A Review: Livestock Predation by Big Cats

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Human-predator conflict is an issue that has confronted humanity for centuries. Across the globe, local residents must find ways to coexist with species that pose threats to their livelihoods. Amongst such problem animals are the big cats; these mammals are capable of damaging sources of income, namely through livestock predation. This paper reviews the peer-reviewed literature on this topic by assessing which big cats are most studied, causes of predation, techniques to evaluate its extent, and resulting effects. Results showed that pumas, lions, jaguars, and leopards were most studied. Environmental factors were most frequently attributed to causes of predation, whereas number of animals killed was the primary method to evaluate predation extent. Changes in animal husbandry and improved infrastructure were the most commonly suggested management practices. Through examining the current literature on livestock predation by big cats, managers can identify research areas of need to find solutions to human-predator conflicts.

Keywords: *livestock, predation, big cats, review, human-wildlife conflict*

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**Introduction:**

Big cats have fascinated humanity for centuries. Though elusive, they captivate the mind of any person fascinated with the mysterious and dangerous. According to the National Geographic Society’s Big Cats Initiative (2011), there are eight species: the tiger, lion, jaguar, leopard, puma, snow leopard, cheetah, and clouded leopard. These adaptable predators inhabit a wide array of ecosystems, from the humid, tropical jungles of Brazil to the snow-topped mountains of Nepal. Yet, despite the awe big cats arouse, their numbers are steadily declining. From the Americas to Southeast Asia, poaching, habitat loss, and lethal control from conflicts with local communities pose imminent threats to these species. Conflict has generally been heavily studied with regard to the five largest cats: the tiger, lion, jaguar, leopard, and snow leopard (Holland et al., 2018). Pumas follow closely behind, whereas cheetahs and clouded leopards are less represented, likely due to their smaller size (Inskip & Zimmermann, 2009). Larger cats also require more space, causing another area of conflict as humans and wildlife compete for land and resources. Further, of the various types of conflict, livestock predation is one of the greatest threats. Thousands of large cats have consequently been killed by ranchers in the past 200 years, and there is little incentive to stop the practice because locals rarely participate in tourism centered around wildlife and receive little support from the funding generated (Loveridge et al., 2010). Understanding the conflict of livestock predation is thus important to implement appropriate management strategies.

Considering the hundreds of published articles on livestock predation by big cats, a literature review is necessary to evaluate where research is still warranted. A review will likewise reveal the most influential factors causing livestock predation, including but not limited to wild prey depletion, habitat loss, and underlying patterns and characteristics of domestic animals killed

(Loveridge et al., 2010). Examining the existent literature also highlights where additional work is needed to assess whether mitigation efforts work in practice as opposed to theory (Inskip & Zimmermann, 2009). Livestock predation falls under the broader topic of human-wildlife conflict, disclosing another need for a review. Previous articles have focused on characterizing conflict in general between big cats and humans, including attacks on people and assessing attitudes toward the felids (Holland et al., 2018; Inskip & Zimmermann, 2009). Focusing specifically on livestock predation will permit a more thorough evaluation.

Although this review is timely, there are several limitations that accompany it. Searching for “big cats” and “livestock predation” on Google Scholar reveals over 380 articles. This paper is based on only ten of those due to time and space restrictions. Consequently, it is a mini review that is not fully representative of the literature and primarily analyzes scientific studies while excluding books and reports. Studies that indirectly mention livestock predation are likewise excluded. Therefore, any conclusions should be interpreted with caution as their importance might be over- or underrepresented. This paper reviews current peer-reviewed literature related to livestock predation by big cats through assessing species most studied, causes of predation, techniques to evaluate its extent, and resulting effects. This will reveal areas of greatest research need and improve understanding of human-predator conflicts to benefit both managers and communities. **Methods:**

A search was conducted in Google Scholar for “big cats” and “livestock predation” and sorted by relevancy. The first ten hits focusing specifically on livestock predation by one or more big cat species were analyzed for causation, characterization, and results of the problem. Articles centering around human-wildlife conflict in general, or mentioning livestock predation as an afterthought, were passed over until ten papers were obtained.

**Results:**

*Big cats most studied:* Of the ten articles reviewed, six studied two big cat species. Pumas came up the most (4x), followed by jaguar, leopard, and lion (3x each), and lastly snow leopard (2x) and cheetah (1x). Tigers were not represented in any articles. This may be because studies on tigers often assess human mortality in addition to livestock deaths, hence discussing livestock predation indirectly and therefore meeting the criteria for exclusion in this review (Holland et al.,

2018).

*Causes of predation:* Major causes of livestock predation were related to management practices and environmental factors, though most papers focused on environmental factors. Management practices can mean the densities and conditions under which livestock are kept, and infrastructure such as bomas or kraals that serve as holding pens. First, three studies assessed predation rates when livestock were confined; all reported higher predation in either lions or leopards when animals were in holding pens instead of grazing in the field (Butler, 2001; Kissui,

2008; Patterson et al., 2004). Only Kissui (2008) noted lions attacked livestock more in the field. Second, other management practices were less frequently discussed. These included livestock densities, proportion of adult animals in the herd, and percentage of animals either vaccinated or receiving supplementary feeding. Each was only mentioned in a single article, and yet they all had some correlation with predation (Reyna-Sáenz et al., 2019; Tortato et al., 2015). Livestock densities and percentage of animals vaccinated or given supplementary feed were most related to predation sites (Reyna-Sáenz et al., 2019). Higher proportions of adult animals in the herd increased protection for young calves which were most targeted (Tortato et al., 2015).

Environmental factors came up more frequently with representation in seven of the ten articles. Two reported increased livestock predation in the wet season involving lions and cheetahs,

whereas a third study concluded there are higher attacks in the dry season, involving lions and leopards (Butler, 2001; Kissui, 2008; Patterson et al., 2004). These discrepancies could be explained by a number of factors, such as variations in availability of wild prey as influenced by migration patterns, or amount of vegetative cover (Butler, 2001). Four of the seven articles focused on landscape characteristics associated with predation sites instead of climatic influences. The presence of croplands and grasslands with shrubs increased predation in a puma study, and forests were likewise an influential factor in a puma and jaguar study (de Azevedo & Murray, 2007; Guerisoli et al., 2017). This is explained by higher levels of cover, affording the big cats increased hunting success. Lower river levels were attributed to fewer attacks in one other jaguar and puma article, which could be due to higher dispersion and less concentration of livestock in areas close to big cat habitat (Tortato et al., 2015). Elevation was mentioned in a single article as being associated with predation sites (Reyna-Sáenz et al., 2019). Big cats are generally nocturnal; thus attacks were primarily at night with the exception of one case study on lions (Kissui, 2008).

*Assessment techniques:* Assessment techniques to evaluate predation extent varied extensively. Eight of the ten articles discussed the number of animals killed, five mentioned economic losses, and two examined diet composition from fecal analyses. Goat and sheep were the most attacked livestock species, though cattle were also frequently targeted (Table 1). In studies with multiple carnivores, the percentage of livestock kills attributable to lions varied from 25% to

97% (Butler, 2001; Kissui, 2008; Patterson et al., 2004), 12% to 15% in leopards (Butler, 2001; Kissui, 2008), 69% in jaguars (de Azevedo & Murray, 2007), and 0% – 3% in cheetahs (Patterson et al., 2004). Tortato et al. (2015) pooled jaguar and puma attacks and found 57% of deaths in general were attributable to these cats. Another study focusing solely on pumas noted losses up to

52% of living sheep stock in one county, and up to 87% in another (Guerisoli et al., 2017).

Economic losses were reported in varying formats, such as total or annual losses over the study period, losses per ranch or household per year, or the percentage of livestock holdings lost (Table 2). The raw number of animals killed was also diverse, though should be viewed in light of a household’s net annual income as some domestic species are worth more than others. Guerisoli et al. (2017) was the only study that found that livestock losses to predation, in this case pumas, were economically minute in some counties relative to income. Mishra (1997) noted a loss from snow leopards equivalent to half the average annual per-capita income over a course of 18 months, whereas Butler (2001) presented an annual loss of 12% of each household’s net annual income from lions and leopards. However, both these studies incorporated an additional non-felid carnivore. Four articles also pointed out that losses to predation were small in comparison to those from natural causes such as disease, parasites, starvation, and accidents (Butler, 2001; de Azevedo

& Murray, 2007; Kissui, 2008; Tortato et al., 2015). Alongside proposing solutions to livestock predation, two studies suggested lowering these other sources of mortality to maximize the economic gain from livestock husbandry (Butler, 2001; de Azevedo & Murray, 2007).

Lastly, two studies implemented scat analyses to assess livestock predation. Bagchi and Mishra (2006) compared livestock predation by snow leopards across two different sites and found that horse composed 12% to 27% of the diet, yak and cattle composed 5% to 18%, and donkey composed 4% to 17%. Ghoddousi et al. (2016) found similar proportions in the Persian leopard at

12% to 13% for sheep and goat, and recommended examining wild ungulate availability relative to livestock abundance. An additional study discovered that livestock represent 6% of the annual diet of lions living on ranches, though this was estimated from lion population size and predation on livestock and ungulates (Patterson et al., 2004). Such results pose the question of whether big cats switch prey should availabilities of wild animals change.

*Results of predation:* Human retaliation was a fairly common outcome from losing livestock to big cats. Of the ten articles examined, both snow leopard studies, a study on pumas, and one involving lions mentioned human retaliation (Bagchi & Mishra, 2006; Guerisoli et al.,

2017; Kissui, 2008; Mishra, 1997). Though snow leopards were not actively hunted, pastoralists drove the cats away from kills when possible and maintained a negative attitude toward them, especially when livestock had a higher economic value than cash crops (Bagchi & Mishra, 2006; Mishra, 1997). Pumas were actively persecuted; 32% to 78% of ranchers who had suffered livestock losses to the cats had killed a puma before, yet this may be attributed to reasons other than livestock predation (Guerisoli et al., 2017). Lions were also hunted following livestock killings; this however was largely due to cultural traditions (Kissui, 2008). Lions moreover were capable of killing livestock of higher economic value and were easier to destroy given their willingness to defend a kill (Kissui, 2008). Ultimately, understanding which predators cause the most problems is important because herders frequently targeted large carnivores, particularly lions, even if they were not responsible for the majority of attacks (Kissui, 2008). These results highlight the need for effective management techniques.

Of seven articles that discussed plausible mitigation measures (Table 3), only two interviewed ranchers to assess the effectiveness of these approaches. Between 60% to 67% suggested carnivore control, 27% recommended implementing changes in livestock management, and 7% to 13% advised economic compensation in Central Argentina (Guerisoli et al., 2017). In the Indian Trans-Himalaya, 35% to 40% recommended either more efficient compensation or herding practices, and 71% stated that a combination of the two would improve the situation (Bagchi & Mishra, 2006). These interview results were fairly consistent with the most recommended management practices in the literature. Improved husbandry came up most, though

encompassed a broad array of topics that were only mentioned once or twice each. Several examples were lowering densities of animals and extensive grazing, providing supplementary feeding and vaccinations, increasing proportions of adults in the herd and shepherding practices, and keeping livestock confined at night and spatially separated from habitats likely to be occupied by predators (Guerisoli et al., 2017; Kissui, 2008; Mishra, 1997; Reyna-Sáenz et al., 2019; Tortato et al., 2015). Improved infrastructure and social programs also occurred several times. The former referred to strengthening kraals, bomas, and other types of holding pens. The latter included community outreach to raise awareness of the importance of large carnivores, increase people’s tolerance of big cats, and mediate attitudes toward predation and conservation through financial security and other economic incentives (Bagchi & Mishra, 2006; Guerisoli et al., 2017; Kissui,

2008). The least suggested alternative was improved economic compensation; the literature also revealed recurring inefficiencies. Bagchi and Mishra (2006) found that all 57 families interviewed in the Indian Trans-Himalaya were dissatisfied with the current compensation scheme, and Mishra (1997) reported the government compensated only around 3% of the perceived annual loss. **Conclusion:**

This work reviewed the current literature on livestock predation by big cats through examining which species are most studied, causes of predation, assessment techniques, and resulting effects such as human retaliation and suggested management practices. Analyzing a specific problem within the broader framework of human-wildlife conflict allows local communities and scientists to focus their efforts on research and management areas of need. To address the issue, a mini literature review of ten articles was conducted. Lions, jaguars, and leopards came up most together with the smaller puma. This could be explained by the ability of the largest cats to kill livestock of high value, and the commonality of the puma in the Americas.

Causes of predation were mostly attributed to environmental characteristics such as climatic conditions and increased vegetative cover, though poor infrastructure of holding pens was representative as well. Techniques to evaluate the extent of predation and resulting damage mainly focused on raw numbers of animals killed in addition to percentages of livestock holdings lost. Calculations of economic loss were common too, yet not always interpreted in light of a household’s net annual income. Lastly, consequences of livestock predation included human retaliation, though this was mentioned in less than half the articles. Management practices were more commonly discussed; changes in animal husbandry and improved infrastructure were most suggested. However, few were examined as to their effectiveness.

These results reveal several directions for future research and management initiatives. First, managers need a more informed understanding of which husbandry practices are most effective in reducing livestock predation. This is especially true considering that improved husbandry practices were suggested in multiple articles, yet with little consistency between them. Second, current infrastructure in holding pens is poorly suited to deterring predators. Scientists should assess new designs and equipment, particularly with regard to keeping out the arboreal leopard. Third, it would be worth investigating a more efficient compensation system given that all interviewed families identified its inadequacy, and few recommended it as a successful mechanism to offset losses. Lastly, these management suggestions should all be adapted to the season and level of cover on the landscape, considering these factors influence when and where predation is highest. If this research is implemented, scientists incorporate local communities in the decision-making process, and managers remain sensitive to cultural values during collaboration, livestock predation by big cats could be drastically reduced and further enhance coexistence between humans and these magnificent carnivores.

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Table 1. Livestock Species Most Frequently Killed by Big Cats

Study Location Big Cat Species Livestock Species Reference

Tanzania Lion Cattle Kissui (2008)

Zimbabwe Lion Goat and Donkey Butler (2001)

Kenya Lion Cattle Patterson et al. (2004)

Tanzania Leopard Goat and Sheep Kissui (2008)

Zimbabwe Leopard Goat Butler (2001)

Iran Leopard Goat and Sheep Ghoddousi et al. (2016)

Indian Trans-Himalaya Snow Leopard Yak/Cattle, Horse, and

Donkey

Bagchi and Mishra (2006)

Indian Trans-Himalaya Snow Leopard Goat and Sheep Mishra (1997)

Central Argentina Puma Sheep Guerisoli et al. (2017)

Kenya Cheetah Goat and Sheep Patterson et al. (2004)

Table 2: Economic Losses (USD) from Livestock Predation

Study

Location

Study Period Length (years)

Big Cat

Species

Total Loss During Study Period

Loss/Ranch or

Household/Year

Total Percentage of Livestock Holdings Lost During Study Period

Reference

Central

Argentina

2 Puma 2,466 1059.5 -

3,398.4

0.1 – 10.4 Guerisoli et al. (2017)

Indian Trans- Himalaya

1.5 Snow

Leopard

\*15,418 \*128 \*18 Mishra (1997)

Zimbabwe 3.5 Lion and

Leopard

3,220 \*\*13 \*\*~5 (in one year only)

Butler (2001)

Brazil 4.8 Jaguar and Puma

350 –

22,750 (per year)

- 0.02 – 2.83 (per year)

Tortato et al. (2015)

Kenya 4 Lion and

Cheetah

30,330 7,583 \*\*\*2.4 (per year) Patterson et al. (2004)

\* Wolves were included in calculations of loss

\*\* Baboons were included in calculations of loss

\*\*\* Hyenas were included in calculations of loss

Table 3: Most Commonly Suggested Management Practices

Management Action Number of Times Suggested

Reference

Improved Husbandry Practices 5 Guerisoli et al. (2017); Kissui (2008); Mishra (1997); Reyna- Sáenz et al. (2019); Tortato et al. (2015)

Improved Infrastructure 4 Butler (2001); Kissui (2008); Mishra (1997); Reyna-Sáenz et al. (2019)

Social Programs 3 Bagchi and Mishra (2006); Guerisoli et al. (2017); Kissui (2008)

Improved Economic

Compensation

2 Kissui (2008); Mishra (1997)