



Mapping the Research Landscape on Poaching: A Decadal Systematic Review

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Poaching is a widespread activity that affects wildlife management goals and undermines conservation efforts worldwide. Despite its complexity, poaching is still commonly addressed by researchers as a one-dimensional phenomenon. To deepen the scientific understanding of poaching, we conducted a systematic literature review in the Web of Science and Scopus databases for the last 10 years, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses methodology. We found that most studies were carried out in Africa, although 43% of all articles on poaching were published by researchers from the United States and the United Kingdom. The most studied species are elephants (22%), rhinos (19%), wolves (9%), and bears (6%). Although this study identified a wide range of motives and drivers behind poaching activities, more than half of the analyzed articles do not attempt to provide a deeper understanding of this phenomenon. Its understanding of poaching usually does not go beyond the environmental impact of illegal hunting. Our study's potential limitations may relate to the focus on exclusively English-language articles and, among them, only those discussing mammal, bird, and reptile species. Our findings indicate that global scientific knowledge on poaching in the last 10 years is biased. There is an imbalance between the developed countries that mostly produce knowledge on poaching (usually from Northern America and Europe) and the developing countries commonly an object of interest. This bias is potentially challenging, as the global scientific knowledge on poaching comes from limited experience based on charismatic species and selective case studies. To overcome this gap and develop a deeper understanding of poaching, the scientific community needs to overcome this bias and address illegal hunting wherever it affects the environment and undermines conservation efforts.

Keywords: poaching, wildlife, charismatic species, motives, drivers, Systematic review, PRISMA methodology

INTRODUCTION

Poaching is a global social, cultural, political, economic, and environmental challenge that affects wildlife populations, impedes the achievement of wildlife management goals, and undermines conservation efforts (Chiarello, 1999; Yiming et al., 2003; Lemieux and Clarke, 2009; Kaczensky et al., 2011; Archie and Chiyo, 2012). It is commonly referred to as illegal hunting, harvesting,

killing, or taking of wildlife (Musgrave et al., 1993; Manel et al., 2002; Johannesen and Skonho, 2005; Liu et al., 2011; International Union for Conservation of Nature, 2020), which indicates that poaching is distinguished from hunting by its legal status. Gombay (2014) links the activity with the property rights and norms, whereas Rizzolo et al., 2017 suggest that poaching should include any non-authorized hunting of wild animals despite any ownership rights. Due to different perspectives on poaching, the definition is highly contested (United Nations Office on Drugs and Crime, 2016).

The role of hunting has changed over time, as well as the attitude toward it accordingly. Historically, in many foraging communities, hunting was a key livelihood activity that ensured survival. And yet, hunting became later a symbol of tyranny and moral indignation, especially during the Renaissance (Cartmill, 1993), the “Age of Exploration,” big cat hunting during the period from 1898 until 1930 in Kenya and India (Storey, 1991), or European imperialism and colonialism (MacKenzie, 1988; Grove, 1995; van Uhm, 2016; Montgomery, 2020). On the other hand, hunting has also been used as a symbol of freedom, for instance, after the French Revolution with The August Decrees (The History Guide, 2004) or in Serbia after the Second Uprising against the Ottoman Empire (Lovački savez Srbije, 2004). Poaching at that time did not exist because ordinary people were allowed to hunt. Not only did hunting play a major role in the European imperial experience in Africa and Asia (MacKenzie, 1988), but also, generally, the history of wildlife and nature conservation has been strongly associated with European imperialism (MacKenzie, 1988; Grove, 1995). Such military and “biological expansion” of Europe (Crosby, 1986), denominated “ecological imperialism” (Crosby, 1986) or “green imperialism” was manifested in white aristocratic exploration, trade, expansion, power, and access to privileged exotic goods (MacKenzie, 1988; Grove, 1995) as well as hunting as a sport in the colonies (MacKenzie, 1988). The fusion of colonial history and conservation history is linked with the exclusion of local communities in the protection and certain restrictions on hunting or even the racial inequalities between Europeans and indigenous hunters (MacKenzie, 1988).

Poaching has deep social and cultural roots, which generates a complex understanding and manifestations of illegal hunting. It was considered as an act of rebellion against hunting privileges or imposed alien cultural values, a form of collective resistance, a violation of culturally determined human–nature interactions and coexistence, or an exercise of traditional rights (Bell et al., 2007). Nowadays, numerous anti-poaching movements are gaining momentum worldwide. According to Rizzolo et al. (2017), cultural factors can affect poaching because community norms impact how poaching is seen and whether the community responds with tolerance or sanctions. In certain socio-cultural and legal contexts where the community-based conservation model is present, the notions of ‘poaching’ and ‘illegal hunting’ should be distinguished from ‘local hunting’ which is seen as legitimate and as the contestation of the conservation discourse (Lubilo and Hebinck, 2019). Thus, understanding of poaching can change across temporal and spatial scales.

Hunting regulations vary significantly among different countries or regions, making it challenging to recognize poaching levels. Usually, poaching activities are considered illegal because they cause damage to the environment or are unethical or immoral. Hunting practices can also be labeled as poaching due to the diversity of regulations applied or cultural context. For example, trapping small carnivores is common in Hungary, roe deer-driven hunting with dogs is a widespread practice in some parts of Germany, but both these techniques are banned in Serbia, and as such, would be considered as illegal hunting. In contrast, in Brazil and India, hunting is forbidden, where only traditional communities and those suffering from hunger are allowed to hunt, with certain exceptions (Anonymous., 1972; Antunes et al., 2019; Bragagnolo et al., 2019). Thus, the perception of legal/illegal hunting, actors involved, and motives for poaching are diverse and complex, which results in illegal hunting occurring in different forms worldwide (Muth and Bowe, 1998; Suutarinen and Kojola, 2018; Montgomery, 2020). Nevertheless, the legal regulation of poaching has to do with imperialism, European socioeconomic interest and interference in species conservation and nature protection, the history of wildlife trade, and the social construction of the value of wildlife (van Uhm, 2018), and thus, the criminalization of wildlife trade which, once legal, became criminalized or “unregulated” (van Uhm, 2016) in the 20th century.

The illicit nature of poaching has made it hard to explore and challenging to monitor (Yiming et al., 2003; Lavadinović et al., 2012, 2015; Montgomery, 2020). Efforts to understand and curtail poaching often suffer from what has been called “disciplinary silo thinking” and fail to depict all components of poaching phenomena. Poaching is considered a one-dimensional problem many times (von Essen et al., 2014; Montgomery, 2020). Therefore, this study aims to provide a deeper knowledge of poaching and its limitations in the last 10 years (2011–2020). We conducted an assessment of the scientific literature to understand this phenomenon at the global level by collecting data on poachers, the geographic distribution of studies on poaching, wildlife species, and the reasons behind poaching. Our study is limited to mammals, birds, and reptiles because these wildlife species are hunted and poached across all continents and, as such, are suitable for comparison.

MATERIALS AND METHODS

To meet research goals, we conducted a systematic search of literature following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses framework (Moher et al., 2009). We searched for articles from SCOPUS and Web of Science databases on August 16, 2020. For Scopus, the following search string was used: TITLE-ABS-KEY (mammal OR wildlife OR bird OR game OR reptile OR bushmeat) AND (poaching OR “illegal hunting” OR “illegal killing” OR “wildlife crime” OR “wildlife trafficking”) AND (causes OR reasons OR motivations OR perspectives) AND NOT (ocean OR sea OR timber OR fish OR coastal OR marine). In Web of Science, a modified search string with similar search terms was used as follows: ALL = ((mammal OR wildlife OR

bird OR game OR reptile OR bushmeat) AND (poaching OR “illegal hunting” OR “illegal killing” OR “wildlife crime” OR “wildlife trafficking”) AND (causes OR reasons OR motivations OR perspectives) NOT (ocean OR sea OR timber OR fish OR coastal OR marine). Only articles published between 2011 and 2020 were selected, which resulted in a total of 1,407 articles. Articles from Web of Science and Scopus were combined, and duplicates were removed, which resulted in a total of 1,082 articles to evaluate. First, we excluded all articles that were clearly unrelated to poaching or the illegal killing of wildlife by reading the titles. Second, we read the abstracts of the articles and discarded articles that were not relevant to our objectives. Lastly, we read the main texts for coding and extraction of information. We only considered articles on mammals, birds, and reptiles due to specific hunting practices and black-market demand. Finally, a total of 211 articles were selected for analysis, which corresponded to 19.5% of the total ($n = 1,082$). **Supplementary Figure 1** shows the flowchart for the identification, screening, and eligibility for the articles. For each article analyzed, several data were collected (**Supplementary Table 1**).

Data Analysis

The dataset was prepared in Microsoft Excel v.20. The data were sorted to prepare infographics for understanding the gaps on spatial and temporal scales. Statistical analysis was done using SPSS v.27 for conducting descriptive statistics, chi-square test, and correlation. Data visualization was done using free access Free Web Creator Visme web page (visme.co). To display the location of studies *versus* the origin of authors/institutions, proportional symbol maps were built in Tableau Desktop v.2020.3, which allows encoding the values per location, with size and/or color. Continent classification was used according to World Population Review (2020). For performing correlations between the variables, initially, the data on species, drivers, motives, and continents were converted into nominal data, and the numerical assigned to these variables were defined in the variable view of the datasheet. Pearson's correlation test was performed to check the significance and strength of correlation between the variables. A chi-square test was performed to see if there was any variation in the articles published between the years.

RESULTS

In total, 211 scientific articles published from January 2011 to August 2020 were analyzed. We found a significant variation among articles published between years ($\chi^2 = 46.109$; $df = 9$; $p < 0.05$), showing an increasing trend over the years. Approximately 30% of the articles focused on problems of poaching and wildlife management, whereas 20% analyzed poaching as part of wildlife trafficking. The other articles covered various topics related to poaching; among the most common are human-wildlife conflict and poaching as a threat to conservation efforts. Thus, it can be said that approximately 50% of articles attempted to provide a deeper understanding of

poaching, whereas the other half was focused on its negative impact on wildlife.

Our analysis shows that poaching is a challenge that is an object of interest for a variety of scientific fields and disciplines (**Supplementary Figure 2**), such as environmental sciences, biodiversity conservation, ecology, genetics, remote sensing, wildlife management, hunting, economics, sociology, anthropology, political sciences, human dimensions in wildlife management, and law. All identified scientific disciplines were classified according to The Organization for Economic Co-operation and Development categories (OECD, 2007). Although the natural sciences' articles are the most common, social studies also have valuable contributions to knowledge production on the topic. We noticed a high number of articles that combine different scientific disciplines. It is also important to note that even inside fields, research on poaching is increasingly becoming interdisciplinary, especially regarding the methods used. As such, poaching seems to be a complex issue explored by different scientific disciplines.

In our sample, 79% of the studies were conducted in one of the 56 countries identified in this research. The other 11% of the analyzed articles have research locations in more than one country, of which the most numerous are regional studies, followed by global studies. Global studies were twice the number of regional studies. The remaining 10% of the articles from the sample did not have a study in any country in particular. The next step was to analyze only articles with study locations in one country or regional studies within the same continent ($n = 183$). In this way, we identified Africa as the most studied continent among the selected articles, as almost half of the performed research were located there (49%) (**Supplementary Figure 3**). The continents that follow are Asia (21%), Europe (17%), South America (7%), and North and Central America (5%). Australia and Oceania are represented with only one article, which studied poaching in Samoa.

The findings show that the selected articles involve 42% of all South American countries, 33% of African, 29% of Asian, 28% of European, and 17% of all North American countries. Accordingly, the analyzed studies are unevenly distributed per continent, as one-third of European studies origin from Scandinavia (**Supplementary Figure 3**); two-thirds of South American studies are from Brazil; around two-thirds of Asian studies are located in China or south-eastern Asia; half of the studies in North and Central America are from the United States (US). In Africa, half of the studies are located in the south, which means that around one-quarter of all selected articles analyzed in this research have their studies in one of the following countries: The Republic of South Africa, Namibia, Botswana, Zambia, Zimbabwe, Mozambique, or Madagascar. In the selected articles, the most popular countries for conducting studies on poaching are the Republic of South Africa (8% of all selected articles), Tanzania (7%), Zimbabwe, and China (6% each). These results indicate the uneven distribution of studies on poaching among continents and countries.

To find out which countries are the most productive on the topic, we analyzed the country of each first authors' institution. We found that European countries were the most productive,

with 77 articles published, followed by North and Central America, with 59 articles, and Africa, with 36 publications, Asia has 22 articles, Australia and Oceania 10, whereas the least productive continent is South America, which published only seven articles (**Supplementary Figure 4**). The most productive country is the US, which published 26% of all analyzed articles, followed by the United Kingdom (17%) and the Republic of South Africa (7%). In fourth place is Australia, which published 4% of analyzed articles, despite not having any study located on its territory. Other European and North American countries are in similar situations, which suggests a misbalance between the scope of studies produced by developed countries and the number of studies located in their territories.

To identify this mismatch, we developed a coefficient of productivity (C_p) for continents, which we calculated by dividing the number of published articles by the number of studies located on that continent (**Supplementary Table 2**). Australia and Oceania ($C_p = 10$) showed the highest C_p value, which suggests that for each research conducted on this continent, its scientists published 10 more articles on poaching. Australia and Oceania are followed by North and Central America ($C_p = 6.6$) and Europe ($C_p = 2.4$). These continents produced more articles on poaching than the number of studies conducted on its territory. In contrast, Asia, South America, and Africa published fewer articles than the studies they hosted.

Most analyzed articles involve research on particular wildlife species (57%). However, a considerable part (43%) either do not consider specific groups or species, as they address poaching as a broad activity or only briefly mentioned them. Within the first group of articles, we ran an analysis to identify which species are the most explored among researchers. Data show that elephants (22%), rhinos (19%), wolves (9%), and bears (6%) are targeted by more than half of all selected articles, which makes these species the most researched ones (**Supplementary Figure 5**). Among big cats' species, the most studied are tigers (5%) and lions (3%), whereas, for bird species, vultures were targeted by 5% of the selected articles and raptors by 3%. In the category "other species," the most dominant groups are apes, which gather half of this category.

A considerable part of the analyzed articles (43%) do not mention any motives for poaching, but those that do show its diversity. For better visualization, identified motives have been grouped and presented in **Supplementary Figure 6**. Income category gathers all motives that aim to improve poachers' household incomes or gain personal profit in various ways, such as offering bushmeat or parts of the animals in the black market, in some cases even capturing live animals to be sold like pets. These motives are the most discussed in the selected articles, which deal with this aspect of poaching. In second place is the category multiple motives, which are combined on a different basis from other categories, and which overlap. This category suggests that poaching is a complex human activity that is performed for more than one reason. Conflict with wild animals and subsistence are also identified as the commonly discussed topics in the selected articles. Poachers who hunt wild animals for the trophy (category trophy) and various acts of rebellion or opposition against authorities (category political) gather the

same number of articles. We find it interesting that several articles identified male affirmation and thrill as reasons for poaching. They are considered inside the category others.

More than half of the articles (55.4%) do not discuss any drivers of poaching activities at all. Among those which do (44.6%), we identified in total 35 different drivers, which are mentioned various times. We grouped drivers into five categories to make them easier for comparison, although this approach potentially limits their diversity. The social-economic drivers are the most discussed ($n = 68$), followed by political ($n = 19$), social-cultural ($n = 15$), and ecological ones ($n = 8$). The remaining drivers ($n = 12$) have been gathered in the category others (**Supplementary Figure 7**). Among the socioeconomic drivers, the most common is the personal search for an increase in income (40%), the black-market demand for wild animals and their parts (example: illegal trade, organized crime, and corporations) (26%), poverty (15%), and providing food security (7%). In the category of social-cultural drivers, the most numerous are culture/traditions in general (47%), demand for ingredients for medicine (13%), and tradition and traditional rights (13%). From the political drivers, the most mentioned are fragile state security, wars and terrorism (37%), the lack of specific programs and enforcement for poaching (21%), and corruption (21%). Category ecological drivers consist of species availability (50%) and seasons (25%, e.g., people usually poach more in the dry season). In the category of others, the most numerous driver is accessibility (42%).

In the interest of providing deeper knowledge on poaching, we tested correlations between different variables from the analyzed articles. Only two analyses provided statistically significant and positive correlations between species and motives ($r = 0.14$; $p < 0.05$) and between drivers and motives ($r = 0.25$; $p < 0.01$). However, both correlations are weak, so we did not go into further analysis.

DISCUSSION

There are a few caveats that we recommend readers consider in the interpretation of our results. This study covers only journal articles, although there are likely other literature sources that provide valuable knowledge on poaching. For the systematic review, we used Web of Science and Scopus databases exclusively, despite the possibility that they will not provide us insight into all available and relevant literature on poaching. Although we focused only on English-language publications, we acknowledge the existence of relevant literature in other languages. Because this study is limited to birds, mammals, and reptile species, there are likely studies on other species that we did not consider. Moreover, it should be underlined that the literature search was conducted in August 2020; hence, any literature on poaching published after our data search was not considered.

Being a complex issue, poaching has been of interest to many different scientific disciplines. Although natural sciences are better represented, social sciences and humanities, likewise articles that combine several scientific disciplines, have gained space in recent years. These results suggest that understanding

poaching requires the involvement of a broad spectrum of scientific disciplines, which has to contribute from different aspects to understand this problem.

Our findings reveal an uneven spatial distribution of studies on poaching for both their origin and study location. Researchers showed particular interest in Sub-Saharan Africa, Southeast Asia, and China, which could be explained by significant poaching and trafficking activities in these regions (Lemieux and Clarke, 2009; Liu et al., 2011; Gao and Clark, 2014; Zhou et al., 2018; Coleman et al., 2019; Lunstrum and Giva, 2020). This finding contrasts with the report of the United Nations Office on Drugs and Crime (2020), which demonstrates that every country in the world plays a role in combating wildlife crime. Martin et al. (2012) find that geographical biases are common in ecological studies in general. Thus, it is likely that regions identified in our study are for researchers more attractive than the others.

We noticed in our findings another bias regarding the origin of the published articles. The most productive continents are Northern America and Europe, whereas the most productive countries are the US, United Kingdom, The Republic of South Africa, and Australia. Researchers from these countries published more articles on poaching than the rest of the world in the last decade. The productivity found for these countries is in accordance with other authors' findings within different research topics (Falagas et al., 2006; Soteriades et al., 2006; Ribeiro et al., 2019). Despite having the most productive researchers, both North America and Europe have fewer studies on their territories than other continents. This is even more evident among the most productive countries. For all these Anglo-Saxon countries, except R. The Republic of South Africa, it is common to have researchers who published more articles on poaching in other parts of the world than in their own countries. Boshoff (2009) found in his research strong dependence of African researchers on their European colleagues, which he describes as neo-colonial science. Malhado et al. (2014), in their study, found that "scientific imperialism" is still present in the case of Amazonia. Many researchers agree that colonial legacy plays an important role in developing countries in many aspects, including wildlife conservation (Mkumbukwa, 2008; Bluwstein, 2018; Infante-Amate and Krausman, 2019). Greater researchers' interests in poaching in former colonies than in their own homeland could be compared with Britain's role in nature conservation during the late Victorian period when the country imposed its control in other parts of the world (MacKenzie, 1990). Malhado et al. (2014) consider that foreign influence in Amazonia is decreasing, but it still plays an important role, despite local researchers' capacities being sufficient to deal with their countries' conservation challenges. We believe that international cooperation is essential to combat poaching efficiently and wildlife trafficking, as long it does not neglect other regions nor diminish the sovereignty of the countries or tries to impose a "one model fits all" approach. Still, our findings indicate that in practice, these relationships are built in a "one-way" direction because the leading countries do not have studies on their territory performed by foreign researchers if they are not affiliated with national institutions.

Our findings demonstrate the imbalance between the publishing of "Northern" countries and the number of studies conducted in "Southern" ones. Commonly, it is considered that the "North" has adequate knowledge to resolve challenges that the "South" faces. However, Sollund and Runhovde (2020) offer the example of Norway, which failed to confront the illegal wildlife trade. The same authors raise concern that the northern countries have expectations regarding conservation in southern countries that they themselves neglect. Goyes et al. (2019) exemplify why global dialogs are crucial in combating international wildlife trafficking, as it is not possible to understand challenges in one region of the world without understanding what happens in the others. According to the same author, it is not productive nor efficient to use northern theories and narratives to understand southern problems to help marginalized southern communities. This northern domination of research relevant to poaching and limited research led and published by southern researchers in southern countries relates to the "North-South divide" or its variations the "North-South gap" and "North-South cleavage" (Eckl and Weber, 2007). The global North-South divide in research has become an established discourse in scholarly writing and has been highlighted in various scientific disciplines and fields, such as climate change (Blicharska et al., 2017), health research (Walsh et al., 2016; Kok et al., 2017), conservation studies, and sustainable development (Jeffery et al., 2008). Having said that, we should acknowledge that the outcomes related to this North-South dichotomy in research on poaching will be similar or equivalent in the case of any other research topic. Building on the framework of postcolonial theory (Hammer, 2005), we argue that the research interest on poaching of the north in the south is grounded in the interconnection between European exploration, imperial experience, power, trade, and wildlife conservation. Poaching thus must be regarded within the historical and imperialist context of European colonialism and postcolonial discourse on nature conservation (Singh and van Houtum, 2002).

Black markets have various demands for animal species, which can increase poaching pressure on wildlife and undermine management plans or conservation efforts (Ribeiro et al., 2019; Scheffers et al., 2019; Morcatty et al., 2020). The report of the United Nations Office on Drugs and Crime confirms that nearly 6,000 species are targeted for poaching and illegal trade, whereas no single species was responsible for more than 5% of seized incidents in the last 20 years (United Nations Office on Drugs and Crime, 2020). Thus, we expected that the scientific community would have an interest in a wide range of species affected by poaching. However, our findings show a strong bias toward charismatic species. Half of the analyzed articles on poaching target only three wildlife species, such as elephants, rhinos, and wolves, of which two are found in Africa. Nevertheless, we believe that concern for these species' survival is not the only reason behind their popularity in the scientific community. It is in accordance with Redpath et al. (2017), who found out that large carnivores in Europe and North America are the most intensively monitored and studied large mammals in the world. It is likely because researchers are more attached to iconic species and tend to

study them more (Fleming and Bateman, 2016; Fink et al., 2020). These species identified in our study are considered to be charismatic and, as such, are used to attract public attention, receive more research interest, and policy coverage (Courchamp et al., 2018; Sibarani et al., 2019; Thompson and Rog, 2019). Lundberg et al. (2020) consider charismatic species to be an effective fundraising tool, which likely attracts researchers to study them.

It should also be taken into consideration that there are research priorities among scientists. Ellison and Degraasi (2017) suggest that some species, such as flagship ones, are considered to be more valuable than others in conservation efforts and, as such, attract more attention. Despite not necessarily agreeing with this statement, we acknowledge it could be considered a criterion for a selection. On the other hand, the main reason that makes these species to be considered flag species and attract interest and empathy among scientists, NGOs, policymakers, and the public is the same one that makes them remain severely endangered (Courchamp et al., 2018). Besides charismatic species, researchers' interest is focused on human-wildlife conflict/human-wildlife coexistence, which we found to be specially related to wolves and birds of prey. Our findings are in accordance with Lavadinović et al. (2017), who found that wolf poaching is an especially popular topic among Scandinavian researchers. In our sample, Scandinavian authors produced one-third of all European articles on poaching. Human-wildlife conflict exacerbates hostility toward wildlife and has become a major threat to species conservation (Anand and Radhakrishna, 2017). However, it is difficult to estimate its scope, as retaliatory killing is widespread among common farmers worldwide (Konig et al., 2020).

Approximately half of the studies did not provide any insights into poachers' motives to hunt illegally. We noticed that many articles often do not go beyond general suggestions, which is not sufficient for a deeper understanding of poaching. Motives behind poaching identified in this study, such as income, subsistence, or trophy, among others, are in accordance with findings of Muth and Bowe (1998). However, the categorization of motives in our study is different, as we grouped them according to the sample size. Muth and Bowe (1998), for example, identified thrill killing as a separate motive for poaching, whereas in our study, it is placed in group others. Our results demonstrate that in analyzed articles, financial gain and human-wildlife coexistence were the most discussed reasons for poaching. Another finding is that motives for poaching commonly overlap. It is in accordance with Montgomery (2020), who identified between poachers' motives "innumerable subcategories." Drivers of poaching were also poorly studied in analyzed articles, as more than half of studies did not consider them. Findings indicate that social-economic drivers were the most prevalent ones for poaching in the reviewed studies, which is similar to Lynch et al. (2017). We noticed that in our findings, drivers for poaching commonly overlap, indicating the challenge to understand deeper the reasons behind poaching. Our findings support Montgomery (2020), who advocates for the recognition of the complexity of poaching as a vital step to align conservation practice and social justice effectively. As such, a deeper analysis

is still needed to deconstruct the poaching phenomenon (von Essen et al., 2014). Correspondingly, we believe qualitative studies, particularly anthropological and sociological ones, might offer further insights into the biological, economic, and socio-political motives for poaching. Further to the debate surrounding poaching motives, the absence of a universally accepted definition of poaching (United Nations Office on Drugs and Crime, 2016) makes it challenging to understand this complex issue better. Hence, previously quoted authors indicate not only how deep roots and diverse character poaching has but also how its forms and meanings are multi-layered (Bell et al., 2007). In the same way, Bell et al. (2007) ground poaching in the collective identity, Brymer (1991) rethinks poaching and hunting as a "deviant subculture," whereas Eliason (1999, 2003) looks at poaching from the philosophical perspective intending to identify "wildlife law violators" and deeper roots of such behavior.

The majority of analyzed studies from our sample consider poaching as an environmental threat (Chiarello, 1999; Yiming et al., 2003; Lemieux and Clarke, 2009; Kaczensky et al., 2011; Archie and Chiyo, 2012). However, poaching has a more complex and far-reaching influence because it is, along with illegal wildlife trade, a part of wildlife crime (United Nations Office on Drugs and Crime, 2020), environmental or green crime (Hall et al., 2016; van Uhm, 2018). As such, poaching affects climate change and biodiversity (United Nations Office on Drugs and Crime, 2020). According to the same source, wildlife crime also impacts national security, social-economic development, and public health. Profits from wildlife crime support the rise of organized crime, spread corruption, obstruct justice, and often involve government officials in various scope and at various levels (Hauenstein et al., 2019; Titeca, 2019; United Nations Office on Drugs and Crime, 2020). Moreover, a wildlife crime has a negative influence on fragile governments, which can participate in wildlife crime activities and businesses. In such a manner, illicit activities are camouflaged under legitimate companies, making the control of wildlife crime even more challenging (van Uhm and Nijman, 2020). Scientists also associate poaching with armed conflicts and terrorism (Beyers et al., 2011; Rotshuizen and Smith, 2013; Haenlein et al., 2016). Thus, poaching's negative consequences go beyond environmental challenges and, in various forms, impose threats to society and stability worldwide (Lavorgna, 2014). The complexity of wildlife crime and its severe negative impacts on both nature and society raise the need for adequate measures to curb poaching. Among analyzed studies, we noticed that implementation of more intensive wildlife monitoring and game protection is discussed. It also includes better trained and equipped gamekeepers to combat poaching. Green militarization is a commonly addressed issue in studies on poaching in the last decade. Militarized conservation has increased worldwide in the past decade, although it is still understudied (Duffy, 2014; Lunstrum, 2014). Thus, researchers highlight the importance of engaging critically with the militarization of conservation, as it frequently produces unforeseen consequences (Lunstrum, 2014; Duffy et al., 2019). Duffy et al. (2019) identified five major themes emerging as critiques to militarized conservation,

which include understanding the ways that local communities experience militarized conservation; how the militarization of conservation can contribute to violence; where conservation operates in the context of armed conflict; and how it fits in with and reflects wider political–economic dynamics. Massé et al. (2018) propose closer interaction between military studies and the political–ecological work on green militarization to provide more adequate solutions in combating wildlife crimes.

FINAL CONSIDERATIONS

Our findings suggest that knowledge on poaching motivations and drivers in the last decade is spatially biased. Studies are mostly led by researchers affiliated with institutions from developed countries, although most of such studies are usually conducted in Sub-Saharan Africa or few other popular regions. Scientists like to study charismatic species such as elephants, rhinos, wolves, or few others. However, there are many other parts of the world with high biodiversity and many more poached species or are killed for illegal trade, but not many studies have been conducted in the last decade. In other words, knowledge on poaching in the last decade is based on selective studies, narrow findings, and limited information. Nevertheless, it still shapes actions on illegal activities or biodiversity protection on a global scale. To better understand these threats, it is necessary to study them everywhere they occur and affect biodiversity or undermine conservation efforts. If it is not a case, like it is in our study, obtained knowledge is not sufficient to support action in many regions of the world.

Findings from this study confirm that poaching is a complex issue that occurs in different forms and various reasons. As such, it has a severe impact on the environment. Although poaching is explored in many scientific disciplines or applied fields, it is usually considered as a threat to conservation efforts, and most studies do not go beyond the evaluation of its negative impacts. Thus, it seems that the analyzed scientific knowledge is not sufficient to develop efficient measures against poaching. Only a limited number of studies from our sample tend to provide a deeper understanding of poaching by analyzing underlying motives and drivers. Considering spatial limitations, there is a concern that available knowledge on poaching is not applicable in other parts of the world. Besides, poaching seems to be a complex social–environmental problem, which integrates innumerable dimensions. It is increasingly important for researchers, NGOs, and policymakers to have an understanding of the social–ecological systems they study, to be deeply involved in generating

information and decision-making for combating poaching and illegal trade in their countries. These issues should not be delegated to other nations, but they need to include them when they can contribute. There is a greater need for research to overcome geographical biases and geopolitical relationships to provide the knowledge necessary to combat poaching and wildlife trafficking at the global and local levels.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are available from the corresponding author on request.

AUTHOR CONTRIBUTIONS

VL and CI analyzed part of the data and contributed to all sections of the manuscript. MC designed the method, analyzed part of the data, ran statistical tests, contributed to discussion, and prepared the references. NM prepared figures, contributed to introduction, discussion and the final version of the manuscript, and critically revised the manuscript. MM ran the literature review, prepared the section “Materials and Methods,” and did the proofreading. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fevo.2021.630990/full#supplementary-material>

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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