplemental feed is provided. In addition, on hunting grounds managed by Croatian Forests Ltd. and some private companies, a part of the red deer and wild boar populations is bred in enclosures, with supplemented feed, and specimens of more prominent trophy characteristics are often introduced in order to improve the trophy structure of the population.

Therefore, the concepts of hunting management according to the type of users of hunting grounds differ significantly. In hunting grounds managed by hunting associations, the hunt is a sport and a recreational activity where the users are not interested in

selling the hunting service through trophy hunting. Hunting tourism is actually practiced only on hunting grounds managed by Croatian Forests Ltd. (as a state-owned company that practices game breeding as a secondary business activity) and by private companies. Regarding the hunting ground status and type of users of hunting grounds, priorities in big-game management also change. In state-owned hunting grounds, more care is given to the breeding of red deer and wild boar, while breeding of roe deer is very extensive.

Differences in hunting management objectives and habitat variations, considering the status of hunting grounds, are the cause of varying trends in the annual relative number of acquired trophies and relative trophy values. In common hunting grounds (CL), the reason for the significant increase in the researched parameters is the growing rise in damages to agricultural crops, particularly caused by red deer and wild boar. Since agricultural areas (mainly arable land) in common hunting grounds have an almost dominant share in the surface structure, it is not surprising that significant increases in the researched characteristics were recorded in hunting grounds of that status.

Since the beginning of the 2020s, population trends of wild ruminants in the researched area have been significantly altered. Firstly, there has been a rapid decline in the abundance of roe deer (*Capreolus capreolus*), so much so that this game species is not harvested at all in most of the researched hunting grounds [35]. Due to the emergence of African swine fever (ASF) from the end of 2018 until present, the Ministry in charge has issued a series of directives stipulating a reduction in the wild boar population status to only 10% of the habitat capacity [20,52,53].

Given the recent situation regarding the abundance of certain big game species in the researched area, long-term sustainable hunting management can only be based exclusively on red deer (*Cervus elaphus*) or fallow deer (*Dama dama*) and European mouflon (*Ovis aries musimon*) in fenced hunting grounds.

The quality of trophies in wildlife populations does not depend solely on random harvesting but is strongly linked to habitat management factors, resource availability, and a selective management approach, which can explain differences between private and other types of hunting grounds. Habitat quality—including food availability, vegetation structure, water sources, and shelter—affects physical development and the growth of antlers or tusks in large game species [54,55].

Assuming favorable genetic predispositions, trophy quality primarily depends on habitat conditions [56]. However, within the limits of habitat carrying capacity, each of the studied species has its own optimal habitat. Thus, red deer achieve the highest trophy values in lowland areas [37], roe deer in hilly terrains [57,58], and wild boar in the mountainous regions of Croatia [59]. Since agricultural land under private ownership predominates in the joint hunting grounds, the hunting concessionaire has limited opportunities to invest in habitat improvement, as these areas are generally not owned by the concessionaire. This is only feasible for Croatian Forests Ltd., as they manage hunting grounds in which state-owned land predominates in the ownership structure. Consequently, game management measures are mostly focused on supplemental feeding [60] and selective harvest.

Management systems that allow for the selection of older individuals and maintain optimal population density can contribute to a higher average trophy quality. Professional approaches that include selection of trophy-valued individuals when setting quotas or regulating harvest levels can increase the average quality of the take without compromising population stability [61]. In private hunting grounds and forest estates, there is often more intensive habitat monitoring (e.g., grazing control, prevention of poaching, maintenance of feeding areas), which reduces anthropogenic stressors and increases resource availability for wildlife. Research indicates that habitat heterogeneity and quality play a key role in shaping growth patterns and trophy characteristics of species [62]. Studies

further show that the selective harvesting of trophy-valued individuals can have long-term effects on the phenotypic characteristics of a population, meaning that trophy quality may change depending on the structured approach to population management. This highlights the importance of balanced, scientifically based management to ensure the long-term sustainability of population quality [63].

In the international context, Croatia stands out for its rich population of big game species, primarily red deer, roe deer, and wild boar, whose trophy values are recognized at the world level. It is the quality of the trophies, along with the authenticity of natural habitats and the professional organization of hunts, that makes Croatia an attractive destination for hunters from numerous European countries. Foreign citizens who wish to hunt in the Republic of Croatia must obtain a hunting license. Issuing of a license is regulated by the Hunting Act [20] and the procedure is carried out by the Croatian Hunting Association or authorized legal entities based on the authorization of the Ministry of Agriculture, Forestry and Fisheries. Hunting tourism connects different sectors—from forestry and hospitality to transportation and craft services—thereby achieving multiplicative effects in the local community. The data used in this research covers the period from 2018 to 2022 and was obtained from the Croatian Hunting Association in Osijek. It provides an overview of the most important countries from which foreign hunters come to Croatia and enables the analysis of trends and a comparison of their share in the overall structure.

5. Conclusions

In the Republic of Croatia, game considered a public good of state interest and enjoys its special protection. Game is managed according to ten-year hunting plans. The number of game is determined according to the quality of the habitat and the capacity of the habitat. Counting and monitoring of game is mandatory every year at the beginning of the year and before the start of the hunting season. A hunting quota is determined according to the number of game and the achieved increase. If the number of game is reduced, hunting may be reduced or even prohibited. Based on the analyzed data, it can be concluded that Osijek-Baranja County has exceptionally rich hunting and economic potential, especially when it comes to red deer, roe deer, and wild boar. Planned management and clearly prescribed quotas contribute to the stability of populations, but also enable hunting grounds to remain attractive to domestic and foreign hunters in the long term. Foreign hunters in the period from 2018 to 2022 mostly came from Germany and Austria, which confirms the long-standing connection of these markets with Croatia. The largest number of visits by foreign hunters in the period from 2018 to 2022 was from Germany, with a total of 351 hunters. Austria came in second place with 242 hunters, followed by Italy with a total of 177 hunters. This also represents the greatest opportunity for the further development of hunting [38].

The data show that the efficiency of hunting ground management differs statistically between users, with Croatian Forests Ltd. and private companies standing out, depending on the type of game. For red deer, the highest relative trophy catch and trophy value were achieved in private hunting grounds, which indicates more intensive and efficient management. Croatian Forests Ltd. also achieves high values of trophy quality, while hunting clubs achieve lower results. For roe deer, the highest relative trophy catch and trophy value are achieved by private companies and hunting clubs in state hunting grounds, while Croatian Forests Ltd. records the lowest values. For wild boar, private companies again show the highest relative trophy value, while Croatian Forests Ltd. and state hunting grounds of hunting clubs are similar in results. County hunting grounds of hunting clubs show the lowest values. Overall, private users achieve the highest trophy values and the highest relative catch for most species, which suggests more efficient and intensive

management. Analysis of trophy data for the period 2007–2018 confirms that red deer represents the most valuable hunting-tourism species with the highest total number of trophies (3239) and the highest economic value (EUR 7.29 million), while roe deer and wild boar contribute to the diversification and stability of hunting tourism, with a total income of over EUR 11.99 million in the observed period.

This data is crucial because it enables the making of informed decisions on sustainable game management, helps preserve biodiversity and natural habitats in Osijek-Baranja County, and supports the development of strategies that balance the economic potential of hunting tourism with long-term environmental protection. Based on the data, operational proposals can be formulated:

- Encouraging efficient economic practices through support for private and public users with high trophy results.
- Balancing ecological and economic objectives, ensuring the long-term sustainability of game populations.
- Integrating hunting tourism with other forms of tourism (gastronomy, enology, nature tourism) to increase the economic contribution to local communities.
- Monitoring and evaluation of the trophy fund as a tool for adapting management strategies in accordance with international sustainable management guidelines (FAO, ELC, CBD).

Red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), and wild boar (*Sus scrofa*) are among the most important species of large game in the Republic of Croatia, from ecological as well as economic and social perspectives. As dominant herbivores and omnivores, these species play a significant role in shaping the structure of forest and agricultural ecosystems by influencing vegetation dynamics, forest regeneration, and trophic relationships within ecosystems [64,65]. Populations of red deer, roe deer, and wild boar in Croatia have shown stable or increasing trends over recent decades as a result of a combination of favorable habitat conditions, the absence of natural predators across much of their range, species adaptability, and active game management practices [66]. Data from the Croatian Bureau of Statistics and the Central Hunting Records indicate high population numbers and significant annual harvest levels for these species, particularly wild boar, whose population is continuously increasing in most European countries, including Croatia [67,68]. The management of large game populations in the Republic of Croatia is regulated by the Hunting Act and its implementing regulations, as well as by game management plans, with the aim of maintaining populations in a favorable conservation status while simultaneously reducing damage to forestry and agriculture and conserving biological diversity [69]. The conservation and protection of these species are based on the concept of sustainable use, which includes planned harvesting, population monitoring, health surveillance, and habitat protection. A particular challenge in the management of wild boar populations is the emergence and spread of African swine fever (ASF), which has significant ecological, economic, and veterinary public health consequences. In this context, population control and intensified monitoring have become key elements of management strategies for this species [70,71].

Given the increasing pressure on habitats, climate change, and intensified wildlife–human interactions, continuous scientific research into population abundance, spatial distribution, and the effectiveness of protection and conservation measures for red deer, roe deer, and wild boar in Croatia is essential to ensure the long-term sustainable management of these species.

On the global market, especially among hunters from the USA and Asian countries, it is necessary to emphasize the attractiveness of hunting packages that can be linked to cultural and natural tourism, which allows Croatia to offer a comprehensive experience that combines hunting with gastronomy, enology tourism, and visits to protected natural

areas. Promotion should rely on modern digital tools, including specialized platforms for hunting tourism, social networks, international fairs, and cooperation with travel agencies specializing in hunting tourism.

The research pointed to the great potential of Croatian hunting. Although natural resources and the quality of game are at a high level, a more modern approach to promotion, better organization of distribution, and stronger connections with tourism are missing. By connecting the tradition of hunting management with an innovative approach, Croatia could strengthen its position as one of the most desirable hunting destinations in Europe. Innovation is essential for achieving the 2030 Agenda for Sustainable Development and the Sustainable Development Goals. The management of wild ungulates in Europe has received a lot of attention recently, due to the large numbers and rapid increases in many of the 20 species that live in European countries. The management alternatives should consider the landscape approach through the European Landscape Convention (ELC) or ecosystem management through the Convention of Biodiversity (CBD) as solutions [16]. Sustainable wildlife management requires appropriate policies, social acceptability, and good governance [72]. The analysis of big-game trophies in Osijek-Baranja County has determined their economic value and quality, which confirms the important role of sustainable hunting management in the Republic of Croatia. In conclusion, the trophy fund of Osijek-Baranja County represents a stable and long-term valuable resource that, through sustainable management and strategic development of tourism, can simultaneously strengthen the economic, ecological, and social sustainability of the region. In the long-term perspective, it can be based on native big game species—red deer, roe deer, and wild boar.

Sustainable population management, high-quality promotion, and the combination of traditional and innovative approaches are key to further strengthening Croatia's position in the European and global hunting-tourism market.

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Abbreviations

The following abbreviations are used in this manuscript:

FACE	Federation of Associations for Hunting and Conservation of the EU
CIC	International Council for Game and Wildlife Conservation
FAO	Food and Agriculture Organization of the United Nations
ELC	European Landscape Convention
CBD	Convention of Biodiversity

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