Scientific Papers. Series D. Animal Science. Vol. LXVIII, No. 2, 2025
ISSN 2285-5750; ISSN CD-ROM 2285-5769; ISSN Online 2393-2260; ISSN-L 2285-5750

DAMAGES CAUSED BY WILD BOARS: A BIBLIOMETRIC REVIEW

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Abstract

Wild boars cause significant damage to agricultural fields and grasslands, leading to millions of Euros in losses each year. Because no existing review or bibliometric study on this topic was found, we conducted this analysis using the Web of Science Core Collection tools, along with VOSviewer, Excel, and Geochart. A total of 197 articles were examined, covering 40 scientific fields, with the most represented being Environmental Sciences-Ecology, Zoology, Agriculture, Veterinary Sciences, and Biodiversity Conservation. The number of publications has grown exponentially since 1978. Authors from 50 countries contributed, primarily from the USA, Japan, and Poland, with affiliations mainly at the United States Department of Agriculture, Consejo Superior de Investigaciones Científicas, and Colorado State University. Among the 124 journals, the most frequent articles on this topic are European Journal of Wildlife Research, Animals, and Plos one. Common key words include "wild boar", "crop damage", "diet", "patterns", and "management". This analysis is essential for highlighting developments and trends in the field, creating a valuable database for current and future researchers, as this topic will continue to be highly relevant.

Key words*: articles, bibliometric review, key words, VOSviewer, wild boar.*

INTRODUCTION

The wild boar (*Sus scrofa*), native to Eurasia and North Africa, consists of 16 subspecies and is commonly found in deciduous and mixed forests, with oak and beech woodlands being particularly suitable habitats.

One of the most pressing issues regarding wild boars is the extensive damage they cause to agricultural fields and grasslands, resulting in millions of Euros in losses annually (Amici et al., 2012). Research has indicated several environmental factors influencing crop damage by wild boars, including the "edge effect" near forests (Thurfjell et al., 2009). Other studies highlight that crops are more vulnerable to boar damage based on factors like their stage of growth and the size of the cultivated area (Schley et al., 2008) or the nocturnal habits of the species (Keuling et al., 2009). The destruction of crops can be particularly severe, leading to substantial financial losses across various European nations, such as Croatia (Novosel et al., 2012), Poland (Frackowiak et al., 2013; Bobek et al., 2017), Luxembourg (Schley and Roper, 2003), Italy (Cappa et al., 2021), Turkey (Ucarli, 2011), and Korea (Lee et al., 2018).

Factors influencing crop damage by wild boars primarily relate to human activities and field characteristics (Cappa et al., 2021). Affected areas typically feature more permanent crops, fewer woodlands, maquis, and urban regions, and are situated closer to shelters like forests and shrublands (Lombardini et al., 2017; Pleşca et al., 2022). Damage levels were positively associated with the farmland-forest boundary and the presence of deciduous forests (Frackowiak et al., 2013; Dincă et al., 2018). Additionally, crop damage is influenced by the composition of the crops themselves (Tudor et al., 2020; Piekarczyk et al., 2021).

Publishing scientific studies is one of the most effective ways to share knowledge gained through research. The visibility of these publications benefits researchers, their affiliated institutions, and the organisations funding the research (Santillán-Fernández et

al., 2023). The rise in scientific production over recent decades, along with indexing in automated bibliographic databases, has amplified the use of bibliometrics, likely because bibliometric analysis generates indicators that measure outcomes of scientific and technological efforts (Allen et al., 2019; Pilelienė et al., 2022; Alsharif et al., 2021).

Bibliometric studies on published articles make it possible to generate indicators and mathematical models to analyse the development and trends in publication frequency and quality (Malesios & Arabatzis, 2012; Alsharif et al., 2022).

Numerous articles have been published regarding wildboar (Posan et al., 2021; Cocor et al., 2022; Tanchev and Balieva, 2023), as well as the environment one (Tarkowski, 2007; Xie et al., 2008; Sun et al., 2012; Huang et al., 2023; Timiș-Gânsac et al., 2025).

This study aims to conduct a comprehensive bibliometric analysis of the scientific literature concerning the wild boar (*Sus scrofa*). The primary research question guiding this review is: *What are the major trends, thematic focuses, and geographical patterns in wild boar research over the past decades?* In addressing this question, we seek to uncover emerging topics, identify underexplored or neglected areas, and assess the evolution of research interests in the field. This includes examining publication output, key contributing countries and institutions, co-authorship networks, and thematic clusters derived from keyword and citation analyses.

A bibliometric review of wild boar-related literature is timely and important due to the increasing ecological, agricultural, and socio-political relevance of this species. Wild boar populations have expanded significantly in many parts of the world, leading to challenges such as crop damage, disease transmission, and human-wildlife conflicts. As such, synthesizing existing scientific knowledge can inform future research directions, support the development of evidence-based management and conservation policies, and highlight geographic or thematic areas that may be underrepresented in the current literature. Additionally, by identifying the most influential publications and collaboration patterns, this review offers valuable insights for researchers and policymakers alike to better coordinate efforts in addressing wild boar-related issues.

MATERIALS AND METHODS

A bibliometric analysis was conducted to assess the global research output related to wild boar damages from 1978 to 2023. The evaluation used the Science Citation Index Expanded (SCI-Expanded) within the Web of Science database, identifying 208 relevant publications. The database was searched using the phrase "wild boar damages" to gather research articles from 1996 onward. The analysis centred on ten key aspects: (1) publication types, (2) scientific disciplines, (3) publication timelines, (4) contributing authors, (5) countries of origin, (6) affiliated institutions, (7) language of publication, (8) journals, (9) publishers, and (10) key terms.

Data processing involved the use of Web of Science Core Collection tools, Excel, Geochart and VOSviewer version 1.6.20, which enabled the creation of visualisation maps and cluster analyses. Only peer-reviewed articles and reviews were included in this study.

RESULTS AND DISCUSSIONS

Publications related to this topic are rather numerous: 208 publications until and including the year 2023. Their distribution is as follows: 185 articles (89% of total publications), 12 review articles (6%), 9 proceeding papers (4%), and 2 book chapters (1%) (Figure 1).

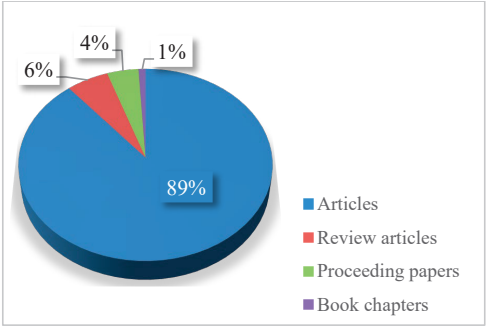

Figure 1. Distribution of the main types of publications used in the bibliometric analysis (source: original)

The review articles refer to wild boar as a useful species (Rekiel et al., 2024), to the

stabilisation of his population (Kamler & Drimaj, 2021), as well as to its impact on the ecosystem (Barrios-Garcia & Ballari, 2012), or on agricultural crops (Schley & Roper, 2003).
We have inventoried 40 scientific fields in which we can frame the articles published on this topic. Among these, the most representative are: Environmental Sciences Ecology (79 articles), Zoology (61 articles), Agriculture (31 articles), Veterinary Sciences (30 articles), Biodiversity Conservation (26 articles) and Forestry (13 articles) (Figure 2).

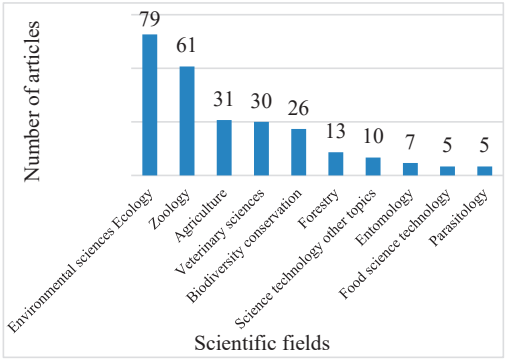

Figure 2. Distribution of the main 10 scientific fields of publications used in the bibliometric analysis (source: original)

The first article on this subject was published in 1978 in a renowned scientific magazine. Starting with 2012, the number of articles has increased significantly, reaching a maximum of 19 articles in 2023 (with even more articles been published until now in 2024-2025) (Figure 3).

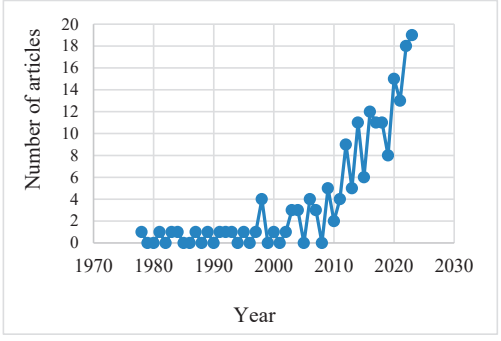

Figure 3. Distribution of articles published per year (source: original)

Over 200 authors have been identified as publishing at least one article on this topic. Two authors are by far in the top of this classification: Kurt VerCauteren (11 articles) and Natan Snow (8 articles), followed by two authors with 4 published articles each: Takeshi Honda and Joaquín Vicente.
A total of 50 countries from 5 continents have been inventoried as belonging to authors who published articles on this subject (figure 4). The most represented countries are the USA (36 articles), Japan and Poland (with 20 articles each), Spain (18 articles), Germany (17 articles), Italy and China (with 15 articles each).

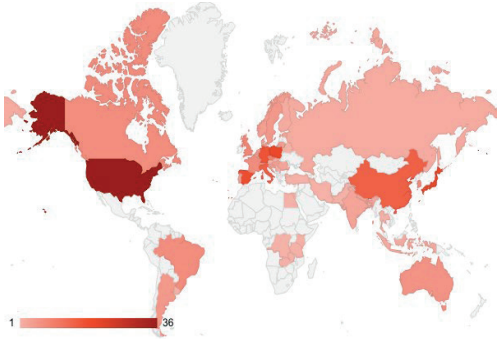

Figure 4. Geography of the use of the damages caused by wild boars in published articles (source: original, using Google chart, 2024)

The countries from where we have authors who published articles on this topic can be grouped in 4 clusters: the first cluster is comprised of Germany, Belgium, Switzerland and Sweden; the second: Spain, Norway, Croatia, Portugsl and Hungary; the third: USA, China and Argentina; the fourth: France, South Korea, Nepla and India (Figure 5).
Over 200 institutions that belong to the authors who have published such studies were inventoried. The most representative ones are: United State Department of Agriculture (17 articles), Consejo Superior deInvestigaciones Cientificas (10 articles), Colorado State University and Instituto de Investigacion en Recursos Cinegeticos (with 7 articles each) and Universidad de Castilla La Mancha and University of Veterinary Medicine Hannover (with 6 articles each).
The majority of articles are written in English (188 articles), followed by other 6 languages: German (6 articles), Polish (4 articles), Czech (2 articles), French, Portuguese and Slovak (each with one article).

The articles published on this topic can be found in 124 magazines. Grouping these publications on the number of articles is led by the European journal of wildlife research (11 articles), Animals and Plos one (each with 7 articles). However, based on the total link strength, the grouping is led by Biological invasions, Journal of wildlife management and European journal of wildlife research (Table 1).

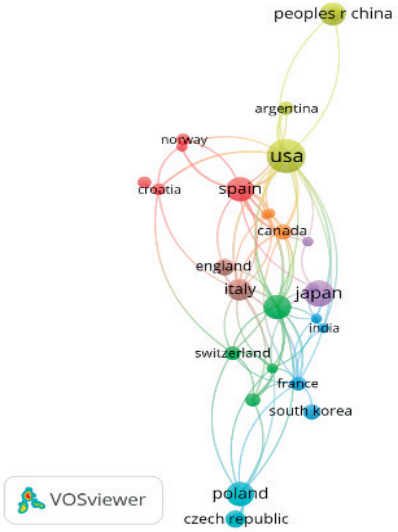

Figure 5. Countries with authors of articles on the damages caused by wild boars (source: original, using VOS Viewer, 2024)

Table 1. The most representative journals where articles about the damages caused by wild boars have been published

Crt. No.	Journal	Documents	Citations	Total link strength
1	Biological invasions	5	559	45
2	Journal of wildlife management	5	201	36
3	European journal of wildlife research	11	311	34
4	Crop protection	5	96	30
5	Mammal review	2	436	30
6	Acta theriologica	2	152	17
7	Pest management science	4	95	17
8	Science of the Total Environment	6	196	15
9	Animals	7	26	14
10	Sylwan	2	13	14
11	Agriculture	4	13	13
12	International journal of paste management	2	41	13
13	Mammal study	5	104	13
14	Plos one	7	183	12
15	Wildlife research	4	47	10

The publications can be grouped in 3 clusters (with a participation of minimum 5 articles per cluster): Cluster 1: International journal of wildlife research + International journal of paste management + Journal of wildlife management + Mammalian biology + Pest management science + Wildlife biology; Cluster 2: Biological invasions + Ecological indicators + Plos one + Transboundary and emerging diseases + Wildlife research; Cluster 3: Acta theriologica + Agriculture + Animals + Crop protection + Environmental conservation, (Figure 6).

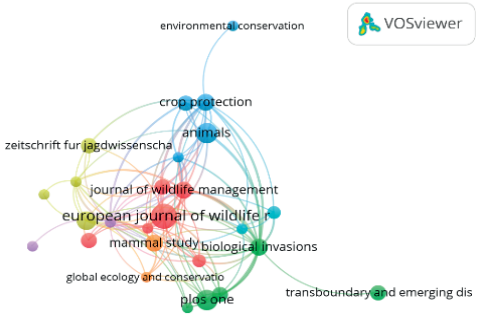

Figure 6. Main journals where articles on the damages caused by wild boars have been published (source: original, using VOS Viewer, 2024)

The most representative publishers are Springer Nature (36 articles), Elsevier (30 articles), Wiley (26 articles) and MDPI (17 articles).
The most used keywords are wild boar, *sus scrofa*, crop damage, diet, patterns and management (Table 2).

Table 2. The most commonly used keywords in articles about the damages caused by wild boars

Crt. No.	Keyword	Occurrences	Total link strength
1	*Sus scrofa*	53	223
2	wild boar	67	202
3	crop damage	41	178
4	diet	31	165
5	patterns	30	157
6	management	30	146
7	impact	24	121
8	damage	28	112
9	selection	17	89
10	human-wildlife conflict	17	80
11	population	18	78
12	wildlife management	13	70
13	predation	14	62
14	density	11	61
15	feral pigs	13	60
16	range	11	60
17	space use	10	59
18	conservation	18	57
19	forest	14	56

The key words can be grouped in 4 clusters, with two of them having 11 words each. The first cluster: consumption, diet, feral swine, habitat, impacts, infection, invasive species, pigs, selection, *sus scrofa* and sus-scrofa; the second one: boar-sus scrofa, crop damage, feral pigs, habitat use, national-park, patterns, population, range, red deer, roe deer and wild boar (Figure 7).

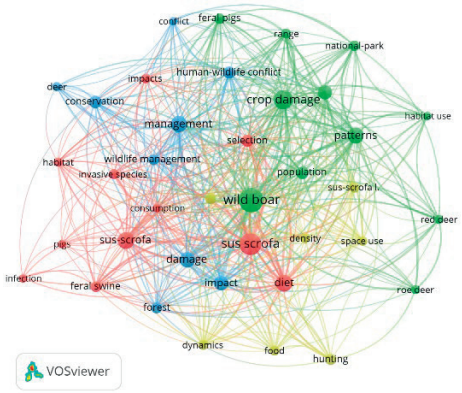

Figure 7. Authors' keywords regarding the damages caused by wild boars (source: original, using VOS Viewer, 2024)

During 2016-2017, authors used keywords such as population, food, hunting, red deer and roe deer; while during 2018-2019 they keywords were invasive species, habitat, wild boar, *sus scrofa*; and in 2020-2021 the main keywords were conservation, impact, space use (Figure 8).

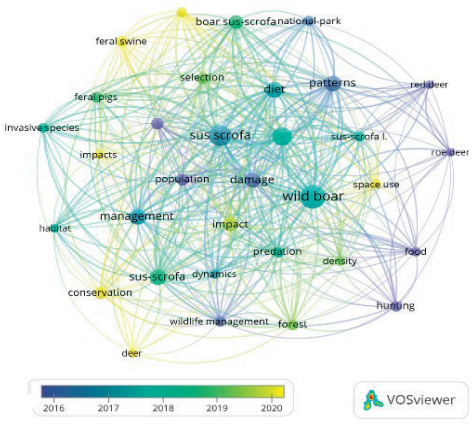

Figure 8. Distribution of keywords concerning the damages caused by wild boars (source: original, using VOS Viewer, 2024)

The bibliometric analysis reveals a substantial and growing body of research on wild boar-related issues. However, a deeper interpretation of the findings suggests several notable patterns and underlying implications as follows.

The dominance of publications from Europe, the USA, and Japan points to a regional concentration of research efforts, which may be reflective of stronger funding systems, better research infrastructure, or more acute management challenges in these areas. Conversely, the relative absence of research from biodiversity-rich but underfunded regions suggests a geographic bias. This underrepresentation may result in knowledge gaps about wild boar behaviour, damage, and management needs in ecologically and socioeconomically diverse contexts.

The most frequent keywords - such as "wild boar", "crop damage", "diet", and "management" - indicate a focus primarily on ecological and agricultural impacts. While these are indeed critical areas, other relevant dimensions, such as the socio-political implications of wild boar proliferation, indigenous knowledge systems, and community-based conflict mitigation, are largely absent. This thematic skewness could lead to a narrow understanding of the broader implications of wild boar interactions with human systems.

A small number of institutions (e.g., USDA, Consejo Superior de Investigaciones Científicas) and authors (e.g., Kurt VerCauteren, Natan Snow) disproportionately contribute to the literature. While this signals expertise consolidation, it also raises concerns about potential research silos and limited diversity in research perspectives. Encouraging broader collaboration across institutions and disciplines could enhance the innovation and applicability of research outcomes.

The heavy focus on biological and ecological dimensions, with relatively fewer studies assessing policy efficacy or management interventions, implies a gap between research production and practical implementation. This lack of applied focus may limit the usability of findings by policymakers, land managers, and local communities, especially in developing contexts where the burden of wild boar damages may be increasing.

These observations underscore the need for a more balanced, inclusive, and application-oriented research agenda that aligns with global biodiversity conservation goals and sustainable agricultural development.

The findings of this bibliometric review reveal several underexplored areas and potential directions for future investigations in the field of wild boar research. Although studies have been conducted in over 50 countries, there is a notable concentration of publications from Europe, the USA, and Japan. There is limited representation from regions such as Africa, Southeast Asia, and South America, despite evidence of wild boar presence and impact in these areas. Future research should address these geographic imbalances by promoting studies in underrepresented countries and ecosystems.

While crop damage and economic losses are frequently studied, fewer publications offer in-depth analyses of prevention or mitigation strategies (e.g., fencing, deterrents, community-based approaches). Further studies evaluating the effectiveness, cost-efficiency, and social acceptability of such methods would be valuable.

Most existing research is framed within ecology, agriculture, and veterinary sciences. There is a need for more interdisciplinary studies incorporating socio-economic, behavioural, and policy perspectives to develop integrated management strategies.

Emerging technologies such as drone surveillance, GPS tracking, and machine learning offer new opportunities for monitoring wild boar behaviour and damage patterns. Research exploring these tools could enhance management precision and reduce human-wildlife conflict.

By addressing these research gaps, future work can contribute to a more comprehensive and globally relevant understanding of wild boar ecology and management.

CONCLUSIONS

The bibliometric analysis realised on 197 articles published in renowned publications regarding the damages caused by wild boars has demonstrated that the number of these articles increases from year to year. Up until now, articles were published in 124 journals (the most being published in *European Journal of Wildlife Research*, *Animals*, and *Plos one),* by authors from 50 countries (with the most representative being USA, Japan, and Poland), affiliated to more institutions (mainly at the United States Department of Agriculture, Consejo Superior de Investigaciones Científicas, and Colorado State University), covering almost all scientific domains (the most representative ones being Environmental Sciences-Ecology, Zoology, Agriculture, Veterinary Sciences, and Biodiversity Conservation. The most used keywords were wild boar, crop damage, diet, patterns and management.

ACKNOWLEDGEMENTS

This research work was carried out with the support of Ministry of Research, Innovation and Digitization (MCID) from Project PN 23090304.

REFERENCES

Allen, L., Jones, C., Dolby, K., Lynn, D., & Walport, M. (2019). Looking for landmarks: The role of expert review and bibliometric analysis in evaluating scientific publication outputs. *PLoS ONE*, *4*, e5910.

Alsharif, A.H., Md Salleh, N.Z., Baharun, R. & Rami Hashem, E.A. (2021). Neuromarketing research in the last five years: A bibliometric analysis. *Cogent Bus. Manag.*, *8*, 1978620.

Alsharif, A., Salleh, N.Z.M., Pilelienė, L., Abbas, A.F. & Ali, J. (2022). Current Trends in the Application of EEG in Neuromarketing: A Bibliometric Analysis. *Sci. Ann. Econ. Bus.*, 69, 393–415.

Amici, A., Serrani, F., Rossi, C. M., & Primi, R. (2012). Increase in crop damage caused by wild boar (*Sus scrofa* L.): the "refuge effect". *Agronomy for sustainable development*, *32*, 683-692.

Barrios-Garcia, M. N., & Ballari, S. A. (2012). Impact of wild boar (*Sus scrofa*) in its introduced and native range: a review. *Biological invasions*, *14*, 2283-2300.

Bobek, B., Furtek, J., Bobek, J., Merta, D., & Wojciuch-Ploskonka, M. (2017). Spatio-temporal characteristics of crop damage caused by wild boar in north-eastern Poland. *Crop Protection*, *93*, 106-112.

Cappa, F., Bani, L., & Meriggi, A. (2021). Factors affecting the crop damage by wild boar (Sus scrofa) and effects of population control in the Ticino and Lake Maggiore Park (North-western Italy). *Mammalian Biology*, *101*(4), 451-463.

Cocor, T., Maftei, M., Dronca, D., Ahmadi, M., & Mărginean, G. E. (2022). Study regarding the evolution of wild boar in Romania-Dobrogea area,

between 2018-2021. *Scientific Papers. Series D. Animal Science*, *65*(1), 567-572.

Dincă, L., Enescu, C.M. & Timiș-Gânsac, V. (2018). Game species from Tulcea county and their management. *Scientific papers series Management, Economic Engineering in Agriculture and Rural Development*, 18, 3, 101-106.

Frackowiak, W., Gorczyca, S., Merta, D., & Wojciuch-Ploskonka, M. (2013). Factors affecting the level of damage by wild boar in farmland in north-eastern Poland. *Pest management science*, *69*(3), 362-366.

Google chart. Region Geo-Charts. Accessed on 38.10.2024. https://developers.google.com/chart/interactive/docs/gallery/geochart#region-geocharts,

Huang, W., Liu, S., Zhang, T., Wu, H., & Pu, S. (2023). Bibliometric analysis and systematic review of electrochemical methods for environmental remediation. *Journal of Environmental Sciences*.

Kamler, J., & Drimaj, J. (2021). Stabilization of wild boar populations: reproduction potential of current boars vs. hunting potential of current hunters-review. *Zprávy Lesnického Výzkumu*, *66,* 2, 95-103.

Keuling, O., Stier, N. & Roth, M. (2009) Commuting, shifting or remaining? Different spatial utilisation patterns of wild boar *Sus scrofa* L. in forest and field crops during summer. *Mamm Biol*, 74:145–152.

Lee, S. M., Lee, E. J., Park, H. B., & Seo, C. W. (2018). Factors affecting crop damage by the wild boar (*Sus scrofa*): a case study in Geochang county, Gyeongnam province, Korea. *Korean Journal of Environment and Ecology*, *32*(2), 140-146.

Lombardini, M., Meriggi, A., & Fozzi, A. (2017). Factors influencing wild boar damage to agricultural crops in Sardinia (Italy). *Current Zoology*, *63*(5), 507-514.

Malesios, C., & Arabatzis, G. (2012). An evaluation of forestry journals using bibliometric indices. *Ann. For. Res*, *55*(2), 147-164.

Novosel, H., Piria, M., Safner, R., Kutnjak, H., & Šprem, N. (2012). The game damages on agricultural crops in Croatia. *Journal of Central European Agriculture,* 13, 4, 631-642.

Piekarczyk, P., Tajchman, K., Belova, O., & Wojcik, M. (2021). Crop damage by wild boar (*Sus scrofa* L.) depending on the crop composition in Central-Eastern Poland. *Baltic Forestry*, *27*(1).

Pilelienė, L., Alsharif, A.H., & Alharbi, I.B. (2022). Scientometric Analysis of Scientific Literature on Neuromarketing Tools in Advertising. *Balt. J. Econ. Stud.*, *8*, 1–12.

Pleșca, B. I., Apostol, B., Pleșca, I. M., Dincă, L. C., & Breabăn, I. G. (2022). The stational and potential favorability of forest habitats for plant and animal species located in ROSCI0076 Dealul Mare-Hârlău. In *Present Environment and Sustainable Development*, 60-66.

Posan, P., Sovarel, E., Maftei, M., & Suler, A. (2021). The dynamics of wild boar herds in the context of the appearance of a disturbing ecofactor, *Scientific Papers. Series D. Animal Science*, 64(2), 492-497.

Rekiel, A., Wiecek, J., & Sonta, M. (2024). Wild boar (*Sus scrofa L*. 1758), a problematic but also a useful species-A review. *Journal of Elementology*, *29*(3).

Santillán-Fernández, A., Vásquez-Bautista, N., Pelcastre-Ruiz, L. M., Ortigoza-García, C. A., Padilla-Herrera, E., Tadeo-Noble, A. E., Carrillo-Ávila, E., Juárez-López, J. F., Vera-López, J. E., & Bautista-Ortega, J. (2023). Bibliometric Analysis of Forestry Research in Mexico Published by Mexican Journals. *Forests*, *14*(3), 648. https://doi.org/10.3390/f14030648

Schley, L., & Roper, T. J. (2003). Diet of wild boar *Sus scrofa* in Western Europe, with particular reference to consumption of agricultural crops. *Mammal review*, *33*(1), 43-56.

Schley, L., Dufrêne, M., Krier, A. & Frantz, A.C. (2008) Patterns of crop damage by wild boar (*Sus scrofa*) in Luxembourg over a 10-year period. *Eur. J. Wildl. Res.*, 54:589–599.

Sun, J., Wang, M.H., & Ho, Y.S. (2012) A historical review and bibliometric analysis of research on estuary pollution. *Mar. Pollut. Bull*, 64:13–21.

Tanchev, D., & Balieva, G. (2023). Wild boar surveillance through electronic module "Hunt" mobile application in Bulgaria. *Scientific Papers. Series D. Animal Science*, *66*(1), 651-659.

Tarkowski, S.M. (2007) Environmental health research in Europe-Bibliometric analysis. *Eur J Pub Health*, 17, 14–18

Thurfjell, H., Ball, J.P., Åhlén, P.A., Kornacher, P., Dettki, H. & Sjöberg, K. (2009) Habitat use and spatial patterns of wild boar *Sus scrofa* (L.): agricultural fields and edges. *Eur. J. Wildl. Res.*, 55:517–523.

Timiș-Gânsac, V., Dinca, L., Constandache, C., Murariu, G., Cheregi, G. & Timofte, C.S.C. (2025) Conservation Biodiversity in Arid Areas: A Review. *Sustainability* 17, 2422.

Tudor, C., Constandache, C. & Dincă, L. (2020). The social and economic contribution of the main categories of non-wood forest products from Buzau County, Romania. *Scientific Papers, Series A. Agronomy*, 63(2), 319-323.

Ucarli, Y. (2011). Effects of wild boar (*Sus scrofa*) on farming activities: A case study of Turkey. *African Journal of Biotechnology*, *10*(44), 8823-8828.

Xie, S., Zhang, J., & Ho, Y.S. (2008) Assessment of world aerosol research trends by bibliometric analysis. *Scientometrics*, 77, 113–130

VOS Viewer, https://www.vosviewer.com/. Accessed on 23.10.2024